Proceedings of the Marine Protected Areas and Fisheries Integration Workshop

March 29-30, 2011
San Diego, California

Hosted by California Department of Fish and Game
Marine Region

Conserving California's Wildlife Since 1870

Cover images, clockwise from left, provided by: *Paulo Serpa, Joel Greenberg, Ed Roberts, Joanna Grebel, and CDFG archives*

This document should be cited as:
Wertz, S., D. Aseltine-Neilson, T. Barnes, J. Vasques, S. Ashcraft, K. Barsky, A. Frimodig, M. Key, T. Mason, and B. Ota. 2011. Proceedings of the Marine Protected Areas and Fisheries Integration Worskhop. California Department of Fish and Game. March 29-30, 2011.

Workshop Participants

Debbie Aseltine-Neilson, Session 2 Moderator, California Department of Fish and Game
Susan Ashcraft, California Department of Fish and Game
Tom Barnes, Session 3 Moderator, California Department of Fish and Game
Kristine Barsky, California Department of Fish and Game
Adam Frimodig, California Department of Fish and Game
Selina Heppell, Oregon State University
Kevin Hovel, San Diego State University
Angie Im, California Department of Fish and Game
Meisha Key, California Department of Fish and Game
Alec MacCall, National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center
Tom Mason, California Department of Fish and Game
Sonke Mastrup, California Department of Fish and Game
Mark Maunder, Inter-AmericanTropical Tuna Commission
Carey McGilliard, University of Washington
Becky Ota, California Department of Fish and Game
Steve Ralston, National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center
Craig Shuman, California Fish and Game Commission
Rick Starr, University of California Sea Grant Extension Program
Jason Vasques, Session 1 Moderator, California Department of Fish and Game
Marija Vojkovich, California Department of Fish and Game
Stephen Wertz, Workshop Coordinator, California Department of Fish and Game
Elizabeth Whiteman, MPA Monitoring Enterprise

Acknowledgements

We want to extend special thanks to Steve Ralston and Alec MacCall of the National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center and Liz Whiteman of the MPA Monitoring Enterprise for their willingness to make presentations during the workshop. We also thank Department of Fish and Game staff Christine Pattison for coordinating the workshop logistics, Angie Im for diligently recording detailed notes, and Nina Kogut for the very useful edits and comments on the proceedings document.

Table of Contents

Executive Summary

The California Department of Fish and Game (CDFG) convened a workshop titled "Marine Protected Areas and Fisheries Integration" in San Diego, California, on March 29-30, 2011. Twenty-two fishery scientists, ecologists, fishery modelers, resource managers, and support staff from government agencies and academic institutions attended. The purpose of this two-day workshop was to openly elicit input from the participants on these topics: the utility and practicality of using a redesigned network of marine protected areas (MPAs) to inform fisheries management; potential effects of the MPA network on California's marine fisheries; and how best to monitor for these effects and incorporate them into ecosystem management.

The workshop's core topics were organized into three sessions with each session building on the previous session(s). To facilitate discussions and maintain a common thread throughout the workshop, four nearshore species/fisheries were used to represent the wide range of life histories, scientific knowledge, and management approaches for fisheries that are expected to be impacted by MPAs: brown rockfish (*Sebastes auriculatus)*, cabezon (*Scorpaenichthys marmoratus)*, California spiny lobster (*Panulirus interruptus)*, and abalone (*Haliotis* spp.). This approach worked well and resulted in a considerable exchange of information between participants who represented a number of different disciplines and experiences. This information was captured in worksheets projected on a screen and populated real-time during each session. After the workshop, this information was supplemented with notes taken by CDFG staff. These compiled results were then sent to participants for their review and input prior to the completion of this report.

A summary of the primary discussion points for each session is provided below:

Session 1: What are the expected effects of the network of MPAs along the California coast on California's marine fisheries? What are the best ways to monitor for these effects?

Fishery Considerations:

- Workshop participants identified the expected effects of a statewide network of MPAs as effort shifts, localized and serial depletion, spillover (adult and larval), increased biomass, and changes in age and size structures.
- MPA effects will vary by species and fishery, accruing at different rates and time scales (e.g., almost immediate for localized effort displacement; more gradual for population and ecosystem responses).
- MPA monitoring metrics such as abundance, density, size, and sex ratios may provide useful information to inform stock assessments or specific fishery management strategies such as setting harvest limits by comparing density and size structure inside and outside of MPAs.
- Participants recommended monitoring fisheries that are expected to be significantly affected by effort shifts and spillover.

- Participants noted the importance of collecting data on compliance and MPA use as estimates of these will be needed when interpreting MPA monitoring data/results (e.g., size, density, abundance).

Session 2: Do our management strategies need to change in response to a network of MPAs? How should these strategies change?

Fishery Considerations:

- In general, the workshop participants felt no critical MPA-fishery management actions were necessary concerning the four focal species/fisheries.
- Participants recommended that management of the cabezon fishery be kept at the status quo until more information becomes available, although if most of the nesting areas are outside of MPAs, then managers could consider a winter spawning closure to protect nesting males.
- For spiny lobster, monitoring of fleet effort after MPA implementation is recommended.
- With implementation of the MPA network, there may be less risk of overfishing for the individual species within the nearshore rockfish complex.
- Participants recommended no initial management changes for the red abalone fishery given the current approach encompasses a solid range of traditional management tools (e.g., size and bag limits, harvest level triggers), ongoing monitoring of the northern California stock, and implemented/proposed MPAs as well as deep water refuges.

Session 3: Can we incorporate the presence of a network of MPAs into stock evaluation, designation of harvest control rules, and other processes related to defining fishery yields? When should we do so?

Fishery Considerations:

- Participants noted that logical arguments can be developed to alter the precautionary adjustment for data-poor stocks as a result of a coastwide network of MPAs, but the basis and magnitude for any such potential adjustment requires further investigation.
- Since the exact response of populations to MPAs is unknown and it may take some time for such a response to be measurable, participants did not indicate a need to modify traditional stock assessment methodologies until MPA effects become better understood.

The CDFG will use these workshop results to identify gaps in the scientific information needed to understand the effects of MPAs on fisheries; inform decisions related to management actions; and improve the CDFG's ability to integrate MPAs within the broader context of fishery science.

1. Background for Workshop

Traditionally, management of California's marine fisheries focused on single species or groups of species. However, starting with the passage of the Marine Life Management Act (MLMA) in 1998, the focus is shifting to an ecosystem-based management approach. Recognizing the need to broaden ecosystem and habitat protection, the State of California subsequently adopted the Marine Life Protection Act (MLPA) in 1999. The MLPA requires the redesign of the state's existing system of marine protected areas (MPAs) to increase its coherence and effectiveness at protecting and conserving the state's marine life, habitats, and ecosystems. The CDFG served as the lead agency in a recently completed statewide MPA network planning and development process called the MLPA Initiative, and is now focusing on implementation and monitoring activities.

The primary focus of the statewide network of MPAs is to protect marine life, habitats, and ecosystems. While only a few of the MPAs within this network have specific fishery resource objectives, the MPAs are expected to result in various biological, ecological, and socioeconomic effects within and adjacent to their boundaries. As such, there will likely be broad implications for the management of California's marine fisheries. Many consumptive users also have raised concerns about expected effects and the desire to adaptively manage fisheries in response to the MPA network. Therefore, research must be designed to provide information critical for management decisions to optimally balance ecosystems and their impacts.

Understanding both the contribution of the statewide network of MPAs to California's fisheries, and how these fisheries may respond to this network, is necessary for the development of effective fishery management strategies. Fishery resources may respond to protection within MPAs through restored biodiversity and increased fish biomass. However, the effects of a network over a broad geographic scale are less certain, and understanding these effects currently relies on modeling (e.g., larval spillover and bioeconomic models). Fisheries may respond through shifts in fishing effort (i.e., magnitude and distribution). For example, shifts in fishing effort may affect local fishery populations resulting in changes to biomass and its distribution, which may ultimately affect fishery landings; therefore, monitoring needs to cover the biological and ecological effects of MPAs as well as the socioeconomic responses.

California's network of MPAs may prove to be a useful tool in the development of an ecosystem-based fisheries management (EBFM) approach. While EBFM concepts have been advanced in the scientific literature in recent years, the evolution of traditional fisheries management to an EBFM approach at a practical level is still conceptual; and incorporating spatial closures such as MPAs adds to an already complex process. An important initial step for implementation planning, and the purpose of this workshop, was to elicit input from participants on the utility and practicality of using a redesigned network of MPAs to inform fisheries management, potential effects of the MPA network on California's marine fisheries, and how best to monitor for these effects and incorporate them into traditional fisheries management.

The following topics summarize a series of presentations that provided the context for the workshop.

1.1 Intersection between Marine Life Management Act and Marine Life Protection Act

The CDFG is a public trust agency within the California Natural Resources Agency mandated to protect natural resources since 1870. The CDFG's marine region mission is to "protect, maintain, enhance, and restore California's marine ecosystems for their ecological values and their use and enjoyment by the public through good science and effective communication". In recent years, it has been more difficult to support this mission because of advancements in fishing technologies and capacities, coastal development, water pollution, and other human activities that threaten the health of marine habitats and biodiversity. Recognizing these and other management challenges, the State Legislature adopted the MLMA and MLPA. The MLMA, adopted in 1998, is California's primary fishery management framework for managing the State's fisheries using an adaptive management approach and including ecosystem-based considerations to achieve the primary goal of resource sustainability. However, recognizing the need to broaden ecosystem protection, the MLPA was adopted one year later mandating an improved system of MPAs that are managed as a statewide network to protect marine life, habitats, and ecosystems. Now that a statewide network of MPAs has been developed, there is great interest within the CDFG, the California Fish and Game Commission (Commission), and our constituents to begin to explore whether MPAs may change how California's marine fisheries are managed. The goal of this presentation was to identify key points of intersection between the MLMA and MLPA that will improve the CDFG's ability to develop scientific information necessary to integrate MPAs within the broader context of fishery science and management; see the full presentation in Appendix A.

