***California Ocean Protection Council***
***California Department of Fish and Wildlife***
***Moss Landing Marine Laboratories***

# Meeting Summary

## Deep-Water Marine Protected Area Monitoring Workshop

**June 26, 2017; 10:00 AM – 6:00 PM**
**June 27th, 2017; 8:00 AM – 2:00 PM**
**Seminar Room**
**Moss Landing Marine Laboratories**
**8272 Moss Landing Drive, Moss Landing, CA 95039**

**WORKSHOP ATTENDEES:**

| | |
|---|---|
| Mark Carr | UCSC |
| Cyndi Dawson | OPC |
| Christian Denney | MLML |
| E.J. Dick | NMFS |
| Ryan Fields | MLML |
| Mary Gleason | TNC |
| Katie Kaplan | OPC |
| Andy Lauermann | MARE |
| James Lindholm | CSUMB |
| Steven Morgan | UCD |
| Nick Perkins | OPC |
| Eric Poncelet | Kearns & West |
| Michael Prall | CDFW |
| Dirk Rosen | MARE |
| Rick Starr | MLML |
| Brian Tissot | HSU |
| Vicky Vasquez | MLML |
| Jimmy Williamson | MLML |
| Lauren Yamane | OPC |

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## Introduction and Overview

The California Ocean Protection Council (OPC), the California Department of Fish and Wildlife (CDFW), and Moss Landing Marine Laboratories (MLML) hosted a two-day workshop in Moss Landing on June 26th – 27th to continue developing a strategy for the long-term monitoring of deep-water marine protected areas (MPA) in California. Experts from across the state were involved in discussions and breakout sessions to identify viable tools and sample designs that would meet the State's objectives.

The state of California is shifting from short-term MPA baseline monitoring projects to long-term MPA monitoring programs across the entire MPA network. While no funding has been guaranteed for this program, OPC staff has indicated there is a maximum $4 million funding that could be available from the State to survey all habitat types along the California MPA network. In order to maximize the effectiveness of available funding, the OPC asked MLML to set up two workshops to inform the development of an appropriate deep-water ecosystem monitoring framework to support statewide MPA monitoring, including monitoring of both individual MPAs and California's MPA network. The objectives of the first workshop were to a) discuss and identify the most important monitoring questions to address (including adaptive management questions) and b) to identify which taxa and habitats are most important to monitor to address the monitoring.

The objectives of this second workshop were to a) discuss various tool and analytical technique combinations for conducting deep-water MPA monitoring b) articulate the tradeoffs between different approaches, and c) provide the State with tool and MPA recommendations for long-term monitoring of deep-water habitats. Similar to the first workshop, both plenary and break-out sessions were established and facilitated by Eric Poncelet (Appendix 1). After a recap of the first workshop, there were two presentations about sampling statistics based on baseline ROV monitoring data and a study comparing data from a ROV and a video lander. The first two breakout sessions included discussions of various tool and study design technique combinations for conducting deep-water MPA monitoring. A third breakout session was scheduled to discuss "various image analysis, data analysis and statistical techniques for evaluating spatial and temporal changes in deep water MPAs". This discussion was largely postponed for another workshop, however, as attendees agreed that it would be more important topic to discuss and recommend specific MPAs along the coast for long-term monitoring.

# Summary of Day 1 Discussions

**Presentations:**

## Nick Perkins (OPC/CDFW): Spatial Point Process Modeling.

Spatial Point Process modeling techniques allows spatial structures for individual fish to be modeled for a given location and provides a powerful way to explore sampling designs. This technique also allows spatial-autocorrelation to be explicitly accounted for within the model. By using baseline ROV data collected by CDFW for three species (Brown, Canary, and Yelloweye Rockfish) near Bodega Bay, Nick demonstrated how the coefficient of variation (CV) was reduced with increased sample size (number of ROV transects). A fixed transect width was used, but future modeling could be developed into a more sophisticated model (e.g., distance sampling). Similarly, environmental covariates can be included in the model to understand statistical associations between fish density and habitat variables. While a scarcity of data associated with some species can lead to high model uncertainty, spatial point process models may be useful as a power analysis to decide final sampling design for the deep water MPA monitoring program.

