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

Proceedings of the:

Visual Survey Methods Workshop

April 8 & 9, 2014

Workshop Co-chairs:

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Table of Contents

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TSC Visual Survey Methods Workshop Overview

Background

At the May 2011 annual meeting, the Technical Subcommittee of the Canada-U.S. Groundfish Committee (TSC) proposed a visual survey methods workshop for groundfish stocks. Visual surveys are nonlethal and fishery independent, and technological advances have allowed these survey tools to be increasingly accessible and affordable. As a result, visual surveys are becoming more common along the West coast for management and research, and similar obstacles are faced by users when designing surveys and analyzing resulting data, especially in the context of fisheries management. At the May 2012 TSC meeting, Kristen Green (Alaska Department of Fish and Game), Dayv Lowry (Washington Department of Fish and Wildlife), and Lynne Yamanaka (Fisheries and Oceans Canada) formed a committee to develop a workshop to address the need for communication about current and future visual survey techniques among management agencies. The workshop dates were set for April 8 and 9, 2014 at the NOAA Fisheries Alaska Fisheries Science Center (AFSC) in Seattle, Washington at the Sand Point Facility. A call for interest was sent out in August 2013 to management agencies and university staff that conduct visual surveys along the West coast; in addition, a pre-planning meeting was held at the February 2014 Western Groundfish Conference.

Workshop Goals

The visual survey methods workshop was directed at those who conduct groundfish resource surveys, using visual survey techniques (submersible, remote operated vehicles, autonomous underwater vehicles, camera sleds, drop cameras etc.), to assess groundfish stocks. The intent of the workshop was to bring together agencies and universities to share knowledge regarding groundfish visual surveys, discuss potential solutions to common issues, provide an opportunity for networking and promote future collaborations. Workshop participants were polled in advance to determine topics for discussion which included:

- Improvement of survey design, sampling methodologies/analyses,
- Development of applications to management/stock assessment;
- Discussion of equipment & vehicle technology (i.e. cameras and lighting issues);
- Detectability of fish, variability in fish behavior;
- Species-habitat associations;
- The development of standard practices in survey design and video review;

Based on the input from potential participants, an agenda was set for a two-day workshop including topics on survey design, stock assessment and management, video review and analyses, and vehicle and vessel technology. Prior to the workshop, the workshop co-chairs (Kristen Green, Dayv Lowry, and Lynne Yamanaka) created a sixty question web-based survey

for the purpose of polling participants about their visual survey goals and design, and the types of technology or survey equipment used. In addition, participants were requested to submit a two page "project profile" to describe their organization's visual survey for distribution to all the workshop attendees.

Workshop Results

The workshop was held between 8:30 am and 5 pm on April 8th and 9th 2014 at the AFSC Traynor Room. A total of 32 participants attended the workshop, representing 13 agencies and organizations. The workshop included four main topics: 1) Survey design, 2) Stock assessment and management, 3) Video review and analyses, and 4) Vehicle and vessel technology. For each topic, one of the co-chairs gave a 15 minute presentation that summarized the workshop participants' survey responses for each of the workshop topics. The presenter concluded with five to seven questions for group discussion. These questions were based on the common problems and issues that researchers and managers using visual survey tools for groundfish commonly encounter. After the presentation, the workshop participants were divided into three groups of 10 to 12 people, with one of the co-chairs moderating each group. The three groups relocated to private conference rooms and discussed the workshop topics. After several hours of discussion, all the participants reassembled together for a brief summary of the highlights of each breakout session. On the second day, the workshop ended with a demonstration of the WDFW remote operated vehicle (ROV) at the NOAA facility dock. Workshop participants had the opportunity to observe the ROV cameras and equipment as well as practice operating the ROV.

Conclusions

Overall, the workshop was a great success and participants were able to share ideas, network, and discuss solutions and standardization practices in regards to visual surveys. The smaller group 'breakout' sessions were a popular format, and promoted discussion amongst participants.

The products from the visual survey methods workshop include the project profiles from each agency or organization's visual survey program, copies of the presentations on each workshop topic, topic discussion questions, minutes of the breakout sessions, and a short summary highlighting the groups' conclusions about each workshop topic.

During the workshop, participants identified the need for the creation of a fish behavior characteristics manual to be shared among agencies to help video reviewers identify species, and continued access to a web-based file storage site where visual survey literature and fish identification photos could be shared among workshop attendees. WDFW staff volunteered to provide a working draft of a fish behavior characteristics manual and it will be made accessible

to all workshop participants. The web-based file storage location will continue to be available for participants to share documents.

Finally, workshop participants were polled after the workshop to learn what was most valuable about the workshop and whether there was interest in convening for another workshop. Most workshop participants desired to meet again for a general workshop in two years. Workshop participants were also interested in meeting one year from now on a more specific topic related to visual surveys. The most requested topics were the standardization of habitat characterization and fish identification using behavior cues. However, participants were also interested in specific meetings on survey design, applications to stock assessment, database design, and fish-habitat associations. Seattle, Washington was the preferred location for these meetings. Ideas to improve future workshops included having more time for breakout sessions, presentations on specialized technology, training sessions on species identification, and a list of 'must read' literature prior to the workshop. Other ideas included a Facebook page or a scheduled webinars on specific topics related to visual surveys.

Acknowledgements

Many thanks to the TSC for initiating and supporting the Visual survey methods workshop. Participants highlighted the benefit of meeting other researchers, many for the first time, for discussion on all aspects of visual methods, in an informal workshop venue. Thanks also to those that helped with the logistics of holding the meeting in Seattle; Wayne Palsson for securing the Traynor and other rooms at the AFSC for the workshop and more importantly, ensuring NOAA security protocols were met for meeting participants, WDFW staff for presenting coffee/tea/snacks, IPHC and Kristen Green (ADFG) for sponsoring the social evening, and Bob Pacunski, Jim Beam, Dayv Lowry and WDFW staff for the ROV "demo" fieldtrip. Bob Pacunski also moderated the final workshop session on vehicle and vessel technology and his help was much appreciated.

Recommendations

The workshop chairs would like to recommend to the TSC that a new Visual Survey Methods Working Group be created with participation from interested agencies. Membership in the working group could be solicited from agencies by the TSC. A member list and the selection of a chair for the working group could be tabled at the 2015 TSC annual meeting. This new working group's Terms of Reference could also be developed and presented at the 2015 TSC annual meeting. A convenient biennial meeting schedule would be offset from the Western Groundfish Conference (even years) and could commence in 2017 where the results of the NOAA Strategic Initiatives on video review automation and catchability could be presented.

Visual Survey Methods Workshop Agenda

April 8th, 2014

8:30 am: Introduction and Workshop Goals

Topic 1: What does it take to design a successful survey?

9:00 am to 9:30 am Presentation

Break

10:00 am to 12:00 pm Discussion Topics

- Defining your question
- What approaches are used for survey stratification?
- How do you determine sampling density?
- How do you select dive or transect location (mapping or fishery data)?
- How to evaluate detectability of cryptic and small species?

12:00 pm to 1:00 pm Lunch (cafeteria onsite or other local options within driving distance)

Topic 2: How are visual survey data used for stock assessment or other management goals?

1:00 pm to 1:30 pm Presentation

Break

2:00 pm to 4:45 pm Discussion Topics

- How to convert fish counts to biomass or densities for management purposes?
- What is your inference space?
- Techniques for determining catchability/detectability
- What are sources of bias and how to correct for bias associated with visual surveys?
- Reconciling estimates from visual surveys with more "traditional" techniques
- How are users incorporating the results into management?

6:00 pm Evening Social

April 9th, 2014

Topic 3: What are the strengths/limitations of methodologies for collecting/analyzing video?

8:30 am to 9:00 am Presentation

Break

9:30 am to 12:00 pm Discussion Topics

- What types of software are being used?
- What types of databases used for housing data?
- Video review "rules" and protocols
- Habitat review methodology (what is useful for categorizing habitat?)
- How are fish measured? (lasers, stereo cameras, etc.)
- Recording on tapes versus hard drives (Digitization of tapes)
- Methods for watching multiple screens at once?
- Positioning and Tracking methods
- What technology is limiting data or analyses?
- What future technology are users planning or hoping to implement?

12:00 pm to 1:00 pm Lunch (cafeteria onsite or other local options within driving distance)

Topic 4: What are the pros/cons of vehicle types, equipment, vessels, and survey protocols?

1:00 pm to 1:30 Presentation

Break

2:00 pm to 3:00 pm Discussion Topics

- Vessel types, configurations, and equipment needs
- Navigation/tracking of vehicle, vessel, and clump weight
- Troubleshooting common ROV or other visual survey vehicle problems
- Vehicle height off the bottom
- Collection of other data during visual survey (temperature, etc.)

Closing and workshop wrap up

3:00 pm Field Trip (Optional) to see WDFW ROV onsite at AFSC (within walking distance)

Visual Survey Methods Workshop Participants

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Workshop Topic 1: What does it take to design a successful survey?

Moderator: Lynne Yamanaka

Discussion questions:

1. Defining your question: What are the survey objectives?
2. What approaches are used for survey stratification?
    - How are dive or transect locations selected?
    - Is direction of vehicle movement predefined?
    - What surrogates are used for substrate?
    - Mapping (acoustic, charts), fishery data?
    - How are species linked to substrate?
3. Why was length or time chosen for your sampling?
    - How was this determined?
4. How are sampling densities determined: encounter rate, species saturation curves, power tests?
5. Why was point, strip or line transect methods selected?
    - What are the challenges?
    - How are densities estimated?
    - Are detection functions constructed by substrate, transect or survey?
6. How is detectability of cryptic and small species evaluated?
7. How are survey sampling estimates expanded to the larger assessment or management area?

Workshop Notes from Topic 1: Survey Design

Breakout Group: "A"

Moderator: Kristen Green
Attending: Liz Clarke, Sean Rooney, Wolfgang Carolsfeld, Rick Starr, Mary Sue Brancato, Scott Marion, Theresa Tsou, Sarah Davies and Lisa Hillier

Kristen begins the session by asking the question: What are your survey objectives?

For Rick, his survey objective were to use a Videolander in un-trawlable areas closed to rockfish harvest to "look and see." He also looks at size and species compositions in closed vs. fished areas. His focus is off the shallow shelf waters for stock assessment. California has good mapping data in nearshore areas.

Participants discussed the appropriateness of stratification levels and what "rocky" really means. How finely are groups differentiating habitats? By breaking down habitats to finer categories can limit sample sizes (statistically).

Scott has the same problem with substrate/habitat differentiation and stratification. Same methods of a "go and see" approach, then modify the design for systematic survey. A quantifiable survey has problems with stratification; a post hoc survey with later habitat stratification was suggested.

Liz said in federal waters there were no maps of rock vs. soft substrates, so it is hard to determine a sampling frame. No idea how much rocky substrate is in Federal waters. The question becomes "Is your end game a relative index or an absolute abundance estimate?" Liz states it will take 10 years to get an absolute abundance, which is a problem. Need to be able to add to an existing data string, especially when people are surveying "all species."

Visual surveys are being held to a higher standard than other types of surveys (i.e., trawl).

Kristen adds that substrate types might be identified using proxies.

Theresa adds that substrate knowledge gaps are one of the reasons WDFW used a stereological survey design to eliminate the need to know the substrate and habitats in the survey area.

Kristen's group uses fisheries data as a proxy (a certain catch per unit effort of rockfish (o.04 yelloweye rockfish per hook) assumed to be over rock habitat, from fisheries logbook data. A

0.5 nm buffer is drawn around these selected commercial longline sets considered rock habitat. The ROV/submersible survey is then limited to rocky areas.

Scott asks if Kristen formally demarcates “fished area” or “rocky habitat” using this method. Kristen infers rock from fisheries data.

Sean states this might be a problem depending on which species you are targeting for a survey.

Liz states that there would also be changes by size/season/density using recreational fishers for species by area. There is good multi-beam information in the South California bight.

Scott asked if this proxy method would create bias due to fish densities.

Rick stated it didn’t matter because it was an “Index”.

Liz adds that the trawl survey is an index, the area is examined systematically at the same time and place. Fewer problems with this as a relative index. It is hard to get a “head count.”

Scott asks if people are using trawl for a “head count.”

Liz says there is a trawl survey in Alaska, but they know about catchability and they give an actual estimate. Few other trawl surveys do that. They just look for a change in density.

Kristen adds that catchability can be >1 and detectability is not >1, and changes by species.

Liz says that catchability is up to 2.8 because of the herding problems (documented for some flatfish). Essentially catch is three times greater than abundance.

Theresa adds that visual surveys with catchability higher than 1 (attract species) need to support management needs. Instead of a biomass estimate, an index might work.

Rick agrees that the survey design and data should be done to fit the data that will be used.

Liz says there is a problem with the decision point. People want an absolute abundance estimate and we are driven to unrealistic goals.

Kristen asks if people are looking at catchability in a non-quantitative way, and are they evaluating fish behavior?

Sean says they are looking at the “abundance” or “distribution” for invertebrates and there are different approaches for assessing these two questions.

Scott adds that the importing thing is to maintain continuity from place to place and time to time. Can estimate density, but not as a biomass. Consistency needs to be maintained over time, so how are people dealing with technology changes (i.e., changing lights).

Theresa says they do a comparison before the survey starts. Run the equipment with the original set up and change to the new equipment and then compare results. She also tells about the 24 hour survey to evaluate diurnal movements of fish and compensate for fish behavior. Other things to consider are where to put the ROV, and are ROV surveys really comparable to trawl surveys? The yelloweye rockfish survey she did with a submersible was not "valid" because of the habitat focus.

Mary Sue states she uses a layering technique to ground truth her surveys (NOAA habitat extrapolations, Acoustic data, Invertebrate trawl survey data, CODAR data).

Liz says that might work regionally with a huge effort. One way is to "assume" (i.e., the West Coast Bottom Trawl Survey assumes all coastal area is trawlable, the % untrawlable is unknown.)

Scott asks if this method produces anything other than a conservative estimate.

Liz says it depends on the changes over time, she says it would be more accurate to do a key representative survey and use the coast-wide trawl survey as an Index.