1.2 Marine Life Protection Act Planning Process and Marine Protected Areas Design Guidelines

The MLPA mandated the CDFG the core charge of redesigning the state's system of MPAs into a statewide MPA network to increase its coherence and effectiveness at protecting the state's marine life, habitat, and ecosystems. To accomplish the planning and development of the statewide network of MPAs, the CDFG served as the lead agency in an extensive public-private partnership called the MLPA Initiative. The MLPA planning process was recently completed, and MPAs in three of the four coastal planning regions have been adopted by the Commission. Following the MLPA planning process, the percentage of state waters currently in MPAs is approximately 16%, and about 9% is in state marine reserves[1]. Key underlying MPA design guidelines covered in this presentation included the role of individual MPA objectives and the fundamental science guidelines developed in the MLPA planning process. Each MPA in the statewide network has specific objectives that were identified

[1] These calculations include MPAs in the proposed north coast preferred alternative, and therefore may be subject to change depending on the final adoption by the Commission. These calculations also include northern Channel Island MPAs (adopted in 2003), but do not include existing MPAs in the San Francisco Bay or special closures.

by regional stakeholders meant to help achieve the six goals of the MLPA. However, only a few of the MPAs have specific fishery resource objectives despite the fact that the MPA network could affect a large number of marine fisheries and their management. The MLPA Science Advisory Team (SAT) developed a number of science guidelines and associated evaluations for how well MPA proposals achieved the science guidelines and MLPA goals. Nine SAT evaluations were used in the MLPA planning process, and this presentation focused on the five core SAT evaluations including levels of protection, habitat representation, habitat replication, MPA size, and MPA spacing; see the full presentation in Appendix B.

1.3 National Oceanic and Atmospheric Administration Marine Protected Area Science Integration Working Group

Dr. Steve Ralston reported in cooperation with the National Oceanic and Atmospheric Administration (NOAA) National MPA Center and the Pacific Fishery Management Council, among others, the NOAA National Marine Fisheries Service (NMFS) began planning efforts in February 2004 to establish a working group to integrate the science of MPAs with fishery science and management. The overall aim of the working group was to develop scientific information necessary to integrate MPAs within the broader context of fishery science and management, including especially EBFM. An array of scientists with expertise in marine ecology, population ecology, stock assessment, economics, sociology, management, and the private sector were convened for an initial workshop that was held at the NMFS Santa Cruz Laboratory October 6-8, 2004. Following this initial workshop, three individual working groups broke out: 1) Fisheries/ MPAs Ecosystem Modeling, 2) Connectivity, and 3) MPAs for Natural Heritage. An additional two working groups, “Density Ratio” and “Maternal Effects and MPAs” were formed later. The working groups operated mostly independent of each other, each involving a varying number of meetings and written products. The working groups collectively produced over 10 peer-reviewed publications as well as a number of presentations delivered at various conferences and symposiums; see the full presentation in Appendix C.

2. Featured Workshop Fisheries

Nearshore fisheries target a great number of species where MPAs have been established. Nearshore fisheries include finfish as well as invertebrates, and represent a wide range of scientific knowledge, from unassessed data-poor stocks to data-rich assessed stocks. Assessments vary greatly, from relatively simple surveys that track changes in relative abundance to fully assessed stocks that have been evaluated with integrated population models that simultaneously analyze many different types of data to determine the stock status and its ability to support a fishery. Furthermore, some stocks are actively managed under comprehensive Fishery Management Plans (FMPs), while others are regulated with only size, season, and/or bag limits. In order to focus discussions on a manageable subset of species and to maintain a common thread throughout the entire workshop, four species were selected to represent the wide range of life histories, scientific knowledge, and management approaches for fisheries that are expected to be impacted by MPAs:

- Brown rockfish (*Sebastes auriculatus)*
- Cabezon (*Scorpaenichthys marmoratus)*
- California spiny lobster (*Panulirus interruptus)*
- Abalone (*Haliotis* spp.)

While these four species/species group were the focus of workshop discussions, the intent was that any recommendations or outcomes could be more broadly applicable to associated fisheries and similar species.

2.1. Brown Rockfish

Brown rockfish have long been an important component of the marine recreational fishery and the nearshore commercial fishery in California, especially north of Point Conception. They occur in shallow nearshore waters and bays and are associated with sand-rock interfaces and rocky bottoms of artificial and natural reefs. Brown rockfish are managed under California's Nearshore Fishery Management Plan (NFMP) (http://www.dfg.ca.gov/marine/nfmp/index.asp) and the federal Pacific Fishery Management Council's Pacific Coast Groundfish Fishery Management Plan (GFMP) (http://www.pcouncil.org/wp-content/uploads/fmpthru19.pdf). The commercial fishery is primarily a live fish hook-and-line fishery, which is managed using a restricted access program, annual catch limits, trip limits, and depth restrictions. The recreational fishery is managed using depth restrictions, bag limits, and gear restrictions. At the peak of commercial landings during the 1990s, half of the commercial catch was at or below size at 50% maturity (10.6 inches [in]) (269 millimeters [mm]). However, under current management measures (2005-2010), the average size landed has increased to above the size at 50% maturity. While directed studies have focused on local abundance in certain coastal areas and within bays, the population size and structure has not been comprehensively assessed. Therefore, brown rockfish is categorized as a data-poor stock and managed using precautionary measures; see the full presentation in Appendix D.

2.2. Cabezon

Cabezon is an important component of the recreational fishery and the nearshore commercial live-fish fishery in California. They are the largest member of the Cottidae (sculpin) family, with some reaching lengths of 3.3 feet (ft) (1 meter [m]). They are primarily a nearshore species found intertidally, among jetty rocks, and in and around kelp forests and rocky reefs. Cabezon are also cryptic species, and males guard nests of eggs during the spawning season. Genetic studies have shown there are several sub-stocks of cabezon throughout California. Cabezon, like brown rockfish, are managed under the NFMP and the GFMP. Three stock assessments have been conducted on this species, and the most current assessment in 2009 concluded that cabezon in California are in a healthy state. This species is managed with size limits, bag limits and trip limits; see the full presentation in Appendix E.

2.3 California Spiny Lobster

The California spiny lobster fishery occurs between Point Conception and the Mexican border and at all the Channel Islands and offshore banks in southern California. Lobsters are found in shallow rocky areas from the intertidal out to 240 ft (73 m) or more. In the winter months, lobsters are in deeper water. Mating takes place from January through April. Females move into shallow water in late March and April to release and fertilize their eggs, which they carry under their tail for eight weeks. Females carry the eggs until they hatch into tiny, transparent larvae known as phyllosomas. The phyllosoma drifts with the prevailing currents, feeding on other planktonic animals. It may drift offshore out to 350 mi (563 km), and may be found from the surface to a depth of over 400 ft (122 m). After 7 to 10 months, the phyllosoma transforms into the puerulus larva. The puerulus actively swims inshore where it settles to the bottom in shallow water and molts into a juvenile lobster if suitable habitat is found. Surfgrass beds are preferred habitat. Lobsters grow by molting, shedding their external exoskeleton. After they reach a carapace size of 2.5 in (64 mm) the lobsters usually molt annually in August through October after completing their reproductive cycle. Lobsters spend the first two years of their lives in nearshore surfgrass beds. Adult lobsters usually inhabit rocky areas and search sandy areas for food. During the day, spiny lobsters usually reside in a crevice or hole, dubbed a den. More than one lobster is usually found in a den. At night, the animals leave their dens to search for a wide range of food. Adult lobsters will consume algae and a wide variety of marine invertebrates such as snails, mussels, sea urchins, clams, and injured or newly molted lobsters. Lobsters are eaten by California sheephead (*Semicossyphus pulcher*), cabezon (*Scorpaenichthys marmoratus*), kelp bass (*Paralabrax clathratus*), giant sea bass (*Stereolepis gigas*), southern sea otters (*Enhydra lutris nereis*), two spotted octopuses (*Octopus bimaculoides*), California moray eels (*Gymnothorax mordax*), horn sharks (*Heterodontus francisci*), leopard sharks (*Triakis semifasciata*), and people.

Both a commercial and a recreational fishery in southern California target lobster. The CDFG has had a commercial logbook system in place for the commercial fishery since 1976. The commercial fishery is a trap only fishery with restricted access and has 200 permittees. Both sexes can be landed, and there are no trip limits, trap limits, or quotas. The recreational season starts the weekend before commercial season and uses hoop nets and diving to take lobsters. Traditional management tools are used in the recreational fishery including a minimum size of 3.25 in (83 mm) carapace length (the same as the commercial fishery), a bag and possession limit of seven, and a lobster report card. Recreational fishermen may use baited hoop nets to catch lobsters from shore, vessels, or man-made structures such as piers. Modified hoop nets with rigid supports have recently become popular in the fishery. This component of the recreational lobster fishery is growing. The CDFG is currently working on a lobster stock assessment that should be ready for peer review in 2011. Lobster is currently being used as a MPA indicator species in the northern Channel Islands. The lobster's lengthy planktonic stage, slow growth, and long life make it vulnerable to environmental changes and overfishing. Such developments as new hoop net designs, climate change (the lobster is a warm temperature species that doesn't flourish in prolonged cold water), and a soon to be established network of MPAs must be considered to make informed management decisions; see the full presentation in Appendix F.