## Christian Denny (MLML): Live-feed Video Lander vs. Remotely Operated Vehicle (ROV)

ROVs transects may survey large areas, but often have relatively few replicates. Drop cameras on the other hand survey much smaller areas, but can achieve higher sample sizes due to ease of deployment. There is an order of magnitude difference in the average area surveyed between the live-feed, drop camera tool (Stereo Video Lander) and MARE's ROV "Beagle", which has implications on sampling effort needed. Analysis revealed that the Lander did not obtain significantly different density estimates for species groups than the ROV tool. This indicates that the Lander may be a viable survey tool for the long-term deep water MPA program and may only require moderate sampling effort to achieve low CV. Because ROVs can cover a much broader area, they may be more appropriate in locations where habitats are patchy or poorly mapped in MPAs. Conversely, where substrates are well mapped and relatively uniform, Video Lander tools can do a good job of quickly and accurately surveying large areas.

# Breakout Session 1

- Identify how alternative tool and technique combinations fit the deep-water monitoring goals articulated in workshop #1
- Describe the tradeoffs between different tool-technique combinations
- Discuss best practices for
  - Tools: **Mini-ROV, ROV, and HOV**
  - Techniques: Strip transects, line transects, photo quadrats

### Mini-ROV

There was as strong consensus that Mini-ROVs (e.g., Seabotix) would be an inappropriate tool for answering primary questions and monitoring objectives. These small ROVs are a 'glorified drop camera' and are severely limited by depth (~70 m) and ocean currents. Because of these limitations, standardization and replication would be difficult with the mini-ROV across a broad range of typical oceanographic conditions. This tool theoretically could obtain the desired metrics across a variety of study designs; however, data are likely to be coarse compared with tools like ROVs or stereo drop cameras. Due to their small size, mini-ROVs have significant constraints in their instrumentation payload, and are unlikely to be equipped with stereo-cameras. Current iterations of this tool do not have any sizing capabilities, making area-swept and fish density estimates extremely difficult or impossible. Despite these shortcomings, the mini-ROV is relatively cheap, can be deployed from any vessel, provides high sample sizes, and only requires a car battery for power. Therefore this tool may have some use as an opportunistic sampling tool.

## Remotely operated vehicle (ROV)

Discussion was limited to mid-sized, observation-class ROVs like the Phantom or Beagle. ROVs are well equipped to conduct any of the survey types outlined (strip transect, line transect, point counts, and photo quadrats) and collect all desired metrics agreed on at the first workshop (biomass, density, length, percent cover). ROVs are capable of depths to 1000 m, and are stable in a variety of oceanographic conditions. Because typical cruising speed is 1.5 – 2 kt, ROVs are capable of covering much larger areas and will better detect rare species compared with a point count survey. Video collected by ROVs could be archived and allow for detailed post-processing. Additionally, archived video may allow future state research objectives to be met post-hoc. Each ROV transect will cover a greater area compared with drop-camera techniques, but this comes at the cost of fewer replicate transects, and possibly less of the overall MPA being surveyed. While fixed transects may be possible with an ROV, there was a consensus that a randomized survey design be implemented. Nonetheless, a relatively short transect length and multiple transects may be important to increase statistical power. Line transects methods are possible with ROVs, however there was agreement that if ROVs are chosen for monitoring, they would be better used to conduct strip transect surveys because that would provide more information for a greater number of species.

There was a discussion of extrapolating ROV densities to abundance estimates. The consensus was that there will need to be an agreed-upon method to define the survey area to accurately extrapolate to abundance. This may mean defined transect lengths, or an agreed-upon method of subsampling a longer transect. Similarly, it will be important to decide a consistent instrumentation (stereo-cameras, altimeter, depth etc.) for the ROV tools used along the coast.

The main drawbacks to using an ROV are: cost for ship time, costs for post processing of video and greater personnel and training needs to operate. If there are time or financial constraints, archived video can always be randomly subsampled. Observation-class ROVs would require vessels at least 50 ft in length, which limits number of available ships along the coast. There was some concern about fish attraction and/or avoidance to ROVs, though this would not be a concern if the State was interested in relative indexes of abundance. If point counts were the desired survey technique, then ROVs would be an impractical tool. Similarly, while photo-quadrat type data could be extracted from HD video, the ROV is possibly ‘overkill’ for a photo-quadrat study and there are no practical means to have fixed photo quadrats for repeated sampling. There were also some concerns that if canyons were selected for surveys, a separate set of protocols would be needed to operate the ROV in those steep environments.

Two main techniques for operating ROVs were discussed: 'High-and-Fast' vs 'Low-and-Slow'.

