Attachment 1

BIOLOGICAL AND CONFERENCE OPINION

on the

Green Diamond Habitat Conservation Plan

MAY 30 2007

National Marine Fisheries Service
Southwest Region

File No. 151422SWR2002AR6231

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I. BACKGROUND AND CONSULTATION HISTORY

From 1997 to the present, the U.S. Fish and Wildlife Service (USFWS) and NOAA's National Marine Fisheries Service (NMFS; collectively referred to as the Services) provided technical and policy assistance to Green Diamond (formerly Simpson Resources Company) that resulted in completion of a draft Aquatic Habitat Conservation Plan (HCP) and Candidate Conservation Agreement with Assurances (CCAA). Between April 1997, and August 2002, at least 94 meetings were held among the Services and Green Diamond. In addition, several field trips were held for the Services to give them a perspective of the Initial Plan Area and the proposed management actions. More than 200 additional discussions were held among the Services and Green Diamond.

The Services formally initiated an environmental review of the HCP/CCAA through a Notice of Intent to prepare an Environmental Impact Statement (EIS) in the Federal Register on July 11, 2000 (65 FR 42674). The Notice of Intent also announced a 30-day public scoping period, during which other agencies, tribes, and the public were invited to provide comments and suggestions regarding issues and alternatives to be included in the EIS.

On July 25, 2002, Green Diamond submitted an application to NMFS for an incidental take permit (ITP) and to the USFWS for an enhancement of survival permit (ESP). An ITP and an ESP (collectively referred to as permits) are both authorized under section 10(a)(1) of the Endangered Species Act (ESA) of 1973, as amended. Issuance of a 10(a)(1) permit is a Federal action subject to ESA section 7 consultation.

On August 16, 2002, the Services announced the availability of the draft EIS, HCP, and Implementation Agreement (IA) for a 90-day public comment period (67 FR 53567). The Services also facilitated this comment period by providing hardbound copies of the documents to three libraries in Humboldt County and one library in Del Norte County.

In response to public, tribal and agency comments, modifications were made to the July 25, 2002, HCP. This biological and conference opinion (Opinion) analyzes the final March 2005 version of the proposed HCP that was prepared following response to public comments.

Green Diamond is requesting an ITP on two listed salmonid Evolutionarily Significant Units (ESUs), one steelhead Distinct Population Segment (DPS) and three unlisted salmonid ESUs that are not currently proposed for listing. In addition, Green Diamond is seeking an ESP for coastal cutthroat trout and two amphibian species: the tailed frog and southern torrent salamander. These three species are addressed in a separate consultation conducted by the USFWS. This Opinion represents NMFS' intra-service consultation and conference required prior to issuance of an ITP associated with the proposed Green Diamond HCP. The conference opinion could be adopted as the biological opinion if any of the unlisted species are listed, but only if no significant new information is developed (including that developed during the rule-making process on the proposed listing) and no significant changes are made that would alter the findings of this Opinion (50 FR § 402.10[d]). This Opinion addresses four salmonid ESUs, two steelhead DPS and designated critical habitat for two of the ESUs and the steelhead DPS. These are: California Coastal (CC) Chinook salmon and its designated critical habitat; Southern Oregon and Northern California Coastal (SONCC) Chinook salmon; Upper Klamath/Trinity

Rivers Chinook salmon; Southern Oregon/Northern California Coast (SONCC) coho salmon and its designated critical habitat; Northern California (NC) steelhead and its designated critical habitat; and Klamath Mountains Province (KMP) steelhead. The Status of the Species section discusses the listing history for each of these.

In summary, this Opinion is based on Green Diamond's March 2005 final HCP/CCAA and IA; the Services' Final EIS (FEIS) and Response to Public Comments on the Draft EIS; several years of discussions and technical assistance with Green Diamond; site visits and meetings with local and regional stakeholders, particularly tribal governments; technical reports; published literature cited or incorporated by reference; and the local knowledge and experience of NMFS' project biologists. A complete administrative record for this action is on file in the NMFS Arcata Area Office, California.

II. DESCRIPTION OF THE PROPOSED ACTION

NMFS proposes to issue an ESA section 10(a)(1)(B) permit authorizing incidental take of listed salmonid species associated with Green Diamond's operations as conducted under the HCP. Six salmonid species under NMFS' jurisdiction are proposed for coverage under the HCP (the "covered species"). The salmonid species proposed for incidental take coverage, and analyzed in this biological opinion are CC Chinook salmon, SONCC Chinook salmon, Upper Klamath/Trinity Rivers Chinook salmon, SONCC coho salmon, NC steelhead and KMP steelhead. Currently unlisted salmonids will be treated in this document as if they were proposed for listing and subject to the conference provisions of the ESA. Upon listing under the ESA, NMFS will issue Green Diamond a permit authorizing the incidental take of the currently unlisted salmonid species under NMFS' jurisdiction. This Biological Opinion also analyzes the effects of the proposed action on designated critical habitat. The term of the ITP is 50 years.

The activities covered by the proposed ITP (covered activities) and described in the HCP include timber operations and certain related management activities on Green Diamond's ownership in the Hydrographic Planning Areas (HPAs) described below and the activities needed to carry out all measures identified in the HCP. These activities will be conducted in accordance with the California Forest Practice Rules (FPRs) as well as the Operating Conservation Plan described in the HCP. Once granted an incidental take permit based upon an approved HCP, the portion of the FPRs known as the "Threatened and Impaired Rules" first implemented July 1, 2000, do not apply. Timber operations and related management activities include, but are not limited to felling and bucking timber, yarding timber, loading and other landing operations, salvaging timber products, transporting timber and rock products, road construction, and maintenance, rock pit construction and use, water drafting for dust abatement and fire suppression, equipment maintenance, regeneration harvest, site preparation, prescribed burning, slash treatment, planting, pre-commercial thinning and pruning, commercial thinning, and the collection and transport of minor forest product such as burls, stumps, boughs, and greenery. Herbicide application is not a covered activity in the HCP or proposed ITP; however, herbicide applications that are interrelated with or interdependent to the conduct of covered activities are analyzed in the *Effects of the Action* section.

A. Action Area

The "action area" is defined as all areas to be affected directly or indirectly by the Federal action, not merely the immediate area involved in the action (50 CFR 402.02). Although the covered activities and interrelated and interdependent activities are restricted to Green Diamond lands, the effects of these activities on the covered species and critical habitat may extend beyond this area, particularly to downstream channels. For this consultation, we have defined the action area to include the eleven HPAs encompassing approximately 1,977 square miles (Figure 1). These are summarized in Table 1. The action area consists of fee lands owned by Green Diamond, lands on which Green Diamond owns timber harvesting rights, and up to 100 miles of road to access Green Diamond timber operations. Currently, Green Diamond's ownership is estimated to include 416,531 acres and constitutes the Initial Plan Area (IPA). The addition or removal of commercial timberlands to the plan area is allowed, provided that neither additions nor contractions exceed 15 percent of the IPA over the term of the permit. The HCP identifies approximately 267,000 acres of other privately-owned commercial timberlands that, subject to a 15 percent limitation on additions, could be added to the plan area if acquired by Green Diamond in the future (Adjustment Area). Together, the IPA and Adjustment Area comprise the "Eligible Plan Area" for the HCP/CCAA (Table 1).

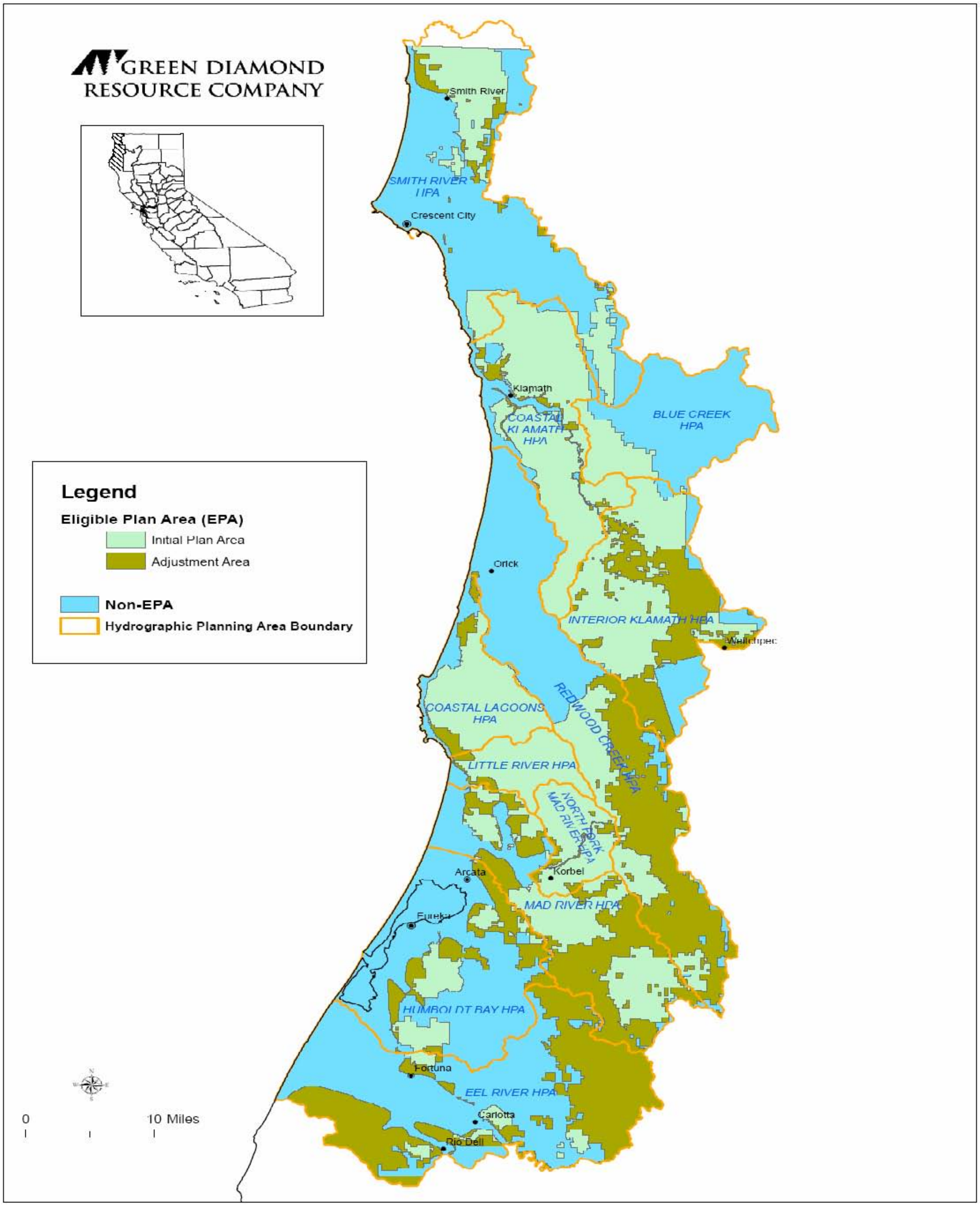

Figure 1. Green Diamond ownership and potential acquisition (adjustment) areas as of April, 2005.

Table 1. Estimated acreage of the Initial Plan Area, Adjustment Area, and Hydrographic Planning Areas (HPAs) of the Green Diamond HCP.

	Eligible Plan Area			
HPA	**HPA Initial Plan Area[1] (acres)**	**Adjustment Area[2] (acres)**	**Potential Plan Area (acres)[3]**	**Total HPA (acres)**
Smith River	44,090	8,036	52,126	181,999
Coastal Klamath	88,759	5,277	94,036	108,150
Blue Creek	15,355	35	15,390	80,303
Interior Klamath	66,127	43,184	109,311	128,006
Redwood Creek	33,038	59,316	92,354	188,335
Coastal Lagoons	39,999	4,505	44,504	53,592
Little River	26,042	1,910	27,952	29,703
Mad River	49,497	46,063	95,560	119,686
North Fork Mad River	28,219	3,197	31,416	31,416
Humboldt Bay	17,465	18,755	36,220	138,719
Eel River	7,940	76,864	84,804	205,160
TOTAL	416,531	n/a[3]	n/a[3]	1,265,069

<u>Notes</u>:

1 Estimated acreage includes that portion of Green Diamond's ownership in the HPAs at the time the HCP was prepared, plus acquisitions that were initiated during HCP preparation and are, or will be complete by the effective date of the Permit (see Figure 1); includes 414,818 acres of fee owned land and 1,713 acres of harvesting rights granted to Green Diamond.

2 Estimated acreage of the Adjustment Area as of the effective date of the Permit; includes other commercial timberlands potentially available for addition to the plan area as of the effective date of the Permit; estimate excludes non-forested commercial timberlands, a large tract of land proposed for conservation commitments, and commercial timberlands covered by an approved HCP.

3 Subject to 15 percent adjustment limit over the permit term as described in the text.

B. Timber Harvest

Timber harvest includes activities necessary to the logging (*e.g.*, felling, yarding, and loading), salvage, and transport of timber products. Such activities are described below:

1. <u>Felling and Bucking Timber</u>

Timber felling is the necessary first step in any logging operation, and usually includes "bucking," or cutting of the felled tree into predetermined lengths that are specified by the timber owner to maximize the value of the tree. Felling and bucking are generally done with chain saws by independent contractors who work in pairs. On terrain that is not too steep, mechanical felling machines ("feller-bunchers") can be used. Feller-bunchers are structurally similar to tracked excavators and have an articulated attachment that grabs the tree, cuts it, and then places it in a pile with other trees to facilitate subsequent skidding of "bunched" stems to the log landing. More complex feller-bunchers have "processor heads" that will de-limb the tree and buck it into logs. Tracked undercarriages and the self-leveling mechanisms configured on some of these machines allow them to operate on moderate slopes. Feller-bunchers have no blade or other attachment capable of moving soil.

2. <u>Yarding Timber</u>

Yarding, also referred to as skidding, is the movement of logs from the stump to the log landing. There are three major classifications of yarding systems; ground based, cable, and aerial.

a. Ground-Based Yarding

Ground-based logging usually involves the use of tractors, either tracked or rubber tired (rubber tired skidders) to skid logs to the landing. These machines use either powered grapple attachments or winch lines to grasp the log, and require constructed "skid trails" for their operation on all but the mildest terrain (*i.e.*, <45 percent). A related system used only with small logs on slopes less than 45 percent is forwarder logging, where a specialized tractor equipped with a small hydraulic boom loader travels into the logging unit and loads logs onto bunks that are mounted on a rearward extension of the tractor's frame - in essence a small self-loading truck designed with tires, gearing, and ground clearance that allow it to operate off-road. Another variant on ground skidding is shovel logging. A shovel, or hydraulic boom log loader, is an excavator that has been equipped with a log loading boom and grapple instead of an excavator boom and bucket. Most shovels are mounted on tracked undercarriages with generous ground clearance, providing some degree of off-road mobility. This capability is used in shovel logging, where a shovel walks off the truck road, picks up felled logs in a unit, and passes them back toward the truck road using its upper structure rotation or "swing" function. This system is very efficient over short distances, since the same machine that does the yarding can load the logs on trucks. However, it is not used over long distances because of the amount of repeated log handling that becomes necessary as distance to the truck road increases. As with feller-bunchers, shovels have no blade or other attachment capable of moving soil and do not require the construction of roads or trails to operate.

b. Cable Yarding

Cable yarding involves the use of steel cables, or wire ropes, to skid logs to a truck road or log landing using a yarder that is set up on the truck road or landing. A yarder has a number of powered drums filled with wire rope, and a vertical tower or leaning boom that is necessary to elevate or provide lift to the cables as they leave the machine. The tower ("pole") or boom that provides this lift is held in position by three to eight wire rope guylines that are also stored on powered drums on the machine. With rare exception, logs are yarded uphill with cable systems. Cable yarding is usually described as either "high lead" or "skyline," depending on how much lift is applied to logs as they are yarded. High lead logging essentially attaches logs directly to the end of the "mainline" that exits the top of the yarder tower. The only lift provided is that resulting from the difference in elevation between the location of the log and the top of the tower. This system is quick to set up and is effective over short distances (generally less than

500 feet) where, depending on terrain and tower height, the resulting lift will be sufficient to prevent the logs from digging into the soil surface during yarding.

Over longer reaches, some form of skyline logging is preferred to provide lift sufficient to increase productivity (reduced drag over long distances significantly increases yarding speed) and minimize ground disturbance. Skyline logging involves use of a skyline cable that extends from the top of the tower to an anchor located at some elevated point beyond the edge of the logging area. This anchor is usually a stump on an opposing hill slope, but can be a suitable tree at the perimeter of the logging unit that has been climbed and rigged to provide the necessary elevation for the skyline. Logs are attached to a carriage that rides on the skyline, and the carriage is pulled to the landing with the yarder's mainline (also referred to as the skidding line in this application). Depending on which variant of skyline logging is used, the skyline can be lowered to attach the logs and then raised to provide lift, or the carriage can spool out its own skidding line through one of various mechanisms and then lift the logs towards the skyline. Either way, enough lift is provided to suspend the uphill end of logs above the ground surface unless an unusually large log is encountered or the only available skyline anchor point cannot provide enough lift. This method of yarding generally produces less ground disturbance since much of the log is suspended with only the downhill portion of the log dragging across the ground.

c. Aerial Yarding

Aerial yarding (*i.e.*, by helicopter or balloons) is used where roads cannot be constructed to provide access to a harvesting unit for conventional (ground based or cable) yarding systems. Steep and/or unstable terrain is/are usually the reason(s) for the decision to use aerial methods, although lack of a road right-of-way may also trigger its use. Aerial logging uses cables or grapples suspended from long cables to pick up logs and hold them for transport to the landing. The logs are lowered to the log loading area and released without the aerial equipment landing. This type of yarding generates virtually no soil disturbance. However, a large landing is required to safely accommodate concurrent landing of logs, truck loading operations, and decking/stacking of logs generated during peak production hours. A separate service landing is also needed to provide a clean, rocked, debris and dust-free surface to protect the helicopter's engines from damage. The disadvantages of helicopter logging are its expense (roughly three times more expensive than cable yarding) and the fact that lack of vehicular access to the area compromises the landowner's ability to accomplish site preparation, reforestation, and other forest management activities in the future.

3. <u>Loading and Other Landing Operations</u>

After logs are yarded to a landing or roadside, additional saw work may be required to remove limbs, buck overly long pieces into shorter segments, or to remove breakage. These tasks are either accomplished with hand labor or with a mechanical delimber, a tracked machine similar to an excavator that has a long boom and moving cutting head that delimbs logs, and that can also accurately measure and buck a tree-length piece into logs. Logs are next loaded onto log trucks using a shovel or front-end loader (a wheeled bucket loader equipped with log loading forks instead of a bucket). Shovels (or heel-boom loaders) can operate on small landings or, if sideslopes are suitable, they can deck logs on the roadside and load trucks without leaving the road grade. In contrast, front-end loaders have a longer turning radius and require larger landings.

4. Salvaging Timber Products

Dead, dying, and windthrown trees are periodically salvaged. This salvage is primarily related to road maintenance or fire damage resulting from prescribed burns or wildland fires. Dead or dying trees are removed from along roads if they can be easily salvaged and yarded onto an adjacent road. Salvage of timber products is conducted through the annual filing of a property wide Exempt Notice [*i.e.*, subject to the California FPRs but exempt from many Timber Harvest Plan (THP) requirements] and also through the THP process. Removal of these products requires a licensed timber operator. If the volume to be salvaged exceeds 10 percent of the average existing timber volume per acre in the harvestable area, a THP is required.

5. Transporting Timber and Rock Products

Timber and rock materials are most commonly transported along roads via truck and trailer. Helicopters may occasionally but infrequently be used to transport logs directly to sawmills.

6. Road Construction and Maintenance

Roads on lands owned in fee by Green Diamond are constructed most commonly by felling and yarding timber along a predetermined road alignment that has been designated on the ground. This activity is followed by excavating or filling hillslope areas, using tractors or excavators. Road construction also commonly involves construction of watercourse crossings which use culverts, bridges, and occasionally fords. Roads also include vehicle turnouts and log landings, which are wide spots capable of being used as destinations of yarded logs as well as locations for loading logs onto trucks. Road construction may also involve the surfacing of native surface roads with rock, lignin, pavement, or other surface treatments approved by the Services.

Road maintenance commonly includes surface grading, clearing bank slumps, repairing slumping or sliding fills, clearing ditches, repairing or replacing culverts and bridges, adding surface material, dust abatement, and installing or replacing other surface drainage structures. Road maintenance for fire prevention, public access, and timber management may include mechanical control of roadside vegetation. Mechanical control may include grading, hand cutting or pulling, use of a "brush buster"-type mechanical device, burning, steaming, other experimental methods, *etc.*

7. Rock Pit Construction and Use

Rock pits, also referred to as borrow pits, are locations where rock is excavated, crushed, blasted, or otherwise produced for eventual use as a road surface, road fill, or rock bank stabilization materials. Activities associated with the use of rock pits also include loading rock into trucks for hauling, hauling of mined rock, and the construction and maintenance of rock pit access roads (see *Road Construction and Maintenance* section).

8. Water Drafting for Dust Abatement and Fire Suppression

Water drafting involves the drafting of stream flow into a water truck which is then periodically sprinkled or otherwise applied to road surfaces to minimize dust production and help maintain a hard, compact surface. Water may also be obtained by the use of gravity fed systems that provide water directly to storage reservoirs or tanks for later use in dust abatement or fire suppression. Occasionally, existing drafting locations within or adjacent to watercourses are excavated and cleaned of debris to increase their in-channel storage areas for drafting purposes.

9. Equipment Maintenance

The use of falling, yarding, loading, trucking, and road maintenance equipment requires equipment fueling and maintenance. This maintenance generally occurs on or adjacent to roads and landings.

C. Silvicultural Regimes and Methods

Green Diamond's silvicultural practices are designed to enhance the productivity of its timberlands by ensuring both prompt regeneration of harvested areas and rapid forest growth. Treatments vary by stand age, stand condition, site class, and species composition, and not all treatments are applied to every site. Table 2 summarizes the treatments, in approximate chronological order, that are considered as part of Green Diamond's forest management regime.

Silvicultural activity involves the specific methods by which a forest stand or area is harvested and regenerated over time to achieve the desired management objectives. Typical management objectives include achieving maximum sustained yield, and the maintenance, alteration, or creation of terrestrial and aquatic habitat. Specific examples of silvicultural activity include: (1) individual (single) tree selection where approximately 65 percent of the conifer volume may be removed and remaining conifers are evenly distributed; (2) group selection where trees are removed in groups less than 2.5 acres; (3) seed tree step where the entire stand is removed in one harvest except for well distributed seed trees of the desired species which may be subsequently harvested; (4) shelterwood regeneration where a preparatory step is utilized to improve designated seed trees, a seed step to promote natural reproduction from seed and a seed tree removal step; and (5) clearcut where the entire stand is removed in a single harvest.

Table 2. Green Diamond's forest management regime

Treatment	**Stand Age (in years)**
Regeneration Harvest	50 and older
Site preparation	0 – 1
Planting	1
Vegetation Management	0 – 10
Pre-commercial thinning	10 – 20
Commercial Thinning	35 – 45

D. Timber Stand Regeneration and Improvement

Timber stand regeneration and improvement includes activities necessary to establish, grow, and achieve the desired species composition, spacing, and rate of growth of young forest stands. Such activities include:

- Site preparation, prescribed burning, and slash treatment
- Tree planting
- Control of competing vegetation
- Precommercial thinning and pruning
- Minor forest-product harvest

Green Diamond manages timber in the IPA under a Maximum Sustained Production (MSP) plan prepared and approved in accordance with state law. Under the MSP plan, annual harvest levels are carefully scheduled to balance forest growth and timber harvest over a 100-year period and to achieve maximum sustained production of high quality timber products while protecting resource values, such as water quality and wildlife. Stands are considered ready for harvest once they enter the 50-year age class. However, state laws that constrain both the size of clear-cut units and the timing of adjacent even-age (*i.e.*, clear-cut) harvesting operations can delay the harvest of many stands until they reach the 70-year age class. The estimated average age of stands to be harvested is expected to be around 55 years. With the exceptions noted below, Green Diamond plans to practice even-aged management across the ownership, using clear-cutting as the harvest/regeneration method. Clearcutting provides for prompt regeneration of redwood and Douglas-fir, the principal commercial tree species in these forests, and maintains these trees in a "free-to-grow" state that is not compromised by competition with a residual overstory of older trees or by the possibility of damage from the repeated site disturbance that is implicit in the application of other silvicultural systems. The growth potential inherent in the use of clearcutting in these forest types was assumed in the calculation of yields for Green Diamond's sustained yield document [also known as an "Option (a)" document; Simpson 1999]. The primary exceptions to clearcutting will occur in the following situations:

- Areas where past use of selection or seed tree logging has left residual mature timber that will be harvested in "seed tree removal" or "overstory removal" operations.

- Areas where buffers along public roads or near urban development are harvested using the shelterwood or selection systems so that the visual impact of timber harvesting is ameliorated.

- Overly steepened or unstable slopes where slope stability concerns take precedence over forest productivity.

- Riparian Management Zones (RMZs), Habitat Retention Areas (HRAs), or other areas managed principally for fish and wildlife habitat.

Clearcut management units will continue to reflect the provisions of Green Diamond's northern spotted owl Habitat Conservation Plan (NSO HCP), principally through the retention of wildlife trees that are left within marked tree clumps or designated habitat retention areas to provide residual vertical structure.

Since essentially all of Green Diamond's property has been harvested at some time in the past, the progress of timber harvesting across the ownership will always reflect to some extent the pattern of age classes imprinted on the landscape by the timing of prior logging activity. In areas where large ownership blocks were initially harvested in more or less continuous logging operations during the railroad logging era (pre-1950s), ensuing harvesting operations will be more concentrated, although state FPR constraints will result in dispersal of activities within these blocks during subsequent rotation periods. In many areas, the pre-WWII pattern of timber harvesting across broad swaths of land was subsequently changed by decades of selective logging throughout the redwood region during the middle of the past century, and by the eventual acquisition by Green Diamond of a patchwork of properties that reflected differing harvest schedules and treatments by prior owners.

The effects of the timing of past harvesting activity are reflected in Table 3, which shows the age classes of Green Diamond's ownership within the 11 HPAs when the HCP was prepared. As indicated in Table 3, this acreage is dominated by forest types less than 60 years old, with approximately 82 percent of the area supporting forests in these age classes. The remainder of the area is in forest types 60 years old or older or oak woodland/prairie settings, such as in the Mad River HPA. The proportion of the area in these older age classes is expected to remain at this level or increase over the life of the HCP for two reasons:

(1) FPR adjacency constraints that are applied to even-aged harvesting units result in retention of many stands far past planned rotation age. If harvesting of a tract of mature timber is initiated around age 50, the harvesting of much of that tract will be constrained into the following decade, and the harvest of a few stands will be constrained past 70 years of age. This effect has been demonstrated in Green Diamond's long-term operating plan.

(2) Current rules and regulations, interacting with provisions of the NSO HCP, result in harvesting restraints or prohibitions on approximately 12 percent of the IPA. Provisions of the HCP will add to the area subject to such restrictions. Trees in these areas will be retained at least through the HCP period and will thus add to the total acreage in older age classes.

Table 3. Vegetation age composition (percent) in Green Diamond ownership for each HPA at the time of HCP preparation (Simpson 2002).

	Vegetation Age Class (approximate percentages)						
HPA	**0-20**	**21-40**	**41-60**	**61-80**	**81-100**	**>100**	non-forest
Smith River	17	48	21	2	2	4	5
Coastal Klamath	23	54	14	0	1	5	3
Blue Creek	23	61	4	0	1	5	5
Interior Klamath	11	56	16	4	6	4	4
Redwood Creek	12	52	21	8	2	0	5
Coastal Lagoons	13	13	61	11	1	1	1
Little River	50	10	6	28	6	0	0
Mad River	31	9	32	11	3	2	11
North Fork Mad River	26	23	38	9	1	0	3
Humboldt Bay	39	17	22	10	9	1	2
Eel River	47	8	28	15	0	0	2

1. <u>Site Preparation, Prescribed Burning, and Slash Treatment</u>

Site preparation is necessary where accumulations of slash[1] following timber harvesting constitute a physical barrier to effective planting, or where weed species (brush or non-merchantable trees) remaining on the site would compete with planted seedlings. In either situation, prescribed burning, machine piling, mechanical scarification, or a combination of these methods may be used to prepare the site for hand planting. Nearly all clearcut harvest units require some form of site preparation.

Site preparation is done as soon as possible after completion of logging so that planting will not be delayed. Mechanical site preparation may be done concurrently with logging operations. If prescribed burning is required, it is scheduled during the first spring or fall following completion of timber harvesting. Timing of such burns is predicated upon temperature, wind, humidity, and fuel moisture conditions that will result in low intensity burns. Such conditions minimize the probability of escape and allow retention of large woody debris and the finer organic matter concentrated at the soil/litter interface. Ignition patterns are designed to keep fire from intruding into RMZs. Prescribed burning is used to reduce slash concentrations or to reduce vegetative levels or control species composition. This practice involves the introduction of fire under controlled conditions to remove specified forest elements with little risk of catastrophic fire damage. Fire may be broadcast across large areas, or may be used in specific sites.

Prescribed burning is also used for slash control and to reduce fuel concentrations in established stands for fire prevention. In general, slash created by logging activity is retained on site without treatment. The FPRs require that accidental deposits of slash within Class I and Class II watercourses be removed. Slash deposited into Class III watercourses must be removed unless it is stable within the channel. When timber harvest is accompanied by restocking (planting of young conifers) after the harvest is complete, slash is either retained untreated,

[1] Slash is defined by the California FPRs as "branches or limbs less than four inches in diameter, and bark and split products left on the ground as a result of timber operations."

mechanically cleared from small circular planting spots, or broadcast burned. Slash developed on log landings as a result of yarding and truck loading activities may be piled and burned on the landing.

2. Tree Planting

Tree planting generally involves hand planting nursery-grown tree seedlings directly into the soil, ensuring good contact between the soil and roots. Tree seedlings will be hand planted in even-aged management areas including landings during the first winter following completion of a THP. Planting will be postponed only if site preparation is necessary but cannot be completed prior to the planting season. The summer after initial planting, Green Diamond will survey planted areas to determine seedling survival rates and, where necessary to achieve full stocking, plant additional seedlings during the following winter. At age 2, a more detailed stocking survey will be done and, if necessary, additional trees planted.

3. Control of Competing Vegetation

As discussed above, application of herbicides is not a covered activity in the HCP; however, NMFS considers herbicide application to be interrelated/interdependent to covered activities. We, therefore, consider herbicide application procedures in this section, and analyze the effects of such procedures later in this analysis.

To provide successful establishment and continuing, rapid growth of desired tree species, it is often necessary to control species that compete with desired species for water and sunlight. Control methods are mechanical cutting, chipping and herbicide use. Green Diamond applies herbicides either by hand or aerially. For aerial applications, Green Diamond uses the following measures:

- No herbicide will be applied within a 100-foot horizontal buffer zone of a Class I or II flowing stream.
- No application of herbicide will take place when the wind velocity exceeds five miles per hour.

For ground applications, the following measures are used:

- Foliar treatments will not be conducted when wind velocity exceeds ten miles per hour at the spray site.
- An untreated 50-foot buffer will be maintained on all flowing water.

A copy of Green Diamond's Spill Contingency Plan will be kept on site in case of an accidental spill of any hazardous materials.

4. Precommercial Thinning and Pruning

Precommercial thinning involves removing dense, young forest trees by mechanical means, including cutting individual trees or mechanically sawing or chipping rows or groups of trees. Pruning removes the lower limbs of desirable tree species to increase the eventual product value of the pruned trees. Between age 10 and 20, pre-commercial thinning may be prescribed to remedy overstocked conditions in planted stands so that crop trees will achieve optimum diameter growth. Currently, pre-commercial stems are not removed from the site because they are too small to meet current merchantable standards. This operation is performed only once in the life of a stand, and only on those stands with an excess number of trees per acre. Although chainsaws are used to cut the non-crop trees, progress in the development of feller-bunchers may eventually lead to machines that are capable of carrying out this operation more efficiently and with less risk of injury to workers. Alternatively, improvements in markets for small wood and in the machinery used to harvest small stems may allow economic harvesting of the excess trees, thus converting pre-commercial thinning to commercial thinning.

5. Minor Forest-Product Harvest

Minor forest products include burls, stumps, boughs, and greenery. Such products are collected, harvested, and transported on Green Diamond timberlands. These activities will comply with all measures in the HCP/CCAA section 6.2 (The Operating Conservation Program described below).

E. Green Diamond's Operating Conservation Program

The Operating Conservation Program reflects all the binding, enforceable commitments Green Diamond will implement as part of the HCP. These measures will be applied throughout the plan area, as adjusted, over the life of the HCP. The Operating Conservation Program consists of five components: riparian management, slope stability, road management, harvest-related ground disturbance and effectiveness monitoring. These measures are based on the Biological Goals and Objectives outlined in the HCP:

- Maintain cool water temperature regimes that are consistent with the requirements of the individual species,
- Minimize and mitigate human-caused sediment inputs,
- Provide for the recruitment of LWD into streams to maintain and allow the development of functional stream habitat conditions,
- Allow for the maintenance or increase of populations of the amphibian covered species in the plan area through minimization of timber harvest-related impacts on the species, and
- Monitor and adapt the HCP as new information becomes available, to provide those habitat conditions needed to meet the general goals that benefit the covered species.

1. Riparian Management

The Riparian management measures are directed at three broad classes of watercourses (Class I, Class II, and Class III[2]). Measures include but are not limited to:

- Establishing RMZs of specified widths and each with an inner and outer zone along all Class I and II watercourses (summarized in Table 4).

- Requiring the outer zone of Class I RMZs to be extended, where necessary, to cover the entire floodplain and, depending on slope, an additional 30-50 feet beyond the outer edge of the floodplain. An additional buffer will be added to the RMZ immediately adjacent to a floodplain, as follows:

Side slopes	Additional floodplain buffer
0 – 30%	30 feet
30 – 60%	40 feet
> 60%	50 feet

- Establishing Equipment Exclusion Zones (EEZs) of specified widths along Class III watercourses (Table 4), and designating Class I and II RMZs as EEZs except for the limited circumstances identified in the HCP.

- Allowing only a single selective harvest entry into a particular Class I or II RMZ over the 50-year term of the Permits.

- In Class I and II RMZs, requiring at least 85 percent overstory canopy closure in the inner zone and 70 percent in the outer zone, prohibiting the harvest of trees that contribute to maintaining bank stability, requiring the retention of all safe snags (snags deemed unsafe by the THP preparer will be fallen and retained onsite), limiting salvage activities, and requiring mulching and seeding of ground disturbances larger that 100 square feet.

- In Class I RMZs and within the first 200 feet of Class II RMZs adjacent to Class I RMZs, prohibiting harvest of trees that are judged likely to recruit to the watercourse. Considerations that will be used by the THP preparer to determine which trees would have a low likelihood of recruiting to a stream include:

[2] State Forest Practice Rules categorize watercourses into three types: Class I waters are characterized by either (1) fish always or seasonally present onsite, includes habitat to sustain fish migration and spawning, and/or (2) domestic supplies, including springs, on site and/or within 100 feet downstream of the operations area. Class II waters are characterized by either (1) fish present offsite within 1000 feet downstream and/or (2) providing aquatic habitat for non-fish aquatic species and excludes Class III waters that are tributary to Class I waters. As defined in Green Diamond's AHCP/CCAA, Class II watercourses do not contain fish, but do support or provide habitat for aquatic vertebrates. Class III waters have no aquatic life present, but show evidence of being capable of sediment transport to Class I and II waters under normal high water flow conditions.

- Tree has an impeded 'fall-path' to the stream (*e.g.*, upslope family members of a clonal group blocked by downslope stems) or;
- Tree, or the majority of the crown weight of the tree is leaning away from stream and the tree is not on the stream bank or does not have roots in the stream bank or stream or;
- The distance of the tree to the stream is greater than the height of the tree or;
- Tree is on a low gradient slope such that gravity would not carry the fallen tree into the stream or objects such as trees and large rocks impede its recruitment path or;
- Tree is not on an unstable area or immediately downslope of an unstable area or;
- Harvesting of the tree will not compromise the stream bank or slope stability of the site, or directly downslope of the site.

• Class III streams will be grouped into one of two tiers according to HPA groupings and slope gradient, as follows:

HPA Group	Slope Gradient
Smith River (Smith River HPA)	<65%=Tier A >65%=Tier B
Coastal Klamath Group (Coastal Klamath and Blue Creek HPAs)	<70%=Tier A >70%=Tier B
Korbel Group (Interior Klamath, Redwood Creek, Coastal Lagoons, Little River, Mad River, and North Fork Mad River HPAs)	<65%=Tier A >65%=Tier B
Humboldt Bay Group (Humboldt Bay and Eel River HPAs)	<60%=Tier A >60%=Tier B

Table 4. Watercourse classes and minimum buffer widths proposed in the Green Diamond HCP. Class II watercourses are divided based on stream order. A first order stream is one with no tributaries. The confluence of two first order streams forms a second order stream. Refer to HCP at section 6.2.1 for a full description of these measures.

Watercourse Class	Further Subdivisions	Total Width Each Side of Channel	Inner Zone Width[1]	Outer Zone Width[2]
Class I	None	150 ft RMZ[3]	50-70 ft[4]	80-100 ft[5]
Class II[6]	2nd order and larger	100 ft RMZ	30 ft	70 ft
	1st order[7]	75 ft RMZ	30 ft	45 ft
Class IIIA[8]	Depends on slope and HPA group (see text)	30 ft EEZ	NA	NA
Class IIIB[9]	Depends on slope and HPA group (see text)	50 ft EEZ plus tree retention	NA	NA

Notes:

1 Retain at least 85 percent overstory canopy in inner zone of Class I and II streams

2 Retain at least 70 percent overstory canopy in outer zone of Class I and II streams

3 Green Diamond will apply a RMZ of at least 150 feet (slope distance) on each bank of all Class I watercourses. Where the floodplain is wider than 150 feet on one side, the outer zone of the RMZ will extend to the outer edge of the floodplain. An additional buffer will be added to the RMZ immediately adjacent to a floodplain, as follows::

0-30% 30 feet
30-60% 40 feet
>60% 50 feet

4 Green Diamond will establish an inner zone within the RMZ, the width of which will depend upon the streamside slope in accordance with the following:

0-30% 50 feet
30-60% 60 feet
>60% 70 feet

5 Green Diamond will establish an outer zone to the RMZ which will extend from the outside limit of the inner RMZ edge to at least 150 feet from the bankfull channel (or CMZ edge) with the additional floodplain buffer set forth above.

6 Green Diamond will establish an RMZ of at least 75 or 100 feet on each bank of all Class II watercourses. A 75-foot minimum buffer will be used on the first 1,000 feet of 1st order Class II watercourses (Class II-1 watercourses). Downstream of this first 1000-foot section, the RMZ will be expanded to at least 100 feet. A 100-foot minimum buffer will be used on all 2nd order or larger Class II watercourses.

7 The first 200 feet of Class II RMZs adjacent to Class I RMZs will be subject to the likely to recruit standards of Class I RMZs.

8 Green Diamond will apply one of two tiers of protection measures within Class III watercourses in accordance with HPA groups and slope gradient, as described in the text.

9 Green Diamond will retain all hardwoods and nonmerchantable timber within the EEZ except where necessary for cable corridors or the safe falling of merchantable trees. Additionally, all conifers contributing to bank stability or acting as a control point in the channel will be retained. A minimum average of one conifer per 50 feet of stream length within the EEZ will be retained.

2. Slope Stability

The Slope stability measures are designed to: (1) reduce management-related sediment delivery to the aquatic system from landslides, and (2) reduce landslide-related erosion that might occur in specific portions of the landscape. Slope stability and erosion problems associated with plan area roads are addressed separately under "Road Management." Initial default prescriptions are identified for plan area lands within each HPA, with HPAs that share common geologic and geomorphic characteristics grouped together. Implementation of the measures will occur on a THP-by-THP basis concurrently with slope stability and mass wasting assessments described under "Effectiveness Monitoring." The initial default prescriptions will be revised based on monitoring results. Initial default slope stability prescriptions may also be modified on a THP-by-THP basis through an onsite review by a qualified geologist. Initial measures include, but are not limited to:

- Identifying in THPs: (a) all steep streamside slopes (SSS) leading to Class I or II watercourses based on initial slope gradients specified for each HPA (Table 5); (b) all headwall swales; (c) all active deep-seated landslides; and (d) those shallow rapid landslides that are field verified to be active or which are likely to be reactivated by harvesting, have a reasonable potential to deliver sediment to a watercourse, and are at least 200 square feet in plan view;

- In THP areas with identified SSS, establishing an SSS zone of specified widths (Table 5), each comprised of an inner Riparian Slope-stability Management Zone (RSMZ), an outer RSMZ, and a Slope-stability Management Zone (SMZ);

- In the Coastal Klamath and Blue Creek HPAs, prohibiting harvesting in the inner and outer RSMZs on all plan area lands;

- In all HPAs except Coastal Klamath and Blue Creek, prohibiting harvesting in inner RSMZs and requiring 85 percent overstory canopy retention in outer RSMZs on plan area lands with Class I or II-watercourses; and requiring 85 percent overstory canopy retention in inner RSMZs and 75 percent in outer RSMZs on plan area lands with Class II-1 watercourses;

- In all HPAs, limiting harvesting in an SMZ or headwall swale to one entry during the term of the Permits and prohibiting harvesting 25 feet upslope from an active deep seated landslide; and identifying single tree selection as the initial silvicultural prescription in SMZs and headwall swales (retention standards for single tree selection are based on site class as follows: Site I - 125 square feet of basal area; Site II and III – 75 square feet basal area; and Site IV and V - 50 square feet of basal area);

- In all HPAs, requiring Green Diamond to avoid road construction in SSS zones and field verified headwall swales, where feasible, and across active deep-seated landslide toes or scarps or on steep (greater than 50 percent gradient) areas of dormant slides except as approved by a registered geologist (RG) and a Registered Professional Forester (RPF) with experience in road construction in steep terrain.

Table 5. Steep Streamside Slope (SSS) Measures proposed under the Green Diamond HCP. SSS measures will be applied within the indicated slope distance for those areas that exceed the minimum hillslope gradient.

HPA	**Minimum Slope Gradient**	**SSS Zone Slope Distance from Watercourse Transition Line (feet)**		
		Class 1	**Class II-2**	**Class II-1**
Smith River	65%	150[3]	100[3,4]	70[3]
Coastal Klamath and Blue Creek	70%	475	200	100
Interior Klamath, Redwood Creek, Coastal Lagoons, Little River, Mad River, and North Fork Mad River	65%	200	200	70[3]
Humboldt Bay and Eel River	60%	200	200	70[3]

Notes:

1 The inner RSMZ on all Class I watercourses will be 70 feet, except where a qualifying slope break exists within that distance. In that case, the inner RSMZ may only extend to the slope break, and the outer zone, if any, will be the remainder of the applicable RMZ distance except where a qualifying slope break exists within that distance.

2 The inner RSMZ on all Class II watercourses will be 30 feet, except where a qualifying slope break exists within that distance. In that case, the inner RSMZ may only extend to the slope break, and the outer zone, if any, will be the remainder of the applicable RMZ distance except where a qualifying slope break exists within that distance.

3 Maximum SSS zone is equal to the RMZ width, but the RSMZ prescriptions will apply.

4 There are no data available for Class II-2 watercourses in the Smith River HPA; values presented here are based on Class I watercourses.

3. Road Management

The purpose of the Road Management Measures is to reduce sediment delivery into watercourses from road sources, including surface erosion from roads, road-related landslides, and watercourse crossing failures (washouts and diversions). In general, chronic surface erosion delivers sediment every winter, whether or not there are any large storms. Sediment delivery from chronic road erosion is generally greatest on roads that are used during the winter, and where ditches are connected to watercourses. Newly constructed roads also exhibit increased risk of surface erosion for the first several years following construction. Sediment delivery from road-related landslides and watercourse crossing failures is episodic in nature, linked to large storm events, and delivers relatively large quantities of sediment to watercourse channels. The risk is typically greatest on old or abandoned roads with undersized culverts that are not properly maintained.

The Road Management Measures address sediment delivery in two primary ways: (1) through an accelerated schedule of road decommissioning and upgrading; and (2) through the systematic application of standards for the construction, management, and use of roads and related facilities. The measures will be implemented concurrent with the road-related sediment delivery assessments described under "Effectiveness Monitoring" and will be revised as appropriate based on monitoring results. Measures include but are not limited to:

- Conducting a detailed assessment of road-related sediment sources in each of 58 sub-watershed road work units (RWUs) that encompass the existing road network on Green Diamond's fee owned lands in the plan area, with the order in which the RWUs are assessed based on a ranking of their biological, geomorphic, and road-related features;

- Prescribing and implementing erosion control and erosion prevention measures in connection with the decommissioning or upgrading of roads at each site where treatable sources of erosion are identified, including but not limited to measures such as road surfacing, dispersing runoff into stable vegetated filter areas, armoring with rock rip-rap, end hauling waste material to stable locations, constructing dips and waterbars, mulching, and revegetating disturbed surfaces;

- Prioritizing sites for treatment as "high," "moderate" or "low" based on; (a) projected volume of future sediment delivery; (b) treatment immediacy; and (c) treatment cost-effectiveness;

- Providing approximately $2.5 million per year during the first 15 years of the Permits' term for the specific purpose of accelerating the treatment of "high" and "moderate" sites;

- Implementing the prescribed treatments at all "high" and "moderate" sites within the term of the Permit;

- Adhering to the time-of-year restrictions identified in Table 6 for road work and use of roads and related facilities in the plan area;

- Requiring that log hauling, road decommissioning, road upgrading, road construction, and use of landings cease, regardless of the time of year, if any portion of a road or landing would result in runoff of waterborne sediment in amounts sufficient to cause a visible increase in turbidity in any ditch or road surface that drains into a Class I, II, or III watercourse;

- On fee-owned lands and harvesting-rights areas where Green Diamond has exclusive road use rights, conducting inspections and implementing repairs and maintenance of mainline roads, roads appurtenant to THPs, secondary roads, and roads not yet decommissioned in accordance with the measures identified in the HCP;

- Requiring that maintenance and repairs be prioritized based on treatment immediacy, with the goal being to complete all priority tasks prior to the winter period;

- Requiring that, wherever feasible, new roads be located on or close to ridge tops or on benches where the road prism can be built with the least soil displacement and be constructed in accordance with the standards identified in the HCP;

- Classifying new roads that are designed for a single-use in a THP as temporary and decommissioning such roads upon completion of operations;

- Limiting width of new roads to 16 to 18 feet of running surface for mainline roads and 14 to 16 feet for secondary and temporary roads, with a combination of outsloped and crowned roads plus inside ditches where appropriate and occasional turnouts;

- Limiting the final grade of new roads to no more than 15 percent, except to avoid unstable slopes, steep slopes, inner gorges, inner gorge crossings, or to access a suitable watercourse crossing location, as measured in minimum 100-foot increments;

- Designing all new permanent watercourse crossing culverts to handle a 100-year return interval flow event without overtopping;

- Conducting emergency inspections of all accessible rocked roads in the affected area if a storm occurs that produces three inches of precipitation or more in a 24-hour period, and prioritizing and scheduling repairs so they are accomplished as soon as possible;

- Requiring that water drafting from Class I or II watercourses, impoundments, and gravity-fed water storage systems conform to the pumping rates and screen design specifications in the HCP and conform with NMFS screening guidelines (NMFS 1997a);

- Prohibiting the use of herbicide mix trucks in direct drafting of water from any watercourse;

- Prohibiting the establishment of new rock quarries and borrow pits within Class I or II RMZs or the use of an existing rock quarry or borrow pit within 150 feet of a Class I, 100 feet of a Class II-2, or 75 feet of a Class II-1 watercourse;

- Requiring that rock quarrying, rock extraction from borrow pits, and hauling not result in a visible increase in turbidity in watercourses or hydrologically connected facilities that discharge into watercourses;

- Training foresters, field supervisors, and equipment operators to conduct road decommissioning, road location and design, road construction, road upgrading, and road maintenance in accordance with the measures of the HCP.

Table 6. Time periods when road work, road use, and harvest-related ground disturbances may/may not occur within the plan area.

Activity	Nov. 16 - April 30	May 1 - May 14	May 15 - Oct. 15	Oct. 16 - Nov. 15
Road decommissioning	None	None	Yes	Yes if[1,3]
Road upgrades	None	Yes if[2]	Yes	Yes if[1,3]
New Road Construction	None	None	Yes	None
New Landing Construction	None	None	Yes	None
Hauling and Loading a. On rocked surfaces b. On unsurfaced roads	 a. Yes b. None	 a. Yes b. Yes if[2]	 a. Yes b. Yes	 a. Yes b. Yes if[1]
Use of helicopter landing areas	Same as above	Same as above	Same as above	Same as above
Vehicle use of unsurfaced seasonal roads	ATVs only	Yes if[2]	Yes	Yes if[1]
Use of landings and roadside deckings within RMZs[4]	None	None	Yes if[5]	None
Mechanized site preparation	None	None	Yes	None
Ground based yarding - Tractor, Skidder, and Forwarder	None	Yes if[6]	Yes	Yes if[6]
Ground based Yarding - Feller-Buncher and shovel logging	Yes if[6]	Yes	Yes	Yes
Skyline and helicopter yarding	Yes	Yes	Yes	Yes
Skid trail Construction and Reconstruction	None	None	Yes	None

Notes:

1 Cumulative rainfall from September 1st through October 15th is less than 4" and activity will cease when cumulative rainfall reaches 4".

2 No measurable rainfall has occurred within the last 5 days and no rain is forecast by the National Weather Service for the next 5 days.

3 A project can be completed in one day and erosion control structures can be installed. If a site requires multiple days for completion, a long-range National Weather Service forecast of no rain for the next 5 days is required.

4 Any proposed use of existing landings and alternatives to roadside decking will be discussed and mapped in THPs and also included on the THP map submitted to the Services.

5 Ditchlines and drainage facilities associated with existing roads within RMZs that are used for landings or roadside decking (May 15th through October 15th) will be repaired immediately following completion of operations and prior to October 16th.

6 Conditioned on use of procedures and limitations specified in the HCP.

4. Harvest-Related Ground Disturbance

The purpose of the Harvest-Related Ground Disturbance Measures are to reduce sediment delivery to watercourses from activities conducted as part of timber harvesting operations. Measures include, but are not limited to:

- Adhering to the time-of-year restrictions identified in Table 6;

- Requiring that all site preparation operations be designed to limit the amount of ground and forest floor disturbance to that which is required for fuel reduction and reforestation operations;

- Designing prescribed fire operations to produce low intensity burns; limiting fireline construction, reconstruction, and use within RMZs and EEZs; and requiring that firelines not in an RMZ or EEZ have drainage structures adequate to prevent the delivery of sediments to RMZs or EEZs;

- Implementing erosion control measures in RMZs or EEZs in areas disturbed by felling, bucking, and yarding activities;

- Prohibiting the use of ground-based yarding systems that require constructed skid trails on slopes over 45 percent, unless greater soil or riparian zone disturbance would be expected from cable yarding; and

- Prohibiting the use of ground-based yarding or skidding equipment in RMZs or EEZs adjacent to Class I, II and III watercourses, except for the limited circumstances identified in the HCP;

- Requiring that field trials of mechanized equipment for silvicultural operations not be conducted unless the Services are provided with documentation that the equipment will not cause compaction or soil displacement measurably greater than the equipment or methods previously used.

5. Effectiveness Monitoring

The purpose of the Effectiveness Monitoring Measures is to track the success of the Operating Conservation Program in relation to the HCP's biological goals and objectives and provide the basis for the Adaptive Management Measures. Four categories of projects will be implemented: Rapid Response Monitoring, Response Monitoring, Long-term Trend Monitoring/Research, and Experimental Watersheds Program.

a. Rapid Response Monitoring

Rapid Response Monitoring projects include: (1) annual property-wide water temperature monitoring in Class I and Class II watercourses; (2) before-after-control-impact (BACI) water temperature monitoring in paired sites on Class II watercourses; (3) monitoring of spawning gravel permeability in selected Class I watercourses; (4) monitoring of road-related delivery of fine sediments into plan area streams and evaluation of the effectiveness of the Road Management Measures in reducing those inputs; (5) BACI monitoring of changes in larval populations of tailed frogs;[3] and (6) BACI monitoring of changes in the persistence of sub-populations of southern torrent salamanders.[3]

b. Response Monitoring

Response Monitoring measures include: (1) measuring changes in the above parameters in reaches of Class I watercourse at least every other year for the duration of the Permits; and (2) BACI monitoring of sediment delivery from Class III watercourses.

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[3] These species are considered in a separate consultation conducted by the USFWS.

c. *Monitoring thresholds*

Measurable thresholds that will trigger management responses when exceeded will be established for all Rapid Response and Response Monitoring projects. Each project will have a "yellow light" and "red light" threshold that triggers different levels of review and response. Based on studies already completed, the thresholds identified in Table 7 have been determined for the property-wide water temperature, Class II BACI, tailed frog, and southern torrent salamander monitoring projects. Thresholds for the other projects will be established by Green Diamond based on data collected from reference sites and appropriate statistical analysis in the time-frame identified in Table 7.

d. *Long-term Trend Monitoring/Research*

Long-term Trend Monitoring/Research projects include: (1) monitoring the effectiveness of the road decommissioning and upgrading measures in reducing road-related mass wasting; (2) delineation of minimum slope gradients and maximum slope distances for plan area lands in each HPA, with the results used to modify the corresponding Slope Stability Measures; (3) evaluation of the effectiveness of the SSS prescriptions based on landslide-relevant data collected in the plan area over the first 15 years of HCP implementation; (4) a two-stage assessment of the relationship between mass wasting processes and timber management processes; (5) channel and habitat typing assessments of selected plan area streams; (6) LWD surveys on the stream reaches selected for channel and habitat typing; (7) annual summer sampling surveys to estimate young of the year coho salmon and age 1+ steelhead and coastal cutthroat trout; and (8) annual out-migrant trapping in the Little River HPA to monitor smolt abundance, size, and out-migration timing. These last two monitoring projects are covered separately under a section 10(a)1(A) research permit.

e. *Experimental Watersheds Program*

Green Diamond will designate the Little River HPA, South Fork Winchuck River in the Smith River HPA, Ryan Creek in the Humboldt Bay HPA, and Ah Pah Creek in the Coastal Klamath HPA as experimental watersheds for additional monitoring and research. Projects in the four watersheds will include: (1) Effectiveness Monitoring that due to its complexity and expense of implementation can only be applied in limited regions (*i.e.*, turbidity monitoring, Class III sediment monitoring, and road-related mass wasting); (2) BACI studies of harvest and non-harvest areas; (3) BACI studies of conservation and management measures; and (4) development and implementation of new or refined monitoring and research protocols. In addition, Green Diamond may expand out-migrant trapping in the Little River HPA to one or more of the other experimental watersheds. No monitoring or research which involves the application of measures other than those prescribed in this HCP will occur without the concurrence of the Services.

Table 7. Yellow and red light thresholds for Rapid Response and Response Monitoring projects.

Monitoring Project/Program	Yellow Light Threshold	Red Light Threshold
Annual Property-wide Water Temperature Monitoring of Class I and II watercourses	• A 7DMAVG above the upper 95 percent PI described by the regression equation: Water Temperature = 14.35141 + 0.03066461 x square root Watershed Area, or • Any statistically significant increase in the 7DMAVG of a stream where recent timber harvest has occurred, which cannot be attributed to annual climatic effects.	• A 7DMAVG above the upper 95 percent PI plus one C as described by the regression equation: Water Temperature = 15.35141 + 0.03066461 x square root Watershed Area, • An absolute value of 17.4 °C (relevant for fish), or • A 7DMAVG value that triggers a yellow light for three successive years
Class II BACI Water Temperature Monitoring	• A statistically significant treatment (harvesting) effect in at least 3 of 8 BACI experiments.	• Significant treatment effects continuing for 3 successive years following treatment in at least 3 of 8 BACI experiments.
Tailed Frog Monitoring	• A statistically significant decrease in the larval populations of treatment streams relative to control streams, or • A statistically significant downward trend in both treatment and control streams	• A statistically significant decline in larval populations in treatment streams relative to control streams in >50 percent of the monitored sub-basins in a single year; • A statistically significant decline in treatment vs. control sites continuing over a three year period within a single sub-basin; or • A statistically significant downward trend in both treatment and control streams that continues for 3 years or more.
Southern Torrent Salamander Monitoring	• Any extinction of a sub-population, or • An apparent decline in the average index of sub-population size in treatment sites compared to control sites	• A statistically significant increase in the extinction of treatment sub-populations relative to control streams, or • A significant increase in the net rate of extinctions over the landscapes
Spawning Substrate Permeability Monitoring and Road-related Sediment Delivery (Turbidity) Monitoring	Will be established after 5 years of data collection for each project	
Class I Channel Monitoring and Class III Sediment Monitoring	Will be established after 10 years of data collection for each project	

Codes:

BACI = Before-After-Control-Impact
PI = Prediction Interval
7DMAVG = highest 7-day moving mean of water temperature

6. Implementation Monitoring

The purpose of the Implementation Monitoring Measures is to track and facilitate compliance with the provisions of the HCP. Measures include, but are not limited to:

- Designating a Plan Coordinator to work in conjunction with Green Diamond RPFs, fisheries, wildlife, and geologic staff to identify the provisions of the HCP applicable to individual THPs and document compliance with the Operating Conservation Program on the THP level;

- Providing the Services with biennial reports that summarize compliance with the Operating Conservation Program, results to date of the Effectiveness Monitoring Measures, and any field reviews conducted in the period since the last report;

- Scheduling annual meetings with the Services for the first 5 years of the HCP, with the annual meeting in the second and fourth years followed with a field review of implemented conservation measures.

7. Adaptive Management

The purpose of the Adaptive Management Measures is to incorporate the results of the Effectiveness Monitoring projects into HCP implementation and provide the basis for necessary modifications to HCP measures over the term of the ITP. Measures include, but are not limited to:

- Changes to RMZ widths and prescriptions that are within the range of options either under state forestry regulations applicable at the time the change is made or the Northwest Forest Plan (FEMAT 1993) riparian measures (up to the balance of the Adaptive Management Reserve Account (as described below);

- Changes to SSS default widths and slope gradients based on results of the SSS Delineation;

- Changes to SMZ default prescriptions based on results of the SSS Assessment, with the prescriptions ranging from no cut to even-age management;

- Changes that would increase the rate at which high and moderate priority sites are treated during the first 15 years of the road decommissioning and upgrading program;

- Changes to the drainage structure and erosion control prescriptions in the Road Management Measures.

Green Diamond will establish an Adaptive Management Reserve Account (AMRA) to "fund" implementation of adaptive management measures over the Permits' term. The AMRA will be "charged" with an "opening balance" of 1,550 Fully Stocked Acres (FSA), and the AMRA account balance will be factored in FSAs throughout the term of the HCP. If the balance falls to zero through the debit process described below, then no more debits will be made until the account is credited. An FSA will be defined as a stand with 42,000 board feet/acre (50 year stand with an index of 350 square feet of basal area) and a species composition of 50 percent redwood, 34 percent Douglas fir, 10 percent white woods, and 6 percent hardwoods. The current California State Board of Equalization (SBE) Harvest Value Schedule will be used to translate FSA to equivalent specific road management plan prescriptions. The percentage of SBE harvest categories will be 60 percent cable yarding, 35 percent tractor, and 5 percent helicopter. The AMRA will be used to accommodate changes in riparian protection measures from conclusive results of the monitoring program and experimental watersheds.

Reduction of the AMRA balance by translating FSA to funds for road prescriptions is limited to 2 percent per year of the opening balance (*i.e.*, the equivalent of 31 FSA). There is no limit to the annual use of the AMRA for RMZ or SMZ modifications. The balance within the AMRA will fluctuate proportionately to the addition and deletion of properties.

The current set of riparian measures will be set as the standard for all future comparisons. The areas to be included in SMZs will be determined at the end of the 5-year property-wide geologic review. Any modification of the standard riparian measures, areas included in SMZs or specific road management plan prescriptions (obtained via monitoring, paired watershed analysis or subsequent geologic review) will be credited or debited from the AMRA. For instance, an increase in the width of a zone will debit the balance, and a decrease in a zone width will credit the balance. Debits and credits will be reflected in the account on an on-going basis as the account acres are retained or harvested, and the account will be summarized biennially. The opening balance of the AMRA (1,550 FSA) was determined based on the amount needed to address risks associated with management prescriptions for SMZs, which Green Diamond estimates will include approximately 8,850 acres. These SMZ acres will be managed using uneven-aged silviculture, which is defined in the Glossary of the HCP as single tree selection. By applying single tree selection, Green Diamond will harvest approximately 65 percent of the conifer volume on the 8,850 acres. Thus, approximately 35 percent of the volume will be retained within the SMZs to produce conservation benefits as the HCP is implemented over time. As proposed, the prescriptions will represent approximately 3,100 acres (or 0.35 x 8,850 acres) of fully stocked timberland. To reduce the risk of potentially underestimating the protection needs of SMZs, Green Diamond will allow up to a 50 percent increase in the retained volume in SMZs. In terms of fully stocked acres, this will equate to 1,550 acres (0.50 x 3,100 acres = 1,550 acres) that can be applied to these zones. As mentioned above, the opening AMRA balance of 1,550 FSA may increase or decrease in response to findings through the monitoring programs or through the results from projects in the Experimental Watersheds. No adaptive management change will be made unless there is a sufficient balance in the AMRA to make the change.

As an example, assume that monitoring indicates that an additional 50-foot buffer is needed along Class II watercourses in three HPAs. Based on the extent of THPs submitted for 2 years, assume that this modification results in a 120-acre “debit” for year-1 THPs and an additional 160-acre debit for the year-2 THPs. Now assume that paired watershed studies indicate that decreasing the buffer width by 25 feet is acceptable on Class I watercourses. In the example THPs, this would result in a “credit” of 350 acres, as the THPs result in the harvest of additional acreage. In year-2, the THPs would result in an additional 400 acres being harvested. At the end of each year, the effects of these adjustments will be reflected in the AMRA balance as follows:

- Opening Balance - year 1 1,550 acres
- Class II debit - year 1 (120) acres
- Class I credit - year 1 350 acres
- Closing Balance - year 1 1,780 acres

- Opening Balance – year 2 1,780 acres
- Class II debit - year 2 (160) acres
- Class I credit - year 2 400 acres
- Closing Balance - year 2 2,020 acres

8. Special Project - Fish Relocation Above Barriers

The purpose of the Special Project is to examine the potential conservation benefits of transporting coho salmon and possibly other salmonids around barriers to spawning and rearing habitat. Green Diamond proposes to undertake a 10-year project that will entail trapping coho salmon in a stream with a barrier to spawning and rearing habitat, transporting them around the barrier during spawning season, and monitoring subsequent spawning, rearing, and out-migration. Coho salmon will be trapped using a weir and trap box at the base of the barrier. Fish will be promptly transported upstream of the barrier and released. Green Diamond anticipates that 10-15 adults will be relocated. Prior to undertaking the project, Green Diamond will evaluate the selected stream based on criteria specified in the HCP to determine that salmonids residing in the basin above the barrier will not be negatively affected by the project.