2.3 Abalone

California has seven species of abalone that are distributed along the coast in response to water temperature and habitat. Five of these species were targeted commercially: red (*H. rufescens*), pink (*H. corrugate*), green (*H. fulgens*), white (*H. sorenseni*), and black (*H. cracherodii*). All except the blacks were also popular with recreational divers. The pinto (*H. kamtschatkana*) and flat (*H. walallensis*) are less common in coastal waters off California. Withering Foot Syndrome, a bacterial infection that emerged in the warm water years in the 1990s, particularly had an effect on black abalone. The black is joined on the Federal Endangered Species list by the white, the deepest species found in southern California in dwindling numbers. Pinks, greens, and pintos are on the Federal List of Species of Concern. Reds are found along the entire California coast. North of Point Conception reds occur from the intertidal out to at least 60 ft (18.3 m). South of Point Conception, they are found subtidally out past 100 ft (30.5 m). The red abalone in northern California is currently the only abalone species being harvested recreationally. Abalones are dioecious, and during spawning events, they broadcast their egg and sperm into the water column. As the size of the animal increases, so does egg production. A fertilized egg hatches into a free-swimming larva that drifts for 4-15 days before it settles to the bottom and develops into an adult form if suitable habitat is located. Very high mortality rates are associated with settlement. Sexual maturity occurs at 3-4 in (76-102 mm), ages 3-5 years. Growth rate slows with age, and especially with older animals, some may only maintain their current size.

An Abalone Recovery and Management Plan (ARMP) was adopted by the Commission in 2005. The ARMP has both recovery and fishery management goals. A Minimum Viable Population was established which is measured in terms of density or number of abalone per hectare = 2000 abalone/hectare. A decision matrix for evaluating the north coast recreational fishery based on red abalone densities from eight dive survey index sites was created. The north coast fishery is managed with a total allowable catch (TAC). The TAC is adjusted whenever trigger levels are approached or hit in the decision matrix based on the results of the densities from the independent dive surveys. The management of the recreational fishery north of San Francisco Bay utilizes traditional tools such as a 7 in (178 mm) minimum size limit, a seven month split season, free diving or shore picking only, a maximum of 3 abalone a day, and a maximum of 24 abalone per year. Every angler must carry an abalone report card and immediately tag any abalone they keep. MPAs are identified in the ARMP as useful management tools for both abalone recovery and fishery management. Populations in southern California are considered to be in recovery, and in the north in management. Central California is excluded from consideration because of the presence of sea otters, which eliminate the number of abalone required to support a fishery; see the full presentation in Appendix G.

3. Introduction to Workshop Sessions

This discussion highlighted the intended flow of the workshop and introduced the three workshop sessions. Each session was designed to build on previous sessions. In addition, to facilitate discussions, the four aforementioned nearshore focal species/fisheries were used to represent the wide range of life histories, scientific knowledge, and management approaches for fisheries that are expected to be impacted by MPAs. Session 1 participants identified the interaction between MPAs and fisheries, explored the potential effects of MPAs to fisheries, including the scale at which these effects might influence fisheries management, and discussed some of the MPA monitoring that occurs or could occur to measure specific metrics that are most useful for fisheries management. Session 2 explored fisheries management responses to MPAs. In this session, participants discussed in more detail some of the effects identified in Session 1, and whether or not management decisions should change based on those effects. Participants also discussed what might trigger a management response on that decision or management action, and the degree to which scale may also influence that decision or management action. Session 3 addressed how to incorporate MPA monitoring information into action. In this session, participants investigated information that might be useful to inform stock assessments and harvest control rules, and how that information could be applied. A key component of this session was a discussion about dealing with risk and the role MPAs might play when assessing risk.

3.1. Session 1: What are the expected effects of the network of MPAs along the California coast on California's marine fisheries? What are the best ways to monitor for these effects?

3.1.1. Rationale

MPA monitoring is designed to detect changes to certain species and fisheries in response to MPAs through the collection of biological and socioeconomic information. However, current efforts focus on assessing MPA efficacy and understanding the dynamic between MPAs and ecosystem condition and thus may not provide all of the information necessary to develop fisheries management recommendations. In an effort to integrate MPA information into fisheries management action(s), the CDFG seeks to better understand how MPAs affect local fisheries and fishery resources both inside and outside MPAs. This session was an opportunity to provide guidance on the type of research and monitoring that may be useful or necessary for determining MPA effects, and evaluating these for incorporation into fisheries management strategies, including adaptive management responses.

3.1.2. Prelude to Session 1

This session began with a presentation from Dr. Liz Whiteman, Program Director for the MPA Monitoring Enterprise whose charge is to lead the development of monitoring plans for California's network of MPAs to meet MLPA goals. In the presentation titled "Informing Fisheries Management through MPA Monitoring", Dr. Whiteman provided an overview of the approach and framework underpinning MPA monitoring designed to meet MLPA requirements. She provided examples of how MPA monitoring data might be directly useful to fisheries management as well as how monitoring might be extended to collect information that informs fisheries management. This presentation illustrated unique characteristics and overlap among monitoring for MPAs, climate change, water quality, and specific to this workshop, fisheries management. An important difference between MPA monitoring and fisheries monitoring is that MPA monitoring is an ecosystem-based and relatively localized spatial approach, while fisheries monitoring is stock based and focuses on individual species and populations. Nonetheless, significant opportunity exists to leverage MPA monitoring to inform fisheries management. Through this presentation, the MPA monitoring metrics relevant to fisheries management were highlighted, including those selected to track changes in ecosystems and human uses (e.g., consumptive uses- such as monitoring the number of fishing trips by recreational fishermen, or monitoring the abundance of select fished species). Specific MPA design and management questions (e.g., measuring the economic effects of MPA placement) were presented. These examples were used to illustrate how MPA monitoring might augment existing data or provide new data in a data-poor environment to help address some of the ecosystem-based fisheries management mandates in the MLMA. The MPA monitoring plans also include a chapter specific to collecting supplemental fisheries information; information extending beyond the needs to meet MLPA requirements (see the full presentation in Appendix H).

3.1.3. Overview

The purpose of Session 1 was to explore the interaction between MPAs and fisheries and identify potential effects or interactions that should be considered for fisheries management. Following the initial session presentation, the group discussed potential effects of MPAs to fisheries, the scale at which these effects may influence fisheries management, and some of the MPA monitoring that occurs or could occur to measure specific metrics that are most useful for fisheries management (Session Topic Tables 1.1-1.5). These key topics were explored by discussing the following questions, and the outcomes of these discussions were used as foundational elements in the next session. Five main questions were asked during this session:

1) What are the potential negative impacts to the fishery (e.g., resource availability, behavioral, economic)?
2) What are the potential contributions MPAs may have to the fishery?
3) What are the biological/ecological responses (e.g., scale: regional, local, and population dynamics)?
4) What other system drivers should be considered (how and when)?
5) What other essential fishery information (EFI) can MPAs provide that is beneficial to management, and what types of monitoring/research could be conducted to acquire this information?

3.1.4. Key Discussion Points

During Session 1, a number of potential fisheries impacts and contributions resulting from the statewide network of MPAs were identified. Expected impacts included but were not limited to effort shifts and localized and serial depletion. However, the scale, duration, and magnitude of expected impacts are likely to vary drastically among fisheries and geographies. For example, it was noted that due to the scale at which fishery stocks are managed, it is important to identify major shifts in effort, whereas moderate shifts are less likely to affect the population or fishery in a detectable manner. Expected contributions that MPAs may have to the fisheries discussed by workshop participants included spillover (adult and larval), increased biomass, and changes in age and size structure. However, workshop participants noted that larval spillover is difficult to measure, and a more useful and cost effective focus might be on simple metrics (e.g. density and size inside/outside of MPAs) for adult fish and invertebrate species.

Many of the metrics that should be monitored (e.g., abundance, size, sex ratios) may provide useful information for stock assessments or informing specific fishery management strategies such as setting harvest limits by comparing density and size structure inside and outside of MPAs. It was noted that monitoring metrics such as abundance, size, and sex ratios, to support management strategies based on fished and unfished ratios, should be conducted from the point of MPA implementation (preferably before an MPA is established). Workshop participants also noted that MPAs may help to provide important information used in stock assessment models, such as improving estimates of natural mortality by focusing on primarily sedentary species (as accuracy is related to how much a species moves), and by enhancing estimates for unfished density.

3.2. Session 2: Do our management strategies need to change in response to a network of MPAs? How should these strategies change?

3.2.1. Rationale

While the objectives for a network of MPAs within California primarily focus on resource conservation, these objectives also encompass the MLPA goals of helping to sustain marine life and rebuild depleted populations. A growing body of scientific evidence suggests that the success of a network of MPAs in providing benefits to fished populations (i.e., helping to sustain and rebuild these populations) is tied to the effective management of fisheries outside of the MPAs. Various studies indicate that the management of fishing effort is particularly important for achieving beneficial outcomes from MPAs. Therefore, with the implementation of the statewide network of MPAs, it is important to consider whether California may need to revise existing management strategies on current or future fisheries.

3.2.2. Overview

The purpose of Session 2 was to consider what potential management actions might be advisable given the implementation of the California MPA network. Specifically, participants were asked to provide their perspective on what effects and/or characteristics of an MPA network might potentially occur for the focal species/fisheries (building upon the Session 1 discussions). Three main questions were asked during this session:

1) What conditions might result from these effects or characteristics?
2) Should management strategies change in response to these conditions?
3) What the risks might be with or without implementation of management actions?

Participants provided their perspectives for three of the four focal species/fisheries. Potential effects and management actions for red abalone had already been touched upon during discussions of the fishery in Session 1, so this fishery was not discussed further during Session 2. Prior to the discussion of each species/fishery, specifics of its life history and management were quickly reviewed.

