U.S.-Canada Technical Sub-Committee (TSC) of the Canada-U.S. Groundfish Committee Presents:

Visual Survey Methods Workshop

April 8 & 9, 2014

Project Profiles of Workshop Participants

Workshop Co-chairs:

Kristen Green, Dayv Lowry, Lynne Yamanaka

Alaska Fisheries Science Center, Sand Point, Seattle, WA

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INTERNATIONAL PACIFIC HALIBUT COMMISSION (IPHC)

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NATIONAL MARINE SANCTUARIES (NMS)

OREGON DEPARTMENT OF FISH AND WILDLIFE (ODFW)

QUINAULT INDIAN NATION

WASHINGTON DEPARTMENT OF FISH AND GAME (WDFW)

WASHINGTON STATE UNIVERSITY (WSU)

Visual Survey Workshop April 2014

ADFG Central Region Groundfish ROV Surveys

Mike Byerly, Josh Mumm, Kenneth Goldman
Alaska Department of Fish and Game

SUMMARY

The Alaska Department of Fish and Game (ADFG) has conducted visual surveys for lingcod and the demersal shelf rockfish complex (with primary emphasis on yelloweye rockfish) in coastal waters of northern Gulf of Alaska since 2005. The DSR complex includes yelloweye, canary, China, copper, rosethorn, quillback, and tiger rockfish. The ROV *Buttercup*, a large observation class ROV is owned by ADFG and has been used to conduct these surveys. Strip transect sampling was used in earlier surveys but distance sampling methods are currently used to estimate density. A series of index sites on the scale of 150 to 400 km^2 are sampled on a rotational basis to track local abundance. Index sites represent a spectrum of harvest histories from de facto reserve to high harvest and are located on rocky banks or coast lines separated by deeper glacial fjords.

AT A GLANCE

Survey frequency:	Annually
Survey initiated:	2005
Survey goal:	Stock assessment
Current vehicle:	ROV (Phantom)
Make/Model:	Deep Ocean Engineering Phantom HD 2+2
Target species:	Lingcod and Yelloweye rockfish
Unit of measurement:	Density (fish/km^2)

SURVEY AREA

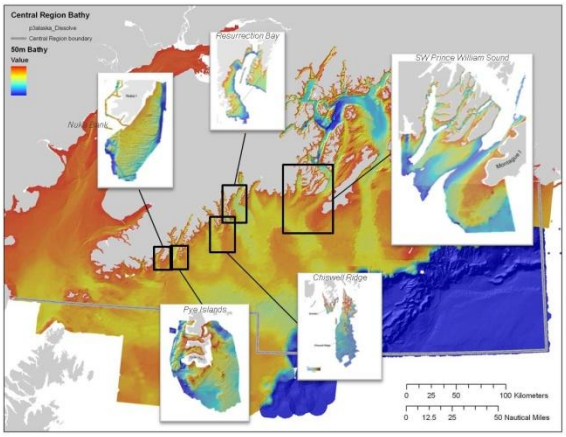

Figure 1. Map of survey index sites for ADF&G Central Region.

METHODS

Survey design:	Random stratified
Depth surveyed (m):	25-200
Camera type:	Machine vision stereo plus low-light wide angle forward and down looking cameras
Camera definition:	High and Standard Definition
Data recorded:	Hard drive (currently)
Vehicle lights:	LED and halogen
Sample unit:	Line transect
Length/time of unit:	300 m
Max sea state:	20 knot winds/6' seas
Habitat reviewed?	Yes, from video.
Video review software:	Event Measure (SeaGIS)

RESULTS

We have completed seven ROV surveys thus far at five different sites. The 2013 survey was the first to revisit a survey site and an earlier survey was conducted to test for responsive movement effects and quantify the 100% detectability assumption. CV's of density estimates among sites have ranged from 15 – 21 % for yelloweye rockfish and 21 – 33% for lingcod. The more patchy distribution of lingcod contributed to the lower precision. Significant differences have been detected between sites indicating adequate power to detect differences in spatial distribution.

MANAGEMENT

Survey data have been used in various contexts to inform management decisions. Abundance and biomass estimates coupled with area specific harvest have been used to estimate exploitation rate for sites sampled. Abundance estimates from Resurrection Bay were used to evaluate harvest rate output from a spawning biomass per recruit model. The goal with the current survey approach is to use abundance and biomass estimates as a tuning index within a region wide population dynamics model.

FUTURE DIRECTIONS

Simulations utilizing data collected over the course of this program will be done to evaluate sampling design, sample size, and appropriate scale of sampling sites. Thus far rocky seafloor features have been delineated for areas where multibeam sonar data exists while preliminary delineations have been completed for single beam / lead line surveyed areas. We will be evaluating the precision and accuracy of rocky substrate classification with the goal of delineating rocky seafloor features for all of Central Region. This in combination with simulation results will help us reevaluate our current program and possibly increase the spatial scale of our surveys. A machine vision stereo camera system utilizing a new fiber optic tether was added to the ROV in 2013. This was a large technical jump that we are still struggling with but hope to have fully operational for the 2014 survey season.

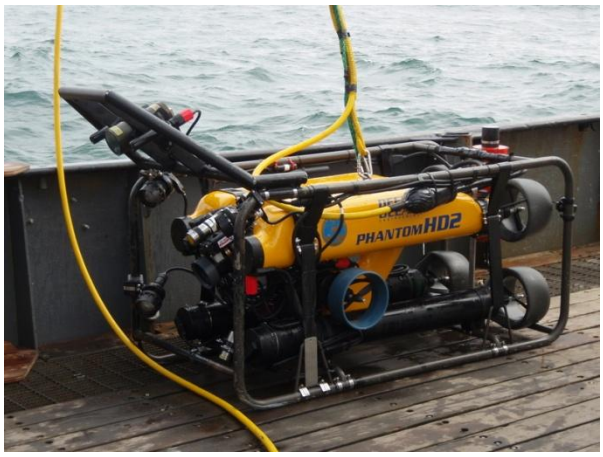

Figure 2. Buttercup showing forward and belly cameras. Not shown are stereo cameras and auxiliary light frame.

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Southeast Region ADFG

(Kristen Green, Jennifer Stahl, Martina Kallenberger)

Visual Survey Workshop April 2014

ADFG Southeast Region Gulf of Alaska Demersal Shelf Rockfish Stock Assessment

Kristen Green, Jennifer Stahl, Martina Kallenberger
Alaska Department of Fish and Game

SUMMARY

The Alaska Department of Fish and Game (ADFG) has conducted visual surveys for the demersal shelf rockfish (DSR) complex in Southeast Alaska since 1989. The species complex includes yelloweye, canary, China, copper, rosethorn, quillback, and tiger rockfish. Yelloweye rockfish account for approximately 96% of DSR harvest, and stock assessment is focused primarily on assessing yelloweye biomass. Stock assessment surveys were conducted using the *Delta* submersible from 1989–2009, but since 2012, a remote operated vehicle (ROV), R/V *Buttercup*, has been used. Distance sampling methods using line transects are used to estimate yelloweye rockfish density with the ROV. Yelloweye rockfish biomass estimates are used to determine an acceptable biological catch for the DSR complex for the commercial and recreational fisheries.

AT A GLANCE

Survey frequency:	Annually
Survey initiated:	1989 (Sub) 2012 (ROV)
Survey goal:	Stock assessment
Current vehicle:	ROV (Phantom)
Make/Model:	Deep Ocean Engineering Phantom HD 2+2
Target species:	Yelloweye rockfish
Unit of measurement:	Density (fish/km^2)

SURVEY AREA

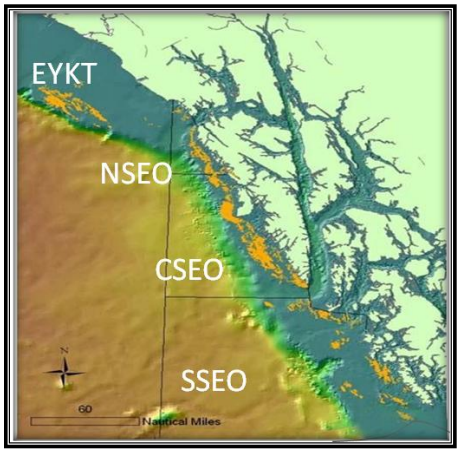

Figure 3.–Map of survey locations: (East Yakutat (EYKT), Northern Southeast Outside (NSEO), Central Southeast Outside (CSEO), Southern Southeast Outside (SSEO).

METHODS

Survey design:	Random stratified
Depth surveyed (m):	100-300
Camera type:	Paired stereo
Camera definition:	High Definition
Data recorded:	Mini DV/hard drive
Vehicle lights:	LED and halogen
Sample unit:	Line transect
Length/time of unit:	1 km
Max sea state:	20 knot winds/6' seas
Habitat reviewed?	Yes, from video.
Video review software:	Event Measure (SeaGIS)

RESULTS

ROV visual surveys were conducted in 2012 and 2013. Density estimates were similar in magnitude to submersible surveys: 752 yelloweye rockfish/km^2 in CSEO in 2012 and 986 yelloweye rockfish/km^2 in SSEO in 2013. Coefficient of variation estimates indicate reasonable precision in density estimates (13% to 22%). Probability detection models were obtained that fit the distance data well. There was no indication of yelloweye rockfish attraction or avoidance behavior from examination of frequency histograms of fish distances or fish behavior from video.

MANAGEMENT

The State of Alaska has management jurisdiction for DSR stocks out to 200 nm in the Eastern Gulf of Alaska. ADFG is responsible for the assessment and management of DSR and submits a Stock Assessment and Fishery Evaluation (SAFE) report annually to the North Pacific Fishery Management Council (Council). The SAFE is reviewed by the Groundfish Plan Team, the Science and Statistical Committee, and the Council. The Council sets a total allowable catch for DSR, which is used to set guideline harvest levels for the commercial and recreational fisheries. The visual surveys described above are the basis of the stock assessment, but commercial fishery catch per unit effort and age, length, weight, and maturity information are also considered.

FUTURE DIRECTIONS

In 2014, an ROV survey will be conducted in the NSEO and EYKT management areas, which will complete a full "cycle" of ROV survey work in the four management areas of the Eastern Gulf of Alaska. Visual surveys will be conducted as time and funding allows in each management area. In the future, visual survey indices of yelloweye rockfish abundance will be incorporated into an age structured assessment model along with total catch, age, weight, length and maturity data to determine yelloweye rockfish biomass. We also plan to explore using fish length data collected from the ROV to calculate biomass using length to weight relationships.

Figure 4.–R/V Buttercup deployed off Cape Edgecumbe, near Sitka, Alaska in 2012.

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Visual Survey Workshop April 2014

IPHC Standardized Stock Assessment Survey

Claude Dykstra
International Pacific Halibut Commission

SUMMARY

The International Pacific Halibut Commission (IPHC) has conducted extractive surveys for the management of Pacific halibut since the 1920's. Systematic setline surveys have been conducted annually in depths of 20-275 ftm along the continental shelves of Oregon, Washington, British Columbia, and Alaska, extending into the Bering Sea (Figure 1). All halibut are measured, legal sized halibut are sampled, and a subset of juvenile halibut is sacrificed for biological data. Incidental catch of other species are generally subsampled for enumeration, and in some cases for biological sampling. In some areas full species accounting occurs, and biological information is collected for certain species in cooperation with state and federal agencies. Video and DIDSON sonar imagery have been collected for hooking success classification in the form of independent experiments (not part of the annual systematic survey).