9. Changed Circumstances

The purpose of the Changed Circumstances Measures is to address reasonably foreseeable changes in habitat conditions and the status of covered species in the plan area. Four types of changes are identified in the HCP as potential Changed Circumstances:

- Fire covering more than 1,000 acres within the plan area or more than 500 acres within a single watershed within the plan area, but covering 10,000 acres or less (a fire greater than 10,000 acres would be considered an Unforeseen Circumstance);

- Complete blow-down of more than 150 feet of previously standing timber within an RMZ, measured along the length of the stream; but less than 900 feet of trees within an RMZ, due to a windstorm (a windstorm that results in a complete blow-down of 900 feet or more, measured along the length of the stream, would be considered an Unforeseen Circumstance);

- Loss of 51 percent or more of the total basal area within any SSS, headwall swale or Tier B Class III watercourses as a result of Sudden Oak Death or stand treatment to control Sudden Oak Death (a pest invasion that is not Sudden Oak Death that results in a significant impact on the covered species would be considered to be an Unforeseen Circumstance); and

- Landslides that deliver more than 20,000 and less than 100,000 cubic yards of sediment to a channel (a landslide that delivers more than 100,000 cubic yards of sediment would be considered an Unforeseen Circumstance).

If such circumstances occur, Green Diamond will implement the applicable supplemental prescriptions described in the HCP (Section 6.3.9). These are summarized here. In cases of fire, Green Diamond will consider salvage of dead or damaged trees with the application of the RMZ measures previously described. Reforestation of any RMZ or SMZ affected by the fire will be implemented as soon as possible. Similarly, in the case of windthrow, Green Diamond will consider salvage of the downed trees with application of the RMZ and SMZ measures previously described. In the case of pest infestation, a RG and RPF will develop additional prescriptions to compensate for the loss of hardwood root strength through retention of additional conifers. For landslides, if either of the Services or Green Diamond determine that management activities contributed to the failure, Green Diamond will retain a qualified geo-technical expert to provide an assessment of the factors causing failure and recommendations for future management activities. The recommendations set forth in the report may form the basis for adaptive management changes. Where new species are listed, Green Diamond will follow the process described in the IA.

10. Unforeseen Circumstances

Unforeseen circumstances are substantial, adverse changes in the circumstances affecting covered species in the plan area that cannot be reasonably anticipated in the HCP. In addition to the Unforeseen Circumstances defined above in the *Changed Circumstances* section above, an earthquake greater than magnitude 6 on the Richter Scale or a flood that is equal or greater in magnitude than a 100-year recurrence interval event in the Plan Area would be considered Unforeseen Circumstances. Should unforeseen circumstances occur, modifications to the HCP will be made only in accordance with the procedures set forth in the IA. If one of the Services makes a finding of unforeseen circumstances, it will have up to 120 days, or a longer period with Green Diamond's consent, to determine the nature and location of necessary additional or modified mitigation required to address the unforeseen circumstances. During such period, Green Diamond agrees to avoid undertaking any activity that would appreciably reduce the likelihood of the survival and recovery of the affected covered species.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

Table 8 presents a summary of the species addressed in this document, and includes their listing status under ESA, Federal Register Notice dates and citations, and geographic distributions. These species will hereafter be referred to as "Pacific salmonids" rather than the covered species discussed in the *Proposed Action* section which refers to a larger number of species. This document addresses only the Pacific salmonids specified in river basins in California and southern Oregon as they overlap with the action area. Within the action area, more specific abundance and distribution information is provided in the *Environmental Baseline* discussion for each HPA.

A. Critical Habitat

This Opinion describes the effects of the proposed action on designated critical habitat for SONCC coho salmon, CC Chinook salmon and NC steelhead. The critical habitat for SONCC coho salmon includes all accessible waterways, substrate, and adjacent riparian zones. Excluded are: (1) areas above specific dams identified in the FR notice; (2) areas above longstanding natural impassible barriers (*i.e.*, natural waterfalls); and (3) tribal lands. In designating critical habitat, NMFS considers the following requirements of the species: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring; and, generally, (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species (see 50 CFR 424.12(b)). In addition to these factors, NMFS also focuses on the known physical and biological features (primary constituent elements) within the designated area that are essential to the conservation of the species and that may require special management considerations or protection. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

The current condition of critical habitat for the three species listed above is discussed in the *Factors Affecting the Species* section below. The *Environmental Baseline* section describes habitat conditions within the action area. Also, for each HPA described in the *Environmental Baseline* section, the conservation value of critical habitat for CC Chinook salmon and NC steelhead is described. This is based on NMFS' Critical Habitat Analytical Review Team (CHART) assessments of sub-watersheds within the ESU (NMFS 2005). Furthermore, the *Effects of the Action* section is largely organized around anticipated effects on fish habitat.

Table 8. The scientific name, listing status under the Endangered Species Act, Federal Register Notice citation, and geographic distribution of the Evolutionarily Significant Units (ESU) and Distinct Population Segment (DPS) covered by the proposed Incidental Take Permit.

Evolutionarily Significant Unit	Scientific Name	Listing Status	Federal Register Notice	Geographic Distribution	Critical Habitat Designation
SONCC coho salmon	*Oncorhynchus kisutch*	threatened	June 20, 2005 (70 FR 37160)	From Cape Blanco Oregon, to Punta Gorda, California	May 5, 1999 (64 FR 24049)
NC Steelhead	*O. mykiss*	threatened	ESU listed on June 7, 2000 (65 FR 36074) Relisted as a DPS on Feb. 5, 2006 (71 FR 834)	From Redwood Creek in Humboldt County, California, to the Gualala River, inclusive	January 2, 2006 (70 FR 52488)
CC Chinook Salmon	*O. tshawytscha*	threatened	June 28, 2005 (70 FR 37160)	From Redwood Creek in Humboldt County, California, south through the Russian River	January 2, 2006 (70 FR 52488)
Klamath Mtn. Province Steelhead	*O. mykiss*	not warranted	April 4, 2001 (66 FR 17845)	From Elk River in Oregon through the Klamath and Trinity Rivers	N/A
Upper Klamath-Trinity Chinook	*O. tshawytscha*	not warranted	March 9, 1998 (63 FR 11482)	All watersheds upstream from the Klamath-Trinity confluence	N/A
SONCC Chinook	*O. tshawytscha*	not warranted	September 16, 1999 (64 FR 50393)	From Cape Blanco, Oregon, south to, but not including, Redwood Creek in Humboldt County, California	N/A

B. Species Life History, Population Trends and Factors Influencing Populations

1. Coho Salmon

a. General Life History

Coho salmon generally exhibit a relatively simple 3-year life cycle. Most coho salmon enter rivers between September and February. Coho salmon river entry timing is influenced by many factors, one of which appears to be river flow. In addition, many small California stream systems have their mouths blocked by sandbars for most of the year except winter. In these systems, coho salmon and other Pacific salmonids are unable to enter the rivers until sufficiently strong freshets open passages through the bars (Weitkamp *et al*. 1995). Coho salmon spawn from November to January (Hassler 1987), and occasionally into February and March (Weitkamp *et al*. 1995).

Although each native stock appears to have a unique time and temperature for spawning that theoretically maximizes offspring survival, coho salmon generally spawn at water temperatures within the range of 10-12.8°C (Bell 1991). Bjornn and Reiser (1991) and Nickelson *et al*. (1992) found that spawning occurs in a few third-order streams, but most spawning activity was found in fourth- and fifth-order streams with a gradient less than 3 percent. Spawning occurs in clean gravel ranging in size from that of a pea to that of an orange (Nickelson *et al*. 1992). Spawning is concentrated in riffles or in gravel deposits at the downstream end of pools featuring suitable water depth and velocity (Weitkamp *et al*. 1995). In summarizing suitable particle size distributions for spawning, Spence *et al.* (1996) stated that mortality of coho and steelhead occurs when fine sediment (<0.85mm) exceeds 13 percent of the substrate composition.

The favorable range for coho salmon egg incubation is 10-12.8°C (Bell 1991). Coho salmon eggs incubate for approximately 35 to 50 days, and start emerging from the gravel 2 to 3 weeks after hatching (Hassler 1987, Nickelson *et al*. 1992). Following emergence, fry move into shallow areas near the stream banks. As coho salmon fry grow, they disperse upstream and downstream to establish and defend territories (Hassler 1987).

Juvenile rearing usually occurs in tributary streams with a gradient of 3 percent or less, although they may move up to streams of 4 percent or 5 percent gradient. Juveniles have been found in streams as small as one to two meters wide. At a length of 38-45 mm, the fry may migrate upstream a considerable distance to reach lakes or other rearing areas (Godfrey 1965 *op. cit.* Sandercock 1991, Nickelson *et al*. 1992). Rearing requires temperatures of 20°C or less, preferably 11.7-14.4°C (Bell 1991, Reeves *et al*. 1987, Bjornn and Reiser 1991). Coho salmon fry are most abundant in backwater pools during spring. During the summer, coho salmon fry prefer pools greater than 1m in depth featuring adequate cover such as LWD, undercut banks, and overhanging vegetation. Juvenile coho salmon prefer to over-winter in large mainstem pools, backwater areas and secondary pools with LWD, and undercut bank areas (Hassler 1987, Heifetz *et al*. 1986). Coho salmon rear in fresh water for up to 15 months, then migrate to the sea as smolts between March and June (Weitkamp *et al*. 1995).

Little is known about residence time or habitat use in estuaries during seaward migration, although it is usually assumed that coho salmon spend only a short time in the estuary before entering the ocean (Nickelson *et al*. 1992). Growth is very rapid once the smolts reach the estuary (Fisher *et al*. 1983). In preparation for their entry into a saline environment, juvenile salmon undergo physiological transformations known as smoltification that adapt them for their transition to salt water (Hoar 1976). These transformations include different swimming behavior and proficiency, lower swimming stamina, and increased buoyancy that also make the fish more likely to be passively transported by currents (Saunders 1965, Folmar and Dickhoff 1980, Smith 1982). In general, smoltification is timed to be completed as fish are near the fresh water to salt water transition. Too long a migration delay after the process begins is believed to cause the fish to miss the "biological window" of optimal physiological condition for the transition (Walters *et al*. 1978).

While living in the ocean, coho salmon remain closer to their river of origin than do Chinook salmon (Weitkamp *et al.* 1995). Nevertheless, coho salmon have been captured several hundred to several thousand kilometers away from their natal stream (Hassler 1987). After about 12 months at sea, coho salmon gradually migrate south and along the coast, but some appear to follow a counter-clockwise circuit in the Gulf of Alaska (Sandercock 1991). Coho salmon typically spend two growing seasons in the ocean before returning to their natal streams to spawn as 3 year-olds. Some precocious males, called "jacks," return to spawn after only 6 months at sea.

b. Range-wide (ESU) Status and Trends of SONCC Coho Salmon

Available historical published coho salmon abundance information were summarized in the NMFS coast-wide status review (Weitkamp *et al*. 1995). The following are excerpts from this document.

> "Gold Ray Dam adult coho passage counts provide a long-term view of coho salmon abundance in the upper Rogue River. During the 1940s, counts averaged ca. 2,000 adult coho salmon per year. Between the late 1960s and early 1970s, adult counts averaged fewer than 200. During the late 1970s, dam counts increased, corresponding with returning coho salmon produced at Cole Rivers Hatchery. Coho salmon run size estimates derived from seine surveys at Huntley Park near the mouth of the Rogue River have ranged from ca. 450 to 19,200 naturally-produced adults between 1979 and 1991. In Oregon south of Cape Blanco, Nehlsen *et al*. (1991) considered all but one coho salmon population to be at "high risk of extinction." South of Cape Blanco, Nickelson *et al*. (1992) rated all Oregon coho salmon populations as depressed.
>
> Brown and Moyle (1991) estimated that naturally-spawned adult coho salmon returning to California streams were less than one percent of their abundance at mid-century, and indigenous, wild coho salmon populations in California did not exceed 100 to 1,300 individuals. Further, they stated that 46 percent of California streams which historically supported coho salmon populations, and for which recent data were available, no longer supported runs.

No regular spawning escapement estimates exist for natural coho salmon in California streams. California Department of Fish and Game (CDFG 1994 *op. cit.* Weitkamp *et al.* 1995) summarized most information for the northern California region of this ESU. They concluded that coho salmon in California, including hatchery populations, could be less than six percent of their abundance during the 1940's, and have experienced at least a 70 percent decline in the 1960's. Further, they reported that coho salmon populations have been virtually eliminated in many streams, and that adults are observed only every third year in some streams, suggesting that two of three brood cycles may already have been eliminated.

The rivers and tributaries in the California portion of this ESU were estimated to have average recent runs of 7,080 natural spawners and 17,156 hatchery returns, with 4,480 identified as native fish occurring in tributaries having little history of supplementation with non-native fish. Combining recent run-size estimates for the California portion of this ESU with Rogue River estimates provides a rough minimum run-size estimate for the entire ESU of about 10,000 natural fish and 20,000 hatchery fish."

Schiewe (1997a) summarized updated and new data on trends in abundance for coho salmon from the Northern California and Oregon Coasts. The following are excerpts from this document regarding the status and trends of the SONCC coho salmon ESU:

"Information on presence/absence of coho salmon in northern California streams has been updated since the study by Brown *et al.* (1994) cited in the status review. More recent data (Table 9) indicates that the proportion of streams with coho salmon present is lower than in the earlier study (52 percent vs. 63 percent). In addition, the BRT received updated estimates of escapement at the Shasta and Willow Creek weirs in the Klamath River Basin, but these represent primarily hatchery production and are not useful in assessing the status of natural populations.

New data on presence/absence in northern California streams that historically supported coho salmon are even more disturbing than earlier results, indicating that a smaller percentage of streams in this ESU contain coho salmon compared to the percentage presence in an earlier study. However, it is unclear whether these new data represent actual trends in local extinctions, or are biased by sampling effort."

NMFS (2001a) updated the status review for coho salmon from the Central California Coast (CCC) and the California portion of the SONCC ESUs. The following is a summary of the updated status review:

"In the California portion of the SONCC coho salmon ESU, there appears to be a general decline in abundance, but trend data are more limited in this area and there is variability among streams and years. In the California portion of the SONCC coho salmon ESU, Trinity River Hatchery maintains large production and is thought to create significant straying to natural populations. In the California portion of the SONCC coho salmon ESU, the percent of streams with coho present in at least one brood year has shown a decline from 1989-1991 to the present. In 1989-1991 and 1992-1995, coho were found in over 80 percent of the streams surveyed. Since then, the percentage has declined to 69 percent in the most recent three-year interval.

Both the presence-absence and trend data presented in this report suggest that many coho salmon populations in this ESU continue to decline. Presence-absence information from the past 12 years indicates fish have been extirpated or at least reduced in numbers sufficiently to reduce the probability of detection in conventional surveys. Unlike the CCC ESU, the percentage of streams in which coho were documented did not experience a strong increase in the 1995-1997 period. Population trend data were less available in this ESU, nevertheless, for those sites that did have trend information, evidence suggests declines in abundance."

Table 9. Summary statistics of historical and current presence-absence data for SONCC coho salmon (from Schiewe 1997a).

				Percent of Streams with Coho Salmon Present	
Area	**Streams historically inhabited by coho salmon**	**Streams recently surveyed**	**Number of streams with coho salmon present**	**New data**	**Brown *et al.* (1994)**
Del Norte County	130	46	21	46	55
Humboldt County	234	130	71	55	69
Total	364	176	92	52	63

Based on the very depressed status of current coho salmon populations discussed above, as well as insufficient regulatory mechanisms and conservation efforts over the ESU as a whole, NMFS concluded that the ESU was likely to become endangered in the foreseeable future (May 6, 1997, 62 FR 24588).

A recent status update (Good *et al.* 2005) indicates a continued low abundance with no apparent upward trends in abundance and possible continued declines in several California populations. The relatively strong 2001 brood year, likely due to favorable conditions in both freshwater and marine environments was viewed as a positive sign, but was a single strong year following more than a decade of generally poor years (Good *et al.* 2005).

Most recently, Williams *et al.* (2006) described the structure of historic populations of SONCC coho salmon. They described three categories of populations; functionally independent populations, potentially independent populations and dependent populations. Functionally independent populations are populations capable of existing in isolation with a minimal risk of extinction. Potentially independent populations are similar but rely on some interchange with adjacent populations to maintain a low probability of extinction. Dependent populations have a high risk of extinction in isolation over a 100-year timeframe and rely on exchange of individuals from adjacent populations to maintain themselves.

c. Factors Responsible for the SONCC Coho Salmon Population Decline

The SONCC coho salmon ESU was listed as threatened due to numerous factors including several long-standing, human-induced factors (*e.g.*, habitat degradation, harvest, water diversions, and artificial propagation) that exacerbate the adverse effects of natural environmental variability (*e.g.*, floods, drought, poor ocean conditions). Habitat factors that contributed to the decline of coho salmon in the SONCC ESU included changes in channel morphology, substrate changes, loss of instream roughness and complexity, loss of estuarine habitat, loss of wetlands, loss and/or degradation of riparian areas, declines in water quality, altered stream flows, impediments to fish passage, and elimination of habitat. The major activities identified as responsible for the decline of coho salmon in Oregon and California included logging, road building, grazing, mining, urbanization, stream channelization, dams, wetland loss, beaver trapping, artificial propagation, over-fishing, water withdrawals, and unscreened diversions for irrigation (May 6, 1997, 62 FR 24588). The manner in which logging and road construction have led to declines in SONCC coho salmon, and Pacific salmonids in general, is more thoroughly discussed in the *Environmental Baseline* section. The processes discussed there are applicable to the ESU as a whole.

Disease and predation were not believed to have been major causes in the species decline; however, they may have had substantial impacts in local areas. For example, Higgins *et al.* (1992) and CDFG (1994) reported that Sacramento River pikeminnow have been found in the Eel River Basin and are considered to be a major threat to native coho salmon. Furthermore, California sea lions and Pacific harbor seals, which occur in most estuaries and rivers where salmonid runs occur on the West Coast, are known predators of salmonids. Coho salmon may be vulnerable to impacts from pinniped predation. However, in the final rule first listing the SONCC coho salmon ESU in 1997, NMFS indicated that it was unlikely that pinniped predation was a significant factor in the decline of coho salmon on the west coast, although they may be a threat to existing depressed local populations. NMFS (1997b) determined that although pinniped predation did not cause the decline of salmonid populations, in localized areas where they co-occur with salmonids (especially where salmonids concentrate or passage may be constricted), predation may preclude recovery of these populations. Specific areas where predation may preclude recovery cannot be determined without extensive studies.

Existing regulatory mechanisms, including land management plans (*e.g.*, National Forest Land and Resource Management Plans, State FPRs), Clean Water Act section 404 activities, urban growth management, and harvest and hatchery management all contributed to varying degrees to the decline of coho salmon due to lack of protective measures, the inadequacy of existing measures to protect coho salmon and/or its habitat, or the failure to carry out established protective measures. Since the listing of the SONCC coho salmon ESU, no new threats have been identified.

2. Steelhead

a. General Life History

Biologically, steelhead can be divided into two basic run-types, based on the state of sexual maturity at the time of river entry and duration of spawning migration (Burgner *et al.* 1992 *op. cit.* Busby *et al.* 1996). The stream-maturing type, or summer steelhead, enters fresh water in a sexually immature condition and requires several months in freshwater to mature and spawn. The ocean-maturing type, or winter steelhead, enters fresh water with well-developed gonads and spawns shortly after river entry (Barnhart 1986). Variations in migration timing exist between populations. Some river basins have both summer and winter steelhead, while others only have one run-type. South of Cape Blanco, Oregon, summer steelhead are known to occur in the Rogue, Smith, Klamath, Trinity, Mad, and Eel Rivers, and in Redwood Creek (Busby *et al.* 1996).

Summer steelhead enter fresh water between May and October in the Pacific Northwest (Busby *et al*. 1996, Nickelson *et al*. 1992). They require cool, deep holding pools during summer and fall, prior to spawning (Nickelson *et al.* 1992). They migrate inland toward spawning areas, overwinter in the larger rivers, resume migration in early spring to natal streams, and then spawn (Meehan and Bjornn 1991, Nickelson *et al*. 1992) in January and February (Barnhart 1986).

Winter steelhead enter fresh water between November and April in the Pacific Northwest (Busby *et al*. 1996, Nickelson *et al*. 1992), migrate to spawning areas, and then spawn, generally in April and May (Barnhart 1986). Some adults, however, do not enter some coastal streams until spring, just before spawning (Meehan and Bjornn 1991).

There is a high degree of overlap in spawn timing between populations regardless of run type (Busby *et al*. 1996). Difficult field conditions at that time of year and the remoteness of spawning grounds contribute to the relative lack of specific information on steelhead spawning. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, steelhead rarely spawn more than twice before dying; most that do so are females (Nickelson *et al*. 1992). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996).

Steelhead spawn in cool, clear streams featuring suitable gravel size, depth, and current velocity. Intermittent streams may be used for spawning (Barnhart 1986, Everest 1973). Steelhead enter streams and arrive at spawning grounds weeks or even months before they spawn and are vulnerable to disturbance and predation. Cover, in the form of overhanging vegetation, undercut banks, submerged vegetation, submerged objects such as logs and rocks, floating debris, deep water, turbulence, and turbidity (Giger 1973 *op. cit.* Bjornn and Reiser 1991) are required to reduce disturbance and predation of spawning steelhead. It appears that summer steelhead occur where habitat is not fully utilized by winter steelhead; summer steelhead usually spawn further upstream than winter steelhead (Withler 1966 *op. cit.* Busby *et al.* 1996, Behnke 1992).

Steelhead require a minimum depth of 0.18 m and a maximum velocity of 2.44 m/s for active upstream migration (Smith 1973). Spawning and initial rearing of juvenile steelhead generally take place in small, moderate-gradient (generally 3-5 percent) tributary streams (Nickelson *et al*. 1992). A minimum depth of 0.18 m, water velocity of 0.30-0.91 m/s (Smith 1973, Thompson 1972), and clean substrate 0.6-10.2 cm (Hunter 1973 *op. cit.* Bjornn and Reiser 1991, Nickelson *et al*. 1992) are required for spawning. Spence *et al.* (1996) stated that mortality of coho salmon and steelhead occurs when fine sediment (<0.85mm) exceeds 13 percent of the substrate composition.

Steelhead spawn in 3.9-9.4°C water (Bell 1991). Depending on water temperature, steelhead eggs may incubate for 1.5 to 4 months before hatching, generally between February and June (Bell 1991). Bjornn and Reiser (1991) noted that steelhead eggs incubate about 85 days at 4°C and 26 days at 12°C to reach 50 percent hatch. Nickelson *et al*. (1992) stated that eggs hatch in 35-50 days, depending upon water temperature.

After 2 to 3 weeks, in late spring, and following yolk sac absorption, alevins emerge from the gravel and begin actively feeding. After emerging from the gravel, fry usually inhabit shallow water along banks of perennial streams. Fry occupy stream margins (Nickelson *et al.* 1992). Older fry establish and defend territories.

Summer rearing takes place primarily in the faster parts of pools, although young-of-the-year are abundant in glides and riffles. Winter rearing occurs more uniformly at lower densities across a wide range of fast and slow habitat types. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small wood. Some older juveniles move downstream to rear in larger tributaries and mainstem rivers (Nickelson *et al*. 1992).

Juvenile steelhead migrate little during their first summer and occupy a range of habitats featuring moderate to high water velocity and variable depths (Bisson *et al*. 1988). Rearing juveniles prefer water temperatures ranging from 12-15°C (Reeves *et al*. 1987). Juvenile steelhead feed on a wide variety of aquatic and terrestrial insects (Chapman and Bjornn 1969), and older juveniles sometimes prey on emerging fry. Steelhead hold territories close to the substratum where flows are lower and sometimes counter to the main stream; from these, they can make forays up into surface currents to take drifting food (Kalleberg 1958). Juveniles rear in freshwater from 1 to 4 years (usually 2 years in the California DPSs), then smolt and migrate to the ocean in March and April (Barnhart 1986). Winter steelhead juveniles generally smolt after 2 years in fresh water (Busby *et al*. 1996). Steelhead smolts are usually 15-20 cm total length and migrate to the ocean in the spring (Meehan and Bjornn 1991). Juvenile steelhead tend to migrate directly offshore during their first summer from whatever point they enter the ocean rather than migrating along the coastal belt as salmon do. During the fall and winter, juveniles move southward and eastward (Hartt and Dell 1986 *op. cit.* Nickelson *et al.* 1992).

Steelhead typically reside in marine waters for 2 or 3 years prior to returning to their natal stream to spawn as 4- or 5-year olds. Populations in Oregon and California have higher frequencies of age-1 ocean steelhead than populations to the north, but age-2 ocean steelhead generally remain dominant (Busby *et al*. 1996). Age structure appears to be similar to other west coast steelhead, dominated by 4-year-old spawners (Busby *et al*. 1996). Some steelhead return to fresh water after only 2 to 4 months in the ocean and are termed "half-pounders" (Snyder 1925). Half-pounders generally spend the winter in fresh water and then out migrate again the following spring for several months before returning to fresh water to spawn. Half-pounders occur over a relatively small geographic range in southern Oregon and northern California, and are only reported in the Rogue, Klamath, Mad, and Eel Rivers (Snyder 1925, Barnhart 1986, Kesner and Barnhart 1972, and Everest 1973).

b. Range-wide (by ESU or DPS) Status and Trends of Steelhead

Klamath Mountain Province Steelhead. The final listing determination (*i.e.*, not warranted) for the KMP steelhead ESU was provided on April 4, 2001 (66 FR 17845). An initial status review on KMP steelhead was presented by Busby *et al.* (1994) and updated in NMFS (2001b). Busby *et al.* (1994) identified five areas of concern regarding the abundance of steelhead within the ESU:

1. Although historical trends in overall abundance within the ESU are not clearly understood, there has been a substantial replacement of natural fish with hatchery fish.

2. Since about 1970, trends in abundance have been downward in most steelhead populations within the ESU, and a number of populations are considered by various agencies and groups to be at moderate to high risk of extinction.

3. Declines in summer steelhead populations are of particular concern.

4. Most populations of steelhead within the area experience a substantial infusion of naturally-spawning hatchery fish each year. After accounting for the contribution of these hatchery fish, we are unable to identify any steelhead populations that are naturally self-sustaining.

5. Total abundance of adult steelhead remains fairly large (above 10,000 individuals) in several river basins within the region, but several basins have runs below 1,000 adults per year.

As part of the status review update (NMFS 2001b), these concerns were revisited with more recent data. The final decision that the KMP steelhead did not warrant listing was based on two major factors:

1. Information indicated that the proportion of naturally spawning hatchery fish, at least in Oregon, is much lower than indicated by data available for the initial steelhead status review. This information increased confidence that naturally sustaining populations are more widely distributed throughout this ESU than previously thought.

2. New information provided information that abundance of natural fish in this ESU is probably at least 50,000 adults and may exceed 100,000.

These findings, coupled with NMFS' conclusion that existing conservation efforts are collectively benefiting steelhead in this ESU, formed the basis for the decision that the KMP steelhead ESU does not warrant listing under the ESA (April 4, 2001, 66 FR 17845).

Northern California Steelhead. Available historical published steelhead abundance data were summarized in the NMFS west coast steelhead status review (Busby *et al.* 1996). The following are excerpts from this document:

> "Prior to 1960, estimates of abundance specific to this ESU were available from dam counts in the upper Eel River (Cape Horn Dam–annual average of 4,400 adult steelhead in the 1930s), the South Fork Eel River (Benbow Dam–annual average of 19,000 adult steelhead in the 1940s), and the Mad River (Sweasey Dam–annual average of 3,800 adult steelhead in the 1940s).
>
> In the mid-1960s, estimates of steelhead spawning populations for many rivers in this ESU totaled 198,000. The only current run-size estimates for this area are counts at Cape Horn Dam on the Eel River where an average of 115 total and 30 wild adults were reported.
>
> Adequate adult escapement information was available to compute trends for seven stocks within this ESU. Of these, five data series exhibit declines and two exhibit increases during the available data series, with a range from 5.8 percent annual decline to 3.5 percent annual increase. Three of the declining trends were significantly different from zero. We have little information on the actual contribution of hatchery fish to natural spawning, and little information on present total run sizes for this ESU. However, given the preponderance of significant negative trends in the available data, there is concern that steelhead populations in this ESU may not be self-sustaining."

Schiewe (1997b) summarized updated and new data on trends in abundance for summer and winter steelhead in the Northern California ESU. The following are excerpts from this document:

> "Updated spawner surveys of summer steelhead in Redwood Creek, the south for of the Van Duzen River (Eel River Basin), and the Mad River suggest mixed trends in abundance: the Van Duzen fish decreased by 7.1 percent from 1980-96 and the Mad River summer steelhead have increased by 10.3 percent over the same time period. The contribution of hatchery fish to these trends in abundance is not known.
>
> New weir counts of winter steelhead in Prairie Creek (Redwood Creek Basin, Humboldt county) show a dramatic increase (over 36 percent) in abundance during the period 1985-1992. This increase is difficult to interpret because a major highway construction project during this time period resulted in intensive monitoring of salmonids in the basin and Prairie Creek Hatchery was funded to mitigate lost salmonid production. Therefore, it is unclear whether the increase in

steelhead reflects increased monitoring effort and mitigation efforts or an actual recovery of Prairie Creek steelhead."

In 2000, NMFS concluded that the status of the population had changed little since the 1997 evaluation. Based on this and a lack of implementation of State conservation measures, NMFS concluded that the NC steelhead ESU warranted listing as a threatened species (June 7, 2000, 65 FR 36074). A more recent review of the status of NC steelhead (Good *et al.* 2005) indicates that none of the recent data suggest any improvements in the status of the species. Most recently, on January 5, 2006, the NC steelhead ESU was reclassified as a DPS (January 5, 2006, 71 FR 834).

c. Factors Responsible for NC Steelhead Population Decline

NMFS identified numerous factors contributing to the decline of NC steelhead (June 7, 2000, 65 FR 36074). First, NMFS noted various sources of both riparian and instream habitat degradation. Increased sedimentation due to the combined effects of land management activities such as timber harvest, agriculture and mining have degraded and continue to degrade habitat conditions for NC steelhead. The processes by which timber harvest has led to declines in NC steelhead populations is more thoroughly discussed in the *Environmental Baseline* section.

A second factor for NC steelhead declines is the influence of past and present steelhead hatcheries- both in terms of genetic introgression and ecological interactions between hatchery and wild stocks. NMFS specifically identified the past practices of the Mad River Hatchery as potentially damaging to NC steelhead. CDFG out-planted non-indigenous hatchery Mad River Hatchery brood stocks to other streams within the DPS. They also attempted to cultivate a run of non-indigenous summer steelhead within the Mad River. CDFG ended these practices in 1996.

A third factor, is the introduction of nonnative species and habitat modifications that have resulted in increased predatory pressures on native steelhead populations. In particular, NMFS believes that predation by artificially introduced Sacramento pikeminnow in the Eel River is a major problem. Finally, NMFS also noted that under some circumstances, the impacts of recreational fishing might become a concern- particularly during years of decreased availability of refugia such as drought years. Since steelhead use similar habitats as coho and Chinook salmon for spawning and rearing, refer also to the *Factors Affecting SONCC Coho Salmon* and *Factors Affecting CC Chinook Salmon* sections of this Opinion for further information on factors affecting steelhead.

3. <u>Chinook Salmon</u>

a. General *Life* History

The coastal drainages south of Cape Blanco, Oregon are dominated by the Rogue, Klamath, and Eel Rivers. The Chetco, Smith, Mad, Mattole, and Russian Rivers and Redwood Creek are smaller systems that contain sizable populations of fall-run Chinook salmon (Campbell and Moyle 1990, ODFW 1995). Presently, spring-runs are found in the Rogue, Klamath, and Trinity Rivers; additionally, a vestigial spring-run may still exist on the Smith River (Campbell and Moyle 1990, USFS 1995a). Historically, fall-run Chinook salmon were predominant in most coastal river systems south to the Ventura River; however, their current distribution in coastal rivers only extends to the Russian River (Healey 1991). There have also been spawning fall-run Chinook salmon reported in small rivers draining into San Francisco Bay (Nielsen *et al.* 1994).

Of the Pacific salmon, Chinook salmon exhibit arguably the most diverse and complex life history strategies. Healey (1986) described 16 age categories for Chinook salmon, 7 total ages with 3 possible freshwater ages. Two generalized freshwater life-history types were described by Healey (1991): "stream-type" Chinook salmon reside in freshwater for a year or more following emergence, whereas "ocean-type" Chinook salmon migrate to the ocean within their first year.

Chinook salmon mature between 2 and 6+ years of age (Myers *et al.* 1998). Freshwater entry and spawning timing are generally thought to be related to local water temperature and flow regimes (Miller and Brannon 1982). Runs are designated on the basis of adult migration timing; however, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and actual time of spawning (Myers *et al.* 1998).

Run timing for spring-run Chinook salmon typically begins in March and continues through July, with peak migration occurring in May and June. Spawning begins in late August and can continue through October, with a peak in September. Historically, spring-run spawning areas were located in the river headwaters (generally above 400 m). Run timing for fall-run Chinook salmon varies depending on the size of the river. Adult Rogue, Upper Klamath, and Eel River fall-run Chinook salmon return to freshwater in August and September and spawn in late October and early November (Stone 1897, Snyder 1931, Nicholas and Hankin 1988, Barnhart 1995). In other coastal rivers and the lower reaches of the Klamath River, fall-run freshwater entry begins later in October, with peak spawning in late November and December - often extending into January (Leidy and Leidy 1984, Nicholas and Hankin 1988, Barnhart 1995).

When they enter freshwater, spring-run Chinook salmon are immature and they must stage for several months before spawning. Their gonads mature during their summer holding period in freshwater. Over-summering adults require cold-water refuges such as deep pools to conserve energy for gamete production, redd construction, spawning, and redd guarding. The upper temperature range for adults holding while eggs are maturing is 15°C (Hinze 1965). The upper preferred water temperature for spawning adult Chinook salmon is 14°C (Bjorn and Reiser 1991). Unusual stream temperatures during spawning migration and adult holding periods can alter or delay migration timing, accelerate or retard mutations, and increase fish susceptibility to diseases. Sustained water temperatures above 27°C are lethal to adults (Cramer and Hammack 1952, CDFG 1998).

Spring-run Chinook salmon eggs generally incubate between October to January, and fall-run Chinook salmon eggs incubate between October and December (Bell 1991). Length of time required for eggs to develop and hatch is dependant on water temperature and is quite variable, typically ranging from 3-5 months. The optimum temperature range for Chinook salmon egg incubation is 7°C to 12°C (Rich 1997). Incubating eggs show reduced egg viability and increased mortality at temperatures greater than 14°C and show 100 percent mortality for temperatures greater than 17°C (Neilson and Banford 1987). Neilson and Banford (1987) and Beacham and Murray (1990) found that developing Chinook salmon embryos exposed to water temperatures of 2°C or less before the eyed stage experienced 100 percent mortality (CDFG 1998). Emergence of spring- and fall-run Chinook salmon fry begins in December and continues into mid-April (Leidy and Leidy 1984, Bell 1991). In addition to temperature, embryo survival rates decrease when fine sediment less than 6.35 mm exceeds 20 percent of the spawning substrate (Bjornn and Reiser 1991).

Chinook salmon populations south of Cape Blanco all exhibit an ocean-type life history. The majority of fish emigrate to the ocean as subyearlings, although yearling smolts can constitute up to approximately one-fifth of outmigrants from the Klamath River Basin, and to a lesser proportion in the Rogue River Basin; however, the proportion of fish which smolt as subyearling vs. yearling varies from year to year (Snyder 1931, Schluchter and Lichatowich 1977, Nicholas and Hankin 1988, Barnhart 1995). This fluctuation in age at smoltification is more characteristic of an ocean-type life history. Furthermore, the low flows, high temperatures, and barrier bars that develop in smaller coastal rivers during the summer months would favor an ocean-type (subyearling smolt) life history (Kostow 1995).

Post-emergent fry seek out shallow, near shore areas with slow current and good cover, and begin feeding on small terrestrial and aquatic insects and aquatic crustaceans. Fry use woody debris, interstitial spaces in cobble substrates, and undercut banks as cover (Everest and Chapman 1972). As they grow to 50 to 75 mm in length, the juvenile salmon move out into deeper, swifter water, but continue to use available cover to minimize the risk of predation and reduce energy expenditure. The optimum temperature range for rearing Chinook salmon fry is 10°C to 13°C (Seymour 1956, Rich 1997) and for fingerlings is 13°C to 16°C (Rich 1997).

Ocean-type juveniles enter saltwater during one of three distinct phases. “Immediate” fry migrate to the ocean soon after yolk resorption at 30-45 mm in length (Lister *et al*. 1971 *op. cit.* Myers *et al.* 1988, Healey 1991). In most river systems, however, fry migrants, which migrate at 50-150 days post-hatching, and fingerling migrants, which migrate in the late summer or autumn of their first year, represent the majority of ocean-type emigrants. Stream-type Chinook salmon migrate during their second or, more rarely, their third spring. Under natural conditions stream-type Chinook salmon appear to be unable to smolt as subyearlings.

The diet of out-migrating ocean-type Chinook salmon varies geographically and seasonally, and feeding appears to be opportunistic (Healey 1991). Aquatic insect larvae and adults, *Daphnia*, amphipods (*Eogammarus* and *Corophium spp*.), and *Neomysis* have been identified as important food items (Kjelson *et al.* 1982 *op. cit.* Myers *et al.* 1998, Healey 1991). The optimal thermal range for Chinook during smoltification and seaward migration is 10°C to 13°C (Rich 1997).

Chinook salmon spend between 1 and 4 years in the ocean before returning to their natal streams to spawn (Myers *et al*. 1998). Fisher (1994) reported that 87 percent of returning spring-run adults are 3 years old based on observations of adult Chinook salmon trapped and examined at Red Bluff Diversion Dam on the Sacramento River between 1985 and 1991.

b. *Range-wide (by ESU) Status and Trends of Chinook salmon*

California Coastal Chinook Salmon. Available historical published Chinook salmon abundance information is summarized in Myers *et al.* (1998). The following are excerpts from this document:

> "Estimated escapement of this ESU was estimated at 73,000 fish, predominantly in the Eel River (55,500) with smaller populations in; Redwood Creek, Mad River, Mattole River (5,000 each), Russian River (500), and several small streams in Del Norte and Humboldt Counties.
>
> Within this ESU, recent abundance data vary regionally. Dam counts of upstream migrants are available on the South Fork Eel River at Benbow Dam from 1938 to 1975. Counts at Cape Horn Dam, on the upper Eel River are available from the 1940s to the present, but they represent a small, highly variable portion of the run. No total escapement estimates are available for this ESU, although partial counts indicate that escapement in the Eel River exceeds 4,000.
>
> Data available to assess trends in abundance are limited. Recent trends have been mixed, with predominantly strong negative trends in the Eel River Basin, and mostly upward trends elsewhere. Previous assessments of stocks within this ESU have identified several stocks as being at risk or of concern. Nehlsen *et al*. (1991) identified seven stocks as at high extinction risk and seven stocks as at moderate extinction risk. Higgins *et al*. (1992) provided a more detailed analysis of some of these stocks, and identified nine Chinook salmon stocks as at risk or of concern. Four of these stock assessments agreed with Nehlsen *et al*. (1991) designations, while five fall-run Chinook salmon stocks were either reassessed from a moderate risk of extinction to stocks of concern (Redwood Creek, Mad River, and Eel River) or were additions to the Nehlsen *et al*. (1991) list as stocks of special concern (Little and Bear Rivers). In addition, two fall-run stocks (Smith and Russian Rivers) that Nehlsen *et al*. (1991) listed as at moderate extinction risk were deleted from the list of stocks at risk by Higgins *et al*. (1992), although the U.S. Fish and Wildlife Service reported that the deletion for the Russian River was due to a finding that the stock was extinct."

Observed widespread declines in abundance and the present distribution of small populations with sometimes sporadic occurrences contribute to the risks faced in this ESU. Based on this information, NMFS concluded that the CC Chinook salmon ESU is likely to become endangered in the near future (September 16, 1999, 64 FR 50393). More recent information for the status of CC Chinook salmon (Good *et al.* 2005) continues to support this conclusion:

> "No information exists to suggest new risk factors or substantial effective amelioration of risk factors noted in the previous status reviews, except for recent changes in ocean conditions. Recent favorable ocean conditions have contributed to apparent increases in abundance and distribution for a number of anadromous salmonids, but the expected persistence of this trend is unclear."

Upper Klamath-Trinity Chinook Salmon. Available historical published Chinook salmon abundance information is summarized in Myers *et al.* (1998). The following are excerpts from this document:

> "Peak run-size in this ESU was estimated to be about 130,000 Chinook salmon in 1912 (from peak cannery pack of 18,000 cases). CDFG (1965) estimated spawning escapement of Chinook salmon within the range of this ESU to be about 168,000 adults, split about evenly between the Klamath (88,000) and Trinity (80,000) Rivers.
>
> The 5-year (1992-96) geometric mean of recent spawning escapements to natural spawning areas was about 48,000 fish. Fish returning to the two hatcheries in the basin accounted for 38 percent of the total (natural + hatchery) spawning escapement. Trends in escapement are relatively stable. The long-term trend statistics mask the fact that minimal abundances were observed in all areas in 1989-91, and populations have increased sharply since then.
>
> Previous assessments of stocks within this ESU have identified several stocks as being at risk or of concern. Nehlsen *et al.* (1991) identified seven stocks as extinct, two stocks (Klamath River spring-run Chinook salmon and Shasta River fall-run Chinook salmon) as at high extinction risk, and Scott River fall-run Chinook salmon as of special concern. Due to lack of information on Chinook salmon stocks that are presumed to be extinct, the relationship of these stocks to existing ESUs is uncertain. They are listed here based on geography and to give a complete presentation of the stocks identified by Nehlsen *et al.* (1991). Higgins *et al.* (1992) provided a more detailed analysis of some of the stocks identified by Nehlsen *et al.* (1991), classifying three Chinook salmon stocks as at risk or of concern. Of the three stocks Higgins *et al.* (1992) listed as at high risk of extinction, two matched with the Nehlsen *et al.* (1991) findings (Klamath River spring run and Shasta River fall run), while one stock was added to the list (South Fork Trinity River spring run). Additionally, three Chinook salmon stocks were identified as of special concern. Of these, Higgins *et al.* (1992) classified one (Scott River fall run) in agreement with that of Nehlsen *et al.* (1991), while two others (Trinity River spring run and South Fork Trinity River fall run) were additions to the earlier list."

The large disparity in the status of spring- and fall-run populations within the ESU make risk evaluation difficult. However, NMFS concluded that, because of the relative health of the fall-run populations, Chinook salmon in this ESU are not at significant risk of extinction, nor are they likely to become endangered in the foreseeable future and, therefore, listing was not warranted (March 9, 1998, 63 FR 11482).

Southern Oregon/Northern California Coastal Chinook Salmon. A status review prepared by the West Coast Chinook Salmon Biological Review Team (BRT, NMFS 1999a) summarizes data and trends for the SONCC Chinook salmon. The following are excerpts from this document relating to population status and trends:

"The BRT was encouraged by the overall numbers of Chinook salmon in this ESU and by the recent increases in abundance in many of the smaller coastal streams. In addition to the large runs returning to the Rogue River, Chinook salmon appear to be well distributed in a number of coastal streams throughout the geographic region encompassing this ESU. Although many of the new data sets received for review by the BRT are of short duration, the BRT was encouraged by recent efforts by the co-managers to improve monitoring of Chinook salmon in this region. Risks associated with the presence of hatchery fish in this ESU are relatively low; nevertheless, the BRT was concerned about the high percentages of naturally-spawning hatchery fish in the Chetco River and in the spring-run Chinook salmon population in the Rogue River. In addition, the restricted distribution of spring-run Chinook salmon to the Rogue and Smith River s and their significant decline in the Rogue River could represent an important threat to the total diversity of fish in this ESU.

The BRT noted several factors that are likely to have improved conditions for Chinook salmon in the Southern Oregon/Northern California Coastal Chinook Salmon ESU, including reductions in the KMZ [Klamath Management Zone] troll fishery, the listing of coho salmon under the Federal Endangered Species Act, changes in harvest regulations by the states of Oregon and California to protect naturally produced coho salmon and steelhead, and changes in timber and land-use practices on Federal public lands resulting from the Northwest Forest Plan."

Previous assessments within this ESU by Nickelson *et al.* (1992) considered 11 Chinook salmon stocks, of which 4 (Applegate River fall run, Middle and Upper Rogue River fall runs, and Upper Rogue River spring run) were identified as healthy, 6 as depressed, and 1 (Chetco River fall run) as of special concern due to hatchery strays. Nehlsen *et al.* (1991) identified the Smith River fall run Chinook salmon as at a moderate extinction risk. However, Higgins *et al.* (1992) deleted this stock from the list.

More specific information on population trends is provided by NMFS (1999a) and excerpted below:

"Although trends in abundance are mixed over the long-term, most short-term trends in abundance of fall Chinook salmon are positive in the smaller coastal streams in the ESU. Spawning ground surveys from a number of smaller coastal and tributary streams from Euchre Creek to the Smith River show declines in abundance from the late 1970s through the early 1990s, but recently, the peak counts are predominantly showing increases. In addition to adult counts, downstream migrant trapping generally shows increases in production in fall Chinook juveniles over the last four years in the Pistol and Winchuck Rivers and in Lobster Creek, a tributary to the lower Rogue River. Short- and long-term trends in abundance for the Rogue River fall Chinook are declining, but as mentioned above, the overall run size is still large."

For the California portion of this ESU, estimates of absolute population abundance are not available for most locations. Of interest in the California portion of this ESU is the Smith

River spring-run Chinook salmon. With the exception of Central Valley populations, this is the only known population of spring-run Chinook salmon along the California coast. Declines in this run have been noted in the Middle Fork of the Smith River while increases have been observed in the South Fork Smith River (NMFS 1999a). The Oregon Department of Fish and Wildlife (ODFW) believes that spring-run Chinook salmon populations in the Smith River probably have always been small, based on in-river fishery landings, historical cannery records and the judgment of local biologists (ODFW 1997).

NMFS concluded that Chinook salmon in the SONCC ESU are not presently in danger of extinction, nor likely to become so in the foreseeable future and, therefore, listing was not warranted. Overall numbers and recent increases in abundance in many of the smaller coastal streams combined with recent changes in ocean harvest and land management are cited as reasons for this conclusion (September 16, 1999, 64 FR 50393).

c. Factors Responsible for CC Chinook Salmon Population Decline

Habitat loss and/or degradation is widespread throughout the range of the CC Chinook salmon ESU. The California Advisory Committee on Salmon and Steelhead Trout (CACSST) reported habitat blockages and fragmentation, logging and agricultural activities, urbanization, and water withdrawals as the most predominant problems for anadromous salmonids in California's coastal basins (CACSST 1988). It identified associated habitat problems for each major river system in California. CDFG (1965, Vol. III, Part B) reported that the most vital habitat factor for coastal California streams was "degradation due to improper logging followed by massive siltation, log jams, *etc.*" CDFG (1965) cited road building as another cause of siltation in some areas. It is important to note the CDFG (1965) was evaluating timber harvest practices occurring in the 1940s and 1950s, and not current forest practices. It identified a variety of specific critical habitat problems in individual basins, including extremes of natural flows (Redwood Creek and Eel River), logging practices (Mad, Eel, Mattole, Ten Mile, Noyo, Big, Navarro, Garcia, and Gualala Rivers), and dams with no passage facilities (Eel and Russian Rivers), and water diversions (Eel and Russian Rivers). Delivery of large sediment pulses during recent major flood events (February 1996 and January 1997) have likely affected habitat quality and survival of juveniles within this ESU. A more thorough discussion of the effects of past logging and related activities is provided in the *Environmental Baseline* section.

Introductions of nonnative species and habitat modifications have resulted in increased predator populations in numerous rivers. Predation by marine mammals is also of concern in areas experiencing dwindling Chinook salmon run sizes. However, salmonids appear to be a minor component of the diet of marine mammals (Scheffer and Sperry 1931, Jameson and Kenyon 1977, Graybill 1981, Brown and Mate 1983, Roffe and Mate 1984, Hanson 1993). Principal food sources are small pelagic schooling fish, juvenile rockfish, lampreys (Jameson and Kenyon 1977, Roffe and Mate 1984), benthic and epibenthic species (Brown and Mate 1983) and flatfish (Scheffer and Sperry 1931, Graybill 1981).

Infectious disease is one of many factors that can influence adult and juvenile Chinook salmon survival. Chinook salmon are exposed to numerous bacterial, protozoan, viral, and parasitic organisms in spawning and rearing areas, hatcheries, migratory routes, and the marine environment. Very little current or historical information exists to quantify changes in infection levels and mortality rates attributable to these diseases for Chinook salmon. However, studies suggest that naturally spawned fish tend to be less susceptible to pathogens than hatchery-reared fish (Sanders *et al.* 1992).

Artificial propagation and other human activities such as harvest and habitat modification can genetically change natural populations so much that they no longer represent an evolutionarily significant component of the biological species (Waples 1991). Artificial propagation is a common practice to supplement Chinook salmon stocks for commercial and recreational fisheries. However, in many areas, a significant portion of the naturally spawning population consists of hatchery-produced Chinook salmon. Many of these hatchery-produced fish are derived from a few stocks that may or may not have originated from the geographic area where they are released. However, insufficient or uncertain information exists regarding the interactions between hatchery and natural fish, and the relative abundance of hatchery and natural stocks. Competition, genetic introgression, and disease transmission resulting from hatchery introductions may significantly reduce the production and survival of native, naturally-reproducing Chinook salmon. Collection of native Chinook salmon for hatchery brood stock purposes often harms small or dwindling natural populations. Artificial propagation may play an important role in Chinook salmon recovery, and some hatchery populations of Chinook salmon may be deemed essential for the recovery of threatened or endangered Chinook salmon ESUs. While some limits have been placed on hatchery production of anadromous salmonids, more careful management of current programs and scrutiny of proposed programs is necessary in order to minimize impacts on listed species. Artificial propagation programs within the CC Chinook salmon ESU are less extensive than those in upper Klamath/Trinity or SONCC ESUs. The Rogue, Chetco and Eel River Basins and Redwood Creek have received considerable releases, derived primarily from local sources. Current hatchery contribution to overall abundance is relatively low except for the Rogue River spring-run.

C. Environmental Influences on Salmonid Populations

1. <u>Climate Change</u>

The acceptance of global warming as a scientifically valid and anthropogenically driven phenomenon has been well established by the United Nations Framework Convention on Climate Change (UNFCCC 2006), and the Intergovernmental Panel on Climate Change (Davies *et al.* 2001). These changes are inseparably linked to the oceans, the biosphere, and the world's water cycle. Changes in the distribution and abundance of a wide array of biota confirm a warming trend is in progress, and that it has great potential to affect species' survival (Davies *et al.* 2001, Schneider and Root 2002). In general, as the magnitude of climate fluctuations increases, the population extinction rate also increases (Good *et al.* 2005). Global warming is likely to manifest itself differently in different regions and considerable uncertainty exists on the longer term evolution of climatic patterns. For example, in California, the overall amount of precipitation may increase, but will also be coupled with an increase in critically dry years, which suggests that storms may become more intense (Cayan *et al.* 2006). Many of the threats to Pacific salmonids are related to poor streamflow conditions, elevated water temperatures and excessive sediment. Changes in the precipitation regime would be expected to alter these processes and potentially increase extinction risks to Pacific salmonids across their range.

2. Ocean Conditions

Variability in ocean productivity has been shown to affect salmon production both positively and negatively. Beamish and Bouillion (1993) showed a strong correlation between North Pacific salmon production and marine environmental factors from 1925 to 1989. Beamish *et al.* (1997) noted decadal-scale changes in the production of Fraser River sockeye salmon that they attributed to changes in the productivity of the marine environment. They also reported the dramatic change in marine conditions occurring in 1976-77 (an El Niño year), when an oceanic warming trend began. These El Niño conditions, which occur every 3 to 5 years, negatively affect ocean productivity. Johnson (1988) noted increased adult mortality and decreased average size for Oregon Chinook salmon and coho salmon during the strong 1982-83 El Niño. Of greatest importance is not how salmonids perform during periods of high marine survival, but how prolonged periods of poor marine survival affect the viability of populations. Salmon populations have persisted over time, under pristine habitat conditions, through many such cycles in the past. It is less certain how they will fare in periods of poor ocean survival when their freshwater, estuary, and nearshore marine habitats are degraded (Good *et al.* 2005).

3. Reduced Marine-Derived Nutrient Transport

Reduction of marine-derived nutrients (MDN) to watersheds is a consequence of the past century of decline in salmon abundance (Gresh *et al.* 2000). MDN are nutrients that are accumulated in the biomass of salmonids while they are in the ocean and are then transferred to their freshwater spawning sites. Salmonids may play a critical role in sustaining the quality of habitats essential to the survival of their own species. MDN (from salmon carcasses) has been shown to be vital for the growth of juvenile salmonids (Bilby *et al.* 1996, Bilby *et al.* 1998). The return of salmonids to rivers makes a significant contribution to the flora and fauna of both terrestrial and riverine ecosystems (Gresh *et al.* 2000). Evidence of the role of MDN and energy in ecosystems suggests this deficit may result in an ecosystem failure contributing to the downward spiral of salmonid abundance (Bilby *et al.* 1996). The loss of this nutrient source may perpetuate salmonid declines in an increasing synergistic fashion.

D. Summary

To summarize the status of the species, we use the concept of viable salmonid populations and the parameters for evaluating populations described by McElhany *et al.* (2000). The parameters are abundance, population growth rate (productivity), spatial structure and population diversity. We briefly summarize the six ESUs/DPSs considered in this Opinion for each of these parameters. Finally, we provide a summary of the conservation value of the designated critical habitat for each of the three listed species.

1. Abundance

In general, smaller populations face a host of risks intrinsic to their low abundance levels. Our review of the status of the species for each of the six species proposed for incidental take coverage indicates that populations have declined well below historic levels. A host of factors has been responsible for these declines.

2. Population Growth Rate

The most recent data indicate continued declines in several California populations of SONCC coho salmon and no apparent trends in the other remaining coho salmon populations. Data for KMP steelhead indicate a general downward trend in abundance, with a particular concern over summer steelhead. Trends in NC steelhead populations show a preponderance of declines. The potential increases in NC steelhead populations are unclear; with introduced hatchery fish and increased monitoring efforts contributing to the uncertainty of the results. Information on CC Chinook salmon suggests mixed trends in populations. Recently improved ocean conditions likely factor into recently observed increases in abundance, but the persistence of this trend is unknown, particularly when ocean conditions shift to less favorable conditions. Chinook salmon of the Upper Klamath-Trinity ESU appear to remain relatively stable, primarily due to the fall run. However, we note that several populations in this ESU have gone extinct and we summarize this below. Populations of SONCC Chinook salmon show recent increases in abundance.

3. Population Spatial Structure

Recent information for SONCC coho salmon indicates that their range continues to shrink, as evidenced by an increasing number of previously occupied streams in which they are now absent. Little information exists on the current spatial structure of KMP steelhead populations. Although data indicate continuing declines in abundance, no information suggests that the distribution of fish has appreciably diminished. Similarly, despite the declines noted for NC steelhead populations, available information does not indicate a diminishing spatial structure. However, we are concerned that the continuing declines may portend a reduction in spatial structure and the limited monitoring conducted to date is not sufficient to detect this. Data for CC Chinook salmon indicate that many of the populations are small and occur sporadically. This raises concern over the future stability of the spatial structure of this ESU. Chinook salmon of the Upper Klamath-Trinity ESU show a clear reduction in spatial structure. A number of extinctions and continuing threats in a number of watersheds continue to limit the existing spatial structure of this ESU. Information for the SONCC Chinook salmon ESU suggests that population spatial structure remains largely intact.

4. Diversity

The primary factors affecting the diversity of SONCC coho salmon appear to be the influence of hatcheries and out-of-basin introductions. In addition, information from the action area indicates that some brood years have abnormally low abundance levels or may even be absent in some areas, furthering restricting the diversity present in the ESU. The diversity of KMP steelhead has been reduced by substantial replacement of natural fish with hatchery fish. Additionally, declines in summer steelhead populations heighten concerns over the diversity of the KMP steelhead ESU. For NC steelhead, low, or extirpated populations of summer steelhead and the influence of hatchery introductions threaten the diversity of this DPS. Little information exists on the current diversity of CC Chinook salmon. Spring-run populations were likely present in the Mad and Eel Rivers, but have since been extirpated. Trends and abundance information suggest that the diversity of the ESU is threatened by continued declines in abundance. Chinook salmon of the upper Klamath-Trinity ESU have experienced notable reductions in diversity. A number of populations have gone extinct and the persistence of the species depends, to a large degree, on the health of the fall-run populations. Information for SONCC Chinook salmon suggests that diversity of the ESU remains intact, although hatcheries and population declines in smaller streams are a continuing threat.

5. Designated Critical Habitat Conservation Value

The condition of designated critical habitat for the three listed salmonid species reflects the legacy of impacts to the respective ESUs and DPS. Land management activities have led to widespread habitat degradation. In particular, habitat elements for access, rearing, and reproduction have been impacted due to the combination of timber harvest and alterations in the natural flow regimes of larger rivers. Access has been restricted due to a number of large dams that form a total migration blockage. On a more localized scale, excessive sedimentation has led to aggraded stream reaches that dry up sooner and may prevent migration of juveniles. Similarly, excessive sedimentation and lack of woody debris has led to declines in the quantity and quality of pools and substrate quality necessary for juvenile rearing. Reproductive success has declined due to excessive sediment which has filled spawning gravels and reduced the quantity of suitable spawning habitat. Under these conditions, fry emergence rates have declined. Where these impacts overlap with the potential effects of the proposed action, we discuss these in more detail in the *Environmental Baseline* section that follows.

IV. ENVIRONMENTAL BASELINE

The environmental baseline includes "the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process" (50 CFR § 402.02). The environmental baseline provides a reference point to which we add the effects of operating under the ITP as required by regulation ("effects of the action" in 50 CFR § 402.02).

The action area is composed of the 11 HPAs extending from the uppermost portions of the drainages downstream to the Pacific Ocean (Figure 1). Although Green Diamond ownership may comprise but a small portion of a given HPA, our approach considers each watershed as a whole. This allows a consideration of baseline effects from upstream activities as well as the downstream effects of the proposed action.

This *Environmental Baseline* section is organized into four parts. First, the factors influencing the Pacific salmonids and their critical habitats across the entire action area are discussed. This includes a discussion of both historic and current impacts. NMFS describes these impacts in terms of the biological requirements for habitat features and processes necessary to support life stages of the Pacific salmonids within the action area. When habitat conditions in the environmental baseline depart from those biological requirements, the viability of the species and the conservation value of the critical habitat have been degraded, as is shown in our summary of historic and current trends for the species and critical habitat, below.

The biological requirements of listed and unlisted salmon and steelhead in the action area vary depending on the life history stage present and the natural range of variation present within that system (Groot and Margolis 1991, NRC 1996, Spence et al., 1996). Each salmonid ESU or DPS considered in this opinion exhibits one or more life stages in the action area. Thus, for this consultation, the biological requirements for listed and unlisted salmon and steelhead are the habitat characteristics that would support successful adult spawning, embryonic incubation, emergence, juvenile rearing, holding, migration and feeding in the action area. Generally, during salmonid spawning migrations, adult salmon require clean water with cool temperatures and access to thermal refugia, dissolved oxygen near 100 percent saturation, low turbidity, adequate flows and depths to allow passage over barriers to reach spawning sites, and sufficient holding and resting sites. Anadromous fish select spawning areas based on species-specific requirements of flow, water quality, substrate size, and groundwater upwelling. Embryo survival and fry emergence depend on substrate conditions (for example gravel size, porosity, permeability, and oxygen concentrations), substrate stability during high flows, and, for most species, water temperatures of 13 degrees celsius or less. Habitat requirements for juvenile rearing include seasonally suitable microhabitats for holding, feeding, and resting. Migration of juveniles to rearing areas requires access to these habitats. Physical, chemical, and thermal conditions may all impede movements of adult or juvenile fish.

Second, the distribution, abundance and trends for salmonids in each of the eleven HPAs are discussed. As part of this discussion, the historic population structure of SONCC coho salmon, CC Chinook salmon and NC steelhead are described to identify and better determine the role of each population in the ESU (or DPS) as a whole. The derivation of these historic populations is described in Williams *et al.* (2006) for SONCC coho salmon and in Bjorkstedt *et al.* (2005) for NC steelhead and CC Chinook salmon. Briefly, populations are categorized as either Functionally Independent, Potentially Independent, or Dependent. Functionally Independent populations were determined to have minimal demographic influence from adjacent populations and were considered viable-in-isolation. Populations that appeared to have been viable-in-isolation but were demographically influenced by adjacent populations were classified as Potentially Independent. Finally, populations that did not have a high likelihood of sustaining themselves over a 100-year time period in isolation and receive sufficient immigration to alter their dynamics and extinction risk were classified as Dependent.

The discussion of the distribution, abundance and trends for salmonids also includes a description of the conservation value for occupied sub-watersheds within a given HPA that was developed as part of the critical habitat designations for CC Chinook salmon and NC steelhead [NMFS Critical Habitat Analytical Review Team (CHART) 2005]. This "CHART process" ranked the conservation value of a particular sub-watershed as "high," "medium," or "low." To arrive at these ratings, the CHART considered a variety of data sources and employed a generally uniform scoring system based on the quality, quantity, and distribution of physical or biological features associated with spawning, rearing, and migration in each sub-watershed. Using its best professional judgment, the CHART rated the conservation value of the critical habitat in watersheds, riverine corridors, and estuarine areas.