Participants also were provided with a list of nine effects/characteristics (which was generated using results from Session 1), and asked to focus their discussions for each fishery on three from this list (although in the ensuing discussions, the number chosen varied between two and four effects/characteristics). The nine effects/characteristics presented to the participants were:

1) Effort shift/depletion
2) MPA design/configuration
3) Spillover/movements
4) Sequestering biomass
5) Stock stability
6) Compliance
7) Environmental conditions
8) Life history characteristics
9) Fishery characteristics

Some of the points were applicable to many fisheries (Session Topic Tables 2.1.A-2.1.B, “general fisheries”), while most of the discussion focused on the specific species/fisheries (Topics 2.2A-2.4.B, two tables per species/fishery). Discussion highlights from the four sets of tables are provided in the subsection below as well as Session 1 discussion points on red abalone that are applicable to Session 2 questions.

Regarding what potential management response(s) might be advisable, the consensus of the participants was that no action is needed at this time to address effort shifts in the three focal species/fisheries discussed. For cabezon and brown rockfish, effort redistribution outside of the MPAs was not considered a concern due to increased harvest targets for cabezon and for the southern nearshore rockfish complex (which includes brown rockfish). Consequently, the risk of no management action was considered low. For the California spiny lobster, some participants noted that the supply of recruits into the fishery might be independent of the spawning stock size. Discussion points touched on both its life history characteristics (e.g., long pelagic larval stage) and its catch history (relatively steady recruitment into the fishery) as support for this notion. If true, then as long as the spawning stock biomass remains above a critical level (e.g., $B_{20\%}$), higher fishing effort outside of MPAs would not impact recruitment and the risk of no management action would be low. Early results from the spiny lobster stock assessment suggest that the fishery might be near its Maximum Sustainable Yield. However, the shape of the yield curve was not available at the time of the workshop. If the curve is relatively flat, then effort shifts in the fishery should not have much effect on overall yield, but local shifts may result in noticeable changes in catch rates. It was recommended that the distribution of California spiny lobster fishery effort be monitored in the south coast region (Point Conception to the US/Mexico border) before and after the MPAs in this region are implemented.

However, the group did view establishment of the MPA network as duplicating the precautionary intent of the lower threshold of the NFMP 60-20 harvest control rule (http://www.dfg.ca.gov/marine/nfmp/index.asp). Specifically, the 20% cutoff level could be reduced to a value of 10% (the cutoff used by the Pacific Fishery Management Council) because of the protection from overfishing provided by the MPA network. Of the three focal species/fisheries, this change would only affect cabezon, which is under single-species management by both the state and federal systems. Brown rockfish is also managed by both state and federal authorities, but is presently unassessed and is treated as a member of a multi-species assemblage.

In addition to the above points, participants noted that certain life history gaps need to be addressed so that the effects of the MPAs on the focal species/fisheries can be better evaluated. Participants also recognized that MPA effects may not initially be distinguishable from background variation, and as a consequence, it may be some time before such effects can be identified. Some participants pointed out that models could initially be used in lieu of long-term data. However, it was also noted that models need to meet the informational requirements for developing management actions (e.g., include the necessary types of data at the appropriate scales) and cannot be based only on assumed properties.

3.2.3. Key Discussion Points

Session 2 information was assimilated and standardized into the following categories shown in sections 3.2.4.-3.28.

3.2.4. General Fisheries

Potential conditions

- MPAs may provide a way to examine the nature of fish assemblages that are currently managed together.
- Due to various constraints, the assemblages that form within MPAs may not represent the “natural” states for those assemblages.

- It is unknown whether current MPA placement will actually increase the number of larvae and young of different target species.

Potential scale of effects

- Even though the scale of effects may be local or regional, management resource availability may constrain the scale of management response.

Potential management actions

- The amount of spillover from MPAs may not be enough to matter to fisheries.
- Many factors need to be investigated before MPAs can be considered a replacement for the precautionary model.
- Multiple management changes at once will not inform us on what is working.

Potential risks

- Waiting for sufficient data to be available to examine effects of MPAs may be risky; modeling approaches should be considered in lieu of long-term data sets. Resulting information, however, must be sufficient data to justify management changes.
- If MPAs are assumed to buffer against fishery management uncertainties, then MPAs provide a means of precaution which can increase the risk tolerance; this risk tolerance may be further increased if traditional management measures are also in place.

3.2.5. Cabezon

Potential conditions

- Total Allowable Catch (TAC) was recently increased because of an updated stock assessment; consequently, effort shift is not considered a concern.
- More information is needed on the movement of different life stages and the distribution of large females and nest guarding males.
- Sequestering biomass may be beneficial if nesting is also protected.

Potential scale of effects

- If most of the nesting area resides outside of MPAs, and effort is concentrated into these nesting areas, then there is potential for an impact at the local population (substock) level.

Potential management actions

- It is recommended to keep status quo for now until more information becomes available, although if most of the nesting areas are outside of MPAs, then managers could consider commercial winter closure to protect nesting males.
- Less precaution might be possible, such as changing from the NFMP 60/20 harvest control rule to a 60/10 rule.

Potential risks

- The risks associated with no management response will probably be more social in nature than biological.
- Changing the harvest rule would result in a small increase to the TAC, which would be of minimal risk given the current status of the stock.

3.2.6. California Spiny Lobster

Potential conditions

- The spiny lobster fishery is almost fully capitalized; changes in the distribution of effort are expected and will likely depend on availability of lobster habitats outside of the MPAs.
- The quality, diversity, and distribution of habitats inside and outside MPAs could affect spiny lobster movement.
- The effect of movement/spillover on the overall fishery is likely to be minimal.
- Recruitment increases from MPAs are not expected due to this species' larval duration and the steady supply of recruits each year into the fishery.
- Evaluations of MPA effects on lobster will need to take into account environmental changes (e.g., temperature).

Potential scale of effects

- Behavioral responses may result in distribution changes of spiny lobster at a local scale over the short term.

Potential management actions

- No management response is suggested; monitoring of fleet effort after MPA implementation is recommended.

Potential risks

- No risks were noted during the discussion.

3.2.7. Brown Rockfish

Potential conditions

- Brown rockfish is a member of the nearshore rockfish complex south of 40° 10' N. latitude; harvest levels for this complex were increased for 2011-2012.
- Commercial fishing for nearshore rockfish is covered under a restricted access program. Commercial fishing for brown rockfish requires a Deeper Nearshore Fishing Permit. The number of these permits is capped, and they are non-transferable.
- More information is needed on movement of different life stages before the benefits of MPA design/configuration and the potential of biomass sequestering can be assessed.

Potential scale of effects

- There may be a potential benefit from the MPA network at the stock scale.

Potential management actions

- No management response is suggested.

Potential risks

- Given that brown rockfish is covered under a restricted access program, and the harvest levels for the nearshore rockfish complex have been increased, risk from the redistribution of effort is considered minimal.
- With the implementation of the MPA network, there may be less risk of overfishing for the individual species within the nearshore rockfish complex.

3.2.8. Red Abalone

Potential conditions

- Recreational fishermen can only take abalone north of San Francisco Bay; SCUBA and surface-supplied air devices are prohibited.
- Since free-divers are limited to how deep they can dive, abalone have a refuge from legal fishing in deeper waters.
- Adult abalone movement is limited; larval duration is short, so larval dispersal is also limited.
- Shifts in effort could occur, particularly in the short term in fishing locations closer to dense population areas. If effort shifts result in lower densities or localized depletion, then serial shift in effort may later be seen (e.g., fishermen traveling ever increasing distances from population areas).

Potential scale of effects

- Any measurable effects from implementation of the MPA network probably will only be observed at the local level (individual MPAs instead of the MPA network).

Potential management actions

- With the ongoing monitoring of the fishery, traditional management tools in place (e.g., size and bag limits, harvest level triggers), and the presence of the MPAs as well as the deep water refuges, managers do not need to consider an initial change to management in response to MPA implementation; they can wait to see how conditions change once the MPA network is implemented.
- Managers may want to keep density levels up to keep the fishing experience satisfactory.

Potential risks

- Illegal activities such as poaching and compliance with current regulations are current concerns for the stock. The total impact of these illegal activities is unknown and adds uncertainty to any management response. With the implementation of the MPA network, managers also need to consider the uncertainties associated with MPA regulation compliance.

3.3. Session 3: Can we incorporate the presence of a network of MPAs into stock evaluation, designation of harvest control rules, and other processes related to defining fishery yields? When should we do so?

3.3.1. Rationale

Traditional stock assessments and fishery management actions are typically based upon the unit-stock approach, which ideally encompasses an entire reproductive population and attempts to understand the stock's status. The existence of a network of MPAs raises numerous questions that may challenge some underlying assumptions within traditional stock assessments and requires rethinking existing management approaches. Sequestering some biomass of a specified stock within a network of MPAs may alter the basis for dealing with management risk, and influence the population dynamics of the stock in ways that should be built into stock assessments. For example, the presence of MPAs might result in an adjustment to harvest control rules because of changes in lifetime egg production. However, uneven spatial distribution of fishing pressure due to MPAs could create localized conservation issues, despite total catches that remain within acceptable levels for the stock as a whole. The need for precautionary management, especially for un-assessed stocks, may be influenced by MPAs. Clearly, there is an opportunity for this workshop to provide guidance on the effect of MPAs on fishery management, including recommended modifications to existing management strategies to adjust for these effects.

3.3.2 Prelude to Session 3

The field of MPAs and fishery management is a topic of current interest that has received considerable attention from innovative researchers, and it is a subject of rapid scientific development. Accordingly, as an introduction to this session, Dr. Alec MacCall, representing the NMFS Southwest Science Center, presented "How Information from MPAs can be used to Assess and Manage Fisheries? Density ratios and other ideas" (see the full presentation in Appendix I). The density ratio method, using fish densities in MPAs as an index of the potential unfished levels and comparing with fish densities in fished areas, could be a trigger to restrict a fishing season as densities in the open areas decline relative to the protected areas. Tracking the status of the resource using this method requires initial and ongoing monitoring. Density ratio harvest control rules applied to single-species management and multi-species management have been evaluated through Management Strategy Evaluation simulations. Other approaches using MPAs to assess and manage fisheries included the "decision-tree", adjusting the allowable catch based on the relationship of catch–per-unit-effort (CPUE) inside and outside MPAs, as well as comparing length and/or age compositions inside and outside of MPAs to evaluate any change in growth.