- High-and-Fast surveys are conducted approximately 1 m off the bottom, and at a maximum speed of 1.5-2 kt. This speed allows much larger areas to be surveyed per each transect. Traveling fast is in some cases easier for the boat operator, but may not be possible in low-visibility conditions. High-and-Fast will allow more ground to be covered in a day. Video ID will contain greater proportions of unidentified rockfishes when traveling fast – compromising the overall quality of data.
- Low-and-Slow is conducted ~20 cm off the bottom and slower (~0.5 kt). This technique may have larger operating windows environmentally because operators will be able to avoid obstacles in turbid water conditions. The Low-and-Slow design will capture the same data that was captured using 'High-and-Fast', and may lead to higher proportions of fish ID'd. A continuous transect design with Low-and-Slow piloting could also cover a large area within a day.
- Note that a third technique that has been used in submersible surveys was not discussed for ROVs. In submersible surveys that have occurred in California, the vehicle has been operated ~0.5-1 m off the bottom and has been driven at a speed of 0.5-1 kt. This technique has been used with randomly located transects of about 200-300 m in length.

### Human Operate Vehicle (HOV)

HOVs were considered slightly better, but similar to ROVs with respect to the type and quality of data obtained. HOVs have the benefit of a human observer, who can annotate all video collected and better ID small fish. Because small fish are not the focus of this long-term monitoring program, this difference may not be important. HOVs require specialized training, can have limited availability, and require larger vessels to carry and deploy than ROVs. HOVs are more expensive to operate than ROVs and cover less distance – limiting sample size (number of transects). If this tool were selected, a strip-transect design would be implemented, and distance-sampling techniques would facilitate more accurate estimates of density and biomass. Line-transect and photo-quadrat surveys could be obtained from archived video as was the case with the ROV. This tool has proven itself capable of collecting excellent data, but financial constraints and limited availability of HOVs may favor the use of ROVs.

### ROV Sample Design Considerations

After discussing the merits and shortcomings of available tools, workshop attendees focused on the questions "*How will we design a study with an ROV?*" and "*What will our sample unit be?*"
It was agreed that a strip transect method would be used with the ROV because this technique would collect the most data for a given effort. Archived high-definition (HD) video would allow other sampling designs (e.g., random photo quadrats) to be conducted post-hoc. Stereo-video should be used to make length measurements because a relatively small number of fish (several hundred) need to be sized in order to characterize the population size structure. Additionally, lengths estimated by lasers have been shown to be biased at the smallest and largest size classes of fishes. The costs associated with stereo-

camera equipment and post-processing are not prohibitive and are comparable to the effort expended using lasers.

There was disagreement on whether the sample unit should be a transect or a sub-sample of a transect, such as in non-overlapping photo quadrats. Some attendees felt it may be inappropriate to use small quadrats to sample fish counts in deep-water, rocky reef habitats because they may result in a high number of zero counts. Existing statistical methods to deal with zero-inflated data are imperfect; therefore, it is important that sample unit be at the scale of the distribution of the target organism. Photo quadrats may be most appropriate for quantifying habitat across a survey area. The final sample design should be evenly applied to all MPAs surveyed along the CA coastline under the assumption that the data will be post stratified during analysis.

A typical ROV survey considers the sample unit to be each transect. Fixed-length transects are randomly placed across the study area. One recent study (Lindholm et al. 2015) had success in flat, soft-bottom habitat using a continuous ROV transect design. These long transects were subsequently subsampled post-hoc (as photo quadrats) to increase both sample size and statistical power. A long transect could be logistically favorable as it minimizes the number of ROV retrievals and deployments needed for a given survey, thereby maximizing sampling effort in a given day. Some workshop attendees objected that subsampling a long transect this way was arbitrary and may amount to 'pseudo-replication', and thus not properly address the issue of spatial autocorrelation. Although spatial-autocorrelation is unlikely to be eliminated from any study, some sample designs will better minimize spatial autocorrelation. Similarly, some modeling techniques may be able to account for some spatial-autocorrelation in the data, but likely do not capture the true scale of auto-correlation present.

Ultimately, the State is interested in a robust sample design along the entire network of MPAs. Tradeoffs likely exist between sampling a single MPA with a long transect versus spreading smaller randomly placed transects across a greater number of MPAs. It was unclear what additional benefits would be gained by using the long transect sample design. Ultimately the group did not agree on what an appropriate ROV sample unit should be. A proposal was made to review previous ROV sampling methods and layout 2-3 methods that have been used successfully.

