TITLE: A fleet of low-cost stationary "dead zone" cameras for determining fish height off bottom by species and size

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11/3/11

Project Duration: 1 year

Total Amount requested: $35,000

Abstract/Summary:
Acoustic assessments of semi-demersal fish are often hampered by the presence of an unknown proportion of undetectable fish near the seabed. Cameras are often used to determine the near-bottom distribution of fishes. However, there may be substantial behavioral responses to an ROV or towed body that bias the observed species or size classes. Therefore, a method to unobtrusively determine the distribution of fish in relation to the seafloor is needed. We will build a prototype and up to 9 replicate low-cost 'camera traps' similar to those that have been used successfully in terrestrial environments for decades. Replicate units are essential to provide adequate target densities and spatial coverage. Stereo-camera methods would be used to quantitatively determine the distribution of fishes relative to the seafloor during acoustic surveys. Each unit will consist of paired consumer grade still cameras and strobe lights mounted on a robust frame (crab pot) lying on the seafloor. The camera will be triggered using a custom designed detector that will use changes in far-red (600-700 nm) light reflectance not visible by fish to signal when a fish moves into the range of the camera lens. We will conduct a field test in which the camera systems will be deployed in fish aggregations within an acoustic survey area for up to 2-3 days in order to determine the distribution of fish by species and size within 2.5 m of the seafloor. This work will address a major source of uncertainty in acoustic measurements of demersal fishes, which is a problem common to the NMFS science centers.

Background and Justification:

Many non-lethal survey methods for marine fishes are being developed within NMFS to address concerns regarding traditional survey methods such as bottom trawls. These non-lethal surveys have often used direct counts or line transect methodology from submersible vehicles to estimate fish abundance (Yoklavich et al. 2009, O'Connell and Carlile 1993), but more recently combination acoustic-optic surveys using ROV's and lowered cameras have been developed (Demer et al. 2009, Rooper, et al. 2010, Jones et al. in review). Visual surveys and especially acoustic-optic surveys depend on an unbiased estimate of the vertical distribution of fish in the near-bottom zone where fish are not observed acoustically (i.e. the 'acoustic dead zone, ADZ' Ona and Mitson, 1996, Lawson and Rose, 1999, McQuinn et al., 2005). A potential bias in fish vertical distribution can arise when the underwater platform provokes a behavioral response in the fish species that are the target of the survey.

As an example, many optical and acoustic-optical surveys to date have focused on rockfish species (*Sebastes* spp.). These species often have been suspected of having an escape response to underwater vehicles (Krieger and Ito 1999, Stoner et al. 2008). This response may be species and/or size specific, in that some rockfish species may dive to the seafloor in the presence of an underwater vehicle, while others may not react. For example, an escape response may be more evident in smaller size classes or species, where the risk of predation is more acute. In addition, there is some evidence that certain species may be attracted to underwater vehicles (Stoner et al., 2008).

The response of rockfish to an underwater vehicle during acoustic-optic surveys can introduce substantial error into the acoustic assessment if all the species observed near the seafloor are assumed to be unobserved acoustically. Species that are always found in close association with the seafloor (such as yelloweye rockfish) may inhabit the acoustic dead zone exclusively, while

other semi-pelagic species (such as widow rockfish) may occur higher in the water column where they are observed with acoustics. If the semi-pelagic species dive to the seafloor in the presence of an underwater vehicle, the occurrence of the species in the acoustic dead zone may be over-estimated. Conversely, species that only occur in the dead zone may be wrongly assumed to occur in the water column where they may be observed acoustically.

Data to describe the natural occurrence of fishes by species and size in the acoustic dead zone is thus very important to accurate acoustic surveys conducted throughout NMFS Science Centers. In addition to concerns related to acoustic surveys, other aspects of fish behavior are important to NMFS surveys, such as species specific diurnal migrations, associations of fish with particular habitat types or behaviors that influence fishes vulnerability to bottom trawls (such as fish hiding in interstitial spaces). These survey uncertainties would be reduced by the ability to observe species in a more "undisturbed" setting, where the observation platform is not influencing the behavior of the subjects.

We are proposing to build a small fleet of ten motion triggered stereo-camera- devices (TrigCams). These camera "traps" would act much as land-based camera traps operate, remotely capturing images of undisturbed fishes in their natural habitats. Land based camera traps have been used to measure the abundance (Karanth 1995, Silver et al. 2004), species diversity (Obrien et al. 2010) and behavior (Bridges et al. 2004, Maffei et al. 2005) of terrestrial species. These techniques have not been translated into the marine environment to our knowledge, but they hold promise for allowing us to ascertain species habitat associations, fish and invertebrate behavior, species diversity and species composition without the effects of a moving underwater video platform or a destructive bottom trawl.

Scope

The specific objectives of this project will be to construct and test a fleet of 10 underwater camera traps. Extensive testing will be conducted both in the laboratory and during local deployments near Seattle, Washington. The goal will be to deploy these camera traps during two acoustic surveys, a survey for gadids in the eastern Bering Sea shelf and a survey for rockfishes in an untrawlable area of the Gulf of Alaska. We will use the camera traps to 1) determine the vertical distribution of fishes from the seafloor to above the boundary where echosounder measurements are biased low (< 2 m off bottom c.f. Ona and Mitson, 1996), 2) determine the size and species composition of fishes, and 3) compare these estimates of size and species specific vertical distribution to estimates from other ground-truthing methods (bottom trawls and drop cameras) deployed at the same location. We will also examine the habitat associations and behavior of observed fishes over a 24 hour deployment.