Rick adds this is a good reason to move to drop cameras, having a fishing fleet or charter boats deploy them to collect a larger amount of data.

Liz adds they are doing a survey that uses a drifting AUV and a bottom trawl at the same time in an open grid pattern. The AUV stays near the bottom, giving you two estimates of relative abundance. This would optimize boat time with multiple sources of info collected, but this all depends on "the Question."

Wolfgang adds it is also dependent on the budget and that we need to tell managers what information is "possible" to collect within budget constraints.

Liz agrees that management drives the process and they want an absolute abundance. She then tells about the NOAA initiative that will be conducted in Mexico to evaluate fish reaction.

Rick questions how you design the vehicle movements for statistical validity. The area needs to be representative, how are the strip surveys done?

Mary Sue says they are randomly selected.

Rick says that running long transects might miss the target habitats depending on how they are run.

Kristen summarizes the first portion of the meeting: Most groups use the surveys as a relative index to begin with. If the goal is absolute abundance, you must first start with a relative

abundance. Strata definitions are very hard to use for survey designs because of a lack of substrate and habitat information. This seems to be a huge problem.

Scott adds that if you are really blind to habitats, the long strip sample would not be biased.

Rick adds that every point needs to have an equal opportunity to be sampled.

Liz adds using a grid as a sample, instead of a habitat designation would work. Run 6 transects in the grid then N=1, not N=6.

Sean asks about comparing pieces of transects based on habitats. Perhaps compare a habitat and depth strata, but then sample sizes might be too small.

Scott adds that this post-processing is different that stratification during the survey.

Sean says that the designs are based on different needs.

Mary Sue added that she worked with statisticians to avoid pseudo-replication.

Liz adds that she never counts overlapping images and sometimes she doesn't count all fish in an image. She uses quadrats but may not count all squares for abundant fish. How many you pull depends on the species.

Mary Sue adds that they do a power test to determine how much area they "count".

Liz says they try to sample what the trawl samples which narrows down the area.

Kristen asks Liz if they compare trawl and AUV. Liz says No, there are different areas, but they might do it later.

Lisa adds that WDFW has done a small comparison of ROV and trawl and had problems due to the ROV's ability to detect flatfish and the fact that the trawl catches fish higher off the bottom (i.e. out of visual range of the ROV).

Liz states she has similar problems based on habitats.

Rick adds that that a long-term issue for visual survey designs is that we don't know the detectability for gear types. For long term use we need to figure out how to calibrate. Small fish are hard to ID and different gear types give a different view of species composition.

Scott adds that the big questions for flatfish are identification and detectability. How big is the unidentified percentage, before the data is unusable?

Rick says some species are easier to identify, others you can and we can't get a handle on the numbers.

Liz suggests spectroanalysis using ROVs.

Rick highlights that a large percentage of fish are buried and that wouldn't work.

Liz explains about the new development of a light field camera (200 little lenses) that might be used to increase the ability to identify. Need to move away from trawl surveys, which are destructive and static.

Kristen adds technology creep will be discussed later. Are people doing different types of strip or line transects? Her group does line transects with stereo cameras. Get at a detection function for yelloweye rockfish. Line transects work well for them because yelloweye rockfish are rare and patchy and they want to be able to include all the fish that they observe, which would not happen if they used strip transects.

Theresa asks if they conduct surveys on rock and how "rocky is rock?"

Kristen answers they survey on "soft or hard."

Sean wonders about habitat-specific bias, many biases.

Kristen adds the surveys are only for yelloweye rockfish.

Rick adds that it is designed for rare species. Theresa asks how they determine a fish behind a rock and figure the obstruction into the detectability estimate.

Rick says they assume the fish are homogenously distributed and you see 100% of the fish along the line.

A short discussion about ROV and AUV wobble along a line and how that affects the survey area.

Wolfgang adds that topography effects the way the ROV flies, and Scott adds that those deviations are not a bias unless they are for a reason (i.e., chasing a fish).

Liz adds that bias is introduced because of edges and current and topography.

Mary Sue adds that following a line introduces a lot less "wobble".

Kristen sums up some of the topics discussed: Relative abundance appears to be a good approach. It doesn't sound like people are addressing detectability and catch-ability issues and they are not being quantified.

Theresa adds that these factors are not really quantifiable. We just want to see low or high bias, and people shouldn't feel bad about not knowing "catch-ability".

Liz says that is a good point and we may be being held to an unreasonably high standard.

Theresa asks “why” we are all doing our surveys and what methods are being used to address our questions.

Kristen states that those questions were not asked in survey monkey.

Breakout Group: "B"

Moderator: Lynne Yamanaka
Attending: Tom Laidig, Jessica Finney, Mike Byerly, Jenny Stahl, Susanne McDermott, Jessica Finney, Ed Bowlby, Brad Speidel

First, everyone gave a description of what they do for visual surveys.

Tom Laidig: Habitat associations, fish associations, will coral be essential fish habitat, how do they interact, stock assessment, whole demersal communities, difficulties with identification etc.

Mike Byerly: Alaska, ROV surveys with Phantom, inform management for lingcod and demersal shelf rockfish, primarily yelloweye rockfish. Looking at index sites rather than looking at the whole area, index sites are 150-400km^2, could get bigger, will sample on a rotational basis, and get trends for abundance and biomass, use for running population dynamics models. Area has been multibeamed, some have single beam or leadline, trying to delineate rocky substrates from single beam.

Susanne McDermott: Looking at untrawlable grounds and Stellar sea lion trawl exclusion zones, and what prey fields are sufficient. Deals with fish (Atka mackerel) that is dense and patchy, intermingle with rockfish.

Jennifer Stahl: Management focus to get density estimates for yelloweye rockfish. Used submersible in the past and now use an ROV. Curious how density works for other species, are line transect methods appropriate to estimate density. Plan to use these data in age structured models.

Ed Bowlby: Works in Olympic Coast National Marine Sanctuary looking at coral. Archive video data to review again, looking at fish associations. Particularly interested in habitat forming coral, mostly found on hard substrate. Stratify by substrate and fishing effort. This is part of identifying essential fish habitat

Brad Speidel: Hook and line, recreational fisheries. Does yelloweye rockfish surveys using International Pacific Halibut Commission protocol. Deals with cryptic behaviors, will fishing gear be appropriate for different fishes, good to have fewer survey removals for yelloweye rockfish, etc.

1. **Question: What approaches are used for survey stratification?**

Lots of people use multibeam to stratify.

Mostly just use depth and hardness (Ed), it has worked out pretty well

Tom – uses background bathymetric maps so that you know where you are. There's been a great progression from when we started to now.
Ed – unique for Washington coast, have done a lot of initial surveys with sidescan, was very successful just using sidescan
Tom – generally draw polygons on map, limited to depth where species is.
Jennifer – don't have multibeam for lots of area, rely on bycatch information. Looking at basic bathymetric data (rugosity etc), is it better than bycatch?
Lynne – DFO's CHS is working on getting the whole coast multibeamed. Have done some depth, hardness, and derived terrain layers: slope, rugosity, BPI analysis. Put ROV observations on top of the multi-band raster , for a supervised classification process to predict habitats. Used presence/absence data, for quillback and ratfish. Create a predicted presence layers for quillback and ratfish, subtracted the ratfish layer (mud) from the quillback layer to stratify surveys. Have done correspondence analysis over different bottom types, to associate species to bottom types. All surveys have been done over areas with multibeam, now trying to overlay fishing data to extrapolate to other areas.
Jennifer – in some transects you end up in areas that are not rock, do you exclude? Biometrician says no.
Mike – if you misclassify a substrate type it's not that big a deal. If you randomly sample within your strata, you're fine. Stratifying improves precision. Use slope and depth, BPI, rugosity to define as soft, hard, rugose substrates, draw polygons, randomly select points within there. Usually the classifications are pretty good.

Jessica – what is "good" substrate classification?
Lynne – Everything is two dimensional in ArcView, 3D in reality, hard to deal with in the field
Ed – we preselect for hard substrate. Sometimes there's just a thin veneer of a soft on top of a hard
Lynne – On one transect you can have multiply substrate types. You try to restrict the habitat to hard, but there are also micro habitats. When you expand to the larger areas you still have microhabitats you try to account for in stock assessments.
Ed – does microhabitat as well. Has primary and secondary substrate types
Susanne - with strata you just look at areas you're interested in, but how do you account for areas not surveyed that are misclassified?
Lynne – do correspondence analysis, how many fish do you see on other substrate types.
Washington Department of Fish and Wildlife representative from San Juan Islands - That's why we're doing stereological design, takes into account that you're going to see different fish on different types of substrate. Trying to get an idea of what is out there. They are also looking for all fish. Will probably go back to random stratified.

Tom – in random stratified you see lots of species on the mud. It depends on your target species. If it's cosmopolitan you have to look everywhere, if they're specialist you can target those areas
Stereological – not looking at distance from rock. Look at video in 30 sec intervals
Jessica – species distribution modeling before you go out to target where you look
Mike – some species are found in a lot of different areas. If you just sample the rock, then there is bias in your survey if you don't delineate your strata well
Lynne – multibeam is ideal, but you need something that covers the whole study area you're looking at
Tom – bathymetry works as well, slope can give clues for where rock might be.

2. **Question: Why was length or time chosen for your sampling?**

Tom – use time standard, don't know why 10-15 min was chosen. Continuous strips broken down by time. Sometimes do 10 min or 15 min, depending on substrate type. Need to go at a speed that an observer can count at. Generally at around the same speed. Transects are by time, but then use distance to equate everything. Try to get the most accurate distance. Depends more on complexity than time
Jennifer – with submersible they did time, with ROV they do distance. In the end it's the same.
Tom – you need to have some consistency between transects.
Ed – lay out predetermined track lines. Don't get back to segmenting until later.
Lynne – have you done power tests to see if you're over sampling?
Tom – about 10 min with cow cod seemed good, but now that it's less complex we do longer time, haven't looked at that recently.
Jessica – species accumulation curves for number of transects and length of transects.
Mike – do about 300 m long transects. Species tend to be across a depth gradient. 300m almost always covers the base of some rocky feature to the top of it. Tries to get as many samples as possible. Has done simulation recently and tested by cutting out portions of the data. Asymptote is about at half the number of transects that they do.
Jennifer – length depends on your study species. Mobile or non-mobile may make a different
Tom – did analysis to estimate time and number of transects.
Lynne – in the beginning with less information we did longer transects so that you would actually encounter the fish on the transect. Wouldn't have seen fish in 60% of transects if they were only 10-15 min.
Susanne – statistically is it better to have more short transects with no observations, or fewer long transects with an observation?
Lynne – for Probability Detection Function (PDF) analysis you needed to see them to build the model.

Mike – there are two components to the model, variance in distance, variability amongst transects. With very short transects you might have a lot of zeros.
Discussion about detectability and strip vs. line transects.
Lynne – fish avoiding ROV/submersible, tried to account for that by using DIDSON to watch fish behavior as ROV approaches. But the submersible weaves slightly, so may have missed some fish even though they didn't move. Used sea urchins as a control, they show up on DIDSON but don't move.
Tom – had a forward looking video that could see the cow cod about 12m ahead, could see if they moved away or not.
Susanne – her study species moves away from the ROV.
Lynne – there are just some species where these techniques are not useful.
Jennifer – can use PDF.
Mike – did some studies on fish response for lingcod and yelloweye rockfish.
Tom – he wrote a paper on that that you can look up. Most things on the bottom, stayed on the bottom. Things that are up off the bottom would move.
Lynne – lingcod were not seen often. Saw them swimming by when they had the DIDSON on. Greenlings move.
Ed – have had halibut attack the camera system.

3. **Question: How are detectability of cryptic and small species evaluated?**

Tom – looks for all of the small species, does density for all of them.
Ed – they have size categories, they can always go back and review the data

How are the survey sampling estimates expanded to the larger assessment or management area?

Tom – used multibeam data to expand out to other areas. Did absolute estimates
Jennifer -
Lynne – stratify surveys for rock habitat and by depth, then expand it up to the survey area. When doing distance methods, did it by bottom type to get density, then expanded it
Mike – in distance you can treat bottom type as a covariate, can use it all in one model.

Danielle – ability to compare surveys from different technologies?
Jennifer – with ROV you're not seeing as much as with the submersible, but with distance methods that's okay because it accounts for visual range anyway. There's also confounding factors with depletion in the species over time. But there was similar results, similar CV, encounter rate, similar magnitude, so they were comparable
Tom – a month apart ran submersible transects and ROV transects, and basically they saw the same thing and same densities for all species. Difference was identification. Submersible could

do way better. Also a sizing issue with mid water things. In general there were only a few species that differed significantly. In 2011 there was a comparison of submersible, ROV, and AUV. Generally seeing the same species
Jessica – divers vs. video vs. photos – divers identified way more than video and photos

Breakout Group: "C"

Moderator: Dayv Lowry
Attending: Keith Matteson, Dave Somerton, Donna Kline, Bob Pacunski, James Pegg

Question 1:

Group discussed that the survey objectives are not always known and in the era of Ecosystem Based Management sometime the objective is to survey everything.

Keith Matteson (ODFW) stated that during the baseline monitoring for the first installments of the Marine Reserves in Oregon that survey objectives were not restrictive. Now the program is reevaluating what to survey and stating specific objectives.

Dave Somerton (NOAA) posed the question "are any survey objectives to inform stock assessments by providing data that can be fed into the stock assessment models?"

This question spurred the discussion of what data are useful, or potentially useful. Variables that were considered were densities, size, and age.

Question 2:

Keith Matteson (ODFW) ODFW stratifies by depth and substrate type.

Dave Somerton (NOAA) posed the question that if surveys are designed to focus on hard substrates and rockfish are you then ruling out the importance of flatfish?

Donna Kline (MLML) stated that in her studies both hard and soft substrates are being targeted at given depth ranges. Specifically they are looking at overfished species and those are the targets. Part of the strategy that they are employing when bathymetric data are unavailable for site selection is using fishing data (specifically anecdotal info from local fishing community). They also use a SIMRAD ES 60 that they use to map areas that are not mapped and target specific habitat types when data is not available or not at an appropriate scale.

