NORTHWEST FISHERIES SCIENCE CENTER (NWFSC)
75TH ANNIVERSARY CENTER-WIDE SYMPOSIUM
"LOOKING TO THE PAST TO ENVISION THE FUTURE"

Celebrating 75 years NWFSC of Innovative Science
December 12 & 13, 2006
Museum of History and Industry (MOHAI)
Seattle, WA

ORAL PRESENTATION ABSTRACTS

Krista Bartz[1], Mark Scheuerell[2], James Battin[1], Mary Ruckelshaus[1], Ray Hilborn[3], Matthew Wiley[4], Richard Palmer[4], Elizabeth Korb[4], Hiroo Imaki[1], Kerry Lagueux[1], Andrew Haas[5], Tim Beechie[6], and Kit Rawson[7]. [1]*NOAA Fisheries, Conservation Biology Division, Northwest Fisheries Science Center, Seattle, WA 98112* (krista.bartz@noaa.gov)*;* [2]*NOAA Fisheries, Fish Ecology Division, Northwest Fisheries Science Center, Seattle, WA 98112;* [3]*School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA 98195;* [4]*Department of Civil and Environmental Engineering, University of Washington, Seattle, WA 98195;* [5]*Surface Water Management Division, Snohomish County, Everett, WA 98201;* [6]*NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112;* [7]*Tulalip Tribe, Tulalip, WA 98271*. **Linking models: a framework for evaluating salmon recovery strategies in a Puget Sound watershed.** One of the most significant challenges associated with recovering imperiled species is identifying the set of actions needed to ensure species' persistence. Here we outline a spatially and temporally explicit framework for translating proposed restoration actions into projected improvements in four population parameters: abundance, productivity, spatial structure, and life history diversity. We applied this framework iteratively to a threatened population of Chinook salmon (*Oncorhynchus tshawytscha*) in the Snohomish River basin of Puget Sound. For the first iteration, we used statistical models to relate restoration actions to salmon productivity and capacity, which served as inputs to a multi-stage Beverton-Holt model along with hatchery and harvest variables. For the second iteration, we incorporated potential effects of climate change by replacing some of the statistical models with mechanistic climate and hydrology models. Results from this second iteration suggest that climate change will lead to increased peak stream flows during winter, decreased base stream flows during summer, and increased water temperatures throughout the year, particularly in high-elevation subbasins. These impacts to stream flows and temperatures are likely to be detrimental to salmon survival and reproduction. Model projections suggest that climate change may cause Chinook population declines of 20% to 40%. Planned restoration actions are predicted to lessen these declines, but meeting population recovery targets is likely to be more difficult when climate change is taken into account.

Brian Beckman[1], Cheryl Morgan[2], Kathleen Cooper[3], Joe Fisher[4], Brad Gadberry[1], and Paul Parkins[3]. [1]*NOAA Fisheries, Resource Enhancement and Utilization Technologies Division, Northwest Fisheries Science Center, Seattle, WA 98112* (brian.beckman@noaa.gov)*;* [2]*Cooperative Institute for Marine Resources Studies, Hatfield Marine Science Center, Newport, OR 97365;* [3]*School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA 98195;* [4]*College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR 97331*. **Marine growth rate of juvenile salmon and its relationship to adult return.** Growth is an important ecological trait and there is a great deal of interest in developing markers for growth rate. A good candidate for an index of growth rate is insulin-like growth factor-I (IGF-I)

- a peptide hormone that directly stimulates cell division and growth. We have examined the relationship between plasma IGF-I and body growth of individually tagged coho salmon in several laboratory experiments. Overall, a significant and biologically relevant linear relationship between individual growth and plasma IGF-I in juvenile salmon was found. Food supply (nutrition), growth, and plasma IGF-I levels were clearly linked in these experiments. In addition, growth - IGF-I relations were similar for fish maintained under differing temperature regimes, suggesting that IGF-I may be used as a growth index for salmon under environmentally relevant conditions. Over the past several years we have monitored plasma IGF I levels in post-smolt coho salmon collected during a series of research cruises off the Oregon-Washington coast. We found significant differences in mean June plasma IGF-I levels between years, suggesting that growth of salmon after ocean entry differs interannually (2000 – 2006). A significant relation was also found between plasma IGF-I levels and an index of relative food abundance (salmon prey biomass/salmon abundance). Furthermore, a positive relationship was found between mean June IGF-I level and survival of adult coho salmon from the Oregon Production Index in the following year. This suggests that inter-annual variation in ocean conditions results in altered growth rate of juvenile coho salmon and that these growth differences affect subsequent adult survival.