Technical Approach

The technical approach of this project will be to construct the triggered stereo-camera units out of "off the shelf" components in order to minimize the cost and maximize future flexibility as better camera and lighting options become available. The major components of the systems will be 1) two synchronized and calibrated stereo cameras with overlapping views, 2) a strobe light system able to illuminate up to 3 meters in front of the lens, 3) a triggering mechanism consisting

of an custom designed microcontroller, an array of far-red (680 nm) LED illuminators, and a photodiode, and 4) a separate sealed battery pack (Fig 1a.). These components will be housed in a low cost machined box-style plastic housing optimized for the camera dimensions. Prototype acrylic housings with a wall thickness of 20 mm have been manufactured at AFSC and successfully tested to a depth of 600 meters (Fig. 1b).

In underwater applications such as this, high quality stereo measurements can be made over short ranges with inexpensive, consumer grade point-and-shoot digital cameras (see Fischer et al., 2007, who demonstrate length accuracy of ~ 5% with a system similar to that proposed here).

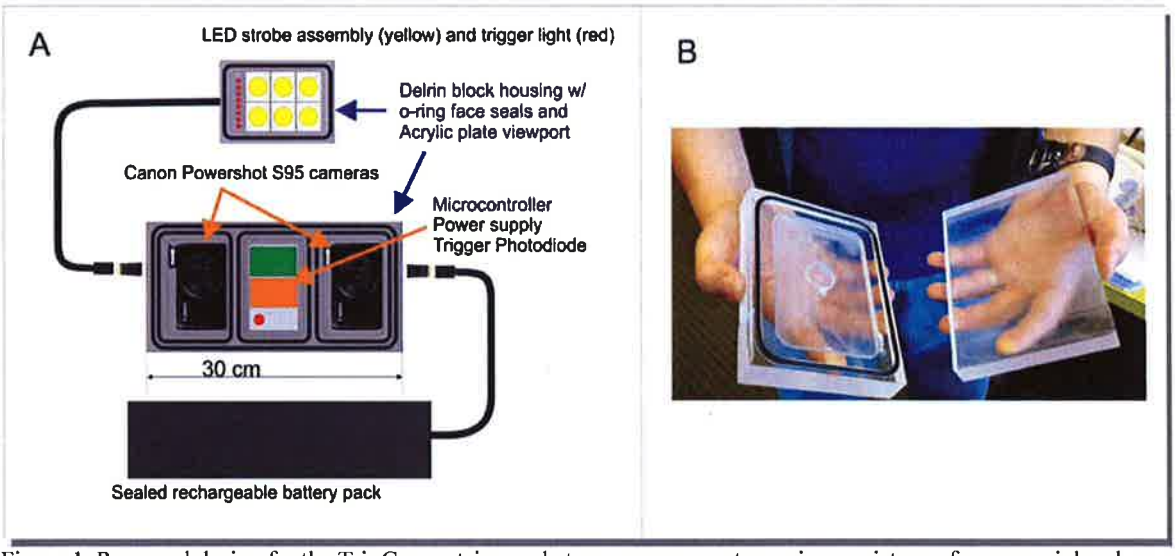

Figure 1. Proposed design for the TrigCam, a triggered stereo camera system using a mixture of commercial and custom components.

An example of a suitable choice for cameras would be the Canon Powershot S95, capable of taking high quality images and having reasonably good performance in low-light environments. Canon Powershot series cameras are especially attractive due to the availability of alternative firmware that provides complete control over critical camera functions, including triggering, manual focusing, zoom levels, and exposure settings such as shutter speeds, apertures and ISO (CCD imager gain). This firmware (CHDK - http://chdk.wikia.com/wiki/CHDK) is installed on the camera memory card and ensures that the user specified settings are used when camera is in operation even if power is completely removed from the camera. The ability to control these critical camera functions effectively turns the consumer grade camera into a low-cost scientific instrument.

The cameras will be equipped with Eye-fi SD cards with built in Wi-fi capability which will allow images to be wirelessly transferred after deployment. This is important because stereo-calibrated camera systems remain useful as long as the camera geometry (i.e. inter-camera position) is stable, and not having to handle the cameras to remove images will insure this stability (Williams et al., 2010). The cameras will be powered externally by a battery pack, as will the other components of the system.

A single LED strobe will be used for image acquisition, designed similar to other LED strobes used for the ASTWG CamTrawl. The strobe design consists of a series of LED illuminators and drivers which are capable of "overdriving" the LED's for short durations, producing a high-intensity pulse of light. This design is compact, power efficient and inexpensive compared with an equivalent power xenon tube type strobe. The strobe will be housed in a separate plastic housing enabling the light source to be offset from the cameras improving the image quality by reducing backscatter from suspended particulates and small organisms in the water.