Robert Pacunski (WDFW) stated that mapping and sounders are not always effective because they have found certain features like mud walls sometimes seem like hard substrate.

James Pegg (DFO) added that though some of these features (like these mud walls) are not originally targeted they still have unique communities and associated species so maybe they should be added based as a unique habitat type for species of interest.

Robert Pacunski (WDFW) brought up that some of the study areas aren't necessarily focused on fisheries responses since these areas are not historically targeted so instead of biomass focus the focus is more on ecosystem based management and ESA species and use these data to develop habitat suitability models to use in areas with no bathymetry and evaluate broad restrictions.

With regards to direction of vehicle movement most group members base it on currents and wind.

James Pegg (DFO) noted that the skipper makes the biggest difference when trying to maintain predefined transect lines.

Robert Pacunski (WDFW) commented that some surveys are designed to survey contours but the needed distance is not always available with regards to the habitats that are being targeted.

Basically the group discussed that you pre-plan your surveys and then adjust as needed.

Question 3 and 4:

Group agrees that time and budgets are constraints.

Donna Kline (MLML) states that in order to determine sampling densities and lengths that they ran species accumulation curves.

Dave Somerton (NOAA) mentions that it is important with long transects that spatial autocorrelation should be understood and considered

Keith Matteson (ODFW) states that transect lengths were somewhat determined based on logistical tradeoffs.

The group agreed that it is important to maximize the rigor of the sampling and that soliciting a statistician's input is useful.

Question 5:

Most agencies are sampling a strip based on transect lines.

Dave Somerton (NOAA) asked about fish counts and the protocols for counting a fish.

Most group members stated that there are stated limits (must be in the same plane of the lasers and be more than 50% to be counted). Everyone acknowledged that this is flawed but that you need to stay consistent.

With drop cameras, a MAX N is collected rather than counts as is customary with strip surveys.

Robert Pacunski (WDFW) tested distance of fish and scored the distance very well with a drop camera for potential use in calculating densities from drop camera data.

Donna Kline (MLML) agreed that their data is consistent with WDFW and got values of 3.8 m to 4m as the distance you can consistently identify fish.

Question 6:

Everyone in the group acknowledged that though there is an assumption of 100% detectability this is not really the case.

Robert Pacunski (WDFW) offered that they have conducted scuba validations of their ROV data to identify cryptic species.

Donna Kline (MLML) discussed that detectability is not the only factor but reactions need to also be considered and enumerated.

Dave Somerton (NOAA) then described that more studies need to be conducted that describe undisturbed distributions and behaviors of fish.

With regards to daily and seasonal variation, it is varied how different projects/agencies approach this.

Question 7:

Most of the group agreed that stratified density estimates are expanded to strata.

A discussion then began about schooling, mid-water column species in which most stated that the best way to obtain information about these species is to use acoustic sensors and evaluate which species these are with visual methods (drop cameras, etc.).

Summary of Breakout Group Discussions: Topic 1 (Survey Design)

The survey design breakout session moderators summarized the discussion points from the three break out groups. All three groups agreed that survey design objectives are not always clear, and always evolving. In the absence of a well defined goal, that most agencies tend to err on the side of taking too much data (collect everything, and sort out the details later). Survey design goals differed depending on if a particular species or entire community or ecosystem assessment was the focus. Most participants agreed that when assessing groundfish populations using visual survey tools, the product is usually a relative abundance of animals and not an absolute abundance given the uncertainty with catchability, detectability, and habitat estimation, among other obstacles. As for survey stratification and design, participants agreed that the better the habitat information is in your area, the better the survey can be designed. Multibeam-habitat information was considered the 'gold standard, while bathymetry and fishery data are also used. Fishery data are typically used as a proxy for rock habitat based on a certain level of catch abundance. Participants highlighted that if there is only "one" stratum in your survey, then it is not truly a stratified survey. Benefits of stratified surveys include the reduction of variance within a stratum, and the assessment of between strata variability which could be used to incorporate correction factors into your results, as well as create distribution models for species abundance over a larger area.

Under the sub-topic of sampling density, the group agreed that avoiding autocorrelation is important. When deciding on sample size, there is a need to account for natural variation in fish abundances by habitat, i.e. are certain species "patchily distributed" and how should this affect your sample design/sample size. Some agencies used statistics such as power tests from pilot studies or previous results to determine an appropriate sample size/design for a new study.

Another major discussion point in this breakout sessions was the topic of detectability/catchability, which affect whether you are observing/recording the 'true' number of species in an area. Some groups dealt with this by conducting another type of survey (i.e. using SCUBA, trawl, a DIDSON, or multiple cameras) to validate their primary visual survey tool. Other groups made assumptions or simply documented whether or not a bias was present (i.e. ratfish are attracted to remote operated vehicles; therefore, there is a positive bias for ratfish catchability) and used that information to determine how a certain data set should be used for management, if at all. If there are undisturbed data on species distribution available, it is easier to test assumptions about catchability/detectability.

Workshop Topic 2: How are visual survey data used for stock assessment or other management goals?

Moderator: Kristen Green

Discussion questions:

1. How are you using fish counts from visual surveys to assess populations/stocks?
2. What are your sources of bias in expanding your visual survey data for management purposes and how are you correcting for these biases (if at all?)
3. What are your techniques for determining catchability/detectability? How is this affecting management?
   -attractance/avoidance (fish behavior)
   -cryptic/small/hiding
4. How do you reconcile visual survey data with "traditional" techniques?
5. What is your biggest obstacle in using data for management?

Workshop Notes from Topic 2: Stock Assessment and Management

Breakout Group: "A"

Moderator: Kristen Green
Attendees: Mike Byerly, Dave Somerton, Donna Kline, Claude Dykstra, Liz Clarke, Susanne McDermott, Bob Pacunski, Dani Lipski, Ed Bowlby, Scott Mazzone, Jen Blaine

1. **Question: How are you using fish counts from visual surveys to assess populations/stocks?**

- Mike – 5 index sites across management regions, using catch-at-age data, effort, harvest data, ultimately want to be able to use local abundance estimates to create a population dynamics model. Have used data to look for red flags. Could use harvest rates for past years to groundtruth abundance estimates. Spawning biomass per recruit model has been created for an area that was closed because it was thought that there were not enough lingcod for a fishery. Estimated how many spawning adults would have to be there to support a population.
- How would that be used for management? Adjust quotas or move harvest areas?
- Not there yet. Managing now from historic harvest levels, low levels of harvest now. Good age structure in the population now. No red flags that there are problems.
- Ed (OCNMS)– in sanctuaries, managing habitats, not fisheries, doing surveys to look at biogenic habitat which contributes to Essential Fish Habitat protection and Sanctuaries Act .
- Susanne (NOAA) – Small scale population abundance but would like to know what is going on in untrawlable habitat. In the beginning of planning a survey. There are high current areas. Working in the Aleutians. Concerns about habitat that might be mud covered. Had assumed that it was all rocky.
- Dave (NOAA) – Have used a drop cam for a small sampling area to count and measure fish and combining that with acoustics which has a large sampling areas of unknown size. The camera is used for relative species composition and also for absolute abundance. The acoustic data will be used in the stock assessment
- Claude (Halibut commission) – Using ROV to groundtruth sites to compare to data captured in longline. Rockfish captured as bycatch is sampled.
- Multiple fisheries information is used in the Canadian stock assessments
- Issues with surveys that are only collected in hard bottom habitat so that it could not be extrapolated out to the whole area
- If sampled in both mud and hard then get a better picture of absolute and relative abundance.
- Cannot get great size info with lasers, need stereo cameras.

- WDFW – what's there, how many, pinpointing unique habitat, with current technology. With stereo cameras could get biomass.
- Stock assessment people want biomass. Models are based on size/age. Visual surveys do not get age. Need otoliths to calibrate.
- Changes in catchability can be caused by density dependent distribution.
- Differences in length in fishery data and visual surveys.
- Some areas of the country (GoM) use visual surveys to drive stock assessment. They use stereo cameras. Age distribution by length… all fixed cameras.
- There are issues with using baited camera stations that are used for this survey, such as used in Pacific Islands and Australia. Can be combined with AUV survey in combination to survey schooling snapper grouper.
- Donna - Using a drop camera with 360 rotation all stereo, have used baited and unbaited. Still doing analysis. RCA analysis in Central CA.
- Dave – GoM survey – goes from Florida to Texas so goes through changes in water clarity, creates issues of detectability.
- Donna – dealing with that in their surveys. Had highly variable visibility and was able to detect fish out to 3.5 meters with constant LEDs.
- Liz – AUV set at 3m off bottom with strobe. Need to keep lights separate from strobe. Does color correction using automated program
- Robert – even using old drop camera limitation was about 4m.
- Donna – doing complete analysis by species because of differences in species.
- Mike – question about how they use data from drop cameras for stock assessment because it can only give you an index.
- Dave – Age freq distribution and relative abundance estimate. After 20 years analyzed ability to detect change – 20% chance of determining 50% change. Lots of effort for little ability to detect change.
- Need to do those analyses ahead of time so you know what you are up against.
- Can use drop cam, AUV, and fishery to sample the same spot to get abundance.
- Robert – did similar work with Lynne in Canada. Put down drop cam where they were using hook and line for rockfish. Raises questions of how to relate fishing data to visual data. Fish were attracted to gear but most just looked at gear.
- Big questions of are fish attracted or repelled. AUV is trying to address this.
- Robert – initial drop cam deployment scared fish away but by the time of the third "pan" of the camera, the fish had stabilized so they would only use the 3rd pan
- Dave – that may be happening with every ROV transect
- Robert – but some fish do not exhibit avoidance. The drop camera and ROV do not have same avoidance patterns. The same fish are always there, and can be seen very far out. As long as the ROV does not hit bottom….and create a dust cloud that startles fishes.

2. Question: What are your sources of biases…?

- Detectability. One way to deal with it is to remove sections of the transect video

- Are there steps you can take in terms of lights or other…
- Kristen – recorded behavior of fish in field of view.
- Mike – used black and white camera forward facing to see forward at what is ahead of ROV, with survey camera tilted down, and downward facing camera. Did it at 4 light levels, ambient (down to 60m), 3 light levels in 200 or 250 watt increments, randomly selected transects. If saw fish in forward facing would look to see if it was in survey camera. For lingcod, yelloweye, quillback. For lingcod no response or movement, for yelloweye more moved into field of view than out of field. For most rockfish movement in and out was equal. Also recorded orientation of fish. Lingcod were randomly oriented (no bias). Rockfish were more likely to be oriented towards ROV. Lynne used a DIDSON to see out 30m. Important to use camera forward so you can account for fish moving in or out and subtract or add fish to your count.
- Liz – uses a forward looking camera because cannot identify rockfish from straight above. Strobes and light are synced. Some people think that fish do not perceive strobe at low levels. When take pictures that overlap you can determine if there is fish response. Sometimes you see puff of sediment. Often that is flatfish. However, that is only occasionally. Liz has the sense that if proceeding with the vehicle at a slow and steady rate that fish are not responding. MBARI old ROV was noisy (hydraulic) and did cause responses but new quiet one does not cause response.
- Robert – we are not missing rockfish because they are fleeing, we are missing rockfish that are hidden behind obstacles.
- Robert – do not stop and chase fish for ID. Messes up with boat driving/ROV.
- Liz – any ROV will be better than current AUV set up because you cannot stop and zoom in on fish. New cameras may help with ID on AUV.
- Robert – another thing they use for their data is to survey sea cucumbers for stock assessment.
- Robert – looked at fish by fish response in one survey but have not analyzed.
- Dave – will be looking at behavior of fish by looking at location of individuals and how they move from stationary cam. Then when ROV goes through and see how it moves then in response. Compare usual milling to response. Will be able to tell at what acoustic level response occurs.
- Challenge will be to orient cameras in the right field of view. 80-120 feet depth. For grouper and snapper. Discussion of challenges in this experiment, such as driving ROV near other cameras in blind conditions.
- Liz – Seabed tech cameras (mouse camera) going to all science centers, black and white cams.
- Robert – laser colors – fish response differently to green or red lasers. Flatfish are attracted to red. Greenlings like green lasers. Green are easier on eye strain for the reviewers.
- If using stereo cameras, some have stopped using lasers. Lasers can be a good backup.
- Day vs. night
- Seasonal differences
- Winch – Susanne – when she turns on winch she sees fish response.

- Dave – back to how survey data are used in stock assessment – will not be possible to do visual survey in all stock assessment area. So what can we do with it? Managers said they want absolute abundance in trawl area, or catchability for trawl. Then population estimate can be constrained by absolute abundance and by catchability for trawl.
- But requires that you have good CPUE data and on the west coast we don't have good CPUE data because the limits are so restricted.

5. What is your biggest obstacle in using data for management? What are your obstacles in peer review?

- Challenges in availability of good habitat data
- Where there is lack of habitat data can use other data such as fishery data.
- Habitat models are good for sessile but not fish, has applications for using models

Challenges:

- Kristen – would want to do comparison between submersible and ROV
- In transition between technologies do both, or do comparison between 'dumbed down" new HD camera and SD camera
- Robert – will be doing surveys using HD and SD cameras
- Dave – down the road will be automatic species recognition
- Donna – biggest challenge – lack of detailed habitat data. Sampling deep and will have difficult extrapolating data to a bigger area.
- Robert – had too few sampling stations relative to the different habitat types that are out there. 197 stations. Only saw 30 copper rockfish. Issue with confidence in estimates. Not getting enough rockfish to say anything with confidence about abundance.
- Mike – scale issues. Could potentially do fewer transects in some areas and add transects in other areas.
- Scott – do not know what is in the area. Do not know if there are good habitat maps but fishermen talk about good reefs.
- Susanne – goal is to get presence/absence data around sea lion rookeries and to develop an index of abundance that is similar to what a trawl would show.
- Ed – for OCNMS, challenge is that there is limited habitat data so that it is difficult to plan surveys. Interested in hard substrate for biogenic habitat surveys.
- Dave – limitation is the scale they are working in. Daunting task to assemble effort and money to cover it.
- Liz – work with AUV because interested in working habitats through west coast. "cheap deep" Overall goal of going to coast wide surveys. But no way to go there without habitat surveys. Need to do pilot surveys in areas where we have habitat data but people need to realize that the habitat info is limiting the ability to get to absolute abundance estimate without. People also need to understand cost and effort.