Barry Berejikian[1], Don VanDoornik[2], Thom Johnson[3], Rick Endicott[4], and Joy Lee[4]. *[1]NOAA Fisheries, Resource Enhancement and Utilization Technologies Division, Manchester Research Station, Manchester, WA 98366* (barry.berejikian@noaa.gov); *[2]NOAA Fisheries, Conservation Biology Division, Manchester Research Station, Manchester, WA 98366; [3]Washington Department of Fish and Wildlife, Olympia, WA 98501; [4]Long Live the Kings, Seattle, WA 98101.* **Conservation hatchery effects on steelhead in Hood Canal.** Conservation hatcheries for anadromous salmonids must strike a balance between increasing production and minimizing genetic, ecological and demographic risks. A conservation hatchery program for Hood Canal steelhead has caused a significant increase in the number of redds in the supplemented Hamma Hamma River compared to the pre-supplementation period. Three monitored control populations (non-supplemented) either remained stable or declined over the same period. The strategy of rearing steelhead full-term to sexual maturity and releasing them for natural spawning accounted for the greatest proportion of redd abundance increases with a negligible 'mining' impact on the natural population. Environmentally induced differences in spawn timing between the adult release group and anadromous adults (wild adults and those released as smolts from the hatchery program) may explain why the adult release group and anadromous adults assortatively formed pairing combinations on the spawning grounds. The level of genetic variation in the juvenile *O. mykiss* population during the supplementation period appears similar to the pre-supplementation period. Genetic analyses indicate that the *O. mykiss* population in the Hamma Hamma River is a mixture of native steelhead and resident rainbow trout that had been introduced above a barrier falls. However, there also is evidence that a small amount of gene flow occurs between the two life history types. The impact of the hatchery program on natural population productivity and longer-term effects on genetic variability will require the termination of hatchery releases and continued monitoring of the supplemented and control populations through the F_2 generation.

Douglas Burrows, David Herman, and Margaret Krahn. *NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112;*

(douglas.g.burrows@noaa.gov). **Assessing Alaskan killer whale feeding ecology using chemical tracers.** Top predators in the marine environment integrate chemical signals acquired from their prey that reflect both the species and source region. These chemical tracers—stable isotope ratios of carbon and nitrogen; persistent organic pollutants (POPs); and fatty acid profiles—were measured in blubber/skin biopsy samples from a large number of eastern North Pacific (ENP) killer whales and were used to provide insight into their diet. Among the three recognized ecotypes in the ENP – offshore, residents and transients – only the fish-eating residents and mammal-eating transients can be unequivocally distinguished from one another by all three chemical tracers. The offshore killer whales can be separated from the other two ecotypes only by their fatty acid and POPs profiles. The high DDTs/ PCBs ratios present in the blubber of the Alaskan offshore killer whales indicated that they also feed at the lower latitudes and this is supported by the photo-identification of these whales in California in winter months. Also, different chemical patterns are observed among differing regional groups of the same ecotype presumably due to differing diets and contaminant sources. For example, resident killer whale populations showed a gradient from west (central Aleutians) to east (Gulf of Alaska) in both stable isotope and specific POP contaminant ratios which may in part reflect a shift from off-shelf to continental shelf-based prey and the spread of pollutants of Asian origin into the ENP, respectively.

Jonathan Cusick, Janell Majewski and Vanessa Tuttle. *NOAA Fisheries, Fishery Resource Analysis and Monitoring Division, Northwest Fisheries Science Center, Seattle, WA 98112* (jonathan.cusick@noaa.gov). **Monitoring catch in the West Coast commercial groundfish fleets: the key to bycatch management.** The US West Coast commercial groundfish fishery is diverse. There are over 80 fish species in the Groundfish Fishery Management Plan, vessels utilize multiple gear types such as trawl, longline and pot and vessels range in size from 18' skiffs to trawlers in excess of 300'. While retained catch data are collected via landing receipts and, in the case of the at-sea hake fleet, processor logs, independently verifiable bycatch and discard data can only be collected through at-sea monitoring programs. Without at-sea monitoring programs, landing receipts only provide a partial picture of total removals. Currently, the FRAM division deploys field biologists (observers) and electronic technology to collect bycatch and discard data to provide an estimate of total removals. Observers collect data on fishing operations (set dates, times, locations, etc.), in addition to estimating total catch weight and speciation of the bycatch and discard. The FRAM division is also testing electronic technology to confirm maximized retention by installing systems to record fishing operations with GPS, winch counter, hydraulic pressure sensors and video cameras. Depending on the specifics of the fishery monitored, data is provided to managers on a real time or regular schedule to be incorporated into estimates of total removals, thus providing managers the tools to manage the fishery within set OYs with greater assurance.