The most innovative aspect of the TrigCams is the triggering mechanism. The purpose of the triggering mechanism (as in any photo trap) is to unobtrusively detect the subject prior to firing artificial lighting, which is required for exposure, but if fired indiscriminately would alter the behavior of the subject. Triggering will be based on changes in reflected light from a secondary red LED array with peak wavelengths of 680 nm. An additional filter will be placed on the LEDs to remove any light lower than 640 nm. In most deepwater (100 + m) fish species, sensitivity is minimal in red light as this wavelength is not present in their habitat (Raymond & Widder, 2007). The presence of the trigger light should therefore be undetectable to the fish and should not cause changes in behavior due to the presence of the light. The entry of a fish into the image space will be detected by monitoring for changes in the total amount of reflected red light using a highly sensitive photodiode.

The light reflectance-based triggering concept can be illustrated using video data shown in Figure 2. The operation of the TrigCam triggering unit is assumed to be analogous to looking at the sum of pixels from video sequences using full spectrum light; as a fish enters the view field, the average brightness, or mean pixel value detected by the camera, increases. In this example we are able to detect fish at significant distances from the camera and in close proximity to the seafloor. By using a photodiode instead of a camera, the strength of the photodiode output signal can be continuously monitored, and a change in this level over a set time interval that exceeds a specified threshold will constitute a trigger.

The success of this approach requires sufficient signal-to-noise ratio in the output from the photodiode. Highly sensitive photodiodes called avalanche photodiodes are similar in operation to photomultiplier tunes while being much more compact, affordable, and easier to incorporate into a simple monitoring circuit. The wavelength sensitivity of the photodiode will be matched to the red light output by the LEDs. Despite the high absorption of red wavelengths in water, the high sensitivity of the photodiode, coupled with appropriate circuitry, should be capable of sensing small changes in reflected light produced by fish targets up to 3 m away. Testing will be conducted to ensure that the LEDs light intensity is sufficient to allow small fish (10 cm) as well as larger ones to trigger the cameras, reducing the potential for size selectivity in the data.

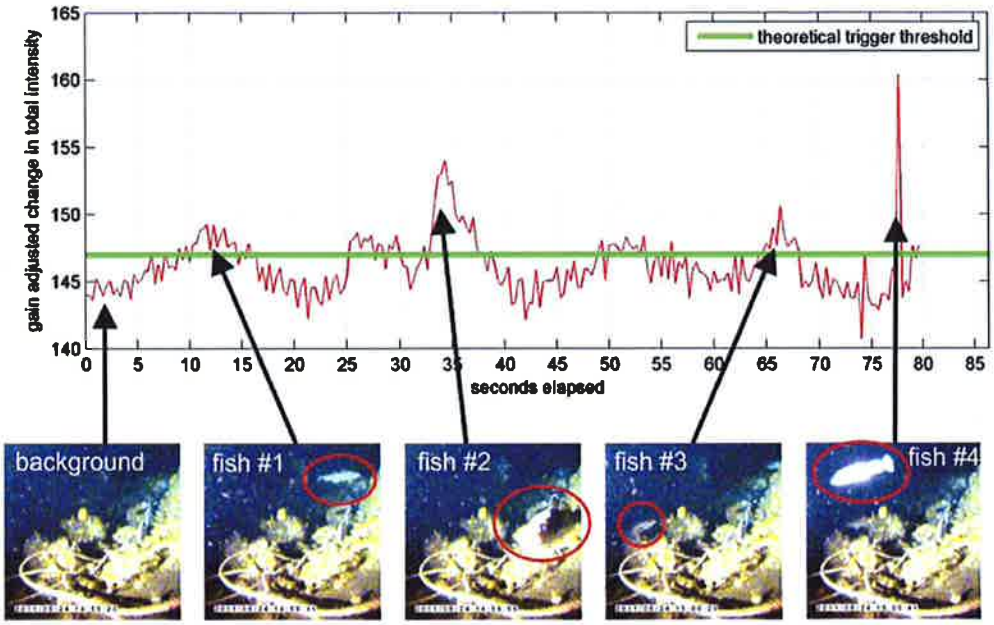

Figure 2. Example of light reflectance-based triggering from video data. Peaks above triggering threshold are associated with the appearance of fish in the video.

For the purposes of determining vertical fish distribution, probability of detection must be uniform across the vertical dimension throughout the imaged volume. To achieve this, the red LED triggering array consisting of up to 10 units will be vertically oriented, and will potentially require a lens element to produce a beam of uniform brightness in the vertical plane. The trigger LED array will be mounted alongside the imaging LED strobe in a separate housing to provide an offset between it and the photodiode. This will prevent small particles near the beam from falsely triggering the cameras.

The system will be powered using a custom built battery pack made of lithium polymer cells without air spaces manufactured to withstand pressures of up to 10,000 psi. The cells will be potted into a solid pack along with a charging circuit with a single 2 pin connector output. This design will make replacement and charging of the batteries simple and will not require any water-proof seals to be opened, increasing robustness and preserving the stereo-camera geometry. The cameras, microcontroller, and photodiode will be housed in a single housing, connected with the strobes and batteries with underwater cables (Figure 1a).