AT A GLANCE

Survey frequency:	Annually
Survey initiated:	1998 (current design)
Survey goal:	Stock assessment
Current vehicle:	Longline vessels
Gear:	1,800 foot skates, 100 #3 (16/0) circle hooks on 18' spacing
Target species:	Pacific halibut
Unit of measurement:	Density (lbs/skate)

SURVEY AREA

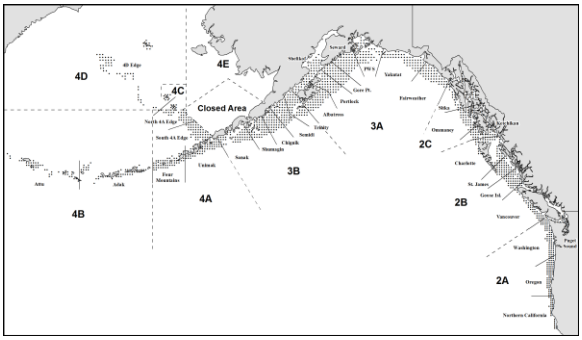

Figure 5.–Map of survey locations: (2A: CA, OR, WA, 2B: BC, 2C: southeast AK, 3A: central GoA, 3B: western GoA, 4A: southern Bering, and eastern Aleutians, 4B: western Aleutians, 4CDE: northern Bering Sea.

METHODS

Survey design:	Systematic Grid
Depth surveyed (m):	36-503 (20-275 ftm)
Sample unit:	Line transect / skate
Survey design:	Hooking success
Depth surveyed (m):	36-503 (20-275 ftm)
Camera type:	DIDSON (Dual frequency Identification Sonar) acoustic camera
Camera definition:	1.8 MHz, 29° arc. Focal point 3m –10m.
Data recorded:	streamed to hard drive
Vehicle lights:	N/A
Sample unit: event	Successful hooking
Length/time of unit:	1 hour increments
Max sea state:	< 4' seas when tethered

RESULTS

Survey Catch: standardized survey information is used as an index of abundance and is used in concert with data collected from the commercial and recreational fleets.

DIDSON: observations of bait attack rates and hooking success coupled with size estimation feed into hooking success estimations (Figure 2).

Video: observations of bait attack rates and hooking success coupled with size estimation feed into hooking success estimations.

MANAGEMENT

The International Pacific Halibut Commission (IPHC), originally called the International Fisheries Commission, was established in 1923 by a Convention between the governments of Canada and the United States of America. Its mandate is research on and management of the stocks of Pacific halibut (*Hippoglossus stenolepis*) within the Convention waters of both nations.

The IPHC conducts numerous projects annually to support both major mandates: stock assessment and basic halibut biology. Current projects include standardized stock assessment fishing surveys from northern California to the end of the Aleutian Islands, as well as field sampling in major fishing ports to collect scientific information from the halibut fleet. In conjunction with these ongoing programs, the IPHC conducts numerous biological and scientific experiments to further the understanding and information about Pacific halibut.

FUTURE DIRECTIONS

Commercial and recreational capture records indicate that fishing occurs outside of standard survey depths during the time of our surveys. Expansion of the survey into waters shallower than 20 ftm (up to 10 ftm) and deeper than 275 ftm (down to 400 ftm) following the 10 nm x 10 nm convention are planned coastwise over a 5 year period. This will allow calibration of catch rates into those unsurveyed areas. Hooking success rates to be further studied using GoPro cameras on larger sized halibut to occur in 2014.

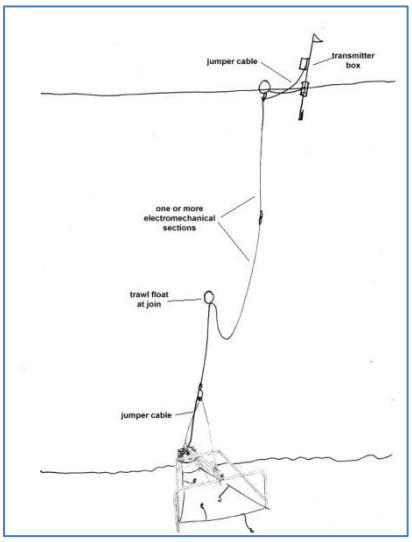

Figure 6. DIDSON hooking success study schematic (2007).

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Visual Survey Workshop April 2014

Fisheries and Oceans Canada

DFO Canada Evaluating Rockfish Conservation Areas in B.C.

K. Lynne Yamanaka Department of Fisheries and Oceans Canada

SUMMARY

Rockfish Conservation Areas (RCAs) were established as a spatial fishery management tool to protect a portion of the inshore rockfish stocks from harvest (DFO 2002). This management measure, together with reductions in fishing mortality, improvements to catch monitoring and stock assessment were the pillars of an inshore rockfish conservation strategy initiated by DFO in 2002 (Yamanaka and Logan 2011). Over five years, 169 RCAs were established coastwide in B.C. meeting the targets of 20 to 30 percent of rockfish habitats protected from fishing activity. Video survey methods were developed and research surveys conducted between 2009 and 2011 initially to establish a baseline of data on nearshore reef-fish abundance and their associated habitats and then to monitor the efficacy of the RCAs in protecting a portion of the rockfish stock from harvest.

AT A GLANCE

Survey frequency:	Semi-Annually
Survey period:	2009 - 2011
Survey goal:	Monitoring and Stock assessment
Current vehicle: Make/Model:	ROV (Phantom) Deep Ocean Engineering Phantom HD 2+2
Target species:	Quillback and Yelloweye rockfishes
Unit of measurement:	Density (fish/km^2)

SURVEY AREA

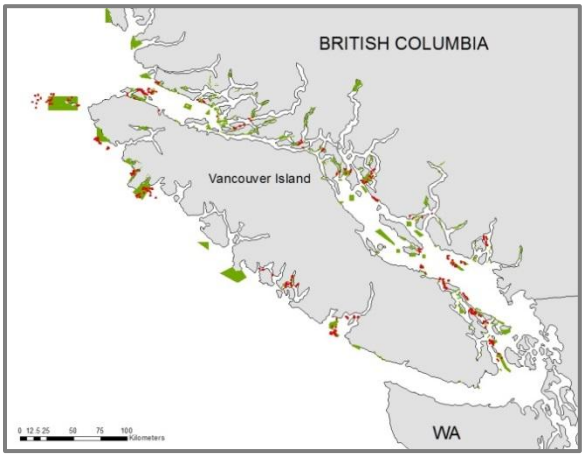

Figure 7. Map of the southern portion of British Columbia showing the Rockfish Conservation Areas in green and the ROV survey tracks in red.

METHODS

Survey design:	Random stratified (depth and substrate)
Depth surveyed (m):	20 - 150
Camera types:	MiniZeus from Insite Pacific; Cyclops
Camera definition:	1080i video (HD-SDI), 8MP still photos
Data recorded:	Hard drives
Vehicle lights:	LED
Sample unit:	Strip transect
Length/time of unit:	500 m
Max sea state:	1.5 – 2 m
Habitat reviewed?	Yes
Video review software:	DVLog, VideoMiner

MANAGEMENT

Since the establishment of the RCAs, discussions have focused on whether these RCAs or closed areas contribute to the overall stock (do RCAs work?) and how to 'treat' a place-based spatial management tool, such as RCAs, in a traditional population-based fisheries stock assessment (Field et al. 2006). This project will primarily investigate the efficacy of RCAs as a spatial management tool and secondarily consider how or if these RCAs and their benefits (if any) could be incorporated into inshore rockfish stock assessments. To evaluate the efficacy of RCAs, research and analyses will be conducted using the 2009–2011 video data combined with habitat maps derived from remotely sensed acoustic data (Yamanaka and Flemming 2013). Reef-fish densities will be determined using strip transect methods over various habitats and compared within and adjacent to RCAs. RCAs are removed from coastwide survey frames and hence do not contribute data into traditional population stock assessments. However, if the RCAs are working as hatcheries for fish stocks, with spill-over of recruits into fished areas, how could this be incorporated into traditional stock assessment? New spatial approaches to stock assessment integrating visual data from both within and adjacent to RCAs and using habitats maps to project biomass over larger areas will be investigated.

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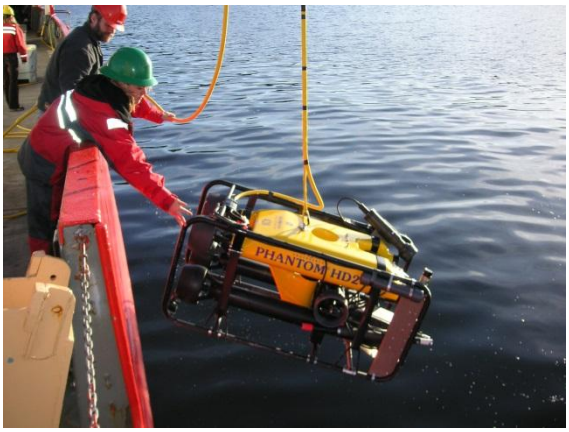

Figure 8. Phantom ROV deployed off the *CCGS Vector*, near Nanaimo, B.C. photo: W. Carolsfeld.

DFO 2002. Towards an Inshore Rockfish Conservation Plan: A structure for consulation. Draft February 2002 36 p.

Field, J.C., Punt, A.E., Methot, R.D. and Thomson, C.J. 2006. Does MPA mean 'Major Problem for Assessments'? Fish and Fisheries vol 7: 284-302.

Yamanaka, K.L. and R. Flemming. 2013. Development of spatial management tools to address fisheries conservation concerns for quillback rockfish (*Sebastes maliger*) in British Columbia Canada. GIS Spatial analyses in Fishery and Aquatic Sciences Vol 5: 199 – 214 p.

Yamanaka, K. L. and G. Logan. 2010. Developing British Columbia's Inshore Rockfish Conservation Strategy. Marine and Coastal Fisheries: Dynamics, Management and Ecosystem Science 2:28–46.

Visual Survey Workshop April 2014

Fisheries and Oceans Canada

DFO Canada World Class Tanker Safety System Benthic Habitat Mapping

Sarah Davies, Jessica Finney, James Pegg, Wolfgang Carolsfeld, Lisa, Lacko, Graham Gillespie
Fisheries and Oceans Canada

SUMMARY

The transportation of oil and hazardous and noxious substances is expected to increase along the coast of Canada. In anticipation of these changes, the Canadian government has implemented a multi-agency World Class Tanker Safety System research program that is dedicated to improving and strengthening the current tanker safety system and emergency response. As a part of this program, Fisheries and Oceans Canada (DFO) Science has been tasked with mapping benthic ecosystems in areas that may be impacted by increased tanker traffic and potential spills. One component of this work will involve ROV surveys along the North coast of British Columbia (B.C.) onboard the CCGS Vector in September 2013 and May and September 2014. Surveys will be conducted between 50-300 m. Data collected from these surveys will be compiled and used to address objectives listed below.

Goal:

- Map benthic ecosystems along proposed tanker route through B.C.'s North coast

Specific objectives:

- Groundtruth benthic substrate classification derived from multibeam and backscatter data;
- Develop list of benthic species observed;
- Identify species community structure; and
- Model distribution of species that are harvested by commercial, recreational, or Aboriginal fisheries, as well as species of concern.

SURVEY AREA

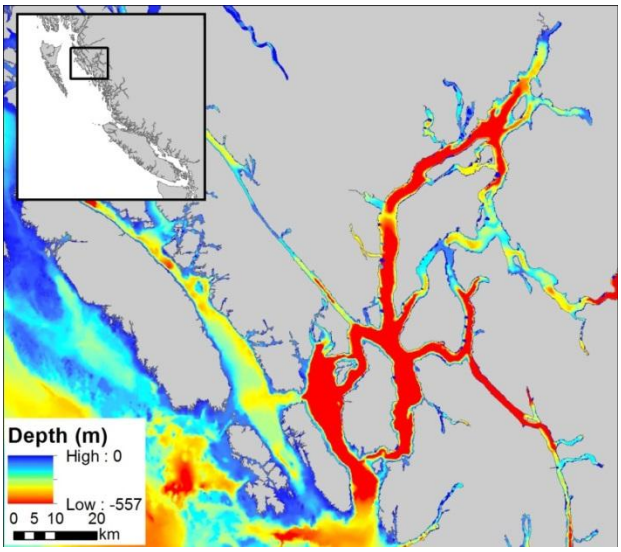

Figure 1. Map of study area for the first stage of the World Class Tanker Safety System benthic habitat mapping project.