The third part of the *Environmental Baseline* section is a discussion of the factors limiting the recovery of salmonids for each HPA. Finally, this information is summarized in the fourth part to describe the current condition of the species, in terms of its likelihood of survival and recovery, and the conservation value of critical habitat in the action area and the role that the action area plays in the overall conservation of the listed species.

A. Historic and Current Impacts to Salmonids and Their Habitat in the Action Area

A number of factors influence salmonids and salmonid habitat across the multiple HPAs that comprise the action area. Given the large extent of the action area, the factors affecting salmonids at the ESU and DPS scales as discussed in the *Status of the Species* section apply similarly to the action area.

1. Freshwater Fisheries

Determining the impact past commercial, historic, and ongoing recreational fisheries have had on the decline of salmonids originating from the action area is difficult. In the early 1900s, canneries at the mouths of large rivers such as the Eel, Klamath and Smith Rivers processed tons of adults returning to the rivers. As populations declined, these canneries were abandoned, but in-stream sport fisheries continued. During the fall, salmon and steelhead often congregate in the lower rivers, awaiting rainfall to proceed upstream, and are vulnerable to angling. In recent years, increased regulations have limited the take of salmonids, even requiring the immediate release of all wild salmonids. However, even with more stringent regulations, incidental hooking mortality of listed salmonids continues.

2. Timber Harvest and Related Activities

In general, timber harvesting and related activities such as road construction, are widespread activities that occur throughout the action area and have been one of the more significant impacts on salmonids and their habitat across the entire action area. The greatest historic impacts of commercial forestry on salmonids and their habitat occurred when timber harvest and road construction were unregulated, resulting in a legacy of impacts that are still observed in the environmental baseline. However, since 1973, commercial forestry has been regulated in California, and those regulations have become increasingly more protective of salmonids and their habitat. Accordingly, past impacts are gradually ameliorated through natural processes and improvements in current forest practices, resulting in habitat conditions that are projected to gradually improve over the life of the proposed action. How past activities and baseline trends influence watershed processes and, consequently, influence stream habitat and salmonids are discussed in the following sections:

a. Changes in the supply of woody debris from hillslopes
b. Changes in sediment delivery to channels
c. Alterations to the hydrologic regime
d. Changes in stream temperatures
e. Changes in the nutrient supply from adjacent vegetation and hillslopes

a. *Woody Debris*

Woody debris entering streams from adjacent stands provides a fundamental salmonid habitat component. Wood provides areas of localized scour and deposition, thus creating pools necessary for juvenile rearing and adult holding, and gravels necessary for spawning. Instream woody debris also stores and meters sediment to downstream reaches, thereby moderating the impacts of upstream sediment inputs. Conifers provide the most functional woody debris because they are larger and more resistant to decay.

In the smaller Class II and III streams, recruited wood usually is not washed away, so logs remain in place and act as check-dams that store sediment eroded from hillsides (Reid 1998). Sediment storage in smaller streams can persist for decades (Nakamura and Swanson 1993). In assessing the characteristics of Class III watercourses in the plan area, Simpson (2002) found that coniferous woody debris was the predominant element in the formation of channel bed grade control points. Furthermore, where channels are prone to debris flows, woody debris and adjacent riparian stands can provide roughness elements that limit the distance debris flows may travel down-channel [Ketcheson and Froehlich 1978 *op. cit.* Swanson *et al.* 1987, Pacific Watershed Associates (PWA) 1998]. For example, in Bear Creek, tributary to the Eel River approximately five miles south of the action area, PWA (1998) noted that debris flows now travel farther downstream and channel aggradation extends farther downstream because of a lack of large wood from landslide source areas as well as streamside stands in the course of the debris torrent.

On larger channels, wood again stores sediment, and also provides a critical element in the habitat of aquatic life-forms (Spence *et al.* 1996, Reid 1998). Sullivan *et al.* (1987 *op. cit.* Swanston 1991) found that woody debris forms abundant storage sites for sediment in forest streams as large as fourth-order (20- 50 km^2 drainage area), where storage is otherwise limited by steep gradients and confinement of channels between valley walls. Studies of this storage function in Idaho by Megahan and Nowlin (1976 *op. cit.* Swanston 1991) and in Oregon by Swanson and Lienkamper (1978; *op. cit.* Swanston 1991) indicated that annual sediment yields from small forested watersheds are commonly less than 10 percent of the sediment stored in channels.

In fish-bearing streams, woody debris is important for storing sediment, halting debris flows, and decreasing downstream flood peaks, and its role as a habitat element becomes directly relevant for Pacific salmon species (Reid 1998). Large woody debris alters the longitudinal profile and reduces the local gradient of the channel, especially when log dams create slack pools above or plunge pools below them, or when they are sites of sediment accumulation (Swanston 1991).

Past timber harvest, particularly on private lands, often occurred right up to the edge of the channel, and in many instances, downed trees were removed from the channel either as part of harvesting or in an attempt to improve fish passage conditions. For example, extensive removal of debris jams after the 1964 flood and salvage of trees and logs in the riparian zone have resulted in a long-term deficit in the supply of LWD in the Smith River HPA [U.S. Forest Service (USFS) 1995b]. In general, the surveys conducted by Simpson (2002) indicate low amounts of LWD and existing size of LWD tends to be small (primarily 1-2 foot diameter pieces). Removal of woody debris in the 1980s (Wooster and Hilton 2004) has likely contributed to the lack of wood observed in many channels, but little information exists describing the extent of streams where removal has occurred. Further, these surveys indicate that many riparian zones tend to be dominated by alder and willow, which do not become functional LWD given their small size and rapid decomposition, and younger conifers (Simpson 2002). This is particularly true of privately owned lands where timber harvesting has occurred much longer and more intensively than on nearby Federally-managed lands. In the lower portions of several HPAs, agricultural and rural development has limited the extent of streamside vegetation. Given the current vegetation age structure within current Green Diamond lands (Table 3), past logging and development history along streams, recruitment of adequately-sized woody debris to many of the stream reaches in the action area is not likely to occur for several decades.

The construction of roads along streams has also had pervasive and long-lasting effects on wood recruitment patterns. Where roads parallel streams, a portion of the riparian zone no longer provides a source of woody debris. The road running surface and areas along the road that are cleared, or "daylighted" (as described in Simpson 2002, pg. 6-26 and 6-37), as well as the interception of trees falling from upslope have reduced recruitment quantities. Approximately 518 miles of Class I streams exist on the current ownership and there are about 116 miles of road that have at least half of the road prism within RMZ of Class I streams (Simpson 2002). Where a road borders a stream, some of the historic and current potentially deliverable wood is unavailable for recruitment. However, in there will be larger trees present between the outer edge of the road and the stream that will be available for recruitment.

We expect levels of LWD will gradually increase over a period of several decades as older, previously harvested streamside stands attain functional sizes. In some cases, wood levels may continue to decline as current in-stream wood decays or is exported from a watershed and adjacent forest stands have not reached adequate size to deliver functional woody debris. This recovery in recruitment will be moderated on approximately 22 percent of the Class I streams by existing streamside roads.

b. Sediment Delivery

The delivery of sediment to streams can be generally considered as either chronically delivered, or more episodic in nature. Chronic delivery, or surface erosion, occurs through rainsplash and overland flow. Therefore, surface erosion occurs often - associated with rainfall. More episodic delivery occurs in the form of mass wasting events, or landslides, that deliver large volumes of sediment during large storm events. Mass wasting is a much more infrequent process, occurring on the order of every few years in association with large storms.

(1) Chronic Erosion and Turbidity. Road construction, use, and maintenance; tree-felling, log hauling, slash disposal, site preparation for replanting, and soil compaction by logging equipment are all sources of fine sediment (Hicks *et al.* 1991, Murphy 1995) that could ultimately deliver to streams in the action area. The potential for delivering sediment to streams increases as hillslope gradients increase (Murphy 1995). The soils in virgin forests generally resist surface erosion because their coarse texture and thick layer of organic material and moss prevent overland flow (Murphy 1995). All of the activities associated with timber management in the action area have previously been known to reduce the ability of forest soils to resist erosion and contribute to the production of non-point sources of stream pollution by fine sediment. Yarding activities that cause extensive soil disturbance and compaction can increase splash erosion and channelize overland flow. Site preparation and other actions which result in the loss of the protective humic layer can increase surface erosion (Hicks *et al.* 1991). Prescribed fires can also consume downed wood that had been acting as sediment dams on hillslopes. After harvesting, root strength declines, often leading to slumps, landslides, and surface erosion [Forest Ecosystem Management Assessment Team (FEMAT) 1993, Thomas *et al.* 1993]. Riparian tree roots provide bank stability; streambank sloughing and erosion often increase if these trees are removed, leading to increases in sediment and loss of overhanging banks, which are important habitat for rearing Pacific salmonids (Murphy 1995). Where rates of timber harvest are high, the effects of individual harvest units on watercourses are cumulative. Therefore, in sub-watersheds where timber harvest is concentrated in a relatively short period of time, we expect that fine sediment impacts will be similarly concentrated.

Construction of road networks can also greatly accelerate erosion rates within a watershed (Haupt 1959, Swanson and Dyrness 1975, Swanston and Swanson 1976, Beschta 1978, Gardner 1979, Kelsey *et al.* 1981, Reid and Dunne 1984, Hagans and Weaver 1987, Best *et al.* 1995). Once constructed, road networks are a chronic source of sediment to streams (Swanston 1991) and are generally considered the main cause of accelerated surface erosion in forests across the western United States (Harr and Nichols 1993). Processes initiated or affected by roads include landslides, road surface erosion, secondary surface erosion (landslide scars exposed to rainsplash), and gullying. Roads and related ditch networks are often hydrologically connected to streams via surface flow paths, providing a direct conduit for sediment.

Hydrologically-connected road segments are a source of ongoing chronic erosion in the action area. Ownership-wide, an average of 30 percent of the road network is estimated to be hydrologically-connected to the stream network (Simpson 2002). However, inventory data from the Little River HPA indicate that 74 percent of the road network, or approximately 218 miles, are hydrologically connected (Simpson 2002), indicating that the degree of connectivity varies greatly across the action area.

Hagans and Weaver (1987) found that fluvial hillslope erosion associated with roads in the lower portions of the Redwood Creek watershed produced about as much sediment as landslide erosion between 1954 and 1980. More recently, the Pacific Lumber Company (PALCO 2001) found that road-related surface erosion accounted for roughly 60 percent of all management-related sediment input in Freshwater Creek, located in the Humboldt Bay HPA. Conversely, in the lower Van Duzen River watershed, PALCO (2002) found that road-related surface erosion accounted for 13 percent of management-related sediment inputs. In the case of the Van Duzen River, management-related landslide sediment delivery was much greater than in Freshwater Creek and, therefore, represents a larger portion of the management-related sediment inputs.

Road surface erosion is particularly affected by traffic, which increases sediment yields substantially (Reid and Dunne 1984). Other important factors that affect road surface erosion include condition of the road surface, timing of when the roads are used in relation to rainfall, road prism moisture content, location of the road relative to watercourses, methods used to construct the road, and steepness on which the road is located.

Historically, roads have negatively affected salmonid habitat by increasing sediment loads and turbidity in streams, altering the morphology of stream channels, destabilizing streambanks, modifying drainage networks, creating barriers to movement, and increasing the potential for chemical pollution of the aquatic ecosystem (Furniss *et al.* 1991). Cederholm *et al.* (1981) reported that the percentage of fine sediments in spawning gravels increased above those found in unmanaged watersheds when more than 2.5 percent of a basin area was covered by roads. For example, chronic sediment accumulation in the form of filled pools and highly embedded spawning gravels have been documented within the Coastal Klamath HPA tributaries of Hunter, Saugep, McGarvey, Omagaar, Bear, Surpur, and Little Surpur Creeks (Voight and Gale 1998). Similar habitat degradation has been documented within the Interior Klamath HPA tributaries of Morek, Johnson, and Tectah (upper and lower reaches) Creeks (Voight and Gale 1998). During the 1999-2000 season, turbidity monitoring at a site in Freshwater Creek showed that turbidity levels were sufficient to induce behavioral, sub-lethal and minor physiological stress in juvenile salmonids (PALCO 2001). Although these data only represent one winter, they highlight the role of chronic turbidity in influencing the growth and fitness of juvenile salmonids.

(2) Mass Wasting. Mass wasting, or the catastrophic and generally episodic delivery of large volumes of sediment to streams, is a major component of sediment delivery to streams (Spence *et al.* 1996). Mass wasting supplies organic debris and coarse sediment to streams that form functional salmonid habitat. The long-term variation in mass wasting, both spatially and temporally, generates a mosaic of stream habitat conditions, causing a succession of salmon habitats ranging from naturally poor to excellent, depending on the time of last disturbance and the salmonid species of interest (Reeves *et al.* 1995). Timber harvest and related activities such as road construction and maintenance increase the frequency of these events (both spatially and temporally), and alter the nature of the disturbances when these landslides deliver to watercourses without woody debris to store and route the sediment (Spence *et al.* 1995). The interaction of these activities can result in cumulative effects that would be greater than the effect of each component considered individually. For example, removal of timber from steep slopes increases the probability of mass wasting. However, woody debris, when delivered to the stream, provides necessary sediment storage and routing functions to moderate the effects of the sediment delivery and provide aquatic habitat. The impact can be compounded as increased sediment loads are accompanied by reduced volumes of woody debris. Thus, harvest of timber from landslide-prone areas can increase rates of sedimentation and simultaneously remove the mechanisms by which sediment is stored and routed through channel networks to form complex habitats. The result is that timber harvest can simplify stream habitats over large areas by increasing the volume and rate of sediment delivery absent the necessary woody debris to form complex habitats. In general, simplified habitats are characterized by a relatively flat longitudinal channel profile: lacking deep pools, backwater areas and other complex habitat features that salmonids require for spawning, rearing and sheltering.

Roads associated with timber harvesting are widespread throughout the action area. Many of the roads were constructed prior to the current forest practice rules and have resulted in large volumes of sediment delivery to fish-bearing channels. Past road, landing and skid trail related landsliding account for 25 percent to 55 percent of the total landslide volume in three inventoried watersheds on the ownership (Simpson 2002). Using the 1997 photo set to estimate most current conditions, roads account for 39 percent of the observed shallow landslide deposits in Hunter Creek (Simpson 2002).

Simpson (2002) estimates that approximately 6.4 million cubic yards (mcy) of road-related sediment exist across the current ownership within the plan area in high and moderate treatment priority sites. To estimate the volume currently in low priority sites, we used data from five watersheds where Green Diamond has conducted road inventories. The total volume of estimated future sediment delivery from low priority sites is 165 cubic yards per mile of road (cy/mi). Using a total of 4,311 miles of road across the ownership (Appendix F3, Simpson 2002), the estimated total future sediment delivery from low priority sites is 711,315 cy. However, a portion of this estimate includes road-related mass wasting which was already included in the high and moderate quantities estimated above. Thus, to avoid double counting the incidences of road-related mass wasting, this quantity of sediment must be removed from the estimate of 711,315 cy presented above. Table F3-1 in Appendix F3 of Simpson (2002), provides plan-area estimates of the volumes of road-related sediment from watercourse crossings, landslides and other sources such as failed cross drains. Road-related landslides account for 23 percent of the road-related sediment. Thus, subtracting this out from the estimate of sediment in low-volume sites yields a volume of 547,713 cy (0.5 mcy). Under current conditions, Simpson (2002) estimates that the long-term average annual road-related sediment production is 77,779 cy/yr from high and moderate sites.

c. Hydrology

Timber harvesting activities can have significant effects on hydrologic processes that determine streamflow. Timber harvests and road construction alter runoff by accelerating surface flows from hillsides to stream channels (Chamberlin *et al.* 1991, McIntosh *et al.* 1994). These accelerated flows can increase summer base (low) flows (Keppeler 1998) and increase peak flows during rainstorms (Ziemer 1998). Removal of vegetation reduces evapotranspiration, which can increase the amount of water that infiltrates the soil and ultimately reaches the stream. Conversely, soil compaction caused by heavy equipment can decrease infiltration capabilities, increasing surface runoff. Forest management activities that substantially disturb the soil, such as yarding, burning, or road and skid trail construction, may alter both surface and subsurface pathways that transport water to streams (Thomas *et al.* 1993, Murphy 1995, Keppeler and Brown 1998). Logging can also alter the internal soil structure. As tree roots die, soil "macropores" collapse or are filled in with sediment. These subsurface pathways are important for water transmission. When subsurface flow pathways are destroyed, the flow may be routed to the surface and increase gully erosion and sediment delivery (Keppeler and Brown 1998). Ditches associated with roads collect run-off and intercept subsurface flows and route them to streams more quickly. Roads act as first order streams and channel more water directly into larger streams (Wemple 1994). Increased peak flows can have direct effects on salmon because the resulting increased stream power can scour stream channels, killing incubating eggs, and displacing juvenile salmon from winter cover (McNeil 1964, Tschaplinski and Hartman 1983).

Much information has been collected and analyzed that demonstrates timber harvesting has increased the magnitude of peak flows in Freshwater Creek (PALCO 2001) and likely Elk River, in the Humboldt Bay HPA. These changes have been brought about by removal of the forest canopy, which reduces rainfall interception and increases the volume of water available for runoff. Additionally, roads are able to capture subsurface storm flows and route the water more efficiently to the channel, thereby increasing the magnitude of peak flows (PALCO 2001). Adding to this effect is the accumulation of logging-related sediment in the mainstem of

Freshwater Creek, which raises the water surface elevation, thereby increasing the elevation of flood peaks. Analysis by PALCO (2001) suggested that these increases in peak flows were insufficient to scour redds or induce channel instability over those expected in the absence of management influence (PALCO 2001). Therefore, while peak flows have increased due to timber harvesting, the effects on salmonids appear to be negligible.

d. Stream Temperatures

Increased water temperatures in streams is often associated with the removal of shade-producing vegetation (Thomas *et al.* 1993). The principal source of energy for heating streams results from solar radiation directly striking the surface of water (Beschta *et al.* 1987). Water temperatures in forest streams increase as a result of reductions in canopy cover, which can increase stream temperatures by as much as 10°C (Beschta *et al.* 1987). Increases in stream temperatures up to 10°C were observed when clear-cutting was followed by burning (Brown and Krygier 1970 *op. cit.* Spence *et al.* 1996). The temperature increase in a stream is directly proportional to the area exposed to sunlight and inversely proportional to the volume of water in the stream. As a result, the effect of canopy removal on stream temperatures is greatest for small, perennial streams and diminishes as streams get wider.

One of the purposes of riparian buffers is to provide adequate overstory canopy to shade aquatic habitat. The removal of overhead canopy cover results in increased solar radiation reaching the stream, which results in increased water temperatures (Spence *et al.* 1996). Spence *et al.* (1996) reported that old-growth stands provided between 80 and 90 percent canopy cover from studies in western Oregon and Washington. Flosi *et al.* (1998) and CDFG (1996) recommended an 85 percent riparian canopy to properly shade streams that might be used by salmonids.

Based on review of numerous investigations, Johnson and Ryba (1992) concluded that forested buffer widths greater than 100 feet generally provide the same level of shading as that of an old-growth forest stand. Other authors (*e.g.*, Beschta *et al.* 1987, Murphy 1995) have also concluded that buffers greater than 100 feet provide adequate shade to stream systems. The curves presented in FEMAT (1993) suggest that 100 percent effectiveness for shading is approached at a distance of approximately 0.75 tree heights from the stream channel. Assuming a tree height of 170 feet (100-year old redwood, site class 2; Lindquist and Palley 1963), this buffer width should be 127 feet to provide 100 percent shading effectiveness.

Simpson (2002) provides data for an extensive network of temperature monitoring stations on streams draining the Green Diamond ownership. With the exception of the mainstem rivers, temperature in most of the tributaries is not of concern for salmonids. Elevated temperatures do exist, generally in more inland locations away from the moderating influence of the coast.

Stressful temperatures are well documented in the larger mainstem rivers. Anderson (1988) determined that in the mainstem of Redwood Creek during the summers of 1980 and 1981, water temperatures were generally between the upper preferred and upper lethal temperatures for juvenile steelhead. In some reaches, water temperatures exceeded the upper lethal temperature. For example, the U.S. Geological Survey measured a water temperature of

33.5°C at the O'Kane gaging station in 1977 (Madej 1996). Water temperatures within the lower Mad River demonstrate a cooling trend from upper river areas; however, according to Jensen (2000), the "general water temperature range in the lower Mad River was 18-22°C (64-71°F), and the maximum sustained temperatures were in the range of 22-24°C (71-73°C)." These temperatures are stressful to lethal for most salmonid species. Water temperatures in the mainstem Eel and Van Duzen Rivers are stressful to salmonids. Jensen (2000) found that fluctuations in daily water temperatures generally ranged from 17°C (62°F) to 21°C (66°F) during the 1999 gravel mining survey season. Maximum sustained water temperatures ranged from 21EC (66°F) to 24EC (75°F). These temperatures indicate that the mainstem reaches of the Eel and Van Duzen Rivers do not provide suitable conditions for salmonid rearing.

In the mainstem Klamath River, poor water quality conditions during the summer have been recognized as a major contributing factor to the decline of anadromous salmonids (Bartholow 1995). The Klamath River mainstem often reaches daytime maximum temperatures well over 25°C (Belchik 2003), well above optimal temperatures for juvenile salmonids. Using a weekly mean temperature of 15°C as a threshold for chronic salmonid stress and a daily mean temperature of 20°C as an acute threshold, the 1966-1982 Klamath River temperatures at Orleans (approximately 15 miles upstream of the plan area) exceeded the acute and chronic thresholds a substantial portion of the time (Bartholow 1995). Campbell (1995) analyzed water quality data for 22 sites in the Klamath River Basin, applying the 1986 USEPA criteria. The most common water quality criteria exceeded were temperature at all 22 sites, and dissolved oxygen concentration at 11 sites.

Stream temperatures in the action area are expected to improve as riparian stands are re-established among formerly harvested channels. The degree to which the larger rivers are expected to recover, is difficult to determine. The recovery of the smaller, tributary streams will certainly benefit the mainstem channels by providing cool water inputs. However, existing dams and altered streamflows may continue to limit the ability of these largest channels to achieve thermal conditions preferred by salmonids. Additionally, the large size of the channels may predispose them to be naturally warm and less desirable to salmonids.

e. Nutrients

The primary productivity of streams within the action area is primarily driven by allochthonous inputs (derived from outside the aquatic system typically through detrital inputs). One of the most important sources of detrital inputs to lower order streams is red alder (Murphy and Meehan 1991). Red alder fixes atmospheric nitrogen and the leaves rapidly decompose in the stream, providing a ready source of nitrogen for primary productivity, ultimately providing the food base that juvenile salmonids depend on for growth prior to migrating out to sea. Another historically important nutrient source is decaying adult salmon carcasses. Given the precipitous declines in salmon populations as described in the *Status of the Species* section, the source of nutrients from salmon carcasses has been reduced from historic levels and may have implications on stream productivity by reducing the abundance of aquatic invertebrates and, therefore, reducing the food base that rearing salmonids depend on. A 2-year study conducted on Green Diamond property showed that canopy removal within 100-meter reaches in the riparian zone increased juvenile steelhead and cutthroat densities and biomass compared to closed canopies, due to increased incident radiation, but were not affected by carcass supplements (Wilzbach *et* *al.* 2005). Differences in the salmonid growth rates between the open and closed riparian zones were greater in sites without carcasses additions than with carcasses. The authors note that canopy removal in light-limited settings where temperature gains associated with canopy opening are not problematic for aquatic resources, gains in salmonid production might be achieved by selective thinning of riparian hardwoods.

Where streamside stands have been harvested, much of the vegetation that has subsequently regrown is composed of red alder (Simpson 2002). Therefore, we would expect that across the action area, past harvesting has led to increases in stream nutrients. However, we do not know the effects this change in nutrient supply has had on salmonids. We expect that the change has had a minor influence, at best, on salmonids, since the overall distribution of forested lands adjacent to streams has changed little across the action area. The primary effect has been a change in vegetation composition, rather than overall presence of vegetation.

Although not directly related to timber harvest, we also note that the Klamath River has elevated nutrient levels derived largely from agricultural practices in the upper watershed. Animal wastes, fertilizers, pesticides, and herbicides enter the stream as a result of storm runoff and return flows from irrigation. This has resulted in elevated nutrient levels in the Klamath River and some tributaries. This, combined with elevated temperatures, results in stimulation of aquatic plant and algae growth. As water temperatures rise and plants and algae decompose, the level of dissolved oxygen decreases. Dissolved oxygen levels in the Klamath River often fall below the state's water quality objective of 7.0 mg/l.

The above framework describing the influences of timber harvest and related activities will be used in the discussions for specific HPAs in the section that follows.

3. Dams and Altered Flow Regimes

Several of the rivers in the action area have been impounded and streamflows have been altered with consequent effects on salmonids. The individual HPAs where dams and altered flow regimes have occurred are discussed below.

a. Dams and Altered Streamflows in the Coastal and Interior Klamath HPAs

Dams impounding water for mining and farming operations were first built in the Klamath River Basin during the 1850s. Some of these dams blocked fish passage in a number of tributary streams. The first hydroelectric dams were built in the Shasta River and the upper Klamath River Basin just prior to the turn of the 20th century. Starting around 1912, construction and operation of numerous facilities significantly altered the natural hydrographs of the upper and lower Klamath River. These changes include a reduction of average late spring and summer monthly flows, an increase in average winter flows and alteration of the natural seasonal variation of flows due to reduced natural water storage and to meet peak power and diversion demands (Hecht and Kamman 1996). Dams on the upper Klamath River were operated in power-peaking mode, and flow releases fluctuated according to anticipated energy demands. Flows could vary by an order of magnitude or more within a 20-minute period. Fish and their food base were often stranded, resulting in mortality [Klamath River Basin Fisheries Task Force (KRBFTF) 1991].

On May 31, 2002, NMFS issued a biological opinion to the U.S. Bureau of Reclamation (BOR) that determined its continued operation of the Klamath Project in a manner similar to the period of 1990-1999 would be likely to jeopardize the continued existence of SONCC coho salmon, and likely to adversely modify critical habitat for the SONCC coho salmon (NMFS 2002a). NMFS, in consultation with BOR, identified a reasonable and prudent alternative (RPA) that concluded SONCC coho salmon would survive from 2002 to 2010 with incremental improvements in flow and habitat.

The Pacific Coast Federation of Fishermen's Association (PCFFA) and other plaintiffs filed suit with NMFS and BOR, requesting the court to declare NMFS' 2002 Opinion to be arbitrary and capricious because long-term flows are not supported by the record, and short-term flows are insufficient to avoid jeopardy to SONCC coho salmon. The District court ruled (Armstrong I) that the RPA was a "reasonable balance" of existing science, and NMFS' phased approach and corresponding flow schedules were not arbitrary and capricious.

Plaintiffs appealed Armstrong I, contending NMFS' 2002 Opinion was arbitrary and capricious in that it employs a phased approach but does not analyze how the first two phases, encompassing 8 years of a 10 year plan, will avoid jeopardy to the coho salmon. The appellate court ruled in favor of the plaintiffs and remanded NMFS' 2002 Opinion to the district court for issuance of injunctive relief. The district court determined that new information indicated the need for reinitiation of consultation, and the flow schedule as outlined in phase III of NMFS' 2002 Opinion remains the only valid portion of the RPA. As such, the court granted injunctive relief to the plaintiffs, requiring NMFS and BOR to reinitiate consultation of BOR's Klamath Project Operations. The court further required BOR to limit irrigation deliveries in order to provide phase III flows until the new consultation is complete.

Around the 1920s, water resources in the Shasta and Scott Rivers were developed for irrigated agriculture. Dwinell Dam in the Shasta River Basin was constructed in 1928 to impound irrigation water for the Montague Water Conservation District. The dam effectively blocked access to the southern headwaters. No minimum flow regimes were established in the Shasta River, and the water quality in Lake Shastina reservoir deteriorated as a result of elevated water temperatures, increased algae growth, and decreased dissolved oxygen levels. Nutrient sources in the basin are from agricultural, urban, and suburban land use. The dam also prevented spawning gravel recruitment into the downstream river reach. The construction of these dams and other smaller agricultural diversions have had additional impacts to the flow regime of the lower Klamath River.

On the Trinity River, Congress authorized the construction of the Trinity River Division (TRD) of the Central Valley Project (CVP; Public Law 84-386) in 1955 to divert water to the Sacramento River. This activity was not supposed to have detrimental effects on the fishery resources within the Trinity River. An average of 88 percent of the annual flow was diverted to the Sacramento River for the next 10 years. Minimum flows released into the Trinity River ranged from 150 cubic feet per second (CFS) to 250 CFS with a total volume of 120.5 thousand acre feet (TAF). The minimum flow releases were focused primarily on Chinook salmon spawning requirements and did not address fluvial geomorphic processes and the requirements of other fish species or life stages [USFWS and Hoopa Valley Tribe (HVT) 1999, Chapter 2].

Within a decade of completion of the TRD, salmonid populations had noticeably decreased (Hubble 1973). Declines in the fishery resources lead to the formation of the Trinity River Basin Fish and Wildlife Task Force (TRBFWTF). In an attempt to stop the degradation of fish and wildlife habitat and formulate a long-term management plan, the TRBFWTF developed the Trinity River Basin Comprehensive Action program. In 1973, the CDFG requested that additional water be released to the Trinity River to stop the decline of salmon and steelhead. A 3-year attempt to evaluate varied flows on salmon and steelhead populations was hampered by flood and drought with no formal evaluation completed.

In 1990, the North Coast Regional Water Quality Control Board concluded that the operations of the TRD impacted spawning and egg incubation within the Trinity River. Subsequently in 1991, temperature control objectives were set from Lewiston to Douglas City (15.6°C from July 1 to September 14, and 13.3°C from September 15 to October 1) and from Lewiston to the confluence of the North Fork Trinity River (13.3°C from October 1 to December 31). Additionally in 1991, an administrative appeal by the HVT resulted in a Secretarial decision (May 8, 1991) to increase Trinity River water releases during the 1992-1996 period to no less than 340 TAF in all years and established low flows of not less than 300 CFS.

The enactment of the CVP Improvement Act in 1992 (CVPIA, Title 34 of Public Law 102-575 - 3406(b)23) restated the flow releases included in the 1991 Secretarial Decision, established a completion date for the flow evaluation study and a date for permanent fishery flow allocation, and established that the HVT and the Secretary must agree with any change in flow. The Environmental Protection Agency (EPA) approved the Trinity River Temperature Objectives as Clean Water Act 303 water quality standards and found that exports to the Sacramento River were “controllable factors” that could be modified to meet the water quality standards. Flows in the Trinity River continue to impact salmonid populations and coordinated efforts are continuing to modify the flow regime to provide for better fish habitat.

b. Dams and Streamflows in the Mad River HPA

On the Mad River, Sweasey Dam was constructed about 7 miles upstream of the North Fork Mad River confluence in 1938. By 1960, its 3,000 acre-foot reservoir was nearly filled with sediment. The dam was removed in 1970, releasing almost five million cubic yards of sediment into the mainstem. We do not have information describing how effective the dam was at passing adult and juvenile salmonids. Based on observations, the dam provided for passage of adults and yielded some of the better run size estimates for the time period. However, the dam likely inhibited the passage of adults to some degree and may have limited the production of salmonids in the Mad River as adults were forced to spawn in the lower, more unstable river reaches.

Currently, flows within the mainstem Mad River through the HPA are influenced by releases from Matthew’s Dam located 84 miles upstream from the mouth and upstream of the HPA. Completed in 1961, Matthew’s Dam and its impoundment, Ruth Reservoir, supply water to the Humboldt Bay Municipal Water District diversion facilities located approximately 5 miles upstream from the mouth. The dominant effects of the impoundment are an augmentation of natural streamflows below the dam during the summer and fall low-flow periods as well as eliminating sediment transport from the upper watershed to the middle and lower portions. During winter storms, the reservoir fills rapidly and flows over the spillway.

The extent to which Matthew's Dam has influenced salmonid populations on the Mad River is unclear. The increased summer flows provided by the reservoir releases likely improve summer salmonid habitat along much of the mainstem. The position of the dam high in the watershed limits the amount of historic habitat rendered inaccessible. The dam likely eliminated access to historic steelhead habitat in some years when they were able to navigate a series of natural boulder cascades in the middle reaches of the mainstem. Currently, the upper limit for steelhead migration is between Wilson Creek (river mile 45) and Deer Creek (river mile 53) in a steep, boulder dominated reach with unstable side slopes. The effects on Chinook and coho salmon habitat are less clear as these natural barriers in the middle mainstem currently do not allow access to the dam. Therefore, under current conditions, anadromous fish are not able to gain access to the dam. However, the changing character of the riverbed in the vicinity of the barriers may allow anadromous fish to gain access to the upper watershed in the future and in this case, the dam would limit the amount of accessible habitat.

c. Dams and Streamflows in the Eel River HPA

Water diversion within the Eel River Basin has occurred for many years at the Potter Valley facilities, located in the uppermost portion of the Eel River watershed. Cape Horn Dam, on the upper mainstem Eel River, was constructed in 1907 with fish passage facilities. Soon after construction, CDFG recognized that the ladder design presented difficulties to migrating fish. In 1962 and 1987, major modifications were made to the ladder to improve passage of salmonids [Steiner Environmental Consulting (SEC) 1998]. Roughly 160 TAF (219 CFS average) are diverted at Cape Horn Dam, through a screened diversion, to the Russian River annually. Scott Dam, which is approximately 19 km (12 mi.) upstream of Cape Horn Dam, was constructed in 1921 without fish passage facilities. VTN Oregon, Inc. (1982) reported that prior to dam construction, 56 to 72 km (35 to 45 mi.) of spawning and rearing habitat existed above Scott Dam and supported 2,000 to 4,000 fall Chinook salmon and winter steelhead. The USFS and the Bureau of Land Management estimate that 160 km (100 mi.) of potential anadromous salmonid habitat have been blocked by the dam (USFS 1995a).

Flow releases from the Potter Valley facilities have both reduced the quantity of water in the mainstem Eel River, particularly during summer and fall low flow periods, as well as dampened the within-year and between-year flow variability that is representative of unimpaired flows. These conditions have restricted juvenile salmonid rearing habitat, impeded adult migration and late emigrating smolts, and provided ideal low-flow, warm water conditions for the predatory Sacramento pikeminnow (NMFS 2002b).

On November 26, 2002, NMFS issued a biological opinion that determined that continued operation of the Potter Valley Project in a manner similar to its historic operation would be likely to jeopardize the continued existence of the three ESA-listed salmonid ESUs. The biological opinion presented an RPA that results in flows that more closely resemble the natural hydrograph, and are deemed necessary to avoid jeopardy. NMFS thinks that the hydrograph produced with implementation of the RPA will more closely resemble the natural hydrograph of the Upper Eel River Basin, which should provide improved habitat conditions for listed salmonids more frequently. Of particular importance is the superior response to hydrologic events in the Upper Eel River Basin and the provision of summer flows that allow for more realistic within-year and between-year flow variability that is representative of the unimpaired flow patterns within the Eel River. These features should provide improved habitat conditions and better survival rates for several salmonid life history phases and thus avoid jeopardy to listed salmonid ESUs.

In the South Fork Eel River, Benbow Dam, located near Garberville, was constructed in 1937. California State Parks and Recreation operates the facility from July through the last weekend in September as a seasonal recreational facility. The facility, which historically blocked passage to adult and juvenile salmonids during the summer operating season, has since been modified to allow adult and juvenile anadromous salmonid fish passage (NMFS 2002c). Operational procedures for managing the seasonal lake have reduced the impacts to listed anadromous fish.

4. Reductions in Estuarine Areas

Many of the streams in the action area historically had large estuaries that provided an important setting for salmonids. These areas have experienced dramatic changes in their size and the quality of habitat they provide, particularly for juvenile Chinook salmon, which rear in estuaries prior to ocean entry.

The Winchuck River estuary has been impacted by a reduction of habitat through channelization for livestock grazing. The estuary habitat for rearing salmonids is currently limited due to both a lack of depth and LWD for protective cover and avian predator avoidance (Simpson 2002). Similarly, the lower channel of the Smith River has been leveed and simplified by agriculture, livestock grazing, gravel mining and urban development. The loss of secondary channels, sloughs, backwaters and LWD has reduced the amount and complexity of rearing habitat.

The salmonid habitat in the lower portions of Redwood Creek and its estuary has been degraded by the flood control levees, which were built by the U.S. Army Corps of Engineers in 1968. The levees bisect the estuary at the mouth of Redwood Creek and drastically impair the physical and biological functions of the estuary and adjacent wetlands, confining the Redwood Creek channel to a width of 300 feet. The levees also disconnected Redwood Creek from its last downstream meander, reduced circulation into the south and north sloughs, and resulted in an increase in ocean derived marine sediment - for a combined reduction of the lower estuary of approximately 50 percent. Reduced circulation within sloughs and embayments has compromised water quality, thus reducing the estuary's value as suitable rearing habitat for listed salmonids.

Little River is unique in that it has more estuarine habitat than many local streams of its size, and surveys indicate that at least juvenile Chinook salmon use this area for rearing (Louisiana Pacific 1986, CDFG 1986). However, the estuary has been impacted by human activities such as grazing and channelization, resulting in increased bank erosion, confinement of the floodplain in limited areas and denudation of much of the riparian zone.

In the Humboldt Bay HPA, residential, commercial, and agricultural development have eliminated or drastically altered most estuarine habitats. There was a period of rapid change of wetlands, mudflats, and marshes surrounding North Humboldt Bay after completion of the Northwestern Pacific Railroad in 1901. Due to the diking, draining, filling, and other development projects, the total area of Humboldt Bay has been reduced to approximately 18,000 acres from 27,000 acres, and salt marsh habitat has been reduced from approximately 7,000 acres to about 970 acres (Barnhart *et al.* 1992).

The diking and conversion of wetlands, mudflats, floodplains and marshes is likely one of the largest contributing factors to the decline of salmon populations in Humboldt Bay watersheds. The area converted represents a tremendous loss of rearing habitat for salmon, and is perhaps most harmful to Chinook salmon, which feed and rear for extended periods in estuarine areas prior to ocean entry. The estuarine rearing habitat that remains throughout Humboldt Bay has been dramatically simplified by the diking, which forms a uniform and straightened edge, without the shallow and varied margins typically favored by rearing juvenile Chinook salmon.

CDFG (1997) reports that the lower Eel River is an important juvenile rearing area, and the estuary provides a nutrient-rich environment where growth rates are superior to upstream nursery areas. The Eel River estuary has been severely altered by many influences in recent times. Estuarine habitat has been degraded by poor land-use practices, animal waste from delta farming areas, and a depletion of riparian forests since the late 1800s. These impacts over time have reduced available habitat for salmonids to a fraction of historic levels. In the estuary, the water quality and quantity elements of critical habitat are in poor condition and functioning at a level below optimum. Physical changes in the Eel River estuary are well documented (Ames 1983). Ships were no longer able to cross the bar at the entrance to the river in 1908 (Ames 1983). Personal accounts from the 1880s described upper reaches of the estuary, as 25-30 feet deep in a stable 300-foot wide channel (Ames 1983). Today, the pools in this reach are approximately 10 feet deep and riffles may be 3 feet deep. The area of the estuarine ecosystem of the Eel River also seems to be shrinking and the number of species it harbors is apparently diminishing (Puckett 1977). Presently, the Eel River estuary may only be 40 percent of its former size. Decreases in the amount of shallow water and tidal channel habitat due to diking and draining of marsh lands in the Eel River estuary have likely substantially decreased the survival of out-migrant juvenile Chinook and coho salmon from the basin.

5. Hatcheries

Salmonids in the Smith River HPA have been influenced by hatcheries, both as a consequence of introducing non-native stocks to the streams in the HPA and the presence of Rowdy Creek hatchery. Hatchery influence on the Smith River has been typical of California north coast streams: intensive stocking of coho salmon, Chinook salmon and steelhead from other river sources throughout the 1930s through the 1960s. Rowdy Creek hatchery was started in 1972. Currently, Rowdy Creek hatchery releases steelhead and Chinook salmon smolts. Although no specific information is available on the effects that fish produced at the Rowdy Creek hatchery have had on native populations, the general effects of hatchery production were discussed previously in the *Status of the Species* section.

Hatcheries on the upper Klamath (Iron Gate Hatchery) and Trinity Rivers (Trinity River Hatchery) were established as mitigation measures for the loss of fish habitat due to dams on the upper rivers. These hatcheries, particularly Iron Gate Hatchery, have a history of out-of-basin transfers. However, out-of-basin transfers to Iron Gate Hatchery have not occurred since 1968. Thus, the frequency and magnitude of out-of-basin plants and transfers in the basin appears to have been relatively low (Weitkamp *et al.* 1995). Although interbasin transfers have ceased, the proportion of hatchery fish in the Klamath River Basin remains high. Approximately 90 percent of the Klamath-Trinity Basin coho salmon are of hatchery origin (Brown *et al.* 1994). The majority of fish produced in the Iron Gate Dam and Trinity River hatcheries are Chinook salmon. Releases of large numbers of hatchery Chinook salmon into the Klamath River Basin increases inter-specific competition for resources which can decrease the survival of wild juvenile salmonids.

The Yurok Tribal Fisheries Program (YTFP) notes artificial stocking efforts in four Klamath River tributaries within the Coastal Klamath HPA (Voight and Gale 1998). Approximately 155,466 juvenile Chinook salmon were stocked in Hunter Creek between 1986 and 1996. Additionally, 1,860 juvenile coho salmon were planted in Hunter Creek in 1989. Juvenile coho salmon from the Alsea River numbering 20,010 were stocked in McGarvey Creek from 1962 to 1963. Surpur Creek was stocked with over 10,000 juvenile coho salmon in 1969. Tectah Creek was stocked with over 20,000 juvenile coho salmon each year from 1966 through 1968. The effects of introducing these out-of-basin stocks is unknown.

Mad River Hatchery was opened in 1970 as mitigation for Sweasey Dam. Chinook salmon, coho salmon and steelhead were produced. Chinook salmon production is limited to a few adults that return to the hatchery each year. Chinook salmon broodstock has generally been drawn from fish returning to the Mad River, however, releases in the 1970s and 1980s have included substantial releases of fish from out-of-basin and out-of-ESU (Good *et al.* 2005). Coho salmon production ceased after the 1999 brood year. The original broodstock was from the Noyo River, which lies outside of the SONCC coho salmon ESU. Subsequent releases included several other out-of-ESU stocks as well as out-of-basin, within-ESU transfers. Concern about both out-of-ESU and out-of-basin stock transfers, as late as 1996, was sufficiently great that the Mad River Hatchery was excluded from the SONCC coho salmon ESU by NMFS (Schiewe 1997a). This conclusion has been rendered moot by the recent decision to cease coho salmon production at the facility (Good *et al.* 2005). Steelhead continue to be produced in large numbers at the Mad River Hatchery. An average of 5,536 adults were trapped annually from 1991 to 2002 (Good *et al.* 2005). Original broodstock was supplied from the Eel River with additional transfers from the San Lorenzo River (Good *et al.* 2005). Introduced summer-steelhead stocks have also been introduced into the Mad River Basin. Therefore, steelhead stocks in the Mad River continue to possess an out-of-basin genetic component.

PALCO operated a small hatchery on Yager Creek (Eel River HPA) from 1976 through the 2001/2002 season. Two satellite facilities were constructed in 1993 on the South Fork Yager Creek and Corner Creek. CDFG allowed the annual take of 100,000 Chinook salmon eggs and 30,000 steelhead eggs. During the 2000/2001 season, PALCO took 13,544 Chinook salmon eggs and 3,900 steelhead eggs. In 2001, capture of steelhead was discontinued. During the 2001/2002 winter season, 47,914 Chinook salmon eggs were taken and 19,054 Chinook salmon fry were released into the Yager Creek watershed. Due to financial constraints, PALCO has closed its hatchery operations at Yager Creek altogether (Darby 2002). These hatcheries have had an unknown, but likely negligible effect on the genetic structure of native salmonid populations in the Eel River HPA given the relatively low numbers of eggs taken and the use of fish from within the watershed.

6. Mining

The discovery of gold in California in the 1860s resulted in intensive mining throughout the northern portion of this region. The Smith, Klamath and Trinity River Basins were the sites of active mining; Suction dredging, placer mining, and gravel mining continues to the present day. Lode mining for gold, copper and chromite continued as recently as 1987. Water was diverted and pumped for use in sluicing and hydraulic mining operations. Hydraulic mining for gold washed hillslopes down into streams, causing siltation and sedimentation of waterways, degradation of riparian habitats, and alteration of stream morphology. Some believed that the hydraulic mining period resulted in greater impacts to the salmon fishery than the large fish canneries of the era. The negative impacts of stream siltation on fish abundance was observed as early as the 1930s. Following mining, several impacted streams containing large volumes of silt seldom had large populations of salmon or trout (Smith 1939).

Since the 1970s, large-scale commercial mining operations have been eliminated due to stricter environmental regulations. However, smaller mining operations continue including suction dredging, placer mining, gravel mining, and lode mining. These mining operations can negatively affect spawning gravels, result in increased poaching activity, decreased survival of fish eggs and juveniles, decrease benthic invertebrate abundance, adversely affect water quality, and impact streambanks and channels.

Gravel and sand removal from streams and adjacent floodplains is common in much of northern California. The greatest demand for these products is for industrial purposes. Removal of these materials from a stream channel may fundamentally alter the routing of water and sediment through the system, resulting in altered channel morphology, decreased stability, accelerated erosion, and changes in the composition and structure of the substrate. For example, complete channel degradation (to bedrock) can occur. This can adversely affect the amount of available salmon spawning habitat and juvenile rearing conditions. The extent to which this type of mining affects streams and rivers depends on many site-specific characteristics, including the geomorphic setting, the quantity of material extracted relative to the sediment supply, and the hydrologic and hydraulic conditions within the stream reach.

Throughout the action area, several rivers have extensive gravel mining activities permitted through the U.S. Army Corps of Engineers. In the Smith River HPA, extraction of instream gravels occurs at several sites on the lower mainstem Smith River and Rowdy Creek. Gravel extraction occurs at two sites on the lower Klamath River. Previous gravel extraction on lower Hunter Creek (coastal Klamath HPA) has ceased operation. Gravel is extracted from the Mad River, downstream of the Mad River Hatchery. Historic gravel extraction on the Mad River is well documented in the Lower Mad River Programmatic Environmental Impact Review (Humboldt County 1994). They included winter drag line operations, pits spanning the entire river, pits excavated in the floodplain, trenches along the low flow channel, and bar skimming adjacent to the low flow channel. Gravel extraction activities have been ongoing since the

1940s, when the primary method was the use of a drag line across the entire channel during the winter months which had significant impacts on channel form and function. CDFG eliminated use of the drag line method in the early 1970s. Estimates indicate that peak extraction occurred in 1970, when 771,000 cy were extracted (Humboldt County 1994). Since 1992, the County of Humboldt Extraction Review Team (CHERT) has guided extraction methods and quantities along this reach. Extraction volumes and methods have been regulated with the objective of minimizing channel instability due to extraction. For the 5-year period 1997-2001, extraction volumes averaged approximately 220,000 cubic yards per year (CHERT 2002). More recently, as a result of formal consultation between NMFS and the U.S. Army Corps of Engineers, gravel extraction volumes have been further reduced and extraction methods have been refined to reduce the effects on salmonid habitat along the lower Mad River. Current impacts associated with gravel mining in these lower river reaches are maintenance of simplified habitat conditions which limit the productive capacity of these lower rivers for juvenile salmonids, specifically steelhead and coho salmon.

On the Eel and Van Duzen Rivers, historic annual maximum amounts of gravel removal appear to have ranged from approximately 700,000 to 1,000,000 cy during the years of 1957 and 1958 for the construction of Highway 101 (Humboldt County 1992). A significantly large flow and depositional event occurred in February of 1986, and gravel was also likely extracted from the Lower Eel River at close to these annual maximum quantities during the late 1980s and 1990, further changing the morphology of the low flow channel of the river (Humboldt County 1992). Along the mainstem Eel River, gravel extraction occurs primarily below the confluence with the Van Duzen River. On the mainstem Van Duzen River, gravel extraction occurs near the mouth and near the confluence with Yager Creek. Recently, gravel extraction at the mouth of the Van Duzen has led to channel widening and stranding of adult Chinook salmon. For the period from 1997-2001, average annual volumes of gravel extracted include 100,000 cy for the Van Duzen River and 244,000 cy of material along the lower Eel River (CHERT 2002). More recently, as a result of formal consultation between NMFS and the U.S. Army Corps of Engineers, gravel extraction volumes have been reduced and extraction methods have been refined to reduce effects on salmonid habitat along the lower Eel and Van Duzen Rivers. Ongoing effects of these activities is maintenance of simplified habitat conditions which limit the productive capacity of the mined reaches.

7. <u>Grazing</u>

In other areas of the western United States, livestock grazing has been associated with increased runoff and erosion. The prairies of the Bald Hills (Redwood Creek HPA) and nearby grasslands were heavily grazed by sheep and cattle between 1860 and 1980. Grazing was eliminated on Redwood National and State Parks (RNSP) lands in the early 1980s. Cattle grazing continues on grasslands in the middle and upper basins and in the Orick Valley, where several dairies are located. Although similar effects may have occurred in Redwood Creek, RNSP considers them to be insignificant in comparison to high natural rates of runoff and erosion and the effects of logging and road building (RNSP 2002). However, information from the Van Duzen River Basin suggests that livestock grazing and subsequent conversion of prairie vegetation from perennial long-rooted native bunch grasses to annual short-rooted exotic grasses may have accelerated or triggered earthflow instability (Kelsey 1978). Where grazing occurs in the action area, we expect increases in fine sediment from ground disturbance and localized destabilization of stream banks that degrade spawning substrate quality and locally reduce complex habitats needed for juvenile rearing.

8. Migration Barriers

Barriers to fish migration are widespread throughout the action area. Unfortunately, the locations of these barriers are poorly documented. The Yurok Tribal Fisheries Program noted full and partial barriers to anadromous salmonid migration in four Klamath River tributaries within the Coastal Klamath HPA (Voight and Gale 1998). Within the Mynot Creek watershed, a box culvert on Mynot Creek Road likely represents a total barrier to anadromous salmonids. A culvert on the mainstem of Hoppaw Creek, just upstream of the North Fork Hoppaw Creek confluence, was noted as a barrier to anadromous salmonid migration in 1996, but was replaced in 1997 (Voight and Gale 1998). Massive log jams on McGarvey Creek currently present a formidable impediment to anadromous salmonid migration. Finally, Voight and Gale (1998) noted that lower portions of Taurup Creek are ephemeral and frequently lack surface flow at its confluence with the Klamath River, preventing salmonid migration during these periods. In the Lindsay Creek watershed (Mad River HPA), numerous county roads over fish-bearing streams have created migration barriers. For example, Taylor (2000) identified six culvert fish barriers in the Lindsay Creek watershed as part of a county-wide survey effort. Five of these barriers have been modified to provide fish passage. Five sites have also been identified in the Humboldt Bay HPA (Taylor 2000). Collectively, these sites prevented access to several miles of spawning and rearing habitat. Of these, three have been modified to allow for improved passage. The existence of these migration barriers has limited the abundance and distribution of salmonids in the action area. Desirable spawning habitat is inaccessible, often forcing fish to spawn in poor quality habitat and the extent of stream space available for rearing is reduced, which forces fish to rear in more crowded conditions or in poorer quality habitat.

9. Introduced Predatory Species

The introduced Sacramento pikeminnow (*Ptychocheilus grandis*) occurs within the larger watercourses of the Eel River HPA. A fisherman using live bait in Lake Pillsbury likely introduced this predator (SEC 1998). Since their introduction, the Sacramento pikeminnow have distributed throughout the basin (SEC 1998). The introduction of the Sacramento pikeminnow impacts salmonids by direct predation, and by displacing rearing juveniles from pool habitat (Brown and Moyle 1991). Sacramento pikeminnow impacts are exacerbated by summer thermal conditions and low flows that provide ideal conditions for Sacramento pikeminnow in the mainstream Eel River.

B. Distribution, Abundance and Trends of Salmonid Populations

Salmonid populations in the action area follow a similar pattern of decline as other salmonid populations along the West Coast.

1. Smith River HPA

Cannery records from the late 1800s show large declines in annual harvest during the early 1900s (USFS 1995b). Discussions with individuals of the Tolowa tribe indicate that spring-run Chinook, chum, and coho salmon were much more abundant than at present. The

Tolowa information indicates that possibly four distinct Chinook salmon runs existed prior to the late 1800s (USFS 1995b).

Green Diamond provided a summary of salmonid species distributions within the Smith River HPA in Table 4-4 of the HCP (Simpson 2002). Appendices C7, C9, and C10 of the HCP provide population estimates and adult spawning survey results in five streams within this HPA-South Fork Winchuck River, Rowdy Creek, Savoy Creek, South Fork Rowdy Creek, and Wilson Creek.

a. SONCC Chinook Salmon Distribution, Abundance and Trends

Chinook salmon within the Smith River HPA belong to the SONCC Chinook salmon ESU, which NMFS determined did not warrant listing under the ESA (September 16, 1999, 64 FR 50393). Fall- and spring-run Chinook salmon occur in the Smith River Basin, where the fall-run is the dominant salmon stock. As mentioned previously, the Smith River contains the only remaining population of spring-run Chinook salmon in coastal California (USFS 1995b). The size and hydrographic nature of the Smith River Basin may limit habitat for spring-run adult Chinook salmon, or sufficient overwintering habitat for juveniles may be lacking in some areas (USFS 1995b). Spring-run Chinook salmon typically occur in larger river systems that have significant inland headwater reaches that provide snowmelt flows during spring thaws, allowing spring-run Chinook salmon to migrate. Since the Smith River is largely a rain driven system, the lack of snow melt flow conditions in headwaters may limit numbers of spring-run Chinook salmon. However, historical records document the existence of a culturally and commercially important spring-run (USFS 1995b).

Spring-run Chinook salmon enter the Smith River typically in mid-April and spawn in October, whereas fall-run Chinook salmon enter from September to December and spawn very soon after arrival (USFS 1995b). The long summer holding time of spring-run Chinook salmon makes them vulnerable to disturbances which alter freshwater habitat and temperature regimes. Spawner surveys confirm presence of Chinook salmon in all of the streams surveyed by Green Diamond, except Wilson Creek (Simpson 2002). Data on population trends and abundance for Chinook salmon are not available for this HPA.

b. SONCC Coho salmon Distribution, Abundance and Trends

Coho salmon within the Smith River HPA belong to the SONCC coho salmon ESU, which NMFS listed as threatened on May 6, 1997 (62 FR 24588). Current abundance of SONCC coho salmon within California may be as little as six percent of the numbers seen as recently as 1940 (Weitkamp *et al.* 1995). The Smith River HPA is comprised of four historic coho salmon populations according to the work on historic coho population structure done by Williams *et al.* (2006). The Winchuck River is listed as Potentially Independent, the Smith River is listed as Functionally Independent while the smaller streams of Elk Creek and Wilson Creek are listed as Dependent Populations.

Coho salmon typically migrate upstream and spawn within the Smith River Basin from November to December, and are most abundant in the lower tributaries, especially in Mill Creek (USFS 1995b). No adult coho salmon were observed during Green Diamond's spawning surveys from 1998 to present (Simpson 2002). Juveniles were encountered on dive counts within the same streams, but their numbers were very low (Simpson 2002). Juvenile population numbers in Wilson Creek have declined steadily from 1995-2000, and have been completely absent from the South Fork Winchuck River in 3 of these 6 years (see Figure 4-8, Simpson 2002). Coho salmon are present in the South Fork of the Smith River and are presumed present in Goose Creek based on anecdotal information (Simpson 2002). Coho salmon are present in Rowdy Creek, but abundance data are lacking.

c. KMP Steelhead Distribution, Abundance and Trends

Steelhead within the Smith River HPA belong to the KMP steelhead ESU, which NMFS determined did not warrant listing under the ESA (April 4, 2001, 66 FR 17845). Steelhead in the Smith River are predominantly winter-run. Some summer, or early fall, steelhead occur, but not nearly to the degree of summer steelhead runs of the Klamath-Trinity Basin (USFS 1995b).

The steelhead population in the Winchuck River were assessed as "healthy" by ODFW/CDFG (Nickelson *et al.* 1992) and the USFS (1993a, b), but it receives heavy input from a hatchery. Smith River winter-run steelhead were considered "healthy" by ODFW/CDFG but summer-run fish were considered at high risk of extinction by Nehlsen *et al.* (1991) and "depressed" by the USFS (from Busby *et al.* 1994). Juvenile steelhead population estimates within South Fork Winchuck River and Wilson Creek show a high range of fluctuation from 1995-2000, ranging from 20 to 1,400 individuals (see Figure 4-8, Simpson 2002). No abundance data were available for Rowdy Creek. Despite the "healthy" rating, NMFS is concerned with the wide swings in population abundance. The abundance information indicate that in some years the population is very close to being absent from the surveyed reaches.

2. <u>Klamath HPAs (Coastal Klamath, Blue Creek, and Interior Klamath HPAs)</u>

Detailed results of anadromous salmonid surveys (adults, carcasses, juveniles and redds) in the Lower Klamath River have been compiled by the YTFP, and much of the information presented in this section is summarized from various YTFP reports in addition to what is presented in the HCP.

There have been a series of salmonid fish die offs in the mainstem Klamath River during the 1990s and early 2000s that have had effects on the abundance of salmonids in the Klamath HPAs. A fish die off was documented (CDFG 2000) which began in mid- to late June 2000, continued into late July and affected more than 60 miles of river between Coon Creek and Pecwan Creek in the plan area. Direct mortality was likely caused by a combination of at least two pathogens endemic to the Klamath Basin. High water temperatures in the mainstem Klamath River and several tributaries exacerbated the problem. Estimates of the magnitude of the die off as documented by CDFG staff and others ranged from "tens of thousands" to 100,000 to 300,000 juvenile Chinook salmon and steelhead. Hatchery and naturally produced Chinook salmon and steelhead were involved and, although no dead coho salmon were observed, they are thought to have been present in the area of the die off. In September of 2002, more than 33,000 adult salmon and steelhead died in the lower 36 miles of the Klamath River. The die-off occurred during a period of unusually low flows (Lynch and Risley 2003, CDFG 2003). The cause of mortality was from naturally occurring pathogens combined with a high density of adults, seasonally high water temperatures and unusually low stream flows (CDFG 2003).

a. SONCC Coho Salmon Distribution, Abundance and Trends

Coho salmon occur in the mainstem Klamath River year round, and also inhabit a number of Klamath River tributaries (Henriksen 1995, INSE 1999, Yurok Tribe 2001). Although the mainstem Klamath River often exceeds the tolerance limits of juvenile coho salmon, they are found near the confluences of larger tributaries where cooler water influence presumably provides pockets of more suitable temperatures. Coho salmon juveniles were observed in 14 locations where the mainstem river temperatures varied from 15.7°C to 25.5°C (USFWS 2001). Tributary water associated with these sampling locations was sometimes cooler, ranging from 13.3°C to 23.0°C. Therefore, the presence of cool water inflows may play a critical role in the distribution of juvenile coho salmon in the mainstem Klamath River during the summer months.

Coho salmon utilize several tributaries in the Klamath HPAs for spawning and rearing. Information and maps showing the known distributions of coho salmon are presented in the Green Diamond HCP (Simpson 2002) and additional information can be found in Gale *et al.* (1998) and Voight and Gale (1998). In general, the lower, low-gradient portions of the tributaries are the primary sites where coho salmon are known to spawn and rear.

Abundance and trend information in the tributaries is limited to isolated surveys conducted by the YTFP and Green Diamond. Although adult counts are often conducted for Chinook salmon, they do not overlap well with the peak spawning period of December through January for coho salmon. In the coastal Klamath HPA, juvenile coho salmon were found in 8 of 12 tributaries sampled by the YTFP in 1996, but were generally scarce and narrowly distributed (Voight and Gale 1998, Simpson 2002). For example, surveys in Hunter Creek from 1998 to 2000 estimated the juvenile coho salmon population was 400 in 1998, but no fish were observed in 1999 and 2000 (Simpson 2002). Blue Creek provides the highest quality coho salmon habitat in the lower Klamath region (Gale *et al.* 1998), but population estimates are unavailable.

In summary, information on coho salmon population abundance and trends in the lower Klamath River Basin is incomplete, but what information exists suggests that adult abundance is extremely low and has been declining for most of the past two decades. All SONCC coho salmon populations within the ESU are depressed relative to their past abundance, based on the limited data available (July 25, 1995, 60 FR 38011; May 6, 1997, 62 FR 24588). As a group, the tributaries of the Lower Klamath River were classified as a single Functionally Independent population by Williams *et al.* (2006). The Klamath River population is heavily influenced by hatchery production, and a large component of the population is of hatchery origin, apparently with limited natural production. The apparent declines in production suggest that the natural population may not be self-sustaining (May 6, 1997, 62 FR 24588). These declines in natural production are related, at least in part, to degraded conditions of the essential features of spawning and rearing habitat in many areas of the SONCC coho salmon ESU. Poor survival of coho salmon fry and juveniles in the mainstem Klamath River, as indicated by upriver versus downriver trapping results, suggests that degraded mainstem rearing habitat is limiting coho salmon production.

b. Chinook Salmon Distribution, Abundance and Trends

Two ESUs of Chinook salmon occur in the Klamath HPA group. The upper Klamath-Trinity Chinook salmon ESU occurs above the confluence with the Trinity River. However, adults and juveniles use the mainstem Klamath River to access these areas in the upper basin. A portion of the ESU may stray into tributaries of the Klamath HPA group, but no data are available to determine the extent of straying that may occur. Otherwise, the lower Klamath HPA group represents the southern extent of the SONCC Chinook salmon ESU. SONCC Chinook salmon primarily use the lowermost portions of the larger tributaries for spawning. Blue Creek is an exception where Chinook salmon occur several miles up into the watershed.