3.3.3. Overview

This session was focused on population assessments and how MPAs may affect stock assessment research, data, analyses, and the application of assessment results in decision-making. Following the presentation by Dr. MacCall, participants were asked to address the following three topics:

1) How do MPAs affect the way stock assessments are developed for both assessed and unassessed stocks? Consider risk. Do MPAs alter stock productivity?
2) Under what conditions should harvest control rules/strategies change, and what kind of data are needed to implement control rules? Do MPAs alter the risk of overfishing, or a stock becoming overfished?
3) How does the network of MPAs affect local populations, and what does that mean for management?

With the recent adoption of a coastwide network of MPAs along the California coast, their effects on fisheries, fish populations, and ecosystem function is transitioning from theoretical to tangible. However, it is clear that the effects will vary by species, accruing at different rates and time scales (e.g., localized effort displacement: almost immediate; population and ecosystem responses: more gradual). Since the exact response of populations to MPAs is unknown and it may take some time to be measurable, the discussion did not indicate a need to modify traditional assessment methodologies until MPA effects become better understood.

3.3.4 Key Discussion Points

The discussion under each of the three topics included concepts that are applicable to California nearshore fisheries in general, as well as some specific comments regarding the focal species/fisheries (Session Topic Tables 3.1-3.3). The density ratio method was thought to be a strong candidate to help inform fishery management decisions. In addition, participants noted that logical arguments can be developed to alter the precautionary adjustment for data-poor stocks as a result of the coastwide network of MPAs, but the basis and magnitude for any such potential adjustment requires further investigation. The new network of MPAs also provides a reason to consider changing the 60-20 harvest control rule for assessed nearshore finfish to 60-10, but this concept would need to be fully explored as part of an amendment to the NFMP. Furthermore, a concern was expressed that MPAs have the potential to exacerbate effort shift and the risk of serial depletion, and consequently attention should be given to improving our understanding of effort shift.

4. Next Steps

Following Session 3, the workshop participants were asked to brain storm about what steps might be considered next to assist efforts on integrating MPAs into fisheries management (i.e., “What do we need to do next to get us where we need to go?”). The resulting discussion centered upon four themes:

- Necessity for more EFI
- Usefulness of MPA baseline survey data
- Necessity for more focused monitoring surveys that address MPA-fisheries questions
- Potential management actions

A summary of the discussion outcomes are provided below.

4.1.1 Necessity for More Essential Fishery Information

No critical MPA-fisheries management issue arose during workshop discussions in regard to the four focal species/fisheries; however, participants noted that this result could be due to a lack of data. In particular, earlier session discussions pointed out that most of the focal species/fisheries lacked some EFI needed to effectively evaluate MPA effects.

4.1.2. Usefulness of MPA Baseline Survey Data

Some MPA baseline survey data will be valuable for fisheries management, although the methods used to collect these data may limit their usefulness. Participants discussed some of the MPA baseline data that potentially could be used, the associated methodological requirements that would need to be in place for these data to be used, and the importance of collecting baseline data immediately pursuant to when an MPA goes into effect.

4.1.3 Necessity for More Focused Monitoring Surveys

Data requirements for managing fisheries are different from those needed to evaluate MPAs. Workshop participants noted that additional monitoring surveys will be needed that specifically address MPA-fishery questions and provided some ideas on types of information that should be collected.

4.1.4 Potential Management Actions

While no urgent management actions were suggested during the workshop, several ideas were floated by participants for management consideration. These included:

- Reviewing the need for seasonal closures for nest-guarding species such as cabezon outside of MPAs
- Exploring the possibility of modifying the 60/20 harvest control rule currently used for the nearshore fishery due to additional precaution provided by MPAs

4.2 Final Considerations

First, the primary goal of this workshop was to openly elicit input from the participants on the utility and practicality of using a marine protected area network to inform fisheries management. This goal was clearly met: the participants brought to the discussions a broad range of knowledge and expertise, and provided valuable input; and the workshop, from the perspective of all participants, provided an effective forum for discussing the various aspects of this topic.

Second, this workshop represents only the first step in the CDFG's efforts to explore the integration of MPAs and fisheries management. While this workshop provides useful results, it obviously does not include all perspectives on the topic. The CDFG expects that the workshop results will serve to catalyze further discussion on this subject and is interested in receiving additional input including ideas not expressed within the workshop. Since no immediate management action is suggested by workshop participants, the CDFG will continue its steps to obtain/solicit further input and perspectives from scientists and ocean managers, fishing industry members, and the community at large.

5. Session Topic Tables

Session 1. What are the expected effects of the network of marine protected areas (MPAs) along the California coast on California's marine fisheries? What are the best ways to monitor for these effects?

Topic 1.1. What are the potential negative impacts to the fishery (e.g., resource availability, behavioral, economic)? Identify and discuss where and when one might expect this for each fishery. Is it captured by MPA or fisheries monitoring? What are the consequences to the fisheries?

Topic 1.2. What are the potential contributions MPAs may have to the fishery?

Topic 1.3. What are the biological/ecological responses (e.g., scale: regional, local, population dynamics)?

Topic 1.4. What other system drivers should be considered (how and when)?

Topic 1.5. What other essential fishery information (EFI) can marine protected areas provide that is beneficial to management, and what types of monitoring/research could be conducted to acquire this information?

Note: Session 1 discussion focused on topics that are often shared across fisheries, as reflected in the general discussion column. Comments specific to each of the four featured workshop fisheries are captured in its corresponding column. Empty cells in the featured workshop fisheries columns do not necessarily indicate a lack of potential effects or interactions for a given fishery, but rather indicate they are likely shared across fisheries.

Topic 1.1. What are the potential negative impacts to the fishery (e.g., resource availability, behavioral, economic)? Identify and discuss where and when one might expect this for each fishery. Is it captured by MPA or fisheries monitoring? What are the consequences to the fisheries?					
Identified Effects	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
Effort shift	❖ Shifts are likely to vary across fisheries and for different sectors of a given fishery, and may depend on MPA size and configuration, as well as the quality and amount of habitat within an MPA versus habitat available to the fishery. ❖ Based on the scale at which stocks are managed,	❖ May not be a population concern due to the scale of	❖ See discussion below pertaining to serial depletion. ❖ May be mitigated by minimum size		❖ Possibility of concentration of effort (e.g., Laguna area) likely depends on habitat and habitat

Topic 1.1. What are the potential negative impacts to the fishery (e.g., resource availability, behavioral, economic)? Identify and discuss where and when one might expect this for each fishery. Is it captured by MPA or fisheries monitoring? What are the consequences to the fisheries?					
Identified Effects	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
	major shifts are important to identify, but moderate shifts are not likely to affect the population/fishery in a detectable manner. ❖ The localized importance will vary by species, based on when potential realized effects would be detectable. ❖ Predicting whether effort shifts may occur requires identifying fishable versus non-fishable habitats/areas (e.g., areas with physical obstructions/regulatory restrictions). For example, the spatial locations for fish catch were used in the Marine Life Protection Act planning process to provide such estimates. ❖ Only fisheries where effort shifts and spillover would be significant enough to impact fishery management should be monitored. ❖ Recreational anglers may target MPA edges for larger “trophy” fish. ❖ Displaced effort to larval source areas could be a concern.	the fishery	limits and depth refuge (e.g., skin divers are generally limited to a depth of less than 30 feet or 9 meters)		diversity ❖ May be mitigated by a minimum size limit ❖ Challenging to manage “turfs” (i.e., fishing grounds sometimes established informally by individuals in fishing communities) vs. regulations
Localized/serial depletion	❖ Currently there is no fisheries management approach to measure localized depletion, and doing so infers a shift in the scale at which fisheries are managed to a smaller regional/local scale. ❖ Moderate localized depletion generally does not have a significant impact on total sustainable yield. o Example: Lobsters have a minimum size limit, which prevents localized depletion from causing significant impacts to lobster. In other words, effort shift can be mitigated by		❖ Department of Fish and Game is already aware of the risk of serial depletion for abalone ❖ Likely varies depending on fishing access and proximity to major human populations		❖ Likely depends on size of MPAs and diversity of habitats inside and outside MPAs (i.e., adult spillover)

Topic 1.1. What are the potential negative impacts to the fishery (e.g., resource availability, behavioral, economic)? Identify and discuss where and when one might expect this for each fishery. Is it captured by MPA or fisheries monitoring? What are the consequences to the fisheries?					
Identified Effects	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
	minimum size limits. ❖ MPAs may act as insurance against depletion of an area through fishing, but not natural disasters. For example, MPAs are more important for preserving larval sources/sinks and protecting from depletion outside of MPAs; whereas natural disasters would impact all areas indiscriminately. However, if larval sources and sinks are incorrectly identified in MPAs (and are indeed placed outside of these resource-rich areas), then they would not act as an insurance, in which case effects of localized depletion may be significant.				
Reduced participation	❖ The effect may not be permanent (latent effort may emerge later). ❖ The effects would likely matter most to individual anglers.				
Reduced catch (short/long term)	❖ Overall reduction in yield outside of MPAs does not appear to be of particular concern based on modeling studies.				