AT A GLANCE

Survey frequency: Three times (September 2013; May 2014; September 2014)

Survey initiated: 2013

Survey goal: Benthic species and habitat mapping

Current vehicle: ROV (Phantom)

Make/Model: Deep Ocean Engineering Phantom HD 2+2

Target species: Invertebrate species that are harvested by commercial, recreational or Aboriginal fisheries & species of concern

Unit of measurement: Count

METHODS

Survey design: Random stratified

Depth surveyed (m): 50 **–** 300 m

Camera type: MiniZeus from Insite Pacific; Cyclops

Camera definition: 1080i video (HD-SDI), 8MP still photos

Data recorded: Hard drives

Vehicle lights: LED

Sample unit: Line transect

Length/time of unit: ~ 200m

Max sea state: 4-6’

Habitat reviewed? Yes, from video

Video review software: Video Miner

RESULTS

A preliminary survey was completed in September 2013. Initial analysis from that survey has not yet been completed. However, personal observations suggest that there are different species assemblages on opposite sides of channels, possibly due to tidal or current influences. Planning for the May and September surveys is currently underway.

MANAGEMENT

This project is part of a multi-agency approach to improve tanker safety and disaster response along B.C.’s North coast. Results from this project will be used by first responders to focus emergency response resources on habitats and/or species deemed to be at greater risk in the event of an oil spill along the proposed tanker route.

FUTURE DIRECTIONS

In the coming years additional surveys will be conducted in other areas of the B.C. coast that could be impacted by increased tanker traffic and/or spills.

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Visual Survey Workshop

WDFW Rockfish Critical Habitat Groundtruthing in Puget Sound

Robert Pacunski, Dayv Lowry, Jennifer Blaine
Washington Department of Fish and Wildlife

SUMMARY

Marine Fish Science staff from the Washington Department of Fish and Wildlife (WDFW) have conducted visual surveys of benthic habitats in Puget Sound since 1994. These surveys have focused primarily on the distribution and abundance of rockfish, greenling, and other structure-oriented fishes. From 1994-2004 a drop-camera system was employed but was limited to depths ≤120 feet. In 2004 use of a remotely-operated vehicle (ROV) rated to 1000 feet began, providing the ability to reach 99% of the Puget Sound seafloor. Habitat data collected from surveys has been used to groundtruth potential habitat maps created from multibeam echosounder (MBES) surveys (Figure 1) in an effort to model critical habitat associations and use patterns, especially those of ESA-listed Puget Sound/Georgia Basin bocaccio, yelloweye and canary rockfish. ROV surveys were conducted in the San Juan Archipelago in 2004, 2005, 2008, and 2010 (see METHODS OVER TIME). The first three surveys were habitat-stratified, whereas the last was designed to sample all habitats in proportion to their occurrence. A Deep Ocean Engineering Phantom HD2+2 ROV was used in 2004 and 2005 and a Seaeye Falcon ROV was used in 2008 and 2010. While similar in size and capabilities, the vehicles differ substantially in their mechanical, electrical, and electronic configurations. Survey designs varied between years with transects ranging from 10 min (2004) to one hour (2010).

AT A GLANCE

Survey frequency:	Intermittent
Survey initiated:	1994 (Drop-cam) 2004 (ROV)
Survey goal:	Habitat associations
Current vehicle:	ROV (Seaeye Falcon)
Target species:	All groundfish
Unit of measurement:	Presence and density

SURVEY AREA

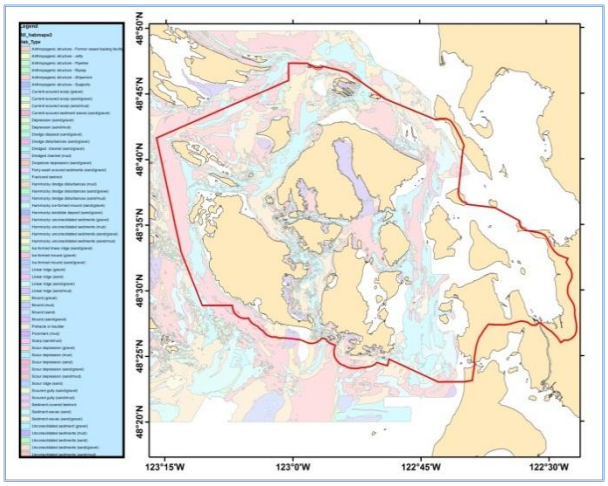

Figure 9. Map of San Juan Archipelago with potential benthic habitats classified from multibeam echosounder and backscatter surveys. (Source: Greene *et al.* 2008)

METHODS OVER TIME

Year	Survey design	ROV	Target species
2004	Depth and Habitat-stratified; two depth zones (<40 m, ≥40 m), all habitats (four categories)	Deep Ocean Engineering Phantom HD 2+2	All bottomfish
2005	Depth and Habitat-stratified; two depth zones (<40 m, ≥40 m), rock and high-relief habitats	Deep Ocean Engineering Phantom HD 2+2	Rockfish, lingcod, greenling, cabezon
2008	Randomized transect location, Depth and Habitat-stratified; two depth zones (<40 m, ≥40 m), rock and high-relief habitats	SAAB Seaeye Falcon 12105	Rockfish, lingcod, greenling, cabezon
2010	Stereological design: systematic sampling with fixed transect location	SAAB Seaeye Falcon 12105 (with additional light-bar)	All bottomfish

RESULTS

In total, 520 ROV transects were completed during the four surveys conducted since 2004 and approximately 350 hours of video (tape and digital) were collected. The habitat information recorded from these surveys was strongly correlated with the MBES potential habitat maps and support the habitat classification methods used by Greene *et al.* (2008). Results of these surveys are now being used to build predictive models of habitat-suitability and distribution for ESA-listed rockfish and other more common Puget Sound rockfish species.

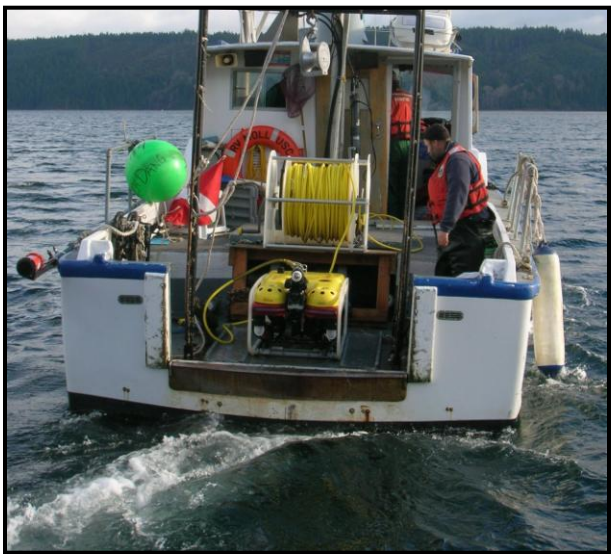

Figure 10. "Yelloweye" ROV onboard the 36' *R/V Molluscan* in the San Juan Islands in 2008.

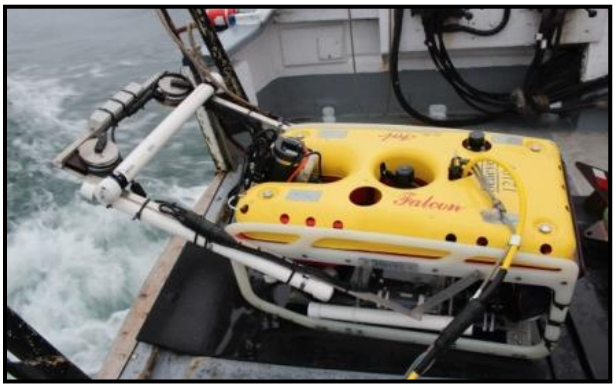

Figure 3. "Yelloweye" ROV in 2010, after the addition of the downward-facing light-bar.

RECENT EFFORTS

Based on the stereological design used in the 2010 survey of the San Juan Islands, WDFW Marine Fish Science staff conducted an ROV survey in 2012-13 that covered the entirety of Puget Sound (see Project Profile for "Puget Sound-wide Groundfish Distribution and Abundance Assessment"). In contrast to the San Juan Islands, habitat information for most of the Puget Sound basin is limited or missing, and the goal of this survey was to estimate the abundance of common groundfish species and the proportion of major habitat types present in Puget Sound. These data are currently being processed and will be used to design successive ROV surveys of the region.

WDFW continues to use the Falcon ROV regularly on a variety of projects and is frequently updating technologies. Most recently, they obtained and installed a high-definition camera (OneCam SubC) and a mini-CTD sensor (Valeport).

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Visual Survey Workshop April 2014

WDFW Puget Sound-wide Groundfish Distribution and Abundance Assessment

Dayv Lowry, Robert Pacunski, Jennifer Blaine, Lisa Hillier
Washington Department of Fish and Wildlife

SUMMARY

Building upon visual survey work conducted in the San Juan Archipelago between 1994 and 2010 (see Project Profile "Rockfish Critical Habitat groundtruthing in Puget Sound"), in 2012 Marine Fish Science staff from the Washington Department of Fish and Wildlife (WDFW) conducted an ROV-based survey of the entire Puget Sound (Figure 1). While prior surveys focused primarily on the distribution and abundance of structure-oriented fishes, this survey employed a stereological design to sample habitats, and presumably species, in proportion to their occurrence in the Sound. Sampling all habitat types allows abundance estimates to be made for each species encountered during the survey, with an associated estimate of variation, on a Sound-wide basis. Additionally, the frequency of occurrence for each species on each habitat type can be used in future modeling and survey design efforts, as well as for targeted species assessment efforts. Strip transects lasted 60 minutes at each station and were generally conducted along a relatively consistent depth contour. Stations were surveyed during all hours of the day in an effort to account for diurnal variability in fish behavior. A total of 215 stations were planned and 197 of these were completed. Video review is underway and should be complete by May of 2014.

AT A GLANCE

Survey frequency:	Every 5 years? (Or as possible)
Survey initiated:	2012
Survey goal:	Abundance estimates; habitat associations
Current vehicle:	ROV (Seaeye Falcon)
Target species:	All groundfish
Unit of measurement:	Presence and density

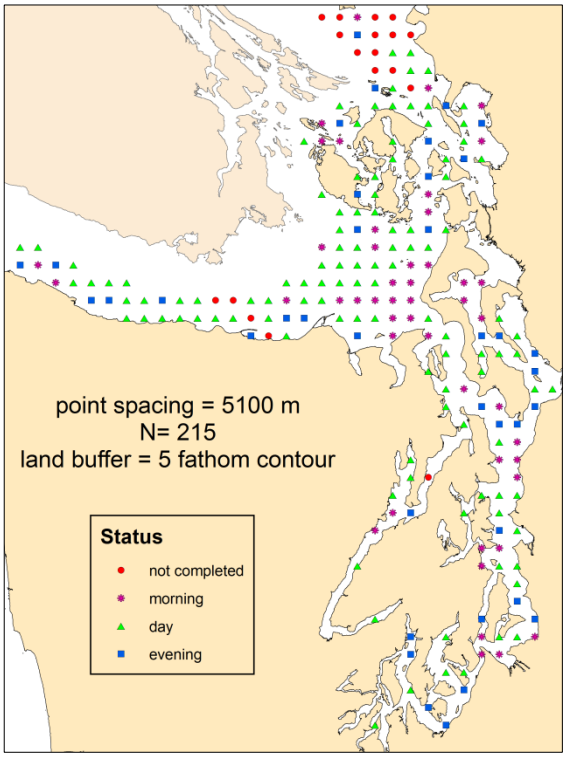

Figure 11. Map of Puget Sound showing planned and completed stations from the Sound-wide survey. Morning = 0001-0800; Day = 0801-1600; Night = 1601-0000.