Breakout Group: "B"

Moderator: Dayv Lowry

Attendees: Sean Rooney, James Pegg, Tom Laidig, Bob Pacunski, Sarah Davies, Keith Matteson, Jessica Watson, Andrea Hennings, Jessica Finney, Bradley Spiel

Question 1:

Most people in the group agreed that densities are being calculated and expanded to area counts.

The topic of community structure was then discussed where most said they were using Primer but that there are some concerns that it is a "black box" technology so you should run stats to complement and verify results.

Sean Rooney (WSU) brought up the point that it is important to understand and consider what is the appropriate scale how applicable it is to expand fine scale studies to larger regions or coast wide.

Question 2:

Robert Pacunski (WDFW) says they have done 24 hour surveys in order to account for bias in diel patterns.

Sean Rooney (WSU) stated that sometimes the identified bias help more with future planning efforts and not always used for correction.

Seasonal variance was also identified as a source of bias.

Tom Laidig (NOAA) discussed the paper he co-authored that looked at fish responses to vehicles.

In general the group discussed that usually these bias calibration studies are usually only conducted once and then used to validate future work.

Sean Rooney (WSU) also brought up the point that bias can be introduced between different processors and QC/QA procedures. He also stated that there can be changes in protocols to limit bias and thus influence the survey design.

Question 3:

James Pegg (DFO): said his project focuses on identifying small invertebrates and cryptic species so they focus their design on to make sure the smallest target species can be identified. To do this they change/develop protocols to maximize detectability.

Tom Laidig (NOAA) stated that detectability is different in different life stages as well as behavioral patterns like schooling vs. demersal. The highest resolution he stated can be gained from direct observation and observation from varying angles.

Sean Rooney (WSU) stated that you can account for the detectability by maintaining consistency by knowing that due to detectability that certain species and species complexes need to be removed from analysis.

Others discussed that metadata and qualifiers when analyzing data can be used to up group or remove certain groups from analysis due to detectability constraints both through identification and observation in general.

Question 4:

The group concluded that traditional techniques can be used in conjunction with visual surveys through comparison studies as well as to develop and incorporate correction factors. You must recognize that no matter what technique being used that there are differences in catchability depending on the method used and that needs to be addressed or at least stated.

Question 5:

The group discussed that the biggest obstacle is bias associated with surveys and acknowledging these bias while not discrediting the results in the view of the public and managers. Other obstacles include budget restraints on collecting and analyzing data.

Breakout Group: "C"

Moderator: Lynne Yamanaka
Attendees: Mary Sue Brancato, Rick Starr, Wolfgang Carolsfeld, Theresa Tsou, Jenny Stahl, Scott Marion, Lisa Hillier, Erin Wright

1) **How are you using fish counts for visual surveys to assess populations/stocks?**

Lynne- using density counts for relative abundance. Logbook catch data construct time series of catch and for more recent years catch per unit effort. Use these in a Bayesian surplus production model.

2) **What are sources of bias?**

Repeatability between estimates- how compare year to year. How much due to change and how much due to survey technique. Rick Starr has done a little in past. Found little variance between years. Lynne says they have looked at seasonal differences, but haven't looked at all the recent annual data. Suggestion to compare estimates between days or years with some species.

Lynne says technology creep is a big thing she doesn't know how to deal with.

Filter data so minimum threshold is met. If get better camera, then assume better at identification but threshold same. But time series still not biased. Can use subset of data rather than all data.

Rick-With time get better cameras. Over time have less unidentified species, so species composition changes. Can limit analysis to four species can always identify or can assume the proportions of species don't change. So can use species proportions done with new camera and apply to past.

Wolfgang- ran high definition and standard definition on same camera for comparison.

Quantify differences among observers. People get better overtime. Differences in accuracy between observers. May be some differences in time between reviewers. They may just do this to calibrate. They don't have multiple reviewers for all tapes.

Doesn't seem like difference between observers

Differences for certain species such as flatfish- more experienced observers may be better

Theresa-Need to set goal- top priorities rather than identify all species, but can mark on tape other species.

Rick-can identify some species of flatfish well but others not well. So maybe use proportion of detectability of one flatfish species to another based on other data, such as trawl data.

Lynne- surveyed with ROV and set longline. Could see much smaller fish with ROV than could catch with longline, so significant difference between catchability.

Jenny- include both subadult and adult yelloweye but could be bias because don't know if fishery catching all subadult yelloweye or just bigger fish. No length information for sub in past. Other people have used lasers to estimate length class.

Scott Marion- change bias between different terrains. In high relief more fish. 2-D to 3-D challenge. Hard to expand biomass estimate. Observation bias changes due to geometry.

Theresa-changed transect from distance measurement to time and assumes constant speed. To account for pinnacles and such.

Jenny- tradeoff because then not account for line length differences.

3) **What are techniques for determining catchability/detectability?**

Attractance/avoidance

Lynne used DIDSON mounted on ROV to see bigger field of view. Seemed to work well and found that DIDSON looked far ahead (30 m) but the ROV looks 2 m ahead so when the ROV slightly sweeps side to side, the DIDSON may see a fish 30 m ahead but the fish may pass 3 m to the side of the ROV view, so had to use an immobile species such as sea urchins as a control to see whether the DIDSON and ROV would see the same proportion of known immobile species.. Want to see if fish were avoiding ROV before saw fish. Would bias estimate if fish moved before.

Rick asked has anyone put side facing camera on ROV? Wolfgang says camera set-up to check ROV umbilical. Some fish travel behind but are not in front. High-definition camera fairly wide-angle.

Mike Byerly binomial study for yelloweye rockfish and lingcod to see if differences in fish moving in and out of frame, but was all a wash.

Species specific behavior. Some species like rockfish don't move but fish like flatfish once the ROV gets close enough to identify then they move.

One size fits all transect doesn't exist.

Lynne- we don't try to assess fish in water column.

Cryptic/small/hiding-

Lynne- if we can't identify juvenile rockfish then just call them little red rockfish in the comments, i.e. So they just sort of ignore them.

Did an experiment with longline and ROV. Travelling from different directions along the longline and did see fish tucked under rocks on one pass and were totally unseen on the return pass. Rick said on second pass might get lower estimate because disturbed them originally. Lynne did not see this with nearshore rockfish.

How concerned about unidentified species? What are goals?

4) **How do you reconcile visual survey data with traditional techniques?**

Rick says Liz said that they haven't reconciled their data.

Lynne- Tried to estimate catchability with hook and line surveys versus sub or ROV running same line.

NWFSC working on data poor models. Why not bring in video survey data? Seems like debate at NMFS whether to use video data. Why not incorporate video time series data.

Jenny- plan for catch data and visual survey biomass estimates in age-structured model.

Theresa- stock assessment panel didn't like survey because only covered rocky habitat. Use stereological design because got criticized by NMFS folks cause didn't cover all types of habitat. Limited money to get precision.

Compare relative trend to stock assessment.

MPAs need a way to evaluate over time.

5) **What are your biggest obstacles for using data for management? Peer review criticism?**

Peer reviewer may criticize survey design. If have experience then want to know about length of transect.

Issues with biometricians- they all have different ideas. Some don't have experience with visual surveys.

Lynne-surplus production models- use lots of indices over time. All indices going in the same direction, so biometricians have no reason to dispute if everything going in same direction. Some indices may show declines faster or slower.

Peer-review- one reviewer was concerned about avoidance, so they had to go back and re-review forward facing camera to show no avoidance.

Can we cite other work rather than redo each time? Information is species specific. Some have to do studies by species, but not hopefully by area.

Theresa- did study over 24 hours to see if species differences. Did about half during day and half at night to try to get diel effect. Still analyzing data but initial pass shows that clear diel differences may exist for some species.

Dependent on goal may take years to analyze so may not be practical for management.

Rick- techniques for catchability- DIDSON. Anyone thought of using echo sounder? Wolfgang horizontal backscatter might have too much backscatter.

DIDSON-High frequency scanning. Sends out matrix of beams. Monochrome. But can identify from shape. Doesn't require light, so can use in poor visibility.

Using GoPro cameras as well.

Summary of Breakout Group Discussions: Topic 2 (Stock Assessment)

After the stock assessment and management workshop session, the moderators summarized the discussion points from the three breakout groups. To assess fish populations for stock assessment, the group relied on long-term "index" sites, as well as relative and absolute abundances indices of species counts from the visual surveys. Other tools for assessing populations included quantifying community structure, species distribution, and fish-habitat relationships. Sources of bias for expanding visual survey data for management included the availability of habitat information, technology changes over time, changes in gear selectivity between different survey vehicles, sampling during different times of year, differences in size and sex of fish, and diurnal and nocturnal fish assemblage differences. All of these factors have the potential to affect detectability, catchability, and species identification, which can affect the way data are interpreted for management.

Workshop participants addressed these biases in many ways. Most agencies/universities/organizations have 'video quality review' rules for which video data to include for analyses. Video reviewers undergo training to increase accuracy and also to avoid inter-observer differences. Some agencies rely on multiple cameras to detect avoidance/attractance behavior in fishes. Many agencies remove the initial footage when a ROV, AUV, drop camera, etc. is deployed to avoid the 'startle effect' on fishes. Validation studies with other visual surveys as well as fishing surveys (trawl, longline) are also important for comparing trends over time. One way to evaluate visual survey data with regards to more "traditional" techniques, such as trawl surveys are to compare the catchability coefficient between the surveys.

Overall, workshop participants highlighted the need to be flexible and potentially adjust a survey design to remove or reduce sources of bias once they are identified. However, participants also pointed out that if survey design and protocols are consistent over time, then at least the sources of biases should be consistent as well. Visual survey data are compared with other data sets to see if the long-term trends are similar.

Lastly, participants discussed the greatest obstacles in using visual survey data for stock assessment and management. For many groups, the amount of review time, and the urgency to complete data analyses on the scale necessary for fisheries management was difficult. For others, it was the lack of comparative, published work, and difficulty in convincing managers that the visual survey data are useful and valid. Others were hindered by lack of habitat data and issues of scale in expanding visual survey data to a larger management area. Finally, some groups were still developing techniques and methodologies for their visual survey program, i.e. they were still in the 'pilot' program stage.

Workshop Topic 3: What are the strengths/limitations of methodologies for collecting/analyzing video?

Moderator: Dayv Lowry

Discussion questions:

1. At what level should habitat be characterized?
2. How do you account for fish behavior?
3. How do you account for variation in visibility?
4. Optimizing video review "rules" and protocols
    a. How many reviews? Independent or "error check?"
    b. When is a review "done?" Time limits?
    c. How do you evaluate reviewer accuracy and bias?
    d. Methods for effectively watching two+ screens at once?
5. What technology is limiting data or analyses?

Workshop Notes from Topic 3: Video Review and Analyses

Breakout Group: "A"

Moderator: Lynne Yamanaka
Attendees: Bob Pacunski, Sean Rooney, Liz Clarke, Andrea, Wolfgang Carolsfeld, Susanne McDermott

1. **Question: What level is habitat characterized?**

Bob Pacunski- use Gary Greene technique of 2 habitat codes for substrate. Substrate code-2 codes. First greater than 50% field of view. 2nd code at least 20%

Kind of get at habitat by what species that you see. How the ROV settles to bottom can help determine type of bottom. Identify habitat when measure belt width for strip transect. Generally 30 second interval plus or minus 5 seconds. But may make judgment call if sand channel in middle of rock. Use dynamic segmentation in ArcGIS to put habitat together. They also characterize patch where fish are in. If fish of interest, then also record at fish location– substrate, complexity, relief, biocover.

Tissot has defined method-patch level habitat. Has to be at least 10 seconds minimum to switch. This method is easier for review. Stein et al. Paper regarding patch? Need to focus on transects.

AUV a little simpler. Every still image count fish in then characterize habitat. Still do two habitat types.

Other people only do biogenetic habitat- if doing specific analysis. Then record where fish is located. Such as a crevice.

Bob's group also codes biocover. Metridium, etc. Biocover code- different code than substrate.

AUV- Liz says do photomosaic and drape photomosaic over multibeam- try to get habitat perspective. Hard when doing stills to get overview. Commercial software that stitches mosaic together. For example, tagging project within contact of photomosaic. Photomosaic gives context.

DFO-use same habitat classification as they use for scuba. Also primary and secondary system.

Lynne suggests working session for habitat review between groups.

Sean- Record habitat when habitat changes not based on time such as every 30 seconds. But advantage is better at getting at patches.

They think easier when switch every 30 seconds for new reviewers.

Bob's group reviews – at least 3 times to review.

Additional code. Habitat association- is fish within body length, fish within meter of coral or sponge, etc.

Liz-can pick fish and software can get information on distance to habitat, etc.

Length measurements- ROV has to be oriented specific way to get lasers in way to measure fish. Use lasers to scale. Fish has to broad side to measure. Some people just use categorical sizes for lengths.

Use invertebrates to characterize substrate if know habitat association.

2. **Question: Can you account for fish behavior?**

Don't count schooling species, because can't guarantee that we can count all of them.

If fish behavior is to zigzag in and out then may not count these fish.

Lynne- they don't bother with fish that have behaviors that cause them to move in and out or frame.

Off bottom schooling rockfish are hard to count.

Bob-record black rockfish but know not getting accurate accounts. Bob only count fish on bottom. Comment on other fish. Use key words if use comments.

Can use quantity field, such as 1 fish, school of fish, etc. instead of putting multiple fish in a comment

Bob- sometimes go back and do acoustic surveys where comment on black rockfish. Groundtruth acoustics with ROV.

What else needed- low light camera work. DIDSON work can show us what going on in distance with limited view of ROV. Especially if worried about low light. DIDSON is array of beams that go out simultaneously. Fan shape picture. See low resolution image. Blue view is a sonar system that can put on ROV, can adjust out to 30 or 40 meters.

For behavior-Studies between different types of gear- different light levels, heights of equipment on fish behavior. More comparative studies.