Heather Day[1], Mark Carls[2], Tracy Collier[1], Nat Scholz[1], and John Incardona[1]. *[1]NOAA Fisheries, Ecotoxicology Program, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112* (heather.day@noaa.gov)*; [2]NOAA Fisheries, Auke Bay Lab, Juneau, AK 99801*. **Molecular approaches for understanding oil spill impacts on nearshore spawning fish.** Coastal oil spills can have severe ecological effects on intertidal and shallow subtidal zones, which provide critical spawning and nursery habitat for numerous species. In particular, several important northeast Pacific forage fish species deposit demersal, adherent eggs in these zones where they subsequently undergo development, including Pacific herring (*Clupea pallasi*), sand lance (*Ammodytes hexapterus*), surf smelt (*Hypomesus pretiosus*) and capelin (*Mallotus villosus*). The sensitivity of teleost embryos to toxic effects of crude oil was demonstrated by the Exxon Valdez oil spill, which coincided with the spawning of Pacific herring in Prince William Sound. Studies following the spill showed that embryonic exposure to polycyclic aromatic hydrocarbons (PAHs) in crude oil induces a common suite of developmental defects including pericardial and yolk sac edema, craniofacial and body axis defects. Moreover, significant sublethal effects result in the absence of obvious malformations. For example, pink salmon exposed to weathered crude oil as embryos and released as normal-looking smolts showed significantly lower rates of adult returns. Our basic studies of PAH toxicity using the zebrafish model identified the developing heart as the primary target of the tricyclic compounds most abundant in crude oil. Using the sophisticated genetic and molecular tools associated with the zebrafish model, such as gene knockdown techniques and DNA microarrays, are working to identify potential candidate genes expressed in the developing heart that are misregulated in response to PAH exposure. Toward the ultimate goal of developing physiologically relevant biomarkers for PAH exposure, we are groundtruthing these findings in Pacific herring embryos.

Kurt L. Fresh[1], Dan Bottom[2], Charles Simenstad[3], and Ed Casillas[1]. *[1]NOAA Fisheries, Fish Ecology Division, Northwest Fisheries Science Center, Seattle, WA 98112* (kurt.fresh@noaa.gov); *[2]NOAA Fisheries, Fish Ecology Division, Hatfield Marine Science Center, Newport, OR 97365; [3]University of Washington, School of Aquatic and Fisheries Sciences, Seattle, WA 98195.* **The Columbia River estuary: implications of recent research for salmon recovery.** This presentation summarizes recent research on juvenile salmon use of estuaries in the Pacific Northwest, focusing on the Columbia River estuary and Chinook salmon. Collectively, this work demonstrates that juvenile salmon use of estuaries is directly linked to population viability and resilience. Use of estuarine habitats varies with estuary, species, population, life history strategy, and size of fish. In the Columbia River, juvenile Chinook salmon are present year round with individual residence times ranging up to 140 days. Fish size and occupation of tidal wetland systems are related, with the smallest size classes of juvenile Chinook salmon (< 90mm) most abundant in these wetland habitats. Larger size classes of Chinook salmon (e.g., yearlings) also benefit indirectly from wetland habitats as a result of food web linkages because the food sources of most of the primary prey of juvenile Chinook salmon are largely plant material from shallow water areas (e.g., benthic algae and wetland plants). Construction of dikes and levees and altered flows has eliminated a large amount of the shallow wetland habitats important to both yearlings and sub-yearlings. The distribution of Chinook salmon life history strategies available to use the estuary has also been significantly altered. However, research in the Salmon River (OR) estuary demonstrates that habitat restoration can help recover life history diversity. In conclusion, to help recover salmon and steelhead, connectivity of the entire habitat landscape (spawning grounds to ocean rearing areas) must be reestablished, of which the estuary is an important part.