Topic 1.2. What are the potential contributions MPAs may have to the fishery? Considering topics that are useful to management strategies, identify these and note differences among fisheries. Is it captured by MPA or fisheries monitoring? What are the consequences to the fisheries?					
Identified Contributions	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
Spillover (larval output)	❖ True spillover is difficult to measure. The focus should be on simple metrics (e.g., density and size inside/outside of MPAs) for adult fish and invertebrate species.				❖ Due to the size and location of MPAs, spillover is unlikely to

Topic 1.2. What are the potential contributions MPAs may have to the fishery? Considering topics that are useful to management strategies, identify these and note differences among fisheries. Is it captured by MPA or fisheries monitoring? What are the consequences to the fisheries?					
Identified Contributions	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
	❖ Large fish may skew the results and not be representative of the fished populations. ❖ Effectively monitoring or measuring larval output would likely require understanding a number of factors, such as larval dispersal potential, oceanographic conditions, scale of MPAs, and identifying larval sinks/sources to name a few. It is therefore probably not practical and/or financially feasible.				be meaningful to fishery management. ❖ Very much depends on scale.
Increased biomass/size and catch	❖ This factor is likely to vary by species and the management effectiveness, including the scale to which fisheries are managed and the scale to which abundance is expected to increase. For example, if management measures were effective outside of MPAs, the contribution from MPAs to increased catch may not be detectable because of the temporal and spatial recruitment variability (unfished biomass is transitory in nature). o However, size may increase. It may not be noticeable in kelp beds, for example, because of ontogenetic shift patterns in which fish leave when they are big enough. o Alternatively, if management measures were not effective outside of MPAs, there may be noticeable effects. ❖ Rock scallops may benefit from MPAs since they are currently only managed by bag limits. This has potential for reducing risk of management mistakes because it relieves the DFG from developing specific management plans for this species.				
Reduced risk	❖ MPAs may act as a buffer to provide insurance for mistakes. Alternatively, they may increase the potential for mistakes. Either way, it should be possible to detect size differences. ❖ Large fish leaving the reserve may cause the fishery to appear more productive than it is, particularly if the amount of large fish leaving an MPA is unknown. ❖ MPAs may be used as an insurance factor for less than				

Topic 1.2. What are the potential contributions MPAs may have to the fishery? Considering topics that are useful to management strategies, identify these and note differences among fisheries. Is it captured by MPA or fisheries monitoring? What are the consequences to the fisheries?					
Identified Contributions	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
	precautionary approaches to management (e.g., Restrepo et al. 1998[1], Restrepo and Powers 1999[2]). ❖ MPAs may allow an accurate assessment of what an unfished population may look like.				

Topic 1.3. What are the biological/ecological responses (e.g., scale: regional, local, population dynamics)?					
Identified Responses	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
Density dependent ❖ Movement ❖ Competition ❖ Reproduction ❖ Larval recruitment and settlement	❖ Understanding movement patterns (e.g. immigration and emigration) of species is important for understanding density changes with in MPAs. Most of the movement studies have been on adults; therefore, monitoring movements over longer periods and broader cycles needs to be analyzed. ❖ The driving force is unfished density, not biomass. ❖ Natural mortality estimates should be improved by focusing on primarily sedentary species. (Accuracy is related to how much a species moves.) ❖ Information on population sources and sinks may be important. o Track a species through its entire life history (model beginning at larval stages). o However, expensive instruments to accomplish this (e.g., current meters)		❖ If abalone can be planted in an MPA as experimental control, must use only as control because of differential growth and recruitment between northern and southern California ❖ Density dependent reproduction is a factor as substantial recruitment is not expected in areas with low numbers of abalone.		❖ Shelters, how they respond to habitats in MPAs from a behavioral response ❖ Competition for habitat holes resulting in spillover

Topic 1.3. What are the biological/ecological responses (e.g., scale: regional, local, population dynamics)?					
Identified Responses	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
	are not available. Building a Regional Ocean Modeling System (ROMS) is very expensive. Perhaps partnerships that already use the ROMS model could be effective. ❖ MPAs could possibly be used as an experiment to investigate species interactions, compensatory responses, and/or to stock selected species within MPAs for focused monitoring assessments.				
Lifetime egg production	Measuring Lifetime Egg Production (LEP) <u>is not urgent</u>. ❖ The current model for LEP is an equilibrium model so one might as well wait until equilibrium (measure with equilibrium response). ❖ Measuring LEP is not a high priority relative to other metrics. Measuring changes in size, age, and movement may be the most important effects to measure, each of which should be monitored as soon as MPAs are adopted.				
Trophic interactions/structure	❖ Finding driving forces behind changes/impacts are important considerations but require more study before adjusting management. Studies should include behavioral response and predation impacts, including ratios of top tier predators.				

Topic 1.3. What are the biological/ecological responses (e.g., scale: regional, local, population dynamics)?					
Identified Responses	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
Age and size structure	❖ Change in size and age is important <u>but must be measured from the very beginning</u> (preferably before MPA is established). ❖ Early monitoring of changes in age/size structure/and mortality is important (concurrently captured via MPA monitoring plan). ❖ For some species, changes may not be seen for many years.				
Larval connectivity	❖ Characterize it as "population" sinks and sources. Identifying larval sources and sinks is a big question mark in estimating a network effect. It is an extremely difficult question to answer. ROMS models may help but may not really get at this question for some time. ❖ For larval connectivity, ascertain whether the right assumptions were made about MPA sites vs. sources and sinks (important for lobster).				

[1]Restrepo, V., G. Thompson, P. Mace, W. Gabriel, L. Low, A. MacCall, R. Methot, J. Powers, B. Taylor, P. Wade, and J. Witzig. 1998. Technical guidance on the use of precautionary approaches to implementing National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act. NOAA Technical Memorandum NMFS-F/SP0-31. 54 pp. Available from: http://www.nmfs.noaa.gov/sfa/NSGtkgd.pdf

[2]Restrepo, V., and J. Powers. 1999. Precautionary control rules in US fisheries management: specification and performance. ICES Journal of Marine Science 56:846-852. Available from: http://icesjms.oxfordjournals.org/content/56/6/846.full.pdf

Topic 1.4. What other system drivers should be considered (how and when)? How do these affect fisheries in terms of management strategies, and when should these be considered?					
Identified System Drivers	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
Ocean conditions ❖ Pacific Decadal Oscillation (PDO) ❖ El Nino/Southern Oscillation (ENSO) ❖ Upwelling index ❖ Sea Surface Temperature (SST)	❖ Larval output depends on oceanographic conditions. ❖ Record temperature using data from other researchers. ❖ Productivity can be highly dependent on temperature.				
Climate change and sea level rise	❖ MPAs may be used to account for climate change. ❖ These are longer-term impacts that would cause noticeable or measurable effects further down the road compared to measuring changes in size, age, and movement.				
Compliance	❖ More quantitative estimates of compliance and use are needed as a control when interpreting MPA monitoring data/results (e.g., size, density, and abundance). MPA monitoring results could be erroneous if compliance is not accounted for.				

Topic 1.5. What other EFI can MPAs provide that is beneficial to management, and what types of monitoring/research could be conducted to acquire this information?					
Identified EFI	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
Unfished density	❖ MPAs could be useful for measuring/estimating unfished density. ❖ Accounting for movement patterns of adults is important for understanding density changes.				
Mortality	❖ MPAs can be useful for estimating natural mortality but should be measured from the onset of MPA implementation.				

Session 2. Do our management strategies need to change in response to a network of marine protected areas (MPAs)? How should these strategies change?

Topic 2.1.A. What set of potential effects and/or characteristics (e.g., specific MPA effects, species life history characteristics, fishery characteristics) might be the most important for **fisheries in general**, what conditions might arise from these effects, and what scale of effects might be expected?

Topic 2.1.B. Given the conditions discussed on the previous topic, what management responses (in general terms) might be advisable, and what are the risks associated with taking or not taking management action?

Topic 2.2.A. What set of potential effects and/or characteristics (e.g., specific MPA effects, species life history characteristics, fishery characteristics) might be the most important for **cabezon**, what conditions might arise from these effects, and what scale of effects might be expected?

Topic 2.2.B. Given the conditions discussed on the previous topic, what management responses (in general terms) might be advisable, and what are the risks associated with taking or not taking management action?

Topic 2.3.A. What set of potential effects and/or characteristics (e.g., specific MPA effects, species life history characteristics, fishery characteristics) might be the most important for **California spiny lobster**, what conditions might arise from these effects, and what scale of effects might be expected?

Topic 2.3.B. Given the conditions discussed on the previous topic, what management responses (in general terms) might be advisable, and what are the risks associated with taking or not taking management action?

Topic 2.4.A. What set of potential effects and/or characteristics (e.g., specific MPA effects, species life history characteristics, fishery characteristics) might be the most important for **brown rockfish**, what conditions might arise from these effects, and what scale of effects might be expected?

Topic 2.4.B. Given the conditions discussed on the previous topic, what management responses (in general terms) might be advisable, and what are the risks associated with taking or not taking management action?

Note: Workshop participants during Session 2 were asked to focus on one specific species/fishery at a time and consider: 1) what conditions might arise given a set of MPA effects or characteristics (development of a potential scenario); and 2) what management actions might be advisable given that scenario. The following tables reflect this approach with the development of the scenario provided in Topic A and the potential management actions, given this scenario, provided in Topic B. Only three of the four focal species/fisheries were discussed. Some of the input provided during these different species/fishery discussions applied more to fisheries in general than to the focal species/fishery. This input was moved into a separate “general fisheries” table (Topic 2.1 A, B).