Circular commercial crab pots used for Dungeness crab fishery will provide ideal protective frames for mounting the units, and will facilitate easy deployment and retrieval using techniques developed for commercial fishing. Sinking (or weighted crab line) line will be used for the first 50 fathoms of the retrieval buoy line so that the line stays on the seafloor in the immediate vicinity of the TrigCam unit, ensuring that the retrieval line does not act as an attractant for fish. The basic operation sequence will be as follows; first, the TrigCam unit will be deployed off the vessel in a desired location (pre-determined or targeted). For example, desirable camera locations would include areas of high acoustic backscatter to maximize target density. The unit will wait a pre-specified amount of time before active data collection to gather a "background"

level of reflected light from the trigger LED array and to allow for any fish reactions to the arrival of the gear to be reduced. A detection mode will then start, waiting for a trigger (change in received red light relative to the background) to be received, which will synchronously fire the cameras and LED strobe (Fig. 3). The system will then start a rest period to ensure the reaction to the strobe has dissipated before the next triggering cycle begins. The battery power will be designed to allow the TrigCams to capture up to 500 shots per charge, and operate the trigger system for a minimum of 24 hours. The units will be able to be re-deployed quickly as a new battery pack and image download are all that is required.

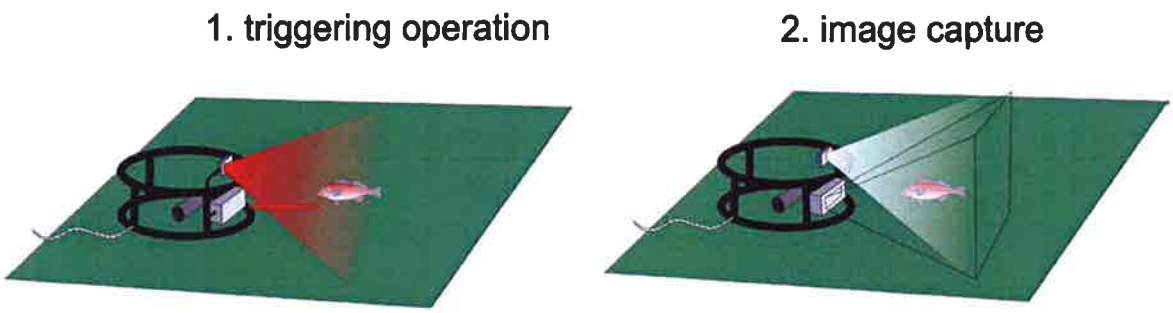

Figure 3. Schematic of dead-zone camera showing location of triggering mechanism, camera orientation relative to the seafloor and proposed triggering and lighting system.

The increased efficiency of data collection using a triggering system compared with a fixed duty cycle can be illustrated using simulated data with randomly generated arrival times of fish in front of a camera. Figure 4 shows the expected number of fish imaged with a triggered system over one hour compared with a fixed 5 minute duty cycle, as a function of the number of fish appearing in the visual field over the hour. For this simulation, fish were assumed to linger in front of the camera for 20 seconds. The triggered camera simulation had a pause cycle of five minutes after each shot. It can be seen that at lower densities the amount of data from a triggered system is almost one order of magnitude greater than a duty cycle approach, and with increasing fish density the gains are reduced but are still significant even at high fish densities.

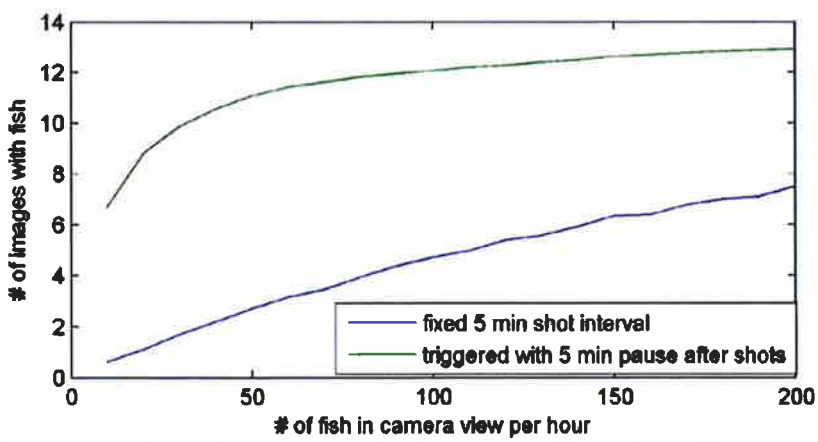

Figure 4. Simulation results comparing success rate (imaging a fish) using a triggered and fixed time interval approach

Deployment of these cameras is expected to occur over two stages in FY12-13. We anticipate deploying the cameras during FY12 on a vessel of opportunity (the NOAA vessel *Oscar Dyson*) during the biennial acoustic survey of the eastern Bering Sea shelf. We will deploy the fleet of cameras during nighttime operations (when ship time is available) for up to 12 hours and examine the near-bottom distribution of pollock and cod. It is anticipated that these experimental deployments will be carried out in multiple locations with multiple densities of fish targets. We will compare the near-bottom distribution of cod and pollock with the acoustic survey estimate of fish on or near the bottom as well as corresponding bottom trawl survey data collected on the eastern Bering Sea shelf.

The final field deployment of the cameras in survey mode will occur in 2013 during the anticipated acoustic survey of the Gulf of Alaska. In this case we will focus on rockfish species in untrawlable areas of the seafloor. The fleet of cameras will be deployed for 24 hours during an acoustic survey of an untrawlable area in Alaska. In the past these surveys have been conducted over fairly small isolated patches of seafloor with very high densities of rockfish. For example, in 2008 a survey was conducted over a ~50 km^2 area containing approximately 16,000 mt of northern rockfish (Rooper et al. 2010) and in 2010 another survey of ~140 km^2 resulted in an estimated biomass of ~4000 mt (Jones et al. in review). We will deploy the 10 cameras at locations with strong rockfish backscatter in the untrawlable areas and then examine the vertical distribution, species and size composition within 2.5 m of the seafloor.