Blue Creek represents the largest, most pristine watershed in the lower Klamath region, and also supports the largest anadromous salmonid populations in the sub-basin (Gale *et al.* 1998). Peak counts of adult fall-run Chinook salmon in Blue Creek from 1988-1996 (surveys were not conducted in 1989 and 1993) ranged from a low of 46 in 1990 to a high of 801 in 1996, with the second highest peak count of 286 adult Chinook salmon in 1988 (Gale *et al.* 1998). Although estimates of total run sizes of fall-run Chinook salmon in Blue Creek are not available, peak counts suggest that Chinook salmon spawning in Blue Creek represent a significant portion of the wild Chinook salmon population within the Klamath River Basin (Gale *et al.* 1998). For example, if Chinook salmon counts from the hatchery-enhanced drainages of Red Cap Creek, Camp Creek, Shasta River, Scott River and Salmon River are excluded, Blue Creek contributed 11.2 percent and 29.4 percent of the wild Chinook salmon production of the entire Klamath Basin in 1995 and 1996 respectively (Gale *et al.* 1998). However, since Klamath River Basin Chinook salmon spawning above the Trinity River confluence belong to the Upper Klamath-Trinity Chinook salmon ESU, the Blue Creek contribution to the wild SONCC Chinook population in the Klamath HPAs is much greater still. Given the existing data, assessing the overall trend of the population is not possible.

c. KMP Steelhead Distribution, Abundance and Trends

KMP steelhead are distributed throughout the Klamath HPA group and often occur much higher in the tributary watersheds than either coho or Chinook salmon. Data on abundance and trends of steelhead in the Klamath HPA group are lacking. Blue Creek appears to support a large population of steelhead, with adults likely spawning in all tributaries with access (Gale *et al.* 1998) but, unfortunately, abundance and trend information is lacking. The following description of KMP steelhead within the Blue Creek watershed is taken from the Assessment of Anadromous Fish Stocks in Blue Creek, Lower Klamath River, California, 1994-1996 (Gale *et al.* 1998):

> "The Blue Creek Basin provides ideal spawning and rearing habitat for steelhead trout. CDFG described Blue Creek as the best steelhead producing stream in the entire Klamath Basin (O'Brien 1973). Steelhead trout appear to have the widest distribution of any anadromous salmonid in the basin. In general, they are distributed farther upstream and occupy a greater variety of habitats than other anadromous salmonids in Blue Creek. Blue Creek appears to be utilized year-round by adult steelhead. The basin supports a substantial run of winter steelhead and may support a remnant population of summer steelhead. The low numbers of

summer steelhead observed in 1996-1997, however, raise doubt whether a reproductively viable population exists (Gale 1996, 1997)."

3. Redwood Creek HPA

Salmonid abundance in Redwood Creek has declined substantially - by perhaps as much as 90 percent by the mid-1970s (EPA 1998), but few data are available to describe past and present salmonid populations in Redwood Creek (RNSP 2002). Current fish runs are far below those that occurred 70-80 years ago as suggested by news accounts and recollections of long-time residents of Redwood Creek watershed (Van Kirk 1994). When designating Critical Habitat for CC Chinook salmon and NC steelhead, the CHART team also determined the conservation value for the three subwatersheds comprising the Redwood Creek watershed (NMFS 2005). For both species, two of the areas were ranked high in conservation value and a third was ranked as medium.

a. SONCC Coho Salmon Distribution, Abundance and Trends

Based on the historic coho salmon population structure work done by Williams *et al.* (2006), Redwood Creek coho salmon likely were a Functionally Independent population owing to the large extent of historically suitable habitat. Coho salmon distribution in the Redwood Creek Basin is limited to the mainstem and the larger low gradient tributaries. Coho salmon are found primarily in Prairie Creek and its tributaries, possibly owing to the lower gradient and more pristine nature of that watershed (Anderson and Brown, 1983). Appendix C of CDFG (2002) confirms the presence of coho salmon within the Redwood Creek mainstem, as well as Prairie, Little Lost Man, Lost Man, Streelow, May, Godwood, Boyes, Brown, Tom McDonald, and Bridge Creeks. Additionally, Table 4-8 of the HCP confirms the presence of coho salmon in Panther, Coyote, and Minor Creeks within the Redwood Creek HPA (Simpson 2002). Redwood National Park staff conducted general stream surveys of the basin in 1980 and 1981 to describe and characterize the salmonid rearing habitat and distribution of juvenile salmonids (Anderson 1988, Brown 1988). Migration barriers were identified during these surveys. No coho salmon were found during these early electrofishing surveys above the barriers. However, subsequent surveys in the 1990s have detected coho salmon in streams that did not have coho in 1980-81. Whether these barriers still exist, have changed to allow fish passage, or new barriers have been created is unknown.

In 1965, CDFG roughly estimated spawning escapement of 2,000 coho salmon from Redwood Creek (EPA 1998). However, these estimates were derived using data from the Eel River, and cannot be considered as reliable as field data from Redwood Creek. A total of 9,610 coho salmon juveniles were seined from Prairie Creek and its tributaries in 1951 (Hallock *et al.* 1952). Most of the coho salmon in Redwood Creek likely occur in the Prairie Creek drainage. With the closure of the Prairie Creek hatchery in 1992, those numbers are probably now much lower. As part of annual spawner surveys, the highest number of live, adult coho salmon observed in Prairie Creek any year since 1983 was 99 (RNSP 2002).

b. CC Chinook Salmon Distribution, Abundance and Trends

Similar to coho salmon, Chinook salmon are found in the mainstem Redwood Creek and lower gradient tributaries such as Prairie Creek and Minor Creek. The historic population work conducted by Bjorkstedt *et al.* (2005) considered the Redwood Creek Chinook salmon population a Functionally Independent population owing to the extent of historically suitable habitat. Spring-run Chinook salmon were likely historically present in the watershed and existed as a Functionally Independent population due to its geographic isolation from other spring-run populations (Bjorkstedt *et al.* 2005).

In 1965, CDFG roughly estimated spawning escapement of 5,000 Chinook salmon from Redwood Creek (EPA 1998). However, like the coho salmon estimates above, these estimates were derived using data from the Eel River, and cannot be considered as reliable as field data from Redwood Creek. The 1979 Chinook salmon spawning run was estimated to be 1,850 fish (Ridenhour and Hofstra 1994) based on that summer's estuarine juvenile population. The highest number of live, adult Chinook salmon observed in Prairie Creek in any year since 1983 was 101 (RNSP 2002). On Bridge Creek, the highest number of Chinook salmon observed was 272 fish in 1986 (RNSP 2002). Chinook salmon continue to decline in some tributaries, but estuary numbers remain as high as those in the early 1980s (RNSP unpublished data, Meyer 1994). The consistent estuary number likely reflects the limited carrying capacity of the estuary in its current state.

c. NC Steelhead Distribution, Abundance and Trends

Historically, the Redwood Creek watershed was occupied by a single Functionally Independent winter-run population (Bjorkstedt *et al.* 2005). Steelhead occur in the same streams as coho and Chinook salmon, likely accessing higher gradient reaches above the general distribution of coho and Chinook salmon. Table 4-8 of the HCP confirms the presence of steelhead in Panther, Coyote, Beaver, Minor, Lupton, Noisy, Minor, Lake Prairie, Pardee, and Twin Lakes Creeks within the Redwood Creek HPA (Simpson 2002).

RNSP began summer steelhead surveys in 1981 and over the following 14 years, adult summer steelhead surveys in a 16-mile index reach determined a high of 44 summer steelhead; however, in a some years, no summer steelhead were observed (Anderson 1993, 1995). Forty-four adult fish is the highest total number observed during summer surveys of portions of the mainstem of Redwood Creek. No adult fish were seen in 1989. No other RNSP streams in the Redwood Creek Basin have been surveyed for summer steelhead; these streams do not have pools large enough to support fish during the warm summer months. Historically, the Redwood Creek watershed provided habitat for a Functionally Independent population of summer-run steelhead (Bjorkstedt *et al.* (2005).

Winter steelhead numbers are much higher. In 1965, CDFG roughly estimated spawning escapement of 10,000 winter steelhead from Redwood Creek (EPA 1998). Juvenile steelhead are the most common and widely distributed fish in the Redwood Creek Basin. During sampling efforts in the summers of 1980 and 1981, steelhead occurred in 57 of the 111 tributaries surveyed. On Bridge Creek, the highest number of live steelhead and carcasses was 126 in 1985 (RNSP 2002). A 1994 analysis found that summer steelhead continued to decline, most likely because of the lack of adequate holding pool habitat (RNSP, unpublished data, 1994). The same analysis found that fall and winter steelhead outnumbered coho salmon and Chinook salmon in Redwood Creek, potentially due to a higher tolerance to elevated sediment and disturbance regimes.

4. Coastal Lagoons HPA

Distribution, abundance and trends of Chinook salmon, coho salmon and steelhead are poorly understood in this HPA. For Stone Lagoon and Big Lagoon, the ability of anadromous fish to enter the system is controlled by the frequency of lagoon breaching which occurs during relatively short time periods (days to weeks) during the winter and spring. In dry years, the lagoons may not breach at all and adults cannot enter the system. Based on Simpson (2002) data, streams within the HPA are expected to contain the following species:

- McDonald Creek (Stone Lagoon tributary): coho salmon, steelhead
- Maple Creek (Big Lagoon tributary): Chinook salmon, coho salmon, steelhead
- Mill Creek: steelhead
- Luffenholtz Creek: steelhead

Very little data are available on the distribution of anadromous fish in the HPA. Long-term data to describe trends in populations are similarly lacking. The CHART effort ranked this area as having a "low" conservation value for both CC Chinook salmon and NC steelhead. In contrast, the historic coho population work by Williams *et al.* (2006) indicated that populations in McDonald Creek and Maple Creek/Big Lagoon were Potentially Independent, suggesting that these populations may have had influenced surrounding populations through straying. For NC steelhead, Bjorkstedt *et al.* (2005) classified the McDonald Creek steelhead population as Dependent, while the adjacent Maple Creek/Big Lagoon population was considered Potentially Independent.

5. Little River HPA

Little River is one of the larger coastal watersheds in the action area. Distribution of salmonid species (SONCC coho salmon, CC Chinook salmon and NC steelhead) is presented in the HCP as Figure 4-32 (Simpson 2002). In general, salmonid species appear to be distributed throughout the mainstem and lower portions of the major tributaries of the watershed as confirmed by spawner surveys and juvenile monitoring. The CHART ranked Little River as having a high conservation value for both CC Chinook salmon and NC steelhead. The Little River HPA is currently the most actively surveyed HPA for adult spawning escapement. Spawning surveys have been conducted on 6 streams within the Little River HPA during the period of 1998 through 2000.

Historic data on salmonid abundance within the Little River watershed is unavailable to infer trends. Since 1998, Green Diamond has monitored juvenile out-migration and spawner abundance in four tributaries (Lower South Fork, Upper South Fork, Carson Creek, and Railroad Creek). For 1999 and 2000, coho out-migrant population estimates are approximately 300 and 3,800 fish, respectively. For steelhead, total out-migrant estimates for four tributaries combined are approximately 200 fish for each year (Simpson 2002).

a. CC Chinook Salmon Distribution, Abundance and Trends

Chinook salmon are distributed throughout the larger tributaries of the Little River watershed. Historically, the Chinook salmon population in Little River served as a Potentially Independent population (Bjorkstedt *et al.* 2005). Although long-term abundance and trends data are not available, spawner surveys were conducted by Green Diamond in 1998 through 2000. Results show Chinook salmon use is focused on the mainstem where counts where 83 live fish and carcasses were observed in 1998/1999 and 66 fish were observed in 1999/2000 along a 15,500-foot survey reach. Lesser numbers of Chinook salmon were observed in the tributaries. During the 1994 monitoring effort conducted by the USFWS, Shaw and Jackson (1994) estimated that over 209,000 juvenile Chinook salmon migrated down the lower mainstem.

b. SONCC Coho Salmon Distribution, Abundance and Trends

Work by Williams *et al.* (2006) indicated that Little River was historically a Potentially Independent population. Juvenile coho salmon population estimates were developed for three Little River tributaries from 1998 through 2000. Population estimates ranged from a low of 176 juveniles from Railroad Creek in 2000 to a high of 7,903 in the Lower South Fork Little River in 1999. Furthermore, out migrant smolt trapping was conducted on Little River tributary streams during 1999 and 2000 in order to estimate overwintering survival. These results indicate that overwinter survival was poor in 1999, ranging from 3.7 percent to 8.4 percent of the previous summer's population. Conditions were improved in 2000 when overwinter survival ranged from 12 percent to 21 percent for the three surveyed streams.

c. NC Steelhead Distribution, Abundance and Trends

Historically, the steelhead in Little River comprised a single Potentially Independent population (Bjorkstedt *et al.* 2005). Juvenile steelhead population estimates were developed for three Little River tributaries from 1998 through 2000. Population estimates ranged from a low of 62 juveniles from Lower South Fork Little River in 2000 to a high of 350 in the Upper South Fork Little River in 1998. Out migrant trapping conducted by the USFWS in 1994 captured approximately 10,000 steelhead parr and 1,100 smolts (Shaw and Jackson 1994).

6. <u>Mad River and North Fork Mad River HPAs</u>

Steelhead, Chinook salmon and coho salmon are all present in the Mad River HPAs. A bedrock cascade in the lower portion of the North Fork Mad River mainstem restricts access for most fish, limiting the distribution to the lower portions of the North Fork watershed. However, limited numbers of steelhead are known to negotiate the barrier (Simpson 2002).

All of the larger tributaries in the Mad River HPA contain anadromous salmonids. Larger tributaries that drain a large portion of Green Diamond-owned lands include Lindsay Creek, Cañon Creek, and Canyon Creek.

The CHART effort (NMFS 2005) for CC Chinook salmon and NC steelhead divided the Mad River into four sub-watersheds. Three of the areas were ranked "high" for conservation value and the fourth area, above Ruth Reservoir, was ranked "low."

a. CC Chinook Salmon Distribution, Abundance and Trends

The extent of historically suitable habitat indicated that the Mad River and its tributaries were occupied by a single Functionally Independent population (Bjorkstedt *et al.* 2005). In 1958, the California Department of Water Resources (CDWR) and CDFG (CDWR-CDFG 1958) estimated that an average of 5,175 Chinook salmon spawned in the Mad River. In 1965, CDFG estimated Chinook salmon escapement in the California portion of the SONCC Chinook salmon ESU at about 88,000 fish, including approximately 5,000 fish in the Mad River, or approximately six percent of the California population (CDFG 1965). Annual counts of adult fall-run Chinook passing Sweasey Dam from 1938 to 1964 are presented in Figure 2. Spring-run Chinook salmon were historically present in the mad River and comprised a single Functionally Independent population, but have been extirpated (Bjorkstedt *et al.* 2005).

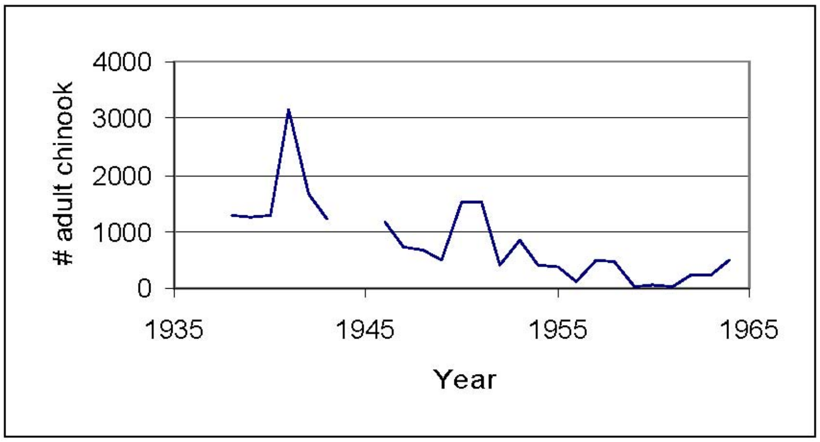

Figure 2. Number of adult Chinook salmon observed passing Sweasey Dam from 1938 to 1964 (CDFG 1968). No data were available for 1944-45.

b. SONCC Coho Salmon Distribution, Abundance and Trends

Coho salmon migrating above Sweasey Dam at river mile 22 were counted by CDFG from 1938-1964 (Figure 3). On average, 474 coho salmon passed the dam with a high of 3,580 fish in 1962 and a low of 3 fish counted in 1958 (CDFG 1968). In 1959, CDFG began artificially rearing coho and stocking them in the watershed, and is thus likely responsible for the increased returns seen 1961-1963. In 1958, the DWR assumed that the number of fish migrating above Sweasey Dam represented approximately 16 percent of the total Mad River population. Most coho salmon, it was assumed, utilized the lower watershed and its tributaries such as Lindsay Creek. Since the early 1970s, the number of coho salmon adults returning to the Mad River hatchery has declined (Figure 3). It should be noted, however, that in the early 1990s the weir that directed fish into the hatchery ceased to operate, therefore, allowing adults to pass the facility. From 1985 to 2000, adult coho salmon counted in index reaches in Cañon Creek and North Fork Mad River averaged 5 and 10 fish, respectively, with the highest counts occurring in the first 5 years of this period for both streams and declining more recently (HBMWD 2003). Given the extent of historically suitable habitat for coho salmon, Williams *et al.* (2006) indicated that Mad River coho salmon were a Functionally Independent population.

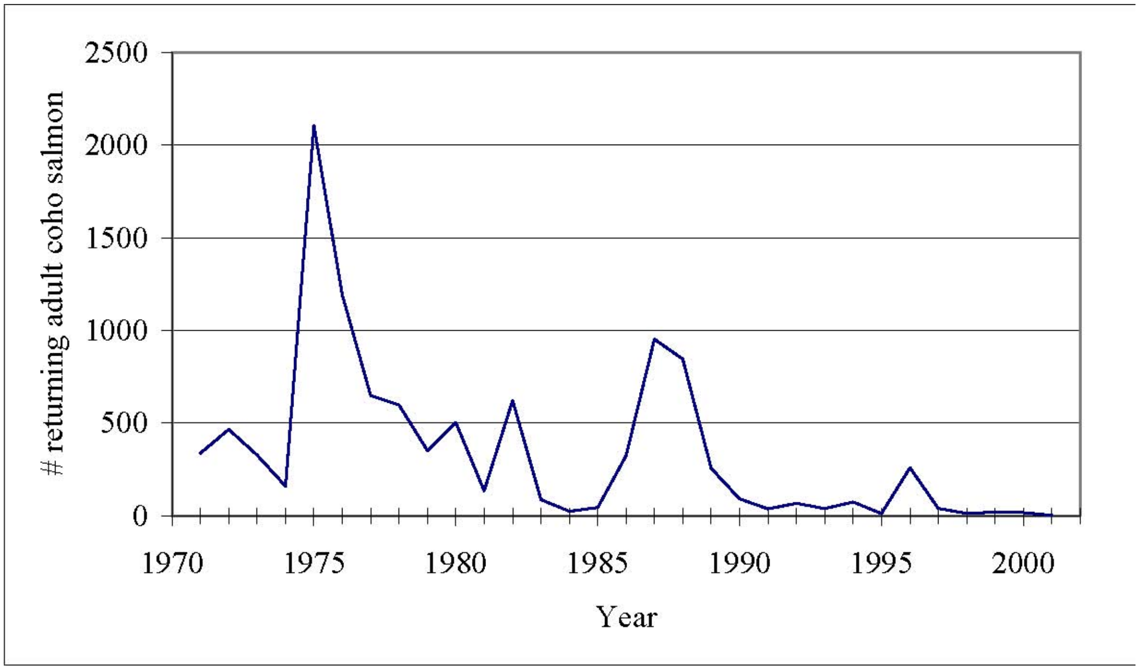

Figure 3. Total adult coho salmon returns to Mad River Hatchery for the period 1971-2001 (Barngrover 1994, HBMWD 2003).

c. NC Steelhead Distribution, Abundance and Trends

Winter-run steelhead in the Mad River watershed were part of a single Functionally Independent population (Bjorkstedt *et al.* 2005), suggesting that the population had a significant influence on the demographics of adjacent populations. Historical estimates of NC steelhead at Sweasey Dam on the Mad River range from 3,800 (Murphy and Shapovalov 1951) to 2,000 (McEwan and Jackson 1996), not including estimates by CDFG in 1965 (CDFG 1965). In 1965, CDFG estimated NC steelhead escapement at 198,000, with the Mad River spawning population at 6,000 fish (Busby *et al.* 1996), representing approximately 3 percent of the total population in the DPS. The Mad River also supports a small population of summer-run steelhead which historically were a Functionally Independent population (Bjorkstedt *et al.* 2005). These fish hold in deeper pools of the mainstem Mad River over the summer months (Simpson 2002).

7. Humboldt Bay HPA

Chinook salmon, coho salmon and steelhead occur in the larger tributaries throughout this HPA. Work by Bjorkstedt *et al.* (2005) suggests that the tributaries to Humboldt Bay were occupied by a single Potentially Independent population of Chinook salmon. These include Salmon Creek, Elk River, Freshwater Creek and Jacoby Creek. Although no documentation of Chinook salmon is available for Ryan Creek, coho and steelhead are present in this watershed. Elk River and Freshwater Creek are known to support sizeable populations of coho salmon. The Humboldt Fish Action Council (HFAC) has operated an egg taking station on Freshwater Creek at Three Corners since late 1978, using a weir to capture adult brood fish. The trapping season extends from the first fall rains through early to mid-February in the next calendar year. Coho salmon egg collection ceased in 1994 because HFAC felt that the stream was reaching carrying capacity for adult spawners. Chinook salmon eggs are still being collected in some years since 1994, with juveniles planted and 22,000 fry released in 1999 (Higgins 2001). The HFAC adult trap record from 1978-1999 provides a minimal index of coho and Chinook salmon returns. The counts cannot be used to calculate population trends because the amount of time and effort expended annually on trapping is unknown, high flows allow adult fish to by pass the weir, and adult salmonids may have avoided the trap during low flow years. Specific information on status and trends within Salmon Creek and Ryan Creek, where Green Diamond owns a large portion of these watersheds, is unavailable. CHART investigations in the Humboldt Bay tributaries and estuary ranked this area as having a high conservation value for both CC Chinook salmon and NC steelhead (NMFS 2005).

a. CC Chinook Salmon Distribution, Abundance and Trends

Chinook salmon occur in the larger stream reaches. Specific to Green Diamond ownership, Chinook occur in Jacoby Creek, the Elk River, and Salmon Creek. Other than data collected from the monitoring efforts in Freshwater Creek, little information exists on the abundance and trends of Chinook salmon in Humboldt Bay tributaries.

b. SONCC Coho Salmon Distribution, Abundance and Trends

The watersheds tributary to Humboldt Bay likely provided some of the best coho salmon habitat in the ESU under historic conditions. The historic population work by Williams *et al.* (2006) listed the Humboldt Bay tributaries as a single Functionally Independent population owing to the extent of historically suitable habitat. The low gradient, gravel-bedded streams, large redwood trees providing woody debris, extensive estuary areas, and proximity to the ocean provided favorable conditions for all life stages of coho salmon. Coho salmon are still present in the larger tributaries of this HPA, such as Jacoby Creek, Freshwater Creek, Elk River, and Salmon Creek, however, longer term data are unavailable to infer any trends in abundance. Several smaller streams may have provided access to coho salmon historically, but these areas are largely overlapped by the urban areas of Arcata and Eureka and the extent to which coho salmon populations have been eliminated from these areas is unknown.

c. NC Steelhead Distribution, Abundance and Trends

Steelhead are distributed throughout the larger tributaries in this HPA and may occasionally be seen in the smaller tributaries. The extent to which the distribution of steelhead has been eliminated from the smaller tributaries is unknown. Historically, the various tributaries to Humboldt Bay were part of a single Potentially Independent steelhead population (Bjorkstedt *et al.* 2005). Available data indicate that winter-run populations declined significantly prior to 1970, and populations have remained at depressed levels with no clear trends since then (Busby *et al.* 1996). In addition, Higgins (2001) cited newspaper accounts from the late 1940s that reported the presence of chum salmon and summer steelhead in Freshwater Creek.

8. <u>Eel River HPA</u>

CDFG (1965) characterized the Eel River as ". . . one of California's most important anadromous fish streams; ranking second in silver (coho) salmon and steelhead trout production, and third in king (Chinook) salmon production." In general, the lower Eel and Van Duzen

Rivers serve as migratory corridors for salmonids. Observations indicate that these lower mainstem reaches are infrequently used for juvenile rearing, most likely due to the high summer water temperatures and poor habitat conditions. Several of the tributaries in this HPA provide important spawning and rearing habitat (PALCO 2002). Information for each species is provided below and summarized in Table 10. The CHART effort subdivided the Eel River into 19 sub-watersheds for assessment purposes. All of these areas were ranked as having either a high or medium conservation value for CC Chinook salmon and NC steelhead (NMFS 2005).

a. CC Chinook Salmon Distribution, Abundance and Trends

Chinook salmon are found throughout the HPA in the mainstem rivers and lower portions of the larger tributaries. In particular, Grizzly Creek is identified as one of the most important tributaries in the Eel River watershed for Chinook salmon spawning based on mark and recapture research conducted in 40 Eel River tributaries for 1982-83 (CDFG 1982). The Eel River estuary also provides key rearing habitat, but the impacts to the estuary (discussed previously) have likely reduced the productivity of this portion of the HPA. Work by Bjorkstedt *et al.* (2005) suggests that the Lower Eel River, Lower Van Duzen River and their tributaries were occupied by a single Functionally Independent population of Chinook salmon.

In 1965, CDFG estimated Eel River Chinook salmon spawning escapement at 55,500, which represents 73 percent of the Chinook salmon production within the CC Chinook salmon ESU (CDFG 1965). CDFG (1965) also estimated that approximately 2,500 Chinook salmon annually migrated up the Van Duzen River. General long-term population trends for the Eel River watershed as a whole (Table 10) indicate long-term declines consistent with declines seen elsewhere in the CC Chinook salmon ESU. Peak index counts and carcass surveys in two tributaries to the Eel River have shown precipitous long-term declines since the 1960s, with recent increases in one tributary (Simpson 2002). Similar monitoring in other tributaries conducted since the late 1980s also show steep declines. The spring-run Chinook salmon in the upper Eel River are possibly extinct, representing a significant loss of life history diversity in the ESU as a whole (September 16, 1999, 64 FR 50393). Historically, this spring-run population in the Eel River was a Functionally Independent population owing to its geographic isolation and the extent of habitat available (Bjorkstedt *et al.* 2005).

b. SONCC Coho Salmon Distribution, Abundance and Trends

Juvenile coho salmon do not appear to rely heavily on the lower mainstem for a nursery (Murphy and DeWitt 1951), likely due to the high summer water temperatures and poor habitat conditions. The bulk of the coho salmon spawning occurs in the larger and lower gradient tributaries in the HPA, rather than the mainstem. Collectively, these tributaries to the Lower Eel and Van Duzen Rivers are considered to comprise a Functionally Independent population by Williams *et al.* (2006).

CDFG (1965) estimated that approximately 500 coho salmon annually migrated up the Van Duzen River. Recent population estimates of natural SONCC coho salmon of 10,000 (Weitkamp *et al.* 1995), when compared to estimates by NMFS of Eel River coho salmon runs of less than 1,000 fish (approximately 10 percent of the ESU), indicate that the Eel River population is important to the overall ESU, and implies that a self-sustaining and self-regulating Eel River population will be necessary for recovery of coho salmon in this ESU.

c. NC Steelhead Distribution, Abundance and Trends

Steelhead occurring in the lower Eel and Van Duzen Rivers may belong to one of several populations of winter run steelhead historically present in the overall Eel River Basin (Bjorkstedt *et al.* 2005). Similarly, summer-run steelhead were also present in the action area, belonging to one of seven Functionally Independent populations. In terms of distribution, Brown (1980) reported many more juvenile steelhead in lower river pools than in upper river pools. These steelhead may prefer lower river pools because they are cooler and more frequently shaded by fog in the summer than upper river pools. Steelhead may use lower river pools as rearing areas in their second year before they migrate to the sea. Puckett (1977) found heavy concentrations of yearling steelhead in the Eel River estuary through the summer of 1975. Brown (1980) found considerable numbers of yearling steelhead in pools in the lower mainstem Eel River from the confluence of the South Fork Eel River to the estuary. Steelhead use many of the tributaries for spawning (PALCO 2002) and much of their rearing probably occurs in these same reaches, rather than in the stressful conditions of the mainstem.

Long-term trends data are shown in Table 10 and are consistent with the long-term declines noted elsewhere for this DPS. Eel River steelhead spawning escapement in 1964 was estimated at 82,000, about 41 percent of the overall production within the NC steelhead DPS (Busby *et al.* 1996). The summer steelhead run in the Van Duzen River is generally considered to be less than 100 (Higgins *et al.* 1992) with no estimates of winter run fish available specifically for the Van Duzen River.

Table 10. Estimates of Eel River Basin and upper Eel River sub-basin anadromous salmonid runs.

	Estimate of Individuals				
Era	**Coho Salmon**	**Chinook Salmon**	**Steelhead**	**Total**	**Reference**
1900	70,000	175,000	255,000	>500,000	CDFG 1997
1964	14,000	55,500	82,000	151,500	CDFG 1965
late 1980s[1]	1,000	10,000	20,000	31,000	CDFG 1997
Present[2]	<1,000	<5,000	<9,000	<15,000	

<u>Notes</u>:

1 NMFS estimate based upon 1964 run proportions.
2 NMFS estimate of wild runs averaged over the last 10 years

C. Factors Limiting Survival and Recovery of Salmonids in the Action Area

1. Factors Limiting Survival and Recovery of Salmonids in the Smith River HPA

a. Lack of Woody Debris Recruitment

Stream channels in the Smith River HPA reflect over a century of logging related impacts and debris removal efforts following the 1964 flood. Past logging, prior to more recent forest practice rules enacted in the 1970s, resulted in the removal of streamside vegetation, particularly along larger, more accessible channels. Following enactment of the 1973 rules, removal of streamside vegetation was substantially curtailed. In many cases, regeneration within these areas is now dominated by hardwoods (*e.g.*, red alder). Hardwood dominance has the dual effect of not providing adequately-sized wood to adjacent channels while suppressing conifer regeneration. The lack of instream woody debris is likely to persist and perhaps worsen in the short-term as existing instream wood decays or is transported downstream and the adjacent stands are not capable of providing adequate wood. Over time, though, riparian stands will attain sufficient size to provide adequately sized wood. Over a period of several decades, wood recruitment will improve and habitat conditions will respond accordingly with improved number and complexity of pools, more effective sediment routing mechanisms in headwater channels that attenuate the effects of upslope mass wasting and improved cover for salmonids.

b. Increased Sediment Delivery from Roads and Landslides

A widespread and aging road network continues to present a sediment hazard to channels in the Smith River HPA. Additionally, hillslope landslides from timber harvest and other activities in the watershed (*e.g.*, mining) provide additional sediment. While some information suggests that the upper portions of the Smith River may be able to transport much of the sediment, lower reaches, particularly the smaller coastal streams in the HPA may be vulnerable to the accumulation of this sediment.

The SONCC coho salmon appears to be the most vulnerable species in the HPA. Data from Wilson Creek, a smaller coastal tributary with a history of intensive timber harvest, suggests a rapid decline in juvenile coho salmon abundance over a relatively short time period. In the Winchuck River, juvenile coho salmon have been absent in two of the six survey years (Simpson, 2002). Based on these limited data, effects on coho salmon could be most pronounced in subbasins near the coast where the combination of intensive past management, lack of extensive, steep, bedrock controlled channels to flush sediment and declining coho salmon populations occur together.

2. Factors Limiting Survival and Recovery of Salmonids in the Klamath HPA Group

a. Lack of Woody Debris Recruitment

As discussed previously, extensive timber harvest throughout the Klamath HPA group has reduced the size and amount of confers available for recruitment to adjacent watercourses. For the Coastal Klamath and Blue Creek HPAs, Simpson (2002) indicates that lack of woody debris is a limiting factor. The dominance of many of the streamside stands by hardwoods (Simpson 2002) will only serve to delay the growth of adequately sized conifers. For the larger channels, appropriately-sized material may not be available for decades. However, over several decades we expect that supplies of wood will gradually increase with a corresponding improvement in stream habitat conditions.

b. Sediment

As a result of past timber harvest and road construction, the frequency of landslides has greatly increased throughout the Klamath HPAs. Excessive sediment due to slope stability issues was identified by Simpson (2002) as a limiting factor in both the Coastal and Interior Klamath HPAs. The role of roads and harvest-related landslides in Hunter Creek noted earlier is likely similar across the three HPAs given similar harvest history. While the upper portions of the tributaries may recover relatively rapidly due to steeper gradients, the lower reaches, where much of the spawning and rearing occurs, may take many years or decades to recover. When combined with the lack of woody debris present in the channels and available for recruitment from streamside stands, the simplification of habitat resulting from excessive sediment creates a setting that provides poor habitat for salmonid spawning and rearing. In particular, spawning habitats for anadromous salmonids are extremely limited in Mynot, Saugep, Johnsons, Morek, and the lower and upper portions of Bear Creeks (Voight and Gale 1998). The YTFP believes that Mynot Creek may currently provide only rearing habitat and spawning habitat is particularly scarce in Morek Creek (Voight and Gale 1998). The two notable exceptions to this negative trend are the middle reaches of both Bear and Tectah Creeks, which appear resistant to the high sediment accumulations that plague most of these watersheds (Voight and Gale 1998). In some instances, sediment accumulations at the mouths of tributaries may be impairing access to migrating salmonids such as was observed in the lower portions of Taurup Creek by Voight and Gale (1998). However, we lack additional data to assess the magnitude of this effect.

c. Mainstem Water Quality

Poor water quality conditions in the mainstem Klamath River through the plan area are likely to continue to limit the production of salmonids. This highlights the importance of the tributaries for rearing as well as cool water inputs to the mainstem.

3. <u>Factors Limiting Survival and Recovery of Salmonids in the Redwood Creek HPA</u>

a. Lack of Woody Debris Recruitment

Stream channels in the Redwood Creek HPA reflect many decades of logging related impacts. Early logging, prior to more recent forest practice rules, removed much of the streamside vegetation, particularly along larger, more accessible channels. In many cases, regeneration within these areas is now dominated by hardwoods (*e.g.,* red alder). Hardwood dominance has the dual effect of not providing adequately-sized wood to adjacent channels while suppressing conifer regeneration. The lack of instream woody debris is likely to persist for several decades and perhaps worsen as existing instream wood decays or is transported downstream and the adjacent stands are not capable of providing adequately sized wood. Combined with the high sediment loads present in Redwood Creek and the lower tributaries, the lack of wood limits the amount of sediment sorting and routing that occurs and results in simplified habitat conditions.

b. Increased Sediment Delivery from Roads and Landslides

Channel deposition has destroyed much of the pool/riffle configuration of the creek, drastically reducing rearing habitat for fish. In 1977, channel aggradation had filled essentially all pools in sampled reaches of the lower mainstem. By 1986, pools had re-established in all sampled reaches, and average residual pool depths were about 4 feet. Although channel deepening and pool development have been observed in all but the lower few miles of the creek, the mainstem generally lacks an adequate pool-riffle structure and cover (RNSP 2002). A continuing lack of woody debris will limit the degree of recovery that may occur in areas where sediment has accumulated.

Cold pools in the lower reaches of Redwood Creek offer high quality rearing habitat and holding areas for juvenile salmonids and migrating adult summer steelhead (Keller and Hofstra 1982, Ozaki 1988). Juvenile salmonids have been observed utilizing cold pools during hot summers on other north coast rivers (Nielsen *et al.* 1994). Cold pools form when gravel bars isolate cool tributary or intragravel flow from streamflow in the mainstem. These cold pools represent less than 8 percent of the total pools on the lower creek and are ephemeral features which form, change locations, or are destroyed during moderate winter flows.

Habitat conditions are probably still quite degraded due to past and ongoing management activities, but are showing signs of improvement. Although channel deepening and pool development have been observed in all but the lower few miles of the creek, the mainstem generally lacks an adequate pool-riffle structure and cover. Coarse sediment deposited in the mainstem allows a large proportion of summer base flows to infiltrate and flow subsurface, thereby limiting the surface water available to fish and increasing surface water temperatures. Large deltas still block some tributary mouths and prevent migration of fish. The lack of suitable rearing habitat in the mainstem and tributaries has forced juvenile fish to the estuary, where they are subject to the impacts of uncontrolled breaching and limited estuarine habitat as described below.

c. Temperature

Canopy closure along the upper reaches of Redwood Creek is increasing, but is still far less than it was early this century. Tributary water temperatures are generally suitable for salmonids, but are sub-optimal for fish along much of the mainstem. As forestry activities avoid disturbing streamside forest canopy, we expect that stream temperatures will improve. This effect may take much longer in the mainstem where export of excessive sediment is needed to narrow the channel and reduce the water surface area subject to insolation.

d. Reduced Estuary Area

The limited area present for estuarine rearing likely continues to limit salmonid production in the Redwood Creek HPA, particularly for Chinook salmon. The relatively consistent numbers of juveniles seen in the estuary during past surveys probably represent a population that is at the carrying capacity. Increases in estuary area and restoration of natural tidal circulation would likely have large benefits for Chinook salmon production in Redwood Creek. However, we do not expect any increases in estuary area in the foreseeable future.

4. Factors Limiting Survival and Recovery of Salmonids in the Coastal Lagoons HPA

a. Instream Woody Debris and Riparian Vegetation

Green Diamond has not conducted any monitoring of woody debris within this HPA (Simpson 2002). Similarly, other data describing current conditions for instream woody debris are not available. Vegetation age data presented by Simpson (2002) show that much of the Green Diamond portion of the HPA (61 percent) is in stands ranging from 41-60 years old. We do not know how well this age distribution reflects conditions within the riparian zones on the ownership or across the HPA as a whole. However, given the legacy of wood removal and streamside harvest seen in other HPAs, we expect that woody debris levels in this HPA will take many years to recover.

b. Sediment

The delivery of fine sediment from timber harvest and related activities, particularly roads, continues to negatively influence salmonid production in this HPA (Simpson 2002). Given the large road network, and the length of road hydrologically connected to the channel network, these impacts are likely to continue.

5. Factors Limiting Survival and Recovery of Salmonids in the Little River HPA

Like many of the watersheds in the action area, Little River reflects a history of intense timber harvest. Given the current age of the vegetation in the HPA, riparian stands may not be able to provide adequately sized woody debris for decades. This is expected to magnify the effects of sediment derived from harvest-related landslides and roads where the low levels of wood do not allow for sediment storage and routing necessary for the formation and maintenance of healthy stream habitat. Habitat data from four reaches in the watershed indicate that 34-51 percent of the surveyed pools are greater than 50 percent embedded (Simpson 2002), suggesting that fine sediment may be impairing emergence success. Although the estuary of Little River is relatively undeveloped, grazing is expected to continue along with suppression of the riparian zone and other channel impacts associated with near-stream grazing. Little River is one of the largest watersheds in the action area draining directly to the ocean and is known to support NC steelhead, CC Chinook and SONCC coho salmon.

6. Factors Limiting Survival and Recovery of Salmonids in the Mad River HPA

Current conditions within the HPA reflect over 100 years of intensive land management including timber harvest and grazing. Channel conditions reflect this through a high amount of fine sediment in the mainstem and tributaries and low levels of woody debris and reduced future recruitment potential. Overall fish passage conditions are expected to improve in the near future as culvert barriers are modified to allow passage. As monitoring in the lower reaches in association with gravel mining continues, NMFS anticipates that extraction techniques will reduce impacts to habitat conditions in the lower river. Development in the lower portions of the HPA is expected to continue with associated road construction and land clearing. The Mad River Hatchery has introduced non-native salmonid stocks into the watershed, further compromising the viability of the population. Salmonid populations in the Mad River appear to be most vulnerable to changes in aquatic habitat due to increased sedimentation and lack of woody debris. Tributaries in the lower portions of the HPA which likely provide the most suitable habitat for SONCC coho salmon are subject to impacts from both timber harvesting as well as residential development.

7. Factors Limiting Survival and Recovery of Salmonids in the Humboldt Bay HPA

a. Estuary Alteration

The estuary will likely continue in its current state for the foreseeable future. Although projects are in the planning phase that will restore some areas to wetlands or tidal marsh, the extent of these projects is unknown at this time. However, we anticipate that these increases in estuary area will be small and not approach the dimensions of estuarine areas that were present prior to the 1800s. In this state, salmonid productivity will continue to be limited, particularly for Chinook salmon, for the foreseeable future.

b. Sediment

The proximity of timber harvest, residential areas and salmonids has spurred a wealth of efforts to better understand ecological processes in the HPA - particularly in the Elk River and Freshwater Creek, where cumulative effects associated with timber-related sedimentation and flooding have focused concerns. Given these recent concerns over cumulative effects in Freshwater Creek, the state has restricted PALCO to harvesting no more than 500 clear-cut equivalent acres per year in the watershed. A similar harvest rate quota is being developed for Elk River, as well, but the acreage limitations are not yet known.

Chinook salmon, coho salmon and steelhead are found throughout the HPA and are subject to a variety of ongoing impacts both individual and cumulative. Tributaries within the Humboldt Bay HPA can be roughly characterized as having upper watersheds subject to timber harvest and related activities with the lower watersheds containing a mix of timber harvest on the hillslopes and rural and suburban development and grazing on the low lying areas. Channels along the lower reaches have been significantly modified to reduce flooding hazard and create pastureland. The result has been a loss of floodplain and tidal wetland connectivity and removal of lowland conifer forests supplying LWD. Similarly, the perimeter of Humboldt Bay has been reduced by extensive dikes. The underlying geology produces an abundance of fine sediments and landsliding occurs along headwall swales and inner gorges. Data from Freshwater Creek suggest that chronic turbidity may be impacting salmonids in addition to the other impacts associated with fine sediment in general. Both Freshwater Creek and Elk River have been listed as sediment impaired under section 303(d) of the Clean Water Act. In addition, the state has declared Freshwater Creek and Elk River as cumulatively impacted by sediment due, primarily, to past timber harvest and related activities.

8. Factors limiting the Survival and Recovery of Salmonids in the Eel River HPA

a. Lack of Instream Woody Debris

Although many of the tributaries currently contain abundant large woody debris from first cycle logging (PALCO 2002), riparian stand conditions throughout the HPA may not be able to supply functionally-sized woody debris to the stream channel for several decades. The dominance of many streamside stands by hardwoods will continue to suppress conifer growth. Over several decades, these stands will gradually reach a size where they are capable of delivering functional wood to adjacent channels. In response, we expect that habitat conditions will improve over very long time periods.

b. Excess Sediment

Past land use has led to tremendous volumes of sediment being deposited in important salmonid habitats. The 1955 and 1964 floods had an especially high impact on instream habitat and salmonids as they occurred following a period of intensive timber harvesting lacking many of the current regulations. The degree to which the largest channels in the action area have recovered from these floods is difficult to determine due to the confounding effects of more recent large floods, such as those occurring in 1996 and 1997. For example, investigations of historic channel change along the lower Mad River by Lehre *et al.* (2005) indicate that the mean channel width has recovered to that seen prior to 1964, suggesting that the bulk of the impacts generated during this storm event may have subsided in the lower mainstem. In cases where the largest stream channels in the HPA are still be recovering from the effects of these floods, continued sediment delivery, particularly when combined with a lack of woody debris, will delay this recovery.

c. Mainstem Water Temperatures

Current temperatures in the mainstem Eel and Van Duzen Rivers often approach lethal levels for juvenile salmonids. We do not have information describing the historic temperature regime of these reaches, and therefore, what additional habitat these areas may have provided for salmonids. However, given the current aggraded state of the lower river reaches, pools were likely deeper and afforded more cool water refuge areas under historic conditions.

d. Poor Estuary Conditions

As discussed previously, the character of the Eel River estuary has changed significantly since the late 1800s. The aggradation seen in the lower river and diking have likely limited the productive ability of this key habitat, particularly for Chinook salmon. We do not expect any appreciable increases in estuary area in the foreseeable future.

D. Baseline Summary

1. Habitat Condition and Influences

The action area, defined as the 11 HPAs and discussed above, contains several salmonid species that have been affected to varying degrees by activities occurring throughout the respective ESUs/DPSs (*e.g.*, timber harvest) as well as impacts that have occurred specific to a given HPA, such as estuary reductions in the Redwood Creek and Humboldt Bay HPAs. A common theme across the action area is the long history of timber harvest and related activities such as road construction. This has resulted in harvest of streamside timber and increased sediment delivery from roads and harvest-related landslides. In some areas, removal of woody debris from the channel has added to the ongoing effects and heightened the importance of adequately-sized streamside stands for resupplying wood to deficient reaches. Cumulatively, the lack of wood and increased sediment has greatly simplified stream habitats. Sediment has filled pools and finer material has infiltrated spawning gravels with little woody debris available to maintain the sediment routing and storage functions necessary for functional stream habitat. The lack of wood will persist for many years and even decades along the larger streams. In some isolated instances, stream temperatures appear to be limiting the production of salmonids, but overall, canopy coverage appears to provide adequate shading across much of the action area. The specific habitat elements and their responses are spawning habitat degradation due to excessive fine sediment levels and lack of suitable rearing habitat, due to excessive sediment delivery and lack of LWD (Table 11). Sediment appears to be a key control on the quality of habitat conditions in 9 of the 11 HPAs (Table 11).

Table 11. Limiting habitat factors for salmonids within the action area (from Simpson 2002).

HPA	**Primary Limiting Factor(s)**
Smith River	Lack of LWD resulting in limited rearing habitat (summer and winter)
Coastal Klamath	General lack of wood and excess sediment (coarse and fine) in some watersheds resulting in limited rearing habitat
Blue Creek	Lack of LWD resulting in limited rearing habitat
Interior Klamath	Excess sediment resulting in embedded substrates and aggraded channels
Redwood Creek	Excess sediment resulting in embedded substrates and aggraded channels
Coastal Lagoons	Excess sediment (mostly fines) resulting in embedded substrates
Little River	Excess sediment resulting in embedded substrates and aggraded channels
Mad River	General lack of wood and excess sediment (coarse and fine) in some watersheds resulting in limited rearing habitat
North Fork Mad River	Excess sediment resulting in embedded substrates
Humboldt Bay	Excess sediment inputs from geologically unstable areas resulting in aggraded channels and embedded substrates
Eel River	Excess sediment inputs from geologically unstable areas resulting in aggraded channels and embedded substrates

Habitat conditions vary across the action area. Thus, caution must be exercised when attempting to generalize habitat conditions across the action area. For example, the HCP (Appendix C) reached the following conclusions on habitat conditions based on the assessment of 58 streams across the action area:

"Taken together, the [habitat] assessments suggested that there were:

1. A lack of complex pool habitat with low levels of LWD as shelter;
2. Dense alder dominated riparian zones that provided excellent canopy closure, yet lacked the LWD recruitment potential of larger, more persistent, conifers;
3. Embedded gravels in many pool tailouts; and
4. Aggraded conditions in the lower reaches of some streams."

To better portray this range of conditions and create a conceptual framework for overlaying the effects of the action, we consider the response of stream channels to increasing sediment loads, since sediment appears to be a dominant factor controlling habitat conditions across the action area. Dietrich *et al.* (1989) suggested that rivers respond to increasing sediment loads by progressing through a series of geomorphic changes, beginning with a progressive "fining" of the streambed, where the overall particle size decreases. As the sediment supply further increases, pools begin to fill in with finer sediment. Eventually, the excess sediment initiates channel widening and aggradation. Finally, where sediment supply is extremely high, a braided channel may result. This progression is illustrated along the horizontal axis in Figure 4. We then consider these physical channel responses to sediment inputs in terms of habitat elements (Table 12). For example, streambed fining is likely manifested through both increased embeddedness and smaller particle sizes, resulting in a decline in spawning habitat quality. Since many of the habitat surveys noted embedded substrates, moderately filled pools, and moderately aggraded channels, we generated a curve to represent a distribution of habitat conditions across the action area (Table 12). This conceptual linking of sediment supply to habitat conditions is intended to form the basis for our effects analysis in areas where sediment is a dominant control on channel form and function. Figure 4, then, is a conceptual model depicting how past and ongoing sediment inputs have created much of the channel conditions seen across the action area.

2. <u>Salmonid Populations and Factors Limiting their Survival and Recovery</u>

Salmonid populations in the action area show a general long-term decline in abundance co-incident with intensive timber harvest. Status of these ESUs/DPSs was summarized in the *Status of the Species* section and much of that discussion is relevant at the scale of the action area, given the scope of the proposed action.

Some populations such as SONCC Chinook salmon show relatively stable or even increasing populations, but these trends are over relatively short time frames and these populations generally occur where Federal land ownership is highest (*e.g.*, Smith River Chinook salmon). Spring-run Chinook salmon populations in the CC Chinook salmon ESU have been extirpated. Many of the fall-run Chinook salmon populations in the action area are Functionally Independent or Potentially Independent populations – indicating that effects on populations in the action area may have effects on the entire ESU as well.

Coho salmon show precipitous declines in abundance, particularly in the northern portions of the action area where some year classes appear to be entirely absent (*i.e.*, Winchuck River). The numerous small, low gradient coastal watersheds that the action area encompasses are likely key areas for the survival and recovery of the SONCC coho salmon ESU. Furthermore, the action area lies within several larger river basins that support important populations of SONCC coho salmon. The historic populations work by Williams *et al.* (2006) indicated that six Functionally Independent coho salmon populations occupied the action area, representing approximately one-third of the 19 Functionally Independent populations in the SONCC coho salmon ESU. Four Potentially Independent populations occupy the action area, representing nearly one-third of the Potentially Independent coho salmon populations in the ESU. Thus, coho salmon populations in the action area are vital to the continued existence of the ESU as a whole.

Steelhead populations have shown similar long-term declines, but appear to occur in greater numbers across the action area, likely owing to their greater ability to utilize disturbed habitats. Similar to SONCC coho salmon, the action area lies within several river basins and smaller coastal watersheds that are important for the survival and recovery of the NC steelhead DPS. Many of the watersheds across the action area are composed of Functionally Independent or Potentially Independent steelhead populations, both summer-run and winter-run. However, many of the summer-run populations in the action area have been extirpated or are at extremely low levels of abundance. Thus, any effects on the populations in the action area will have effects on the DPS, as a whole, as well.

The specific habitat elements that have likely contributed to the species declines and continue to limit species abundance are degraded spawning habitat due to excessive fine sediment levels and lack of suitable juvenile rearing habitat due to excessive sediment delivery and lack of LWD (Table 11). We think this explains the particularly steep decline of coho salmon because they require complex pool habitat for instream rearing. Thus, coho salmon have been faced with multiple habitat alterations that have reduced their long-term viability - poor spawning habitat and lack of complex rearing habitat. Conversely steelhead, which we expect are better able to utilize disturbed habitat, have experienced less of an impact from rearing habitat simplification when compared to the coho salmon. Chinook salmon, which are most dependent on spawning conditions and estuary quality, have suffered declines likely reflecting the elevated sediment yields that have degraded spawning habitat and led to filling of estuary habitats which have also been degraded by agricultural development in coastal lowlands of the action area.

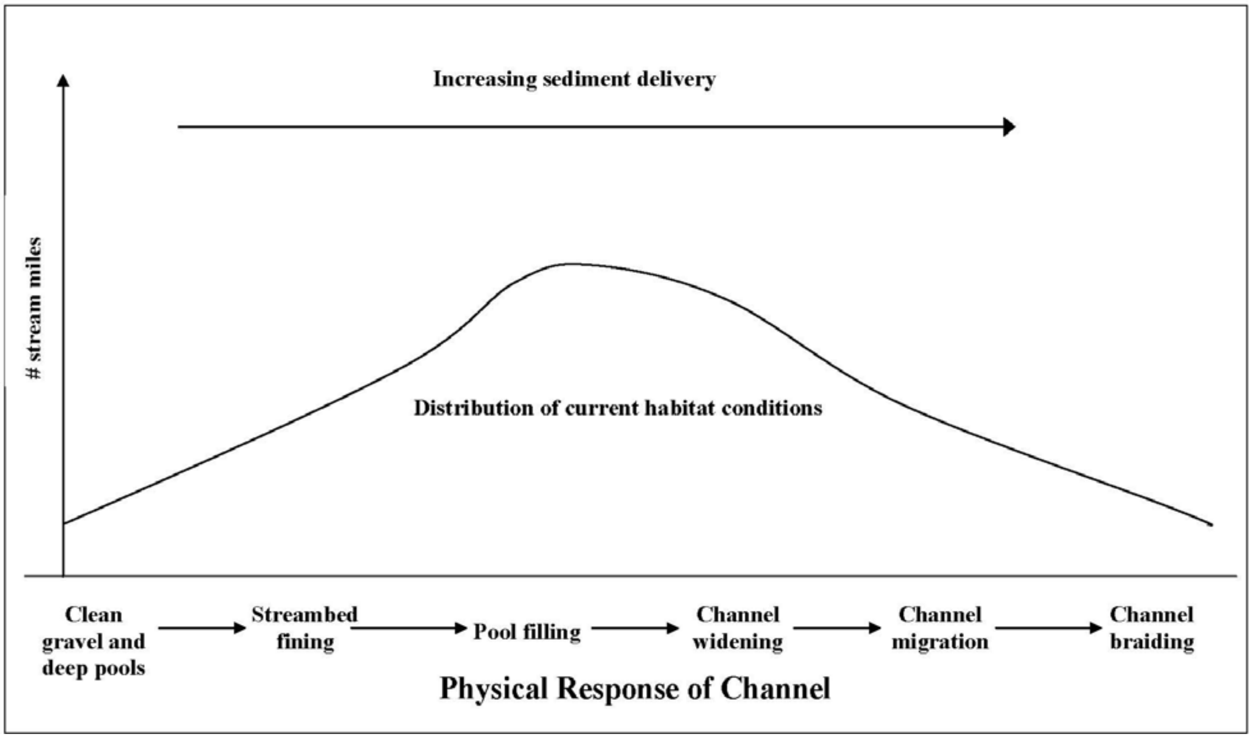

Figure 4. The distribution of current habitat conditions as described in the *Environmental Baseline* section is compared to the range of physical channel responses expected with changing sediment delivery rates. This progression of responses, which does not include consideration of conservation plan measures, is more fully described in the text. These physical responses are then linked to specific habitat elements as indicated in Table 12. For example, pool filling is associated with reduced rearing habitat for juvenile coho salmon which require pools for freshwater rearing.

Table 12. Progression of channel geomorphic response to changing sediment inputs suggested by Dietrich *et al.* (1989). To better link these with salmonid response, we have listed key habitat/life history attributes affected by each change.

	Geomorphic Response	**Habitat response**
Increasing sediment supply ↓	*Streambed fining*	• Reductions in spawning gravel permeability • Reductions in salmonid prey base (substrate characteristics)
	Pool in-filling	• Further reductions in spawning habitat quality • Further reductions in prey base • Reduced juvenile rearing space
	Channel Widening	• Increased bed mobility, reductions in spawning habitat stability • Reductions in juvenile rearing space (depth and volume)
	Channel Migration	• Continued reductions in spawning habitat stability • Further reductions in juvenile rearing space
	Channel Braiding	• loss of spawning habitat stability • loss of juvenile rearing habitat • migration barriers

3. <u>Critical Habitat</u>

Designated critical habitat for SONCC coho salmon in the action area is vital to the species' continued survival. The action area provides spawning and rearing habitat, as well as migratory corridors. As mentioned previously, the coastal watersheds that are encompassed by the action area are key areas for the production of SONCC coho salmon. These low, gradient coastal watersheds have the capability of providing ideal habitats for the species. The low gradient nature of the channels allows for the scour of deep pools and deposition of appropriately-sized spawning substrate. Coastal forests provide the large wood necessary for complex rearing habitats and this wood also moderates the effects of mass wasting-derived sediment. Streamside forests and the coastal climate provide a moderating effect on stream temperatures. Thus, the conservation value of the designated critical habitat in the action area is extremely important for the species.

Designated critical habitat for NC steelhead occurs throughout the action area. The designated critical habitat encompassed by the action area provides necessary spawning, rearing and migratory habitat. In terms of conservation value of the critical habitat, the extensive overlap between the action area and designated critical habitat for NC steelhead indicates that measures influencing critical habitat will have effects across multiple populations and across a substantial portion of the DPS. As described for each HPA, the efforts of the CHART determined that the bulk of the sub-watersheds within the action area have a high conservation value for NC steelhead (NMFS 2005).

Similar to NC steelhead, the action area encompasses a large swath of CC Chinook salmon designated critical habitat. The action area lies at the northern end of the ESU and encompasses larger rivers such as Redwood Creek and Mad River where mainstem spawning occurs. Additionally, larger tributaries such as Grizzly Creek in the Van Duzen River watershed provide key areas for populations of Chinook salmon in the Eel River. The CHART process determined that most of the sub-watersheds within the action area have a high conservation value for CC Chinook salmon (NMFS 2005).

V. EFFECTS OF THE ACTION

Pursuant to section 7(a)(2) of the ESA, Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The purpose of the analysis in this Opinion is to determine if it is reasonable to expect that the direct and indirect effects of the proposed action and any interrelated and interdependent actions, when added to the environmental baseline and any cumulative effects of future non-Federal actions, are likely to appreciably reduce the likelihood of both the survival and recovery in the wild of the anadromous salmonids proposed for incidental take coverage under the HCP or likely to destroy or adversely modify designated critical habitat [16 USC 1536(a)(2), 50 CFR 402.02 and 402.14(g)]. For the critical habitat analysis, this Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, the analysis looks to the statutory provisions of the ESA relevant to critical habitat, as provided in NMFS' November 7, 2005, memorandum to Regional Administrators from Assistant Administrator William T. Hogarth.

Specifically, NMFS will analyze the direct and indirect effects of the proposed action and interrelated and interdependent actions on SONCC coho salmon, CC Chinook salmon, SONCC Chinook salmon, Upper Klamath/Trinity Rivers Chinook salmon, NC steelhead, and KMP steelhead and designated SONCC coho salmon, NC steelhead and CC Chinook salmon critical habitat. The status of each species and the condition of critical habitat was previously described in the *Status of the Species and Critical Habitat* and *Environmental Baseline* sections. The effects analyses determine the anticipated effects of the action on currently owned Green Diamond lands (IPA) as well as on the Adjusted Areas. We assume the Adjustment Areas will respond similarly as the IPA to the proposed actions given their proximity to currently owned lands. Therefore, when we refer to the "ownership," we refer to the eligible plan area, unless otherwise indicated. The proposed ITP would have a 50-year term. Therefore, the analyses will consider effects over the life of the 50-year ITP, and effects that would continue beyond the life of the ITP. For example, harvesting in the last decade of the ITP has the potential to influence landslide rates beyond the 50-year permit period. Since many of the activities influence watershed processes that respond over long time periods (*e.g.*, wood recruitment), much of the effects analysis addresses conditions existing in the decades following the 50-year permit period when the entire ownership has been subject to HCP implementation.

For the purpose of this analysis, we also assume that timber harvest and other activities that have potential environmental effects will occur across the majority of covered lands over the life of the HCP. We assume that harvest will be distributed throughout the permit area and it will occur at a sustainable rate as required by California law. Using this assumption, we expect that the habitat in all HPAs will respond similarly to the proposed action at some point over the life of the HCP. We also realize that a portion of covered lands will not be subjected to harvest practices during the term of the permit due to regulatory constraints, conservation commitments, and a planned 50-year rotation that will not necessarily result in an entry and harvest of all available stands over the life of the permit. Our analysis should thus be viewed as a reasonable approach in estimating the impacts of the covered activities.

During the implementation of the HCP, we assume that all covered activities will be conducted in accordance with law and as prescribed by the HCP. We assume that failure to identify features requiring buffers or avoidance will be rare. We also assume that failure to identify unstable features will be infrequent for smaller features and rare for larger features. We make these assumptions because the harvest area will be visited several times by RPFs, licensed geologists, fish and wildlife specialists, and representatives of regulatory agencies during the THP development and permit approval process. We consider the impacts of these isolated instances of mis-identification further in the *Effects Analysis*. Adaptive Management, monitoring, and changed circumstances processes included in the HCP and IA will permit adjustments to plan measures over time as new information is developed through proposed monitoring programs.

A. Effects Analysis Assessment Approach

In recent years, the decline and extinction of Pacific salmon populations has been linked to habitat loss and degradation in their spawning and rearing streams (Nehlsen *et al.* 1991). As a result, and because many of the proposed HCP activities have the potential to adversely affect aquatic habitat, this assessment of the effects of the action associated with the proposed ITP for Green Diamond on six salmonid ESUs/DPSs, and designated critical habitat is primarily habitat-based.

The relationship between changes in habitat quantity, quality, and connectivity and the status and trends of fish and wildlife populations has been the subject of extensive scientific research and publication, and the assumptions underlying our assessment are consistent with this extensive scientific base of knowledge. For more extensive discussion of and data supporting the relationship between changes in habitat variables and the status and trends of fish and wildlife populations, readers should refer to the work of Fiedler and Jain (1992), Gentry (1986), Gilpin and Soule (1986), Nicholson (1954), Odum (1971, 1989), and Soulè (1986). For detailed discussions of the relationship between habitat variables and the status and trends of salmon populations, readers should refer to the work of FEMAT (1993), Gregory and Bisson (1997), Hicks *et al.* (1991), Murphy (1995), National Research Council (1996), Nehlsen *et al.* (1991), Spence *et al.* (1996), Thomas *et al.* (1993), The Wilderness Society (1993), and any of the numerous references contained in this rich body of literature.

Gregory and Bisson (1997) stated that habitat degradation has been associated with greater than 90 percent of documented extinctions or declines of Pacific salmon stocks. This conclusion is also supported by Lichatowich (1989), who identified habitat loss as a significant contributor to stock declines of coho salmon in Oregon's coastal streams. Beechie *et al.* (1994) estimated a 24 percent and 34 percent loss of coho salmon smolt production capacity of summer and winter rearing habitats, respectively, since European settlement in a Washington stream. Beechie *et al.* (1994) identified three principal causes for these habitat losses, in order of importance, as hydromodification (*e.g.*, dams and diversions), migration-blocking culverts, and forest practices. Several authors have found positive relationships between habitat complexity, LWD in streams, and salmonid populations (Tschaplinsky and Hartman 1983, Reeves *et al.* 1993, McMahon and Holtby 1992). Nickelson and Lawson (1998), in modeling extinction risk of coho salmon along the Oregon coast, found that probability of extinction was inversely related to habitat quality for starting populations of 50 and 100 individuals. Furthermore, Nickelson and Lawson (1998) found that there would be a substantial increase in risk of extinction for Oregon coast coho salmon in basins with poor habitat quality if habitat quality declines by 30-60 percent over the next century. The regulations that listed the different Pacific salmon ESUs as threatened and endangered species reflected this body of evidence by stressing the role of present and threatened destruction, modification, and curtailment of aquatic habitat in the decline of Pacific salmon.