METHODS

Survey design:	Stereological (random uniform)
Depth surveyed (m):	10-330
Vehicle make/model:	Seaeye (Falcon)
Camera type:	Single, forward-facing
Camera definition:	SD
Data recorded:	Hard drive
Vehicle lights:	LED and halogen
Sample unit:	Strip transect
Length/time of unit:	60 min
Max sea state:	15 knot winds/6' seas
Habitat review:	Yes, at several levels
Video review software:	VLC Media Player and Access database

RESULTS

To date, the field component of the survey is complete and 142 of 197 video files have undergone primary review for biological and habitat data. Staffing shortages and competing priorities have prevented meeting initial project deadlines, but video analysis should be complete by May of 2014. Preliminary results demonstrate that: 1) much of Puget Sound consists of mud or mud/sand bottom; 2) high-relief, rocky habitats are patchily distributed and clustered to the "edges" of most sub-basins; 3) while many species demonstrate "anticipated" habitat associations, some occur at higher proportions on habitats not predicted at the onset of the study (e.g., records of rockfish over open mud flats); and 4) biases in species detection, as evaluated by comparison with trawl survey data, may significantly hamper the utility of visual surveys for flatfishes and species that are demersal but not benthic (i.e., occur too far off the bottom to be regularly detected by the ROV).

MANAGEMENT

Data from this study are pending final collection, QA/QC, analysis, and interpretation. The ultimate goal is to develop a comprehensive survey program for Puget Sound groundfish that generates unbiased abundance estimates for use in stock assessment and status evaluations in support of fishery management activities. This program may incorporate benthic trawling, ROV surveys, hydroacoustics, and targeted scuba surveys. Ongoing studies, including the one here, are evaluating the utility and comparability of each method to ensure data are scientifically defensible and can be obtained in a timely manner for a reasonable cost.

Habitat associations for both individual species and species assemblages will be used to evaluate fishery regulation changes in the future, potentially allowing localized or sub-basin-specific fisheries for select species when the absence of species of special concern can be reasonably presumed.

FUTURE DIRECTIONS

WDFW continues to use the Falcon ROV regularly on a variety of projects and is frequently updating technologies. Most recently, they obtained and installed a high-definition camera (OneCam SubC) and a mini-CTD sensor (Valeport).

Though plans to repeat the Sound-wide survey are contingent on the final results of the study, preliminary results indicate the study will be repeated at 3-5-year intervals in the future.

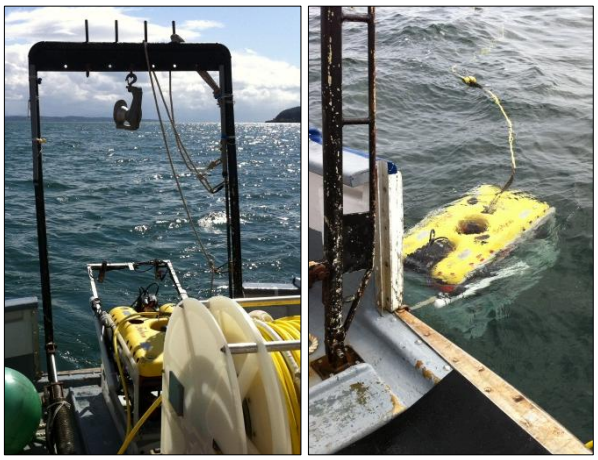

Figure 12. The Seaeye Falcon ROV "Yelloweye" preparing to be deployed from (left) and off the back deck of (right) the 36' *R/V Molluscan*.

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Visual Survey Workshop April 2014

NOAA fisheries Acoustic-Camera Surveys for Rockfish in Untrawlable Areas

Chris Wilson, Chris Rooper, Darin Jones
Alaska Fisheries Science Center, RACE Division

SUMMARY

Since 2006, there has been an ongoing effort within the RACE Division to address concerns with rockfish assessment in untrawlable areas. Much of this research has been collaboration between researchers in MACE and GAP working together with those at the University of New Hampshire Center for Coastal and Ocean Mapping (UNH-CCOM). Visual survey research has focused finding alternative assessment methods for estimating rockfish abundance in untrawlable areas (acoustic-camera surveys). Methodology consists of conducting acoustic surveys and using a stereo drop camera (Williams et al. 2010) to verify targets by species and length. Results of previous studies can be found in Rooper et al. (2010), Jones et al. (2012) and Rooper et al. (2012).

AT A GLANCE

Survey frequency:	Biennial (eventually)
Survey initiated:	2008-09 (pilot work)
Survey goal:	Abundance estimates
Current vehicle:	DropCam
Make/Model:	NA
Target species:	Semi-pelagic rockfish
Unit of measurement:	Density (kg/ha)

SURVEY AREAS

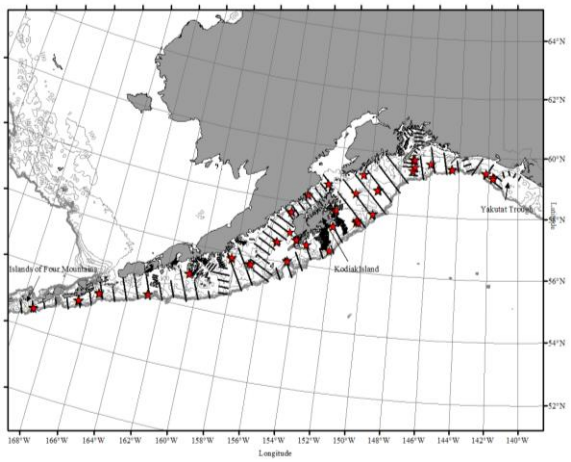

Figure 13.– MACE summer pollock acoustic-trawl survey trackline. Red stars show locations of acoustic-camera surveys.

METHODS

Survey design:	Random systematic
Depth surveyed (m):	50-300 m
Camera type:	Paired stereo
Camera definition:	High Definition
Data recorded:	Hard drive
Vehicle lights:	LED strobes
Sample unit:	Acoustic transect
Length/time of unit:	15 minutes- 1 hour
Max sea state:	25 knot winds/8' seas
Habitat reviewed?	Yes
Video review software:	SEBASTES

RESULTS

Initial studies were carried out in 2008 and 2009 in the eastern Bering Sea and Gulf of Alaska to develop techniques. A pilot study was conducted during the summer 2013 MACE pollock acoustic-trawl GOA survey. At night, small-scale Acoustic-Camera surveys were conducted within a group of 37 grid cells identified as untrawlable (n =16) or trawlable (n = 18) based on the RACE GOA bottom trawl survey grid pattern. The AC surveys consisted of a single pass along three parallel transects spaced 0.6 nmi apart within each cell to collect multibeam (Simrad ME70) and split-beam (EK60) echosounder data. Up to 3 stereo camera drops were also conducted to determine habitat characteristics and fish species and size composition information within each grid cell. These data will be analyzed in 2014 to produce biomass estimates for rockfish in the matched trawlable and untrawlable grid cells.

MANAGEMENT

The eventual goal of this project is to provide usable biomass estimates (and variances) for semi-pelagic rockfish species in the Gulf of Alaska in untrawlable areas. This would complement the biomass estimates provided by the biennial GOA bottom trawl surveys to provide a more accurate picture of rockfish biomass trends in the ecosystem for stock assessment.

FUTURE DIRECTIONS

In the future, we hope to combine the AC surveys with the MACE AT survey for pollock in the GOA. We are also conducting experiments to examine rockfish behavior in the presence of our drop camera and other camera systems, as well as developing new camera systems that will be suitable for verifying acoustic targets for surveys.

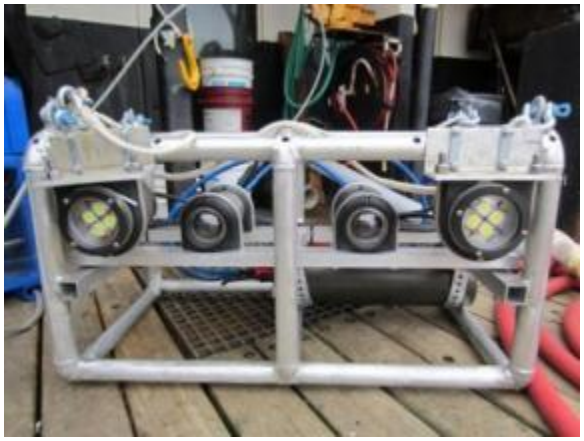

Figure 3.–Stereo DropCam deployed during AC surveys of untrawlable areas.

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April 2014 Visual Survey Workshop

NOAA fisheries Aleutian Islands and Eastern Bering Sea Coral and Sponge Surveys

Chris Rooper
Alaska Fisheries Science Center, RACE Division

SUMMARY

Effective management of deep coral and sponge ecosystems in Alaska requires spatial maps of where these organisms are present, their abundance and their diversity. The large scale of Alaska's marine waters necessitates the development of predictive models to best determine where sponges and corals are located, since not every site can be explored. Therefore a systematic and analytical approach to verifying model predictions is needed to determine model accuracy. We are conducting visual surveys using a drop camera at random locations in the eastern Bering Sea slope and the Aleutian Islands to estimate presence, abundance, diversity and size of coral and sponge and verify model predictions.

AT A GLANCE

Survey frequency:	One-time
Survey initiated:	2012
Survey goal:	Distribution mapping
Current vehicle:	DropCam
Make/Model:	NA
Target species:	Coral and sponge
Unit of measurement:	Density (coral/m^2)

SURVEY AREAS

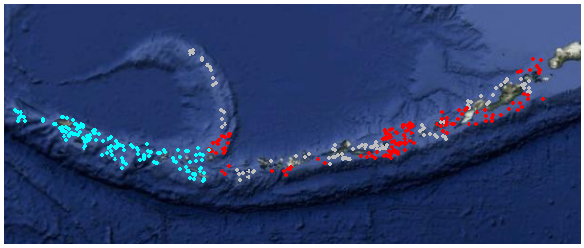

Figure 14.– Randomly selected sampling sites from Unimak Pass to Stalemate Bank, Alaska. Red dots indicate stations to be occupied during 2013, grey dots indicate stations completed in 2012, blue dots indicate stations to be occupied during 2014.

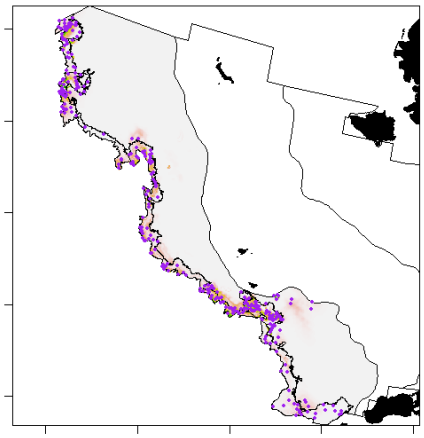

Figure 2.– Randomly selected sampling sites on the outer shelf and slope of the eastern Bering Sea, Alaska. Purple dots indicate stations to be occupied during 2014.

METHODS

Survey design:	Random stratified
Depth surveyed (m):	50-1000 m
Camera type:	Paired stereo
Camera definition:	High Definition
Data recorded:	Hard drive
Vehicle lights:	LED strobes
Sample unit:	Line transect
Length/time of unit:	15 minutes
Max sea state:	25 knot winds/8' seas
Habitat reviewed?	Yes.
Video review software:	SEBASTES

RESULTS

Visual surveys for coral were conducted in summer 2012 in the eastern and central Aleutian Islands. Surveys for coral and sponge will be conducted in FY14 on the eastern Bering Sea slope and in the western Aleutian Islands. The observations of coral presence and absence matched predictions well for coral (correct classification = 67% of transects, AUC = 0.75) and not very well for sponge (correct classification = 77%, AUC = 0.55). Analysis of the data and images is ongoing.

MANAGEMENT

Coral and sponge ecosystems are an important habitat concern facing the NPFMC, the 5-year review of the Essential Fish Habitat – EIS and other issues (such as recent proposed ESA listing for 43 species of coral in Alaska). The models and maps produced by this survey will be invaluable in addressing these questions.

FUTURE DIRECTIONS

Surveys for coral and sponge will be conducted in FY14 on the eastern Bering Sea slope and in the western Aleutian Islands. Images will be analyzed for presence or absence, abundance, diversity and size. Habitat classification will also be performed.