## Breakout Session 2

Discuss second set of tool and study design technique combinations for conducting deep water MPA monitoring.

- Identify how alternative tool and technique combinations fit the deep-water monitoring goals articulated in workshop #1
- Describe the tradeoffs between different tool-technique combinations
- Discuss best practices for
    - Tools: **Drift Camera, towed cameras, sled cameras, live-feed landers, drop cameras**
    - Techniques: Strip transects, line transects, photo quadrats

## Towed Cameras

The use of a towed camera would be most appropriate for rapidly surveying habitat or geology types and less suitable for fish density estimates. Towed cameras have depth limits of approximately 200 m, but can be consistently operated across a range of current speeds. Tow speeds range between 1-3 kt allowing for larger survey areas in a given day compared with drift or drop cameras. Relatively small boats (20- 30 ft) can operate towed camera sleds. The cost of building and operating these tools is cheaper than a typical ROV, and towed cameras can be equipped with a similar array of sensors and instruments as a ROV. Strip transects and photo quadrat survey designs are attainable with towed cameras, though maintaining a consistent quadrat area would be challenging. Similarly this tool can be difficult to navigate in high-relief, rocky habitat – ultimately leading to sections of poor quality data. Newly developed towed camera systems have more sophisticated controls to navigate medium relief terrain, but these tools require more expertise to operate. Towed cameras also have coarse positional accuracy, which makes fine-scale habitat associations difficult. Additionally, it has been shown that some fish avoid the approaching cable of the towed camera system – a behavior that could compromise fish density estimates.

## Drifting Cameras

A drift camera (e.g., Woods Hole Oceanographic Institute's SeaBOSS), is weighted and hangs below the vessel. Rather than being towed, it would drift with the boat passively, or with some small directional inputs from the vessel. As such, less area is surveyed than a towed camera system, though drifting cameras are much quieter and may have less fish avoidance issues. A simple winch system and live-feed video allows this tool to be hoisted over rugose habitat and maintain a constant distance from the seafloor. Drifting cameras would be compatible with stereo-camera systems and could attain the necessary precision in size estimates. Because this tool is approximately straight below the ship of operation, position could be easily triangulated with a pinger. Current implementations of drift camera tools are large in size and require vessels with an A-frame; however, future iterations could be built smaller to accommodate medium sized ships-of-opportunity.

## Benthic Sled

While benthic sleds have been used successfully in previous studies of low-relief habitat, this tool was quickly decided against because contact with the seafloor may damage sensitive habitat. When bottom contact is not an issue, benthic sleds perform well in strong current conditions, and are not depth limited. Sleds are generally cheaper to build and operate than ROVs, but this can be variable depending on the instrument configuration. Vessel requirements are the same as towed cameras—allowing for a greater size range of vessels to be used. Replication is easily achieved with this tool; however, density estimates can be difficult to obtain accurately because maintaining a constant depth over rocky habitat is challenging. Altimeter sensors can alleviate this concern somewhat. Overall, this tool is best suited for soft bottom habitat.

## Drop Cameras

Drop cameras have been used globally to successfully quantify relative indexes of fishes. When equipped with stereo-cameras, drop cameras can achieve accurate density and biomass estimates. Drop cameras are relatively cheap to build and maintain, and many are lightweight enough to be deployed off any vessel size class. Some have been deployed independent of the ship, while others remained tethered. This type of tool is suitable for photo quadrat and point count type surveys only. Because there is no live-feed to the surface, it is likely that a certain percentage of surveys would need to be excluded due misplacement of the drop camera, or the camera system tipping over in high-relief habitat. Additionally, there may be higher zero counts with a drop camera, in part because of the imprecise spatial deployment, and partially because the area surveyed is relatively small when compared with a towed camera, ROV, or HOV. Subsurface recording of video translates into greater top-side download times. Because these tools can be so quickly deployed over a large area, the cumulative benefits may out weight some of the logistical concerns and the cost of excluding a portion of the surveys.