These references establish that the value of habitat for any species is largely determined by the quantity and quality of the resources available in the species' habitat and is usually represented by the number of individuals the habitat can support at any point in time (this is commonly referred to as the habitat's "carrying capacity"). If the population size or vital rates of a listed species are limited by one or more of the physical, chemical, or biotic resources available in the species' "habitat," then reducing the quantity or quality of those limiting resources would also be expected to reduce the species' reproduction, numbers, or distribution. The physical, chemical and biotic resources that constitute a species' habitat fluctuate with time and space, which is why species use different habitats or the same habitat for different reasons at different stages of their development and at different times of an annual cycle.

Available information indicates that populations of threatened and endangered Pacific salmon are limited by the existing condition of aquatic habitat, and these populations were depleted, at least partially, due to past forestry practices. The *Environmental Baseline* section established that habitat conditions in the action area have been degraded by past activities, particularly timber harvesting and other activities such as road construction (although these activities may not be the sole cause of habitat degradation in the action area). As indicated in the *Environmental Baseline*, we also expect that current forest practice regulations should result in improving habitat trends relative to past historic practices as past impacts are gradually ameliorated through natural processes and improvements in current forest practices[4] result in reduced short and long-term adverse effects and ultimately result in a habitat condition that is projected to gradually improve over the life of the proposed action.

NMFS evaluated the effects of the proposed action, specifically the effects of the covered activities and interrelated and interdependent actions, when added to the environmental baseline on the overall trend in habitat conditions, positive or negative, and on the specific habitat

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[4] For purposes of this analysis, current forest practices are defined as the 2002 California State Forest Practice Rules, which were the rules in place at the time the HCP was written.

conditions required by the species and critical habitat. We analyzed whether the expected changes to habitat conditions resulting from the proposed action, when added to the environmental baseline, are sufficient to meet the biological requirements of the species and will allow primary constituent elements of critical habitat to remain functional or become functional. The purpose of this assessment is to determine the effects of the action on the fitness of individuals of the species, the viability of the species' populations, and the value of critical habitat to support species' conservation. NMFS identified the biological requirements of the covered species and the condition of critical habitat primary constituent elements in the *Status of the Species and Critical Habitat* and the *Environmental Baseline* sections, above. In summary, the biological requirements for the covered species and the condition of critical habitat elements, as they relate to the habitat effects of the proposed action, are the habitat characteristics that would support successful adult spawning, embryonic incubation, emergence, juvenile rearing, holding, migration and feeding in the action area.

We used the best available scientific and commercial information to determine the effects of the proposed HCP measures and the biological requirements of the species. In some cases, the published information expresses the species' needs in terms of habitat conditions unaffected by land management activities. This analysis is described in greater detail below.

1. Jeopardy Analysis

To assess the effects of the proposed action, we asked the following questions:

(1) What are the physical, chemical, and biotic resources contained in the aquatic ecosystems of the action area (*i.e.*, the watershed processes) that are likely to be directly or indirectly exposed to the land management activities associated with the proposed action over the 50-year duration of the ITP?

(2) How are those watershed processes likely to respond to that exposure?

(3) How are the responses of those watershed processes likely to affect the quality, quantity, and availability of the habitat conditions for Pacific salmonids in the action area?

(4) What threatened or endangered species of Pacific salmonids are likely to be exposed to those changes in the quality, quantity, and availability of their habitat conditions?

(5) How are the different life stages of those salmonids likely to respond to those changes in habitat conditions, expressed in terms of the fitness (specifically, the growth, survival, and lifetime reproductive success) of these salmonids?

(6) What are the probable consequences of any changes in the fitness of these individuals on the viability of the populations and the species?

To answer these questions, we utilized information provided by Green Diamond as well as information gained from numerous literature searches. The following discussion briefly summarizes the approach we took to answer each question and the assumptions or assessments we made to complete the analysis.

(1) What are the physical, chemical, and biotic resources contained in the aquatic ecosystems of the action area that are likely to be directly or indirectly exposed to the land management activities associated with the proposed action over the 50-year duration of the ITP?

Our assessment is structured around the physical and chemical processes that dictate habitat conditions in the action area. We determined whether the proposed activity affects five principal watershed processes as defined by Lisle (1999). The products of these processes are water, woody debris, sediment, heat, and nutrients. We use these processes and products as indicators of the physical, chemical, and biotic resources exposed to the proposed action because these five watershed processes dictate freshwater and estuarine habitat conditions that salmonids depend on for their survival.

In considering the spatial and temporal extent of the proposed activities, we assume that the proposed activities will occur at one time or another over the entire ownership over the 50-year term of the HCP, since 50-year old timber stands are considered harvestable (Simpson 2002). Similarly, we expect that the effects of the action will occur throughout the action area as a result of implementing the proposed HCP measures. Because we do not have projections on where timber harvest will be focused over the life of the HCP, we assume that all areas will be harvested (with the exception of designated no-harvest areas such as Northern Spotted Owl nest sites) in a continuous fashion over the life of the HCP as areas reach 50 years of age or greater and the effects will, therefore, be somewhat continual. As a result, we expect that harvesting will occur nearly continuously in the HPAs because all of the HPAs are composed of multiple age classes of standing timber.

(2) How are those watershed processes likely to respond to that exposure?

The delivery of the various watershed products and their interactions with stream reaches in the action area will be influenced by many of the activities proposed in the HCP. The effects analysis estimates the flow regimes, wood recruitment patterns, sediment delivery rates, temperature regimes and nutrient fluxes likely to result from implementing the proposed HCP.

For example, many of the proposed activities in the HCP will reduce sediment delivery rates if they are implemented in accordance with the HCP. Thus, we look at the various activities that have the potential to influence sediment delivery rates. We then consider these activities collectively to estimate an overall sediment delivery rate. In many cases, input rates are expressed relative to "background" conditions, or those rates expected if land management had no influence on the watershed process of interest. We do this only to facilitate comparisons with existing information. For example, some authors (*e.g.*, Wilson *et al.* 1982, Skagit Watershed Council 1998, Beamer *et al.* 2000, and Pyles *et al.* 2002) describe sediment delivery rates influenced by land management activities as a percentage of background rates, with a value of 100 percent reflecting conditions where management has no influence on sediment delivery rates (background conditions). As management-related sediment delivery increases, the percentage increases. Sediment delivery rates under the proposed HCP are compared to the expected rates under background conditions to determine the overall effects of the proposed action on the species and critical habitat. Given the expected rates under the proposed HCP, we then determine if the overall sediment delivery rates will result in habitat conditions that meet the species' life history needs.

A common approach used throughout this analysis is expressing a component watershed input process (*e.g.*, mass wasting sediment delivery to watercourses) as a proportion of the entire watershed input. We then structure our analysis around the specific input process and consider the overall influence of that input using the proportional weight of a given input factor. For example, consider the case where 60 percent of hillslope landslides are generated on landform "x" and the remaining 40 percent originate on landform "y". Further, assume the two landforms deliver landslides to watercourses at an average total rate of 10 landslides per year under background conditions. Lacking additional information, we would assume that, on average, 6 landslides per year come from landform x (60 percent of 10 landslides/year) and 4 landslides originate from landform y (40 percent of 10 landslides/year). Now, assume that a proposed activity covered by the ITP on landform x is expected to increase the rate of landsliding on that landform by 150 percent (1.5 times) in comparison to predicted background conditions. The expected rate of landsliding for landform x is 9 landslides per year (6 landslides per year x 150 percent). Taken collectively over all landforms, the overall change in landslide rates delivering to streams is expressed as the expected proposed action rate (13 landslides/year) divided by the background rate (10); or 13/10 = 130 percent. That is, landslides under this hypothetical example are expected to occur at a rate that is 130 percent of the predicted background rate.

This approach enables us to assess the magnitude of changes in a given watershed process from proposed practices (*e.g.*, total landslide sediment delivery) and the influence of each component over large areas (*e.g.*, landslide delivery from headwall swales). For purposes of the jeopardy and adverse modification analysis, the expected changes are also added to the existing impacts of the environmental baseline to determine whether habitat trends will change as a result of the proposed HCP. As discussed in the *Environmental Baseline* section, recent forest practices are expected to result in improving habitat trends relative to past historic practices; proposed practices under the HCP that are more protective or conservative of salmonid habitat features than current practices would be expected to either maintain or improve the current rate of overall habitat improvement. As discussed in Question 5, we then determine whether the expected habitat improvements or degradations will result in conditions that meet the biological requirement of the species to assess effects on the fitness and viability of the species and the conservation value of critical habitat, and to determine instances or habitat conditions that are likely to result in incidental take.

(3) How are the responses of those watershed processes likely to affect the quality, quantity, and availability of the habitat conditions for Pacific salmonids in the action area?

The delivery of the various watershed products dictates the condition of habitat in the action area. For example, sediment delivery rates are recognized as a significant influence on the form and function of stream channels (*e.g.*, Nelson 1998, Tripp and Poulin *op. cit.* Nelson 1998) and a conceptual model for the interaction of sediment and habitat was presented in the summary of the *Environmental Baseline* section. Using this approach, the channel form dictates the quantity and quality of various habitat types that salmonids depend on for various life history stages. Thus, understanding sediment delivery rates from question #2 above is critical to understanding the response of various in-stream habitat types to the proposed action.

Since many habitat responses are dependent on the interactions of more than one watershed process (*e.g.*, sediment and woody debris interactions), we describe the effects on habitat in the *Integration and Synthesis* section. For example, quantities of coarse sediment and LWD are thought to be factors responsible for habitat conditions (Nelson 1998), and, consequently, rearing conditions (Beechie *et al.* 1994). Thus, the *Effects of the Action* section describes anticipated delivery rates for individual watershed processes and the *Integration and Synthesis* section considers these processes in tandem.

Thus, a key component in this assessment is the quality, quantity and availability of existing habitat as described in the *Environmental Baseline* section (*e.g.*, Figure 4). Any adverse changes in habitat expected under the proposed action would have to be further examined to determine whether the delivery of watershed products under the proposed action resulted in continued poor habitat conditions (in the case where existing habitat is degraded), with potential adverse effects on salmonids, or if the delivery of these products was sufficient to promote or maintain functional habitat. To further refine our estimates of habitat conditions as a result of the proposed action, we use best scientific and commercial data available that describes stream channel conditions resulting from similar watershed process rates in other study locales.

(4) What threatened or endangered species of Pacific salmonids are likely to be exposed to those changes in the quality, quantity, and availability of their habitat conditions?

Depending on the location, all six salmonid species described in the *Status of the Species* section are likely to be exposed to any changes in habitat quality, quantity, and availability. As described above, we expect that timber harvest and related activities will occur across the entire ownership over the 50-year term of the proposed ITP. Similarly, all six salmonid species proposed for incidental take coverage are known to occur within the action area and utilize habitat for one or more life history stages. Thus, all six salmonid species will be exposed to the effects of the action at some point during implementation of the proposed HCP. We describe these interactions between habitat and salmonids in greater detail in the *Integration and Synthesis* section.

We also recognize that salmonids in the action area are influenced by anthropogenic disturbances that do not readily fit into the five watershed process categories, and these disturbances are not necessarily habitat-related. These are instream equipment use, activities to allow fish access around barriers and the use of forest herbicides; each of these are analyzed in their own section in the following analysis. While these activities may not directly affect habitat, they potentially result in direct effects to salmonids.

(5) How are the different life stages of those salmonids likely to respond to the resulting habitat conditions, expressed in terms of the fitness (specifically, the growth, survival, and lifetime reproductive success) of these salmonids?

Given the habitat conditions resulting from the proposed action (question #3), and the distribution of Pacific salmonids in the action area (Question #4), we compare the expected habitat response with life-stage specific biological requirements for salmonids. In conducting our assessment of habitat responses, we use the best scientific and commercial data available to determine what constitutes functional habitat for various life stages of the species. We determine whether the habitat conditions resulting from the proposed action would reduce or improve growth, survival, or reproductive success of exposed individuals.

The habitat assessment focuses on the following life history stages: egg incubation and emergence, juvenile rearing and out-migration, and adult migration and spawning. Most importantly, we consider the effects on life history stages that may be limited by one or more habitat elements. For example, the *Environmental Baseline* section describes many areas where excessive management-related sediment and a lack of woody debris recruitment have resulted in poor quality pool habitat. Under these conditions, juvenile abundance is currently limited for species that depend on pools, such as juvenile SONCC coho salmon.

(6) What are the probable consequences of any changes in the fitness of these individuals on the viability of the populations and the species?

This analytical approach assumes that these species, in general, will experience demographic changes [that is, changes in abundance, population growth rates (productivity), spatial structure and diversity] commensurate with the changes in the habitat-related variables described above. We consider the affected life history stage(s), the populations that are likely to be affected and compare these fitness changes to the viability of the populations as described in the *Environmental Baseline* and *Status of the Species* sections. In many cases, the extent of the effects will be across entire watersheds and influence entire populations. Although we do not have sufficient data to identify each specific geographic area that individual populations are dependent on for their survival and recovery, the overall extent of the action area and the extent of the effects across the action area simplify the approach somewhat.

We consider how the effects may influence the viability of populations (as defined by McElhany *et al.* 2000) in the action area, depending on the magnitude and consequence of habitat responses described in question #3 when added to the current conditions as described in both the *Status of the Species* and *Environmental Baseline* sections. If effects on individual fish could influence any of these measures of population viability, then NMFS must determine whether the effects on the affected populations will increase the species' risk of extinction. If the viability of one or more of these populations is impacted by the proposed action, and these populations play an influential role in the survival and recovery of the ESU or DPS as a whole, we would assume that the proposed action would have impacts on the viability of the entire ESU or DPS. On the other hand, if the effects of the action result in conditions that are sufficient to meet the covered species' biological requirements, then they would not adversely influence population viability, obviating the need for further analysis to support a "No Jeopardy" determination.

2. Adverse Modification Analysis

To determine if the proposed permitted activities are likely to result in the destruction or adverse modification of designated critical habitat for SONCC coho salmon, NC steelhead or CC Chinook salmon, NMFS will analyze the effects of the action on the primary constituent elements of critical habitat identified as essential to the conservation of the species. This analysis starts the same as the jeopardy analysis described above. That is, using the best scientific and commercial data available, we estimate the delivery of watershed products as they may influence substrate and sediment levels, water quality conditions, flow, stream temperatures, physical habitat elements, channel condition, chemicals and nutrients, riparian vegetation, habitat accessibility, and the general condition of watersheds that support the biological and ecological requirements for the conservation of the species. The purpose of the assessment is to determine whether critical habitat in the action area would remain functional for the conservation of the species or retain the current ability for the primary constituent elements to be functionally established. If the effects of the proposed action, when combined with the cumulative effects and added to the environmental baseline, do not destroy or adversely modify the value of constituent elements essential to the conservation of SONCC coho salmon, CC Chinook salmon, or NC steelhead in the action area, then the adverse modification or destruction threshold is not exceeded. Conversely, if the conservation value of the affected primary constituent elements in the action area is destroyed or adversely modified, the NMFS must determine whether the impacts result in an appreciable diminishment of the value of the overall critical habitat for the conservation of the species. Many activities can take place within designated critical habitat without diminishing the value of constituent elements for the species' conservation. On the other hand, the adverse modification threshold may be exceeded if an action diminishes the constituent elements in a manner likely to appreciably diminish or preclude the role of those habitat elements in the conservation of the species.

3. Organization

The effects analysis that follows is organized around the five watershed processes and products (*i.e.*, water, woody debris, sediment, heat and nutrients) and other anthropogenic activities that have the potential to cause adverse effects to the six salmonid ESUs DPSs. For each watershed process, we provide the following:

- An overview of how the individual watershed process influences habitat (including the primary constituent elements of critical habitat) and salmonids;
- A review of the environmental baseline as it pertains to the watershed process;
- An overview of the activity types that may influence the watershed process of interest (Question #1);
- The rates of these watershed processes resulting from implementation of the proposed action (Question #2); and the resulting effects on quantity, quality, and availability of habitat features (Question #3).

As described previously, the *Integration and Synthesis* section considers these effects on individual watershed products collectively and analyzes the aggregate effects of the proposed action on habitat and affected salmonids (Questions #3 and #4). This includes an assessment of the duration of effects and disturbance frequency over the life of the HCP and beyond, in the case of effects that persist beyond the 50-year permit period. This step is critical to the effects analysis because, although we discuss the watershed products independently, the full extent of their influences on aquatic habitat cannot be understood until they are considered in tandem with one another and with the habitat conditions of the environmental baseline and cumulative effects. Specifically, we describe the effects in terms of habitat quantity and quality (Question #3), and the likely impact on individual life history stages (Question #5), critical habitat (adverse modification analysis), populations, and finally, the ESU or DPS (Question #6, jeopardy analysis).

B. Effects of the Proposed Action on Hydrologic Processes

1. Review Baseline Hydrology

A review of the baseline for each HPA shows that the mainstem Klamath, Mad and Eel Rivers have altered hydrology due to upstream dams and/or diversions. Specific information on these ongoing effects is provided in the *Environmental Baseline* section of this Opinion. In the Klamath and Eel Rivers, dams have altered seasonal flow variations, resulting in reduced juvenile rearing habitat and increased mainstem temperatures. Elsewhere, timber harvest and road construction has likely increased the magnitude of peak flows in smaller watersheds. This was probably associated with a pulse of increased sediment delivery and deposition.

2. Effects of Altered Hydrology on Pacific Salmonids and their Habitat

Timber harvesting activities can have significant effects on hydrologic processes that determine streamflow. Timber harvest and road construction alter runoff by accelerating surface flows from hillsides to stream channels (Chamberlin *et al.* 1991, McIntosh *et al.* 1994). These accelerated flows increase peak flows during rainstorms (Ziemer 1998). Also, removal of vegetation reduces evapotranspiration, which increases the amount of water that infiltrates the soil and ultimately reaches the stream. Streams draining recently logged areas may see increased summer flows (Keppeler 1998), which could result in both positive and negative effects for fish and aquatic resources.

Soil compaction caused by heavy equipment can decrease infiltration capabilities, increasing surface runoff. Forest management activities, such as yarding, burning, or road and skid trail construction, may alter both surface and subsurface pathways that transport water to streams (Thomas *et al.* 1993, Murphy 1995, Keppeler and Brown 1998). Logging also alters the internal soil structure. As certain types of tree roots die (unlike redwood and most common hardwoods where where tree roots do not die when stems are harvested), soil "macropores" collapse or are filled in with sediment. These subsurface pathways are important for water transmission. When subsurface flow pathways are destroyed, more flow is routed to the surface and increases gully erosion and sediment delivery (Keppeler and Brown 1998). Ditches associated with roads collect run-off and intercept subsurface flows and route them to streams more quickly. Roads act as first order streams and channel more water directly into larger streams (Wemple 1994).

Increased peak flows can have direct effects on salmon because the resulting increased stream power can scour stream channels, killing incubating eggs, and displacing juvenile salmon from winter cover (McNeil 1964, Tschaplinski and Hartman 1983).

3. Hydrologic Response to HCP Implementation

For the purpose of this analysis, we assume that timber harvest and other activities that have the potential for causing hydrologic change will occur across the majority of covered lands over the life of the HCP. Using this assumption, we expect that the habitat in all HPAs will respond similarly to the proposed action at some point over the life of the HCP. We realize that a given area may experience intensive harvest over a short time period, followed by a period of relatively little activity where the hydrologic effects decrease as vegetative recovery occurs. We also realize that a portion of covered lands will not be subjected to harvest practices during the term of the permit.

a. Roads

Green Diamond anticipates a gradual reduction in road density over the life of the HCP. Also, road decommissioning and stabilization will provide for some reduction in the amount of roads that deliver water to the channel network. Considered here also are the effects of rock quarries and borrow pits, which we expect to behave similarly as roads. Although altered peak flows still occur due to past and ongoing activities, the increase in peak flows from roads will be small, due to the proposed road construction and upgrading guidelines that call for hydrologically disconnecting much of the road network over the life of the HCP. Since much of the road network across the ownership has been constructed, we anticipate that the effects of road-related peak-flow increases will diminish over the life of the HCP as roads are upgraded to HCP standards.

b. Harvest Units

Timber harvest and associated site preparation activities influence hydrologic processes, as discussed above. NMFS expects that some increases in peak flows and summer low flows will occur in sub-watersheds that drain recently harvested areas. Table 13 presents the estimated maximum annual harvest rate for the plan area by HPA. Effects of harvest on hydrologic processes will be greatest where harvest is concentrated in one sub-watershed over a relatively short time period. The purpose of Table 13 is to provide a relative measure of the potential increases in peak flows due to harvesting. Given the resolution of the data, and the many variables that factor into peak flows (*i.e.*, road connectivity, soil types, degree of ground disturbance), we cannot determine the specific response of peak flows to harvesting.

c. Water Withdrawals

While not directly related to hydrologic alterations discussed above, we also consider water drafting here. Water drafting has the potential to adversely affect salmonids through: (1) excessive withdrawal rates that reduce available habitat, (2) high intake velocities that entrain fish, and (3) inadequately-sized intake screens that allow fish to pass through. Green Diamond proposes measures to minimize impacts due to excessive withdrawal rates by not exceeding a maximum withdrawal rate of 350 gallons per minute (0.8 cfs), not withdrawing more than 10 percent of the daily above-surface flow or reducing maximum pool depth by more than 10 percent, and not drafting in watercourses that have less than 1 cfs of surface flow. To address intake velocities and screen size, Green Diamond will follow water drafting guidelines prepared by NMFS (1997a). NMFS expects conformance with these criteria will avoid entrainment of juvenile salmonids and not result in adverse effects to exposed individuals.

Table 13. Current estimates of maximum cutting rate in each HPA with RMZ, SSS, Headwall Swale, and Northern Spotted Owl conservation areas subtracted from the available acreage. We assumed that the remaining acreage with vegetation greater than 50 years old could be harvested at a maximum rate of 50 percent every five years. This value is based on California State Forest Practice Rules Adjacency Requirements and approximates a legal maximum cut rate in a given area, other limitations not withstanding.

HPA	Total HPA acreage (acres)	Initial Green Diamond ownership (acres)	Total area currently available for harvest >50 years old (acres)	Ownership available for harvest (%)	HPA harvestable per year under current conditions[1](%)
Smith River	181,999	44,177	9,450	21	0.52
Coastal Klamath	108,150	88,760	12,624	14	1.17
Blue Creek	80,303	15,393	1,561	10	0.19
Interior Klamath	128,006	66,139	15,911	24	1.2
Redwood Creek	188,335	33,038	7,850	24	0.42
Coastal Lagoons	53,592	39,981	15,529	39	2.90
Little River	29,703	26,041	7,413	28	2.50
Mad River	119,686	49,376	15,454	31	1.29
North Fork Mad	31,416	28,209	8,541	30	2.72
Humboldt Bay	138,719	17,484	4,940	28	0.36
Eel River	205,160	7,933	1,856	23	0.09

1. These values are based on current stand conditions and do not represent cutting rates over the life of the HCP. Also, these values apply only to Green Diamond ownership within each HPA. There will likely be additional harvesting in a given HPA by other landowners.

4. Anticipated Effects to Habitat from Altered Hydrology

Increases in peak flows can increase channel erosion in areas where individual harvest units may cumulatively encompass a large area of the subwatershed. Where this occurs, we expect an increase in channel erosion in lower-order channels resulting in an increased volume of sediment transported to downstream fish-bearing reaches. However, to some degree, this channel adjustment may have previously occurred during initial logging in the late 1800s and early 1900s (PWA 1999), and channels may already be enlarged to some degree to accommodate any increased peak flows with renewed harvest. Based on analysis conducted in the Humboldt Bay HPA (PALCO 2001), we do not expect that the proposed activities will influence peak flows to the degree that redds are scoured. The PALCO (2001) modeling confirmed that peak flow increases do occur as a result of timber harvest, but these increases did not cause premature scour of redds.

We expect the roads program in the HCP will provide for expedited restoration of hydrologic processes given the focus on watershed-scale treatments proposed in the HCP. We also expect that implementation of the roads program will lead to decreases in the effects of roads on peak flows by reducing the extent of the road network that is hydrologically connected to the natural channel network. Therefore, we expect that implementation of the proposed measures may cause localized, short-term increases in peak flows and sediment delivery where harvest and new road construction occur, but the net effect over longer time periods, and the action area as a whole, will have little, if any, effect on redd stability and overall habitat conditions.

We do not expect that any changes in summer low-flows will have detectable effects on salmonids or their habitat. The principal mechanism for influencing summer low flows would be changes in rate of timber harvest. Since the proposed action does not propose changing the rate of timber harvest relative to past rates, we assume that effects on summer low flows (*i.e.*, increased summer low flows in areas of high timber harvest rates) will remain largely unchanged compared to current, or baseline, conditions. The available information suggests that summer low flows may increase somewhat due to timber harvest (Keppeler 1998) and this may provide minor increases in rearing habitat. However, the effect is likely negligible in larger, fish-bearing channel reaches which drain a combination of recently logged and un-logged areas.

C. Effects of Proposed Action on Instream Woody Debris Supply

1. <u>Baseline Summary of Woody Debris Conditions Across the Action Area</u>

Most of the streams within the action area currently have either low instream woody debris loadings or low future recruitment potential from streamside stands due to past harvest and development, or both (see Table 3 for a list of vegetation ages in each HPA). Simpson (2002) identified four HPAs it believes suffer from low instream wood levels that are limiting salmonid habitat: Smith River, Coastal Klamath, Blue Creek and Mad River (Table 11). Logging debris has contributed to observed levels of instream debris in several streams in the action area and may comprise a large portion of the instream woody debris load (PALCO 2001, 2002). Although this debris may currently provide functional habitat elements, riparian stands may not be of sufficient size and extent to maintain debris loadings as the existing instream load gradually decays or is exported from the watershed. We expect that baseline conditions as they relate to the supply and delivery of woody debris will gradually improve. Under current conditions, we expect this recovery of woody debris supply and its consequent effects on habitat will take many decades, if not longer, as trees grow to sizes large enough to provide stable, functional pieces to adjacent stream channels. Expected changes in habitat include increased pool quality and quantity for juvenile rearing and adult holding, and a greater abundance of wood in smaller, non-fish bearing channels to buffer the effects of sediment inputs.

2. Influence of Woody Debris on Salmonids and their Habitat

In-stream woody debris provides a fundamental habitat component for salmonids in forested settings. The role of woody debris in forming habitat for salmonids is well documented (*e.g.*, Spence *et al.* 1996). Large pieces of wood delivered from hillslope sources, including blowdown of streamside stands and delivery from landslides, provide many habitat functions, including:

- *Storage and routing of sediment.* Individual pieces and accumulations of wood act as check dams that moderate the delivery of sediment to downstream reaches. This helps to preserve downstream habitat features, such as pools, which might be wiped out with large, relatively instantaneous delivery of sediment. In steeper reaches, the storage of sediment behind debris jams may provide spawning habitat.

- *Pool scour.* Woody debris provides stable roughness elements in a channel where pools form, resulting in juvenile rearing and adult holding habitat.

- *Cover.* Pieces and jams provide cover from predation and high water velocities.

As the supply of woody debris is decreased or is lacking altogether, the effects on salmonids are numerous. The decrease in pool quantity and quality described above will limit the amount of rearing habitat and cover available for juvenile salmonids, particularly juvenile coho salmon which depend on pools as the principal habitat type for rearing (Meehan and Bjornn 1991, Tschaplinski and Hartman 1983). As a result, competitive pressures would increase, resulting in reduced growth rates and mortality. Winter mortality rates and predation would increase due to the lack of cover provided by the woody debris (Everest *et al.* 1985 *op cit.* Spence *et al.* 1996).

3. HCP Measures Affecting Woody Debris

The HCP describes several activities that will influence the supply of woody debris to streams. These activities include: (1) delineation of floodplains and channel migration zones (CMZ), (2) activities within RMZs, (3) mass wasting avoidance and minimization areas, and (4) road construction, maintenance and rock quarries. Each of these proposed activities relative to woody debris recruitment is summarized below. For each activity, the effectiveness of the proposed measures is assessed relative to what would be expected under pre-harvest conditions in these areas. We use this approach following the assumption that salmonids have evolved with the general patterns of unimpaired woody debris recruitment expected from these areas. Therefore, a change in woody debris recruitment dynamics is expected to have a corresponding change to instream habitat and production and/or survival of salmonid populations relative to pre-harvest conditions. To a large degree, past activities have reduced the inputs of woody debris to streams by both harvest of riparian stands, and direct removal of wood from channels (as discussed in the *Environmental Baseline* section). Much of the analysis of effects here is focused on how the proposed action will allow for long-term recovery of natural wood recruitment processes.

a. Channel Migration Zones and Floodplains

Green Diamond will map all CMZs and floodplains of Class I watercourses within 5 years of the effective date of the ITP. Thus, the current extent of CMZs and floodplains on the ownership is largely unknown. We expect that across the ownership, most floodplains and CMZs will be of limited extent and occur primarily along the lower portions of larger channels where channels are more likely to flow through unconfined valleys. Under the HCP, a general guide for determining floodplain extent will be by using the area inundated at a discharge equal to two times the bankfull depth. Site specific modifications may be made at a later date, but the HCP does not provide details on how these modifications may occur and whether the outcome would result in more, or less protective measures. We assume, for the purposes of this effects analysis, that any prescriptive modifications made to CMZs and floodplains, or the definitions of these features, will not result in less protection than that discussed here. The extent of CMZs is intended to correspond to the modern floodplain, as described above, with the potential for including adjacent terraces subject to bank erosion. The final determination of the boundaries of all floodplains and CMZs will include the oversight of a team of experts that may include a hydrologist, fluvial geomorphologist, geologist and fisheries biologist selected by Green Diamond and the Services.

Where floodplains are present, but no CMZ is present, the RMZ outer zone (proposed 70 percent canopy overstory prescription) will be extended 30-50 feet beyond the floodplain, if necessary, depending on slope. We assume that the RMZ inner zone (proposed 85 percent overstory canopy retention prescription) will be 50 feet wide because floodplains are typically low gradient and likely not subject to the increased inner zone widths (60 to 70 feet) on the basis of slope. For a more detailed description of these prescriptions, refer to the *Proposed Action* section.

Where CMZs are present, the RMZ will begin at the outer edge of the CMZ. No harvest or salvage will be permitted in the CMZ.

Channel migration may occur gradually, through progressive bank erosion, or more abruptly by channel avulsion, where the channel abruptly shifts position during a high flow event (O'Connor and Watson 1998). Predicting when and where these processes are likely to occur can be difficult, particularly in the case of channel avulsion. Should a channel migrate through an area inappropriately delineated as a floodplain rather than a CMZ, the paucity of large, stable wood will result in poorer habitat conditions than would otherwise be expected if the CMZ was properly identified. We expect instances of mis-identification to be infrequent because the HCP requires an inter-discplinary team to identify and delineate CMZs. Significant channel migration is most likely to occur on larger channels where larger woody debris is necessary to remain stable in the channel and provide habitat and other instream functions. Specific areas on the ownership where CMZs potentially exist are the lower portions of Wilson Creek, Terwer Creek, Blue Creek, Bear Creek, Maple Creek (Big Lagoon), Cañon Creek, and Ryan Creek. Portions of the Klamath River and Mad River may also have CMZs (House 2003).

Where CMZs are appropriately delineated, NMFS expects the CMZ prescription to provide for relatively unimpaired recruitment of woody debris from channel migration and associated bank erosion because it will encompass the lateral extent of potential channel migration over time periods of sufficient length to allow trees to attain sufficient size to function in the channel (i.e., decades to hundreds of years for larger channels).

b. Riparian Management Zones

(1) Class I. All Class I watercourses will have an RMZ of at least 150 feet (slope distance) on each bank. The RMZ width will be measured from the first line of perennial vegetation from the stream or the outer CMZ edge, where applicable. The RMZ for Class I watercourses will be divided into an inner zone and an outer zone. The outer zone will be extended, where necessary, to cover the entire floodplain and an additional 30 to 50 feet beyond the outer edge of the floodplain. Widths of the two zones will also vary depending on slope (refer to Table 4 in the *Proposed Action* section).

Over the life of the HCP, only a single entry into Class I RMZs may occur. At least 85 percent of the overstory canopy, which may include both hardwoods and conifers, will be retained in the inner zone and 70 percent in the outer zone. Also, trees within the RMZ that are judged likely to recruit or contribute to bank stability will not be harvested. In no case will harvest within Class I RMZs reduce the conifer stem density to less than 15 conifer stems greater than 16 inches diameter at breast height (DBH) per acre.

We expect that the proposed measures will increase the potential for woody debris recruitment from within the RMZ. The overstory canopy retention standard coupled with the likely-to-recruit standard will provide few harvest opportunities in the RMZ. Green Diamond (2004) quantified the amount of recruitable trees that would be harvested under the proposed riparian measures. Based on current stand conditions, removal of trees, primarily along the outer edges of the RMZ, resulted in a <1 percent reduction in recruitment potential from within the RMZ based on current stand conditions (Green Diamond 2004). Under this scenario, harvest of individual trees would have an almost negligible effect on the amount of woody debris originating from within the RMZ. However, the results from Green Diamond do not account for tree growth, where more trees become recruitable quicker as time passes. In this case, removal of individual trees would have greater effects on the longer term recruitment patterns. However, given the range of recruitment reductions under current conditions (0 to 0.51 percent) based on surveys along five Class I stream reaches, we expect that longer term reductions in recruitment will continue to be small and have little influence on the overall recruitment patterns seen from RMZs.

The above discussion focused on the effectiveness of woody debris recruitment from within the Class I RMZs. The width of the RMZ is critical in determining how much woody debris is available for recruitment. Many studies and modeling efforts have examined the role of buffer widths in providing woody debris to streams (*e.g.*, Bisson *et al.* 1987, Murphy and Koski 1989, McDade *et al.* 1990, Robison and Beschta 1990, Van Sickle and Gregory 1990, Reid and Hilton 1998, Beechie *et al.* 2000). In general, these studies indicate that riparian buffer widths equal to one-site potential tree height are adequate to provide for nearly unimpaired wood recruitment from streamside stands.

The simplest means to assess the effectiveness of streamside buffer widths is to assume that wood recruitment is derived only from tree mortality and windthrow. Recruitment may also occur from mass wasting and is further discussed later in this section. In the short-term, before trees reach one site-potential tree height, Simpson (2002) uses a managed tree height to describe the effects of the buffer widths on recruitment. In Simpson's (2002) analysis, managed tree height is equivalent to the average height of trees at 60-years, or approximately 100-120 feet tall with some stands outside of this range due to local growing conditions. Given the 50-year harvest rotation employed by Green Diamond, 60 years was used as the managed tree-height because it corresponds to the expected average harvest rotation age across the ownership given adjacency requirements of the FPRs and other constraints that prohibit harvest of most stands at exactly 50-years. Thus, this is the maximum height that trees are expected to attain where harvesting occurs. Using managed tree height, the proposed buffer widths along Class I streams are capable of yielding 98-99 percent of the woody debris that would occur if no harvest occurred in the adjacent, upland stand. However, trees within the RMZ will be increasing in age and size over the life of the proposed permit. Simpson (2002) estimates that approximately one-third of the stands comprising the RMZs will be greater than 100-years old at the end of the permit period. At age 100 in a typical RMZ in the redwood zone, the tallest trees will reach 170 feet and exceed 48 inches DBH. Analysis by Simpson (2002) indicates that the proposed Class I buffers will provide for 84-88 percent of the recruitment levels as compared to hillslopes where recruitment is unaffected by harvest.

Work by Reid and Hilton (1998) in a coastal redwood environment indicates that while approximately 96 percent of the wood originates from within a tree-height distance from the channel, the rate of input is affected by the size of the stand adjacent to the RMZ. Where clearcuts occur up to the edge of the RMZ, increased fall rates may exist for several years following harvest (Reid and Hilton 1998). Therefore, under the proposed action, we expect that streamside stands adjacent to recent clearcuts may deliver woody debris at higher rates than would be expected under unharvested conditions. The effects of this increased rate on stream habitat are problematic. Given the low levels of wood observed in many of the Class I streams across the action area, increased rates of recruitment would be desirable. However, given that trees in the RMZ stands are currently smaller than their site potential, some of the wood may be of limited function in the channel. Further, premature recruitment of this smaller material would reduce the quantity of wood available in the future, when the trees would have been larger and more functional. In many cases, the RMZ will be abutted by trees retained as part of the SSS zones and this will reduce the premature recruitment rates an unknown amount. In other instances, the near-term increases in wood delivery may provide for better growing conditions for remaining trees, where they are able to achieve larger sizes more rapidly. However, we do not know the magnitude of this effect. We reason that the increased near-term delivery and reduced longer-term delivery will effectively balance out such that the overall recruitment patterns remain at the levels reported by Simpson (2002) for site potential tree heights (*i.e.*, 84 to 88 percent).

Discussion of the implications of the modified recruitment regimes from RMZs can be found in the summary of overall effects of wood recruitment on stream habitat and salmonids at the end of this section as well as in the *Integration and Synthesis* section where sediment delivery can also be factored into the analysis.

(2) Class II. Class II watercourses are divided into two types, depending on size. For first order Class II watercourses, the first 1000 feet downstream from the headward extent of the Class II/III demarcation will have a total RMZ width of 75 feet. These "Class II-1" RMZs will have a 30 foot inner band subject to 85 percent overstory canopy retention. The outer band, extending from 30 feet out to 75 feet from the channel, will have a 70 percent overstory canopy retention standard.

Class II watercourses that are either second order or greater, or are downstream of a Class II-1 watercourses, are considered "Class II-2." RMZs associated with Class II-2 watercourses will be 100 feet wide on each side of the channel with a 30 foot inner band subject to 85 percent overstory canopy retention and the outer 70 feet will be 70 percent overstory canopy retention.

For all Class II watercourses, regardless of stream order, the first 200 feet above the outer edge of a Class I RMZ will be treated as a Class II-2 RMZ. Additionally, within these areas, no trees judged likely to recruit, as described in the *Proposed Action* section, will be harvested. Also, trees that contribute to bank stability along all Class II watercourses will be retained. Harvest in all Class II RMZs will be limited to one entry over the life of the HCP, coinciding with the harvest of the adjacent stand.

We expect that the proposed measures will not substantially reduce recruitment of woody debris from within the RMZ relative to unmanaged conditions due to the likely-to-recruit provisions and overstory canopy retention standards. This is similar to our findings for Class I RMZs. Simpson's (2002) analysis indicates that for the proposed Class II-1 and II-2 RMZ widths, the managed tree heights will provide for 85 percent and 95 percent recruitment levels, respectively, when compared to conditions where all recruitable trees are retained. Using site potential tree heights, the proposed RMZ widths will allow for 52 to 73 percent recruitment levels, respectively, depending on the site class and particular Class II RMZ implemented at the site. This effect will be realized over several decades as current stands may have been recently harvested and recruitment potential currently does not approach the values cited above.

The effects of this level of woody debris recruitment will be manifested primarily over the long-term as changes in the transport and storage of sediment. Where abundant woody debris is present, sediment is stored behind wood. Under these conditions, wood serves to moderate sediment-related impacts to downstream, fish-bearing habitats. Given the smaller size of Class II streams, individual pieces do not have to be as large in order to remain stable. However, the sediment storage capacity increases as piece size increases (O'Connor 1994). Wood in these channels may also represent an important source for downstream reaches. Where debris flows occur, the rapid export of wood from these lower order stream channels may provide important habitat elements in fish-bearing reaches (May 2002, Benda *et al.* 2003). Since the primary impact on salmonids regarding management of RMZs and woody debris concerns sediment and debris delivery to downstream reaches, these will be considered in the *Integration and Synthesis* section at the end of this effects analysis where changes in sediment delivery can be integrated into the analysis. Effects of the RMZ widths on stream temperatures are discussed in the appropriate section on stream temperatures.

(3) Class III. Riparian protections adjacent to Class III channels are divided into two tiers, depending on hillslope gradient. These slope classes, as determined for each HPA group, are described in the *Proposed Action* section. Class III-a channels (those with relatively flatter sideslopes) would receive no tree retention standards. Only previously downed wood within 30 feet of the channel would be retained. For Class III-b channels, where adjacent slopes are steeper, all hardwoods and non-merchantable trees within 50 feet of the channel would be retained. Conifers contributing to bank stability or providing a control point in the channel would also be retained. A minimum average of one conifer per 50 feet of stream length within the 50-foot zone would be retained along Class III-b channels.

In terms of wood supply to the stream network, due to the proposed tree retention standards, we expect that Class IIIs will receive only a fraction (<10 percent) of the wood that would enter these watercourses under unmanaged background conditions because these areas are subject to unrestricted harvest except for the tree retention standards described above for channels with steeper adjacent slopes. Some of this wood will be provided by the remaining hardwoods, non-merchantable timber and regrowth of stands between harvest rotations. However, we expect the contribution from hardwoods will be minimal as Simpson (2002, Appendix C4) observed relatively few hardwoods such as red alder near Class III watercourses. The retention of single conifers along the banks may lead to increased susceptibility of blowdown and locally increased sediment generation and delivery attenuated by the presence of blow-down pieces in Class III channels. The overall, cumulative effect of class III considerations is discussed in the *Integration and Synthesis* section where the roles of sediment, wood and water are collectively analyzed.

c. Mass Wasting Minimization/Avoidance Measures

The proposed action describes measures to reduce the incidence of management-related mass wasting. Specifically, four landforms are identified which have a high likelihood of failure and delivery of materials to watercourses based on past observations. Specific measures are applied to: (a) Steep Streamside Slopes, (b) Headwall Swales, (c) Deep-seated landslides and (d) Shallow Rapid Landslides. Proposed protective measures on these four areas are discussed below in terms of potential for influencing delivery of woody debris to watercourses.

(1) Steep Streamside Slopes. As described in the proposed action and analyzed in the mass wasting section of this effects analysis (section E), the SSS provisions (Table 14) are expected to cover an area responsible for delivering the majority of mass wasting sediment to watercourses, depending on HPA group and channel type. To assess the effectiveness of the SSS zones in providing wood to streams, we consider two aspects of wood delivery from these areas.

First, selection harvest within the SSS zone will remove potentially recruitable material that might have been delivered to streams, assuming a high rate of SSS failures over the course of the ITP. Proposed SSS prescriptions are summarized in Table 14 along with an estimate of the amount of wood that will remain available for recruitment following harvest within each band (described in the footnotes of Table 14). We assume that timber harvest within the selective harvest band will remove potentially recruitable woody debris. This is based on the expectation that Green Diamond will harvest up to 65 percent of the volume within selective harvest areas (Simpson 2002, Appendix F3). We calculate the effectiveness of the proposed SSS zones to supply woody debris by multiplying the proportional width of each band times its respective effectiveness (Figure 5, Table 15). Note that this estimate represents the effectiveness of wood supply from within the SSS zone and includes the RMZ.

Second, the SSS zones do not capture all of the streamside landslides and we discuss this in more detail in the mass wasting section of this effects analysis (section D). For example, SSS measures along Class I watercourses in the Smith River HPA group are expected to encompass landslides which are responsible for delivering 79 percent of the streamside landslide volume to Class I watercourses. Conversely, in the Humboldt Bay HPA group, landslides originating in the SSS zone cover only 40 percent of the streamside landslide volumes along Class II-2 watercourses (refer to Table 14 for HPA groupings). We note that the SSS zones are effective at capturing a large number of slides, but a portion of slides originate outside of the protections afforded by the SSS zones. Delivery of material from these slides will traverse the adjacent SSS zone, where present, and the RMZ. While the outer portion of the slide may have been harvested, the downslope travel of the slide mass may incorporate wood from streamside protection zones. Many of these "outside of zone" slides originate from near the outer edge of the SSS zone. Thus, the harvest of trees from the triggering point of the slide may be a relatively minor component in the overall quantity of woody debris entrained and delivered by the slide. We assume that this harvesting will remove approximately one-fifth of the trees that could potentially recruit to the stream if a stream side failure occurs. This is a crude approximation based on observations that many of the slides trigger near the edge of the SSS zone (thus implying a very low effect of harvest), while recognizing that a few individual slides may originate well away from the SSS where harvest of the slide initiation point and downslope travel path would remove a greater proportion of recruitable wood. This provides an estimate of the overall effectiveness of the SSS zones by multiplying the within effectiveness values in Table 15 by our 80 percent effectiveness estimate described above. We note that the effectiveness values assume that harvest has occurred within the SSS and on the adjacent slopes that supply a portion of the streamside landslide volumes and the landslide results in delivery to the channel. In many cases, we expect that the SSS zone, where present, may capture landslides originating from upslope and prohibit delivery of any material. Thus, the values in Table 16 assume that full delivery of landslides will occur.

Table 14. Proposed steep streamside slope (SSS) prescriptions for Class I, II-2 and II-1 watercourses. The SSS is divided into a near-stream, Riparian Slope Stability Management Zone (RSMZ) with inner and outer zones, and an outer Slope Stability Management Zone (SMZ). The effectiveness at providing woody debris to watercourses is summarized in the footnotes describing each prescription. Note that Class III watercourses do not have SSS provisions and are discussed separately in the text.

HPA Group	**Slope Gradient**	**Class I**				**Class II-2**				**Class II-1**			
		Total width (feet)	**RSMZ (inner)**	**RSMZ (outer)**	**SMZ**	**Total Width (feet)**	**RSMZ (inner)**	**RSMZ (outer)**	**SMZ**	**Total Width (feet)**	**RSMZ (inner)**	**RSMZ (outer)**	**SMZ**
Smith River	65%	150	0-70[(1)]	70-150[(2)]	None	100	0-30[(1)]	30-100[(2)]	none	75	0-30[(2)]	30-75[(3)]	none
Coastal Klamath Group (Coastal Klamath and Blue Creek HPAs)	70	475	0-70[(1)]	70-150[(1)]	150-475[(4)]	200	0-30[(1)]	30-100[(1)]	100-200[(4)]	100	0-30[(1)]	30-75[(1)]	70-100[(4)]
Korbel Group (Interior Klamath, Redwood Creek, Coastal Lagoons, Little River, Mad River, and North Fork Mad River HPAs)	65	200	0-70[(1)]	70-150[(2)]	150-200[(4)]	200	0-30[(1)]	30-100[(2)]	100-200[(4)]	75	0-30[(2)]	30-75[(3)]	none
Humboldt Bay Group (Humboldt Bay and Eel River HPAs)	60	200	0-70[(1)]	70-150[(2)]	150-200[(4)]	200	0-30[(1)]	30-100[(2)]	100-200[(4)]	75	0-30[(2)]	30-75[(3)]	none

Prescriptions:

1 No harvest (100 percent effective at providing woody debris)

2 85 percent overstory canopy retention (we assume this will provide 95 percent of the woody debris to streams compared to retention of all recruitable trees)

3 75 percent overstory canopy retention (we assume this will provide 90 percent of the woody debris to streams compared to retention of all recruitable trees)

4 Note: All effectjveness percentages are based on the assumption that all identified features will actually fail. The harvest prescriptions are less than 100% effective in achieving recruitment only if the SSS actually fails. Because it is unlikely that all SSS will fail, it is recruitment potential – not recruitment,-- that is reduced relative to no harvest. To determine a true effectiveness it would be necessary to estimate an annual SSS failure rate and a proportion of those failures where harvest occurred and may have reduced the recruitment relative to no harvest conditions.

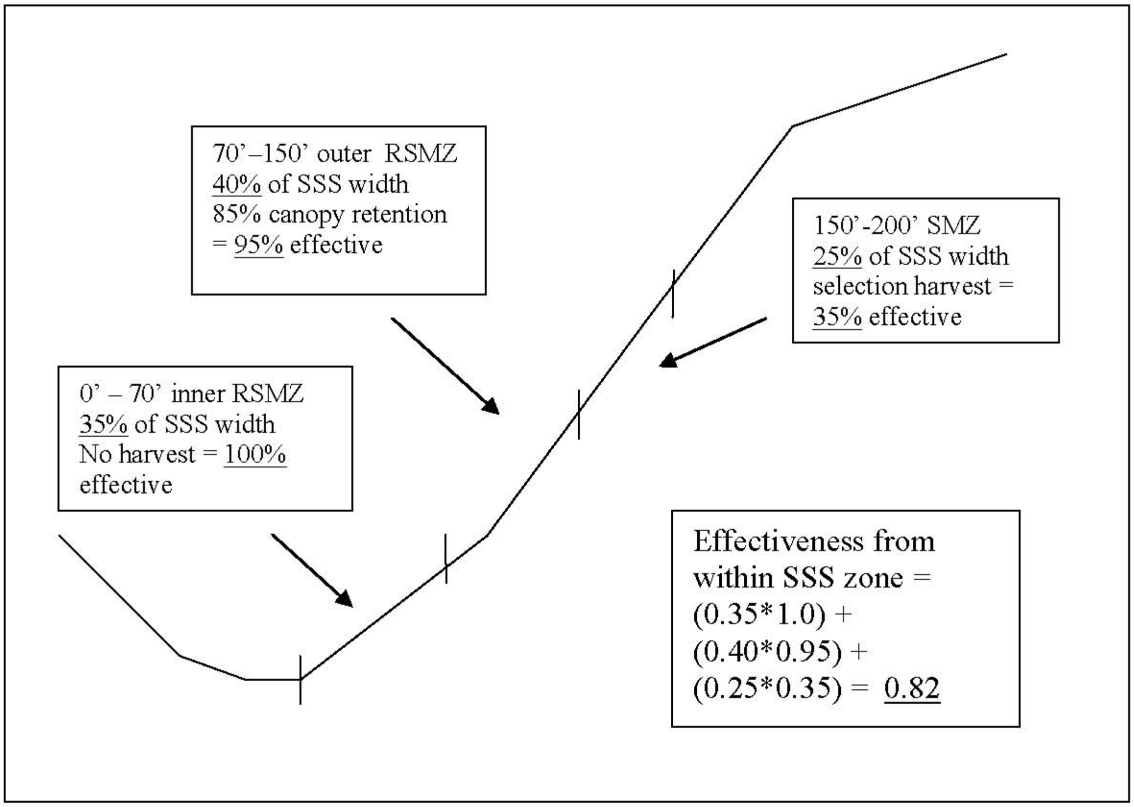

Figure 5. Potential effectiveness of proposed harvest prescriptions within the SSS zone to supply woody debris to streams. This illustrates how the values in Table 15 were derived. Example for Class I stream in Korbel and Humboldt Bay HPA groups. Since the proposed SSS zones do not encompass the entire population of streamside landslides (*e.g.*, some wood-delivering landslides may originate upslope of the proposed SSS boundary), an additional level of effectiveness is presented in Table 16 that considers the proportion of streamside landslides that fall within the proposed SSS boundaries.

Table 15. Potential effectiveness of the various SSS zones to provide recruitable woody debris. Note that these effectiveness values are potential wood recruitment from all zones within the SSS and do not consider the effectiveness of the SSS zones in capturing all streamside landslides. Those estimates are presented in Table 16.

HPA Group (see Table 14 for HPA groupings)	**Potential Effectiveness**		
	Class I total SSS width	**Class II-2 total SSS width**	**Class II-1 total SSS width**
Smith River	97%	96%	92%
Coastal Klamath	56%	68%	80%
Korbel	82%	66%	92%
Humboldt Bay	82%	66%	92%

Table 16. Overall potential effectiveness of SSS zones to provide for unimpaired recruitment of woody debris from streamside landslides. These estimates are the product of within SSS wood effectiveness values presented previously in Table 15 and the proportion of streamside landslides encompassed by the proposed SSS boundaries (refer to Table 20 in the mass wasting effects discussion).

HPA Group (see Table 14 for HPA groupings)	**Percent Effectiveness to Provide Recruitment of LWD from Streamside Landslides**		
	Class I SSS zone	**Class II-2 SSS zone**	**Class II-1 SSS zone**
Smith River	78%	77%	74%
Coastal Klamath	45%	54%	64%
Korbel	66%	53%	74%
Humboldt Bay	66%	53%	74%

Table 16 is important for understanding the magnitude of overall effects of the proposed SSS measures on woody debris recruitment from streamside landsliding. It suggests that the aggregate effect of partial harvest within the SMZs and the portion of streamside landslides not addressed by the SSS measures reduces the supply of woody debris.

(2) Headwall Swales. These areas are defined as areas of steep (typically greater than 70 percent), convergent topography. Headwall swales are typically perched above the initiation of low order, Class II or III channels. In the plan area, under current conditions, landslides originating in headwall swales are estimated to account for 19 percent of the total estimated landslide sediment entering watercourses, not including road-related mass wasting (Simpson 2002 Table F3-8) with a range of from 11 percent to 34 percent for three sampled watersheds. Under the proposed HCP, headwall swales will contribute an estimated 14 percent of the hillslope landslide sediment. As proposed in the HCP, headwall swale identification will be based primarily on field observations by trained and qualified personnel of slope qualities that are characteristic of the landform. A computer model, SHALSTAB, will be used to generate a map depicting areas of convergent topography to be potentially treated as headwall swales. This modeling will be used as a screening tool to identify areas of the landscape where headwall swales are likely to occur, but will not necessarily be used to delineate harvest boundaries.

Headwall swales, due to their location, are prone to direct delivery of woody debris to watercourses when such areas fail. Green Diamond proposes single tree selection with a target of even spacing of residual conifers, where feasible, and retention of representative pre-harvest species and size classes. Assuming that, on average, 35 percent of the trees will be retained on headwall swales as was assumed for the selection harvest proposed for SMZs (Table 14), and assuming that 100 percent of headwall swales would otherwise fail during the term of the proposed ITP, we expect that proposed conservation measures may provide for 35 percent of pre-harvest wood recruitment potential from these areas. This is analogous to the within effectiveness values estimated for the RMZs. However, the single tree selection parameters, as defined, allow for fewer trees to remain on lower productivity sites than on more productive sites. Therefore, we expect that the average recruitment value of 35 percent represents a range: low productivity sites will have relatively little wood retained while higher productivity areas will have more wood retained. Also, since the default harvest measures on headwall swales are subject to modification based on the likelihood of failure, we do not expect that all headwall swales will receive this level of protection. In some instances, the default measures may not encompass the entire feature that delivers material, and in other cases, headwall swales that exist in the THP area may not be identified. For example, Dietrich *et al.* (2001) found that SHALSTAB was effective at identifying approximately two-thirds of the areas prone to landsliding from convergent topography. We assume that pre-harvest inspections during THP preparation may help identify features that were initially missed and refine the boundaries of the feature itself.

As a result, we think a reasonable estimate of the effectiveness of headwall swale identification is 90 percent. This accounts for the coarse screening provided by SHALSTAB and the expected on-the-ground site reviews and modifications. Given this, the overall headwall swale measures are expected to be approximately 32 percent effective (35 percent x 90 percent) at retaining woody debris when compared to pre-harvest conditions where full recruitment potential exists (*i.e.*, unmanaged forests that do not currently exist as such in the *Environmental Baseline*). Alternatively, the headwall swale measures will allow for the removal of approximately 68 percent of the wood from these features. Given the estimate of the relative proportion of headwall swales in the landslide sediment budget for the plan area (19 percent), we expect that headwall swales would provide approximately 19 percent of the total potential <u>landslide derived</u> woody debris under a scenario where all potential recruitable trees remained, and 6 percent under the proposed HCP measures (*i.e.*, assuming a 68 percent reduction in timber available for delivery). Again, this estimate is based on the assumption that all headwall swales in the plan area will fail and it encompasses a range where lower productivity areas will have fewer trees available for recruitment while more productive growing areas will have more trees available. Therefore, where headwall swales fail and deliver materials to watercourses following harvest and before growth of new trees has attained sufficient size to function, much of the delivered material could be without abundant woody debris for sorting and routing sediment, forming habitat in fish-bearing reaches in cases where the slide mass reaches a fish-bearing reach, and retarding debris flows.

Our estimates above indicate that under the proposed action, headwall swales will have the potential to deliver roughly one third (32 percent) of the LWD that would occur if all trees were retained. However, this assumes that the features will fail during a period when the existing vegetation is not capable of providing functional wood. In reality, while the headwall swales may be most prone to failure in the first decade following harvest when root strength is at a minimum, the actual distribution of failures will encompass a range of vegetation ages and, consequently, a range of wood functionality. Since many of the headwall swales will deliver to low order channels (Class II-1 and Class III), the size of wood may be less critical. However, larger wood capable of providing more sediment storage and debris flow interactions would likely be absent a much greater portion of the time. Therefore, while harvest on headwall swales may reduce the overall delivery of wood by two-thirds compared to no harvest on these features, in practice, the reduction will be less than this and a likely increase in potential delivery over current conditions and practices. Further, while headwall swale areas are prone to failure, such failures will not occur 100 percent of the time, and these areas may not always serve as a pathway for wood delivery. Assuming that the background headwall failure rate ranges between 50 and 100 percent over the 50-year period of the ITP, the estimated reduction in background, unmanaged wood delivery from headwall swales could range between 34 and 68 percent.

We expect that trees approximately 50-years old would be needed to provide functionality on headwall swales, should they fail and deliver to a watercourse. A tree this old would be of a sufficient diameter to provide sediment storage and routing functions and the overall piece volume would influence the transport and deposition of sediment should it be incorporated into a debris flow, as discussed in the *Environmental Baseline* section. The effects of landslide delivery rates and wood supply are more thoroughly discussed in the integration and synthesis portion of this analysis.

(3) Deep-Seated Landslides. Deep-seated landslides are large mass wasting features that occur throughout the plan area. The size of deep-seated landslides does not permit assessing these features relative to specific landforms as is done for shallow landslides. In fact, many deep-seated landslides may be large enough to generate landforms prone to shallow landsliding (*e.g.*, SSS zones at the downslope terminus of deep-seated landslides). Identification of deep-seated landslides will be based on a combination of aerial photograph interpretation and various publications describing field features. For purposes of the HCP, conservation measures are proposed for deep-seated landslides if: (1) a scarp or ground crack is present that exhibits at least 3 inches of horizontal displacement or at least 6 inches of vertical displacement within the past 50 to 100 years, or (2) the landslide toe exhibits evidence of activity within approximately the past 50 to 100 years. In isolated instances, these criteria may be difficult for trained professionals to observe due to the relatively wet and temperate climate where revegetation occurs rapidly and evidence of movement may be concealed within a few years. This is particularly true where the movement rate of the slide is low and ground cracks and scarps are rapidly concealed.

In the case of a scarp or ground crack, described above, a no-cut zone will be established within 25 feet upslope of the identified scarp. Other proposed landslide mitigation measures in the HCP may also apply if the appropriate conditions are met (*e.g.*, slope and distance to stream). For deep-seated landslide toes exhibiting activity within the last 50 to 100 years, a no-cut zone will apply from the base to 25 feet upslope of the active convex, lobate landslide toe.

In order to assess the relative role of deep-seated landslides in providing woody debris to streams, we used information from Simpson (2002, Appendix F3, Table F3-8) listing the amounts of sediment delivered to watercourses from various landslide types. Based on Simpson's estimates, deep-seated landslides contribute, on average, 39 percent of the mass wasting derived sediment. However, using this estimate as a simple surrogate for wood delivery is not appropriate for all deep-seated landslides. Many of these features occur in grassland settings and wood is not naturally present on these areas. For example, 49 percent of the ground in the upper Mad River area is oak woodland or grassland (Simpson 2002). Furthermore, the more rapidly-moving features may not allow for the growth of larger conifers. Green Diamond's best estimate of the amount of deep-seated landslides covered in conifers is 50 percent and we use this estimate as the proportion of deep-seated slides that are capable of delivering wood to streams. Therefore, while deep-seated landslides contribute an average of 39 percent of the mass wasting sediment, we expect that, on average across the plan area, approximately 20 percent of a watershed's instream woody debris is supplied from deep-seated landslides. This estimate will vary widely depending on the occurrence of deep-seated landslides within a given watershed. For example, deep-seated landslides in Little River are estimated to account for 62 percent of the sediment delivery, while they only represent 11 percent of the sediment delivery in Hunter Creek. Regardless, this information suggests that deep-seated landslides are an important source of woody debris in many watersheds.

In order to estimate the effectiveness of the no-cut areas proposed on deep-seated landslides, we estimate average input rates of material. Then, if we assume that deep-seated landslides slowly and continuously deliver material, including woody debris, to streams via a conveyor belt-like process, and we know the long-term movement rate, the slope distance necessary to provide for long-term sustained delivery of woody debris to the adjacent watercourse could be calculated.

Estimated average movement rates of deep-seated landslides are presented in Simpson (2002, Appendix F, Table F1-10) and range from 0.8 feet/100 years to 43 feet/100 years with a most likely estimate of 7 feet/100 years for historically active earthflows. We assume that a 100-year old tree will be of sufficient size to provide instream function across most stream sizes on the ownership. Thus, a buffer width of 43 feet would be necessary to provide the width necessary to attain the appropriate tree size for the most rapid-moving features, even though these most rapidly-moving features are likely too unstable to support conifer growth. Although this represents an overly-simplistic view of deep-seated landslide processes, it does suggest that the 25-foot no-cut buffer will be mostly effective at providing functional wood to adjacent watercourses where deep-seated landslides are appropriately identified and are moving at the most likely value of 7 feet/100 years. Furthermore, along Class I and II streams, the existing RMZ may be sufficiently wide to allow for tree growth and recruitment at the toes of slower moving deep-seated landslides. While we cannot accurately depict the effectiveness of the proposed measures on deep-seated slides, we expect that the overlay of the no-cut buffer, RMZs and SSS zones, where present, will not interrupt the recruitment of wood from these areas.

(4) Shallow Rapid Landslides. These are landslides that have already occurred. Conservation measures will apply to only field-verified individual shallow rapid landslides that are at least 200 square feet in plan view and that have been observed to deliver sediment to a watercourse or exhibit indicators of instability with the potential to deliver sediment to a watercourse. These determinations are to be made by the RPF, or an RG, if deemed necessary by the RPF preparing the THP.

The default conservation measures for shallow rapid landslides will be no harvest within the landslide boundaries, and a minimum of 70 percent overstory canopy retention within 50 feet above a slide and 25 feet on the sides of the slide. These buffers around the edges of shallow rapid landslides have the effect of providing root strength to resist the expansion of the slide area and, when slides expand, these buffers have the effect of providing additional woody debris with potential for delivery to watercourses. As in the previous landslide measures, modifications may be made to these defaults based on geologic review. We expect that the overall outcome of geologic review will be increases in harvest within the limited-harvest areas surrounding the slide. Review of such changes by qualified, professional geologists will help ensure protective standards are maintained. If timber harvest increases and those sites fail, this will reduce, over time, the quantity of wood delivered to channels. However, we do not expect an appreciable reduction in instream wood loadings to occur when these failures occur along Class I and II streams. For Class III streams, in instances where harvest is increased and the site subsequently fails, a reduction in wood delivery will result as many of the failures may occur immediately adjacent to the channel (Simpson 2002, Appendix C4).