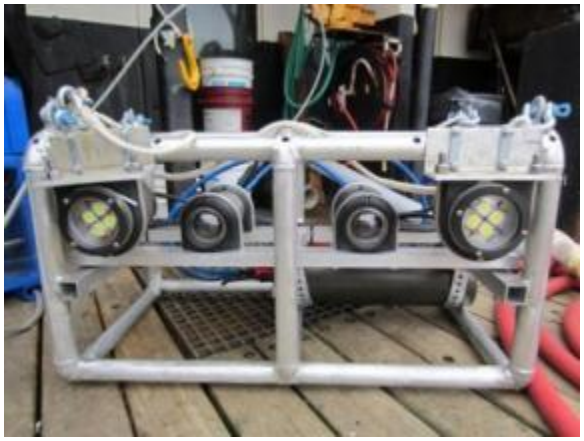

Figure 3.–Stereo DropCam deployed during coral and sponge survey operations.

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Visual Survey Workshop April 2014

NOAA fisheries Steller Sea Lion Prey in the Aleutian Islands

Susanne McDermott, Elizabeth Logerwell, Kimberly Rand
Alaska Fisheries Science Center

SUMMARY

In 1997, the Western stock of the Steller sea lion has been declared endangered. The decline of the sea lion populations has continued with the steepest decline in the Western and Central Aleutian Islands. The Alaska Fisheries Science center has conducted studies to examine interactions between fisheries and the main prey species of Steller sea lions. One of the most common prey species in the Aleutian Islands is Atka mackerel. In order to estimate local abundance and movement patterns, the Alaska Fisheries Science Center has conducted Atka mackerel tag and recovery cruises in the Aleutian Islands. In addition, the relative abundance of other prey species close to rookeries and haulouts has been examined with CPUE data. Since many areas around rookeries and haul outs are in untrawlable grounds, the AFSC is interested in developing an underwater camera tool to estimate prey species distribution and local abundance in areas around rookeries and haulouts as well as define habitat with respect to Steller sea lion foraging patterns. The species most important to Steller sea lion foraging are Atka mackerel, Pacific Cod, POP, Northern rockfish, and Pollock.

To date the AFSC has conducted camera tows in areas where trawl tows were conducted. Preliminary results showed that it is possible to deploy a small camera on a commercial fishing vessel in the often rough ocean conditions in the Aleutian Islands. Data to date are being analyzed.

RESULTS

Camera tows were conducted opportunistically in 2011 and 2012. Data analysis is still in progress.

MANAGEMENT

In order to avoid negative impacts from fishing on Steller sea lion prey species, trawl exclusion zones were established around rookeries and haulouts in 1997. In 2011 the entire Western Aleutian Island subarea was closed to fishing. Just recently (April 2nd 2014) this decision has been reversed in the 2014 Biological opinion and the fishery has been reopened in the Western Aleutian Islands.

It is therefore of utmost importance to understand the local population size of Steller sea lion prey, local exploitation rates and Steller sea lion foraging behavior. Understanding prey composition and

density in untrawlable habitat in the Aleutian Islands will be a large contribution to understanding fisheries impact and Steller sea lion foraging behavior.

FUTURE DIRECTIONS

In 2014, we are planning to deploy an underwater stereo camera during the tag recovery cruise. This camera will be a pilot study to see if this camera can be successfully deployed off a factory trawler. We will attempt to conduct transects in the places where the vessel has trawled and then compare abundance and species composition between camera transects and trawl tows.

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Visual Survey Workshop April 2014

NOAA Fisheries Surveys of West Coast Groundfish and Deep Sea Coral

Elizabeth Clarke, Erica Fruh and Curt Whitmire
NOAA, Northwest Fisheries Science Center

SUMMARY

Visual surveys using a SeaBED type Autonomous Underwater vehicle (Figure 1) are being developed to survey bottomfish in rocky or other areas inaccessible by bottom trawls or other more traditional tools. In addition, several years of surveys have been conducted to determine the distribution of deep seas corals and sponges.

The SeaBED-class AUV is unlike other, more traditional AUV's, in that its vertically oriented twin-hull design provides greatly enhanced stability for low-speed photographic surveys. Built by Woods Hole Oceanographic Institute (WHOI), SeaBED is designed to autonomously follow the terrain approximately 3–4 m above the seafloor, collecting high-resolution color imagery. With a maximum depth range of 2,000 m and maximum single-dive time of 6–8 hours, SeaBED is being used to survey habitats ranging from shallow coral reefs to deep groundfsih environments. SeaBED is programmed with a survey plan while still aboard the ship. Programming parameters include navigational waypoints, speed, altitude to maintain above the seafloor, and frequency of photographs.

AT A GLANCE

Survey frequency:	Sporadically
Survey initiated:	2005
Survey goal:	Stock assessment
Current vehicle:	SeaBED AUV
Make/Model:	SeaBED, Seabed Technologies, Inc.
Target species:	Groundfish and Deep Sea Coral
Unit of measurement:	Density (fish/km^2)

Figure 15.– SeaBED AUV on deck of vessel.

METHODS

Survey design:	Random stratified
Depth surveyed (m):	15-2000 m
Camera type:	Still cameras. Stereo downward and single forward looking
Camera definition:	5 and 11-megapixel still cameras
Data recorded:	Hard drive
Vehicle lights:	Camera Strobe
Sample unit:	Quadrant
Length/time of unit:	3 m^2

The SeaBED AUV carries two downward-looking 5-megapixel still cameras and one forward looking (~35˚) 11-megapixel still camera to aid in fish identification. Lighting is provided by a strobe that is synced with the cameras. Measurement of organisms and features is made using stereo-images. Imagery from the stereo downward-looking cameras is analyzed to characterize fish and benthic communities (Figure 2) while the forward-looking camera imagery provides a slight side view to aid fish species identification. The ability of the AUV to be pre-programmed to conduct very precise overlapping survey tracks allows photomosaics to be created (Figure 3).

RESULTS

It has been proven that the SeaBED AUV can effectively collect information on the distribution of corals, sponges and groundfish in rocky habitat during small scale surveys. The methods and resources for large scale surveys are still being developed.

MANAGEMENT

So far data on groundfish abundance have not been used in stock assessments but have been used to understand the distribution of groundfish on rocky versus soft sediment. Information on the distribution of corals and sponges has been used to inform management decisions on Essential Fish Habitat designations.

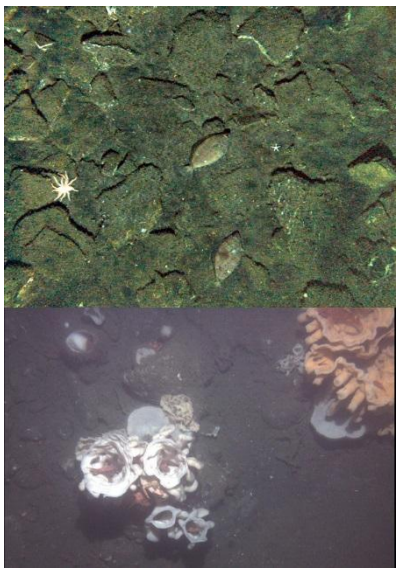

Figure 2.– Example images collected from SeaBED AUV.

FUTURE DIRECTIONS

In 2014, in order to develop methods to allow absolute abundance indices to be determined, an experiment to understand the behavioral responses of fish to the SeaBED AUV, a Phantom AUV and a CBASS towed camera system will be conducted in the Gulf of Mexico. An additional survey to determine the distribution of corals in areas of historical high coral bycatch in depths to 1500 m in Northern California and Southern Oregon will also be conducted in 2014. Absolute abundance estimates will allow survey information to be used in stock assessment in the first year the data area collected.

Figure 3.–Photomosaic of a WWII plane crash developed during surveys with the SeaBED AUV.

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Visual Survey Workshop April 2014

Quinault Indian Nation Taholah, Washington

Joe Schumacker Marine Scientist
Scott Mazzone Marine Fish/Shellfish Biologist

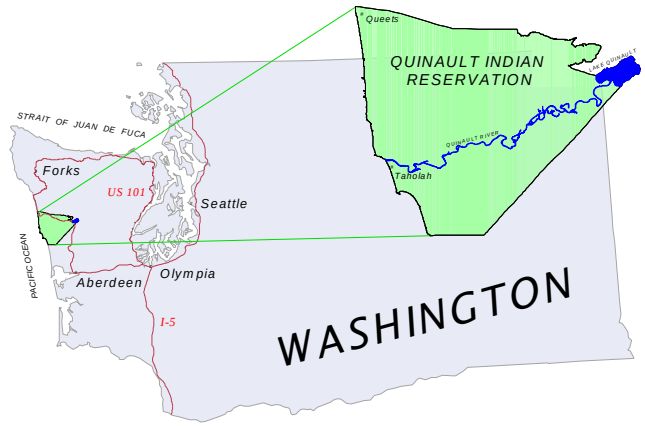
Background

The Quinault Indian Reservation is located on the outer coast of Washington just north of Greys Harbor. The reservation itself is around 325 square miles in size with 23 miles of pristine coastline. In 1974 judge Boldt upheld the tribe's treaty rights with the United Sates and guaranteed Quinault 50% of all fish and shellfish within their Usual and Accustomed (U&A) fishing grounds; an area approximately 3,000 square nautical miles (see Figure 1). Quinault was also granted self-regulatory status. Due to a proven history of sustainable harvest, they are the sole managers of fisheries within the reservation. For ocean fisheries within the U&A, Quinault Dept. of Fisheries co-manages with state and federal authorities.

Visual Surveys

Currently Quinault does not conduct visual surveys, nor have we at any time in the past. This is something we are looking to change in the near future. We see visual surveys as; an effective way to estimate and manage rockfish species in un-trawlable areas, excellent for habitat identification, and useful for resource documentation and mapping.

Unlike other areas, very little work has been done in regard to mapping on the WA outer coast. We are long overdue for a habitat assessment within and adjacent to our U&A in order to see what's out there and to use the information as a tool for ecosystem based management. Accurate habitat identification is key to Marine Spatial Planning.



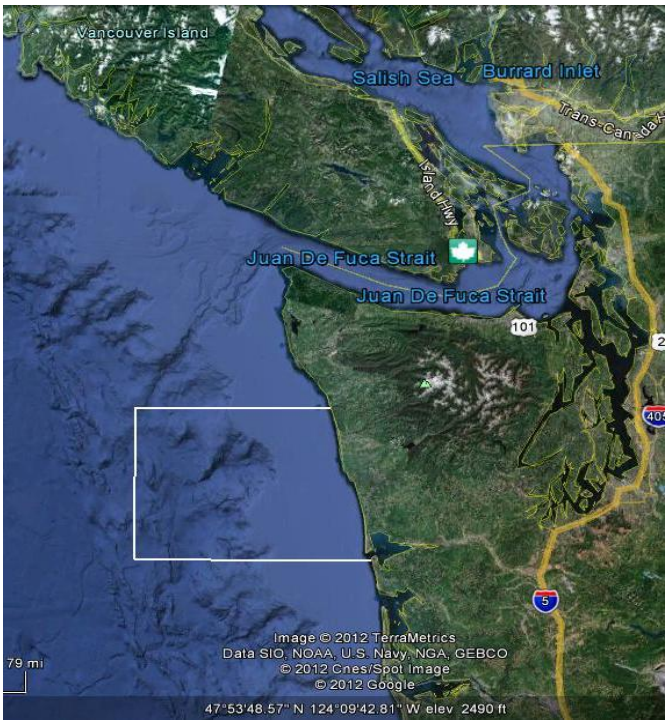


Figure 16.–Top map shows the location of the Quinault Indian Reservation in relation to Washington State. The white outline in the lower map depicts Quinault's Usual and Accustomed (U&A) fishing area.

Currently many of our fisheries allocations are determined by NMFS trawl data. Large areas of our U&A are un-trawlalbe and therefore, we are potentially receiving and managing on inaccurate data regarding the composition and health of fish stock. We see the inclusion of visual surveys within our U&A essential to accurately estimate the current stock, set yearly sustainable catch limits, and protect our treaty share.

We are attending this workshop for the purpose of; learning what types of visual surveys are available, the advantages and disadvantages of each type, survey design and implementation, methods for data analysis, relevance of data, collected, and the future direction of visual surveys.