**Live-feed Drop Cameras**

Live-feed drop cameras have the additional benefit of monitoring the survey in real time. These cameras can be placed with much greater positional accuracy on the bottom compared to blind drop cameras, and can be righted if tipped over – reducing the amount of data excluded post sampling. Additionally, the live-feed allows the operator to verify that the survey is being conducted in the targeted habitat type, further reducing wasted effort. To date, the live-feed camera systems have been approximately 200- 300 lb and require a medium-sized vessel and winch to deploy. While not depth limited for the purposes of this long-term monitoring project, the umbilical tether creates a logistical challenge, as it can be difficult for a vessel to hold station over the camera. Live-feed drop cameras are more expensive to build than their blind counter parts ($80-100K total cost), but are still considerably cheaper than ROV type tools. Live feed drop cameras are stereo-camera compatible and can be equipped with a broad array of additional sensors. Current iterations of this tool record video subsurface and require downloading at the surface. Future iterations of live-feed drop cameras will be designed to minimize time on bottom, allow HD topside recording, and alleviate other logistical concerns with deployment. Less area is surveyed per deployment of the drop camera, which may lead to zero inflated data; however, a greater spatial coverage of the MPA might be surveyed with this tool since replicates are easily obtained. Life-feed drop cameras would be used with a stratified random point survey to adequately cover all depths and habitats within each MPA of interest.

# Summary of Day 2 Discussions

## MPA Selection: Which MPAs should be sampled?

Attendees postponed the discussion of sample design, video analysis, and statistical methods until a future date. Instead, workshop attendees decided that their time was better-spent reviewing individual MPAs along the coast in order to recommend a short list of priority MPAs that should be monitored. Experts attending the workshop used personal experience and the general criteria listed below to select priority MPAs along the coast. Note that the moderators recommended that bolded items be weighed more heavily during the decision making process. The proposed long-term monitoring program should prioritize the representativeness of an MPA to the broader coastline over the availability of previous survey data for that MPA. Additionally, MPAs should also be selected to represent and span important biogeographic features along the coast.  Because there are many definitions of biogeographic regions and the MLPA regions are not based strictly on biogeography, the group suggested that selection of MPAs to be monitored should not be constrained by the MLPA management regions as currently drawn on the map.

- **Representativeness** (depth, habitat, community composition, biogeographic region)
- **Focus on State Marine Reserves (SMR) or functional equivalent**
- **Feasibility and Practicality** (this includes cost)
- **Practicality**
- Species richness and diversity
- Historical fishing pressure data
- Existing time series of sample data
- Presence of appropriate reference area
- Expected recovery from fishing pressure
- Amount of rocky reef available

### Selection of Priority MPAs

Nineteen MPAs were selected as being preferred for a robust sample design during the first part of the discussion. Thirteen of these MPAs were agreed upon as the minimum level of sampling that could be confidently recommended for the long-term deep water MPA monitoring program. Below the MPAs listed as "*Tier 1*" represents the minimum 13 MPAs recommended by the workshop attendees. The additional six MPAs listed as "*Tier 2*" make up the rest of the 19 MPAs that are the preferred coast-wide sample design.

## Proposed high-priority Survey sites (North to South)

**Pt. St George SMCA:** *Tier 1*. This MPA is accessible and historically had instances of Yelloweye Rockfish (*Sebastes ruberrimus*) – a species of management concern.

**Sea Lion Gulch SMR:** *Tier 2.* This MPA has a high level of species richness and the largest continuous reef structure in the north, but is small and difficult to access.

**Ten Mile SMR:** *Tier 1*. This MPA is accessible and overlaps existing SCUBA survey sites which could be useful for comparison. Other survey data exists here.

**Pt Arena SMCA/SMR**: *Tier 2*. There is high species richness here, although this MPA is difficult to access (no nearby ports, rough conditions etc.). This site is of high interest since it neatly divides the north vs north-central regions of the California coastline. A time series of data exists for Pt. Arena. This site may be most appropriate to the north biogeographic region.

**Bodega SMCA/SMR:** *Tier 1*. Accessible. Large area of reef and historic time series of survey data.

**SE Farallon Islands SMCA/SMR:** *Tier 1*; This MPA contains abundant rocky reef habitat with high fish abundance and a large amount of data on both fish assemblages and fishing pressure in the area.

**Portuguese Ledge SMCA:** *Tier 2*. This MPA represents a unique rocky ledge feature in Monterey Bay, associated with the continental slope and historically has been a site of high fish abundance. Also, it has been studied extensively.

**Pt Lobos SMCA/SMR:** *Tier 1*. This MPA is relatively easy to access, representative of central coast species, contains unique geology, and has abundant deep rock habitat. There are lots of previous data from Point Lobos, and suitable reference sites.