Camera estimates of the proportion of fish in the ADZ and immediately above the ADZ can be used correct acoustic estimates for the effects of the dead zone (Mitson and Ona, 1996, Jones et al., in review). The camera derived target depth distribution will be used to calculate the proportion of fish (P_{ADZ}) that are in the ADZ as $P_{ADZ}= C_{ADZ}/(C_{above}+ C_{ADZ})$, where C_{above} is the target density from the top of the ADZ to the upper limit of the camera sampling volume (~2.5 m), and C_{ADZ} is the density of targets observed within the ADZ. This can be used to correct echosounder (E) measurements for the ADZ. For example, with an ADZ of 0-1 m, and a layer of 1-2.5 m that is jointly observed by the TrigCam and the echosounder, the corrected backscatter from 2.5m above bottom to the seafloor can be estimated as follows: $E_{corr}=E_{1\text{-}2.5m}+ (P_{ADZ}* E_{1\text{-}2.5m})$. For a depth of 100 m and a bottom that is flat over the beam footprint, the ADZ ranges from 0.7-1.2 m depending on how the echosounder is operated (Ona and Mitson, 1996). This indicates that the TrigCam and echosounder will overlap sufficiently to allow corrections to be estimated under field conditions.

Existing corrections for the ADZ make the assumption that fish density in the ADZ is equivalent to that immediately above the ADZ (e.g. Ona and Mitson, 1996, McQuinn et al., 2005). However, direct observations suggest that this is rarely the case for semi-demersal species: fish density often decreases rapidly with height from the seafloor (e.g. Lawson and Rose, 2009, Rooper et al., 2010, Jones et al., in review), which would lead to an underestimate of fish abundance if a uniform distribution is used. Vertical distributions can change dramatically as a function of time of day (Lawson and Rose, 2009, Rooper et al., 2010). The direct observations from the TrigCams will be used to determine the appropriate functional form of the (e.g. uniform, linear, exponential) of fish density as a function of height of bottom and time of day using model selection procedures. This will allow for an improved model-based corrections in

high relief areas where the ADZ extends above the field of view of the TrigCam (e.g. Demer 2009).

In addition to the ADZ to non-ADZ comparisons, the data from the TrigCam's will be compared to drop camera estimates of the species and size compositions of fish in the ADZ to determine how fish reactions to the lowered instrument may bias the observations. We would anticipate that once developed the TrigCam fleet could be routinely deployed in survey operations to verify the species and size composition of fishes in and directly above the ADZ.

Expected Results and Products

Much of the preliminary testing of the triggering mechanism and housing components have been completed or will be completed by December 2011. The success of this testing and previous positive experience with building stereo video systems using similar methods gives us substantial confidence that these novel technologies can be combined into a triggered underwater camera trap. If funded we expect that the details of construction and testing of the prototype will be accomplished early in 2012.

This project can be easily transitioned to NMFS-wide operations through publication of the technical specifications and design of the cameras as a NOAA technical memorandum or peer-reviewed manuscript. The investigators will be pleased to consult with other interested scientists on building their own camera systems, and if possible the cameras manufactured through this proposal will be made available to other NMFS users in other science centers. In addition the results of the field test deployment will be communicated as a peer-reviewed publication.

Scientific Merit

The underwater camera trap described here will have a direct effect on improving NMFS stock assessment surveys by increasing our knowledge of 1) the natural distribution of fish near the seafloor, 2) fish behavior that may affect their vulnerability to acoustic observation, visual observation or trawl capture and 3) fish habitat associations that can be used to better stratify surveys and estimate abundance.

Principal Investigators:

Chris Rooper is a research fisheries biologist at the AFSC. His expertise is in using underwater video systems to describe rockfish habitat use and determine the abundance of benthic fishes and invertebrates.

Alex De Robertis is a research fisheries biologist at the Alaska Fisheries Science Center. His primary expertise is in using acoustic methods to investigate the abundance, distribution and behavior of marine organisms.

Kresimir Williams is a research fisheries biologist at the AFSC, working in the Midwater Assessment program. He has extensive experience with underwater stereo-camera systems, including system design, assembly, and custom analysis software.

Scott McEntire has over 20 years experience in building underwater camera and light systems for a wide variety of purposes, including examining fish behavior in response to nets, using cameras to examine the fishing configuration of trawls, using cameras to estimate escapement from nets by fishes and invertebrates.

Rick Towler is an Information Technology Specialist in the Midwater Assessment program at the AFSC. He has developed software and electronics products for fisheries acoustics and other scientific applications for over 13 years and specializes in instrument design and construction.

Project Schedule and Milestones:

Research on the triggering mechanism and camera housings has already begun at the Alaska Fisheries Science Center with existing equipment. The system will be fully designed by January 2012, and a prototype camera will be built when the funding becomes available (March-June 2012). The prototype will be tested locally (to Seattle) in May 2012. Up to nine additional cameras will be built in June-July 2012 and they will be deployed as a special project aboard the *Oscar Dyson* during the biennial acoustic survey of pollock in the eastern Bering Sea shelf. Data will be analyzed at the conclusion of the survey (September 2012) and technical specifications and design description written up as a technical memorandum or peer-reviewed article in fall 2012.