FUTURE DIRECTIONS

The increasing reliance on visual survey data to manage fisheries is telling. The technology is improving, the cost is decreasing, and the data collected essential. At the very least, we at Quinault want to educate ourselves visual survey methods and their effectiveness in order to better manage our fisheries.

Ideally, we will take the knowledge learned from this workshop and begin to develop our own future visual survey program. While we will have little to offer during workshop discussions, we thank you for the opportunity to attend and learn from your experience.

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Visual Survey Workshop April 2014

WSU Ecological Importance of Deep-sea Corals & Sponges

Brian Tissot, Sean Rooney
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Washington State University & Humboldt State University

SUMMARY

The Washington State University Benthic Ecology lab has been working since 1998 to explore, map, and quantify deep-sea coral and sponge abundance and distribution as potential groundfish habitats using submersibles and ROVs down to depths of 1000 m along the West Coast. Specifically, we are examining the role of deep-sea invertebrates, especially cold water corals and sponges, and how they may be important as habitat for commercially important fishes. Our lab is also involved studies of wave energy sits surveys off the Oregon; work on deep-sea corals communities in the Olympic Coast National, and a review of fish habitats in submarine canyons in the Bering Sea. We work in close collaboration with multiple Federal (e.g. NOAA Fisheries, NOAA National Marine Sanctuaries, & BOEME) and State agencies (Fish and Wildlife departments in Washington, Oregon, and California), as well as several universities and non-profit organizations.

AT A GLANCE

Survey frequency: Variable

Survey initiated: 2000-2009 (Sub)
2000-present (ROV)

Survey goal: Research on fish habitats and deep-sea invertebrates, especially cold water corals and sponges; MPA and ocean energy site monitoring

Current vehicle: Variable (see past projects)

Target species: Deep-sea fish and invertebrates

Unit of measurement: Density (invertebrates/km^2) as well as behavioral information

PAST PROJECTS

- Heceta Bank Fish-Habitat Associations (2000-02)
- Astoria Canyon: *Continuing the Lewis and Clark Legac*y (2001)
- Structure-forming Invertebrates of Cordell Bank (2002-03)
- Structure-forming Invertebrates in the Cowcod Conservation Areas (2003-05)
- Megafaunal Invertebrate-Fish Associations in Submarine Canyons (2003-08)
- Structure-forming Invertebrates in the California Islands "Foot Print" (2005-07)
- Megafaunal Invertebrates in Relation to Fishing Intensity off central California (2006-08)
- Baseline Surveys of Central California MPAs (2007-09)
- Analysis of AUV (Autonomous Underwater Vehicle) Surveys in the Olympic Coast National Marine Sanctuary (2011-12)
- Megafaunal Invertebrates in the Olympic Coast National Marine Sanctuary (2011-13)
- Wave Energy Benthic Habitat Surveys off Central Oregon: OSU-BOEME (2010-12)
- Evaluation of Benthic Habitats in Bering Sea Submarine Canyons (2012-13)

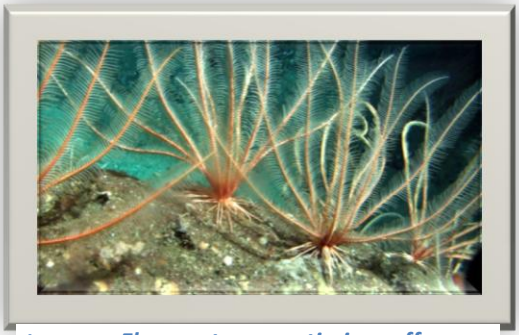

Figure 17. *Florometra serratissima* off central California

METHODS

Survey design:	Random stratified
Depth surveyed (m):	50-1,000 m
Camera type:	Multiple non-stereo cameras
Camera definition:	Standard and HD
Data recorded:	Mini DV/hard drive
Vehicle lights:	LED and halogen
Sample unit:	Strip transect
Length/time of unit:	Variable (20 min.-days)
Max sea state:	20 knot winds/6' seas
Habitat reviewed?	Yes, from video.
Video review software:	N/A

MANAGEMENT

Our research has been used to identify deep-sea coral and sponge abundance and distribution patterns and has been used to formulate management strategies for west coast bottom trawling and in the development of legislation in Congress.

FUTURE DIRECTIONS

In 2014, the Benthic Ecology Lab moved to Humboldt State University. New visual surveys will continued to be conducted as time and funding allows. Analysis is ongoing at WSU of existing data from Heceta Bank, OCNMS and the Bering Sea Canyons.

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NOAA Fisheries: SWFSC
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Olympic Coast National Marine Sanctuary
(Ed Bowlby, Jennifer Bright, Mary Sue Brancato)

California Sea Grant
(Rick Starr)

Marine Conservation Alliance
(Merrick Burden)

Oregon State University
(Mark Hixon, Chris Goldfinger, Sarah Henkel)

University California, Santa Barbara
(Milton Love)

Figure 2. *Primnoa pacifica* in the Olympic Coast National Marine Sanctuary

Visual Survey Workshop April 2014

Assessments of Deep Sea Benthic Habitats in Olympic Coast National Marine Sanctuary

Ed Bowlby, Mary Sue Brancato, Jennifer Bright
NOAA Olympic Coast National Marine Sanctuary

SUMMARY

Olympic Coast National Marine Sanctuary (OCNMS) has conducted visual surveys for deep water benthic habitats (50-650m) off the coast of Washington state since 1999. Exploratory dives were conducted in 1999 by *DeepWorker,* a one-person submersible. From 2000-2001, *Delta*, a two-person submersible, was used to assess benthic habitat recovery after trenching of commercial fiber optic cables. This monitoring effort, using quantifiable transect lines, continued from 2002-2008 with various remotely operated vehicles (ROVs), and expanded to include targeted surveys for biogenic habitats on hard substrate, primarily structure-forming deep-sea corals & sponges and associated fauna (e.g., fish) in 2004, 2006, 2008, 2010 & 2011. Since the OCNMS designation in 1994, only incremental progress on seafloor mapping has been made, since only ~25% of the area has been adequately characterized for substrate types.

AT A GLANCE

Survey frequency:	Periodically (mostly annual until 2011)
Survey initiated:	1999 (Sub); 2002 (ROV)
Survey goal:	Assess Benthic Habitats & Mega Fauna
Current vehicle:	Usually ROPOS ROV
Make/Model:	Work/Science Class ROV, Canadian Scientific Submersible Facility
Target species:	Deep Sea Corals & associated species (e.g., demersal fish)
Unit of measurement:	Density (corals/1,000m^2; fish/ m^2)

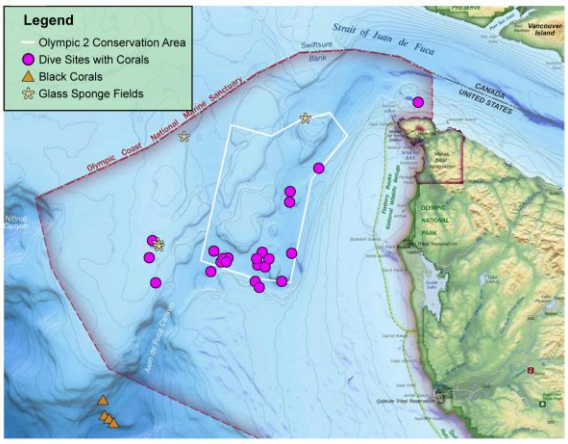

Figure 18.–Map of survey locations off the Olympic coast of Washington state, both within the Groundfish EFH Conservation Area (Olympic 2) and adjacent sites, all within boundaries of OCNMS.

METHODS

Survey design:	Stratified Random
Depth surveyed (m):	50-6500m
Camera type:	Vertical & forward facing HD videos with paired lasers & digital still camera
Data recorded:	Mini DV/hard drive
Vehicle lights:	3 x 400 W HMI, 3 x 350 W LED, 2 x 150 W HID, 8 x 150 W LED
Sample unit:	Strip transect
Length/time of unit:	dependent on substrate patch size
Max sea state:	15 knot winds/6' seas
Habitat reviewed?	Yes, from video.
Video review software:	MBARI's Video Annotation and Reference System (VARS)

RESULTS

Post-processing of ROV video data using MBARI's Video Annotation and Reference System (VARS), georeferenced with nav data, has been completed for substrate types, and density of corals and sponges. Density of fish on transects is partially completed as well as preliminary fish-habitat associations.

MANAGEMENT

OCNMS has management authority to protect the living, non-living, and cultural marine resources within its boundaries (ranging from intertidal to across the continental shelf and 3 canyon heads) while allowing recreational & commercial activities that are compatible with the Sanctuary's primary goal of resource protection. NMFS, WDFW, & PFMC have management authorities for fisheries in this area, which are also co-managed by coastal treaty tribes in their U&As. PFMC initiated its mandated 5-year review of groundfish EHF, which includes one area within OCNMS that prohibits bottom trawling (Olympic 2 Conservation Area).

FUTURE DIRECTIONS

In 2013, OCNMS and Wash. Dept. of Fish & Wildlife submitted a proposal to PFMC to expand protection of rare, hard substrates and sensitive biogenic habitats within and adjacent to Olympic 2 Conservation Area as part of the groundfish EFH 5-year review cycle. This is now being pursued in consultations with the coastal treaty tribes with their U&As. Visual surveys will continued to be conducted as time & funding allows and the sanctuary is interested in long-term collaborations with other agencies & organizations to combine their biogenic habitat surveys with quantifiable fish surveys. In the future, we would like to continue investigations of the role of structure-forming corals & sponges with associated demersal fish, to determine if there is a seasonal use and/or need in their life histories. OCNMS will also continue seafloor mapping with multibeam.

Figure 19. ROPOS ROV being deployed off NOAA Ship *McArthur II*, near Cape Alava, Washington in 2006.

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COLLABORATORS

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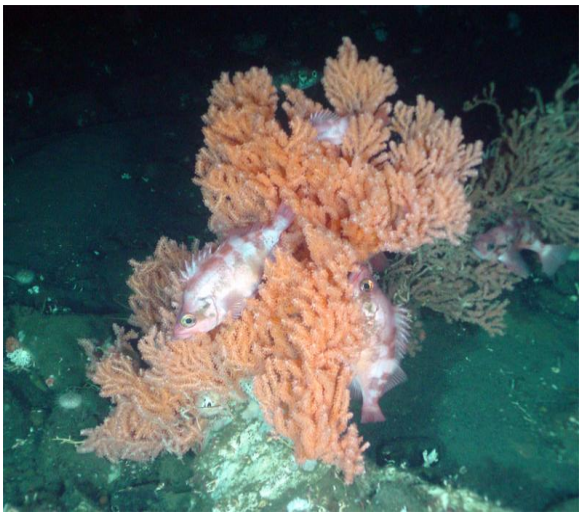


Figure 3. Red tree coral (*Primnoa pacifica*) and associated rockfish species in 2006.

Visual Survey Workshop, April 2014

ODFW Marine Habitat Project

Scott Marion, Bill Miller, Arlene Merems
Oregon Department of Fish and Wildlife

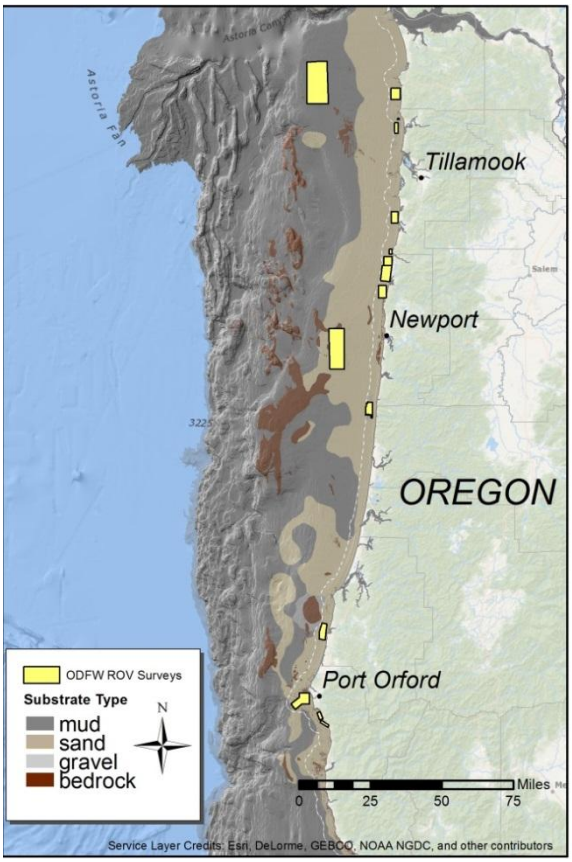
SUMMARY

The Marine Habitat Project has conducted ROV surveys for diverse research and resource management purposes focusing on Oregon's nearshore rocky reefs since 2000. A major goal is to develop statistical models of species-specific habitat associations of demersal fishes for the eventual purpose of habitat-based stock assessment and predictive modeling of distribution and abundance. In 2008, we initiated ecological baseline assessments supporting the establishment of Oregon's first marine reserve sites, complementing the Marine Reserve Program's video sled and video lander assessments. Other targeted research questions include assessing the impact of bottom trawling in soft-bottom habitats and the impact of seasonal hypoxia.