**Pt Sur SMCA/SMR:** *Tier 1*. Relatively accessible and representative of central coast species. There is abundant deep rock habitat, lots of previous data, and suitable reference sites. Point Sur met the matrix criteria more strongly than Big Creek for this region of the coastline.

**Piedras Blancas SMCA/SMR:** *Tier 1.* Piedras Blancas contains extensive deep rocky habitat, has a high diversity of fish species, and may contribute more to connectivity than Point Buchon SMR.

**Pt. Conception SMCA/SMR:** *Tier 2*. Point Conception is an important biogeographic break that separates central and southern California. The rocky reefs here are small but very important to local species. Unusual tar seeps.

**Harris Point SMR**: *Tier 1*. Harris Point has abundant rocky reef habitat with high fish abundance, and is logistically more feasible to sample than Richardson Rock SMR on San Miguel Island. There are large amounts of data on fish assemblages and fishing pressure in the area.

**South Point SMR:** *Tier 2.* South Point SMR has ample rocky reef habitat with high fish abundance, large amount of data on fish assemblages and fishing pressure in the area.

**Gull Island SMR:** *Tier 1*. A good time series of data exists for Gull Island SMR, and this site is relatively protected from inclement weather. It may be more difficult to establish a representative reference area; however, heavy fishing in the areas adjacent to the SMR may lead to larger temporal differences inside/out of the MPA.

**Anacapa Is. SMCA/SMR:** *Tier 1*. Anacapa has plenty of deep rock habitat, lots of previous survey data, detailed benthic maps of the area, and a strong record of fishing pressure in the area.

**Footprint SMR:** *Tier 1*. Footprint SMR is similar to Anacapa but has rocky reef at greater depths (100+ m). There are lots of reference sites, and 10-15 years of historical data available from Milton Love.

**Farnsworth SMCA:** *Tier 2*. Farnsworth is the only MPA on Catalina Island with significant deep rocky reef, and has somewhat unique characteristics as an offshore bank with deep sea corals. It may be difficult to locate an adequate reference site for Farnsworth SMCA. Additionally, some pelagic fishing effort in this reserve may make future across-MPA comparisons statistically difficult

**San Clemente Island**: *Tier 1*. This area has been a de-facto reserve for ~40 years due to the US Navy's use of the island and water space.

**S. La Jolla SMCA/SMR:** *Tier 1*. This is one of the only MPAs suitable in the San Diego region. This MPA is representative of southern region habitat and fish assemblages and has plenty of reef available to survey.

### How to Sample the MPAs?

Consistency in sample design will be needed so that data are comparable across the MPA network. This may not necessarily require the same tool to be used across the state, but the data must ultimately be comparable across MPAs. It was agreed that each MPA may require a different amount of sampling to adequately characterize fish populations and detect changes through time. This is in part due to inherent variability in both species abundances and habitat availability. Some reefs, such as those at Ten Mile SMR, will be sampled in their entirety, whereas other, larger MPAs will need to be stratified and subsampled for both habitat and depth. MPAs need to be surveyed across the range of depths that species are distributed with at least two samples from each depth strata. In order to extrapolate density and biomass estimate to a larger area (i.e., the entire reef structure or MPA), stratified sampling must be conducted over representative habitat. It is ok for random sampling to include non-rock features like sand channels so long as these are representative of the broader MPA, but large, non-representative soft bottom features should be avoided for this long-term program.

Although a final transect design was not agreed upon, it was suggested that transects start off the rocky reef habitat and move onto the reef in order to capture the important transition zone between sand and rock. Still to be decided was whether the entire reef within an MPA should be stratified and sampled, or whether smaller portions of the reef should be selected as representative of the entire MPA. The latter design would allow more intense sampling at smaller scales as opposed to spreading sampling over a larger area. The down side to this type of sampling is that spatial variation is not sampled, so differences observed over time can only be attributed to that site and not the entire MPA. Because the representativeness of a subsample is crucial to the extrapolation of density and biomass estimates, there was a consensus that accurate geo referencing of a tool is needed to match sample data with habitat data. It was therefore agreed that the accuracy and accuracy and precision of navigational equipment should be as accurate as possible. Finally, as technology improves through time after sampling begins, data will be collected according to lowest resolution capabilities. This will ensure data remains comparable throughout the duration of this long-term monitoring program.