Milestone	Anticipated completion
Camera design completed	Jan-12
Prototype manufactured	May-12
Bench-top and local testing of prototype	Jun-12
Manufacture of additional units	Jul-12
Field testing	Aug-12
Completion report	Sep-12

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Table of Partnerships:

All the work for this project will be carried out by the principal investigators listed above. All are with the NMFS Alaska Fisheries Science Center

Principal Investigator	Institution	FY12 Funds Requested (Cost Sharing)
Rooper, Williams, De Robertis, McEntire, Towler	Alaska Fisheries Science Center	$35,000
Totals		$35,000

Budget Page(s):

	Description	Amount FY12
1100	Direct Labor:	
1150	Overtime and Hazard Pay	
1200	Benefits:	
2100	Travel	
2200	Transportation	
2300	Rents et al.	
2400	Printing	
2500	Contracts:	
2600	Supplies and Materials:	
3100	Equipment:	
	Cameras	$18,000
	Strobe lights	$10,000
	Triggering system	$3,000
	Miscellaneous	$4,000
4100	Grants	
	Total	$35,000

Budget Justification:

The budget will be spent exclusively on the manufacture and delivery of one prototype and nine units of the dead zone camera. Major purchases necessary include 20 cameras for stereo-optic capability ($18K), 10 strobe lights ($10K) and 10 triggering mechanisms ($3K). The units will be shipped to Alaska and deployed on a vessel of opportunity in the summers of FY12 and FY13.

Curriculum Vitae:

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Education

Ph.D. University of Washington, Aquatic and Fishery Sciences, 2002
M.S. University of Alaska, Fairbanks, Fisheries and Aquatic Sciences, 1996
B.S. Oregon State University, Biology, 1991

Employment

2002-present	Research Fishery Biologist- Alaska Fisheries Science Center, RACE Division, Seattle Washington, USA.
1999-2002	Research Assistant- School of Aquatic and Fisheries Sciences, University of Washington, Seattle Washington USA
1999-2000	Teaching Assistant- School of Aquatic and Fisheries Sciences, University of Washington, Seattle Washington USA
1997-1998	Biological Science Technician- U.S. Forest Service, Juneau Forestry Sciences Laboratory, Juneau, Alaska, USA.
1997	Fishery Biologist- U.S. Geological Service, Columbia River Research Lab, Cook Washington, USA.
1996-1997	Biological Science Technician- U.S. Forest Service, Juneau Forestry Sciences Laboratory, Juneau, Alaska, USA
1994-1996	Research Assistant- Juneau Center, School of Fisheries and Ocean Sciences, University of Alaska, Fairbanks, Alaska, USA.
1992-1994	Experimental Biology Aide- Oregon Department of Fish and Wildlife, Clackamas, LaGrande and Astoria, Oregon, USA

Five most relevant publications

Rooper, C.N., G. R. Hoff & A. De Robertis. 2010. Assessing habitat utilization and rockfish (Sebastes sp.) biomass in an isolated rocky ridge using acoustics and stereo image analysis. Can. J. Fish. Aquat. Sci. 67:1658-1670.

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Rooper, C.N. & M. Zimmermann. 2007. A bottom-up methodology for integrating underwater video and acoustic mapping for seafloor substrate classification. Continental Shelf Research 27:947-957.

Rooper, C.N., J.L. Boldt & M. Zimmermann. 2007. An assessment of juvenile Pacific Ocean perch (*Sebastes alutus*) habitat use in a deepwater nursery. Estuarine, Coastal, and Shelf Sciences 75:371-380.

Five other publications

Rooper, C.N., M.E. Wilkins, C. Rose & C. Coon. 2011. Modeling the impacts of bottom trawling and the subsequent recovery rates of sponges and corals in the Aleutian Islands, Alaska. Cont. Shelf Res. 31:1827-1834

Rooper, C.N. & M.H. Martin, 2009. Predicting presence and abundance of demersal fish: a model application to shortspine thornyhead (Sebastolobus alascanus). Mar Ecol Prog Ser 379:253-266

Boldt, J. L. & C. N. Rooper. 2009. An examination of links between feeding conditions and energetic content of juvenile Pacific ocean perch in the Aleutian Islands. Fishery Bulletin 107:278-285.

Rooper, C.N. 2008. An ecological analysis of rockfish (Sebastes spp.) assemblages in the north Pacific along broad-scale environmental gradients. Fishery Bulletin 181:1-11.

Rooper, C. N., D. R. Gunderson, & D. A. Armstrong. 2006. Evidence for resource partitioning and competition in nursery estuaries by juvenile flatfish in Oregon and Washington. Fish Bull 104:616-622

Memberships and Awards

Member: Sigma Xi
American Society of Limnology and Oceanography
American Fisheries Society, North Pacific International Chapter
Pearl Jam 10 Club

Best Student Paper, Pacific Estuarine Research Society Annual Meeting, 2000

Greater Seattle Hockey League All-Star: Division 6-7 (2003-04), Division 5-6 (2006-07)

Cobb Fellowship, University of Washington, 1998

Graduation with High Honors, Oregon State University, 1991

CURRICULUM VITAE

Alex De Robertis

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PROFESSIONAL INTERESTS:
Fisheries acoustics, survey methodology, behavioral ecology of fish and zooplankton, optical ecology, predator-prey interactions, biological oceanography, research vessels.