AT A GLANCE

Survey frequency:	Annual
Survey initiated:	2000
Survey goal:	Resource assessment, research, & MPA monitoring
Current vehicle:	ROV
Make/Model:	Deep Ocean Engineering Phantom HD 2+2
Target species:	Rockfish, reef fish and invertebrates
Unit of measurement:	Density

SURVEY AREA



METHODS

Survey design:	Random stratified
Depth surveyed (m):	20 – 150 m
Camera type:	Canon Vixia GF10
Camera definition:	High Definition
Data recorded:	SD card
Vehicle lights:	LED and halogen
Sample unit:	Line transect
Length/time of unit:	500 m
Max sea state:	20 knot winds/6' seas
Habitat reviewed?	Yes, from video.
Video review software:	Adobe Premiere Pro

RESULTS

To date, the Marine Habitat Project has surveyed marine fishes and habitat offshore of Port Orford, Cape Blanco, Cape Perpetua, Cape Foulweather, Lincoln City, Pacific City, Tillamook, Nehalem, and Cannon Beach, as well as deep-water surveys of Nehalem Bank and Stonewall Bank. Using the ROV, we acquired the first seafloor images of the now-persistent "dead zone" that first developed in Oregon during 2002. We continue to monitor this seasonally hypoxic/anoxic area with the ROV to document continuing hypoxia-induced disturbance and recovery of benthic communities. Marine reserve baseline data collection is complete for four of Oregon's five marine reserve sites.

MANAGEMENT

Our current visual survey work informs Oregon's Marine Reserve Monitoring Program, with the goal of completing a two-year baseline survey for the five marine reserve sites before closure to fishing: Cape Falcon, Cascade Head, Otter Rock, Cape Perpetua, and Redfish Rocks Marine Reserves.

Investigations are also used to inform the continued development of the Nearshore Ecological Data Atlas for marine spatial planning in state waters, support the validation and interpretation of recent high-resolution seafloor mapping efforts by OSU's Active Tectonic and Seafloor Mapping Lab, support the decision-making process surrounding the development of offshore renewable energy, and provide the direct assessment of resources necessary for developing Oregon's Nearshore Strategy.

FUTURE DIRECTIONS

We are currently initiating an investigation of biogenic habitat in nearshore, shallow-water environments. Most effort on biogenic habitat has focused on the potential role of deep-water communities as Essential Fish Habitat, but little is known about the contribution of shallow water invertebrates.

In the coming years, ROV assessments of the previously surveyed marine reserves will begin to generate a timeline of reserve effects relative to pre-closure baselines and comparison areas.

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Brittany Huntington, Keith Matteson-
ODFW Marine Reserves Ecological Research and Monitoring

Visual Survey Workshop, April 2014

ODFW Marine Reserves Ecological Research & Monitoring

Keith Matteson[1], Brittany Huntington[1], Jessica Watson[21]*Oregon Department of Fish and Wildlife,* [2]*Partnership for Interdisciplinary Study of Coastal Oceans*

SUMMARY

In 2010, Oregon completed designation of five marine reserve sites within its state waters to advance scientific research and conserve habitats and biodiversity. Oregon Department of Fish & Wildlife (ODFW) is responsible for overseeing the management and monitoring of Oregon's marine reserves. ODFW has been using underwater visual survey tools on three platforms: lander, sled and ROV to monitoring baseline ecological conditions in the reserve.

The **video lander** is a camera system designed for use in high-relief habitat to collect indices (MaxN) on fish and target invertebrate species, as well as quantify biogenic structure. The design uses an off-the-shelf HD video camcorder in a pressure housing, parallel lasers (10cm spacing), and LED lights. The camera sits parallel to the seafloor providing a forward facing field of view. The lander can be deployed in waters too deep for divers and too shallow for the ROV.

Figure 1. Lander drop camera configuration

Our **video sled** is used for line transects over unconsolidated bottom, which is the dominant substrate type in the majority of Oregon's reserves. The sled is towed at a target speed of 0.7-1 kts and uses dropper chains to maintain a height of 5-10 cm above the benthos. Tickler chains are strung across the forward rails of the sled and the camera angle is -30°. We use a timecode generator to match video frames with GPS location approximated from the towing vessel for mapping of substrate type and species observations (though ultimately transect area is approximated). Transects target lengths of 700-1000m. We use the same HD camera, light, and laser system as the lander, with the addition of a small standard-definition camera with live feed to the surface allowing monitoring of the status of the sled in real-time.

Figure 2. Video sled deployment

The **ROV** uses a clump-weight and is operated from a live vessel. Line transects of 500m are covered, in depths from 18-60m in the marine reserves. The high-definition video with parallel lasers is later analyzed for fish and invertebrate densities, and habitat type. ORE TrackPoint III provides accurate location of the ROV in relation to the platform vessel. Use of the ROV extends our ability to obtain density estimates of fish and invertebrates over greater areas and with more detail than can be done with the lander or sled alone.

AT A GLANCE

Survey frequency:	2-year baseline survey followed by periodic long-term surveys
Survey initiated:	2010
Survey goal:	Detecting community change in reserves
Current vehicle:	Lander Sled ROV
Make/Model:	(ROV) Deep Ocean Engineering Phantom HD 2+2
Unit of measurement:	Max N (Lander) Density (Sled & ROV)
Survey design:	Random stratified
Depth surveyed (m):	10-60+
Camera type:	Canon Vixia GF10
Camera definition:	High Definition
Data recorded:	SD card
Vehicle lights:	LED and halogen
Sample unit:	Line transect (Sled, ROV) Point drop (Lander)
Length/time of unit:	700-1000m
Max sea state:	20 knot winds/6' seas
Habitat reviewed?	Yes, from video.
Video review software:	Adobe Premiere Pro CS6

Figure 3. Phantom-2+2 deployment

MANAGEMENT

Our current visual survey work informs Oregon's Marine Reserve Monitoring Program, with the goal of completing a two-year baseline survey for the five marine reserve sites before closure to fishing: Cape Falcon, Cascade Head, Otter Rock, Cape Perpetua, and Redfish Rocks Marine Reserves.

FUTURE DIRECTIONS

Baseline data collection is complete for four of Oregon's five marine reserve sites. In 2014-15 visual surveys will be conducted at the remaining open site, Cape Falcon Marine Reserve. Visual surveys will continue to be conducted as time and funding allows in each reserve site, with periodicity as yet undetermined (likely in the 3-5 year range). Our goal is to isolate and quantify changes in the nearshore community that result explicitly from marine reserve protection, as well as support research activities in the reserves that improve our understanding of these nearshore environments.

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Visual Survey Workshop

Cordell Bank National Marine Sanctuary characterization and monitoring

Danielle Lipski, Dan Howard, Michael Carver, Kaitlin Graiff
NOAA Cordell Bank National Marine Sanctuary

SUMMARY

Cordell Bank National Marine Sanctuary (CBNMS) has conducted visual surveys since 2000. From 2000 to 2005 surveys were completed in partnership with NMFS using the Delta submersible. After 2005 funds were unavailable for submersible surveys. Camera sled surveys were completed over soft bottom habitat in 2004 and 2007. In 2006 CBNMS began using a sanctuary ROV, initially for marine debris reconnaissance and removal. CBNMS is initiating ROV visual surveys to characterize and monitor resources of CBNMS, including the bank and surrounding soft sediment habitat.

AT A GLANCE

Survey frequency:	Previously annual with sub, intermittent past ROV work, 2 years camera sled, 1 year AUV, goal is for annual or bi-annual ROV surveys
Survey initiated:	2000 (Sub), 2004 (Sled), 2014 (ROV)
Survey goal:	Characterization and monitoring
Current vehicle:	ROV (Phantom)
Make/Model:	DOE Phantom HD 2+2
Target species:	Invertebrates, Fish

SURVEY AREA

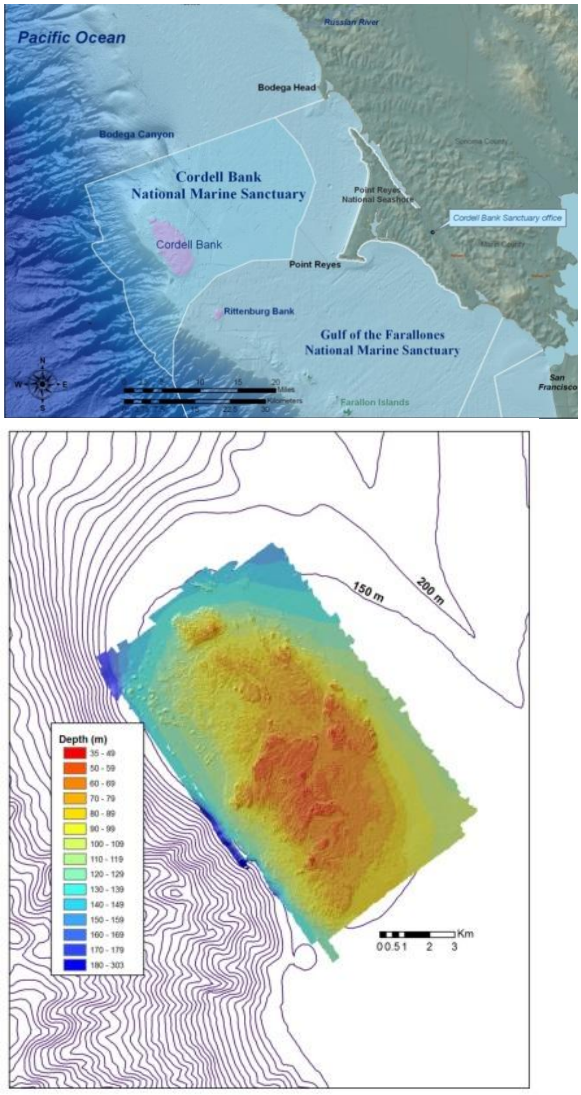

Figure 20.–Map of Cordell Bank National Marine Sanctuary (top), detail map of Cordell Bank.

METHODS

Survey design:	stratified with depth, slope, sediment
Depth surveyed (m):	target 60-120
Camera type:	2 Sony video, 1 Insite Pacific still
Camera definition:	2 high-resolution
Data recorded:	tapes
Vehicle lights:	Halogen, strobe
Sample unit:	Line transect
Length/time of unit:	1 km
Max sea state:	~20 knot winds/6' seas
Habitat reviewed?	Yes, from video/stills
Video review software:	Coral point (still images)

RESULTS

A variety of technologies and approaches have been used to assess biological communities on Cordell Bank. Submersible surveys from 2000-2005 focused on describing the benthic environment and groundfish assemblage over spatial extent of Bank and sampling annually to assess temporal change. The analysis focused on associations between habitat and fish and invertebrates. Camera sled surveys in 2004 and 2007 focused on soft sediment habitat on the shelf. The goal of the planned 2013 ROV surveys was to characterize and quantify invertebrate assemblages. This cruise was canceled by the government shutdown and is scheduled for August 2014.