Time of day on behavior- Bob has done and Sean is working on with Hecate Bank.

Bob- Lot of repeat transects. Kelp greenling go to sleep at night. Didn't see a lot of fish so will be a bit hard to get at. Black rockfish hunker down at night. Didn't see difference with yelloweye at night or canary in exact same spot.

Fish behavior can be used to size lingcod by the way it swims.

3. **Question: How do we account for variation in visibility?**

Built in for line transects, but difficult for strip transects.

Light tags made for fish geolocation. $2000 tag that can put on camera. Gives back light intensity and time. Would have to turn lights off to get visibility?

If visibility really poor then don't use the section of video.

Tried to get at visibility- coded visibility. Used it a little bit. So didn't end up throwing out segments.

AUV- visibility is not issue for detection because fly off bottom. But only issue is how well can identify things dependent on visibility. But usually not a big issue. May cause you to lose a little confidence with substrate or invertebrates.

If off bottom, then code "off bottom", then cut out that section.

Eupahusiids can cause problem with visibility but usually patchy

High tide, currents- may be too much sediment to see.

Get raw information off of still cameras and run through color correction.

If visibility is poor for a predetermined amount of time, then leave and come back to the transect.

Lynne went to ROV studies in winter to have better visibility.

With DIDSON could see crabs 3 meters in front when visibility is only 1 meter.

4. **Optimizing video review rules and protocols-**

Bob exploring different ways to review to reduce time when reviewing, but retain high levels of detectability and identification.

Lot of discrepancies among reviewers.

Cross checks between reviewers. Two reviewers side by side. Reviewer eye fatigue and complexity between habitats. Predetermined time limit for allowing people to stare at screen. Accuracy drops after particular time, but also dealing with deadlines.

Level of interest tends to pull persons eyes away more. Some people have 4 hour max, some have 5 hour max.

Some people go back to past years and re-review to get better fish IDs.

Brian Tissot has a protocol which is really good and consistent. Training program for video reviewers.

Look for gross numbers with database output.

Cross-check: can record information for important species such as yelloweye at-sea and cross-check after do video review.

With submersible can do a debrief after dive.

Two-screens- database on one screen and video on another screen. Size of screen is important.

Sean- uses habitat key to help himself reset. Pictures of scatter versus clump habitat.

5. **Question: Technology limiting data or analysis?**

Whole digital concept causes to lose lines.

IT issues with government.

Security rules are very difficult. Can't show people at different NOAA center copies of images.

Automating. NOAA trying to advance this process. Working with digital stills, so don't have access to nice software.

Kresimir – looking at coral. Has created his own software.

In medical field pushing for dealing with digital stills. So sounds like NOAA is working with medical field.

Database limitations. Space to archive stuff and allow accessibility to more than one group. Really limiting with digital stills.

DFO –using Video Miner? Started with DV log. Free? They have the right to share.

Backups – 3 different copies!

Lynne- has digital copy of everything. But not throwing out old tapes. Standard for most is three copies on two different media in three different locations.

Photoshop Premier Elements for switching from tapes to digital.

Breakout Group: "B"

Moderator: Kristen Green
Participants: Sarah Davies, Andrea Hennings, Tom Laidig, Scott Marion, Keith Matteson, Brad Speidel, Jessica Watson, Erin Wright

Session participants opened with discussion of their visual data collection protocols and associated hardware and software. The following are summaries of the information provided by participants:

ADFG- Kristen Green

- Deep Ocean Engineering Phantom HD 2+2 ROV
- Machine vision stereo cameras
- AVI video files
- SeaGIS Event Measure for video review
- Only record fish from "good" quality video
- Habitat is recorded, though there are no established research questions which require its collection. Additionally, the habitat classifications will require more definition and refinement.

ODFW- Keith Matteson and Jessica Watson

- Videolander, sled, and Deep Ocean Engineering Phantom HD 2+2 ROV
- Single high definition camera for all survey methods
- Videos played through Adobe Premier Pro, data entered into Microsoft Access database
- Data collected on camera SD card, video tape prior to last year
- AVI video files
- The sled is not tracked but depth is known
- Collect fish and invertebrate indices (MaxN) from video lander and fish and invertebrate densities from ROV and sled
- Sled data utilizes X-key with time code generator to match species occurrence in the video frame to a GPS location (using second PC); habitat and sled status are collected on the first video review, and fish and invertebrates are collected on a subsequent review
- Use additional tracking software (Fugawi) for GPS location data
- Video is assigned a visibility designation based on quality
- Species are entered into the database with either 100% reviewer confidence or they are assigned a the next highest taxonomic level

DFO- Sarah Davies and James Pegg

- Deep Ocean Engineering Phantom HD 2+2 ROV

- Custom video review software (VideoMiner)
- Set time from screen overlay, then counts frames from time code and populates positional data in Microsoft Access database
    - Fish, invertebrates, and habitats selected from database look up tables
- No standard video review protocol, though each group who uses video makes their own protocols based on needs
- Transects partitioned into 10-second segments
- Focused initially on inverts, then fish; inputs can be customized with color-coded buttons
- No established QA/QC protocols
- Can record on/off bottom within a segment in an ROV behavior field (e.g., ROV moving toward transect is “transiting”, ROV surveying is “transect”)
- Contract video review

SWFSC- Tom Laidig

- Data entered into a Microsoft Access database, database storage using SQL server
- Watch video and classify habitat in three-second intervals
- Imbedded time code populates fields in Access, look up tables
- Off bottom pieces cut out from overall transect (called segments)
- Strip transects
- Fish and marine debris are reviewed first, with invertebrates reviewed second, and habitats reviewed third; fish and marine debris are identified by two independent reviewers
- Reviewer confidence in fish identification is assessed on a scale of 1-3 (confident to not confident); a percentage of 3’s undergo additional review
- All analysis is conducted on one CPU

WDFW- Erin Wright and Andrea Hennings

- Videos played through VLC Media Player, data entered into a Microsoft Access database
- Habitat and GPS position collected every 30-seconds at beginning of a segment
- Substrate and biocover: Primary (>50%) and Secondary (10-49%) coverage
- Segment is designated “Off bottom” if the ROV is high or the substrate is not visible for more than 10-seconds during a 30-second segment
- Species of interest are collected within each 30-second segment
- Reviewer 1 completes two video view passes for all habitat and species data; Reviewer 2 completes a third view pass for percentage of videos

ODFW- Scott Marion

- Five separate ROV transect reviews, beginning with classifying whether ROV video is usable (cutting out unusable footage or "gaps"); ODFW assessing how much video should be cut for future surveys
- Noted reviewer protocols are closely linked to ROV piloting protocols and behavior (e.g., if driving is poor, it affects reviewability)
- Currently cut gaps if they don't meet a certain quantitative characteristics- wanting to reassess actual usability
    - Might include different codes for reasons why gap was cut
    - Problems with certain integrated systems based on usability and data entry error, importing, etc.

Jessica Watson (noted from a previously held position)

- Forward and downward facing cameras; downward camera collected pictures at will or on 30-second intervals
- Data collected primarily from forward camera and entered into Microsoft Access database; run off the same CPU
- Downward camera visualized on separate DV (usually used for species ID)
- Start and end times recorded for frames; if no forward movement, not classified
- Habitat and frame, then fish and inverts, then fish and inverts
- QA for fish and invertebrate classifications

Additional discussion during noted the following:

- Archipelago Marine Research (Victoria, BC) views videos from multiple cameras on a single screen, possibly with proprietary video processing software
- Most groups are using habitat classification from Greene et al. (1999)
- Pictures can be useful to determine habitat percent cover, species ID, and species detection
- Some groups collect secondary video for species detection; can present problems for double counting if the videos are not compared directly

Question 1: At what level should habitat be characterized? How is this determined/optimized?

- Define the question, then select habitat types and designations based upon need
- SWFSC uses habitat for analysis of species assemblage/associations
    - Use hard/mixed/soft for some transects and break down further to dual habitat designations when looking at an area more closely
- No groups stratify by consolidated or unconsolidated substrates, though it may influence species assemblages based upon unconsolidated sediments or grain size

- Classification of habitats based upon multi-beam backscatter (Greene et al. 1999)
    - Finer vs. more coarse resolution of habitat types and subsequent subjective methodologies based upon visual data collected by ROV, submersible, etc.
    - How much does this variation affect species assemblages, especially invertebrates and fishes like sand lance?
- ODFW initially used Greene et al. habitat types and is/may be switching to NOAA Coastal and Marine Ecological Classification Standard (CMECS) due to accounting for unconsolidated sediments
    - ODFW starting to do biogenic structure in analysis
- Not many groups utilize relief and complexity when classifying habitats
    - Problems with consistent identification of relief may occur when assessed subjectively
    - WDFW assesses relief and complexity for a subset of their species of interest

Question 2: Can you explicitly account for fish behavior? How?

- Some record for every fish response and some only do specific species
- Noted that larger benthic species don't move as much as smaller or more pelagic species (Laidig et al. 2013)
    - Assessed movement based upon body length for relative measurement; determined to have moved if fish changed direction of travel or no movement if the fish did not move or would have been hit by the survey vehicle
- Can measure relative abundance rather than absolute for some species based upon their reactions
    - Assume each fish will respond the same as any other and then extrapolate
- ADFG assessed fish movement due to attraction or avoidance
    - Ultimately did not find net bias, so stopped assessing
- Absolute counts present an issue for schooling species- some ignore
    - Presence/absence or relative abundance is less of an issue
- Fish behavior and subsequent counts have implications for MPA characterization, stock assessment
    - Could measure size of fishes and compare between in and out of MPA rather than use counts
    - Calculate relative abundance for some species and density for others- clearly note which is which, though this could restrict community analysis later
    - May also do absolute abundance with the caveat of possible under or over sampling
- Develop species identification based upon fish behavior
- No apparent difference in identification of larger fishes using HD vs. SD video cameras
    - Downward camera which takes still images using strobe lights improves species identifications

        - SWFSC has a ~95% identification rate on flatfish using the downward camera

Question 3: How do you incorporate or correct for variation in visibility?

- Visibility should be determined in field if already poor- abort survey if necessary
- Some groups have visibility indices which influence use of part or all of a transect for analysis

Question 4: Optimizing video review "rules" and protocols

- Most groups review videos 3-4 times; additional review for a subsample of videos
- May never every truly be "done" with a video review if there are additional objectives or revisits based upon future research questions
- ODFW plots dive times in R to check elapsed time and ensure full videos were recorded for a transect
- Discussion of time code generators and how they work through coding to audio
- VARS users had some difficulties for querying
    - Species list for California comes with the VARS package and it's difficult to remove or update
- SWFSC updates their species list/look ups based on AFS standards on a yearly basis
- DFO populates their species list from surveys; over 50,000 species (mostly invertebrates)
- Data storage on external hard drives, BlueRay disc, external servers
    - Incremental backups to a server
    - ODFW stores some at home due to tsunami danger at offices
    - SWFSC IT personnel stores some data at home for external backup
    - Data speeds can be a barrier to external servers due to traffic or physical distance

Question 5: What technology is limiting data or analyses?

- No specific answers or discussion for this question

Group recommendation: Develop a species identification website, repository, or forum following the workshop which includes behavior, video clips, and pictures

Breakout Group: "C"

Moderator: Dayv Lowry
Attendees: Rick Starr. Dave Somerton, Mike Byerly, Claude Dykstra, Ed Bowlby, Dani Lipski, Jen Blaine

Question #1 ~ Habitat Level

Ed: -First pass looking at just habitat for 20 second patches (small patch habitat)

-3rd pass, looking at fish associations with habitat

Rick: -students did landscape-view scale, which was a composite of small-scale habitat patches

-This gave a different perspective

-The scale at which you look at habitat influences the answers you get to your question

-With small habitat patches, you only get a potentially biased association (e.g.: missing the larger habitats surrounding the exact patch)

Dayv: - look at both "macro" and micro" habitats

-30-sec habitat patches, but also recording the exact habitat with which a fish is associated (eg: overall mud habitat, but with one random boulder where 5 quillback are hanging out)

-in some cases this micro habitat is very significant

Rick: **How do you incorporate these habitat details into management? This scale has yet to be figured out**

Dayv: helps to have very detailed multibeam

Dave: is the habitat on video always related to multibeam?

-**multibeam is only used to inform survey area**

Dayv: **video then is also used to groundtruth multibeam maps, which leads to a better prediction of what's on bottom**

Ed: use multibeam and side scan for the hard, mixed, soft signal, then use drop-cam to verify these data

Dave: **how is MBES used in biomass extrapolation?**

Dayv: **incorporates with rockfish/MPA siting—it's less about biomass and more about predicting habitats**

Claude: assumes that at a certain saturation point, the habitat actually covered doesn't matter (but he is not looking at reserve siting)

Dave: must know sampling frame to apply to biomass

Rick: **-we're defining associations at a fine scale, but extrapolating to a much larger scale**

- **Must look at associations at this larger scale in order to know how these relate**

Dayv : we have a GIS modeler working towards combining the Benthic Terrain Model, MBES, and rockfish observations to develop a model that will hopefully provide the ability to look at associations at different scales

Dave: "groundtruthing" is really vague—there is no algorithm for this, and **what we see is not necessarily what fish see**

Dayv: -WDFW did an ROV survey in 2008 in the San Juan Islands that was depth stratified and only looked at rock habitats; then a survey in 2010 with a stereological design that included all habitats

-added to abundance estimates

Dave: MBES is really expensive—what do we really get with it?

-seems to be no consensus on what habitat level we need to look at

Rick: we can get rugosity, slope, hardness, etc.

-what parameters/metrics do we use? What are the fish responding to?