Rick Gustafson. *NOAA Fisheries, Conservation Biology Division, Northwest Fisheries Science Center, Seattle, WA 98112* (rick.gustafson@noaa.gov). **Pacific salmon extinctions: quantifying lost and remaining diversity.** Widespread population extirpations and the consequent loss of ecological, genetic, and life history diversity depletes a species' biological capital and may lead to extinction of evolutionarily significant units (ESUs) and species. This study represents the efforts of a group of scientists from the NWFSC to systematically enumerate extant and extinct populations and ESUs and characterize and quantify lost ecological, life history, and genetic diversity types in six species of Pacific salmon (*Oncorhynchus* spp.) from the western contiguous United States. We estimate that, collectively, 30% of the over 1,200 historic populations of these six species (Chinook salmon *O. tshawytscha*, sockeye salmon *O. nerka*, coho salmon *O. kisutch*, chum salmon *O. keta*, pink salmon *O. gorbuscha*, and steelhead *O. mykiss*) have been extirpated in the U. S. Pacific Northwest and California since Euro-American contact. Aggregate losses of major ecological, life history, and genetic biodiversity components in these species are estimated at 33%, 15%, and 27%, respectively. We believe that these population extirpations likely represent a loss of between 16 and 30% of all historic ESUs in the study area. On the other hand, remnants of over two-thirds of historic Pacific salmon populations in this area persist, and considerable biocomplexity remains at all scales. However, over one-third of the remaining populations belong to threatened or endangered "species" listed under the federal Endangered Species Act, and it is becoming increasingly clear that persistence of existing, and evolution of future, biodiversity will depend on the ability of Pacific salmon to continue to adapt to anthropogenically altered habitats.

Brad Hanson[1], Robin Baird[2], Candice Emmons[1], Jennifer Hempelmann[1], Greg Schorr[2], and Don Van Doornik[3]. *[1]NOAA Fisheries, Conservation Biology Division, Northwest Fisheries Science Center, Seattle, WA 98112* (brad.hanson@noaa.gov)*; [2]Cascadia Research Collective, Olympia, WA 98501; [3]NOAA Fisheries, Conservation Biology Division, Manchester Research Station, Manchester, WA 98366.* **Using molecular genetic techniques to address key questions for Southern Resident Killer Whale conservation.** A key risk factor identified as a possible cause of the decline of the ESA listed Southern Resident killer whale population was reduced prey availability. In order to evaluate the influence of this risk factor on this whale population a contemporary sample of prey preferences was needed. A prey selection study of this whale population was undertaken in the San Juan Island portion of their summer range from 2004 to 2006. By following the whales in a small boat, fish scales and tissue remains from predation events were collected using a fine mesh net. Fecal material was also collected in a similar manner. Fish scale analysis provided important information on species and age of the fish consumed. However, the application of genetic species identification techniques to fish tissue and fecal material has increased the sample size of identified prey. More importantly, for the fish scales and tissue, genetic stock identification (GSI) has identified prey items to stock. Based on a combination of these techniques, Chinook were identified as the primary species consumed and most fish originated from the Fraser River. This information will be of significant value in guiding management actions to recover the Southern resident killer whale population. The fecal material also yielded killer whale DNA, which in many cases was from known individual whales. Samples have been collected from a substantial portion of the population and will allow determination of paternity patterns which will be of significant importance in evaluating the potential for inbreeding in this small population.

Eric E. Hockersmith, Gordon A. Axel, Darren A. Ogden, and Doug B. Dey. *NOAA Fisheries, Fish Ecology Division, Northwest Fisheries Science Center, Seattle, WA 98112* (eric.hockersmith@noaa.gov). **A history of telemetry technology development in the Columbia River basin and its use in evaluating fish passage behavior and survival.** The Bureau of Commercial Fisheries (now NOAA Fisheries Service) reported the first use of telemetry in fishery research 50 years ago. These early studies examined adult salmonid passage behavior at hydroelectric dams in the Columbia River Basin (CRB) but the technology was limited in a number of respects and sample sizes were small (< 50 fish). Over the past several decades, the Fish Ecology Division (formerly the Coastal Zone and Estuarine Studies Division) has pioneered new fisheries research applications and technological developments in telemetry. Today, telemetry is a frequently used as an extremely useful tool providing critical information and insights regarding migrational behavior, fish passage, and survival that inform fisheries and hydrosystem management decisions. Recently the focus of telemetry studies has shifted from adult passage and survival issues to those of juvenile salmonids – and in particular, the juveniles of ESA-listed stocks. Now the largest telemetry studies in the world are conducted with juvenile salmonids in the CRB, with more than 15,000 juveniles tagged annually. With this shift new challenges have emerged, including increased sample sizes, the need for smaller tags, isolating specific passage routes at dams, collecting and processing massive amounts of data, and developing analytical models. With continued technological innovation, future applications of telemetry will likely provide insights that are currently unavailable. New telemetry applications are currently being developed to measure system survival for individuals through the entire hydropower system (8 dams and over a distance of more than 695 km).