MANAGEMENT

CBNMS was established in 1989 to protect and preserve the marine ecosystem surrounding Cordell Bank which includes the high relief habitat of the bank itself, the soft sediments of the continental shelf, as well as the continental slope. The sanctuary contains an extraordinary diversity and abundance of fish and invertebrates, and prey species are so concentrated there in upwelling seasons that the area is considered a hotspot for foraging marine mammals and seabirds. In addition to protections under the National Marine Sanctuaries Act that prohibit disturbance of the seafloor, discharge of material or matter, and other ecosystem protections, the CBNMS area is subject to protections under the Magnusen-Stevens Act that include Essential Fish Habitat and Rockfish Conservation Areas. Key to effective management of CBNMS is understanding the status and trends of these resources including how they may respond to fishing closures that have been in place since 2003 and to stressors such as climate change, hypoxia, disease events, and invasive species.

FUTURE DIRECTIONS

An ROV survey is planned for August 2014. An initial sampling scheme has been developed to assess invertebrate assemblages. CBNMS intends this to be the start of an effective, sustainable, long term sampling ROV sampling program to monitor the sanctuary ecosystem.

CONTACT

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Visual Survey Workshop April 2014

NOAA fisheries SWFSC Habitat Ecology Team

Mary Yoklavich, Tom Laidig, Diana Watters, Lisa Krigsman, Andrew Taylor, and David Huff
NMFS, SWFSC, Santa Cruz

SUMMARY

The Habitat Ecology Team conducts research in direct response to the mandates of the Magnuson-Stevens Reauthorization Act of 2006, with a focus on deep-water California demersal communities. Our goal is to provide sound scientific information to ensure the sustainability of marine fisheries and the effective management of marine ecosystems, with objectives to 1) improve stock assessments, especially of overfished rockfish species in complex habitats; 2) characterize fish and habitat associations to improve EFH identification; 3) contribute to MPA design & monitoring, and to Integrated Ecosystem Assessments; and 4) understand the significance of deep-sea coral habitats.

We use a variety of survey tools and approaches to improve our assessments of demersal fishes, macro-invertebrates (including members of deep-water coral communities), and associated seafloor habitats in water depths from 20 to 900 meters off central and southern California.

AT A GLANCE

Survey frequency:	Annually
Survey initiated:	early 1990's
Survey goal:	Stock and habitat assessments; distribution data
Current vehicle:	HOV
Make/Model:	Dual DeepWorker Nuytco, Canada
Target species:	Benthic fish and inverts
Unit of measurement:	Density (fish/km^2)

SURVEY AREA

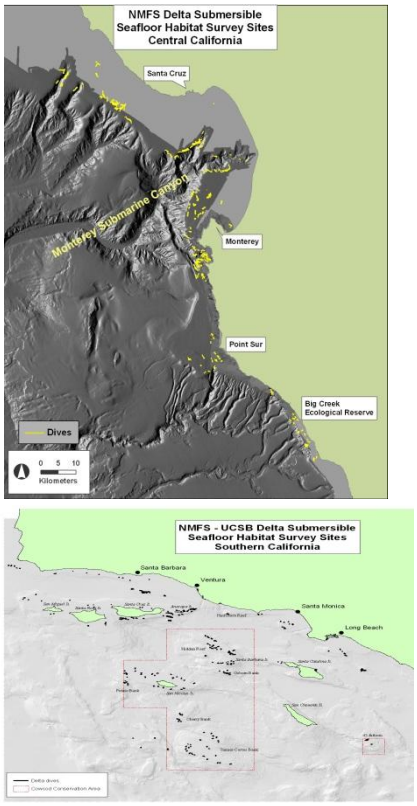

Figure 21.–Map of survey locations: Top central California; Bottom Southern California.

METHODS

Survey design:	Random stratified
Depth surveyed (m):	20-900; typically 100-350
Camera definition:	High Definition
Data recorded:	Mini DV/hard drive
Vehicle lights:	LED and halogen
Sample unit: transect	#/km2; Line and strip
Length/time of unit:	10 or 15 min
Max sea state:	20 knot winds/6' seas
Habitat reviewed?	Yes, from video.
Video review software:	Access

RESULTS

We conduct non-extractive, visual surveys of juvenile and adult life stages of numerous Pacific Coast demersal species using remotely operated vehicles (ROV), manned submersibles, scuba, laser line scan, and towed cameras, coupled with seafloor maps of the continental shelf and upper slope off California. These surveys have resulted in habitat-specific assemblage analyses on multiple spatial scales; fishery-independent stock assessments; baseline monitoring of MPAs; documentation of marine debris on the seafloor; and are being used in the California-NOAA-USGS Seafloor Mapping Program.

We have completed approximately 700 dives, which includes 1800 transects over 21,000 min (349 hrs). There are 26 publications related to this work, most of them peer-reviewed.

MANAGEMENT

Data produced from our surveys have been used in stock assessments (e.g., Cowcod) and submitted to the Pacific Fisheries Management Council as part of Pacific Groundfish EFH review. Results of our early surveys were used to design and implement MPAs off central California. Our 2007-8 surveys were used to gather baseline fish and invertebrate information (species and densities) in these newly created MPAs.

FUTURE DIRECTIONS

In 2014, we plan to use a SeaBed AUV and drop camera to survey deepsea coral and sponges off northern California in 800-1200 m. We are synthesizing our data, and producing predictive distributional maps to determine areas of high abundance of fish and coral species.

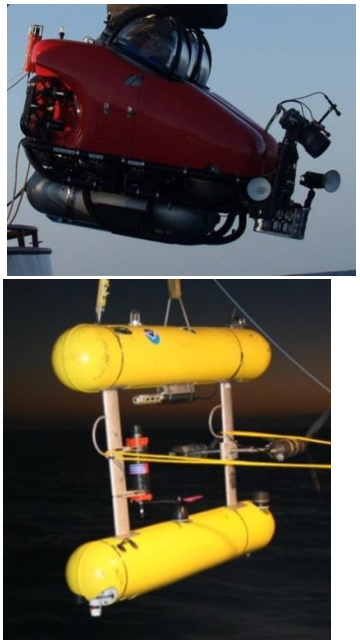

Figure 22. The Dual DeepWorker submersible (top) and the NWFSC/PIFSC AUV (bottom)

CONTACT

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NOAA NMFS AFSC, Seattle
University of California Santa Barbara and Santa Cruz
Moss Landing Marine Laboratories
Oregon State University
US Geological Survey

Visual Survey Workshop

MLML Video Surveys to Evaluate the Use of Rockfish Conservation Areas to Rebuilding Overfished Species

Rick Starr, Mary Gleason, Donna Kline, Steve Rienecke
Moss Landing Marine Laboratories, The Nature Conservancy

SUMMARY

For ten years, the depth-based Rockfish Conservation Areas (RCAs) have been an important, though coarse-scale, tool to support rebuilding overfished species (OFS) along the US West Coast. However, there has been limited research on finer scale demographic and distributional patterns of rebuilding species that could allow fishermen to better target healthy populations while avoiding OFS. The rocky habitats that many of these OFS prefer are under-sampled by annual coast-wide trawl surveys. Consequently, we need to know more about the distributions and relative abundance of overfished stocks to inform bycatch avoidance plans and promote fishing opportunities for underutilized stocks. To address these issues, we assembled a broad partnership that includes fishermen, NGOs, fisheries agencies, and academics to conduct collaborative research focused on mapping predicted OFS distribution based on existing fisheries data. We are ground-truthing predictive maps by fishing inside the RCAs with a Exempted Fishing Permit, and characterizing abundance, length, and habitat associations of OFS in the same locations using stereo-visual surveys.

AT A GLANCE

Survey frequency:	3-5 Times Annually
Survey initiated:	2013
Survey goal:	Fish density estimates
Current vehicle:	Rotating Video Lander
Make/Model:	Marine Applied Research and Exploration (MARE) Custom
Target species:	OFS
Unit of measurement:	Density (fish/km^2)

SURVEY AREA

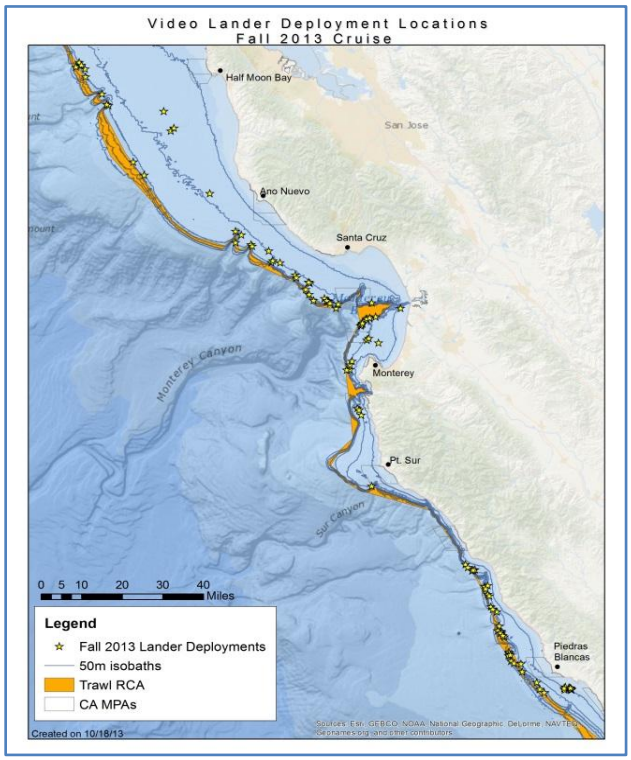

Figure 23. Map of survey locations extending from south of the Farallon Islands to Cambria, CA.

METHODS

Survey design:	Random stratified
Depth surveyed (m):	60-285
Camera type:	DSPL Nano Seacam
Camera definition:	Standard Definition
Data recorded:	Recorder/hard drive
Vehicle lights:	LED
Sample unit:	Drop
Length/time of unit:	8 min
Max sea state:	20 knot winds/6' seas
Video review software:	Event Measure (SeaGIS)

RESULTS

Visual surveys were conducted in RCA depths in May, July, and in conjunction with directed fishing in Sept-Oct 2013. We calibrated the stereo-visual lander system with volume/area estimates ($25m^3/10m^2$), species accumulation curves (8 min soak) and measurement accuracy estimates (Max SE $\pm$5% of TL). The first year of field surveys yielded 419 fishing sets and 398 lander drops in locations identified by finalized predictive distribution maps for the central California Coast. A total of 136 Lander drops co-occurred with directed fishing. Directed fishing landed 16 species, primarily epibenthic and midwater rockfishes including two rebuilding species – Bocaccio and Canary Rockfish. The ratio of target to rebuilding species was 8:1. Video observations included species landed with additional sightings of Cowcod and Yelloweye Rockfish in areas fished.

MANAGEMENT

The Rockfish Conservation Area (RCA) depth-based closures and other restrictions were implemented with an aim towards minimizing the potential catch of OFS and to help these depleted stocks rebuild. Furthermore, the recent transition of the trawl sector of the groundfish fishery to an Individual Fishing Quota (IFQ) management system, and the associated hard caps for these rebuilding species, has created strong new incentives for fishermen to avoid these species on their own. In addition, there are other species, such as Lingcod, Yellowtail Rockfish, and Chilipepper Rockfish that could be more fully utilized if fishermen could fish "cleaner" by avoiding areas where risk of bycatch of rebuilding species is high. These factors drive a growing interest in developing better spatial maps of the distribution of OFS to inform fishing activities (i.e. bycatch avoidance plans, risk pools, etc.) and management efforts (including potentially a reexamination of the role and configuration of the trawl RCA).

FUTURE DIRECTIONS

In 2014, Video Lander surveys will again be conducted in conjunction with directed fishing surveys inside the RCAs along the Central California coast between Half Moon Bay and Morro Bay. Beyond 2014 visual surveys will continued as time and funding allows for longer term monitoring of fish populations. Applications to age-structured assessment are ongoing. Biomass estimation techniques are being developed.

Figure 24. Lander deployed off F/V *Donna Kathleen* off Monterey, California in 2013.

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