-his group is looking at km^2 patches and comparing differences and then extrapolating to fish associations

Claude: use other tools than just limited visual observations

Ed: **MBES scales vary around areas—limited in extrapolation by the coarsest scale**

Question #2 ~ Fish Behavior

Mike: use multiple cameras to look at fish behavior

-throws out observations based on behavior

-becomes a gray area between natural and responsive movement

-experimented with this and found certain species had no difference in response to ROV (eg: lingcod) while some did (eg: Yelloweye)

-review videos at same time, sometimes multiple reviewers

Dave: most observations all from video—very few/none based on external observations (eg: acoustics)

Dayv: hard to build a model on this, but we just assume that any bias is at least consistent across the survey and predict over/underestimation

Ed: we have multiple cameras for this purpose, but have not reviewed this

Rick: if you can sample consistently across those variables that might influence, should be able to use across time

Mike: line transect models out there for other animals to incorporate movement (birds, sea lions, etc), but difficult to use these for underwater use

Dave: Mary applies this using a parabolic model, but different…

Dayv: some people using DIDSON, other measures, but not all can afford this

Question #3 ~ Visibility

Rick: uses **SeaGIS** software to measure out to edge of visibility with **stereo drop cam**

-can define area either by drop, or apply a minimum range to all drops

-changes for size of fish

-looking at differences between the ways of using a model

Dayv & Ed: visibility will end a transect if we can't see a fish within a foot

Ed: used **AUV** to automatically survey areas that might be good to then return to with an **ROV**

Dayv: need to practice/work on retrieval methods for AUVs

How do you balance attraction and detraction of fish?

Rick: going to get **DIDSON** to 'see' further out

-**analysis of frequency distribution relationship over time shows less of a 'scare' factor and more of an 'attraction' factor** (don't use after 8 minutes)

-**stereo stationary cameras** are new, so still grappling with issues

Dayv: there was a tropical study with cameras watching fish behavior in response to divers, but they got limited results

Dave: if we could observe the entire water column and say what proportion are what species, etc, we could get a better acoustic look—this could be the future for stock assessments? With **Landers**?

Dayv: we'll be attempting to do an **ROV** and **acoustic** combination

Ed: -1-year **benthic landers** to do time-lapse photography

-goal for future to monitor protected areas

-not interested in stock assessment, but more life history and habitat associations

-**Venus and Neptune**, Canadian Oceanic

-nodes with sensors all cabled together in arrays

-stream data to web—lots of info

-**NaNoos** doing something similar?

Question #4: Review Protocols

Ed: can't be done in just one pass

-methodology based on Tissot lab—passes look at something different

Tissot lab method:

-first pass looks at habitat and defines patches

-second + passes look at identifying and counting invertebrates

-separate passes look at fish

-last pass(es) identify fish and invertebrate associations

Rick: tested reviewer bias with each new person, but don't re-test over the years

Dayv: would like to do a review of number of passes, time, etc to be able to assign a time limit for future reviews on particular habitats so that reviewers don't spend too much time on just plain mud

Claude: had a standard of break times, work span, etc—all systems would automatically shut off at designated break and end work times to enforce these

System to apply an estimate/correction for reviewers' accuracy level—should re-test over years

Mike: uses multiple reviewers at the same time, but also viewing multiple camera footage

-also uses a training set of videos

Post Processing Software:

Dayv: VLC and Access

Rick: SeaGIS (Australia) and Access (with stereo)

Dave: for stereo, uses custom-made software (free)

Dani: Coral Point Count for future stills for invert cover

Ed: MBARI video adaptation software—has audio annotation both at sea and during video review

Question #6 ~ Data Recording and Archiving

Ed: started on external drive and tapes, backups on shared drive, but capacity is getting limited

Dayv: -ROV records to external hard drive and laptop

-now have almost 10 external hard drives

-save to desktop for review

-lots of old tapes still

File formats change so much—is it worth holding on to them and just archiving the data?

-degradation of tapes over time

-no one backs up to virtual cloud storage because the files are too big

-MBARI has converted their massive storage to digital?

-Rick: has held onto tapes and has found them very valuable

-Claude has started collecting extra otoliths to preserve for potential future technological advances

-switch from tapes, etc, to digital can be expensive

-CA has a georeferenced web interface for people to see clips and stills from past surveys; while this is good for outreach, it is not actually archiving data because the entire videos cannot be interfaced

-Dave: uses machine vision – each clip/save is saved as a file

-Dayv: tried linking images with Access file, but file got way too big

Mike: uses NORPIX software (handles SD, HD, machine vision, with a proprietary file system)

Rick: SubC –records internally, not through signal

-DVR records to SanDisk to hard drive, uses codecs to play and compress in SeaGIS software

Mike: NORPIX software can do compressed JPEG with good quality and fast frame rate, and can batch process file conversions

Rick: has the option of recording at different rates and can't tell the difference between mid and high level, so they record in mid to save space

Dave: adding color would make storage crazy with machine vision, possibly up to 15TB per day

-must compromise on something: frame rates, file size, resolution, etc

Summary of Breakout Group Discussions: Topic 3 (Video Review & Analyses)

After the video review and analyses workshop session, the session moderators summarized the discussion points from the three breakout groups. The groups first discussed how habitat should be characterized and categorized during video review. The groups agreed that it is important to collect data at a level of detail that is relevant to your question. Most agencies used the same few habitat references for categorizing habitat (Stein et al. 1992, Greene et al. 1999, and the NOAA Coastal and Marine Ecological Classification Standard, or CMECS). In addition to describing the habitat type (i.e. rock, mud, sand, etc.), many agencies also collected information on habitat relief, complexity, and scope, as well as the primary and secondary biocover present. An individual fish was typically described as associated with a certain habitat if the individual was within one body length (its own body length) of that habitat.

Prior to the habitat or fish video review, most agencies conducted a 'quality review' so that video segments with poor visibility, or other problems, could be removed before video analyses. Fish behavior was quantified differently by different agencies. Some groups described the fish's reaction or orientation to the cameras. Multiple cameras were often used for this. Other groups analyzed fish behavior in relation to certain factors, i.e. day, night, light levels, etc. Fish reactions were also compared among different vehicles. These data were used to determine if a particular visual survey tool was appropriate for a particular species. The NOAA Southwest Fisheries Science Center (Laidig et al. 2012) published a paper on fish reactions to different types of vehicles. All participants agreed that more comparative studies are needed!

In terms of optimizing video review "rules" and protocols, participants agreed that having consistent protocol was key (e.g. Tissot et al. 2007). Most agencies invest a substantial amount of time into training video reviewers, testing consistency and accuracy, and reviewing and fixing errors. Defining video review rules *a priori* regarding how to record fish behavior were helpful to end users in determining whether to include certain fish in the analyses. Ideally, video reviewers consult other experts as needed when identifying species, there is a protocol for how to resolve discrepancies in fish identification. Another helpful hint from some of the participants was to institute mandatory rest breaks during video review so that video reviewer fatigue does not compromise data quality.

Everyone agreed that using the most current American Fisheries Society standardized fish name list was important for consistency in naming and identifying species.

When discussing the technology that limits data or analyses, participants agreed that having access to Information Technology (IT) department staff that are knowledgeable in troubleshooting complicated video review software issues was critical, especially since there is not a standard video review program among visual survey programs.

Finally, the group discussed storage of visual survey data. Data storage is a continual problem, and with advanced technology there are larger file sizes. In addition, data formats keep evolving (i.e. everyone

used tapes in the past, but now hard drives are used), so there is a constant need for file conversion. Most participants agreed that having three copies of data was sufficient.

Workshop Topic 4: What are the pros/cons of vehicle types, equipment, vessels, and survey protocols?

Moderator: Bob Pacunski

Discussion questions:

1. Are the upgrades made incrementally or in batches? Are validation studies done to avoid "tech creep?"
2. How do you determine/control flight speed and height?
3. What advantages/burdens come with collecting in HD? Is it really "better" than SD?
4. What advantages/burdens come with stereo cameras? How are fish measured when stereo not an option?
5. Is additional supplemental data collection possible? Bathymetry? Water samples? Temp? What else?
6. Are there collaborative options for limiting survey cost on a regional basis?

Workshop Notes from Topic 4: Vehicle and Vessel Technology

Breakout Group: "A"

Moderator: Lynne Yamanaka

Participants: Mike Byerly, Sarah Davies, Andrea Hennings, Tom Laidig, Danielle Lipski, Scott Marion, Susanne McDermott, James Pegg, Rick Starr, Jessica Watson

Question 1: Are technology upgrades made incrementally or in batches? Are validation studies done to avoid "technology creep"?

- Upgrades to technology occur over time, often in batches as funding is available
- Data can be revisited, reviewed, and compared
- Adult fishes are likely not an issue, as you can see them just as well with Standard Definition (SD) as High Definition (HD) cameras
    - Juveniles and cryptic species may be more easily identified with HD
- May have issues with borrowed or contracted equipment and comparing if the technology is different between surveys
- Field of view is an issue for groups changing cameras
    - ODFW created an overlay of a trapezoid calibrated to the size differences between the old SD and new HD field of views for direct comparability when analyzing (SD field of view is smaller than new HD)
- Do we know all the sources of error and are they acknowledged (e.g., measuring field of view may be a smaller source of error than calculating transect width and have they been compared)?
    - Distance sampling may reduce sources of error when compared to calculating transect width
    - DFO surveys deep to shallow up walls to reduce error in strip width
    - Ranging altimeter to measure distance off bottom can help or be integrated into calculation of distance
- Assumptions are being made about distance as measured on a 2-D map vs. high-relief habitat measured in 3-D
- Comparisons of pros and cons of Doppler velocity log (DVL) vs. Ultra Short Baseline (USBL)
    - USBL are less expensive, while DVL have a higher navigation rate and precision
    - ADFG purchased calibration software for USBL for ~$1000
- Poor navigational or positional data requires extensive smoothing; the amount of smoothing necessary is linked to quality of tracking software and hardware
    - Survey tracks, vehicle angle and path, and transponder positioning may influence quality of transmitted data

    - Changing settings may help (e.g., Hz, inputs, filters, depth)
    - Speak with an engineer when issues become too much to solve in house
- Study at CDFG looked at precision of USBL data; drove to known landmarks and compared actual distance with smoothed tracking data- results suggested good fit when smoothed
- Motion detection and compass data can be integrated from boat to correct for arc of vessel's pitch and roll when moving

Question 2: How do you determine/control flight speed and height?

- Some outside entities have different protocols for different studies; ultimately, piloting protocols should follow study design
- Integrate DVL or altimeter to measure height and speed
- DFO will integrate inertial sensor in near future as cheaper option to DVL
- Pilots can visually assess their speed and should remain aware when habitats are more or less complex (e.g., speeding over mud)

Question 3: What are the advantages or disadvantages with collecting in HD?

- Stationary objects may appear blurry on HD video (objects of same speed have good resolution, while background blurs)
    - True progressive HD vs. interlaced video- changing interlace settings can help reduce blur
    - Possibly reduce aperture if sufficient lighting?
- Bandwidth is an issue when streaming up the umbilical for recording
    - Some groups have fiber optic cables necessary to transmit HD video to support vessels
    - Other groups capture HD video remotely and transmit SD video to support vessel for navigations

Question 4: What are the advantages and disadvantages with stereo cameras? How are fish measured when stereo is not an option?

- Review time increases slightly
- Allows for distance sampling and measuring fish length
- ADFG does not stop to measure fish when transecting; previously sampled sites randomly at a later date to measure fish at those sites where >4-5 yelloweye were encountered in the original transect
- MLML measured error rates for fish measurement based upon fish orientation; low measurement error even when at a 45-degree angle to camera
    - Now measuring gorgonians vertically for growth rate
    - Ultimately provides a lot of information that would otherwise be guessed

- DFO, WDFW measure with lasers
- SWFSC estimated size when conducting submersible work
    - Training involved looking at fake fish underwater and calculating reviewers bias
- Any camera can be used to develop a stereo system and calibrated to capture overlap/geometry
- Backscatter can be an issue if cameras are mounted in the same direction as lights
    - May be an issue of available space when trying to put more equipment onto vehicle

Question 5: Is additional supplemental data collection possible? Bathymetry? Water samples? Temp? Anything else?

- Some groups use CTDs, altimeters
- Ensure extra equipment is really needed and not just taking up space
- Manipulator arms for biological or substrate collections
    - Limited ability to obtain samples from smaller vehicles

Question 6: Are there collaborative options for limiting survey costs on a regional basis?

- Back to back surveys should be considered so tear downs, equipment removal are minimized
- Vessel sharing between projects (SCUBA/ROV/AUV/etc.)
- One team working during day, other at night for different projects
- *Delta* surveys moved down West coast and project costs were shared along the way

Question 7: Is anyone interested in data sharing/exchanges similar to Committee of Age Reading Experts (CARE)? Also, a workshop once a year?

- Discuss issues like habitat types, species identification, and biocovers
- How can you tell the difference between species and split out of species complexes?
- Develop information repositories
- Email chains or forum
- Develop behavioral indices
- Habitat types for species assemblages
- Wiki-type page developed by one person and edited by another
- Preference from group to setting a date and time for group meetings rather than emailing
- Conference calls for species identification, habitat types, visual survey issues, hardware/software updates
    - Email pictures to group and discuss over call (GoToMeeting, Webinar, etc.)

Breakout Group: "B"

Moderator: Kristen Green
Attendees: Claude Dysktra, Jennifer Stahl, Wolfgang Carolsfeld, Jim Beam, Scott Mazzone, Erin Wright

1. **Question: Technology upgrades made incrementally or in batches?** As we have money or things come available. Implementation depends on how complex. Implementation can also depend on focus of trip. Generally modifying something every trip, such as light. Changed light, which caused changes to power. Sometimes have to eliminate something to add other things.

Some people take backup SD camera if using HD for first time.

Most people don't do validation to avoid creep. But some people have plans.

2. **Question: Determine flight speed or height?**

Travel faster on rockfish transects then invertebrate transects.

"Low & slow" or "high & quicker" dependent on species. Sandy substrate can go faster. Rare to go consistent speed throughout for DFO.

½ knot or less. Slow enough that you can see the lasers.

80-90 cm from bottom? Compromise dependent on cameras. If visibility bad then closer to bottom.

How the lights are set up can determine how fast you can see the vehicle.

DFO puts 2 LEDs to side to get rid of backscatter and get better lighting.

3. **Question: What advantages/burdens with HD?**

Clyde-DIDSON could see shadows. If fish motionless hard to see. As soon as a tail moves, for example, it is easier to see.