E. E. Holmes[1], Lowell W. Fritz[2], Anne E. York[3] and Kathryn Sweeney[4]. [1]*NOAA Fisheries, Conservation Biology Division, Northwest Fisheries Science Center, Seattle, WA 98112* (eli.holmes@noaa.gov); [2]*NOAA Fisheries, National Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA 98115;* [3]*York Data Analysis, Seattle, WA;* [4]*School for Aquatic and Fishery Sciences, University of Washington, Seattle, WA.* **Teasing demographic rates out of abundance data: age-structured modeling provides evidence for a 30-year birth rate decline in Steller sea lions.** Since the mid-1970s, the western stock of Steller sea lion (*Eumetopias jubatus*) inhabiting Alaskan waters from Prince William Sound west through the Aleutian Islands has declined by over 80%. Concurrently, other apex predators in the North Pacific Ocean also experienced large declines. In 1990, Steller sea lions were listed as threatened under the U.S. Endangered Species Act, and in 1997, the western stock was uplisted to endangered. Over $120 million in federal funding was allocated between 2001 and 2004 for research on factors hypothesized to impact the population, but their complexity, indirectness and cumulative impact have made it difficult to associate abundance changes to specific impacts. In this study, we used age-structured models to analyze abundance and juvenile fraction data for Steller sea lions in the central Gulf of Alaska and found strong support for a steady 30-year decline in birth rate concurrent with a steady increase in survivorship after a severe drop in the early 1980s. This result was robust to variations on the underlying Leslie matrices, including a generic matrix, and the model predictions concur with the limited available field data on survivorship, age-structure and fecundity. These results suggest that (1) direct mortality is currently low and is not the primary threats to recovery for the western Steller sea lion, and (2) new research efforts should focus on the reproductive ecology and energy budgets of adult female Steller sea lions.

Kym Corporon Jacobson[1], Rebecca Baldwin[2], and Mary Bhuthimethee[2]. [1]*NOAA Fisheries, Fish Ecology Division, Hatfield Marine Science Center, Newport, OR 97365* (kym.jacobson@noaa.gov)*;* [2]*Cooperative Institute for Marine Resources Studies, Oregon State University, Newport, OR 97365*. **Using parasites to study marine populations and**

ecosystems: an old tool brought to the future. The integration of parasitology into marine ecology has a long tradition. As early as the 1930s parasites were being used as biological tags for marine populations. Parasites have been, and continue to be studied worldwide to understand marine fish populations and their environments by providing information on fish diet, migration, habitat use, and habitat health. To better understand migration and stock structure of marine fish, population studies have used single parasite species, parasite communities, and most recently genetic analysis of parasites. Parasites can also be used to examine trophic structure and history, as many parasites use transfer through predator-prey interactions to complete their complex life cycles. Because parasites can remain in hosts for months to years, their presence provides an extended history of trophic interactions beyond that provided by fish stomach contents. In the Estuarine and Ocean Ecology Program of the Fish Ecology Division, we have studied parasites to increase our knowledge of the trophic interactions of juvenile salmonids and associated marine nekton. We are currently studying parasites in juvenile salmon in the Columbia River estuary and during early marine residence as indicators of habitat residence and habitat differentiation. Recently we began a study using parasites as biological tags for delineation of expanding Pacific Sardine (*Sardinops sagax*) stocks. This project will combine information from parasite community structure with the genetic structure of parasites; a recent tool showing promise for the future of fisheries research.

Peter Kiffney[1], George Pess[1], Joseph Anderson[2], and Tom Quinn[2]. [1]*NOAA Fisheries, Watershed Program, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112* (peter.kiffney@noaa.gov)*;* [2]*School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA 98195*. **Recolonization of the Cedar River, WA by Pacific salmon: genetic to ecosystem-level effects**. Removal of barriers is one of the primary methods to restore anadromous fish populations. Documenting the ecological consequences of barrier removal, however, is rarely done. The city of Seattle constructed a fish passage facility at the Landsburg diversion dam in 2003 to allow anadromous fish access to the upper Cedar River, WA and 27 km of relatively high quality habitat. This dam has blocked migration of anadromous fish for over 100 years. In 2000, we initiated a long-term study to document effects of salmon at different levels of ecological organization. These studies include reproductive success of salmon using genetic techniques; growth, survival and movement of trout and salmon populations; effects of juvenile salmon on resident fish communities; and effects of salmon carcasses on nutrient dynamics using stable isotopes. Between 2003 and 2005, 35 coho and 44 Chinook redds were identified: 81% were located within a 4 km reach immediately above the dam. To date, dispersal by juvenile coho has been a significant component of the overall colonization process, as they have dispersed into a major tributary of the Cedar River that was passed over by adult coho. We have no evidence that salmon carcasses have affected nutrient dynamics; however, N^{15} levels in fish and other organisms in locations historically accessible by salmon (before 1906) were higher compared to locations above a natural barrier suggesting a "salmon legacy".