We do not have data describing increases in landslide size following the initial failure. We expect that further failures above the original landslide and along the margins will be small relative to the initial landslide and the wood retained will represent a large proportion of what would otherwise be delivered if all recruitable trees were retained. However, we are concerned that the presence of shallow rapid landslides may indicate a larger landform that is prone to failure. In these instances, the other mass wasting measures of the HCP may apply and protective measures in the HCP would be applied if features of active instability were observed. These other areas of potential instability as sources of woody debris are discussed below.

(5) Overall Role of Mass Wasting in the Recruitment of Wood to Streams. In order to better assess the effect of reducing recruitment of woody debris from various sources, understanding the distribution of recruitment processes over a watershed-scale is necessary. To quantify the relative input mechanisms of woody debris over the action area, we use data from the Van Duzen River, Little Lost Man Creek, Prairie Creek (Benda *et al.* 2002), and Freshwater Creek (PALCO 2001). Other data are presented by Reeves *et al.* (2003) for a coastal Oregon watershed, but we consider the data presented by Benda *et al.* (2002) and PALCO (2001) to be most representative of local conditions. The data presented by Reeves *et al.* (2003), appear to most closely align with the data presented by Benda *et al.* (2002) for Little Lost Man Creek, where landslide inputs are a principal source of woody debris. The survey areas of Benda *et al.* (2002) and PALCO (2001) are both within the action area. Table 17 presents the relative proportion of woody debris recruitment from natural sources (*i.e.*, excluding logging debris). We note a significant component of instream woody debris on managed lands within the action area is comprised of logging debris (PALCO 2001, 2002). As this management-related wood gradually decays and is exported from a stream reach, natural input processes will be responsible for future supply of wood.

Table 17. Relative proportion of woody debris inputs, by volume, from known natural sources in three watersheds in the action area, varies depending on the geomorphic setting. Prairie Creek is largely a low-gradient stream meandering through a wide valley. Little Lost Man Creek is more confined and situated in steeper topography. The Van Duzen River and Freshwater Creek encompass areas with both characteristics, with woody debris in the lower reaches of the inventoried streams typically derived more from bank erosion and toppling. Prairie Creek and Little Lost Man Creek represent unharvested conditions while the Van Duzen River and Freshwater Creek are within previously harvested watersheds.

	Study Area			
Recruitment Mechanism	**Prairie Creek**[1]	**Little Lost Man Creek**[1]	**Van Duzen River**[1]	**Freshwater Creek**[2]
Toppling (windstorm and fire)	60%	20%	40%	55%
Bank erosion	40%	22%	35%	31%
Landslides	0%	58%	25%	14%

Notes:

1 Data are from Benda *et al.* (2002). In order to express the proportion of wood inputs from natural processes, we excluded the logging debris category (50 percent of observed wood) and express the remainder relative to 100 percent.

2 Data are from PALCO (2001). In order to express the proportion of wood inputs from natural processes, we excluded the railroad debris (0.7 percent of total wood observed), instream structures (5.4 percent), pieces spanning the channel (0.7 percent) and unknown recruitment (69.9 percent) categories and express the remainder relative to 100 percent.

Based on information presented in Table 17, wood delivery from landslides accounts for up to 58 percent of natural input processes in steep topography watersheds. This is similar to findings reported by Reeves *et al.* (2003) for a coastal Oregon watershed where landslides accounted for 65 percent of the instream pieces. Therefore, the effect of removing trees on hillslopes that are prone to mass wasting can have a substantial influence on the supply of wood to streams. Where areas are subject to relatively high mass wasting inputs and lack extensive floodplains and CMZs, the proportion of wood unavailable for recruitment due to harvest will tend towards the high part of the range. We expect this estimate may be slightly lower where active landslides are identified and the shallow rapid landslide measures are applied. However, we assume the amount of wood will be small as subsequent failures along the perimeter of existing landslides may lack sufficient energy to reach a watercourse. We note that while most of these areas will have trees on them, they will be typically less than 60 years old (*i.e.*, approximate age of harvest). Therefore, we expect that much of the vegetation derived from these areas will be composed largely of smaller pieces with limited ability to provide instream function (Bilby and Ward 1989, Fox 1994). However, over the course of the HCP, many of these retained trees will attain an age and size that will provide significant function if delivered to streams in the plan area. Under current management in watersheds with threatened or impaired values as defined by the FPRs, an unknown portion of these potentially unstable areas could receive restricted harvest prescriptions to minimize increases in landslide hazard if they are adjacent to a Class I watercourse and occur within an inner gorge as defined in the FPRs (§§ 916.9, 936.9, 956.9). We expect that implementation of the HCP will provide greater assurances that a larger number of trees will be retained in potentially unstable areas and supplied to streams during active slides.

d. Effects of Road Construction and Maintenance on Woody Debris Supply.

As described in the *Environmental Baseline* section, the presence of streamside roads has decreased the overall supply of wood available. We do not expect an appreciable reduction in the effects that roads, associated "daylighting" (as described in Simpson 2002, pg. 6-26 and 6-37) and interception of upslope wood have on recruitment patterns from riparian zones. Many of these roads paralleling streams are likely key haul routes into the watershed and will be maintained for use over the life of the HCP.

4. <u>Anticipated Effects of Proposed Measures on Woody Debris Recruitment Processes</u>

In considering the overall effectiveness of the proposed measures influencing woody debris, the effects of selection harvest need to be assessed. Each of the tree retention standards allow for some degree of selection cutting. Selection cutting will occur on headwall swales and the outer portions of the SSS. Some harvest will also occur on the outer portions of the Class II-1 RMZ buffers. We expect that selection harvest, in addition to reducing the overall quantity of wood available for recruitment, will remove a portion of the larger trees that could potentially provide the greatest function to receiving watercourses. While difficult to quantify, we expect the HCP to retain some larger wood pieces from areas subject to partial harvest. All species and size classes represented in pretreatment stands will be represented post harvest where feasible. Single tree selection will limit the loss of root strength and provide canopy for rainfall interception and evapotranspiration.

We expect the proposed action will allow for the nearly undisturbed growth of trees along the margins of unroaded Class I and II watercourses. The limited nature of harvesting proposed in these zones, due to the overstory canopy standards and retention of trees likely to recruit, will provide for nearly uninhibited recruitment of woody debris to channels from bank erosion. However, where roads exist in the riparian zone, localized reductions of recruitment potential will continue to occur. This baseline condition will be greatest in Class I streams where roads have been constructed through the wider valleys developed by these larger watercourses. Where road decommissioning occurs within RMZs, woody debris recruitment potential will increase over time.

The establishment of SSS management zones will provide for some recruitment of wood depending on timing of last harvest and, hence, stand age and size. The specific quantity of deliverable wood relative to watershed-wide inputs will vary depending on dominant delivery mechanisms. Compared to unimpaired recruitment, the effectiveness of the SSS measures in providing for potential wood recruitment from streamside landslides is estimated to be 45-78 percent depending on stream type and HPA. Estimates from Benda *et al.* (2002) indicate that landslides may contribute 14 to 58 percent of the total woody debris to a stream. Therefore, we expect input of woody debris from streamside landslides to be less than background rates, but an increase over current rates. For headwall swales, we estimate that wood recruitment to watercourses accounts for 11 percent of the overall wood budget. Selection harvest on these features could reduce potential wood by 7.5 percent of the overall wood budget should these features fail. The majority of this reduction would directly affect non-fishing bearing streams. In addition, as discussed previously, vegetation growing between a harvest cycle (0 to 60 years) may not attain a sufficient size to function in a given channel.

This section on woody debris has focused largely on quantifying the potential effectiveness of wood recruitment from various source areas as a result of implementing the proposed HCP. We have not integrated these estimates into a comprehensive plan area, or HPA-specific wood budget. A partial wood budget would address the relative contributions from each source for a given area (*e.g.*, an individual HPA), and then the overall effectiveness for a given HPA, for example, could be determined. However, the range in values, given the information available, would be large and nearly meaningless. For example, we cited work by Benda *et al.* (2002) showing the large range in values for the proportion of wood coming from landslides. Similarly, the level of protection afforded by the SSS measures varies across the individual HPAs. Furthermore, individual sub-basins within an individual HPA may behave differently than the HPA as a whole and not be accurately represented in a single wood budget. An isolated CMZ that is adjacent to important salmonid rearing habitat would provide wood that has numerous functions, including the creation of habitat and sediment storage and routing functions. Conversely, recently harvested landslides that deliver only a portion (*i.e.*, 10 percent) of the wood to a Class III channel would have a very different influence on the same downstream salmonid-bearing reach. A more detailed anlaysis of the effects of the action on woody debris and salmonid habitat is presented in the *Integration and Synthesis* section, where the multiple watershed products and species needs are integrated.

D. Effects of Proposed Action on Chronic Sedimentation and Turbidity

1. Baseline Information on Chronic Sedimentation and Turbidity in the Action Area

A review of the environmental baseline for each HPA suggests that nearly all areas suffer from excess sediment from past activities (Table 11). Several watersheds in the action area have been listed under the Federal Clean Water Act as impaired due to sediment and/or turbidity (Mad River, and by extension the North Fork Mad HPA, Freshwater Creek, Elk River, Eel River and Van Duzen River).

2. Effects of Chronic Sedimentation and Turbidity on Pacific Salmonids and their Habitat

Chronic delivery of sediment, typically fine sediment, can have several different impacts, both directly on salmonids and their habitat, and via more indirect means such as effects on prey base. The following discussion on the effects of chronic sedimentation and turbidity is largely taken from a more comprehensive summary by Spence *et al.* (1996).

Chronic siltation of streambeds may reduce the diversity and densities of aquatic macroinvertebrates used as a food source by salmonids. Turbidity can adversely affect fish at every stage of their life cycle. When concentrations are sufficiently high, suspended sediment can cause gill abrasion. Sediment deposited on the streambed reduces the amount of interstitial cover available to juveniles. Excessive siltation of spawning gravels leads to reduced juvenile emergence success, suffocation of fry, and entombment. Turbidity affects light penetration, which, in turn, affects the feeding abilities of salmonids. When turbidity levels are persistently elevated, juvenile growth rates may be suppressed due to the poor feeding conditions.

3. Proposed HCP Measures Influencing Chronic Sedimentation and Turbidity

The HCP proposes several measures that will reduce the delivery of fine sediment to watercourses relative to current conditions. These fall under the general categories of timber harvesting, riparian buffers, mass wasting provisions and roads (including rock quarries and borrow pits, since these areas represent a similar type of disturbance as roads). In order to facilitate a discussion of the overall effects of the proposed HCP on fine sediment delivery and turbidity levels, we assess the changes in fine sediment that will occur relative to current conditions. Then, using data from several areas in northwest California that describe current conditions as they relate to fine sediment delivery, we estimate the sediment delivery relative to those conditions that would be expected to occur if management had no influence on delivery-prone areas (*i.e.*, the background rate). These two comparative points provide the basis for inferring probable responses of habitat and effects on salmonids (see *Integration and Synthesis*).

a. Harvest and Site Preparation

The proposed action section details several methods Green Diamond will use to minimize the generation and delivery of fine sediments from harvest units to stream channels. In general, these measures focus on tractor, skidder and forwarder operating restrictions, prescribed fire objectives, EEZs, fireline construction measures, and bare soil exposure measures.

Logging systems, silvicultural prescriptions and site preparation can result in compacted soils and disturbed soil cover. This combination of bare, compacted soil, is more susceptible to erosion and lower water infiltration rates than a comparable undisturbed site, thereby increasing the potential for overland flow and sediment transported to stream channels. The majority of sediment transported from harvest will occur the first year or two following harvest or site preparation, and will continue to a lesser extent until revegetation of the sites, or approximately 5 years (PALCO 2001), effectively protecting the soil from rain fall impact, and sheet erosion. The HCP includes conservation measures for treatment of bare mineral soil within harvest units. All of these harvest-related ground disturbance conservation measures are expected to contribute directly to reducing management-related surface erosion within harvest units. Although several measures are taken to reduce sediment generation and delivery, we anticipate watercourses below harvest units will receive sediment from upslope activities. In general, the proposed riparian buffers will capture a portion of the generated sediment, and this is discussed in the next section. Over the 50-year term of the ITP, we expect that harvest will occur at least once throughout the entire Green Diamond ownership within the action area. Therefore, effects of fine sediment from harvest and site preparation have the potential to impact stream habitat and salmonids throughout the action area.

To evaluate the relative effects of timber harvest on fine sediment production, we use the vegetation age data to indicate where harvest is most likely to be concentrated (*i.e.,* stands >50 years old). We then assume a maximum future clearcut rate of 50 percent of a given area within 5 years (the period of a typical THP). This value is based on FPR adjacency requirements and represents a legal maximum cut rate in a given area, other limitations not withstanding. These projections are used to depict the overall proportion of an HPA that may be harvested under current vegetative conditions (Table 18). Based on these considerations, we expect the production of fine sediment from harvest units in any given watershed to be constrained not only by the adjacency requirements but the amount of timber available for harvest at any given time over the life of the ITP. Unfortunately, we do not have vegetation age data for lands that Green Diamond may acquire over the life of the ITP. Therefore, assessing the effects of additional land acquisitions is difficult. Generally, we expect that acquired lands will have experienced timber harvesting in the past and stand ages are not likely to exceed 50 years. In this regard, we expect the distribution of ages will reflect stands that are immediately harvestable and those that may be decades from harvestable age.

We expect that harvest-related surface erosion will be a relatively minor component in the overall delivery of fine sediment to streams. Past harvest in the HPAs has created a distribution of vegetation ages that limits the area that may be cut at any given time (Table 18). In quantifying sediment sources in Freshwater Creek, PALCO (2001) found that harvest-related surface erosion accounted for 4 percent of the surface erosion inputs. The greatest proportion of surface erosion was generated from roads. Additionally, the provisions for avoiding ground based yarding operations during the winter period (October 16 through May 14) will limit the amount of fine sediment that is generated during harvest operations. Provisions for site preparation (*e.g.*, fire line construction and prescribed burns) will further limit the amount of material available for delivery. In general, where Green Diamond acquires lands over the life of the ITP, we expect that the effects on fine sediment delivery will be nearly undetectable where the acquired lands are already in commercial timber use. The largest increase would be where Green Diamond acquires uncut stands draining primarily an unharvested watershed. However, we do not expect this to happen over the life of the ITP. The acquired lands will likely be commercial timber land that has been previously harvested. Therefore, the effects of the land acquisitions on fine sediment delivery will be a perpetuation of current conditions.

Table 18. Current estimates of maximum cutting rate in each HPA with RMZ, SSS, Headwall Swale, and Northern Spotted Owl conservation areas subtracted from the available acreage. We assumed that the remaining acreage with vegetation greater than 50 years old could be harvested at a maximum rate of 50 percent every five years. This value is based on FPR adjacency requirements and approximates a legal maximum cut rate in a given area, other limitations not withstanding.

HPA	Total area currently available for harvest >50 years old (acres)	Ownership available for harvest (%)	HPA harvestable per year under current conditions[1] (%)
Smith River	9,450	21%	0.52%
Coastal Klamath	12,624	14%	1.17%
Blue Creek	1,561	10%	0.19%
Interior Klamath	15,911	24%	1.24%
Redwood Creek	7,850	24%	0.42%
Coastal Lagoons	15,529	39%	2.90%
Little River	7,413	28%	2.50%
Mad River	15,454	31%	1.29%
North Fork Mad	8,541	30%	2.72%
Humboldt Bay	4,940	28%	0.36%
Eel River	1,856	23%	0.09%

1 These values are based on current stand conditions and do not represent cutting rates over the life of the HCP. Also, these values apply only to Green Diamond ownership within each HPA.

b. Riparian Buffers

Riparian buffers can reduce the amount of sediment delivered from riparian and upland areas by providing physical barriers to trap sediments moving overland, and interception and dissipation of raindrop impacts (Spence *et al.* 1996). Ketcheson and Megahan (1996) found that distance of hillslope sediment transport was inversely proportional to the amount of surface roughness found on the forest floor. Various studies have suggested different buffer widths necessary to control overland sediment flow. The Forest Ecosystem Management and Assessment Team (FEMAT 1993) review of literature suggested riparian zones greater than one site-potential tree height from the edge of the floodplain as adequate to remove most sediment from adjacent hillslopes. However, this review did not specify whether these buffers were able to stop channelized flow. A review prepared by Johnson and Ryba (1992) noted that the available literature reported buffer widths ranging from 50 to 151 feet to control sediment, but that three of the five references they reviewed suggested 100 feet for this function. These studies focused on minimizing overland flow, but O'Laughlin and Belt (1994 *op. cit.* Spence *et al.* 1996) suggested that sediment control from timber harvest activities cannot be achieved through riparian zones alone, because channel erosion and mass wasting are significant sources of sedimentation in forested streams. Therefore, additional buffers around areas susceptible to mass wasting would be necessary to provide full protection from upland and riparian sediment sources caused by timber harvesting.

Under the proposed HCP, measures within the RMZs would minimize ground disturbance, thus allowing natural roughness elements on the forest floor to capture a portion of the fine sediment generated and delivered from upslope harvest and roaded areas. These measures include limiting the amount of ground disturbance within RMZs so that the physical barriers (*e.g.*, humic layer, downed wood) that trap overland flow of sediment are retained; treating most sites within the RMZs that are disturbed due to harvest activity such that they will continue to trap overland sediment flow; prohibitions on removing downed wood that also provides physical barriers to overland flow; and a high tree retention level. The width of RMZs, combined with the SSS provisions on Class I and II waters will provide for filtering of fine sediment transported through overland sheet flow. The degree of protection will depend on the streamside slope and the resulting RMZ width.

As noted above, the results of the literature varies in respect to the riparian buffer width necessary to buffer streams from unchannelized surface flow originating from upslope sources. The ability of a given buffer width to control sediment inputs is a factor of soil type, slope, and ground cover (Spence *et al.* 1996). The RMZs for Class I and II streams established in the HCP are different widths and with the exception of Class II-1 streams, generally fall within the cited literature values.

Exclusion of heavy equipment and mechanical site preparation within Class I and Class II RMZs, plus exclusion of heavy equipment in Class III EEZs, would reduce the level of ground disturbance that occurs adjacent to Primary Assessment Area watercourses under the proposed action. Maintaining at least 50 percent surface cover and treating bare soil in excess of 100 square feet would reduce the potential for management-related sediment delivery from within the RMZs along Class I and Class II watercourses.

Based on the buffer width recommendations from these literature sources, we expect that the Class I RMZs in the HCP will trap most suspended sediment transported as overland sheet flow, while the Class II RMZ widths will be slightly less effective at sediment filtration.

Class III EEZs (Table 19) are narrower than the buffer widths recommended in the literature reviews. Because of the narrow Class III EEZ buffer widths, we expect that a moderate amount of sediment from surface erosion will deliver into Pacific salmonid habitat. The impact from sediment inputs on aquatic resources will also be compounded by the high density of Class III channels within the action area. For industrial timberlands in the southern portion of the action area, we estimate that Class III watercourses represent about 36 percent of the total channel length in a given watershed (NMFS 1999b). The EEZ and retention of previously downed woody debris will provide some filtration of fine sediments from overland flow. As slope increases and the potential for sediment delivery increases, retention of hardwoods and downed woody debris will provide an additional level of filtration. Further, although the proposed measures prohibit ignition of fires within the EEZ, we expect occasional fires associated with site preparation may consume live vegetation and downed woody debris in portions of Class III EEZs and decrease the level of protection. We do not have information on the expected frequency that this may occur and cannot assess the level of effect this may have. However, we expect any fires intruding into the EEZ will be relatively cool burning and not consume the debris on the forest floor and not expose bare mineral soil. This is based on Green Diamond’s fire prescriptions which are designed to consume only a portion of the fuelbed, and only lightly consume the duff layer and woody fuels greater than 3 inches in diameter. We expect that such fires, should they escape into areas with continuous overstory canopy, will tend to self-extinguish. Therefore, we do not expect the filtration functions of the forest floor to be disrupted.

Table 19. Slope criteria for applying Class III Tier A and B protection measures. Tier A watercourses receive a 30-foot EEZ and retention of all previously downed woody debris. Tier B protections require a 50-foot EEZ, retention of all hardwoods, retention of all conifers that maintain bank stability or provide channel control, and a minimum average of one conifer per 50 feet of stream.

HPA Group	**Slope gradient**
Smith River	<65% = Tier A
	>65% = Tier B
Coastal Klamath	<70% = Tier A
	>70% = Tier B
Korbel	<65% = Tier A
	>65% = Tier B
Humboldt Bay	<60% = Tier A
	> 60% = Tier B

Despite the protective measures proposed along Class III watercourses, we expect continued delivery of fine sediment to watercourses in unknown quantities and with potentially adverse effects on both downstream habitat (in the form of pool filling and substrate degradation) and Pacific salmonids (directly by turbidity-related effects on feeding, rearing, *etc.*). This expectation is based on both the recognition that the proposed buffer widths are less than suggested widths in the literature and the large extent of Class III watercourses across the action area. To address this, Green Diamond will initiate Class III sediment monitoring. This effort will involve establishment of turbidity thresholds for Pacific salmonids, documentation of changes in channel morphology, turbidity monitoring, and overland sediment transport monitoring adjacent to harvest units and at the downstream end of harvest units. The intent of this monitoring effort is to provide a comprehensive evaluation of sediment delivery from these streams. The adaptive management process would allow limited modifications (subject to the available acreage in the AMRA) to Class III EEZs based on these findings. Initial results from the Class III monitoring are anticipated after 5 years of HCP implementation. Following this, modifications could be made to the Class III riparian measures pursuant to the limitations provided by the AMRA.

c. Hillslope Mass Wasting Provisions

The effects of the HCP on mass wasting are discussed in a following section. Much of that discussion focuses on the overall delivery of sediment and does not differentiate between fine and coarse fractions of the landslide mass, nor does it address chronic sedimentation generated from existing slide masses that have delivered to a channel or adjacent to a channel and continuously deliver fine sediment after the initial slide has occurred. Although we do not have data that indicate the relative proportion of fine sediment that is delivered from hillslope landslides (versus road-related slides), we expect landslides are responsible for a relatively high proportion of the fine sediment observed in streams throughout the action area. This is based on data from Simpson (2002, Appendix F3) that estimate hillslope landslides account for approximately 54 percent of the total sediment delivery across the plan area. Thus, measures that influence the frequency of landslides and the quantity of material delivered will influence the level of effects from fine sediment and turbidity. In the *Integration and Synthesis* section, we discuss the effects of fine sediment and turbidity on salmonids and their habitat.

d. Road Management

The proposed action includes several measures intended to minimize sediment-related adverse effects from roads, including use, construction, reconstruction, upgrading, maintenance, closure, and decommissioning. Proposed management measures for roads are divided into five categories: (a) sediment assessment and sub-watershed prioritization, (b) road erosion control and prevention, (c) road construction and maintenance, (d) road inspections, and (e) seasonal use restrictions.

(1) Sediment Assessment. This is a survey process intended to inventory and identify sites prone to sediment delivery. How quickly Green Diamond completes the sediment assessment may indirectly affect salmonids in terms of the identification of high priority sites for stabilization. A long assessment process would increase the probability of sediment delivery if the delay in identifying high priority sites results in the generation of sediment into salmonid habitat. For purposes of inventory, the plan area will be divided into two areas from which sub-watershed RWU priorities will be established: (1) Lower Klamath River and (2) remaining portion of Green Diamond's ownership in the HPAs. There are a total of 28 RWUs outside of the Lower Klamath River assessment area. Prioritization is based on a scoring system that considers biologic, geomorphic and road-related management criteria. The Lower Klamath priorities are based on an already established ranking system developed by the Lower Klamath Restoration Partnership and is based on biologic, instream and hillslope parameters. In order to expedite the process, Green Diamond will provide $2.5 million annually (as adjusted for inflation) for the first 15 years of the HCP. This value may fluctuate as new information collected during the assessments refines the volume of treatable sediment sources. As proposed, road work would be given highest priority in the northernmost watersheds (*i.e.*, Winchuck River, Rowdy Creek, and Wilson Creek). The exception is the South Fork of Little River where high densities of watercourse crossings, coupled with adjacent habitat represents a relatively high risk to salmonids.

(2) Road Erosion Control and Prevention. Once sites are identified as having a high or moderate sediment delivery risk, Green Diamond will implement the plan through road decommissioning or upgrading. We do not have information that describes the anticipated extent of decommissioning over the life of the HCP. We note that road work will not necessarily be tied to the RWUs described above. We expect that efforts will be focused in areas where THPs are proposed, where routine road maintenance is scheduled and in the already inventoried RWUs. Therefore, in general, the road work proposed in the HCP will be spread out over the plan area, rather than focused in any one particular area. We expect that decommissioning will most likely be associated with short spur roads accessing previously harvested units. We expect the overall length of roads decommissioned will be small as many of the roads will be required for harvest of adjacent stands, pre-commercial stand thinning, and access to monitoring sites. Where decommissioning is proposed, however, Green Diamond proposes to follow measures outlined in Weaver and Hagans (1994) and detailed in the proposed action. Decommissioning will not occur during the winter operating period (October 16 through May 14) unless unseasonably dry weather persists in the fall as described in the *Description of the Proposed Action* section (Table 6).

Where a high or moderate priority site is identified on a road that is needed for future management purposes, Green Diamond will stabilize road features identified as having a moderate or high likelihood of delivering sediment to waters. Effects of upgrading on fine sediment delivery to watercourses include both short-term and long-term effects.

Adverse effects to Pacific salmonids and their habitat due to road decommissioning and upgrading are caused primarily by inputs of fine sediment and crushing by equipment crossing the wetted channel where fish are present. We expect these adverse effects to be relatively short-lived with the greatest effects occurring during the first storms following the activities and diminishing within approximately 2 years as revegetation and channel adjustment occurs. Under the HCP, road decommissioning and upgrading will be conducted primarily between May 15 and October 15 of any year, thereby reducing the amount of material delivered during winter or spring months when eggs and alevins may be present in the substrate. Some salmonid fry, particularly steelhead and coastal cutthroat trout, may not emerge from gravels until June. Decommissioning and stabilization after May 15 that involves instream equipment use could crush steelhead eggs and alevins, which may still be present in the gravel when instream activities may commence. Turbidity generated by instream equipment could settle on downstream redds, smothering or impairing the ability of fry to emerge from gravels. These impacts are discussed further in the *Effects of Instream Equipment Use on Salmonid Eggs and Fry* section. During the summer months, the possibility of a juvenile or adult salmonid being crushed by instream equipment use is considered remote, due to their flight response. Juvenile wild salmonids tend to move to deeper water when disturbed (Knudsen *et al.* 1992). Also, we expect that much of the decommissioning work will occur on upslope areas, away from fish-bearing stream reaches.

In the long-term, we anticipate that road upgrading will reduce sediment generated from the existing road network. These actions are known to reduce the possibility of debris slides from road or water crossing failures and minimize the generation of sediment from surface erosion (Weaver and Hagans 1994). Although we do not have information to quantify the volume of material that may be prevented from entering watercourses from surface erosion, we anticipate that approximately 93 percent of the treated road network will be hydrologically disconnected from the stream network based on information presented in Simpson (2002, Appendix F2, Table F2-6). Note that this value only applies to segments of road where stabilization measures are implemented. This estimate is not intended as an estimate of the overall extent of roads in a given area that are hydrologically disconnected from the stream network.

The ability of Green Diamond to successfully minimize sediment delivery from its road network depends on the accurate and timely identification of unstable road features that may deliver sediment to waters and, once identified, the prompt stabilization of those features. The HCP requires that all high and moderate sites will be treated within 50 years. To expedite the process, Green Diamond is providing $2.5 million annually for the first 15 years of the HCP. Under this schedule, certain unstable road features will not be stabilized for up to 50 years, and impacts to salmonids or designated critical habitat could occur during the interim if these features fail and deliver sediment into waters. The distribution of the treatments will be guided by those associated with individual THPs and RWU priorities previously described. We expect this will result in road work sites generally distributed across the plan area rather than overly concentrated in one particular area. This will reduce the short-term adverse effects on salmonids and their habitat by avoiding concentrating the disturbance in any one area over a short period of time. Despite these actions, sediment generation will not be completely eliminated under the proposed action and the road density per square mile of land will remain relatively high. Therefore NMFS anticipates that road-related sediment will continue to be delivered into salmonid waters and designated critical habitat from roads within the action area.

We expect that the road measures over the life of the HCP will reduce road-related fine sediment inputs. This is based simply on the amount of road that we expect to be hydrologically disconnected from the channel network and our best estimate of the effectiveness of these treatments. At many individual sites, reductions in sediment delivery may approach 100 percent, while other sites may remain persistent sources due to their proximity to streams and lack of practical treatments short of relocating the road.

(3) Road Construction and Maintenance. New and reconstructed roads will be built to the specifications described in the *Description of the Proposed Action* section and the HCP. We expect that the prescriptions on the amount of cut and fill, road width, road gradients, road surface drainage specifications, stream crossings design, and other construction, reconstruction, and upgrading standards will reduce the possibility of debris slides from road or water crossing failures and minimize the generation of sediment from surface erosion from new, reconstructed, and upgraded roads. Sediment from these sources cannot be completely eliminated, and with additional new roads, and an unspecified, and unknown amount of reconstructed roads to be built during the next 50 years, we anticipate that fine sediment will continue to be generated from these sources. Existing state regulations and permit requirements reduce the likelihood that road construction activities disturb salmonid eggs when equipment must cross the wetted channel because such regulations require installation of a proper crossing pursuant to an approved State permit.

Based on information provided in Weaver and Hagans (1994), the design specifications identified in the HCP are expected to increase the probability that culverted stream crossings can withstand a high flow event. In addition, we anticipate that the inspections and maintenance of these culverted stream crossings will aid in reducing culvert blockages that cause catastrophic failures.

(4) Road Inspections. Routine and emergency inspections and work (*e.g.*, unblocking culverts, brushing, spot rocking) may be completed during the winter and spring if necessary to prevent water diversions and fill failure or avoid damage to property. Heavy equipment might be used in the stream for these emergency activities. If equipment is used in the water, there could be short-term direct effects to Pacific salmonids and proposed or designated critical habitat from these activities during the winter period, including destroyed redds, smothered or crushed eggs and alevins, increased turbidity, blocked migration, and a disruption or disturbance of overwintering juvenile and adult salmonids. Pacific salmonids are particularly vulnerable during the winter, when adult salmonids are migrating and spawning, and the spring, when eggs and fry are still present in the substrate. The activities could scare juveniles out of overwintering habitats such as side channels and deep pools, into inferior habitats or high velocity waters. Impacts incurred due to emergency activities during the winter are likely to be localized and short-term, but may be locally intense, especially if redds are destroyed. With the assessment and stabilization schedules established under the HCP, we expect that the frequency of occurrence for such extensive emergency stabilization treatments will be relatively low. Also, over time, as roads and stream crossings are upgraded to the specifications required in the HCP, the necessity for winter and spring emergency stabilization work should decline. The short-term impacts would be further offset by the immediate and long-term benefits provided from stabilizing fill, preventing culvert blow outs, and minimizing erosion problems.

(5) Seasonal Use Restrictions. Timing of road use affects the production and generation of sediment from roads (Reid and Dunne 1984, Mills *et al.* 2003). Wet season road use can be a significant source of chronic turbidity and fine sediment in streams (Reid and Dunne 1984). Similarly, Weaver and Hagans (1994) reported that road-related activities should be performed during the dry season in order to reduce delivery of sediment to streams. The HCP prescriptions are expected to minimize sediment production associated with the various road-related measures, primarily by limiting many activities to the dryer months (May 15 - October 15). As an additional minimization measure, during May 15 - October 15, activities would cease during periods of rainfall when the activity results in runoff of waterborne sediment in amounts sufficient to cause a visible increase in turbidity in any ditch or road surface draining to a watercourse. Activities would not resume until the road surface has dried sufficiently to allow use without resulting in runoff of waterborne sediment in amounts sufficient to cause a visible increase in turbidity in any ditch or road surface draining to a watercourse.

During the winter period, Green Diamond may haul or load timber only on rocked surfaces and must cease hauling per the turbidity restrictions above. Temporary and localized increases in turbidity could result from activities at stream crossings, which could adversely affect salmonids. Also, where harvest is concentrated in a particular area, the access roads may deliver greater amounts of sediment following the activity as the road surface is broken down and fine sediments are made available for transport to watercourses. A study in the Oregon Coast Range indicated that detectable turbidity increases at stream crossings during wet weather hauling were limited to approximately 10 percent of the sites when roads were adequately rocked (Mills *et al.* 2003). Furthermore, the limited number of sites that delivered fine material to streams were rapidly diluted in larger, receiving tributaries and the effects were not detectable (Mills *et al.* 2003). However, turbidity increases were noted where roads paralleled streams. The quality of aggregate used to surface roads is a key predictor of potential sediment yield from rocked roads (Foltz and Truebe 1995). Green Diamond proposes to use a 12 inch base of coarse, high quality aggregate for rocked roads. While this will not eliminate sediment delivery, results from Oregon and Washington suggest that hauling on high quality, rocked roads can reduce sediment delivery by several orders of magnitude (*e.g.*, Reid and Dunne 1984, Bilby *et al.* 1989, Foltz and Truebe 1995). While we cannot accurately estimate the reduction specific to Green Diamond ownership, we expect the seasonal use restrictions will provide a significant reduction in the volume of chronic sedimentation that occurs from roads.

4. <u>Effects Summary of Proposed HCP Measures on Chronic Sedimentation and Turbidity</u>

Harvest and site preparation activities can cause soil compaction and exposure of bare soil, some of which could deliver to watercourses. Green Diamond proposes several measures to minimize fine sediment production from harvest units that we expect will reduce the amount of sediment generated and transported to stream channels. Riparian buffer widths and associated streamside slopes will filter a large portion of fine sediment originating from harvest units. Further, the vegetation age class structure combined with the delineated management areas where only limited harvest can occur, serves to reduce potential harvest rates in a given HPA.

Roads will continue to generate fine sediment through the life of the HCP, although we expect the amount of road-related fine sediment to decrease over the life of the HCP as a result of seasonal use restrictions and hydrologically disconnecting portions of the road network. We do, however, expect periodic short-term increases in fine sediment as a result of road construction, upgrading and decommissioning, resulting in short-term impacts to instream habitat and causing elevated turbidity that would adversely affect Pacific salmon. These short-term impacts will be greatest from years 1 through 17 (allowing 2 years for vegetative recovery after the 15-year road program) during implementation of the accelerated road actions. The proposed road assessment will identify problem road areas, and as discussed in the HCP (Simpson 2002, Appendix F2, Table F2-6), implementation of the plan will result in increasing the number of hydrologically-disconnected roads from 67 percent to 93 percent.

Overall, the measures proposed in the HCP will reduce the delivery of fine sediment to watercourses and reduce current levels of fine sediment delivery to instream habitat. We expect this will allow for a gradual improvement in habitat over the life of the HCP as the expedited road stabilization and decommissioning occurs and the amount of the road network delivering to streams is reduced. However, continued delivery of fine sediment into watercourses under the proposed HCP will still result in impacts to habitat quality and salmonids. To address this, Green Diamond proposes to develop a monitoring program to address these issues and implement changes to RMZs through the adaptive management process, if warranted. We expect delivery of fine sediment to continue to cause localized impacts to habitat and direct, turbidity-related effects on salmonids, particularly where timber harvest and road use are concentrated in a sub-watershed.

Estimating the HCP-related fine sediment delivery relative to rates expected if activities had no influence on delivery-prone areas (*i.e.*, a background rate) is problematic. Rates of timber harvest could dictate the amount of ground disturbance in a given area and also the amount of road use and maintenance. Where significant upgrading occurs in association with harvest, additional short-term impacts will occur as well. Furthermore, the relative contributions of fine sediment from harvest units are expected to be relatively minor when compared to fine sediment delivered from roads.

The measures proposed in the HCP will reduce sediment quantities from timber harvest and roads. While we cannot reliably estimate the magnitude of this reduction given the many variables, we can evaluate likely sources of sediment to ascertain whether proposed conservation measures are likely to address sediment-related impacts. Simpson (2002, Table E-2) presents the results of several regional erosion source studies in northern California. These studies divided the management-related sources into a mass wasting component and a non-mass wasting component (including road erosion, road surface erosion and other sources). These data indicate that the non-mass wasting component comprises from 10 to 57 percent of the total sediment yield, with the majority of this sedimentation attributable to road crossing and gully erosion. Management-related erosion attributable to mass wasting may comprise 1-24 percent of the total sediment yield; however, these percentages include erosion attributable to roads as well. This analysis suggests that road-related erosion is a significant portion of the total sediment yield, emphasizing the impact of road erosion on aquatic habitat. This conclusion is supported by studies indicating that the sediment inputs from timber harvesting are substantially less than those from associated road systems (Raines and Kelsey 1991, Best *et al.* 1995). In the *Integration and Synthesis* section, we consider fine sediment inputs described above with other sediment sources and link these aggregate sediment inputs to the biological requirements of the species.

E. Effects of Proposed Action on Sediment Supply from Mass Wasting Processes

1. Baseline Information on Mass Wasting Processes and Conditions

A review of the environmental baselines for each HPA suggests that nearly all areas are impacted from excess sediment from past activities. Several watersheds in the action area have been listed under the Federal Clean Water Act as impaired due to sediment and/or turbidity (Freshwater Creek, Elk River, Eel River, Van Duzen River, Mad River, and by extension the North Fork Mad HPA). Based on the information provided in the baseline for each HPA, excessive sedimentation was a significant concern for aquatic habitat across the entire action area. In many areas, past mass wasting is a significant component of the observed sediment impacts. The proportion of road-related mass wasting versus hillslope mass wasting, both natural and management-related, varies across watersheds. In Hunter Creek (Coastal Klamath HPA), roads are estimated to account for 55 percent of the overall sediment delivery volume, while hillslope landslides, composed of both shallow and deep-seated processes, account for the remaining 45 percent. In Salmon Creek (Humboldt Bay HPA), roads are only estimated to account for 24 percent of the observed sediment delivery, while the remaining 76 percent is derived from hillslope mass wasting, which includes both deep-seated and shallow landslides. Across the eligible plan area, Green Diamond estimates that 46 percent of the total sediment is delivered from roads (Simpson 2002, Appendix F3). We note that these estimates do not include sediment delivered from surface erosion and streambank erosion. Regardless of source, management-related increases in mass wasting have led to long-term and persistent impairments to stream habitat across the eligible plan area. This is consistent with observations on the Oregon coast made by Reeves *et al.* (1995), suggesting that the frequency and pattern of watershed disturbances (*e.g.*, mass wasting) strongly influence the quality and distribution of salmonid habitat.

2. Effects of Mass Wasting on Salmonids and their Habitat

Mass wasting is a principal mechanism for the delivery of sediment to stream channels. Once in the stream channel, the quantity and rate of sediment supply is a dominant factor in the distribution and quality of habitat for Pacific salmonids (Reeves *et al.* 1995). Excessive rates of sediment supply are manifested as increased levels of fine sediment in the streambed, widened channels, filled pools, and, in the case of extremely high sediment yields, braided channels (*e.g.*, Dietrich *et al.* 1989). In terms of salmonids and their habitat, these physical changes lead to: reduced spawning habitat quality, reduced interstitial spaces for juvenile cover, decreased diversity and abundance of aquatic invertebrates, decreased pool volumes for juvenile rearing and adult holding, lack of stable spawning habitat and shallow or dry reaches that present access problems to migrating fish (*e.g.*, Spence *et al.* 1996). In the action area, excessive sedimentation, due principally to mass wasting from both roads and hillslopes, has decreased the quality of spawning habitat and rearing habitat. In reviewing the factors limiting salmonid production in the action area, Simpson (2004) indicates that excessive sedimentation rates have led to embedded stream substrates and simplified juvenile rearing habitat in nine of the eleven HPAs.

Based on the physical responses of channels and stream habitat to mass wasting, salmonids would experience effects associated with increased sedimentation, including reduced reproductive success as a result of reductions in survival-to-emergence rates (*e.g.*, Spence *et al.* 1996). The emergence of salmonid fry would be reduced due to unstable substrates, and fine sediment that reduces gravel permeability and causes entombment. Juvenile salmonids would be exposed to greater competitive pressures due to a lack of adequate habitat quantity and quality and, as a result, experience reduced growth rates, increased predation and mortality.

3. Proposed HCP Measures Influencing Mass Wasting-Related Sedimentation

Green Diamond proposes several conservation measures to reduce mass wasting hazard associated with timber harvest and roads. These measures can be broadly categorized as those described within the riparian conservation measures, hillslope management strategies and the roads program. The components of each of these conservation measures that may influence mass wasting hazard are discussed below. In the descriptions that follow, we use estimated background, pre-plan and post-plan sediment yield estimates as provided in Simpson (2002, Appendix F3, Table F3-8). Background rates are those rates expected if management had no influence on sediment production rates. We then determined how effective the proposed landslide sediment measures are relative to background yields by dividing the anticipated post-plan annual yield by the estimated background yield. This approach expresses mass wasting sediment inputs as a percentage over background where a value of 100 percent means that no management-related influences are expected. Values over 100 percent are incremental additions to the background rate (*i.e.*, 106 percent means that an additional 6 percent of sediment is supplied due to management-related activities). We also compare these rates to rates resulting from current practices. These two comparisons are done in order to better understand the range and magnitude of changes involved and provide a better basis for understanding habitat-related changes as discussed in question #3 of the *Effects Analysis Assessment Approach*.

a. Proposed Riparian Conservation Measures

Restrictions on timber harvest adjacent to watercourses have been discussed previously in the woody debris section (see Table 4 for a summary of RMZ widths). In general, we expect the high overstory canopy retention standards will not produce a detectable increase in mass wasting frequency from within these areas due to removal of individual trees. However, harvest on adjacent upslope areas may result in an increased frequency of mass wasting farther downslope, based on anecdotal evidence (Spittler 2002). This occurs when removal of timber upslope reduces evapotranspiration, increasing the quantity of groundwater, resulting in increased pore pressures and mass wasting hazard downslope of the harvest unit. Although we have no data to quantify this effect, we use Simpson's estimate (2002, Appendix F3), which suggests that landsliding in RMZs is expected to continue at a rate that is 0.3 percent above background rates within these areas, resulting in a sediment yield of 10,276 cy/yr. Arguably, the effects of upslope harvest are already incorporated in the estimates of pre-plan yields, since much of the data were collected from examination of aerial photos and, therefore, reflect actual conditions.

b. Proposed Hillslope Management Strategies

Green Diamond proposes to address mass wasting on specific areas of the landscape outside of RMZs known to have a high likelihood of delivering sediment from landslides. These areas, the SSS, headwall swales, deep-seated landslides and shallow active landslides are individually discussed below.

(1) Steep streamside slopes. Slopes adjacent to streams are afforded protective measures if they exceed a minimum slope and fall within a specified distance of a given watercourse type. These measures are summarized in Table 14 in the discussion on woody debris. The SSS provisions will apply to streamside areas that meet certain specified criteria intended to identify steep slope areas. The proposed conservation measures are intended to reduce shallow landslide hazard on streamside slopes judged most likely to deliver sediment to a watercourse based on slope and distance to a Class I or II watercourse. To accomplish this, landslide data from select areas within three subwatersheds were used to determine a cumulative landslide volume delivery for slope and distance from the stream (Simpson 2002, Figures 6-3 and 6-4). Only areas with high landslide densities were used in order to maximize the number of landslides observed in the sampling effort. From these data, the minimum slope containing 80 percent of the observed landslide delivery volume was determined. Exceptions are provided for the Smith River and Coastal Klamath HPA groups where steeper slopes dominate and landslide delivery on gentler slopes may not be adequately represented in the sampling approach described above. For these two HPAs, a value of 90 percent of the cumulative observed landslide volumes was used to determine the minimum slope threshold. A similar approach was used by Green Diamond for slope distance, where the objective is to delineate a distance from the watercourse that represents 60 percent of the observed sediment delivery. However, 80 percent is used for the Coastal Klamath HPA based on geomorphic conditions. Green Diamond proposes to conduct additional landslide inventories to refine the SSS dimensions based on the above cumulative volume objectives.

Timber retention standards within the SSS areas are summarized in the discussion on woody debris (Table 14). Single tree selection is proposed in the outer zone (SMZ) of SSS zones with a one-time entry over the life of the HCP. Retention standards for single tree selection are based on timber site class as follows: Site I - 125 square feet of basal area; Sites II and III - 75 square feet basal area; and Sites IV and V - 50 square feet of basal area. For purposes of this discussion, we assume that up to 65 percent of the basal area may be removed during selection harvesting as described in Simpson (2002, pp. 6-171).

Table 20 demonstrates the extent to which the proposed SSS dimensions overlap with existing landslides. As mentioned above, the SSS objectives are not intended to provide harvest restrictions on all slopes subject to landsliding. Therefore, some volume will originate on slopes that are either too gentle or landslides will originate from points beyond the outer edge of the proposed SSS zone. However in both of these scenarios, RMZ prescriptions will be applied and additionally, in the latter scenario, a SSS zone will be applied to a portion of the potential slide area at a minimum. The SSS criteria address high hazard slopes where the majority of failures are likely to occur, and available data suggest the majority of delivery volume will occur in SSS areas. Table 20 also shows that a portion of the sediment delivery volume is triggered by landslides originating from outside the proposed SSS zones. For example, proposed SSS zones in Class II-2 channels in the Humboldt Bay HPA group apparently miss a large portion of the delivered landslide volumes. In this case, one large landslide originating 380 feet from the channel is responsible for the apparent ineffectiveness of the proposed SSS zone, while the proposed SSS zone overlaps with 88 percent of the total *number* of landslides. This theme applies across all the sampled areas. In several cases, two or three large landslides originating hundreds of feet from the channel will be responsible for a disproportionate delivery volume. However all of these slides will have some level of protection through the application of the RMZ prescriptions and the SSS prescriptions on the lower portions of these few slides that may extend beyond the SSS zone. The proposed SSS zones optimize the extent of restricted harvest buffers: avoiding extraordinarily large buffers that capture a handful of potential large, distant landslide sites or slides originating on unusually gentle slopes, but retaining a sufficient buffer to capture a large proportion of the number of slides. Professional geologic review of SSS areas may result in the identification of areas and protection of high risk areas outside default areas, thus addressing to some degree this concern.

Table 20. The spatial extent of the proposed SSS zones for a particular watercourse type within an individual HPA group as expressed by the volume of delivered landslides the SSS zone is expected to represent based on sampling of existing landslides. Note that these effectiveness values in the right hand columns simply represent the landslides that fall within the SSS zone and do not consider the effects of partial harvesting within the SSS zone on landslide rates. Secondly, the SSS zones are only credited as effective if the entire slide volume is encompassed by the SSS zone. In other words, if 99 percent of a slide mass volume is within the SSS zone and 1 percent extends beyond the protection zone, the entire slide volume is considered 100 percent not addressed by the proposed SSS zone.

HPA Group and Stream Class	Slope gradient	Target cumulative streamside landslide volume represented by slope	Slope Distance (feet)	Target cumulative streamside landslide volume represented by distance	Percent landslide volume addressed by proposed SSS zones	Delivery volume not addressed by proposed SSS zones
Smith River Class I	65%	90%	150	60%	79%	21%
Smith River Class II-2	65%	90%	100	60%	60%	40%
Smith River Class II-1	65%	90%	75	60%	59%	41%
Coastal Klamath Class I	70%	90%	475	80%	70%	30%
Coastal Klamath Class II-2	70%	90%	200	80%	77%	23%
Coastal Klamath II-1	70%	90%	100	80%	88%	12%
Korbel Class I	65%	80%	200	60%	88%	12%
Korbel Class II-2	65%	80%	200	60%	48%	52%
Korbel Class II-1	65%	80%	75	60%	77%	23%
Humboldt Bay Class I	60%	80%	200	60%	51%	49%
Humboldt Bay Class II-2	60%	80%	200	60%	27%	73%
Humboldt Bay Class II-1	60%	80%	75	60%	40%	60%
All Class III	NA	0%	NA	0%	<5%[1]	>95%[1]

1 - We assume the retention of hardwoods and conifers contributing to bank stability will provide some, albeit slight, level of protection against streamside mass wasting along class III-B channels.

In estimating mass wasting sediment yields relative to background rates within the SSS zone, we used the background rates presented in Simpson (2002, Appendix F3). Therefore, timber harvest within SSS zones is expected to result in a sediment yield that is 141 percent of the background rate and represents an approximately 30 percent reduction from current landslide rates (Table 21).

(2) Headwall swales. Headwall swales, identified by computer modeling and field review, will be afforded single tree selection harvest with a target for even spacing of residual conifers and retention of all hardwoods. All species and size classes represented in pretreatment stands will be represented on site after harvest where feasible. Retention standards for single tree selection are provided in the previous discussion on SSS zones. Green Diamond anticipates that tree retention will be greatest along the axis of headwall swales and decrease upslope. For purposes of this discussion, we assume that up to 65 percent of the stand may be removed as described in Simpson (2002, pp. 6-171). Green Diamond calculates that proposed management measures on headwall swales will result in a mass wasting rate that is 160 percent of the background rate, and we use this estimate in our calculation of overall effectiveness of the HCP measures at controlling sediment derived from mass wasting in headwall swales (Table 21). This also represents approximately a 36 percent reduction in landslide rates from current practices. We think the number of headwall swales not identified will be small and the effects this will have on overall sediment delivery is well within the range of uncertainty surrounding the estimates of landslide rates from headwall swales sampled. Also important in discussing an average rate is the variable retention of trees on headwall swales, as defined by the single tree selection parameters. Where growing conditions are relatively poor (*e.g.*, Sites IV and V), less trees will be left on site and therefore the potential increase in landslide hazard is likely greater than more productive areas (*e.g.*, Site I) where higher tree retention standards apply.

(3) Deep-seated landslides. Deep-seated landslides are much larger mass wasting features that occur across the action area. Further, many deep-seated landslides may be large enough to generate landforms prone to shallow landsliding (*e.g.*, SSS zones at the downslope terminus of deep-seated landslides). Deep-seated landslides will be identified by RPFs. The RPF will determine if one of the following two criteria are met: (1) a scarp or ground crack is present that exhibits at least 3 inches of horizontal displacement or at least 6 inches of vertical displacement within the past 50 to 100 years or, (2) the landslide toe exhibits evidence of activity within approximately the past 50 to 100 years.

In the case of number one, above, a no-cut zone will be established within 25 feet upslope of the identified scarp. Other landslide mitigation measures proposed in the HCP may also overlie the area if the appropriate conditions are met (*e.g.*, slope and distance to stream). For deep-seated landslide toes exhibiting activity within the last 50 to 100 years, a no-cut zone will apply from the base to 25 feet upslope of the active convex, lobate landslide toe.

For purposes of assessing the effects of harvest on deep-seated landslides, we assume the entire feature is subject to conventional timber harvest unless evidence of recent movement is present, as described above. Unfortunately, little information exists on the effects of timber harvest on deep-seated slides. In general, vegetation removal decreases rainfall interception and evapotranspiration losses and results in higher pore water pressures. Therefore, where vegetation removal is extensive, we might expect some increase in movement rates on those deep-seated slides most sensitive to fluctuations in pore water pressure. Consequently, the HCP assumes that timber harvest over an entire deep-seated landslide may increase sediment delivery rates by about 1.28 times and that the effects of proposed conservation areas coinciding with deep-seated features (*e.g.*, RMZ, SSS, headwall swale) will reduce management-related increases by 15 percent (Simpson 2002, Appendix F1, p.F-25). The HCP (Simpson 2002) suggests that this may be an over estimate of harvest-related impacts due to the fact that the harvest unit does not normally encompass the entire slide block. Lacking more detailed information, we use the value presented by Simpson (2002, Appendix F-3, Table F3-8), that estimates deep-seated landslides under the HCP will deliver sediment at a rate that is 106 percent of background rates. However, we expect the slides that are not correctly identified will have very slow movement rates, and additional timber harvest will not appreciably change the estimate above.

(4) Shallow active landslides. Conservation measures are proposed for landslides that are field verified to be active or which are judged likely to be reactivated by harvesting, have delivered sediment directly to a watercourse, and are at least 200 square feet in plan view. The default prescription for these areas will be no-cut within the landslide boundaries, and a minimum of 70 percent overstory canopy within 50 feet above a slide and 25 feet on the sides of a slide.

The effects of these shallow landslide measures on woody debris recruitment have been considered previously in the discussion on wood recruitment. Although we do not have data describing the enlargement of landslides following the initial failure, the trees retained near a slide's periphery will provide localized maintenance of root cohesion. It is possible that some active landslides may fall outside of established mass wasting management zones (*e.g.*, RMZ, SSS, headwall swale). Many of these areas may fall within deep-seated landslides which are described above.

c. Effectiveness of Overall Hillslope Mass Wasting Conservation Measures

In order to assess the overall effectiveness of the proposed mass wasting conservation measures on non-road-related sediment delivery, we estimated the amount of landslide sediment that is potentially addressable through the proposed hillslope mass wasting measures in the previous section. We used estimated background, pre-plan and post-plan sediment yields as provided in Simpson (2002, Appendix F3, Table F3-8). Again, background rates are those rates expected if management had no influence on sediment production rates. We then determined how effective the proposed landslide sediment measures are relative to background yields by dividing the anticipated post-plan annual yield by the estimated background yield (Table 21). This approach expresses mass wasting sediment inputs as a percentage over background where a value of 100 percent means that no management-related influences are expected. Values over 100 percent are incremental additions to the background rate (*i.e.*, 106 percent means that an additional 6 percent of sediment is supplied due to management-related activities).

A key factor in this effects analysis is the portion of the eligible plan area that falls outside of any mass wasting protection zone. This was mentioned previously in the section discussing shallow, active landslides. Data from three pilot watersheds; Salmon Creek, Little River and Hunter Creek, indicate that 46 percent, 43 percent and 39 percent, respectively, of non-road-related shallow landslide sediment sources that deliver to watercourses originate outside of any mass wasting prescription zone (Simpson 2002). We acknowledge that these data were generated remotely and will vary based on site-specific field review. However, these figures appear to approximate our calculations of potential sediment delivery not addressed by the SSS measures as presented in Table 20. We also realize that a small portion of these estimates will be effectively captured by the tree retention standards proposed along the periphery of active slides. However, no hazard minimization measures are provided that pro-actively address landslide hazard on hillslopes that fall outside of currently proposed conservation areas and show no visible evidence of instability. Specifically, the RPF preparing the plan will be responsible for disclosing the location of any unstable ground (as defined in the FPRs) in the THP. During THP review, the reviewing agencies will be responsible for recommending site-specific measures to address those areas. Our best estimate of how effective these reviews will be is already incorporated in the estimates of mass wasting increases over background because the data used to derive this estimate are largely from California and were subject to the California FPRs at the time of THP implementation (see discussion below).

Timber harvest in areas not subject to any HCP mass wasting measures are expected to experience higher mass wasting rates relative to background rates, but they are far less likely to contain potentially unstable features than those areas subject to mass wasting measures. Additionally, the volume from the "outside of zone" areas is distributed from over 65 percent of the landscape (*e.g.*, about 42 percent of the non-road-related volume comes from more than 65 percent of the area while 58 percent of the non-road-related volume comes from 35 percent of the area). In those areas falling outside of mass wasting prescription zones, Green Diamond uses a value of 200 percent above background rates to estimate mass wasting due to management. That is, clear-cut timber harvesting is expected to approximately double the frequency of mass wasting over the long-term. Estimates in the literature vary widely and are sensitive to particular harvesting techniques and the geologic setting where the harvest occurs. More importantly, how the landslide data are collected is critical. Where aerial photos are used for the inventory of landslides, forest cover may obscure some slides, thereby underestimating the number of landslides occurring in clearcuts. In reviewing the literature, Robison *et al.* (1999) found that where appropriate field verification was conducted in addition to the photo inventories, landslide erosion rates were 1.2 to 4.0 times higher in harvested stands than in unharvested stands. Additionally, the study in coastal Oregon by Robison *et al.* (1999) found that landslide erosion increased by 0.3 to 5.1 times over conditions found in unharvested areas. Nearer the action area, short-term increases as high as 11.5 times have been observed in Bear Creek, located approximately 10 miles south of the Eel River HPA. In Jordan Creek, adjacent to Bear Creek, and in a similar geologic setting as Bear Creek, landslide increases over a 22-year period were 3.0 (Simpson 2002).

Mass wasting increases have also been noted from watersheds within the eligible plan area. Results from the Elk River watershed (Humboldt Bay HPA) indicate an increase of mass wasting of 2.3 times background rates (PWA 1999) over a 28-year assessment period. In Freshwater Creek, also in the Humboldt Bay HPA, mass wasting rates were estimated to have also increased by 2.3 times (PALCO 2001). Unpublished data from Hunter Creek (Simpson 2002) indicate that mass wasting erosion may increase up to 1.7 times due to harvesting. A simple average of these three estimates yields an increase of about 2.1. For illustrative purposes we use a simple estimate of 2.0 to evaluate the potential effects of clearcut harvest on rates of mass wasting erosion. In other words, clearcut harvesting is expected to increase the rate of mass wasting by 200 percent. It is important to note that as discussed above, the actual long-term rate of mass wasting will vary based upon a number of site-specific factors, and the actual rate may be higher or lower.

Table 21. Effectiveness of the various HCP hillslope mass wasting protection zones (MWPZ) to reduce timber harvest-related mass wasting. A value of 100 percent indicates that mass wasting will not be increased due to timber harvest. These effectiveness values do not factor in upslope harvest effects that may alter hillslope hydrology and cause downslope failures, thus these values likely slightly underestimate sediment delivery rates. Yield values are from Simpson (2002, Appendix F3) as modified per discussion in the text and described in the footnotes. These are plan area-wide estimates and assume that harvest will occur over the entire ownership during implementation of the HCP. "Background" refers to the resulting sediment delivery rates that would be expected if activities were tailored such that they had no influence on sediment production.

MWPZ	Background landslide yield (cubic yards/year)	Pre-plan yield (cy/yr)	Post-plan yield (cy/yr)	Management-related sediment delivery (cy/yr)	Percent over background rate due to management
RMZ	10,241	13,200	10,276	35	100.3[1]
SSS	4,374	8,748	6,182	1,808	141
Headwall Swale	6,981	17,451	11,169	4,188	160
Deep Seated Landslide	22,832	24,442	24,201	1,369	106
Shallow Rapid[2]	n/a	n/a	n/a	n/a	n/a
Other areas[3]	13,610[4]	27,220	27,220	13,610	200
Total	58,038	91,061	79,048	21,010	**136%**

1 - A key uncertainty in this estimate is the role that upslope harvest has on landslide rates within the RMZ.

2 - For purposes of this analysis, we assume that active, shallow landslides are already accounted for in the estimates of mass wasting occurring from the other areas outside of designated protection areas.

3 - We assume that a portion of shallow landslides occurring in other areas will receive protections that will provide for a small level of effective protection (<5 percent) and reduce the expected increase. We have not incorporated this into the increases over natural levels, since our estimate of 200 percent, as discussed in the text, is subject to a large range and modifying the number by 5 percent would have no significant effect on the overall result given the uncertainties involved.

4 – Background values were calculated to reflect a clearcut harvest ratio of 2.0 for all areas.

d. Other Landslide Inputs - Roads

As discussed in the *Environmental Baseline* section, roads are a significant source of landslide-derived sediment across the action area. On average, road-related mass wasting comprises approximately 46 percent of the overall mass wasting delivery to watercourses (Simpson 2002), and long-term average annual sediment production is 77,779 cy per year from high and moderate priority sites.

As part of its road assessment and decommissioning/stabilization plan, Green Diamond will remove or stabilize all of the high and moderate priority road sites over the life of the HCP [a total of 6.4 million (m) cy treated]. To expedite this, Green Diamond will provide $2.5 million annually, averaged for inflation, for the first 15 years of the HCP. This amount may vary as assessments are completed and high and moderate sediment volumes are refined. Simpson (2002) anticipates that approximately 47.5 percent of the overall volume, or 3.1 mcy will be removed during the first 15 years of the HCP (203,863 cy/yr). This volume of sediment represents mass wasting and other catastrophically-derived sediment as well as stream crossing sites and other sites prone to sediment delivery and does not include the volume of fine sediment from road surface erosion that will be removed. Following the initial 15-year accelerated effort, Green Diamond will continue to treat high and moderate priority sites. Over the 50-year term of the ITP, all high and moderate treatment priority sites will be treated.

We note that only high and moderate priority sites will be addressed over the life of the HCP. Simpson (2002, Appendix F3) estimates that over the course of implementing the HCP, eligible plan area sediment delivery will decrease to 3,000 cy/year from an initial value of 77,779 cy/yr under current conditions. However, these estimates are only for the high and moderate treatment priority sites. We anticipate that sites will fail that were not identified as high or moderate and, thus, will result in additional road-related sediment production over the eligible plan area. Furthermore, sites that are upgraded will be recharacterized as low priority sites. These sites, while possessing a much lower hazard, still present a potential source of sediment to watercourses, but they will have no more potential than they would have without the HCP. In the *Environmental Baseline* section, we estimated the volume currently existing in low priority sites (547,713 cy). Then, we estimate the annual volume that will become low priority as a result of upgrading. We take this total volume in low priority sites and estimate the average annual rate of sediment delivery these sites represent.

To estimate the amount of sediment that will be re-classified as low priority due to treatments, we use the total volume treated over the life of the HCP (6.4 mcy) and assume that the bulk of it, or approximately 65 percent, will remain after treatment as a low priority site rather than removed entirely (*i.e.,* not decommissioned). Examples of cases where sediment would be removed would be where diversion potential is corrected at road-stream crossings, or where unstable sidecast road fills are removed. In many cases, however, we expect that treatments will entail replacement of an undersized culvert. In these instances, the amount of material available for delivery would remain on site, only the chance of delivery would be reduced. This results in 4.2 mcy existing in low priority sites. Therefore, the total volume existing in low priority sites at the end of the HCP period will be the sum of existing low-priority sites (0.5 mcy) and the 4.2 mcy that become low priority as a result of treatment over the life of the HCP, or 4.7 mcy.