Malcolm-uses GoPro on sablefish traps

WDFW trying to figure out lighting with HD and narrow field of view. 60 degrees with HD and 90 degrees with standard. Opposite with DFO they have better field of view HD- miniZeus. They have constant feed to surface. Need high definition speed, so need fiber optic cable instead of copper cable for live feed. WDFW get live feed from standard but record on HD.

DFO has autofocus on HD camera. While to implement HD. 60,000 for camera and to implement.

Clump weight on separate winch.

Difficult to switch to fiber optics. Lots of things to do to adjust.

They use duct tape instead of clips for ROV tether and winch cables? Single wrap of tape. Just tape umbilical to clump weight. That way if comes up fast then tape will break which doesn't happen with clips. Duct tape not a limitation on how fast they can go down with the ROV.

4. **Question: Supplemental Data**

WDFW just got CTD as well as DFO. ADF&G uses tidbits. With CTD can add oxygen, pH sensors, other things. Current, temperature, depth.

How hardware is mounted is factor for sensors.

5. **Question: Tracking**

DFO uses trackpoint for ROV. Have compass GPS for boat which feeds into Hypack. Can do less than a second of GPS information.

Hypack integrates, boat, ROV, and clump weight tracking.

Motion sensor that measures boat motion. Takes out noise from boat. Another $10,000.

Built into tracking hardware 2 algorithms, inside cone uses one algorithm. Outside cone uses **different algorithm.**

Breakout Group: "C"

Moderator: Bob Pacunski
Attendees: Dayv Lowry, Brad Speidel, Keith Matteson, Donna Kline, Sean Rooney, Ed Bowlby, Jessica Finney

1. Technology upgrades incrementally or in batches?
   – Ed: Contract work out – changes out of control. Problems with standardization. More expensive to contract but usually the latest equipment involved.
   a. How do you compare data after upgrades?
   -Donna: We run new tech (cameras) by reference site. Comparisons between tech assumes slight difference (better species ID abilities.)
   -Dayv: Reference sites are variable? Comparative studies are critical.
   -Others say it is difficult to do comparative studies – tech advancement often happens during surveys. Comparisons sometimes are done post survey. Systematic sampling to post correct surveys patterns are hard to discern. No scaling f/x possible. Frustrating.
   -Cross validation can inform you on "other" issues. IE Trawl not catching very small fish.
   b. Is technology creep a "big" Issue?
   No one wants to revert to old technology. Documentation on changes and changes in protocol is critical.
   Problems with Index – Need to watch for inflation or changes because of technology – Need to know the amount of change in detectability.

   *Documentation is Key

2. How do we determine height/ speed of vehicle?

   -Based on what you are surveying – change height/ speed.

   Measurements for area covered done by laser measurements (WDFW)

   -Sean: Need individual habitat correction factors – AUV/ROV higher based on substrate.

   Need some measuring device available (lasers, stereo cams)

   -Ed: "Elevator" survey – up and down the substrate.

   Scientists communicate with ROV pilots as needed. Need to be height/speed aware.

   Tracking screens available to boat pilots.

   Communication needs between ROV pilot and boat Captain.

   -Jessica: 3 lasers to determine distance and height.

Angle of camera fixed for survey.

a. Is it possible to use machine vision cameras? HD to run faster transects? Review in normal speed. Audio Issues?
-Some surveys don't work unless the boat has controlled positioning. Need slow idle speeds and bow thrusters to maintain positions.
- Commercial skippers and good at maintaining positions – regardless of boat tools.
-Problems with changes in vessel/personnel/working together. Challenge if you don't own your own boat and/or vehicle.
- Consistency not only a problem with technology creep.

Project management issues and concerns. Need to have realistic planning for projects. Hard to justify taking the time to plan. Scaling issues: larger ship cruises – 2 days of dock time. Doing things "on the fly." Problems happen and need to be dealt with – problems prior to leaving – end projects without any usable product. Need <u>front end time</u>.

3. Advantages to HD? SD – can be high line resolution. HD good for inverts. HD good for juvenile fish?

-Keith: HD sees better through flocculants.

- Need to turn off auto focus.

Habitat dependent? Makes flocculants specs. Instead of large in view. "Cannon" autofocus looks through flocculants?

Opposite opinions. Cannon with controller cards. Keith's camera works well in HD in flocculants.

Keith uses a small camera to send info to surface while recording HD in the "can" (pilot camera)

*What is the optimal camera set up for a fish survey?

Two? Forward oblique (epibenthic fish) and 1 pointing down (flatfish) also a strobed HD still for primary focus of the survey.

Also – a safety camera for umbilical.

*Is anyone using stereo?

-Donna – only on drop camera using Event Measure to analyze.

Changes based on survey type.

*Lights?

- problems with lights in wrong positions – backscatter.

4. Fish measuring accuracy? Good estimates with stereo (<5% error) verified in a pool. 7 cm fish measurements.

5. What other collection gadgets used?

-a CTD attached to many ROVs would like a current meter to help ID where the fish will be located – down current? Up current? Easily adapted. Need a current meter to inform where bait plume would go –use flocculants as relative measure.

Some limitations – IE: length of umbilical for vehicle deployment.

Many don't track their Videolander – they can see it on sounders. Great captains for deployment accuracy.

- Some collect samples with manipulator.

Limitations w/ able to see different directions.

IE: caught in crab gear – can't see the tangle.

DIDSONs can see in advance. Better than up facing cameras.

How are new pieces of equipment prioritized?

-Add more Foam!

-Don't add "jewelry" gets stuff tangled up.

ROV tangled in shrimp gear.

How can you repair a fiber optic umbilical? Or co-axial?

6. How accurate is your tracking? Raw to trackline?

Paek – in ArcGIS for smoothing Algorithim with pre filtering in HyPack

Donna – Record at 2 seconds – Filter outliers then import to Arc GIS. Use the smoothing package in R. Make a line in Arc GIS. Lines are used and points are used for different things. Cut off bottom segments.

How raw import Hypack into Excel?

Donna- can generate a log file for just your dive. Keep raw files as back up. Time codes associated with long/lat.

Real navigation is better than what we are predictions.

Need to understand your system to be sure you are not introducing new errors.

Summary of Breakout Group Discussions: Topic 4 (Vehicle & Vessel Technology)

After the vehicle and vessel technology workshop session, the session moderators summarized the discussion points from the three breakout groups. The groups first discussed how and when technology upgrades are implemented within visual surveys and if there is a standardized process for this. Workshop participants agreed that it is best to calibrate in between vehicle and camera and lighting upgrades, but this is not always possible. 'End of the fiscal year' spending often prompted technology upgrades. The move to new technology components can be complex, and fraught with problems. To avoid having to quit in the middle of a survey due to equipment failure, most agencies and organizations brought back up equipment to sea during surveys in. However, despite the complexity associated with new technology, there was an overwhelming consensus on wanting to move forward with new technology.

Visual survey vehicle such as ROV and AUVs were operated at movement rates relative to the survey objectives (i.e. 'low and slow' for invertebrates and benthic fish, but higher and more rapidly for pelagic species). Altimeters on the vehicle helped with maintaining a constant height above the bottom, and tracking systems (Doppler velocity logs, ultra-short baseline) were critical to determining transect length, but smoothing the resulting 'trackline' is important as is validating your equipment i.e. driving to known landmarks to verify distance traveled.

Many of the agencies/universities conducting visual surveys are in the process or have recently changed to high definition cameras from standard definition cameras. There were a surprising number of drawbacks described about HD cameras (changed field of view, different lighting needs, increased complexity, need for fiber optic tethers, increased weight of system, and blurrier video for moving fish); but these were still outweighed by the overall increased quality of the video and easier identification of species and habitat.

The workshop participants discussed the use of stereo cameras, which allow for better measurements from the cameras to fish, and more accurate measurement of fish lengths, but like the HD cameras, stereo cameras systems are more complex systems overall.

Additional data that workshop participants are collecting during visual surveys includes conductivity-temperature-depth (CTD), specimens via a robotic collection arm, and temperature loggers.

Appendix A: Workshop Presentations

US-Canada Technical Sub Committee Visual Survey Workshop

April 8 & 9, 2014

Alaska Fisheries Science Center Seattle

Workshop Genesis

- Need for visual survey workshop discussed at last several TSC meetings
- Co-chairs: Lynne Yamanaka, Dayv Lowry, and Kristen Green (also Bob Pacunski)
- Thanks to TSC for sponsorship, AFSC for facilities (Wayne Palsson)

Introduction

Visual surveys becoming more ubiquitous for research and management….

- nonlethal
- fishery independent,
- potentially cost-effective
- data archival (record everything)
- multiple vehicles in different sizes
- increased technology

Workshop Goals

- "Hands-on" (Discussion-based rather than presentation)
- Purpose**: to get agencies and research groups together to discuss groundfish visual surveys in the context of fisheries management**
- Network with others, discuss common issues and potential solutions and set stage for standardization
- Workshop outcomes/products: (Project profiles, collaborations, document potential solutions and next steps)

With new methods, comes new ~~problems~~…..opportunities.

- How to compare to 'traditional surveys'?
- Are we 'catching' all the fish we think we are?
- Can we standardize survey methodology?
- How do we incorporate these results into management?
- Do we have the 'latest and greatest'?
  - Do we *need* the 'latest and greatest'?
- Etc.

Participants' Goals (based on survey responses)

- Equipment & vehicle technology (cameras and light issues);
- Detectability of fish, variability in fish behavior;
- Develop standard practices, use for coast wide analyses;
- Improve survey design, sampling methodologies/analyses,
- Appropriate resolution for video review;
- Develop applications to management/stock assessment;
- Networking/collaboration;
- Share/expand knowledge.

Participants

Agency and University scientists: ADFG, NOAA, IPHC, DFO Canada, WDFW, Quinault Indian Nation, WSU, OCNMS, ODFW, HSU, MLML, CBNMS, CDFW & CSUMB (in spirit)

Survey Monkey:18 survey respondents representing 35 individuals

19 “Project Profiles”

Primary species assessed

- Rockfishes
- Pacific Halibut
- Flatfishes
- Invertebrates (Deep-sea coral/sponges)
- Lingcod
- Atka mackerel
- Tropical snappers and groupers

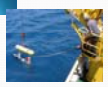


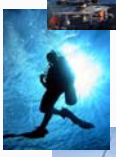
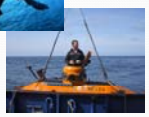


Variety of tools:

AUV
Drop camera
ROV
Submersible
Camera sled
SCUBA



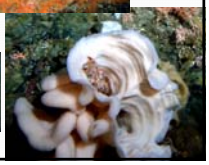


Secondary species assessed

- Other rockfishes
- Benthic invertebrates (mobile and sessile)
- Snapper/Groupers
- Greenlings
- Gadids
- Sculpins
- Pacific halibut
- all other bottom fish




Visual Survey Frequency

- 20% of participants began surveys in late 80s or early 90s
- 30% ……..began between 2000 and 2005
- 30% ……..began visual surveys between 2008 and 2013
- 20% …….still developing a visual survey

- Half of workshop participants conduct a survey at LEAST annually

- Over half of survey respondents expect this to change with reduced funding in the future or with changing monitoring goals.

Survey goals

- **Stock assessment/management**
- Rockfish Conservation Area monitoring
- MPA siting
- Species/habitat associations
- Ocean energy site surveys
- Identify prey fields for Steller sea lions
- Habitat mapping and ground truthing
- Species distributions
- Locate biogenic (coral/sponge) habitat

Workshop Agenda

Day 1:

Workshop Topic 1: (Lynne)
What does it take to design a successful survey?

Workshop Topic 2: (Kristen)
How are visual survey data used for stock assessment or other management goals?

Social @ Mamma Melina's @ 6 pm
(sponsored through ADFG/IPHC)

Workshop Agenda

Day 2:

Workshop Topic 3: (Dayv)
What are the strengths and limitations of methodologies for collecting and analyzing video?

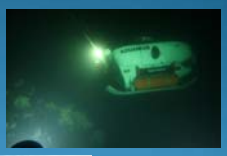
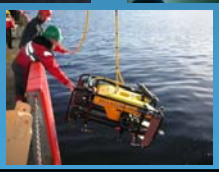
Workshop Topic 4: (Bob)
What are the pros and cons of vehicle types, vehicle equipment, survey vessels, and survey protocols?

Field trip to see WDFW ROV at 3 pm

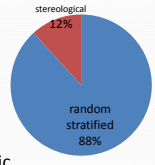
Discussion Groups

- Three "Breakout" groups
  - Look at name tags for colors
- 1.5 hours per topic, Same key questions
- Group summary at end of topic
- Moderators: Kristen, Dayv, and Lynne
  - Tom Laidig, Rick Starr, and Bob Pacunski
- Need note takers

Overview: Topic 1 - Survey Design

Summary of Survey Responses



What type of survey design do you use?

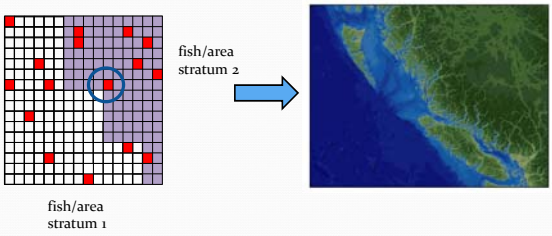
16 Respondents

15 Random stratified
2 Stereological design / stratified systematic
\+ Targeted sampling (habitats/depths/areas)
Replicate tag recovery hauls
Observations - fishing experiments

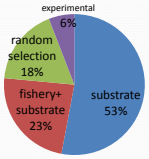
How do you select your strata?

- densities homogeneous and intra-stratum variance is low
- trends in abundance from previous surveys

Overview: Topic 1. Survey Design



Summary of Survey Responses



How do you select your *strata and* sampling locations? 17 Respondents

9 substrate type
4 combination of fishery data and substrate including depth
3 random selection in the study area
1 experimental

What approaches are used for survey stratification?

- What surrogates are used for substrate?
- How are species linked to substrate?

How are samples standardized: starting points, direction of travel?

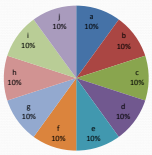
Overview: Topic 1. Survey Design

How do you obtain samples and make observations?