Jonathan Lee and Barry Berejikian. *NOAA Fisheries, Resource Enhancement and Utilization Technologies Division, Manchester Research Station, Manchester, WA* 98366 (jon.lee@noaa.gov). **Effects of hatchery rearing on behavioral diversity—some tests with rockfish and steelhead.** The effects of hatchery rearing on fish behavior have attracted attention because behavioral differences between wild and hatchery fish can have negative impacts on wild fish. However while most studies focus on differences in behavioral means, differences in behavioral variation may also be important. Behavioral variation could be adaptively maintained in nature through heterogeneous selective environments or negative frequency dependence. Hatchery rearing may alter behavior through differential survival of different behavioral phenotypes, and through environmental effects on behavioral development. We tested the former mechanism in juvenile brown rockfish (*Sebastes auriculatus*) and the latter mechanism in juvenile steelhead (*Oncorhynchus mykiss*). Brown rockfish showed considerable individual variation in feeding and predator inspection behaviors. However, after four months of hatchery rearing, there was no detectable relationship between behavioral phenotype and growth or survival. This may be due to the fact that behavioral profiles of individuals were unstable through time. We discuss a possible relationship between behavioral stability and selection. Next we will shift to an experiment with steelhead that examined the effect of alternative rearing environments on behavioral development. Compared to fish reared in structured environments, fish reared in barren environments exhibited greater variation in later feeding behavior, and appeared to exhibit greater variation in exploratory behavior. We discuss a possible mechanism through which environmental structure may reduce behavioral variation.

Phillip Levin[1], Nick Tolimieri[1], Kelly Andrews[1], Greg Williams[1], Steve Katz[2], Mary Moser[3], Debbie Farrer[4], Greg Bargman[4]. *[1]NOAA Fisheries, Fisheries Resource Analysis and Monitoring Division, Northwest Fisheries Science Center, Seattle, WA 98112* (phil.levin@noaa.gov)*; [2]NOAA Fisheries, Conservation Biology Division, Northwest Fisheries Science Center, Seattle, WA 98112; [3]NOAA Fisheries, Fish Ecology Division, Northwest Fisheries Science Center, Seattle, WA 98112; [4]Washington Department of Fisheries and Wildlife, Olympia, WA 98501.*
Beyond birth and death: the potential value of behavioral ecology to ecosystem management. While patterns of density are ultimately produced by the interaction of births, deaths and movement, far more attention as been paid to the processes of births and deaths than to movement. However, the manner in which organisms move through their environment is crucial to the success of individuals. Furthermore, individual patterns of movement can generate observed spatial patterns of the population. We have been examining patterns of movement in sixgill sharks, sevengill sharks, copper rockfish, quillback rockfish and lingcod as a means to better predict the consequences of environmental change and/or human perturbation on these species. We will illustrate the use of three different systems to quantify movement patterns in this diverse group of fishes. Acoustic monitoring allows us to track coarse-scale movement of large, mobile species over long periods of time. Manual active tracking is used to quantify movement tracks over short (36 hour) time spans and provides us with a detailed understanding of how fish use their habitat. Remotely operated acoustic arrays allow us to track the fine-scale movements of species with small home ranges over long periods of time. Together, these tools are beginning to help us understand habitat requirements, the minimum area necessary for marine reserves, trade-offs in habitat preferences and the utility of census techniques for this group of species.