Expressing this value as an expected average annual sediment yield is problematic. First, understanding how the low-moderate-high priority delineations were made is important. For the Green Diamond inventories, determination of high and moderate priority sites is based on both the treatment urgency and deliverable volume at the site, combined with factors that consider accessibility and cost-effectiveness. Therefore, we expect that sites that pose an immediate threat of sediment delivery may not be considered as high or moderate priority because they are inaccessible and the cost of treatment would be excessive. Therefore, simply saying that low priority sites are less likely to fail is not entirely accurate. As a group, however, low priority sites likely present much less of a sediment delivery threat than the high and moderate priority sites. Based on aerial photo analysis, Simpson (2002, Appendix F3) estimates that the entire road network will deliver sediment at an annualized rate of 77,779 cy/yr, or 1.2 percent of the total volume in high and moderate priority sites each year. We expect that the failure rate from the low priority sites will be much less, on the order of 0.3 percent, or one quarter the rate from the high and moderate sites.

Therefore, given the 4.7 mcy estimated to be in low priority sites at the end of the HCP period, and assuming that 0.3 percent of this volume delivers each year, we expect that the low priority sites will deliver approximately 14,100 cy/yr. We include this estimate in our final estimates of road-related sediment production at the end of the HCP period. Thus, given the proposed measures for treatment of all high and moderate priority sites, we expect that implementation of the HCP will result in an average annual sediment yield of 17,100 cy/yr from roads. The additional 3,000 cubic yards per year in the above figure comes from Green Diamond's estimates of post-treatment effectiveness - realizing that upgraded sites will generate some short-term sediment delivery. The same assumptions were used to estimate the expected delivery rate from low priority sites under current conditions (547,713cy X 0.3 percent, or 1,643 cy/yr). Thus, implementation of the HCP is expected to reduce the long-term average annual road sediment delivery from an initial 79,422 cy/yr under current conditions to a final rate of 17,100 cy/yr when all sites are considered.

4. Road Construction

Roads may increase landslide activity through altered hillslope hydrology, by destabilizing toe slopes and removing vegetation that provides slope stability. The effects of roads on landslide rates will be a function of road location and drainage design. The HCP proposes to avoid new road construction on SSS zones, headwall swales and deep-seated landslides, where feasible. Many of these new roads will be temporary roads, removed after completion of harvest operations, or located on ridge tops where sediment delivery hazards are negligible. However, we expect that new roads will present some level of sediment delivery hazard throughout the action area, albeit at a reduced rate than what is currently occurring.

Where roads are proposed across potentially unstable areas, the services of a qualified geologist or engineer are required for construction in these areas. We think this will substantially reduce the hazard of any roads constructed across potentially unstable features. The HCP provides for notification to NMFS when new construction is proposed across unstable areas. We expect this provision will not appreciably reduce the effects of roads on mass wasting in these areas, since we assume that Green Diamond will have already determined that alternative routes were infeasible and the planned road location is the only alternative. Only in rare instances do we expect the notification process to result in relocation of a road, or a decision to not construct the road altogether.

The HCP does not describe the extent of new road construction or estimates of landslide-related sediment from newly constructed roads. We think that new road construction will unintentionally result in small instances of mass wasting over the 50-year term of the ITP. We reason that this increase will be relatively small given that the design of these roads will employ measures to reduce mass wasting, including those discussed above. In order to better quantify this so that the overall mass wasting budget can be assessed, we need to assume the mileage of roads that will be built in a given year, particularly across potentially unstable features, the expected frequency of failure, and the volume delivered. Given that most of the primary road network is already in place, we expect that new roads will be mostly limited to short spur roads accessing individual harvest units.

Since we do not know the extent of road mileage to be constructed, their locations, and whether they will be temporary, an estimate of landslide sediment production is difficult. As a conservative over-estimate of sediment production, we expect newly constructed roads to behave similarly to upgraded roads with a low treatment priority. From the discussion in the previous section, our estimate of sediment production from low-priority treatment sites at the conclusion of the ITP term was 14,100 cy/yr. This value encompassed the entire treated road network (approximately 4,000 miles), resulting in 3.525 cy/mi/yr. If 5 miles of road are constructed per year across the ownership and remain, we would expect a total of 250 miles of new road construction over the 50-year term of the ITP. This would result in a potential sediment production rate of 881 cy/yr at the conclusion of the permit term. We caution that this number is intended only to be a general estimate to compare with the sediment production rates anticipated from the existing road network. Given the magnitude of sediment reduction from roads proposed over the life of the ITP (*i.e.*, from 79,422 cy/yr to 17,100 cy/yr), the sediment production from newly constructed roads represents only a small moderation of this long term sediment reduction.

5. Summary of the Effects of the HCP on Mass Wasting Sediment Delivery

The effects of the HCP on sediment delivery through mass wasting have been discussed in terms of hillslope landslides and road-related landslides. Implementation of the measures proposed in the HCP is expected to result in a long-term average hillslope landslide rate of approximately 79,048 cy/yr from an initial rate of 91,061 cy/yr under current conditions (Table 21). This is compared to the background landslide rate of 58,038 cy/yr and results in an increase in landslide rates over background rates of approximately 1.4 (Table 21). Similarly, implementation of the HCP will remove many of the high and moderate priority road sites, thus reducing the average annual sediment yield from roads from an initial estimate of 79,422 cy/yr to an average of 17,100 cy/yr. When roads are added into the mass wasting volume estimates, the HCP will result in an estimated mass wasting sediment delivery rate that is approximately 167 percent the background rate as shown below.

Management-related hillslope landslide rate (cy/yr):	21,012
Road-related mass wasting rate (cy/yr):	17,100
Mass wasting from newly constructed roads (cy/yr):	881
Total management/road-related mass wasting rate (cy/yr):	38,993
Background rate (cy/yr):	58,038
Total sediment yield (including background) from mass wasting at end of HCP period (cy/yr):	97,031
Estimated mass wasting sediment delivery rate as a % of background:	167%

Table 22 summarizes the effects of the HCP on mass wasting derived sediment. In Appendix A of this Opinion, we have estimated sediment delivery rates for each of the four HPA groups to provide a finer scale of analysis. Considering an IPA of approximately 650 mi^2 (Table 1), the proposed HCP will yield a long-term average landslide sediment input of 149 cy/mi^2/yr. Table 22 also expresses the effects of the proposed HCP on mass wasting yields relative to those expected if no harvest occurred on potentially unstable features. We note that a large portion of the potentially controllable sediment is triggered by landslides originating from the areas that receive no mass wasting provisions other than the FPRs. Data from Simpson (2002, Appendix C) notes the presence of 23 slides along approximately 39,560 feet of surveyed Class III watercourses (approximately 3 slides per mile). Furthermore, 90 percent of the slides were observed to originate within 30 feet of the channel. Analysis from Simpson (2002) suggests that instability along Class III channels is most likely where channel gradients and side-slopes are highest. Thus, we suspect that much of this delivered sediment originates from steep Class III watercourses and areas upslope of Class I and II channels that are slightly outside the defined SSS criteria in the HCP. We discuss the role of Class III channels more thoroughly in the *Integration and Synthesis* section.

Table 22. Summary of the expected delivery rates of mass-wasting derived sediment for the various components in the HCP at the beginning (pre-plan) and end of the HCP period. Values are adjusted from Simpson (2002, Appendix F3) based on assumptions used and described in the text and footnotes. Results for each of the four HPA groups are presented in Appendix A.

	Roads (cy/yr)	**RMZ (cy/yr)**	**SSS (cy/yr)**	**Headwall Swale (cy/yr)**	**Deep-seated landslides (cy/yr)**	**Not protected (cy/yr)**	**Total (cy/yr)**
Background rate	0	10,241	4,374	6,981	22,832	13,610	58,038
Pre-plan rate	79,422	13,200	8,748	17,451	24,442	27,220	170,483
Post-plan rate	17,981	10,276	6,182	11,169	24,201	27,220	97,029
Pre-plan yield (%)							**293**
Post-plan yield (%)							**167**

The hillslope landslide modeling data involves numerous assumptions and incorporates large uncertainties. We cannot overemphasize this. This uncertainty derives from five principal components: (1) extrapolating hillslope landslide characteristics and prescriptions from three sampled subwatersheds to the HPA-group level and the entire ownership, (2) assessing the effectiveness of selection harvest on landslide hazard, (3) determining the increase in landslide frequency due to even-aged management, (4) expressing mass wasting sediment production as an annualized volume, and (5) assessing background landslide rates.

The HCP proposes a long-term research and monitoring program to assess the effects of timber harvest on slope stability. However, preliminary results from this study are not anticipated for 7 years into the HCP. Modifications as a result of this and other landslide assessments, therefore, may not be implemented until after the first decade of the HCP unless new information triggers changed circumstances or other provisions under the HCP or IA.

Over the short-term, landslides from hillslopes could continue to occur as a result of past management practices. During THP reviews, mass wasting areas may be identified and protections recommended by reviewing agencies. While we presently do not possess information to assess the level of site-specific professional geologic review all plans will receive, adequate review and oversight by a qualified, professional geologist should help ensure that mass wasting hazards are recognized prior to vegetation removal. We expect that the overall outcome of geologic review will be increases in harvest within the limited-harvest areas surrounding the slide. Review of such changes by qualified, professional geologists will help insure protective standards are maintained, but does not prevent unintentional misidentification of hazard areas. If timber harvest increases and those sites fail, this will increase, over time, the quantity of sediment delivered to channels. For headwall swales, for example, geologic review could indicate a headwall swale is not a "high risk" site and be subject to greater timber harvest. However, the site is still prone to failure. Therefore, the effect would be an increase in mass wasting (and concomitant decrease in wood delivery). Although in most instances, geologic review may result in an alternative prescription that does not increase risk to aquatic resources, in some instances, the alternative prescriptions will unintentionally lessen the overall protection that the default prescriptions provide. Until monitoring programs are completed and the effects of mass wasting on stream habitat are assessed, management-induced landslides may occur across the ownership, both within and outside of the designated protection zones, and result in potential adverse impacts to salmonids and their habitat.

Monitoring programs to refine mass wasting areas and assess their effectiveness will occur over the life of the HCP. Green Diamond will complete an SSS delineation study within 7 years after the effective dates of the permits to modify the initial minimum slope gradient and maximum slope distance for each HPA. This will involve the collection of additional landslide distribution data to better achieve the proposed effectiveness values for a given HPA. The effectiveness of the SSS prescriptions in providing for adequate stream habitat will be evaluated over the first 15 years of the HCP. Finally, a mass wasting assessment to examine the relationships between mass wasting processes and timber management practices will be completed within the first 20 years of the HCP. Given the long response times of mass wasting to timber harvest, due primarily to root decay and the occurrence of triggering storms, and consequent instream effects, we expect that initial modifications to the mass wasting provisions will not occur until at least 10 years into the HCP following the preliminary results and the effects of these changes not realized for several years afterwards. Additionally, the channel morphology monitoring program will contribute information on instream conditions, but linking these conditions to upslope practices will be difficult, given limitations in current scientific information. Therefore, we anticipate the current mass wasting minimization and avoidance strategy may remain unchanged across the landscape for at least the first 10-15 years of the HCP, with more substantive changes expected after 20 years. The risk this presents to instream habitat and Pacific salmonid is discussed in the *Integration and Synthesis* section.

This effect may be compounded because roads measures will not become effective until several years have elapsed to allow for stabilization efforts to occur and a triggering storm to occur that will allow for reduced sediment delivery rates from roads. The expedited approach proposed by Green Diamond will assist in realizing the benefits of roads stabilization and decommissioning slightly more quickly than currently occurs, particularly in the northernmost watersheds (*e.g.*, coastal Klamath HPA group) where these are given a higher priority. These issues are discussed in the *Integration and Synthesis* section.

F. Effects of the Proposed Action on Stream Temperature Regime

1. Review of Baseline Temperature Information

Our review of the baselines for each HPA suggests that stream temperatures are of greatest concern within the inland watersheds. However, excessive temperatures in Salmon Creek within the more coastal Humboldt Bay HPA indicate that localized temperature problems may occur anywhere within the action area. Prior to implementation of streamside buffers under the California FPRs, many streams in the action area likely experienced temperature regimes that were stressful and even lethal to salmonids. We expect many of these streamside areas are recovering and thermal conditions are becoming more suitable for salmonids once again. However, we note that the larger mainstem rivers such as the Klamath, Eel and Van Duzen Rivers continue to experience summer water temperatures that are stressful to salmonids.

2. Factors Influencing Stream Temperature Regimes

Increased water temperatures in streams are often associated with the removal of shade-producing vegetation (Thomas *et al.* 1993). The principal source of energy for heating streams results from solar radiation directly striking the surface of water (Beschta *et al.* 1987). Water temperatures in forest streams increase as a result of reductions in canopy cover, which can increase stream temperatures (Beschta *et al.* 1987). Increases in stream temperatures were observed when clear-cutting was followed by burning (Brown and Krygier 1970 *op. cit.* Spence *et al.* 1996). Burning is a common method used by Green Diamond to clear away debris from logging after a clear cut. Stream temperatures can be impacted by burning due to loss of overstory canopy and increases in sedimentation. The temperature increase in a stream is directly proportional to the area exposed to sunlight and inversely proportional to the volume of water in the stream. As a result, the effect of canopy removal on stream temperatures is greatest for small streams and diminishes as streams get wider.

One of the purposes of riparian buffers is to provide adequate overstory canopy to shade aquatic habitat. The removal of overhead canopy cover results in increased solar radiation reaching the stream, which results in increased water temperatures (Spence *et al.* 1996). Spence *et al.* (1996) reported that old-growth stands provided between 80 and 90 percent canopy cover from studies in western Oregon and Washington. Flosi *et al.* (1998) and CDFG (1996) recommended an 85 percent riparian canopy to properly shade streams that might be used by salmonids.

Cafferata and Munn (2002) reported that post harvest overstory canopy in riparian zones along class I and II streams in the Coast Forest Region in California was approximately 80 percent. Brandow *et al.* (2006), in a separate review dealing with timber harvest completion reports found that post harvest overstory canopy in riparian buffers adjacent to Class I and II streams in the Coast Forest Region averaged 84 percent. Both reports were focused on evaluating the efficacy of the California FPRs, and all field sample data were collected from completed plans that had been exposed to several years of winter weather.

Based on review of numerous investigations, Johnson and Ryba (1992) concluded that forested buffer widths greater than 100 feet generally provide the same level of shading as that of an old-growth forest stand. Other authors (*e.g.*, Beschta *et al.* 1987, Murphy 1995) have also concluded that buffers greater than 100 feet provide adequate shade to stream systems. The curves presented in FEMAT (1993) suggest that 100 percent effectiveness for shading is approached at a distance of approximately 0.75 tree heights from the stream channel. Assuming a tree height of 170 feet (100-year old redwood, site class 2; Lindquist and Palley 1963), this buffer width should be 127 feet to provide 100 percent shading effectiveness.

3. Response of Salmon to Changes in the Temperature Regime of Aquatic Habitats

Salmon populations are adapted to the specific, natural temperature ranges of their natal streams. The empirical evidence available demonstrates that altering these temperature regimes adversely affects all of the salmonid life stages. For example, high temperatures inhibit the upstream migration of adult salmon and increase the incidence of disease throughout a salmon population. Berman and Quinn (1991) reported that survival and development of spring Chinook salmon eggs were adversely affected by elevated water temperatures. Laboratory studies demonstrated that juvenile salmon respond to changes in stream temperature regimes with reduced development, reduced growth, reduced survival, and changes in the timing of life history phenomena (Beschta *et al.* 1987, Thomas *et al.* 1993). For example, fluctuating diel temperature regimes that had peak temperature of 28°C within a cycle killed 50 percent of age-0 coho salmon (350 mg) while peak temperatures of 26°C killed half of age-2 fish. As stream temperatures increase, competition between salmon and warm water fish species can increase, which can cause salmon populations to become extirpated as a result of the competitive pressure (Reeves *et al.* 1987).

Based on this body of evidence, we would expect juvenile salmon within the action area to respond to increases in the temperature regimes of streams in the action area by abandoning their rearing areas or experiencing reduced rates of growth and survival. By themselves, both of these responses would be expected to reduce the fitness of adult salmon in the action area by reducing their probability of lifetime reproductive success.

4. Proposed HCP Measures Affecting Stream Temperature

The proposed HCP measures that may directly influence stream temperature are the RMZs. The influence of Class III riparian measures are not considered here because these watercourses are dry much of the year except during and immediately following rainfall when ambient air temperatures are cool and water temperatures are generally not a concern for salmonids in the action area.

a. Class I Watercourses

All Class I watercourses will have an RMZ of at least 150 feet (slope distance) on each side of the channel. The RMZ width will be measured from the first line of perennial vegetation or the outer CMZ edge, where applicable. The RMZ for Class I watercourses will be divided into an inner zone and an outer zone. The outer zone will be extended, where necessary, to cover the entire floodplain and an additional 30-50 feet beyond the outer edge of the floodplain. Widths of the two zones will also vary depending on slope.

Over the life of the HCP, only a single entry into Class I RMZs may occur. At least 85 percent of the overstory canopy will be retained in the inner zone and 70 percent in the outer zone. Also, trees within the RMZ that are judged likely to recruit or contribute to bank stability will be retained. In no case will harvest within Class I RMZs reduce the conifer stem density to less than 15 conifer stems that are greater than 16 inches DBH per acre.

b. Class II Watercourses

Class II watercourses are divided into two types, depending on size. For first order Class II watercourses, the first 1,000 feet downstream from the headward extent of the Class II/III demarcation will have a total RMZ width of 75 feet slope distance on each side of the channel. These “Class II-1” RMZs will have a 30-foot inner band subject to 85 percent overstory canopy retention. The 30-75 foot outer band will have a 70 percent overstory canopy retention standard.

Class II watercourses that are either second order or greater, or are downstream of a Class II-1 watercourse are considered “Class II-2.” RMZs associated with Class II-2 watercourses will be 100-foot wide on each side of the channel with a 30-foot inner band subject to 85 percent overstory canopy retention and the remaining 70 feet will be 70 percent overstory canopy retention.

Green Diamond proposes additional measures associated with RMZs to maintain adequate buffers between upslope burning activities and the stream channels. The measures are designed to keep prescribed fires out of RMZs by limiting prescribed burns to only those times when optimal conditions exist and by requiring fire-setting techniques that will encourage the fire to burn away from RMZs. Numerous variables such as vegetative moisture content, wind, and humidity can influence the ability to control a prescribed fire once it is set. The condition of the RMZs should also create a microclimate differential which may aide in limiting fire entry into an RMZ. Although management of controlled burns may never be 100 percent effective, these measures described in the HCP are expected to minimize the possibility of fire from prescribed burning compromising the integrity of the shade-providing canopy in the RMZs.

5. <u>Anticipated Effects of Proposed Riparian Measures on Stream Temperatures</u>

Based on the overstory canopy retention standards and riparian widths proposed by Green Diamond, NMFS expects that protection of riparian zones along Class I streams will result in negligible increases in water temperatures. Shading along Class II-1 watercourses may not be sufficient to approximate undisturbed thermal conditions based on the literature reviewed above. Given that these channels likely represent the smallest Class II watercourses, we expect that many of them will be dry when stream temperatures are a concern. Therefore, we expect some minor, localized increases in Class II-1 stream temperatures that may influence temperatures in downstream, fish-bearing reaches. We expect, in these instances, that the adaptive management process will provide some degree of flexibility to modify riparian management measures should temperatures exceed monitoring thresholds. Unlike the mass wasting monitoring, this process may be able to more rapidly institute changes should the proposed measures result in undesirable temperature regimes for salmonids because the effects will be seen in the first seasons following harvest.

G. Effects of the Proposed Action on Nutrient Inputs

The primary productivity of streams within the action area is primarily driven by allochthonous inputs (derived from outside the aquatic system typically through detrital inputs). One of the most important sources of detrital inputs to lower order streams is red alder (Murphy and Meehan 1991). Red alder fixes atmospheric nitrogen and the leaves rapidly decompose in the stream, providing a ready source of nitrogen for primary productivity, ultimately providing the food base that juvenile salmonids depend on for growth prior to migrating out to sea. Studies indicate that nutrients increase in the first few years following logging (Hicks *et al.* 1991). Where light is provided to the stream, these increases may cause short-term increases in salmonid growth, but effects on overall salmonid production have not been detected (Hicks *et al.* 1991). Given the buffers proposed in the HCP, any nutrient increases following harvest will likely not have a detectable effect on salmonids.

As described in the baselines for each of the HPAs, much of the riparian vegetation is composed of hardwoods, largely red alder. Furthermore, we do not anticipate removal of these trees as a part of timber harvest due to their proximity to the stream. Over the life of the HCP, conifers may begin to out-compete streamside hardwoods such as red alder and result in a gradual reduction in red alder inputs to the stream. However, given the prevalence of red alder across the action area, we expect it will continue to be a significant source of allochthonous inputs over the life of the HCP. Therefore, NMFS does not anticipate any detectable changes in salmonid production as a result of changes in stream nutrient loads from measures proposed in the HCP when compared to current conditions.

H. Effects of Fish Relocation Above Barriers (“Special Project”)

During the course of the HCP, Green Diamond proposes a 10-year project to relocate adult coho salmon above barriers. Although the HCP is not specific, we presume that both natural and artificial barriers will be included in the project. The objective is to enhance coho salmon smolt production by providing access to currently inaccessible reaches. In assessing the effects of this special project, we recognize that the project has both beneficial and adverse effects on species covered in the HCP. Mortality of adult coho salmon may occur during the capture, handling and transport of individual fish. In fish transport operations around a small dam on a tributary to the Rogue River, Oregon, adult coho salmon mortality was typically 2-3 fish for approximately 600 adults transported, or <1 percent (Satterthwaite 2004). Green Diamond anticipates that approximately 10-15 individuals will be relocated upstream of a barrier each year. Based on the information from Oregon, we do not expect more than one adult coho salmon per year would perish as a result of transport. The Oregon efforts also showed that relocated coho salmon were able to spawn successfully as indicated by juvenile outmigrants in years following relocation (Satterthwaite 2004). However, if relatively few adults are relocated in an area with a large amount of unutilized habitat by that species, fish of the opposite sex may fail to "pair up." In this instance, the effect of the project would be a reduction in the reproductive success of the individuals relocated. Where populations are limited to a few individuals, the presence of natural barriers may help concentrate adults and increase reproductive success.

We do not have information to assess the effects of this project on overall population genetics - both within and among species. Many natural barriers may function as selective barriers and allow passage to only a certain species and/or select for the most "fit" individuals. In these cases, the barriers may provide an important source of genetic diversity. Species successfully negotiating the barrier and successfully reproducing are able to rear with less competitive pressure and their particular genetic traits are contributed to the overall gene pool. Similarly, the degree of blockage fluctuates at many natural barriers. This can occur at the terminus of a deep-seated landslide or earthflow where the nature of the barrier is constantly changing.

Adverse effects will occur through the handling and transport of sexually mature adults and the potential for decreased reproductive success of the relocated individuals. There will also be an unknown effect on population genetics. However, for fish that are able to successfully spawn, the increased rearing habitat afforded by reaches upstream of the barrier may locally increase the coho salmon population in the sub-watershed. A portion of returning adults would continue to encounter the barrier and be subject to the above-mentioned effects (*i.e.*, handling and transport mortality and decreased reproductive success). Overall, we expect the offspring from successfully spawning fish above the barrier will encounter less competition for space and other resources than below the barrier, thus experiencing better growing conditions. We expect an increase in the fitness of the juvenile population in the affected watershed. This will likely lead to a small increase in abundance of returning adults.

I. Effects of Instream Equipment Use on Salmonid Eggs and Fry

Adverse effects to Pacific salmonids due to road construction, decommissioning, upgrading, and maintenance activities at Class I watercourse crossings can be caused by heavy equipment operating instream and crushing eggs and emergent fry that are residing or taking refuge in the interstitial spaces of gravel. To develop an estimate of the impacts to eggs and fry from such road activities, NMFS relies on assumptions on the presence and density of eggs and fry at instream road work locations and the number of locations at which Green Diamond conducts such work.

NMFS assumes the preponderance of work sites are relatively narrow (*i.e.*, approximately 25 feet wide, or less) and of limited size (*i.e.*, 400 square feet), similar to the composition of Class I watercourse crossings currently in existence on Green Diamond's property. As a result, the capacity of these sites to contain spawning redds is limited. Redd size can vary depending on the species and size of the female, but an average for coho is 2.6 square meters (*i.e.*, 28 square feet) (Groot and Margolis 1991). In addition, redds are typically evenly distributed and arranged in diagonal rows across the stream due to the territorial nature of the females (Groot and

Margolis 1991). Based on this information, NMFS expects a maximum of 8 redds could be present when spawning has occurred at a given work site. However, observations of spawning densities on the California north coast suggest a reasonable average is 1 redd per site (Clancy 2007) given that the majority of such sites contain either no redds or only contain a single redd. Finally, although fecundity varies between and within salmonid species on the California north coast, NMFS assumes redds contain an average of 2,500 eggs per redd based on the range of values in Groot and Margolis (1991) presented for northern California.

The operational windows for instream work partially, and sometimes completely, overlap periods when eggs and fry are present. Emergency road maintenance activities requiring equipment use instream, though infrequent, can be required at any time of the year. Road construction, decommissioning, upgrading, and non-emergency maintenance requiring use of heavy equipment instream can occur from May through mid-November. Salmonid eggs can be present in redds from November into June, depending on the species and annual variations in environmental conditions. In addition, emergent fry, whose fright response is to hide into the interstitial spaces of adjacent gravel, can be present from February through the end of June. Approximately 40 percent of the operational window for road work activities, excluding emergency maintenance, overlaps with the potential presence of eggs and emergent fry. NMFS assumes emergency maintenance results in another 10 percent of instream work occurring during the period of potential presence of eggs and emergent fry, resulting in a total of 50 percent of instream work occurring when eggs and emergent fry are potentially present.

Green Diamond's use of equipment in Class I watercourse crossings, when conducting road construction, decommissioning, upgrading, and maintenance activities, averages nine locations per year, with a recent one year peak of 20 locations. NMFS estimates the average impact to be 11,250 eggs crushed per year (9 locations x 0.5 locations worked on when fry are potentially present per location x 1 redd per location when redds present x 2,500 eggs per redd). Assuming instream work at a maximum of 25 locations, NMFS anticipates a maximum of 31,250 eggs (25 locations x 0.5 locations worked on when fry are potentially present per location x 1 redd per location when redds present x 2,500 eggs per redd) will be injured or killed per year.

Densities of emergent fry have been documented to be 5 fry per 100 square feet (Halligan 2002), or 20 fry per 400 square ft. NMFS estimates the average annual anticipated injury or mortality to be 90 emergent fry (9 locations x 0.5 locations worked on when fry are potentially present per location x 20 fry per location). Assuming instream work at a maximum of 25 locations, NMFS anticipates a maximum of 250 emergent fry (25 locations x 0.5 locations worked on when fry are potentially present per location x 20 fry per location) will be injured or killed per year.

J. Changed Circumstances

The purpose of the Changed Circumstances Measures is to address reasonably foreseeable changes in habitat conditions and the status of Covered Species in the Plan Area. Four types of changes are identified in the HCP as potential "changed circumstances" as defined in applicable Federal regulations and policies, such as: fire, windthrow, pest infestation and landslides. If such circumstances occur, Green Diamond will implement the applicable supplemental prescriptions specified in the IA and HCP.

In cases of fire, Green Diamond will consider salvage of dead or damaged trees with the application of the RMZ measures previously described. Reforestation of any RMZ or SMZ affected by the fire will be implemented as soon as possible. Similarly, in the case of windthrow, Green Diamond will consider salvage of the downed trees with application of the RMZ and SMZ measures previously described. In the case of pest infestation, a RG and RPF will develop additional prescriptions to compensate for the loss of hardwood root strength through retention of additional conifers.

Based on historic experience within the eligible plan area, a landslide that results in the delivery of more than 100,000 cubic yards of sediment is not reasonably foreseeable and is considered an unforeseen circumstance. If a landslide results in the delivery of more than 20,000 cubic yards of sediment to a channel (either from a source area or from combined source area and propagated volumes), Green Diamond will provide NMFS with information regarding such landslide within 30 days of its discovery. With respect to such a landslide, and unless this landslide constitutes an "unforeseen circumstance," Green Diamond and NMFS will confer to determine if it is reasonably possible that management activities on or adjacent to the area of the landslide could have materially contributed to causing such landslide. If NMFS or Green Diamond concludes that it is reasonably possible that management activities materially contributed to the occurrence of such a landslide, Green Diamond will retain a qualified geo-technical expert to analyze the slide and develop a written report. The report will include, at a minimum, an assessment of the factors likely to have caused the slide and any changes to management activities, which had they been implemented on or adjacent to the area of the slide, would have likely prevented the slide from occurring. Upon receipt of such a report, Green Diamond will forward the report to NMFS. Where appropriate, the recommendations set forth in the report may form the basis for adaptive management changes to the SSS measures.

K. Interrelated and Interdependent Actions - Effects of Herbicide Use

The application of forest chemicals is not a covered activity in the HCP, but we consider it to be interrelated and interdependent with the HCP (Table 23). Both direct effects from exposure and indirect effects from the alteration of habitat or changes in primary and secondary production may occur within the action area. Accordingly, the effects of herbicide applications that are reasonably foreseeable during the course of HCP implementation are considered in this analysis.

The contamination of surface waters by herbicides, and the resultant risk of toxic effects on salmonids, depends on the form and application rate of the chemical, the application method, soil type, weather conditions during and after application, the presence of riparian buffers, and the distance of the application area from flowing water. The persistence of these chemicals in the environment varies due to differences in water solubility, absorption rates into organic and inorganic matter, and sensitivity to photo decomposition or microbial activity. No-spray riparian buffers substantially reduce the risk of contamination (Norris *et al.* 1991), but toxic levels of chemicals may still reach streams from runoff and wind drift (Schulz 2004). If contamination of surface waters occurs and results in sufficiently high concentrations of a chemical, impacts to salmonids and designated critical habitat will occur, including acute and chronic toxicity, leading to injury or death, behavior modifications, reduced growth, decreased reproductive success, and increased vulnerability to diseases and pathogens (reviewed in Beschta *et al.* 1995). Norris *et al.*

(1991) reviewed the behavior and toxicity of many of the commonly used herbicides, but newer chemicals are not discussed. Although there is substantial literature on the toxicity of various herbicides on salmonids, most of the information comes from laboratory studies focusing on acute lethal doses and not on chronic toxicity (Spence *et al.* 1996).

On January 22, 2004, the district court for the Western District of Washington in Seattle issued an injunction against the Environmental Protection Agency (EPA) and vacated EPA's authorization of most agricultural uses of 54 active ingredients within 20 yards (and aerial application within 100 yards) of salmon streams in California, Oregon, Idaho, and Washington (Washington Toxics Coalition v. Environmental Protection Agency, Case No. C01-0132C). Those active ingredients which require buffers are indicated in Table 23. There are further modifications imposing stricter requirements for certain specific pesticides and excluding certain other practices from the injunction. The injunction lasts until EPA has completed its consultation obligation. NMFS, EPA and USFWS have issued a joint rule to streamline pesticide consultation procedures (August 5, 2004, 69 FR 47732).

In this assessment, NMFS also considers the application methods used by Green Diamond in the absence of the court-mandated buffers. Green Diamond applies herbicides either by hand, roadside or aerially. The associated application methods are listed in Table 23 for each chemical. For ground and aerial applications, Green Diamond follows the procedures listed below:

For aerial applications, Green Diamond uses the following default measures:

- No herbicide will be applied within a 100-foot horizontal buffer zone of a Class I or II flowing stream.
- No application of herbicide will take place when the wind velocity exceeds 5 miles per hour.

For ground applications, the following measures are used:

- Foliar treatments will not be conducted when wind speeds exceed 10 miles per hour on the spray site.
- An untreated 50-foot buffer will be maintained on all flowing water.
- A copy of Green Diamond's Spill Contingency Plan will be kept on site in case of an accidental spill of any hazardous materials.

The application of chemicals by Green Diamond or its representatives is subject to the requirements of all applicable Federal and State laws, including the recent court decision cited above, as well as the prohibitions against take of listed species pursuant to section 9 of the ESA.

Table 23. Forest chemicals and methods of application currently used by Green Diamond as part of its forest management activities. On June 22, 2004, the district court for the Western District of Washington in Seattle (see Washington Toxics Coalition v. Environmental Protection Agency, Case No. C01-0132C) vacated EPA's authorization of most agricultural uses of 54 active ingredients within 20 yards (and aerial application within 100 yards) of salmonid streams in California, Oregon and Washington. Those chemicals requiring this buffer are indicated.

Chemical Trade Name	Application Type	Active Ingredient	Buffer required?
Aatrex	Pre-emergent; applied by hand. Short in duration in the soil.	Atrazine	No
Arsenal	Post-emergent; applied by hand. Used to prepare clearcut sites for reforestation, to release conifers from competing vegetation, and to provide control of many annual and perennial weeds.	Imazapyr	No
Chopper	Post-emergent; applied by hand. Used to control perennial broadleaf weeds.	Imazapyr	No
Garlon 4	Post-emergent; applied by hand, aerially, and roadside. Used to control broadleaf weeds and brush.	Triclopyr BEE	Yes
Honcho	Post-emergent; applied by hand. Used to control undesirable grasses and broadleaf species.	Glyphosate	No
Mirage	Post-emergent; applied by hand and roadside. Used to control undesirable grasses and broadleaf species.	Glyphosate	No
Oust	Pre-emergent; applied by hand. Used for nonselective weed control. Applied to soils at extremely low rates and has moderate to low persistence.	Sulfometuron methyl	No
Riverdale LV6	Post-emergent; applied by hand, aerially, and roadside. Used to control many types of broadleaf vegetation, especially woody species such as willow, alder, sumac, and sagebrush.	2,4-D	Yes
Herbimax (adjuvant)	Foliar applications	Oil surfactant	No
Moract (adjuvant)	Foliar applications	Oil surfactant	No
R-11 (adjuvant)	Foliar applications	Non-ionic surfactant	No
Activator 90 (adjuvant)	Foliar applications	Non-ionic surfactant	No
MSO concentrate (adjuvant)	Foliar applications	Methylated seed oil	No
Soy oil	Basal applications	Soy bean oil	No

1. Atrazine

Atrazine is the active ingredient in "Aatrex" and is used by Green Diamond for the selective control of broadleaf and grassy weeds. Tests indicate that most of the atrazine disappears from the soil within one year of application. However, while in the soil, atrazine is highly mobile and may be delivered to watercourses during rainfall events and potentially affect aquatic biota. Studies on agricultural croplands indicate that runoff from adjacent fields may generate concentrations in receiving streams up to 0.032 mg/L (Frank and Sirons 1979, *op cit.* Norris *et al.* 1991). No residues were detected in receiving waters when a 3-meter unsprayed buffer strip was left adjacent to the watercourse (Douglass *et al.* 1969, *op cit.* Norris *et al.* 1991). Given that Green Diamond applies atrazine by hand, we do not expect instream concentrations will exceed those seen for the above cited agricultural plots where the substance was more broadly applied.

Aquatic invertebrates, which provide a food source for salmonids, are also sensitive to atrazine. Concentrations of 0.23 mg/L of atrazine resulted in reduced hatching success, larval mortality, developmental retardation and a reduction in the number of emerging adult chironomids (Macek *et al.* 1976, *op cit.* Norris *et al.* 1991). Although chironomids are typically not a principal source of invertebrate prey for salmonids, the data indicate the magnitude in which effects to aquatic invertebrates could be expected. A limitation with using chironomids is that they may be a more tolerant species than mayflies and caddisflies, which are a principal food source for juvenile salmonids. However, given the concentrations observed in the above field studies compared to the sensitivity of chironomids to atrazine in the water column, we do not expect that any mortality or developmental changes in aquatic invertebrates will appreciably alter the prey base available to juvenile salmonids.

Laboratory and field tests show that atrazine is toxic to fish when present in sufficient concentrations. Concentrations of 0.24 mg/L produced significant reductions in the survival and growth of brook trout fry (Macek *et al.* 1976 *op. cit.* Norris *et al.* 1991). Analysis of muscle tissue from brook trout indicated that these fish did not bioconcentrate detectable amounts of atrazine after prolonged exposure (Macek *et al.* 1976 *op. cit.* Norris *et al.* 1991). We reason that the low concentrations expected in streams combined with the levels required to induce effects in salmonids will not result in detectable changes in salmonid growth, reproduction or survival rates. Although the above information is for juvenile fish, we do not have information concerning the effects on other life history stages. We expect that adults are least likely to be affected given that when they are present in streams most likely to contain detectable amounts of atrazine, stream flows are much higher, and any sources of atrazine are diluted. Although we do not have information on the susceptibility of developing salmonid eggs to atrazine exposure, we expect that levels which would affect the development of aquatic invertebrates would be sufficient to cause a change in egg-to-fry development. In this case, we note that the earliest developmental stage of gammarids (amphipods) was reduced when exposed to 0.14 mg atrazine/L (Macek *et al.* 1976 *op. cit.* Norris *et al.* 1991). This suggests that the smallest developing organisms will not experience detectable effects by the presence of atrazine given the expected concentrations of the substance in the water column. In summary, we do not expect that the application methods and expected concentrations of atrazine will result in detectable effects on salmonids in the action area.

2. Imazapyr

Imazapyr is the active ingredient in “Arsenal” and “Chopper,” used by Green Diamond to prepare clearcut sites for reforestation and control competing vegetation around young conifers. A substantial amount of testing of imazapyr products has been conducted to evaluate its potential toxicity to non-target organisms. In Washington State, Imazapyr was undetectable in the initial tidal exchange waters following the direct application of the compound to estuarine sediments

[Washington State Department of Agriculture (WSDA) 2004]. Imazapyr is considered practically non-toxic to fish based on standard 96-hour exposure studies (WSDA 2004). Bioaccumulation of imazapyr in aquatic invertebrates is low, therefore, the potential for exposure through ingestion of other organisms is also low (WSDA 2004). Tests for sub-lethal effects revealed no effects on hatching or survival in rainbow trout with concentrations up to 92 and 118 mg/L (WSDA 2004). Based on this information, we do not expect any mortality or changes in reproductive success of salmonids from Green Diamond's use of this herbicide.

3. Triclopyr BEE

Triclopyr BEE is the active ingredient in "Garlon 4," used by Green Diamond for control of competing vegetation in recently clearcut areas. Garlon 4 is highly toxic to rainbow trout, with median lethal concentrations (LC_{50}) occurring at 0.74mg/L (Dow Chemical Company 1983 *op. cit.* Norris *et al.* 1991). Fortunately, triclopyr dissipates relatively rapidly in the soil through microbial activity and photo decomposition, reducing the likelihood of exposure. In soils of increasing organic matter such as would be found on Green Diamond's timber lands, this dissipation appears to occur much more rapidly (Norris *et al.* 1991). McKellar *et al.* (1982 *op. cit.* Norris *et al.* 1991) found that water concentrations of triclopyr following heavy treatment in small, forested watersheds (11.2 kg/hectare) ranged from non-detectable to 0.02 mg/L. Lee *et al.* (1986 *op. cit.* Norris *et al.* 1991) concluded that there is little likelihood that triclopyr will leach from adjacent forest applications into water. Therefore, given the buffers required for application, avoiding aerial application when wind speeds exceed 5 mile per hour, and the low mobility of Garlon 4, we expect a low likelihood of salmonid exposure to Triclopyr BEE. We reason that the uncertainties associated with buffer strips and aerial application measures (Schulz 2004), combined with the length of the ITP term (50 years), may result in one or more instances of exposure over the life of the ITP. However, in the event of exposure, we do not expect the concentrations of the compound will occur in sufficient quantities to cause a detectable response in salmonids based on the studies cited above.

4. Glyphosate

Glyphosate is the active ingredient in "Honcho" and "Mirage" and is used to control grasses and other undesirable plant species. Glyphosate is very immobile in the soil and rapidly rendered inactive over a period of several weeks (Norris *et al.* 1991). Where agricultural applications have been monitored, concentrations in runoff ranged up to 5.2 mg/L when runoff occurred the day after heavy application (8.96 kg/hectare) but for lower application rates, concentrations up to 0.094 mg/L were observed (Norris *et al.* 1991). In forested applications with no buffer strips and the streams receiving direct aerial application of the herbicide, the concentration of glyphosate reached 0.5 mg/L (Norris *et al.* 1991). Studies indicate median lethal concentrations for rainbow trout occurring as low as 2 mg/L, but effects are very dependent on pH. Glyphosate is considered relatively non-toxic to fish and one of the forest herbicides least likely to have sublethal effects (NMFS 2003). The potential for the compound to build up in the tissues of aquatic organisms is very low (Extoxnet 1996). Since glyphosate is applied by hand and roadside, and is very immobile in the soil, we do not expect instream concentrations to approach those seen in studies referenced above. Thus, we expect that the salmonids will rarely be exposed to the substance. Therefore, we do not expect any salmonid mortality or changes in growth rates or reproductive success.

5. Sulfometuron-methyl

Sulfometuron-methyl is the active ingredient in "Oust" and is used by Green Diamond in the control of competing vegetation. Sulfometuron-methyl is used for conifer site preparation and release and general weed control along roadsides. The following information is summarized from the California Department of Pesticide Regulation's (CDPR undated) document summarizing the environmental fate of Sulfometuron-methyl. Sulfometuron-methyl is slightly toxic to fish and aquatic invertebrates. Its LC_{50} in adult rainbow trout is greater than 12.5 mg/L. Toxicity to rainbow trout occurs at 13 parts per million (ppm). Levels of sulfometuron-methyl in bluegill sunfish were well below the level for toxicity after exposure to the compound for 28 days and, therefore, is not thought to bioaccumulate. Because it does not bioaccumulate, the compound is only slightly toxic to freshwater fish. Sulfometuron-methyl is practically nontoxic to the water flea (*Daphnia magna*), suggesting that aquatic invertebrates, and thereby the prey base of salmonids, are not affected by low levels of the compound in streams. Little specific information is available on the potential sublethal effects of the compound (NMFS 2003), although the water flea is often regarded as a sensitive indicator to toxic substances (CDPR undated). Since sulfometuron-methyl shows little tendency to bioaccumulate and does not have long-term persistence in food chains, we do not expect any chronic effects to occur (NMFS 2003). Given the hand application of this compound and the relatively low rates of application by Green Diamond, we expect salmonid exposure to the compound to be very low, if any, and, consequently, we do not expect any mortality or reduced reproductive success or growth rates in salmonids.

6. 2,4-D

2,4-D is the active ingredient in "Riverdale LV6" and is used to control competing woody vegetation (Table 23). This is a widely used herbicide, applied to control vegetation for several purposes. In soil, 2,4-D persists for a very short time, rapidly disappearing due to plant uptake and microbial decomposition. Further, soil organic matter readily adsorbs 2,4-D, which tends to limit its mobility. Norris (1981 *op. cit.* Norris *et al.* 1991) concluded that direct application and drift to surface waters are the processes most likely to produce the highest residue levels, but that persistence is brief, usually less than 48 hours. In comparing expected concentrations resulting from field application to lethal thresholds, NMFS (2003) concluded that no impacts to any aquatic species is likely to occur from the general use of 2,4-D in a watershed.

Physiological and morphological alterations have been seen in fish exposed to 2,4-D. Common changes seen in physiological parameters are changes in enzyme activity levels (Nešković *et al.* 1994). Exposure to 2,4-D has also been shown to cause morphological changes in gill epithelium in carp. These changes include lifting of the gill epithelium and clubbing of gill filaments, but are considered non-lethal if the fish is removed to clean water for recovery (Nešković *et al.* 1994). In field conditions, this would be equivalent to swimming to an untreated area or the herbicide concentration decreasing to negligible levels. Carpenter and Eaton (1983) investigated the metabolism of 2,4-D in rainbow trout after injection, and found that almost 99 percent of the compound is excreted in the urine as unchanged 2,4-D, with a half-life of only 2.4 hours. Less than 1 percent was found in the bile of treated fish, presumably as a conjugated metabolite. The aerial application buffers and avoiding aerial application when wind speeds exceed five miles per hour will minimize any drift, particularly where herbicide is applied on recently harvested areas and the application is from a low altitude. However, given the uncertainties surrounding the effectiveness of no-spray buffers and aerial drift, there is still the likelihood that some of the compound may enter a nearby watercourse over the life of the ITP. However, given the short persistence time in water should drift occur, we do not expect any mortality or reduced reproductive success or growth rates from the use of 2,4-D.

7. Adjuvants

The various adjuvants listed in Table 23 used by Green Diamond are surfactants used to improve the emulsifying, dispersing, spreading, wetting, or other surface modifying properties of liquids. Surfactants are frequently toxic. The surfactant R-11 has a 96-hour LC_{50} of 3.8 ppm for rainbow trout, making it considerably more toxic to fish than the glyphosate it is commonly mixed with (Diamond and Durkin 1997). Curran *et al.* (2004) found that R-11 was significantly more toxic to smaller rainbow trout (0.39 g) than it was to larger fish (15.46 g) when the LC_{50} of each size was compared (5.19 ppm v. 6.57 ppm) and that EPA test criterion size (<3g) indicates that differences in fish size may cause differences in the 96-h LC_{50} as great as 200 percent. Furthermore, the surfactant R-11 has been implicated as causing endocrine disruption in fish and amphibians as one of its constituents is a nonylphenol polyethoxylate (NPE). Nonylphenols are weakly estrogenic, and have been shown to cause endocrine disruption under laboratory conditions at low doses (20 ppb, UK Marine SACS Project 2003). In comparison to the herbicides used during vegetation treatments, the surfactant R-11 is more toxic and has a range of effects that present themselves in the low parts per billion concentration range. Unfortunately, little information could be located on the potential toxicity of the other adjuvants listed in Table 23. For methylated seed oils, a LC_{50} value of 53.1 mg/L was reported (NMFS 2003), suggesting that mortality is unlikely given the relatively high water concentration needed and provisions for avoiding streams. Preliminary laboratory results indicate that R-11 is likely the most toxic of the adjuvants used (Cabarrus *et al.* 2002).

There is some risk of surfactant drift during aerial applications that the spray buffers and wind speed limitations will reduce. Also, the proposed action will retain forested buffers along Class I and II streams, and areas within the buffer will not be aerially treated. Given these limitations, we expect that aerial drift will enter flowing watercourses only in rare instances. However, given the small concentrations of R-11 needed to cause the effects noted above, the aerial application of adjuvants may ultimately increase the likelihood of reproductive disruptions, reduced growth rates or even mortality of salmon and steelhead. Sublethal effects are characterized as those that occur at concentrations that are below those that lead directly to death. Sublethal effects may impact the fish's behavior, biochemical and/or physiological functions, and create histological alterations of the fish's anatomy. In addition, changes in the sensitivities of fish to other contaminants (*i.e.*, chemical synergism) may increase the likelihood of mortality of exposed fish. For example, the toxicity of R-11 may increase when mixed with an herbicide (WSDA 2003). Thus, the additive and synergistic effects of chemical mixtures may result in greater than expected toxicity (Lydy *et al.* 2004). In considering the effects of R-11 on salmonids, we note two critical areas of uncertainty: (1) the extent of toxicity of R-11 to salmonids and their prey base, and (2) the uncertainties surrounding the effectiveness of no-spray buffers and aerial application measures discussed by Schulz (2004). While the application measures reduce the chance of exposure, over the 50-year term of the ITP, the likelihood exists that exposure may occur. We consider this a low likelihood of occurring given that the application site must be near a watercourse with salmonids present. We also presume that Green Diamond will comply with any R-11 use restrictions that are imposed from future assessments of the impacts of this compound on listed species.

Given that toxicology data are largely unavailable for the other adjuvants, the effects on salmonids are unknown except for soy oil discussed below.

Soybean oil is mixed with herbicides and used by Green Diamond as an adjuvant. Adjuvants can affect herbicide performance in many ways including the spread of spray droplets on the leaf surface, retention of spray on the leaf, and penetration of the herbicide through the plant cuticle. The base oil is considered non-toxic to aquatic organisms, but formulated products may have additive effects that are toxic. The LC_{50} for rainbow trout in laboratory tests was 633 parts per million, but bubbling air through the test containers virtually eliminated the toxicity (Cheng *et al.* 1991). Although we do not have information on the concentrations that may be found in watercourses following soy-oil based applications, we expect the combination of buffer strips and application at the base of vegetation will minimize the delivery of soy oil to watercourses. We do not expect any toxic effects in salmonids given the high concentrations needed and the effects of turbulence (similar to bubbling air described above) in reducing toxicity.

8. Summary

Our review of the application methods, transport and fate of the various herbicides indicates that the chance of these chemicals entering a fish-bearing watercourse is low. Further, toxicology data indicate that the exposure levels to be expected under forest application would not be sufficient to cause adverse effects to salmonids. However, we note that mixtures of the various compounds may be having greater effects on salmonids and their habitat than that considered for the compounds individually (Lydy *et al.* 2004). For instance, we are concerned with the aerial application of these chemicals and the adjuvants used. Despite the lack of information on the toxicology of these adjuvants, and the uncertainties surrounding mixtures of these compounds, existing information for the surfactant R-11 indicates that aerial application of these substances may cause sublethal effects with consequent mortality of salmonids where streamside buffers are narrow and aerial drift occurs. While we expect that the risk to salmonids is exceedingly low in any given year, when considered over the 50-year term of the ITP, isolated incidences of aerial drift and exposure may occur. Furthermore, given the low concentrations of compound needed to induce a sub-lethal response, the likelihood exists, where aerial applications occur adjacent to fish-bearing streams, that individual salmonids may experience reductions in growth rates or other sub-lethal effects as a result of effects arising from the presence of adjuvants in streams. As previously mentioned, we consider this a low likelihood of occurring given that the application site must be near a watercourse with salmonids present, and we presume that Green Diamond will comply with any R-11 use restrictions that are imposed from future assessments of the impacts of this compound on listed species. Chemical application is under the jurisdiction of several Federal, state, and local agencies and their use is expected to be conducted under applicable laws.

VI. CUMULATIVE EFFECTS

NMFS must consider both the effects of the proposed action and the cumulative effects of other activities in determining whether the action is likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat. Under the ESA, cumulative effects include the effects of future State, tribal, local, or private actions (excluding the effects of the proposed action) that are reasonably certain to occur in the action area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

NMFS believes that listed species, other Pacific salmonids, and critical habitat may be affected by numerous actions by State, tribal, local, or private entities that are reasonably certain to occur in the action area. These actions include, but may not be limited to, those discussed below. Although each of the following actions may reasonably be expected to occur, we lack definitive information on the extent or location of many of these categories of actions, particularly since this is a 50-year assessment. The following discussion provides available information on the expected effects of these activities on Pacific salmonids.

A. Timber Management

Timber management, with associated activities such as harvest, yarding, loading, hauling, site preparation, planting, vegetation management, and thinning, is the dominant human activity in the action area. Future timber harvest levels in the action area cannot be precisely predicted, however, we assume that harvest levels on private lands in Humboldt County in the foreseeable future will be within the approximate range of harvest levels that have occurred since the listing of the northern spotted owl in 1992. Based on data for recent years, the annual harvest level in Humboldt County is expected to be about 500 million board feet (California Board of Equalization 1998). We do not have information on the extent of timber harvest anticipated to occur in Del Norte County.

Implementation of THPs under the FPRs has not consistently provided protection against unauthorized take in relation to Pacific salmonids listed under the ESA by NMFS, such as coho salmon. NMFS has informed the California Board of Forestry (BOF) of its ongoing concern over the lack of specific provisions for Pacific salmonids in the FPRs. Discussions continue on this issue between NMFS, BOF, and the California Resources Agency. Recent revisions to the FPRs address many concerns related to salmonids. However, until these issues are resolved, unauthorized take from direct, indirect, and cumulative effects of listed Pacific salmonids from timber harvest and its associated activities may be occurring and likely will continue to occur. The extent and amount of any unauthorized take is unknown.

Reasonably foreseeable effects of timber management activities may also impact designated critical habitat for SONCC coho salmon, NC steelhead or CC Chinook salmon. An undetermined number of miles of fish-bearing streams are on private land outside of Green Diamond ownership but within the action area. Within the action area, direct, indirect, and cumulative effects of timber harvesting on lands outside of Green Diamond ownership may degrade the habitat features identified as essential for the conservation of coho salmon. These effects are expected to be similar to the effects of the covered activities on Green Diamond's ownership. In the *Integration and Synthesis* section that follows, we discuss the effects of timber harvesting not associated with the proposed Green Diamond HCP on designated critical habitat.

B. Control of Wildland Fires on Non-Federal Lands

Control of wildland fires may include the removal or modification of vegetation due to the construction of firebreaks or setting of backfires to control the spread of fire. An undetermined amount of suitable habitat for Pacific salmonids may be removed or modified by this activity.

C. Industrial Activities, Sawmills, and Associated Activities

Most sawmills located in the action area are expected to remain in operation for the foreseeable future, based on a relatively steady supply of timber, as discussed above. Facilities are expected to operate within applicable laws. Where waste water discharge may affect habitat for listed species, NMFS expects that the ESA and the California Endangered Species Act will be enforced. Further large-scale industrial development is not anticipated, but if such development should occur, we expect that all applicable laws will be applied.

D. Construction, Reconstruction, Maintenance, and Use of Roads

While the level of construction of new roads and reconstruction of old roads on private and state lands cannot be anticipated, we expect construction to continue at a pace similar to the current pace. The increased emphasis on protection of aquatic resources is expected to result in higher standards for road construction, reconstruction, maintenance, and use as compared to historical standards. Improvement of environmental conditions on private and state lands related to roads throughout the action area is expected over the long-term. Noticeable improvements on private and state lands (excluding Green Diamond lands) in the short-term are unlikely due to a projected increase in the number of road miles per square mile of land, the lack of comprehensive road standards, existence of numerous older (“legacy”) roads, and lack of routine inspections and maintenance of existing roads.

E. Gravel Mining, Quarrying, and Processing

NMFS anticipates that river bar gravel mining, and upland quarrying and associated gravel processing, will continue to be conducted by non-Federal parties within the action area. Instream gravel extractions have been permitted through the U.S. Army Corps of Engineers (Corps) and are not considered here. The effects of quarries and rock mines on aquatic resources in the action area depend on the type of mining, the size of the quarry or mine, and distance from waters. Rock mining can cause increased sedimentation, accelerated erosion, increased streambank and streambed instability, and changes to substrate. Surface mining may result in soil compaction and loss of the vegetative cover and humic layer, thereby increasing surface runoff. Mining may also cause the loss of riparian vegetation. Chemicals used in mining can be toxic to aquatic species if transported to waters. Because the effects of quarries and rock mines depend on several variables, the effects of quarries and other commercial rock operations within the action area on Pacific salmonids are unknown. Commercial rock quarrying will continue to be under the regulation of Humboldt and Del Norte Counties.

F. Habitat Restoration Projects

NMFS anticipates that, as monitoring information accumulates on past projects, the focus of stream restoration projects will gradually shift toward more effective restoration actions. Because such activities are usually coordinated with one or more of the resource agencies, we anticipate that all applicable laws will be followed. Restoration activities conducted through CDFG's Fisheries Habitat Restoration Program are covered by a section 7 consultation with the Corps, and are therefore not considered a cumulative effect. Restoration activities that are not conducted pursuant to CDFG's program may cause temporary increases in turbidity, alter channel dynamics and stability, and injure or scare salmonids if equipment is used in the stream. Properly constructed stream restoration projects may increase habitat complexity, stabilize channels and streambanks, increase spawning gravels, decrease sedimentation, and increase shade and cover for salmonids. We do not know how many restoration projects will be completed outside of CDFG's program, therefore, the effects of these projects cannot be predicted. However, we anticipate many of these projects may still require a Corps permit, and, thus, require consultation. These projects often focus on identifying source problems in an area (*i.e.,* roads) and apply corrective measures to eliminate or minimize the adverse effects to aquatic resources.

G. Agricultural Activities

Agricultural activities including grazing, dairy farming, and the cultivation of crops. The recent upward trend in value of dairy-related agricultural products (*e.g.*, milk, cows and calves, pasture, hay, and silage) in Humboldt County, for example, is expected to continue as human populations continue to increase. As a result, the dairy industry in the action area, primarily in the lowlands of the Eel, Mad and Smith River watersheds below Green Diamond ownership, is expected to persist. Impacts on water quality would be expected to be regulated under applicable laws.

The impacts of this use on aquatic species is anticipated to be locally intense, but the longevity of the impact depends on the degree of grazing pressure on riparian vegetation, both from dairy and beef cattle. Grasses, willows, and other woody species can recover quickly once grazing pressure is reduced or eliminated (Platts 1991) through fencing, seasonal rotations, and other measures. Assuming that appropriate measures are not taken to reduce grazing pressure, impacts to aquatic species are expected to increase with the predicted continuation or increase in grazing. Anticipated impacts include decreased bank stability, loss of shade- and cover-providing riparian vegetation, increased sediment inputs, and elevated coliform levels.

H. Residential Development and Operation of Existing Residential Infrastructure

The moderate rate of human population growth in Humboldt County (about 2.8 percent increase from 1995 through 1998) and the three north coastal counties (about 3.3 percent overall increase from 1995 through 1998, California Department of Finance 1997, 1998a, 1998b) is expected to continue. In Humboldt County, most of this growth is expected to occur near the cities of Eureka, Arcata, and McKinleyville. Impacts on water quality related to residential infrastructure would be expected to be regulated under applicable laws.

Once development and associated infrastructure (roads, drainage, *etc*.) are established, the impacts to aquatic species are expected to be permanent. Anticipated impacts to aquatic resources include loss of riparian vegetation, changes to channel morphology and dynamics, altered watershed hydrology (increased storm runoff), increased sediment loading, and elevated water temperatures where shade-providing canopy is removed. The presence of structures and/or roads near waters may lead to the removal of LWD in order to protect those structures from flood impacts. The anticipated impacts to Pacific salmonids from continued residential development are expected to be sustained and locally intense, but given the predicted slow growth rate development within the action area, impacts are not expected to increase substantially over current levels.

I. Recreation, Including Hiking, Camping, Fishing, and Hunting

Expected recreation impacts to salmonids include increased turbidity, impacts to water quality, barriers to movement, and changes to habitat structures. Streambanks, riparian vegetation, and spawning redds can be disturbed wherever human use is concentrated. Campgrounds can impair water quality by elevating coliform bacteria and nutrients in streams. Construction of summer dams to create swimming holes causes turbidity, destroys and degrades habitat, and blocks migration of juveniles between summer habitats. Impacts to salmonid habitat are expected to be localized, mild to moderate, and temporary. Fishing within the action area, typically for steelhead or coastal cutthroat trout, is expected to continue subject to the California Fish and Game Code. The level of take of Pacific salmonids within the action area from angling is unknown, but is expected to remain at current levels.

J. Water Withdrawals

An unknown number of permanent and temporary water withdrawal facilities exist within the action area. These include diversions for urban, agricultural, commercial, and residential use, along with temporary diversions, such as drafting for dust abatement. Due to the anticipated slow urban/residential growth within the action area and the expected increase in agriculture (dairy farming), the number of diversions and amount of water diverted is expected to increase gradually within the action area. Impacts to salmonids are expected to include entrapment and impingement of younger salmonid life stages, localized dewatering of reaches, and depleted flows necessary for migration, spawning, rearing, flushing of sediment from the spawning gravels, gravel recruitment, and transport of LWD. Water diversions are expected to be conducted under applicable laws, including the ESA, California Fish and Game Code, and Clean Water Act.

K. Chemical Use

NMFS anticipates that chemicals such as pesticides, herbicides, fertilizers, and fire retardants will continue to be used within the action area. Chemical application is under the jurisdiction of several federal, state, and local agencies and their use is expected to be conducted under applicable laws. The effects of these chemicals on salmonids are expected to be similar to the effects described in the *Effects of Herbicide Use* section of this Opinion.

VII. INTEGRATION AND SYNTHESIS OF THE PROPOSED ACTION

Our synthesis of the effects of the measures proposed in the HCP summarizes the current status of the species, the environmental baseline, cumulative effects and the anticipated effects of the proposed action on watershed processes, salmonid habitat, species vital rates, and distributions. These effects are then summarized for each ESU/DPS.

As described previously, this section summarizes the effects of the HCP on individual watershed products collectively and analyzes the aggregate effects of the proposed action on habitat and affected salmonids (Questions #3 and #4 of the Assessment Approach in the *Effects of the Action* section) when added to the environmental baseline. This includes an assessment of the duration of effects and disturbance frequency over the life of the ITP and beyond in the case of effects that persist beyond the 50-year ITP period. This step is critical to the effects analysis because, although we discuss the watershed products independently, the full extent of their influences on aquatic habitat cannot be understood until they are considered in tandem with one another. Specifically, we describe the effects in terms of habitat quantity and quality (Question #3), which populations and life stages are exposed to the effects (Question #4), the likely response of individual life history stages (Question #5), changes in viability of populations, and impacts to the viability of the ESU or DPS (Question #6), and finally impacts to the value or function of primary constituent elements of critical habitat (Adverse Modification Analysis).

For the final portions of this analysis, we determine if the expected changes to habitat conditions, when added to the environmental baseline, are sufficient to meet the biological requirements of the species and will allow primary constituent elements of critical habitat to remain functional or become functional. If, for example, the biological requirements of the species are not met and the resulting responses of individual fish could influence measures of population viability, then NMFS must determine whether the effects on the affected populations will increase the species' risk of extinction. On the other hand, if the effects of the action result in conditions that are sufficient to meet the covered species' biological requirements, then they are not likely to adversely influence population viability, obviating the need for further analysis to support a "no jeopardy" determination. It is important to note that even if the biological requirements of the species will be met overall in the short- and long-term by the proposed action, incidental take of covered species may still occur as a result of operations under the HCP where effects of the action result in localized habitat conditions that impair the ability of individual fish to grow, rear, migrate, or spawn. These habitat conditions have been described in the *Effects of the Action* section and the resulting species responses are described below. These responses form the basis for the incidental take that will be authorized by the proposed ITP.

A. Status Summaries

The *Status of the Species* section describes general life history and population trends for each ESU and DPS. The *Environmental Baseline* section provides additional information, where available, on species abundance and trends within individual HPAs. The status of each species is summarized below.

1. SONCC Coho Salmon

Of all the covered species, this ESU appears to be the most susceptible to continued declines in abundance, productivity and spatial structure. Most data across the ESU and within individual HPAs show a steady decline in coho salmon abundance. As recently as 1997, data show that the number of streams where coho salmon are present continues to decrease. Data from the Winchuck River, at the northern end of the action area, indicate that coho salmon were absent from the basin in 2 out of 6 years. Precipitous declines have also been noted in the Mad River and North Fork Mad River. Many of these declines are based upon relatively short data series, and thus conclusions regarding the species' trends remain uncertain.

2. NC Steelhead

Populations of NC steelhead are of concern due to a preponderance of significant negative trends in the available data. Recent data suggest that steelhead abundance continues to decline in the Van Duzen River watershed. Trends in other watersheds are less certain due to unknown hatchery influences and changes in monitoring methods through time in specific areas.