Topic 2.1.A. What set of potential effects and/or characteristics (e.g., specific MPAs, species life history characteristics, fishery characteristics) might be the most important for fisheries in general, what conditions might arise from these effects, and what scale of effects might be expected?	
Potential Conditions	**Discussion Points: General Fisheries**
What effects and/or characteristics are important?	❖ The response of a specific species or fishery to the implementation of the statewide MPA network, and the resulting conditions under which it will need to be managed, will depend on potential effects and/or characteristics. A number of potential effects were identified during Session 1, the most relevant of which are included here: o Effort shift/depletion o MPA design/configuration o Spillover/movement o Sequestering biomass o Stock stability o Compliance o Environmental conditions o Life history characteristics o Fishery characteristics
What conditions might arise from these effects and/or characteristics?	❖ Responses are unique and vary spatially and temporally; consequently, management needs to be adaptive. Understanding the response requires information beyond what is needed to determine whether MPAs are protecting/conserving ecosystems and habitat. ❖ MPAs may only demonstrate changes for certain fish/fisheries. They are unlikely to provide sufficient evidence for conclusions that apply to all fisheries outside of MPAs. o Focused evaluations should be considered for those fish species or fisheries that may be affected by MPAs. ❖ Mixed species stocks – MPAs have the potential to bring attention to issues surrounding the mixing weak stocks with healthy assemblages, a topic of currently neglect. o On the west coast of the United States, weak stocks are being lumped into healthy assemblages; on the east coast, weak stocks species are being taken out of fishery management plans and are not included in assemblages. o Composition inside and outside of MPAs (through surveys) may be illuminating on this front; they may provide a snapshot of assemblages, and reveal whether fisheries are changing the nature of these assemblages. ❖ Setting aside small parts of the ocean does not mean that we will see “natural” assemblages. o Even if MPAs do not represent a “natural” state, they represent a “more natural” state of less exploitation. o MPA size may constrain how much “natural” structure we will see. o Outside fishing activities can potentially impact assemblages inside of MPAs. o If MPA implementation is combined with increasing Total Allowable Catch (TAC), then confidence of seeing “natural” assemblages will not be high. ❖ Whether MPA network placement will increase larval production is unknown and depends on locations of larval sources

Topic 2.1.A. What set of potential effects and/or characteristics (e.g., specific MPAs, species life history characteristics, fishery characteristics) might be the most important for fisheries in general, what conditions might arise from these effects, and what scale of effects might be expected?	
Potential Conditions	**Discussion Points: General Fisheries**
	(areas with high larval dispersal) versus larval sinks (areas with high larval retention). This is worth studying for evaluating MPA siting effectiveness.
What scale of effects might occur?	❖ Are effects likely to occur on a regular basis throughout the MPA network or just occasionally in a particular locale? ❖ Are effects likely to impact the entire stock or substocks and/or populations? ❖ Are effects likely to impact community structure? ❖ Are effects likely to impact all of a fishery, a specific subset of the fishery, or just a few fishery participants? ❖ What is the temporal scale (e.g., short-term, long-term)? ❖ The scale of management response (regional vs. statewide) will most likely be constrained by resources (financial and otherwise).

Topic 2.1.B. Given the conditions discussed in the previous table, what management responses (in general terms) might be advisable and what are the risks associated with taking or not taking management action?	
Potential Actions	**Discussion Points: General Fisheries**
What possible management actions might be considered?	❖ How do we interpret the effects of fishing - by looking at what we see inside a state marine reserve? Will it inform how effective management is outside of the MPAs? ❖ To what extent do bigger fish coming out of MPAs matter to fisheries? Is the amount of spillover enough to matter to fisheries? ❖ Are MPAs a sufficient alternative to precautionary management measures to merit reconsidering the need for those measures? o Many factors need to be considered before MPAs can be considered a replacement for the precautionary model (e.g., larval and adult movement and inherent differences between areas inside and outside of MPAs). o Will sufficient biomass be sequestered in MPAs to sufficiently lead to stock stability/resilience? ❖ What data would merit an increased TAC? Use caution in changing management based on the supposition that MPAs will have a positive effect on populations. Wait for evidence. o Perhaps, we can ONLY talk about changing the aspects that are built-in precautions. We need to distinguish what part of management is precautionary and what is fundamental. ❖ Multiple changes at once will not inform us on what is working (e.g., evaluating the effects of MPAs concurrently with a new increased TAC would complicate the comparison between, inside, and outside of MPAs)

Topic 2.1.B. Given the conditions discussed in the previous table, what management responses (in general terms) might be advisable and what are the risks associated with taking or not taking management action?	
Potential Actions	**Discussion Points: General Fisheries**
	❖ Drop the bottom threshold (e.g., to less than 10% of spawning biomass prior to fishing [B_0]). Under the federal Harvest Control Rule (HCR) of 40/10 for Pacific coast groundfish, rebuilding goes into effect at 25% of initial biomass. For targeted fishing to occur, groundfish need to be kept above 10% of B_0. We need to follow the precept of federal law, which requires biomass targets and thresholds. This will require some phase planning. ❖ Examine the potential for integrating MPAs into new stock assessment methods. ❖ We may need to redefine level of what is "sustainable fishing" outside of MPAs given that MPAs sequester unfished populations.
What are the potential risks with taking or not taking management actions? ❖ Stock ❖ Fishery ❖ Ecosystem conservation	❖ Clarify what information is needed for management actions. o The effects of MPAs will likely not be identified until some time has passed; we cannot afford (biologically) to wait until monitoring data are sufficient. We should consider whether to use modeling approaches initially in lieu of long-term data sets and whether resulting information will be sufficient to justify changing current management. ❖ The degree to which MPAs can replace other sources of precaution depends on movement and connectivity. o The protected substock in MPAs may not be the same as in fished areas; if it is not, then differences in fishing mortality in these areas could lead to reduced genetic diversity. ❖ Consider making the assumption that MPAs buffer against fishery management failures/uncertainties and, consequently, that the MPAs provide a means of built-in precaution due to sequestering part of the stock. This precaution can increase the risk tolerance (less risk to stock). o A lower harvest buffer could be considered. (e.g., set ABC/OY=MSY or, under more recent reference point terminology, allow ABC to be buffered down to 85% of OFL instead of 80%, or allow fishing at FMSY; where ABC=Acceptable Biological Catch, OY=Optimum Yield, MSY=Maximum Sustainable Yield, and OFL= Overfishing Limit) o Risk associated with dropping the bottom of the federal 40/10 HCR to less than 10% or even to zero is low; the trade-off is high social gain. ❖ The managers' risk tolerance will be affected by the suite of management measures that are in place (less risk if traditional management measures also in place). ❖ The jury is out on risk of increasing harvest outside (to FMSY); it depends on the manager's confidence in the FMSY estimate. o Fishing at levels higher than FMSY: Sustainable fishing is possible, but concurrent lower level production of FMSY catch will result. A precedent for fishing at higher than FMSY exists. (FMSY=Fishing mortality rate, which if applied constantly, would result in MSY.) o A higher risk is associated with our current policy of using a proxy for FMSY based on spawning potential ratio (SPR). Possibly we can use data from inside of MPAs to calculate a more reliable SPR. (This applies to less productive species). In time, the SPR will increase. ❖ Counting on MPAs as a precautionary measure is not risky; fishing at FMSY is not a big deal. There is risk in getting an

Topic 2.1.B. Given the conditions discussed in the previous table, what management responses (in general terms) might be advisable and what are the risks associated with taking or not taking management action?	
Potential Actions	**Discussion Points: General Fisheries**
	assessment wrong and consequently implementing wrong management actions. ❖ The Pacific coast groundfish disaster occurred because fishing was at $f_{35\%}$ (approximately FMSY), so the stocks became depleted. o Fishing above or below FMSY in terms of catch is not much for species that are not very productive, like rockfish. It is easier to make small errors in calculation, which trickle down into large errors because of the small catch of rockfish to begin with. o Low turnover: A frequent misconception is that rockfish would have a high yield, but this does not manifest due to low turnover. ❖ Having a network structure distributes risk and opportunity, which can prevent localized depletion. Initial evidence due to shifting effort may be apparent, but be cautious not to act on that because trends will settle out over time.

Topic 2.2.A. What set of potential effects and/or characteristics (e.g., specific marine protected area effects, species life history characteristics, fishery characteristics) might be the most important for cabezon, what conditions might arise from these effects, and what scale of effects might be expected?	
Potential Conditions	**Discussion Points: Cabezon**
What effects and/or characteristics are important?	❖ Effort shift/depletion ❖ Spillover/movement ❖ Life history characteristics
What conditions might arise from these effects and/or characteristics?	❖ Stock has been assessed. ❖ Commercial fishery— year-round fishery; functional slot-limit (in addition to minimum size limits, live finfish markets prefer "platter-sized" fish so larger fish are typically not taken). Because females grow larger, this may result in mostly males being taken, possibly impacting stock assessments. ❖ Recreational fishery—all sizes above minimum size limit are taken. ❖ Discarded fish have high survivability. The fishery has little impact on sub-adults, but the number of sub-adults is important in terms of replenishment to the fishery. o Do MPAs increase the number of sub-adults? ❖ The fishery operates under a variable TAC; TAC was recently increased substantially because of updated stock assessment indicating a healthy stock; therefore, displacement (i.e., effort shift) is not a significant biological concern but possibly a social issue.

Topic 2.2.A. What set of potential effects and/or characteristics (e.g., specific marine protected area effects, species life history characteristics, fishery characteristics) might be the most important for cabezon, what conditions might arise from these effects, and what scale of effects might be expected?	
Potential Conditions	**Discussion Points: Cabezon**
	❖ Tagging studies suggest high site fidelity with potential sojourns. ❖ Anecdotal information indicates that larger individuals are in deeper water. o MPAs may not make a difference in available sizes of cabezon. ❖ Nesting occurs during the winter. ❖ There is uncertainty regarding nest-guarding sites relative to MPA placement. Nest-guarding patchiness may be a factor if key nesting sites are mainly outside of MPAs; ❖ Recreational fishing is closed for two winter months of the nesting period (January-February), but commercial is not. ❖ Is there enough hard substrate within MPAs (e.g., North-Central Coast) to say that this species is protected? ❖ Effort shift is not a driver for changing current fishery management. ❖ More information is need on movement (juveniles, sub-adults, adults) and distribution of large female breeders and nest guarding males respective to MPA locations. ❖ Sequestering biomass may be beneficial if nesting is also protected.
What scale of effects might occur?	❖ Substocks or evolution of sub-stocks must be considered as a result of MPAs (inside vs. outside of MPAs). ❖ Consideration of MPA placement relative to key ecological conditions: o Are nesting areas captured? If nesting areas are outside of MPAs, this may affect a local stock heavily. If nesting areas are patchy, there are likely to be at least some protected by MPAs, especially for males of desirable size. o Are pathways provided to connect ontogenetic movements? How do movement of juveniles from tidepools and dispersal of sub-adults relate to MPA placement and boundaries? o What is the larval dispersal in regard to larval sources and sinks?