Carl Lian. *Fisheries Resource Analysis and Monitoring Division, Northwest Fisheries Science Center, Seattle, WA 98112* (carl.lian@noaa.gov). **Successful economic surveys for commercial fisheries management.** The Magnuson Act requires fisheries managers to consider the economic, social, and biological impacts of regulatory measures. A lack of economic data has placed severe constraints on our ability to conduct economic analyses of West Coast commercial fisheries. Low response rates to previous economic surveys of commercial vessel owners and processors have been a key reason for this lack of economic data. A recent data collect effort has been much more successful. This presentation describes the design of the survey and discusses which factors have produced a high survey response rates to date. The FRAM Economics Team has led the implementation of a program to collect needed economic data on the federally managed groundfish and salmon fisheries. This data will be used in research addressing important economic performance measures such as profitability, production efficiency, regional economic impacts, and bioeconomic models. The first step in this program has been the development and implementation of an economic survey of the limited entry fleet. The presentation will also provide a preliminary analysis of survey data.

Karma Norman[1], Todd Lee[2], Carl Lian[2], Mark Plummer[1], Suzanne Russell[1], Philip Watson[2]. [1]*NOAA Fisheries, Socioeconomics Program, Science Director's Office, Northwest Fisheries Science Center, Seattle, WA 98112* (karma.norman@noaa.gov); [2]*NOAA Fisheries, Fishery Resource and Analysis Division, Northwest Fisheries Science Center, Seattle WA 98112.* **Big picture, smaller snapshot: an overview and example of social science research at the NWFSC.** At the Northwest Fisheries Science Center (NWFSC), an emergent research focus is on the human dimensions – the people and their institutions and activities – that are a central component of the marine and inland ecosystems of the U.S. west coast. In this presentation, I describe the range of social science research projects at the NWFSC, and the current status of each of these research areas. The NWFSC first developed its capacity for economic research by bringing economists into the center and, in recent years, has added both economists and scientists trained in other social science disciplines. Social science research occurs within two groups: 1) economic research supporting the scientific and management information goals of the Fishery Resources Analysis and Monitoring (FRAM) division and 2) social science research that supports scientific and management work for all species within the NWFSC purview. After briefly describing each social science research effort from within both contexts, I will elaborate on the approach and conclusions of a single socioeconomic research project – the large-scale rank ordering and profiling of west coast communities methodologically defined as 'dependent on' or 'engaged in' the fisheries of the Pacific Fishery and North Pacific Fishery management regions. The particular project described brings together fisheries, economic and demographic data and, as such, represents an apt example of both baseline socioeconomic research and its utility in terms of Pacific fishery management.

Linda Rhodes[1], Mark Strom[1], Rebecca Deinhard[2], Alison Coady[1], Sudheesh Ponnerassery[1,3], Cindra Rathbone[2], Lee Harrell[1], William Fairgrieve[2], Shelly Nance[1], Colleen Durkin[1], Casey Rice[4], Steviebrooke Wallis[1], Surafel Gezahegne[1], Gregory Wiens[5], Daniel Rockey[6], Anthony Murray[7], and Diane Elliott[7]. [1]*NOAA Fisheries, Resource Enhancement and Utilization Technologies Division, Northwest Fisheries Science Center, Seattle, WA 98112* (linda.rhodes@noaa.gov); [2]*Pacific States Marine Fisheries Commission, Portland, OR 97202;* [3]*Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83844;* [4]*NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112;* [5]*National Center for Cool and Cold Water Aquaculture, USDA-ARS, Leetown, WV 25430;* [6]*College of Veterinary Medicine, Oregon State University, Corvallis, OR 97331;* [7]*Fish Health Program, Western Fisheries Research Center, Seattle, WA 98115*. **Multiple facets of a salmon bacterial disease.** As salmon populations decline in the Pacific Northwest, factors such as chronic diseases can become more important. Bacterial kidney disease (BKD) has been known as both a chronic and acute disease among salmon biologists for more than 60 years. Historically, progress in understanding the disease and its etiological agent, *Renibacterium salmoninarum*, had been slow, due to difficulty in culturing and manipulating the bacterium and to the often cryptic nature of infection and disease progression. Over the past 10 years, our studies of BKD and *R. salmoninarum* have ranged from genomics to clinical therapies to epidemiology. Through reverse genetics, we characterized the importance of a protein required for pathogenicity by *R. salmoninarum*, identifying it as a target for vaccine development. Complete genome sequencing of *R. salmoninarum* has provided information in formulating strategies for novel therapeutants. Clinical studies of BKD have evaluated antibiotic treatments and the risk of the emergence of drug-resistant strains of *R. salmoninarum*, and the genome sequence is offering insights into possible mechanisms of resistance. Efforts to develop a vaccine against BKD produced a moderate efficacy reagent with both prophylatic and therapeutic value. Research on the host side of the disease equation is characterizing how fish can effectively fight infection and yielding markers that can be used in laboratory studies. Field surveys have identified factors that may be important contributors to infection among free-ranging salmon. These insights into BKD are providing critical focus and knowledge to our future investigations of a problematic, but fascinating, salmon disease.