EDUCATION AND EMPLOYMENT:

2003-Present Research Fishery Biologist, Alaska Fisheries Science Center. Research related to acoustic surveys in the North Pacific.

2001-2003 National Research Council Postdoctoral Fellow, Northwest Fisheries Science Center. Project title: Feeding ecology of juvenile salmonids in turbid environments. Adviser: Richard D. Brodeur

1995-2001 Ph.D. Biological Oceanography, Scripps Institution of Oceanography. Dissertation: Small-scale spatial distribution and swimming behavior of euphausiids in relation to visual predation risk. Adviser: Mark D. Ohman.

1995 BS Biology University of California Los Angeles. College Honors.

FIVE PUBLICATIONS RELEVANT TO THE CURRENT PROPOSAL:

De Robertis, A., and Handegard, N. O. in review. Chapter 4. Fish behavioural responses to approaching research vessels. In ICES cooperative Research Report, Causes and Consequences of Fish Reaction to Fisheries Research Vessels. J. K. Parrish and F. Gerlotto, Eds.

Jones, D., Wilson, C. D., De Robertis, A., Weber, T. C., and Butler, J. L. in review. Evaluation of Rockfish Abundance in Untrawlable Habitat: Combining Acoustics with Alternate Sampling Tools. Fisheries Bulletin.

Rooper, C., Hoff, J., and De Robertis, A. 2010. Assessing habitat utilization and rockfish biomass on an isolated rocky ridge using acoustics and stereo image analysis. Can J. Fish. Aquat. Sci., 67: 1658-1670

Kotwicki, S., De Robertis, A., von Szalay, P., Towler, R. (2009) The effect of light intensity on the availability of walleye pollock (*Theragra chalcogramma*) to bottom trawl and echo-

integration trawl surveys in the Eastern Bering Sea. Canadian Journal of Fisheries and Aquatic Sciences, 6:983-994

Jaffe, J. S., Ohman, M. D., and De Robertis, A. 1998. OASIS in the sea: Measurement of the acoustic reflectivity of zooplankton with concurrent optical imaging. Deep-Sea Research, 45: 1239-1253.

FIVE OTHER PUBLICATIONS

De Robertis. A. Cokelet, E. D. (in press). Distribution of Fish and Macrozooplankton in Ice-covered and Open-water Areas of the Eastern Bering Sea. Deep Sea Research II

De Robertis, A., and Wilson, C. D. 2011. Silent ships do not always encounter more fish (revisited): comparison of acoustic backscatter from walleye pollock recorded by a noise-reduced and a conventional research vessel in the eastern Bering Sea. ICES Journal of Marine Science. doi:10.1093/icesjms/fsr146

De Robertis, A., McKelvey, D., and Ressler, P.H. (2010) Development and application of empirical multi-frequency methods for backscatter classification in the North Pacific. Canadian Journal of Fisheries and Aquatic Sciences 67: 1459-1714.

De Robertis, A., Ryer, C. H., Veloza, A., and Brodeur, R. D. (2003). Differential effects of turbidity on prey consumption of piscivorous and planktivorous fish. Canadian Journal of Fisheries and Aquatic Sciences, 60:1517-1526.

Gómez-Gutiérrez, J., Peterson, W. T., De Robertis, A., and Brodeur, R. D. (2003). Massive mortality of euphausiids caused by apostome ciliates. Science, 301: 339.

Kresimir Williams

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Seattle, WA 98115
206-526-4133
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Education:

M.S. Auburn University, 2002, Fisheries And Aquaculture
B.S. Samford University, 1995, Biology

Positions:

Fishery Biologist, NMFS, NOAA, AFSC, Midwater Assessment and Conservation Engineering, 2003-present
Fisheries Observer, Alaskan Observers, Inc. 1997-2000

Research Interests:

Influence of fish behavior on survey design and uncertainty, advanced sampling technology and underwater instruments fish observation and enumeration, fisheries management, population modeling

Computer Skills:

Proficient programming skills in Matlab, Python, VB. Database design, image processing, 3-D visualization

Awards:

Bronze medal, NOAA, 2007 – for development of open design high precision fish measurement device
H.S. Swingle Award for Outstanding Master's Student, Auburn University, 4/02
Presidential Fellowship, Auburn University, 9/00 – 5/02
Russel – Barber Award for Excellence in Marine Studies, Samford University, 6/93

Publications:

Williams, K.; Punt, A.E.; Wilson, C.D.; Horne, J.K. 2011. Length-selective retention of walleye pollock, Theragra chalcogramma, by midwater trawls. ICES J Mar. Sci. 68:119-129.

Williams, K., Rooper, C. N., Towler, R. 2010. Use of stereo camera systems for assessment of rockfish abundance in untrawlable areas and for recording pollock behavior during midwater trawls. Fish Bull 108(3): 352-362.

De Robertis, A; Williams, K. 2008. Weight-length relationships in fisheries studies: The standard allometric model should be applied with caution. *TRANSACTIONS OF THE AMERICAN FISHERIES SOCIETY* 137 (3): 707-719.