3. KMP Steelhead

KMP steelhead show mixed results in trends. As of 2000, many sub-populations showed modest upturns in abundance. In some cases, populations are still declining. Although the DPS does not appear in danger of extinction, there is continued uncertainty with the overall viability of this ESU.

4. CC Chinook Salmon

Data for CC Chinook salmon are similarly limited and mixed. Strong negative trends in abundance are documented in the Eel River Basin, with mostly upward trends elsewhere.

5. Upper Klamath-Trinity Chinook Salmon

Remaining stocks of Upper Klamath-Trinity Chinook salmon appear to be relatively stable. Several stocks remain of concern and seven stocks are extinct.

6. SONCC Chinook Salmon

SONCC Chinook salmon, as of 1999, the date of the most recent status review for this ESU, show a general increase in abundance. However, the Smith River spring-run Chinook salmon remains a concern for the diversity of the ESU due to declines in abundance.

B. Baseline Summary

Our baseline analysis was organized around the HPAs delineated by Green Diamond. This provided a format for assessing conditions relative to salmonids at appropriate scales. Within this framework, we are able to identify individual sub-basins within particular HPAs that may have heightened significance to salmonids. Similarly, we are able to aggregate effects across larger areas to more readily assess effects of the action to specific ESUs/DPSs. A general theme across all HPAs is widespread habitat degradation due to past land management activities. Given the lack of dams, diversions and extensive urbanization across a large portion of the streams in the action area, habitat degradation due to past land management activities such as timber harvest and road construction appears to be the dominant factor limiting salmonid production in the action area.

More specifically, the baseline documents sedimentation from increased landsliding and a general decrease of instream woody debris under past forest practices due to past removal or previous harvest in areas that are likely to recruit wood to channels. Current forest practices represent an improvement over past forest practices, thus, we assume that baseline conditions are improving at an unknown rate. Current riparian stands in many locations are dominated by hardwoods or conifers too small to provide functional woody debris to adjacent watercourses. Timber harvest and road construction on unstable slopes have increased mass wasting and caused a broad-scale simplification of salmonid habitat. This has resulted in degraded spawning habitat. In many locations, pool frequency is reduced, pool depth is diminished and overall complexity of habitat units is decreased, limiting the amount of juvenile rearing habitat available.

Salmonid populations in the action area have responded similarly to that seen at the ESU- and DPS-level. Although very little long-term data are available for populations in the action area, the existing data suggest long-term declines in abundance, productivity and spatial structure continuing up to the present. Hatchery influences also present an ongoing threat to the diversity of populations in the action area. The changes in habitat described above have reduced juvenile survival rates through decreased fry emergence rates, lack of summer and winter rearing habitat and, in some cases, loss of suitable estuarine habitat.

C. Effects Summary

Our analysis of effects was primarily organized around five watershed products: water, woody debris, chronic sediment (surface erosion), catastrophic sediment (mass wasting) and nutrients. Since these factors control the quality and distribution of freshwater habitat, we assumed that salmonid populations will respond to changes in the inputs of these watershed products. Declines in the quality and distribution of freshwater habitat due to changes in these products, principally woody debris and sediment, appear to be the primary factors in the decline and current status of salmonids in the action area. Since salmonid populations appear to be strongly influenced by freshwater habitat in the action area, our determination of effects is focused on anticipated changes to stream habitat. We consider these habitat modifications below in terms of salmonid spawning, emergence, juvenile rearing and out-migration.

1. Management-Related Peak Flow Increases

While the hydrologic regime is likely different than what historically occurred prior to any management in these watersheds, we think the adverse effects of the proposed activities under the ITP on peak flows are small and not limiting to populations of salmonids in the action area. We expect localized impacts associated with peak flows to occur, such as enlargement of receiving channels and increased sediment delivery. However, channel expansion due to peak flows may have largely occurred during previous timber harvest and any additional widening will likely not be as extensive as that following the first harvests. This will likely not result in nearly the same magnitude of effects as occurred during the first harvests. The current distribution of stand ages across the action area and within individual HPAs, combined with California FPR adjacency requirements, largely precludes concentrated timber harvest over larger areas and, therefore, further reduces the risk that peak flows will have adverse effects in larger fish-bearing channels. Over the life of the ITP, the potential consequences of global climate change and changes in the precipitation regime across the action area make this conclusion less certain. As discussed in the *Status of the Species* section, an increase in critically dry years and more intense storms could result in changes in habitat and the distribution of salmonids. Dry years could restrict the range of salmonids to areas with adequate water quantity and quality, while an increase in the magnitude and frequency of large storms could dramatically alter the morphology of channels. The measures provided in the HCP, such as hydrologically disconnecting roads and the various channel and water quality monitoring and adaptive management processes, would help address some of these changes in the rainfall-runoff regime.

2. Effects on Woody Debris Recruitment and Function

Woody debris supply will gradually increase over the ITP period as riparian stands continue to attain larger sizes. Mass wasting conservation areas will also contribute to this gradual increase in wood abundance, although the selection harvest proposed in SMZs and headwall swales may limit this increase in wood abundance when and if those sites fail. There are some watersheds where woody debris inputs from landslide inputs account for more than 50 percent of the wood recruitment (Table 17). Although the Class I inner band retention standards provide nearly an effective no-cut zone, our analysis shows that woody debris can be delivered from more distal landslide areas that will be subject to either partial harvest or even-aged management. For the SSS measures, we assume that up to 47 percent of the wood could be harvested in the smallest Class II streams (Table 16). SSS source areas adjacent to Class I streams appear relatively more effective at providing wood after harvest (Table 16) where the maximum expected removal of wood would reduce inputs on the order of one-third of pre-harvest levels. On headwall swales we assume that up to 68 percent of trees will be removed in the proposed selection harvest areas. We expect these effects to be greatest in larger channels where larger pieces of wood are necessary to form stable habitat elements such as pools, velocity refugia and well-sorted spawning substrate. These reductions in recruitment will moderate the improvements resulting from application of the HCP. In order to fully understand the effects of reduced wood recruitment, the delivery of sediment to the same streams must also be considered. We consider the combined effects of wood and sediment in the *Anticipated Effects on Habitat* section below.

3. Chronic Sediment Delivery

The roads treatment strategy proposed in the HCP expedites decreases in fine sediment in priority watersheds. We anticipate that full implementation of road-related conservation measures will result in an anticipated increase in the estimated proportion of hydrologically disconnected roads to 93 percent from 67 percent (Simpson 2002, Appendix F2, Table F2-6). While this represents a substantial improvement, some road segments will remain hydrologically connected and will continue to deliver sediment. Timber harvest and site preparation will likely continue to introduce some amount of fine sediment; however, we expect such sediment contributions to decline as a result of the proposed HCP.

In order to more fully understand the overall sediment delivery profile expected under the HCP, we quantify the surface erosion inputs. These estimates are based on the assumption that Green Diamond's proposed measures will reduce surface erosion quantities on the order of 50 percent from current levels. This will be primarily through the roads measures: hydrologically disconnecting road segments, wet weather hauling restrictions, and surfacing of unrocked roads. We then applied this assumption to regional sedimentation estimates summarized in Simpson (2002, Table E-2). In summarizing regional sedimentation studies, Simpson (2002) notes that management-related erosion sources other than mass wasting, primarily road-related erosion, are at least as large, or larger than management-related mass wasting. Simpson's (2002) summary of these regional studies indicates that the management-related, non-mass wasting component accounts for 10-57 percent of the total volume of sediment delivery (Table 24). Total sediment delivery as summarized in Table 24 is composed of three parts: (1) non-management-related sources ("background"); (2) management-related mass wasting that includes landslides from both roads and harvest units; and, (3) management-related non-mass wasting that includes road erosion, road surface erosion and other sources. Management-related erosion attributable to mass wasting may comprise 1-24 percent of the total sediment yield; however, these percentages include erosion attributable to roads as well. This analysis suggests that road-related erosion is a significant portion of the total sediment yield, emphasizing the impact of road erosion on aquatic habitat. Our estimates of items 1 and 2 are presented in Table 22 where we estimate quantities of landslide sediment.

Table 24. Summary results of recent regional erosion source studies in northern California (from Simpson 2002, Table E-2).

Watershed	Background[1] (% of total)	Management Sources		
		Mass Wasting[2] (% of total)	Surface Erosion, Road Erosion, Other Sources[3] (% of total)	Surface ErosionComponent (subset of mgmt sources) (% of total)[5]
Sproul (S.Fk.Eel)	24	19	57	9
Tom Long (S.Fk.Eel)	71	5	24	6
Hollow Tree (S.Fk.Eel)	43	24	33	7
Noyo River	58	13	28	--
Upper S. Fk. Trinity	66	11	23	11
Lower S. Fk. Trinity	68	21	10	5
Hayfork Cr. (S. Fk. Trinity)	49	1	50	--
Freshwater Cr.[4]	40	16	44	8
Mean	**52**	**14**	**34**	**8**
Range of Values	**24-71**	**1-24**	**10-57**	**5-11**

Notes

1 Includes streamside landslides thought to be of natural origin and all deep seated landslides.

2 Includes road and harvest related slides; harvest related slides are typically assumed to be triggered by harvest if they are observed in harvested area, regardless of actual triggering mechanism.

3 Road surface erosion (sheet and rill erosion of road tread and cut slopes) is the dominant surface erosion process assessed; additional road erosion is from gullies and other road-drainage related erosion. Other sources (*e.g.* bank erosion) are relatively small.

4 Pacific Lumber Co. Watershed Analysis (WPN 2001)); all others are TMDL studies by USEPA or NCRWQCB.

5 Based on our assumptions that management will have an influence on mass wasting rates, we excluded Hayfork Creek from the analysis which indicates that management-related mass wasting is negligible. Also excluded were Noyo River and Freshwater Creek because there was not sufficient information presented in the original reports to accurately derive the management-related surface erosion contribution.

We use the management-related landslide volumes resulting from current practices ("pre-plan rate") presented in Table 22 to solve for volumes of surface erosion (a small proportion of the management related, non mass-wasting component). We assume that surface erosion under the proposed ITP will be half of the surface erosion component from Table 24, as described previously. Because these estimates have a wide range, we portray the maximum, minimum and average rates in Table 25. Based on our assumptions that management will have an influence on mass wasting rates, we excluded Hayfork Creek from the analysis, which indicates that management-related mass wasting is negligible. Also excluded were Noyo River and Freshwater Creek because there was not sufficient information presented in the original reports to accurately derive the management-related surface erosion contribution.

Table 25. Estimates of chronic, or surface, erosion under the proposed HCP. The derivation of these estimates is explained in the text. Appendix A also presents results for each of the four HPA groups.

	Surface erosion inputs (cy/yr)		
Pre-plan management-related landslide sediment inputs (cy/yr)[1]	using **low** estimate of surface erosion from Table 24 (10%)	using **high** estimate of surface erosion from Table 24 (57%)	using **average** estimate of surface erosion from Table 24 (31%)[2]
112,465	13,389	67,479	36,028

1 – The background volume was subtracted out of the estimate to provide a measure of management-related volumes only. We note that this volume also includes sediment delivery from "fluvial erosion" such as stream crossing washouts and road-related gullies.
2 – As discussed in the text, we excluded the Hayfork Creek, Freshwater Creek and Noyo River datasets. Thus, this average value differs from the 34% portrayed in Table 24.

4. Catastrophic, or Mass Wasting-Derived Sediment

Our assessment of effects suggests that landslides from both roads and hillslopes will occur at a rate approximately 1.67 times background rates (Table 22). As noted in the *Summary of the Effects of the HCP on Mass Wasting Sediment Delivery* section, these modeled results do not reflect the role that site-specific modification of the HCP default measures will play. Under the HCP, we expect a tendency to simply defer to the default measures. However, the default measures in the proposed HCP may be modified, and although the modification may be either more or less restrictive, we expect that instances of lessening the default measures will occur simply because on-the-ground evidence of potential failure is often difficult to interpret. We expect that the overall outcome of geologic review will be increases in harvest within the limited-harvest areas surrounding the slide. Review of such changes by qualified, professional geologists will help insure protective standards are maintained. If timber harvest increases and those sites fail, this will increase, over time, the quantity of sediment delivered to channels.

Where landslides with limited wood are delivered to watercourses, we expect habitat simplification will likely occur with a consequent impact on salmonid spawning and rearing habitat. During HCP implementation, we expect that a portion of landslides will deliver sediment to streams lacking sufficient woody debris to sort and route additional sediment inputs. Therefore, the impacts of these landslides are expected to persist until the sediment is gradually transported out of the reach and/or adjacent wood is recruited to form functional habitat. Green Diamond proposes three mass wasting assessments as part of the ITP (*i.e.*, SSS delineation, SSS assessment, and a mass wasting assessment). These studies will be completed at 7, 15, and 20 years, respectively, following issuance of the ITP. Given the long response times of mass wasting to timber harvest, due primarily to root decay and the occurrence of triggering storms, and consequent instream effects, we expect that initial modifications to the mass wasting provisions, if needed, will not occur until at least 10 years into the HCP following the preliminary results, and the effects of these changes not realized for several years afterwards. Our analysis indicates that mass wasting is likely to pose the greatest threat to salmonids and their habitat in the Korbel HPA group (Mad River, North Fork Mad River, Coastal Lagoons and

Redwood Creek HPAs), the Humboldt Bay HPA Group (Eel River and Humboldt Bay HPAs), and Class II-1 and II-2 streams in the Smith River HPA (refer to Table 20). The proposed SSS zones will not provide full protection to potentially unstable areas outside the SSS zone. Although the observed slides initiating outside the SSS zone are few in number, sampling data indicate that these slides often are large volume contributors of sediment.

The effects of the roads measures are not likely to be realized for several years into the life of the HCP. During this time, both hillslopes and roads are likely to continue to fail as a result of past practices and baseline conditions, therefore, perpetuating adverse impacts to salmonid habitat in the action area before meaningful sediment reductions occur from the roads measures. Additionally, our analysis indicates significant uncertainties associated with estimating long-term sediment inputs. This uncertainty stems from: (1) reliance on landslide and roads data from a relatively small proportion of the action area, (2) uncertainty in estimating long-term increases in hillslope landslide frequencies due to timber harvesting and associated activities, (3) uncertainty over the extent of road mileages across the action area to determine the extent and type of road-related sediment problems likely to occur, and (4) use of background sediment production rates to assess the effectiveness of the proposed HCP.

The changed circumstances provisions contained in the HCP will address a range of reasonably foreseeable events, including landslides. These provisions will help reduce the risk of adverse impacts on the listed species, and in particular, will help ensure that reasonably foreseeable landslides will be addressed by the applicant during the course of the ITP.

5. Overall Sediment Inputs

To better understand the overall quantities of sediment expected under the HCP, we combine our estimates of fine sediment delivery (Table 25), with estimates of mass wasting (Table 22). We also include a soil creep estimate to account for non-management-related sediment inputs not fully accounted for in the mass wasting estimates. The range of estimates is presented in Table 26.

Using the average rates, implementation of the HCP is expected to generate sediment in quantities that are approximately 1.8 (Table 26) times background rates. Fine sediment inputs will manifest as changes in turbidity, spawning habitat quality and pool volume. In addition to the above impacts, landslide-derived sediment is likely to result in changes in channel morphology and habitat complexity.

Assessing the response of habitat using a simple expression of sediment yield is problematic. Over long periods of time, channels change form in response to changing inputs, which themselves change in response to the timing of large storms and other disturbances such as periodic forest fires. The result, over a large area, is a mosaic of stream conditions providing a range of habitat conditions - each of which may provide an optimal set of conditions for a given species and life history stage (Reeves *et al.* 1995). Simple calculations of sediment production do not reflect this dynamic environment. However, the estimates can be used to infer general conclusions of habitat conditions in response to changes in the sediment delivery regime. For example, in the *Environmental Baseline* section, we presented work by Dietrich *et al.* (1989) suggesting that stream channels progress through a range of geomorphic responses depending on sediment loads. We expect these channel geomorphic responses can be linked to specific habitat responses (Table 12).

Timber management may dampen the range of sediment delivery and consequent habitat conditions across a large area. For example, chronic sedimentation will continue across the entire action area regardless of the occurrence of large storms. Further, increased landslide delivery due to timber harvest on unstable slopes is likely to result in simplified habitat conditions and delay the attainment of certain habitat conditions. We discuss expected habitat conditions in the following section.

Estimates of soil erosion are complicated by the role of global climate change. As was briefly discussed in the *Status of the Species* section, a shift in the precipitation regime could have consequences on the habitat and salmonids in the action area. For example, an increase in the magnitude and frequency of large storm events could lead to increases in the rate of landsliding across the action area – with consequent effects on habitat. We cannot reliably estimate the types of changes that will occur, but any shift in the sedimentation regime presents potentially significant risks to salmonids.

6. Nutrients

We do not expect any significant near-stream vegetation modification through harvesting or rapid shift in stand composition to adversely affect instream nutrient conditions as they pertain to salmonids. We expect that vegetative composition of streamside stands is not likely to appreciably change (aside from attainment of larger trees along streamside zones and greater conifer dominance) when comparing HCP measures to current practices. Consequently, we do not expect any appreciable changes in nutrient levels originating from streamside vegetation. Since streamside stands will remain fully forested, we expect that nutrient inputs from these areas will provide similar inputs that the species have evolved with. Thus we expect that the biological needs of the species will be met with regards to nutrient inputs from streamside vegetation and any changes are not likely to have an appreciable effect on salmonids.

Table 26. Sediment input quantities expected under the proposed HCP. The soil creep estimate used (59 cy/mi^2/yr) is converted from the Freshwater Creek watershed analysis value of 90 tons/mi^2/yr (PALCO 2001).

	Background sediment yields (cy/yr)			Total sediment inputs (cy/yr) expected under the HCP. This is the sum of mass wasting (which includes the background yield), soil creep, and the appropriate surface erosion estimate from Table 25.				Sediment inputs (%) relative to background rates		
Plan area (acres)	Background landslide inputs	Soil Creep	Total background sediment inputs	Mass wasting inputs	Total inputs (using **low** estimate of surface erosion)	Total inputs (using **high** estimate of surface erosion)	Total inputs (using **average** estimate of surface erosion)	using **low** surface erosion estimate	using **high** surface erosion estimate	using **average** surface erosion estimate
412,145	58,038	37,955	96,033	97,029	148,413	202,503	171,052	154	211	178

7. Role of Class III Channels

The importance of Class III watercourses should be considered in the assessment of the effects of the proposed measures. Class III watercourses can represent a large portion of the drainage network. For example, on PALCO lands in the southern portion of the action area, Class III channels were estimated to account for 36 percent of the total stream length (NMFS 1999b). Given the extent of Class III channels, these areas represent a large portion of the hillslope/channel interface. Watershed products delivered from hillslopes adjacent to Class III channels have effects throughout the channel network. Where multiple Class III watercourses deliver these materials to fish-bearing reaches, the effects are compounded. Therefore, these smallest channels are likely to represent significant source areas for downstream adverse effects to salmonids and their habitat.

The effects analysis identified two key areas where Class III channels influence downstream habitat: woody debris and sediment delivery. We are concerned that a portion of the landslide sediment not addressed by the proposed conservation measures may originate from Class III catchments. However, results from Simpson (2002) indicate the landslides are relatively uncommon in all but the steepest channels. However, when combined with the absence of woody debris, we expect: (1) elevated mass wasting rates in these steepest channels, and (2) a more rapid delivery of sediment to downstream reaches due to lack of storage and roughness elements provided by large wood. The extent of Class III watercourses across the action area, particularly the steeper, landslide-prone areas, represents a significant source of both fine and coarse sediment lacking the necessary woody debris to moderate the impacts of catastrophic sediment delivery.

Since Class III watercourses represent a large portion of the drainage network across the eligible plan area and there is little information available that quantifies the amount of sediment delivered by these channels, a monitoring and adaptive management component of the HCP was established to address this uncertainty. Specifically, the Class III Sediment Monitoring program (Simpson 2002, Section 6.3.5.3.2 and Appendix D2.3) will quantify the amount of sediment delivered to Class III channels following timber harvest on adjacent slopes relative to unharvested Class III channels. This monitoring will be done throughout the four experimental watersheds, which were selected to be representative of the range of geologic and physiographic conditions throughout the IPA. Results from a retrospective study (Simpson 2002, Appendix C4) that evaluated 100 Class III channels across the eligible plan area suggest that there were no obvious short-term effects of timber harvest on erosion in and near Class III channels. There were relatively few landslides associated with Class III channels, and those that occurred were associated with steeper side slopes and stream gradients. Both large and small woody debris were dominant features in Class III channels following harvest and were important in the formation of channel bed grade control points. The monitoring and adaptive management components of the HCP will help address uncertainties that arise, and help ensure that additional protective measures will be applied in areas with demonstrable need.

D. Anticipated Effects on Habitat

We note that the action area is recovering from a long legacy of intensive timber harvest that predates current forest practice rules. This continued recovery is vital to salmonids in the action area, where populations are severely depressed or absent in some areas. Our analysis indicates that implementation of the proposed HCP is likely to generate management-related sediment that will likely affect habitat conditions. Overall, we reason that implementing the HCP is likely to allow for a shift in the distribution of habitat conditions towards one of increasing complexity and we discuss this in greater detail below. This will occur due to gradually increasing wood recruitment and a decrease in the long-term sediment delivery rates from current conditions. We expect stream beds are likely to respond with greater topographic variability similar to that described for discrete sediment pulses by Madej (2001).

An approach to understanding the effects of implementing the HCP on habitat from changing sediment input levels was presented in the summary of the *Environmental Baseline* section. We caution that this is a simplistic view of actual processes and this is subject to continuing field studies (Dietrich *et al.* 1989).

An assumption we will make here is that this process works similarly in reverse, and improvements in habitat condition occur sequentially (Figure 6). However, the rate of these improvements is likely very different from the rate at which they were created. In essence, there is likely a considerable lag time for attaining certain habitat functions when sediment supply is decreased because of the gradual transport of stored sediment out of the channel. Exactly how sediment reductions alter the morphology of the stream bed is a subject of ongoing research (Lisle 2004). Given these uncertainties, a decrease in the amount of sediment causes a progression of habitat changes and attaining one state requires having achieved the previous state. For example, we do not expect to see braided streams free of fine sediment. Many of the streams in the Green Diamond ownership are in an aggraded state with embedded substrates. Instances of channel braiding are infrequent. Given the distribution of past impacts across the action area and consequent channel impacts, there is likely a range of habitat conditions centered around the pool filling – channel widening portion of Table 12 owing to the generally aggraded conditions described in the *Environmental Baseline*. Employing the above assumption that habitat changes will likely occur in a progression suggests that the sediment reductions afforded by implementing the HCP will tend to first result in a lessening of the aggraded conditions, with a gradual increase in habitat quality and complexity.

We do not have information to quantify how much of a sediment reduction is required to cause a corresponding shift in habitat conditions. However, there are a few studies that document habitat conditions as a function of sediment yields. The existing studies suggest that stream habitats typically take on characteristics of poor habitat for salmonids when rates significantly exceed background levels. However, determining a single threshold for this is problematic, owing to the numerous and dynamic factors that drive habitat conditions in a given area. For example, Wilson *et al.* (1982) found that where sediment yields are naturally low, larger percentage increases can occur before habitat becomes "out of equilibrium." In their study, they defined an equilibrium stream as one where coarse-textured stream beds are common with rubble and boulder-sized material dominating. In these equilibrium settings, there is limited bar development and channel bed forms consist primarily of nondescript accumulations of gravel and rubble materials that form the riffle and run areas found in such streams. Streams with high natural sediment delivery rates that exceed equilibrium conditions are characterized by finer bed materials, development of bars and other bed forms (Wilson *et al.* 1982). While streams in the action area are likely characterized as out of equilibrium simply due to high natural rates of sedimentation, Wilson *et al.* (1982) suggest that as natural sediment delivery rates increase, watersheds can withstand progressively less sediment increases. The assimilative capacity of the stream to process additional sediment without declines in habitat quality decreases as sediment yield increases. Extrapolating their data to high sediment yield areas, such as the action area, implies that even small quantities of management-related sediment may degrade habitat. However, the authors caution that sediment yields do not, in themselves, provide a means to evaluate changes in channel conditions.

Beamer *et al.* (2000), working in western Washington, considered sediment supply as "functioning" when average mass wasting sediment supply was less than 100 $m^3/km^2/yr$. If the average sediment supply was greater than this and exceeded 150 percent of background rates, sediment supply was considered impaired with degraded habitat resulting. In a companion document (Skagit Watershed Council 1998), they described this degraded habitat as being disturbed to such an extent that it had no significant salmonid production or was not preferred by the majority of life stage combinations considered. However, they noted that this was simply intended to be a coarse screening tool based on cursory observations of stream habitat and mass wasting sediment delivery rates and that further refinement was needed (Beechie 2004). Conversion of the mass wasting sediment delivery rates for the HPA groups in Tables 23-26 to metric equivalents show that sediment delivery rates expected under the proposed HCP range from 40 to 60 $m^3/km^2/yr$. Thus, using the screening tool presented by Beamer *et al.* (2000), habitat conditions under the HCP are not likely to approach a level where "significant salmonid production" is eliminated.

Work in the Freshwater Creek watershed by PALCO (2001) attempted to relate sediment delivery rates as a percentage of background to observed habitat conditions. Background rates were defined as the expected sediment input rates that would likely occur if management had no influence on sediment delivery. In this case, total sediment delivery represents a combination of fine and coarse sediment delivered by numerous processes, including landslides and surface erosion. The primary cause of habitat degradation in Freshwater Creek was fine sediment filling spawning substrates and pools. Poor spawning conditions were noted when sediment yield exceeded approximately 250 percent relative to background levels. Poor spawning conditions were characterized with substrates greater than 40 percent embedded in fine sediment and fine sediment filling the interstitial spaces of the subsurface gravels. The estimates involve considerable variation. For example, good spawning habitat quality was observed in one subbasin where sediment rates were approximately 360 percent relative to background levels. This was likely due to high levels of woody debris and frequent bedrock outcrops that provided roughness elements for sorting, storing and scouring fine sediment. The other three areas where spawning habitat was judged in good condition had sediment delivery rates ranging from 150 percent to 195 percent. Good spawning habitat was characterized by substrates less than 25 percent embedded and dominated by gravel-sized material. Spawning habitat in "fair" condition existed in subbasins where overall sediment delivery rates were 200-250 percent relative to background levels. In subsequent review of the prescriptions that were generated from the Freshwater Creek watershed analysis, Pyles *et al.* (2002) noted that threshold values where probable channel impacts may occur range from 150 percent to 200 percent relative to background levels.

Available studies indicate that considerable variation exists when trying to predict the expected quality of salmonid habitat based upon predicted sediment delivery rates. In general, available information suggests that functioning spawning habitat exists when predicted sediment levels range from 150 to 360 percent. Available data from regional water quality studies suggest that implementation of the proposed HCP will result in estimated sediment inputs ranging from 154 to 211 percent relative to background levels, with an estimate of 178 percent using the average surface erosion estimate.

In summary, predicted sediment levels across the action area suggest that the quantity of ongoing sediment inputs, as a whole, will gradually allow functional habitat conditions to be attained. The majority of sediment inputs attributable to the proposed HCP will occur from the road network, and under the proposed HCP, Green Diamond would identify problem roads, and implement conservation measures that would reduce the hydrological connection of about 93 percent of such roads. RMZ and related measures will also preclude further degradation of riparian areas, further decreasing sediment loading into streams.

Implementing the HCP is expected to promote improvements in habitat conditions from current conditions, which are already assumed to be in a state of recovery from past impacts. A remaining uncertainty in this analysis is the role of global climate change over several decades of implementing the HCP. Ongoing global climate change may alter streamflow and sedimentation regimes across the action area; however, the extent to which this would impact salmonid habitat is uncertain. We highlighted potential changes in the physical processes across the action area, particularly potential changes in the precipitation and sediment regime that could affect habitat conditions across the action area over longer time periods. Considerable uncertainty exists over the evolution of storm patterns in the region in response to climate change (Cayan *et al.* 2006). In a worse-case scenario, increases in the frequency of high intensity rainfall events could trigger additional sediment delivery to streams in the action area and lessen the habitat improvements anticipated over the term of the HCP, or even lead to degradation of habitat if the changes were severe. Conversely, an increase in critically dry years could reduce the distribution of salmonids due to inadequate streamflows or increases in stream temperatures. Despite these uncertainties, improvements in habitat conditions due to HCP measures may provide additional resilience or resistance to adverse change in habitats affected by changing rainfall patterns.

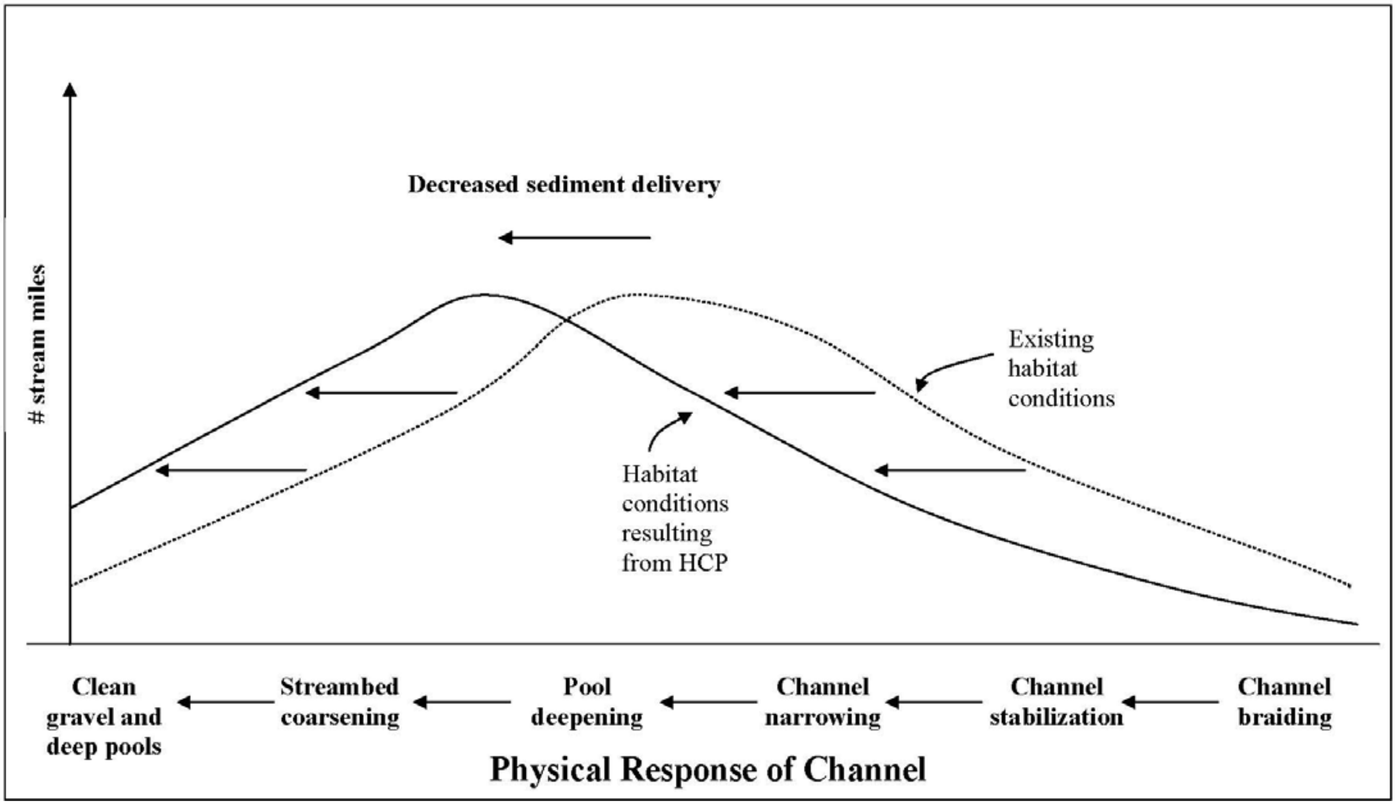

Figure 6. Because the HCP will likely result in less sediment delivery than current practices, we expect an improvement in habitat conditions as they are affected by sediment. Likewise, this physical response is expected to result in an improvement in certain habitat conditions that may be impairing the survival rates of specific life history stages of salmonids under current conditions. For example, we expect implementation of the HCP to result in an overall greater occurrence of deep pools for juvenile coho salmon rearing.

E. Anticipated Effects on Species Life History Phases

Changes in the flux of watershed products and changes in habitat were summarized above. These changes in terms of species-specific responses are discussed below. Harm to individuals of the covered species may still occur as a result of operations under the HCP where effects of the action result in localized habitat conditions that impair the ability of individual fish to grow, rear, migrate, or spawn. We consider the overall effects of the action in the subsequent summary of effects on each covered species.

1. Spawning, and Egg Incubation and Fry Emergence

Many of the principal spawning areas for salmonids are in the lower gradient reaches where multiple sediment inputs and large wood sources accumulate. Fine sediment from surface erosion and landslides is likely to continue impacting spawning habitat in the action area. Where landslides deliver to streams with limited wood, we anticipate short-term, localized channel instability and a lack of suitable spawning habitat leading to reduced spawning and incubation success. The proposed HCP is likely to reduce the amount of fine sediment delivered to channels, due principally to the roads measures and wet weather hauling restrictions. The sediment yield data and preceding discussions suggest that impacts to spawning habitat are probable and will likely occur in localized instances in response to road activities, timber harvest or landslides. In addition, instream use of heavy equipment is anticipated to result in the injury or death, by crushing, of a maximum of 31,250 incubating eggs and 250 emergent fry per year.

Overall, though, we expect that conditions will gradually trend towards meeting the biological requirements of the species as indicated by the sediment yield data. The frequency and distribution of higher quality spawning habitat will increase over the term of the HCP. Given these improvements in conditions, we expect increased spawner and egg incubation success resulting from the shift in the distribution of habitat conditions as suggested in Figure 6. Based on the anticipated pattern of road work on Green Diamond's ownership, NMFS believes the effect of direct mortality from instream equipment use on eggs and emergent fry is likely to be distributed across the approximately 400,000 acres of covered lands. Hence, this injury and mortality is not expected to be concentrated on any one population. This level of effect is equivalent to one to two adults not returning to any given HPA and is not anticipated to result in an appreciable reduction in abundance at the population level.

2. <u>Juvenile Rearing</u>

Rearing habitat is located in the larger tributaries, where the effects of sediment delivery and wood recruitment accumulate. Much of this habitat, particularly for species such as coho salmon which utilize pools for much of their rearing, occurs in lower gradient alluvial reaches, where the sensitivity to wood and sediment inputs is greatest. Past activities in the action area have resulted in simplified habitat conditions in these reaches, limiting the production of juveniles. Rearing habitat, due principally to excess sediment and lack of woody debris, is cited as one of the principal limiting factors in many of the 11 HPAs (Simpson 2002). In many areas, available habitat for rearing is currently limited both during summer months (lack of adequate pool depths for shelter) and winter months (lack of adequate roughness features for high flow refuge). The HCP will continue to delivery sediment to streams in the action area that may have localized effects on the quantity and quality of rearing habitat. For example, management-induced landslides from within the SSS zone will increase sediment loads downstream of the slide, filling pools and potentially reducing the extent of available rearing habitat. Given the reductions in sediment delivery and gradually increasing woody debris recruitment, an increase in pool quantity and complexity is likely to result from implementation of the HCP. This response will allow for an overall increase in juvenile abundance and distribution over the long term as suggested in Figure 6.

3. <u>Smolt Migration and Survival</u>

Implementation of the proposed HCP and associated land management actions is likely to continue to contribute fine sediment to streams. Resulting turbidity will likely reduce growth rates of exposed smolts, which has consequences for their survival and ultimate return as adults. However, the HCP will promote long-term increases in overall smolt survival over current conditions, primarily due to road measures that lead to reductions in turbidity levels.

F. Summary of Effects for Each Species and Designated Critical Habitat

Overall, our analysis suggests that implementation of the proposed HCP will lead to improvements in habitat condition, or a reduction in existing impairments. Despite some local impacts from individual road segments and landslides, the expected channel response is likely to be one of narrowing and deepening due to gradually increased wood recruitment and decreases in long-term sediment delivery rates.

1. SONCC Coho Salmon

SONCC coho salmon are particularly sensitive to further or ongoing degradation of their habitat. Several watersheds have extremely low juvenile abundance and even missing age classes. Fine sediment delivery from Green Diamond's activities will continue to impair the emergence success of coho salmon fry, but at a lesser rate than currently experienced. The *Environmental Baseline* section indicates that rearing habitat is the dominant factor limiting the size of coho salmon populations in the action area, due to limited quantity and quality of pools. Given the expected response of habitat to HCP implementation, most notably increased pool quantity and quality, we expect implementation of the action to allow for increases in juvenile abundance. Because the HCP will result in a lessening of a key limiting factor, we expect that populations of SONCC coho salmon in the action area will experience increases in abundance, productivity and distribution commensurate with the expected improvements in habitat and increased availability of formerly inaccessible or unsuitable habitat. We expect implementation of the HCP will have little influence on the diversity of coho salmon populations since a principal cause of lost diversity is hatcheries. The increases in abundance, productivity and distribution are expected to slow the decline of these populations; although these populations are also influenced by numerous factors not related to Green Diamond's activities. Thus, we expect that implementation of the HCP will not appreciably reduce the likelihood of the species' survival and recovery.

2. SONCC Coho Salmon Designated Critical Habitat

Our analysis of effects has largely focused on anticipated effects to habitat. Therefore, given the above discussion on impacts to coho salmon as a result of modifications in habitat, we have determined that the proposed action is likely to reduce sediment inputs over current conditions and promote improvements in habitat condition. While HCP implementation is likely to affect coho salmon critical habitat through continued delivery of sediment and reduced woody debris recruitment, the habitat response as a result of HCP implementation will allow critical habitat to remain functional or retain its current ability for primary constituent elements to be functionally established and serve its intended conservation role for the species.

3. NC Steelhead

Similar to SONCC coho salmon described above, the action area encompasses several key river basins containing NC steelhead populations. Continued declines in abundance in the Van Duzen River and the recognition that past habitat degradation has contributed to steelhead declines suggest that the proposed HCP can have a direct influence on populations. Unfortunately, steelhead data from the smaller coastal tributaries are largely absent. Reductions in sediment from several sources accompanied by an increase in woody debris are likely to promote increased emergence success and improved rearing conditions across these key river basins. Similar to SONCC coho salmon, sediment delivery expected under the HCP will continue to impair emergence success, but at a lower level than currently experienced under baseline conditions. As a result of HCP implementation, emergence rates are expected to increase and likely lead to increases in abundance, productivity and spatial structure of populations in the affected watersheds as habitat conditions and access improve. We expect the HCP will have little influence on the diversity of exposed populations of NC steelhead, since a dominant cause of reduced diversity is hatchery impacts. Given that the affected populations occur in several river basins important to the continued survival of the species, these effects are likely to be felt at the DPS-level as well. Consequently, the likelihood of survival and recovery of NC steelhead for the DPS, as a whole, is likely to increase.

4. NC Steelhead Designated Critical Habitat

As described for SONCC coho salmon, our analysis of effects has largely focused on anticipated effects to habitat. We reason that habitat conditions under the proposed HCP will likely improve. While HCP implementation may affect the emergence of steelhead fry and juvenile rearing capacity, the improved conditions afforded by the proposed HCP will allow critical habitat to remain functional or retain its current ability for primary constituent elements to be functionally established and serve its intended conservation role for the species.

5. KMP Steelhead

Populations within this DPS appear to be relatively more stable than NC steelhead. Presumably, this is due to the large portion of Federal lands with very little timber harvesting contained in the DPS. However, data for smaller coastal watersheds in the California portion of this DPS, where private ownership is greatest, are largely absent. We expect the proposed HCP will improve habitat conditions in the action area due to improvements in channel morphology that deepen pools and coarsen the substrate. Similar to SONCC coho salmon, sediment delivery expected under the HCP will continue to impair emergence success, but at a lower level than currently experienced. These increased emergence rates are likely to lead to increases in abundance, population productivity and spatal structure of populations in the affected watersheds as habitat conditions and access are improved. As a result, the improved conditions afforded by the proposed HCP will not likely appreciably reduce the likelihood of the species to survive and recover.

6. CC Chinook Salmon

The action area encompasses a number of key river basins that are important to the continued survival of the CC Chinook salmon ESU. These include Redwood Creek, Little River, Mad River, Eel River and Van Duzen River. Since the HCP is likely to lessen the stressors that are currently contributing to the species' decline, particularly spawning habitat quality, we expect an increase in abundance and productivity of the affected populations. Thus, the likelihood of survival and recovery of the species is not likely to decrease as a result of the HCP. Given that the HCP affects several populations in river basins important for the conservation of the species, we expect these improvements in reproductive success will improve ESU viability as well.

7. CC Chinook Salmon Designated Critical Habitat

Given the above discussion on impacts to spawning habitat, we have determined that the HCP is likely to deliver sediment at lower levels that allow for an improvement in current conditions. Overall, the HCP will promote gradual improvements in habitat quality across the action area. While HCP implementation may affect Chinook salmon spawning and rearing habitat, the improved conditions afforded by the proposed action will allow critical habitat to remain functional or retain its current ability for primary constituent elements to be functionally established and serve its intended conservation role for the species.

8. Upper Klamath-Trinity Chinook Salmon

The primary effect of the HCP on upper Klamath-Trinity Chinook salmon is water quality originating from tributaries to the mainstem Klamath River. Our effects analysis determined that increases in temperature are not likely and continued growth of previously harvested riparian stands may lead to decreases in temperature over time. Since much of the spawning habitat for this ESU occurs upstream of the action area and juveniles migrate quickly downstream through the action area (utilizing cool water refugia), the HCP appears to have little effect on individuals of this species and is not likely to appreciably reduce the likelihood of survival and recovery of Chinook salmon in this ESU.

9. SONCC Chinook Salmon

We do not expect an appreciable reduction in the likelihood of survival and recovery of SONCC Chinook salmon due primarily to recent observed increases in population abundance and the limited management occurring on Federally-managed lands that overlap with the action area in this ESU. Since a large portion of the Smith River watershed is in Federal ownership and subject to the more protective Northwest Forest Plan management guidelines, we expect adverse impacts from impairment of spawning habitat quality are likely to be more localized, at a lower level than currently experienced, and, to a large degree, buffered by the conservation measures provided for in the Northwest Forest Plan. Given this, we do not expect that the HCP will appreciably reduce the likelihood of survival and recovery of the species.

VIII. CONCLUSIONS

After reviewing the current status of SONCC coho salmon, CC Chinook salmon, NC steelhead, designated critical habitat for these three species, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that implementation of the proposed HCP is not likely to jeopardize the continued existence of threatened SONCC coho salmon, CC Chinook salmon and NC steelhead, and is not likely to destroy or adversely modify designated SONCC coho salmon, CC Chinook salmon and NC steelhead critical habitat.

After reviewing the current status of KMP steelhead, Upper Klamath-Trinity Chinook salmon, SONCC Chinook salmon, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that implementation of the proposed HCP is not likely to jeopardize the continued existence of KMP steelhead, Upper Klamath-Trinity Chinook salmon and SONCC Chinook salmon.

IX. INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the ESA prohibits the take of endangered species without a specific permit or exemption. Protective regulations adopted pursuant to section 4(d) extend this prohibition to threatened species. Take is defined as to harass, harm, pursue, hunt, wound, kill, capture or collect, or to attempt to engage in any such conduct [ESA section 3(18)]. Harm is further defined by NMFS as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering (50 CFR § 222.102). Incidental take refers to takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR § 402.02). Section 7(o)(2) exempts any taking from the take prohibition that meets the terms and conditions of a written incidental take statement.

Section 7(b)(4)(i) of the ESA provides that an incidental take statement must specify the impact of such incidental taking on the species [16 U.S.C. § 1536(b)(4)(A)(i)]. The joint consultation regulations further provide that the incidental take statement must specify the impact, *i.e.*, the amount or extent of incidental taking that would occur under the Federal action [50 CFR § 402.14(i)(1)(i)]. In order to monitor the impacts of the incidental take, the applicant must report to NMFS on the progress of the action and its impacts on covered species, as specified in the Incidental Take Permit (ITP) [50 CFR § 402.14(i)(3)]. If during the course of the action, the impact on the species contemplated in the biological opinion is exceeded, reinitiation of consultation must occur [50 CFR § 402.14(i)(4) and 50 CFR § 402.16]. In addition, reinitiation of consultation must occur where NMFS retains discretionary involvement or control and new information reveals effects of the action that may affect listed species or their critical habitat in a manner not considered in the biological opinion [50 CFR § 402.16(b)].

Under section 10(a)(1)(B) of the ESA, habitat conservation plans are developed and incidental take permits are approved under criteria similar to those addressed by an incidental take statement following consultation under ESA section 7. A habitat conservation plan must, among other things, specify the impact of the take on covered species and minimize and mitigate the impacts of such take so that, ultimately, such taking will not appreciably reduce the likelihood of survival and recovery of the species in the wild [16 USC §§ 1539(a)(2)(A) and (a)(2)(B)]. The proposed AHCP/CCAA and its associated documents clearly identify the anticipated impacts to affected species likely to result from incidental taking and the measures that are necessary and appropriate to minimize and mitigate those impacts. The proposed action, issuing the ITP, does not cause incidental take, nor does it permit the underlying activities that cause the incidental take. The ITP only authorizes the incidental take that occurs as a result of conducting the otherwise lawful covered activities that are described in the ITP and conducted according to the conditions required by the ITP.

A. Amount or Extent of Anticipated Take

The amount or extent of take of covered species may be expressed as a number of individual animals that are anticipated to be incidentally taken, or as habitat surrogates for the extent of anticipated take. In this instance, NMFS expresses anticipated take as a combination of both individuals and habitat surrogates, depending on the covered activity. NMFS expresses anticipated take as numbers of individuals in the case of the "Special Project," in which a specific number of individuals are captured, harmed, injured, or killed. As part of the "Special Project," Green Diamond will take a maximum of 15 adult coho salmon per year (*I.e.*, capture, harm, or injure), over a contiguous 10-year period, by capturing and transporting the fish upstream of a known migration barrier and allowing them to spawn, unassisted, in habitat previously unutilized by coho salmon. One of three potential sites will be chosen for this project, all of which are located in the Mad River drainage. The three potential sites include: (1) the upper portion of the North Fork Mad River; (2) Simpson Creek, tributary to the mainstem of the Mad River; and (3) Sullivan Gulch, tributary to the North Fork Mad River. Our analysis of effects indicates that a maximum of one adult coho salmon per year would perish as a result of stress accrued during the capture, handling, and transport of these coho salmon as part of the "Special Project."

Use of equipment instream during road construction, decomissioning, upgrading, and maintenance activities may also cause injury or death to salmonid eggs or fry by crushing. Green Diamond conducts such instream activities at an average of nine locations per year, with a recent peak of 20 locations in 1 year. NMFS anticipates a maximum of 31,250 eggs and 250 emergent fry will be injured or killed as a result of use of equipment instream. This estimate of anticipated take is based on Green Diamond's use of equipment use instream at a maximum of 25 locations per year.

NMFS cannot express anticipated take as numbers of individuals for the remaining covered activities, and therefore, relies on multiple habitat surrogates as indications of harm. The natural variability in salmonid population parameters (*e.g.*, abundance, productivity, *etc.*) make it impractical to attribute or determine the numbers of individuals taken arising from the remaining covered activities given their scale, both temporally and spatially, and the indirect and cumulative nature of their effects on salmonids. For example, (1) it can be difficult to separate the impact on the species arising from human-induced habitat modification from the impact on the species arising from naturally-occurring, and often stochastic, watershed processes that form a wide distribution of habitat conditions; (2) salmonids possess complex life histories, with multiple life stages that rely on a broad range of habitat conditions, both spatially and temporally; (3) salmonids exhibit high natural mortality rates in the wild, and it is exceedingly difficult to first detect distinct instances of mortality, and then attribute mortality to specific actions affecting habitat conditions; and (4) habitat conditions vary over time and space due to natural and human-induced factors, and it is difficult to predict where and when salmonids may experience such habitat conditions and whether those conditions will lead to take. In view of these complexities, NMFS relies on habitat surrogates to define the amount of anticipated take by describing the extent of expected modification to habitat that results in injury or mortality of salmonids.

Take in the form of harm will result from reduced function of watershed processes that create and maintain habitat, which meet the ecological needs of the covered species. Harm will accrue from the environmental effects of timber harvest and road construction and maintenance activities in the action area as described in the Biological Opinion. Specifically, habitat modifications that may cause take will occur in the form of: (1) increased sediment inputs into watercourses, which degrade spawning habitat, rearing habitat, or impair migration; (2) reductions in the sources of LWD recruitment, which result in decreases in in-stream LWD loading; and (3) increased water temperatures, when such increases or reductions are lethal or significantly impair essential behavioral patterns.

The conservation measures in the AHCP/CCAA target specific habitat processes that are represented by habitat-based surrogates. In this case, the primary surrogates for the incidental take of the species are water quality, spawning substrate, and habitat complexity, each of which are measured in several ways, including stream temperature, sediment loading, pool depth, and LWD. The key sets of measures in the Operating Conservation Program that address these surrogates include Riparian Management (6.2.1), Slope Stability (6.2.2.), Road Management (6.2.3), and Ground Disturbance (6.2.4). The Operating Conservation Program uses compliance monitoring to ensure proper implementation of these prescriptive measures (6.2.7). The Operating Conservation Program uses effectiveness monitoring to evaluate whether those measures are producing the expected protection or improvement in the habitat conditions beneficial to covered species. The effectiveness monitoring is built on multiple quantitative measures to evaluate habitat conditions and responses (6.2.5). Table 27 identifies specific monitoring programs used to evaluate the impacts of the AHCP/CCAA on habitat over the course of its implementation.

NMFS will regularly review monitoring data, collected as a requirement of AHCP/CCAA section 6.2.5, taking into account the habitat surrogate indicators of habitat impairment described in the fifth column of table 27. Although NMFS will consider the response data of individual habitat surrogates as potentially indicative of the effectiveness of the AHCP/CCAA, NMFS will also consider available data from all habitat surrogates before making judgments as the effectiveness of the AHCP/CCAA. In the event habitat surrogates indicate that the AHCP/CCAA (including full implementation of the Adaptive Management Program) is not protecting or improving habitat conditions, as originally anticipated in this Biological Opinion, and AHCP/CCAA implementation is causing the degradation of habitat conditions not previously considered, NMFS will reinitiate consultation as appropriate under 50 CFR part 402.16(b). The amount and extent of take will be exceeded and reinitiation of consultation will also be triggered under 50 CFR part 402.16(a) if the provisions of AHCP/CCAA sections 6.2.1 through 6.2.7, which limit the amount of habitat modification, including the adaptive management and monitoring programs, are not implemented in the manner described in the AHCP/CCAA.

Table 27 lists the various monitoring programs that will occur under the AHCP/CCAA and the relevant watershed processes and habitat elements these monitoring programs will evaluate through the use of habitat-based surrogates. NMFS believes these habitat surrogates to be appropriate metrics for quantifying take because they are most directly influenced by the alteration of watershed processes, which in turn determine salmonid habitat conditions. This close connection means the metrics are intrinsically more responsive and that it will be easier to distinguish between natural variability in watershed conditions and impacts arising from the proposed action. These same metrics were also used as the basis for development of the HCP's minimization and mitigation requirements, the focus of the HCP's adaptive management components, and are the metrics being monitored in the HCP's required monitoring program.

Table 27. Monitoring programs contained in the AHCP/CCAA that will evaluate the impacts of the proposed action through the use of habitat-based surrogates. These monitoring programs are described in the HCP in section 6.2.5 and are explained further in section 6.3.5.

Monitoring Measures	HCP references	Watershed Processes	Habitat Elements	Surrogate Indicators of Habitat Impairment
Property-wide Temperature Monitoring	6.2.5.1.1 6.3.5.2.1 Appendix D.1.2	Stream Temperature	Temperature	Broadly distributed[1] increases in the 7DMAVG water temperature in Class I or II watercourses[2] following timber harvest, which are not attributable to annual climatic variation.
Class II BACI Water Temperature Monitoring	6.2.5.5.2 6.3.5.2.2 Appendix C5	Stream Temperature	Temperature	Broadly distributed[1] increases in the 7DMAVG water temperature in Class II watercourses[2] following timber harvest, which are not attributable to annual climatic variation.
Spawning Substrate Permeability Monitoring	6.2.5.1.3 6.3.5.2.3 Appendix D.1.5	Sediment	Spawning Substrate	Broadly distributed[1] decreases in permeability values beyond red light thresholds.
Road-related Sediment Delivery (Turbidity) Monitoring	6.2.5.1.4 6.3.5.2.4 Appendix D.1.5	Sediment	Turbidity	Broadly distributed[1] visible increases in road-related turbidity, following road treatments, allowing for short-term increases immediately following treatments.
Class I Channel Monitoring	6.2.5.2.1 6.3.5.3.1 Appendix D.2.2	Sediment Woody debris	Pool Depths Habitat Complexity	Broadly distributed[1] decreases in pool depths and habitat complexity, as informed by longitudinal profiles.
Class III Sediment Monitoring	6.2.5.2.2 6.3.5.3.2 Appendix D.2.2	Sediment	Pool Depths Habitat Complexity Spawning	Broadly distributed[1] increases in anthropogenic sediment delivery.
Road-related Mass Wasting Monitoring	6.2.5.3.1 6.3.5.4.1 Appendix D.3.2	Sediment	Pool Depths Habitat Complexity Spawning	Broadly distributed[1] increases in sediment delivery rates from upgraded and decommissioned roads relative to sediment delivery rates associated with non-treated roads.
Steep Streamside Slope Assessment	6.2.5.3.3 6.3.5.4.3 Appendix D.3.4	Sediment Woody debris	Pool Depths Habitat Complexity Spawning	Broadly distributed[1] increases in landslide rates from within SSS zones resulting in more than a 30 percent increase in landslide delivery volume compared to merchantable-sized uncut SSS areas

Monitoring Measures	**HCP references**	**Watershed Processes**	**Habitat Elements**	**Surrogate Indicators of Habitat Impairment**
Mass Wasting Assessment	6.2.5.3.4 6.3.5.4.4 Appendix D.3.5	Sediment Woody Debris	Pool Depths Habitat Complexity Spawning	Broadly distributed[1] increases in mass wasting rates resulting from timber harvest where such rates are higher than those contemplated in the Biological Opinion (Tables xx and xx).
Long-term Habitat Assessment	6.2.5.3.6 6.3.5.4.5 Appendix D.3.6	Sediment Woody Debris	Pool Depths Habitat Complexity Spawning	Broadly distributed[1] degradation of habitat conditions (as evidenced by decreased pool depths, fine sediment dominated substrate composition, and reductions in overall habitat complexity).
LWD Monitoring	6.2.5.3.6 6.3.5.4.6 Appendix D.3.7	Woody Debris	Pool Depths Habitat Complexity Spawning	Broadly distributed[1] decreases in LWD abundance, which cannot be attributed to shorter-term climatic, hydrologic, or other natural causes.
[1] Broadly distributed is defined as occurring in two or more locations within each of two or more Hydrographic Planning Areas and attributable to the impacts of arising from implementation of the Green Diamond AHCP/CCAA. [2] Increases in 7DMAVG beyond Red Light temperature thresholds (defined in AHCP/CCAA 6.2.5 and 6.2.6) and compared to pre-harvest conditions in 4th order or smaller Class I and II watercourses with drainage areas less than 10,000 acres.				

B. Reasonable and Prudent Measures

The applicant shall minimize the extent of incidental take by implementing the following Term and Condition.

1. Term and Condition

All conservation measures described in the final AHCP/CCAA section 6.2, the Operating Conservation Plan (Green Diamond 2006), together with the associated Implementation Agreement and the section 10(a)(1)(B) ITP issued with respect to the HCP, are hereby incorporated by reference as terms and conditions within this Incidental Take Statement. Such terms and conditions are nondiscretionary and must be undertaken for the exemptions under section 10(a)(1)(B) and section 7(o)(2) of the ESA to apply. If the permittee fails to adhere to these terms and conditions, the protective coverage of the section 10(a)(1)(B) permit and section 7(o)(2) may lapse. The associated reporting requirements and provisions for disposition of dead or injured animals are as described in the HCP and its accompanying section 10(a)(1)(B) ITP.

X. CONSERVATION RECOMMENDATION

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. Conservation recommendations are discretionary measures suggested to minimize or avoid adverse effects of a proposed action on listed species, to minimize or avoid adverse modification of critical habitat, to help implement recovery plans, or to develop additional information. NMFS has not identified any conservation recommendations.

XI. REINITIATION NOTICE

This concludes formal consultation and conference on the actions outlined in the proposed action. As provided in 50 CFR Part 402.16, reinitiation of formal consultation is required where discretionary Federal involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in this opinion, (3) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

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APPENDIX A.

Sediment delivery data are presented for the four HPA Groups described in the HCP. Although portraying the data at this finer scale involves considerable uncertainties, this analysis was conducted to assess whether there were any large differences among these four broad hydrologic groupings that may have been overlooked in the overall analysis.

Table 1. Expected delivery rates of mass-wasting derived sediment for the **Smith River HPA group** at the beginning (pre-plan) and end of the HCP period. Values are adjusted from Appendix F3 of Simpson (2002) based on assumptions used and described in the text and footnotes.

	Roads (cy/yr)	RMZ	SSS	Headwall Swale	Deep-seated landslides	Not protected	Total
"background" rate	0	2,008	14	335	3,684	1,460	7,501
pre-plan rate	8,021	2,632	27	839	3,903	2,919	18,341
post-plan rate	1,815	2,010	18	538	3,866	2,919	11,166
pre-plan yield (%)							245
Post-plan yield (%)							**149**

Table 2. Expected delivery rates of mass-wasting derived sediment for the **Klamath HPA group** at the beginning (pre-plan) and end of the HCP period. Values are adjusted from Appendix F3 of Simpson (2002) based on assumptions used and described in the text and footnotes.

	Roads (cy/yr)	RMZ	SSS	Headwall Swale	Deep-seated landslides	Not protected	Total
"background" rate	0	1,987	2,414	3,357	2,733	5,071	15,562
pre-plan rate	20,145	2,494	4,819	8,391	2,856	10,149	48,854
post-plan rate	4,560	2,003	3,409	5,373	2,836	10,149	28,330
pre-plan yield (%)							314
Post-plan yield (%)							**182**

Table 3. Expected delivery rates of mass-wasting derived sediment for the **Korbel HPA group** at the beginning (pre-plan) and end of the HCP period. Values are adjusted from Appendix F3 of Simpson (2002) based on assumptions used and described in the text and footnotes.

	Roads (cy/yr)	**RMZ**	**SSS**	**Headwall Swale**	**Deep-seated landslides**	**Not protected**	**Total**
"background" rate	0	5,405	1,736	2,851	16,266	6,079	32,337
pre-plan rate	45,203	6,979	3,462	7,128	17,540	12,163	92,475
post-plan rate	10,231	5,427	2,449	4,566	17,347	12,163	52,183
pre-plan yield (%)							286
Post-plan yield (%)							**161**

Table 4. Expected delivery rates of mass-wasting derived sediment for the **Humboldt Bay HPA group** at the beginning (pre-plan) and end of the HCP period. Values are adjusted from Appendix F3 of Simpson (2002) based on assumptions used and described in the text and footnotes.

	Roads (cy/yr)	**RMZ**	**SSS**	**Headwall Swale**	**Deep-seated landslides**	**Not protected**	**Total**
"background" rate	0	1,958	3	345	2,274	1,475	6,055
pre-plan rate	6,073	2,570	6	863	2,409	2,950	14,871
post-plan rate	1,374	1,958	3	554	2,386	2,950	9,225
pre-plan yield (%)							246
Post-plan yield (%)							**152**

Table 5. Estimates of chronic, or surface, erosion under the proposed HCP for each of the four HPA groups. The derivation of these estimates is explained in the *Integration and Synthesis* section of the Biological Opinion.

		Chronic sediment inputs (cy/yr)		
HPA Group	Pre-HCP management-related landslide sediment inputs (cy/yr)[1]	using low estimate of surface erosion from Table 25 in B.O. (10%)	using high estimate of surface erosion from Table 25 in B.O. (57%)	using average estimate of surface erosion from Table 25 in B.O. (31%)[2]
Smith River	10,840	1,290	6,504	3,473
Coastal Klamath	33,294	3,964	19,976	10,666
Korbel	60,136	7,159	36,082	19,264
Humboldt Bay	8,817	1,050	5,290	2,824
Plan Area	112,465	13,389	67,479	36,028

1 – The background volume was subtracted out of the estimate to provide a measure of management-related volumes only. We note that this volume also includes sediment delivery from “fluvial erosion” such as stream crossing washouts and road-related gullies.
2 – As discussed in the text, we excluded the Hayfork Creek dataset which suggests that management-related mass wasting is only 1 percent of the observed inputs. Thus, this average value differs from the 34% portrayed in Table 24 of the Biological Opinion. And also excluded Noyo and Freshwater Creeks.

Table 6. Sediment input quantities expected under the proposed HCP. The soil creep estimate used (59 cy/mi^2/yr) is converted from the Freshwater Creek watershed analysis value of 90 tons/mi^2/yr (PALCO 2001).

		Background sediment yields (cy/yr)			Total sediment inputs (cy/yr) expected under the HCP. This is the sum of mass wasting (which includes the background yield), soil creep, and the appropriate surface erosion estimate from Table 25 of the B.O.				Sediment inputs relative to background rates		
HPA Group	Plan area (acres)	Background landslide inputs	Soil Creep[1]	Total background sediment inputs	Mass wasting inputs	Total inputs (using **low** estimate of surface erosion)	Total inputs (using **high** estimate of surface erosion)	Total inputs (using **average** estimate of surface erosion)	using **low** surface erosion estimate	using **high** surface erosion estimate	using **average** surface erosion estimate
Smith River	41,163	7,501	3,795	11,296	11,168	16,253	21,467	18,436	144	190	163
Coastal Klamath	102,471	15,561	9,447	25,008	28,330	41,741	57,753	48,443	167	231	194
Korbel	243,106	32,338	22,411	54,749	52,182	81,752	110,675	93,857	149	202	171
Humboldt Bay	25,405	6,054	2,342	8,396	9,226	12,618	16,858	14,392	150	201	171
Overall plan area	412,145	58,038	37,955	96,033	97,029	148,413	202,503	171,052	154	211	178