Ian J. Stewart. *NOAA Fisheries, Fisheries Resource Analysis and Monitoring Division, Northwest Fisheries Science Center, Seattle, WA 98112* (ian.stewart@noaa.gov). **The perils of point estimates: effective scientific presentation in the face of uncertainty and human psychology.** Effective presentation of scientific uncertainty is one of the top challenges facing fisheries scientists and managers. We perform computationally intensive analyses to accurately represent the uncertainty associated with point estimates, but may fall short in delivering these results due to human psychology. When faced with uncertainty, people start from an initial value and then adjust their perception based on available information. However, this adjustment is usually insufficient, and therefore different initial values can yield different conclusions. This is phenomenon is called *anchoring*. Because of anchoring, people tend to underestimate the probabilities of failure in complex systems. Understanding anchoring, and the conditions that affect it, may help us to more effectively convey our scientific results. I present some simple examples of anchoring and suggest the use of probabilistic statements, informative graphics and caution when presenting point estimates.

John C. Wekell. *NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112* (john.c.wekell@noaa.gov). **From chemical warfare, spies, and drugs; and the tropics to the cold north Pacific: a history of marine biotoxin research at the Northwest Fisheries Science Center.** Work on marine biotoxins here at the Center goes back to the late 1940s by the old Seattle Technological Laboratory. Work then centered on Paralytic Shellfish Poisoning (PSP) and means to reduce or eliminate the toxins from processed shellfish, *e.g.*, through canning. Some of this early work was done in conjunction with a sister laboratory/field station in Ketchikan, AK. In the late 1940s and 1950s, the Ketchikan laboratory provided assistance and support to accumulate PSP toxins for the Chemical Warfare Corp of the U.S. Army in Fort Detrick, MD. This accumulated toxin (which has a story in itself worthy of a "spy novel" since it involved the CIA), consisting mostly of what is now known as saxitoxin, became the standard that is currently used by regulatory labs in the United States. Biotoxin work in Seattle went into hibernation until the late 1960s when we got involved in Ciguatera fish poisoning in Caribbean. This program was a joint effort with the then Bureau of Commercial Fisheries and the Food and Agriculture Organization (FAO). Research on marine biotoxins evolved in the 1970s, to finding useful and potent compounds that might have pharmaceutical value ("Drugs from the Sea"). Biotoxin and marine natural product research went into a hiatus during the late 70s and to the late 80s. Marine Biotoxin research was restarted in the early 1990s when we got Seafood Safety funds. An outbreak of domoic acid poisoning in Monterey Bay shifted our focus away from PSP to domoic acid. At the beginning of the 90s, we focused on analytical methodology and surveillance of domoic acid but later turned to causes of the blooms of *Pseudo-nitzschia* that produced this toxin. Grants from National Center for Coastal Ocean Sciences for monitoring and surveillance and another grant from ECOHAB have now given the program a far better understanding on origins of this noxious diatom.

Rich Zabel, James Faulkner, Steven Smith, Mark Scheuerell, Lisa Crozier, Michelle McClure, John Williams, and Milhouse Van Houten. *NOAA Fisheries, Fish Ecology Division, Northwest Fisheries Science Center, Seattle, WA 98112* (rich.zabel@noaa.gov). **Salmon population viability in an uncertain future: prognosticating impacts of climate and hydropower.** Population Viability Analysis (PVA) based on stage-structured life-cycle models is a powerful tool for assessing the impacts of changes in specific survival rates on future population viability. We developed stochastic life-cycle models for populations of Snake River spring/summer Chinook salmon that contain density-dependent recruitment and climate relationships in freshwater and the ocean. We used these models as a framework to ask how changes in climate and in hydrosystem operations and configuration will affect our ability to recover these threatened populations. We found that future ocean conditions will play a huge role in population viability. Also, the role of freshwater climate will become increasingly important due to deteriorating hydrological conditions related to decreasing snow pack. To address hydropower impacts, we, along with scientists throughout the region, developed the Comprehensive Passage (COMPASS) model that predicts juvenile survival through the hydrosystem in relation to alternative scenarios of hydrosystem operation. The COMPASS model also characterizes latent effects related to hydrosystem passage based on several alternative hypotheses. The magnitude of this latent mortality largely determines the efficacy of hydrosystem related mitigation actions for recovering Snake River salmonid populations.