How do you use them to estimate the characteristics of the whole population?


Summary of Survey Responses

How did you determine how long to sample at each station? 10 Respondents



species saturation curves / encounter rates
somewhat arbitrary, variable
logistically feasible
10 – 15 min standard
pilot fatigue
optimal sampling
statistically

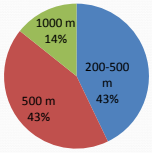
Just long enough to show similarities within a stratum and differences between stratum.

Summary of Survey Responses

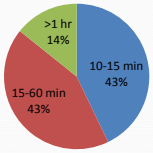
How long do you survey at each station?

14 Respondents: 7 length (range 200 m - 1 km)
7 time (range: 10 min - 52 hrs)

3 Length 200-500 m
3 Length 500 m
1 Length 1000 m



3 Time 10 to 15 min
3 Time 15 to 60 min
1 Time > 1hr

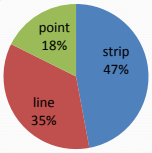


Time (experimental – until a fish is hooked)

Summary of Survey Responses

What is your sampling unit*/methodology*?

17 Respondents



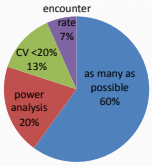
8 Strip transect
6 Line transect
3 Point transect

Why was point, strip or line transect methods selected?
What are the challenges?
How are densities estimated?
Are detection functions constructed by substrate, transect or survey?
How are detectability of cryptic and small species evaluated?

Summary of Survey Responses

How do you select your sample size?

15 Respondents



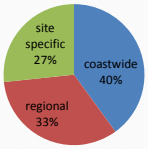
9 As many as we can do
3 Power analyses based on past surveys
2 Based on a target precision (CV <20%)
1 Encounter rate of target species

Trade-offs here between sample size and survey logistics like travel time, costs and personnel, and ship time.

Summary of Survey Responses

What is your inference space or population as a whole?

15 Respondents



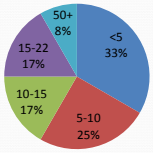
6 Coastwide (GoA, E-GoA, GoA-AI, BS-OR, WA, CA)
5 Regional (AI, WA coast, PS)
4 Site specific (OCNMS, MR, MPA, RCA)

How are survey sampling estimates expanded to the larger assessment or management area?

Summary of Survey Responses

How many sampling units can you perform per day?

12 Respondents - dependent on travel time between samples



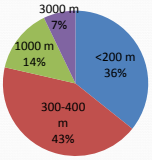
4 <5 samples
3 5 to 10 samples
2 10 to 15 samples
2 15 to 22 samples
1 50 +

How is sampling optimized between the time spent on each sample and the number of samples that can be collected in a day?

Summary of Survey Responses

What depth range do you conduct your visual surveys?

16 Respondents



5 <200 m
6 300 – 400 m
2 1000 m
1 3000 m

Dependent on target species and/or vehicle capabilities

Summary of Survey Responses

What month(s) of the year do you survey?

16 Respondents

Jan	x	x	x	x											x
Feb	x	x	x	x											x
Mar	x	x	x	x									x	x	x
Apr	x	x	x	x	x	x									
May	x	x	x	x	x	x	x							x	
Jun	x	x	x	x	x	x	x	x	x				x		
Jul	x	x	x	x	x	x	x	x	x	x	x	x		x	
Aug	x	x	x	x	x	x	x	x	x	x	x	x	x		
Sep	x	x	x	x	x	x	x	x	x	x	x			x	x
Oct	x	x	x	x	x					x	x			x	
Nov	x	x	x	x											x
Dec	x	x	x	x											x

Trade-offs between calm seas and visibility?

Topics for group discussion

1. Defining your question: What are the survey objectives?
2. What approaches are used for survey stratification?
   - What surrogates are used for substrate?
   - How are species linked to substrate?
3. How are sampling densities determined: encounter rate, species saturation curves?
4. How are dive or transect locations selected: mapping (acoustic, charts), fishery data?
5. How are samples standardized: starting points, direction of travel?
6. Why was length or time chosen for your sampling?
   - How was this determined?

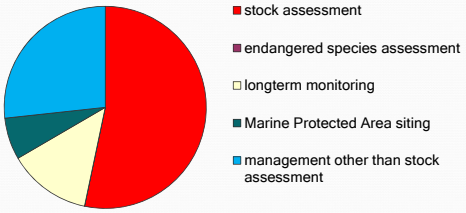
Topics for group discussion - continued

7. Why was point, strip or line transect methods selected?
   - what are the challenges?
   - how are densities estimated?
   - are detection functions constructed by substrate, transect or survey?
8. How are detectability of cryptic and small species evaluated?
9. How are survey sampling estimates expanded to the larger assessment or management area?
10. ???

Topic 2: Stock Assessment and Management

Kristen Green
Groundfish Project Leader
ADFG
Kristen.green@alaska.gov

Management Goals



Question:

How are visual survey data used for stock assessment or other management goals?

Secondary goals

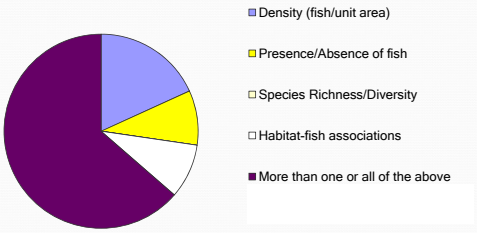
- Essential fish habitat
- Index of abundance
- Exploitation rates
- Siting for MPAs
- Collaborative research
- Education and outreach
- Long-term monitoring (of MPAs, RCAs, etc.)
- Oil spill response
- Abundance indices

Survey Responses

Incorporating Results into Models

- Four groups incorporating visual survey data into models
- Most users have goal of developing a model
- Models used include stock synthesis, Bayesian surplus production, age structure assessment/production

Metrics used to assess species

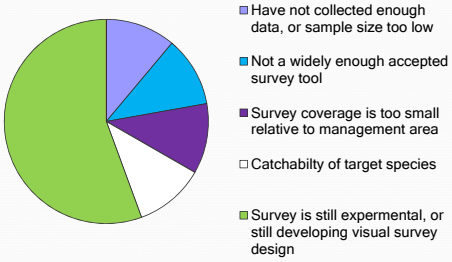


Most said 'all of the above' . Others looked at density/biomass by habitat or measured inverts in addition to fish density, or used data for acoustics.

Discussion Questions:

4. How do you reconcile visual survey data with "traditional" techniques ?
5. What is your biggest obstacle in using data for management?

Biggest obstacles to stock assessment



Other comments "all of the above", or "data not intended for stock assessment".

Discussion Questions:

1. How are you using fish counts from visual surveys to assess populations/stocks?
2. What are your sources of bias in expanding your visual survey data for management purposes and how are you correcting for these biases (if at all?)
3. What are your techniques for determining catchability/detectability? How is this affecting management?
   - -attractance/avoidance (fish behavior)
   - -cryptic/small species

Topic 3: Data Collection and Video Review Methods

Dayv Lowry
Senior Research Scientist
WDFW
dayv.lowry@dfw.wa.gov

What to do with all the video!

- 85% of respondents review videos 2-3 times
  - Reviews may only collect one type of data (e.g., fish counts) then another (e.g., habitat type)
  - Multiple passes may be made to collect then check, data
- 53% of respondents use software "package" for review
  - SeaGIS and Event Measure are most popular (21%)
  - Many custom built analytical suites
    - 57% use "custom" software to view, annotate, and extract/store data from the recordings
  - 14% use "unintegrated" viewer and database

Moving to operational details

- Symposium Day 1:
  - How do you design a successful survey?
    - Sample size, stratification, site selection, etc.
  - What can you use the data for? Stock assessment?
    - Counts, converting to biomass estimates, issues with species detectability, validation studies of "new" surveys
    - Most of us plan to incorporate "the data" into stock assessments
- Symposium Day 2:
  - What data do you actually collect, and how?
  - What tools and vessels are used to get these data?

What about variability?

- Data entry variability arises from *many* sources
  - Fish detectability and identification
    - Contingent on equipment, visibility, speed over ground
  - Individual differences in expertise (if multiple reviewers)
  - Time taken/available to complete review
  - Keystroke and other transcription errors
  - Training can solve some issues. Evaluation is key.
- 42% of respondents generate an estimate of variation in expanded count/biomass estimates
  - Most use coefficient of variation (replicates or bootstraps)

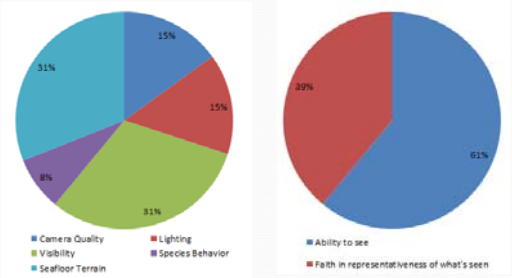
Fish are focus, but what else?

- Counting and identifying fish (and macroinvertebrates) is only the start
  - Stock assessment doesn't *require* knowledge of details like habitat associations
- 100% of respondents describe seafloor habitat at some level, varying from dominant type per sample to fish-specific microhabitat
  - Knowing/modeling where fish are opens options for diverse protection measures and fishery regulations
  - Also informs future studies

What are limiting factors?

- Species identification
  - Due to camera resolution, lighting, speed over ground
  - Turbidity and water clarity
  - Possible/known presence of similar looking species
- Assumptions about species detectability
  - Impact of species behavior is largely unknown
    - Effects of season? Time of day? Sex?
- Limited availability of survey days (and gear)
- Limited video review and data interpretation time

What's the "biggest" issue?



Discussion topics/issues

- At what level should habitat be characterized?
- How do you account for fish behavior?
- How do you account for variation in visibility?
- Optimizing video review "rules" and protocols
  - How many reviews? Independent or "error check?"
  - When is a review "done?" Time limits?
  - How do you evaluate reviewer accuracy and bias?
  - Methods for effectively watching two+ screens at once?
- What technology is limiting data or analyses?

Topic 4: Vehicles and Vessels Being Employed

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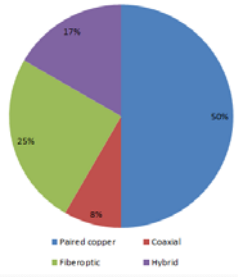
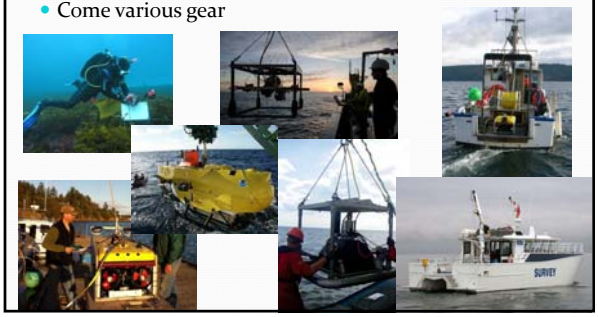
What tools are being used?

- 88% of tools tethered
  - Most have some variant of copper conductor
  - 25% are exclusively fiber optic
- A few tools custom- designed to stand alone
  - Power, recording, lighting, all contained within housing



With various goals and limits. . .

- Come various gear

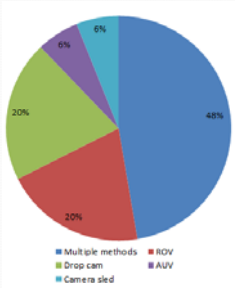


What tools are being used?

- 71% of respondents own their survey tools, the remainder contract services
  - Over 80% of those contracting are happy with it
  - Vessel+survey tool daily rate = $7-16k
- ROVs mostly DOE Phantom HD 2+2 or custom built
  - All have "after market" modifications
    - Nearly all have upgraded lighting, some cameras, etc.
  - Operating speed <3 knots for 84% of tools
    - Max current <4 knots for all tools

What tools are being used?

- 15 Responses – 3 respondents aren't yet surveying
  - 47% using multiple methods
    - All use ROV+sub, AUV, drop cam, scuba, towed cam
      - Ave 2-3 methods, sometimes 4
  - 20% each ROV only, drop camera only
  - 7% each AUV only, camera sled only



What about the camera/video?

- 50% of tools use >1 camera, but not stereo, while 36% use stereocams. Only 14% use a single camera
  - May be down-looking, still cams, non-recording navigational units
  - Methods for fish measurement vary, some don't measure
    - Paired lasers, stereocams, binned estimates using reference
- 66% are recording in HD, while 33% are using SD
  - Many are combining formats depending on need
  - 80% recording to hard drives, 20% tapes/DVDs
- Lighting is 85% LED or LED+halogen, 15% halogen

A word on deployment/clumps

- Tools weigh from tens to thousands of kg
  - Most <300 kg, only 3 over 2000 kg
  - Most deployed with small davit/crane
- Position of tool typically (69%) tracked in water
  - Using Tracklink, Hypack, custom ArcGIS modules
- 71% use a clump weight to hold the tether in place
  - May not be used in shallow deployments
  - Weighs from 80-300 kg, corresponding loosely with vehicle size/weight
  - Tracked along with tool in at least 50% of surveys

Key questions/discussion items

- Are the upgrades made incrementally or in batches? Are validation studies done to avoid "tech creep?"
- How do you determine/control flight speed and height?
- What advantages/burdens come with collecting in HD? Is it really "better" than SD?
- What advantages/burdens come with stereo cameras? How are fish measured when stereo not an option?
- Is additional supplemental data collection possible? Bathymetry? Water samples? Temp? What else?
- Are there collaborative options for limiting survey cost on a regional basis?

What about "other" sampling?

- 79% of tools can't or don't collect physical samples
- 36% of surveyors using Blueview or DIDSON sonar
- Most collect correlated environmental variables in some way, often qualitative, but few collect physical samples

What about the platform?

- Roughly even split between government-owned and chartered research vessels. Cost $7-16 k per day.
  - 87% are 50+ ft, 13% in 30-39 ft range
  - Operate in 11-25 knot winds at most
  - 78% of respondents work in max. 6-ft swells
  - Require 2-5 scientific crew
    - Vessel crew more variable. 2-6 crew
- 72% of respondents survey less than 20 days per year
  - 28% survey 25+ days per year