## Future Tasks

There were numerous statistical and sample design considerations that were not fully agreed upon. There was a consensus however that existing data should be used when possible to provide guidance with respect to a final sample design. Questions the group thought should be investigated included:

*"Exactly how precise do we need our size estimates to be?"* Existing data can be used to answer this question by looking at how biomass estimates are changed by grouping size estimates into coarser bins.

If there are cost/benefit tradeoffs between sizing with stereo cameras versus lasers, this analysis may help the final decision.

*"How much sampling is needed, at a single MPA, to detect an effect through time?"* There is concern that intense sampling may be required in each MPA to detect change through time, which may in turn severely limit the number of MPAs sampled along the coast. A simulation with existing data will help answer this question. This power analysis is needed in order to realistically set out a sampling design along the coast.

*"How much sampling is needed by each tool to get the same CV for a given metric?"* It may also be possible to evaluate the quality of baseline data to inform which tool will be most appropriate for a long-term study. It may be necessary to weigh the relative benefits of a tool that minimizes the CV of density estimates versus a tool that minimizes CV of length estimates. Length-weight ratios are a tight relationship, and it is likely that the variability in biomass estimates is most influenced by variability in the *density* estimates as opposed to length estimates. Another consideration is the relative amount of effort needed to reduce the CV of either density or length estimates. A cost-prohibitive amount of additional sampling may be needed to reduce density estimate CV, whereas only modest amount of sampling may be required to reduce associated CV in length measurements. This is a question that could also readily be explored with existing data.

Another workshop will likely be needed to decide final sample design and statistical considerations. The results from the analysis above will inform that workshop. Additionally, several other topics will need to be finalized. The final sample unit for an ROV study was not agreed upon during this workshop. A suggestion was made to review the literature and to discuss 2-3 previously used ROV techniques in more detail at a future workshop. It was agreed that previously used ROV techniques could be modified for this long-term program if necessary so long as the techniques were applied consistently across the state. A variety of additional statistical concerns will need to be fully addressed including spatial-autocorrelation and pseudo-replication. There also was no discussion comparing the results of the first breakout session (ROV was the preferred tool) with the final results of the second breakout session (live-feed drop camera was the preferred tool). There seemed to be a consensus was that ROV would ultimately be a tool used, but further discussion may be warranted on the feasibility of a hybrid study design with both ROV and live-feed drop cameras. The final sample-design recommendation could be presented as tiered stages based on funding availability. This would allow the State to evaluate the quality and scope of data it could expect given a set of budget restrictions.

## Final Statement

Deep water rocky habitats are unique and more likely to show an MPA effect than some other habitats, such as beaches, and thus are key habitats to monitor. Surveying deep water MPAs will be cost intensive, but this is in part due to their expanse along the coastline. Shallow MPAs and areas closer to shore are much more likely to be taken advantage of by opportunistic sampling and citizen science programs, leaving the deep water habitat in need of more funding for experts, vessels, and use of visual survey tools.

There was a consensus that the 19 MPAs (Tier 1 and Tier 2) outlined are part of a preferred long-term monitoring program for deep water MPAs. These 19 MPAs span the important biogeographic features along the coast of California. The 13 MPAs listed as “Tier 1” represents the minimum number of MPAs that should be sampled in a long-term monitoring program. MPAs ultimately selected for the long-term program should be representative of the important biogeographic features along the coastline.

ROVs and/or live feed Video Landers equipped with stereo-cameras, or a combination of the two tools, are the preferred tools to use in a long-term program. A strip transect design or point counts would maximize data collection and facilitate the objectives of tracking changes in lengths, density, and biomasses of selected fishes though time. There was a consensus that stereo video should be used to collect length estimates within the precision guidelines, and that efforts should be made to reduce the CVs in density estimates.

Although final sample design logistics still need to be decided upon, it was agreed that consistent sampling techniques will need to be applied across the state. Additionally, habitat and depth should be stratified so that subsamples within an MPA represent the larger reef structure. Similarly at least two samples per depth/habitat strata are preferred.  Because there will be a review of the MPA program in 2022, it is recommended that sampling be conducted annually, as soon as possible. Each MPA should be paired with an adjacent reference site and sampled annually.