Handegard, NO; Williams, K. 2008. Automated tracking of fish in trawls using the DIDSON (Dual frequency IDentification SONar). *ICES JOURNAL OF MARINE SCIENCE* 65 (4): 636-644.

Williams, K. 2007. Evaluation of the Macroscopic Staging Method for Determining Maturity of Female Walleye Pollock *Theragra chalcogramma* in Shelikof Strait, Alaska. *ALASKA FISHERY RESEARCH BULLETIN* 12 (2): 252-263.

Williams, K; Papanikos, N; Phelps, RP; Shardo, JD. 2004. Development, growth, and yolk utilization of hatchery-reared red snapper *Lutjanus campechanus* larvae. *MARINE ECOLOGY-PROGRESS SERIES* 275: 231-239.

Scott McEntire

Fishery Biologist, Conservation Engineering Task
RACE Division, Alaska Fisheries Science Center
National Marine Fisheries Service, Seattle Washington

Bachelors Degree,	Fisheries Biology	1978	Humboldt State University
Masters Degree,	Marine Affairs	1989	University of Washington

Speciality:

The development and design of underwater instrumentation for fisheries research.

Completed Systems:

Bottom Contact Sensor,
One hundred plus units deployed worldwide with fisheries research organizations
Trawl mounted autonomous video systems
Twenty five plus units in service with NOAA, universities and state labs.
Portable winch drop video systems
Towed on bottom sled video systems.
Neutrally buoyant towed video sytems.
Fiber optic cable towed video system.
Embedded PC for autonomous control of scanning sonar systems
Depth rated diver carried VHF radio
Pot/trap door event counters
Pot drag distance logging
Battery and control for Didson imaging system

Systems include:

The design and construction of over 300 pressure housings for batteries, power and control electronics, data loggers, video recorders, micro computers, cameras and lights.
Depth ratings in excess of 2,000 meters seawater
Housing components of titanium, aluminum, stainless steel and thermal plastics
All instrumentation housings incorporate no catch easy open designs
Autonomous video systems incorporate depth or time delay activation
Design and mounting of internal electronic control and interface sub assemblies
Synch control boards for strobe lighting interface with progressive scan video cameras.
Board level design, layout and construction of microcontroller circuits.
Assembly level programming of PIC microcontrollers.
Interface, power, protection and long line amplifier boards.
Design of water corrected Rebekoff type optical ports for video cameras.
Design and mounting of low voltage HID and LED lighting.
Battery power and charging subsystems for remote instrumentation.

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PROFESSIONAL PROFILE

Experienced in all stages of instrument design from concept to production including circuit design and layout, sensor integration, and embedded and host software development with extensive background in software development using languages common to the scientific community.

EXPERIENCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ALASKA FISHERIES SCIENCE CENTER, SEATTLE, WA
MIDWATER ASSESSMENT AND CONSERVATION ENGINEERING — 2004 TO PRESENT
IT Specialist

UNIVERSITY OF WASHINGTON, SEATTLE, WA
SCHOOL OF AQUATIC AND FISHERY SCIENCES
FISHERIES ACOUSTICS RESEARCH LAB — 2000 TO 2004
Research Consultant

UNIVERSITY OF MICHIGAN, ANN ARBOR, MI
COOPERATIVE INSTITUTE FOR LIMNOLOGICAL AND ECOLOGICAL RESEARCH
GREAT LAKES ENVIRONMENTAL RESEARCH LAB — 1997 TO 2000
Programmer/Analyst

SHIELD INSURANCE SERVICES, GRAND RAPIDS, MI — 1996 TO 1997
Applications Developer

EDUCATION

B.S., Fisheries and Wildlife, Michigan State University, East Lansing, MI — 1995

AWARDS

NOAA Bronze Medal — 2007
For inventing and refining an inexpensive electronic measuring device to provide quick and accurate measurements of fish lengths.

PUBLICATIONS

Honkalehto, T.H., Ressler, P.H., Towler, R.H., and Wilson, C.D. 2011. Using acoustic data from fishing vessels to estimate walleye pollock abundance in the eastern Bering Sea. Can J. Fish. Aquat. Sci.68:1231-1242.

Williams, K., Towler, R., Wilson, C. D. 2010. Cam-Trawl: A Combination Trawl and Stereo Camera System. Sea Technology 51(12): 45-50.

Williams, K., Rooper, C. N., Towler, R. 2010. Use of stereo camera systems for assessment of rockfish abundance in untrawlable areas and for recording pollock behavior during midwater trawls. Fish Bull 108(3): 352-362.

Towler R., Williams K., 2010. An inexpensive millimeter-accuracy electronic length measuring board. Fisheries Research 106: 107-111

Kotwicki, S., De Robertis, A., von Szalay, P., Towler, R. 2009. The effect of light intensity on the availability of walleye pollock (*Theragra chalcogramma*) to bottom trawl and echo-integration trawl surveys in the Eastern Bering Sea. Can J. Fish. Aquat. Sci., 6:983-994

Henderson, M J, Horne, J K, Towler, R H 2007. The influence of beam position and swimming direction on fish target strength. ICES Journal of Marine Science, 65: 226–237.

Towler, R H, Jech, J M, Horne, J K 2003. Visualizing fish movement, behavior, and acoustic backscatter. Aquat. Living Resour., 16: 277-282.