**Appendix 1**

***California Ocean Protection Council***
***California Department of Fish and Wildlife***
***Moss Landing Marine Labs***

# Agenda

## Deep-Water Marine Protected Area Monitoring Workshop 2

**June 26, 2017; 10:00 AM – 5:30 PM**
**June 27, 2017; 9:00 AM – 12:00 PM**
**Moss Landing Marine Laboratories**
**8272 Moss Landing Drive, Moss Landing, CA 95039**

***Meeting Purpose/Objectives***:

- Discuss various tool and analytical technique combinations for conducting deep-water MPA monitoring
  - Identify benefits and drawbacks
  - Articulate the tradeoffs between different approaches
- Describe the implications of using different tool and technical combinations for study design
- Describe how particular data gathering approaches are related to analytical approach

**Day 1: June 26, 2017**

| TIME | ITEM | PRESENTER/ MATERIALS |
|---|---|---|
| *9:30 AM* | *Arrivals* | |
| 10:00 | **Welcome, Objectives, and Introductions**<br>• Welcome by MLML<br>• Introductions<br>• Review of meeting objectives, agenda, and ground rules | • Rick Starr<br>• Eric Poncelet<br>*Materials: Agenda, Participant Roster* |
| 10:15 | **Background and Orientation**<br>• 2015 MBARI Visual Tools Workshop<br>• CBNMS 2016 Benthic Survey Workshop<br>• Deepwater MPA Workshop #1 results<br>• Spatial Point Process Model<br>• Comparison of ROV and Video Lander approaches | • Rick Starr<br>• Nick Perkins<br>• Christian Denney<br>*Materials: Workshop Reports, Tools Spreadsheet, Intro PPT* |
| 11:00 | **Breakout Session 1:** Discuss various tool and study design technique combinations for conducting deep-water MPA monitoring. Discussion topics:<br>• Identify how alternative tool and technique combinations fit the deep-water monitoring goals articulated in Workshop #1<br>• Describe the tradeoffs between different tool-technique combinations<br><br>Each group will discuss *best practices* for use of the following tools with the following techniques: | • 3 breakout groups (all with same assignment) |

| | | |
|---|---|---|
| | • Tools: a) Mini-ROV, b) ROV, and c) HOV<br>• Techniques: a) strip transects, b) line transects, c) photo quadrats | |
| *12:30* | *Lunch (sandwiches will be brought in)* | |
| 1:30 | **Reports Back and Discussion** | • All |
| *2:30* | *Break* | |
| 2:45 | **Breakout Session 2:** Discuss various tool and study design technique combinations for conducting deep-water MPA monitoring. Discussion topics:<br>• Identify how alternative tool and technique combinations fit the deep-water monitoring goals articulated in Workshop #1<br>• Describe the tradeoffs between different tool-technique combinations<br><br>Each group will discuss *best practices* for use of the following tools with the following techniques:<br>• Tools: a) Towed cameras, b) Sleds, c) Live-feed Landers, and d) Drop Cameras<br>• Techniques: a) Strip transects, b) Photo quadrats, c) Point counts | • Same 3 breakout groups |
| 4:15 | **Reports Back and Discussion** | • All |
| 5:15 | **Wrap Up and Preview of Day 2** | |
| *5:30 PM* | *Adjourn; no-host dinner at The Haut Enchilada* | |

**Day 2: June 27, 2017**

| TIME | ITEM | PRESENTER |
|---|---|---|
| 9:00 AM | **Overview and Reflections on Day 1** | • Eric Poncelet |
| 9:15 AM | **Plenary discussion:** Discuss various image analysis, data analysis, and statistical techniques for evaluating spatial and temporal changes in deep-water MPAs<br><br>1. What is the best way to do image analysis?<br>2. What is the best way to do data analysis?<br>3. What are the best statistical techniques to allow change detection? | • All<br><br>*Materials: CBNMS 2016 Benthic Survey Workshop, Intro PPT* |
| *10:45* | *Break* | |
| 11:00 | **Discuss trade-offs between monitoring a few MPAs intensively vs monitoring many MPAs less intensively** | • All (plenary) |
| 11:45 | **Wrap Up and Next Steps** | • Rick Starr<br>• Eric Poncelet |
| Noon | *Adjourn* | |

**Meeting Materials**

- Agenda
- Workshop Roster of Participants
- Deep-water MPA Monitoring Workshop 1 outcome: List of goals for deep-water MPA monitoring
- MBARI Visual Tools Workshop - spreadsheet of tools
- MBARI Visual Tools Workshop - Report
- Cordell Bank National Marine Sanctuary 2016 Benthic Survey Workshop – Report
- List of relevant academic studies/articles