Topic 2.2.B. Given the conditions discussed in the previous table, what management responses (in general terms) might be advisable and what are the risks associated with taking or not taking management action?	
Potential Actions	**Discussion Points: Cabezon**
What possible management actions might be considered?	❖ No management response is advised; hold the status quo until we can observe what the MPAs are actually doing to the system. There are inherent risks in taking two actions at once (i.e., implementing MPAs and changing management measures or TAC simultaneously would confound our ability to understand the role of each action). o However, how much information/observation would be considered “sufficient” to act? We cannot afford to wait until all answers are crystal-clear. o Modeling may be an approach to address this until long-term data are available.

Topic 2.2.B. Given the conditions discussed in the previous table, what management responses (in general terms) might be advisable and what are the risks associated with taking or not taking management action?	
Potential Actions	**Discussion Points: Cabezon**
	❖ Consider a commercial closure in winter to protect nest guarding. ❖ Select measures that are in place for precaution of conservation (but not fundamental management measures) can be reduced. Alternatively, conservation measures that can be considered replaced by MPAs can also be changed. (e.g., consider MPA area closures as replacement to seasonal closures) ❖ We can lower the bottom threshold of the nearshore fishery management plan HCR 60/20 down to 60/10. ❖ Dropping the lower end may gain a lot of credibility without a big change in harvest. (If the bottom threshold were moved from 20 to 10, then the present TAC likely would not change by maybe more than 5 tons. Though the harvest change might be insignificant, this could create a major positive shift in perception.)
What are the potential risks with taking or not taking management actions? ❖ Stock ❖ Fishery ❖ Ecosystem conservation	❖ "Risks associated with no management response" are mostly social in nature. Examine trade-offs by modeling changes (for more immediate responses to change fishery management) versus holding the status quo for 20-30 yrs to see actual MPA effects.

Topic 2.3.A. What set of potential effects and/or characteristics (e.g., specific marine protected area effects, species life history characteristics, fishery characteristics) might be the most important for California spiny lobster, what conditions might arise from these effects, and what scale of effects might be expected?	
Potential Conditions	**Discussion Points: Lobster**
What effects and/or characteristics are important?	❖ Effort shift/depletion ❖ MPA design/configuration ❖ Spillover/movement ❖ Environmental conditions
What conditions might arise from these effects and/or characteristics?	❖ Development of a fishery management plan is under consideration and a stock assessment is in progress. Current model results indicate that the stock is close to MSY. ❖ The fishery is almost fully capitalized. ❖ Concerning MPA design, the quality/diversity of habitat influences whether or not lobster forage outside of MPAs or move

Topic 2.3.A. What set of potential effects and/or characteristics (e.g., specific marine protected area effects, species life history characteristics, fishery characteristics) might be the most important for California spiny lobster, what conditions might arise from these effects, and what scale of effects might be expected?	
Potential Conditions	**Discussion Points: Lobster**
	from MPAs. “Hard bottom habitat” is a broad characterization that does not work for lobster. This habitat classification needs to be refined. ❖ Size-frequency will change but will not have a big effect on the fishery due to commercial size preferences. ❖ This species shows high sensitivity to environmental conditions (ocean temperature changes). o How does recruitment change with environmental conditions? ❖ Recruitment increases from MPAs are not expected with this species due to larval duration and steady supply of recruits. o The proportion of larvae coming from California vs. Mexico is unknown; stocks are much larger in Mexico, and they are generally well managed. ❖ Could there be a negative effect to MPAs? Lobsters aggregate and have behavioral changes to disturbance, so fishing the line will drive lobsters into the MPA. ❖ Do southern California MPAs include enough habitat to make a difference for this stock? o Close to 30% of catch is taken from just the Point Loma-La Jolla area (block 860). ❖ Compliance here is a factor for the commercial fishery because of trap gear and potential movement into the MPA and resulting violations. o Risk to maintaining a permit leads to commercial fishery participants NOT fishing the line (e.g., Channel Islands). o Assume poaching is a constant. ❖ Effort shift is expected. ❖ Information is needed regarding habitat distribution/diversity inside and outside of MPAs and lobster use/movement within this habitat. ❖ Any effect of movement/spillover is likely minimal to the overall fishery. ❖ Any evaluation of lobster in MPAs will need to take into account changes in environment (e.g., temperature).
What scale of effects might occur?	❖ Localized trophic shifts may be observed due to effects on community structure. Behavioral aspects would change on a local scale. o MPAs are producing larger lobster, but other ecological changes in community structure (e.g. changes in kelp, urchins) are not evident. o These ecological effects (e.g., those above; predatory effects) may not change for long time and require more investigation. o Changes in behavioral aspects may be more important in short-term effects. o See Kevin Hovel’s work on bight-wide assessment (student research). ❖ This stock is highly productive. The current management system (i.e., no TAC) works because of the consistent supply of recruits. Therefore, stock-level changes in recruitment are not expected from MPAs. ❖ Open areas may see reduced catch-per-unit-effort (CPUE) that is not related to stock size reduction but because of

Topic 2.3.A. What set of potential effects and/or characteristics (e.g., specific marine protected area effects, species life history characteristics, fishery characteristics) might be the most important for California spiny lobster, what conditions might arise from these effects, and what scale of effects might be expected?	
Potential Conditions	**Discussion Points: Lobster**
	movement into MPAs (i.e., will lobsters moving from MPA edges into MPAs reduce fishing opportunities, as observed in closed waterfowl zones?). Will this be compounded by compaction issues? ❖ Discrete areas could see an effect in CPUE due to behavioral changes in the short-term, but likely would not be a population-scale effect. In the long-term, this would be countered by density-dependent movement out due to MPA saturation. ❖ Could movements be related to temperature?

Topic 2.3.B. Given the conditions discussed in the previous table, what management responses (in general terms) might be advisable and what are the risks associated with taking or not taking management action?	
Potential Actions	**Discussion Points: Lobster**
What possible management actions might be considered?	❖ No management response is suggested. o Do not change management in response to social experiences in the short-term due to lobster behavior changes (initially). Track the changes for initial years. ❖ Given that a lot of recruitment comes from Mexico (where much area is under reserve), we need to manage for catch rates – not for fishery sustainability. Edge effect is a minor factor for this stock. ❖ Fishery participants want compensation for the effect of sequestering biomass. ❖ Marine Stewardship Council (MSE) Certification: The lobster fishery would get credit for MPAs (in consideration for fishery sustainability). Will science support this MPA credit? ❖ Create structure outside the MPA to provide safe harbor for density-dependent movement out (in the future) and to 'earn" fishery participant compliance. ❖ Consider similarities to the Dungeness crab fishery (trap limits, etc). ❖ Turfs (i.e., user right incentives): o Experiment by University of California Santa Barbara academics in Channel Islands assigning user turfs next to MPAs. The concept is to provide incentive to comply with no fishing in MPAs. o Turfs are not practical from management perspective.

Topic 2.4.A. What set of potential effects and/or characteristics (e.g., specific marine protected area effects, species life history characteristics, fishery characteristics) might be the most important for brown rockfish, what conditions might arise from these effects, and what scale of effects might be expected?	
Potential Conditions	**Discussion Points: Brown Rockfish**
What effects and/or characteristics are important?	❖ MPA design/configuration ❖ Sequestering biomass
What conditions might arise from these effects and/or characteristics?	❖ Brown rockfish is a member of the federal nearshore rockfish complex south of 40° 10. ❖ Complex managed using Restrepo-type control rules (e.g., Restrepo et al. 1998[1], Restrepo and Powers 1999[2]) and an acceptable catch limit (ACL) ❖ Harvest levels for this complex were increased for 2011-2012. ❖ Commercial fishing for nearshore rockfish is covered under a restricted access program. Commercial fishing for brown rockfish requires a Deeper Nearshore Fishing Permit. The number of these permits is capped, and they are non-transferable. ❖ Are MPAs sufficiently large to capture the whole range of the population? o Distribution of low relief rock inside/outside MPAs will affect movement. o Large ontogenetic movement (high settlement in bays/estuaries) occurs, so contiguous bay/inshore/offshore configuration will be a factor. o MPAs will protect sedentary species at a higher level than other species with high movement (consider species movement). ❖ Sequestering biomass is a possibility, but presently there is not enough existing evidence to support that it will happen. ❖ Currently there is no size limit. Many are caught in San Francisco Bay. ❖ More information is needed on movement of juveniles, sub-adults, and adults to help evaluate MPA design/configuration and potential biomass sequestering.
What scale of effects might occur?	❖ Conservation benefit at stock scale: o This is a species with less information than other stocks, so there may be a conservation benefit in demonstrating MPA effects on this fishery. o There is less risk of overfishing within the nearshore rockfish complex despite lack of data. ❖ Are pathways provided to connect ontogenetic movements? How do movement of juveniles from tidepools or estuaries and dispersal of sub-adults relate to MPA placement and boundaries?

[1]Restrepo, V., G. Thompson, P. Mace, W. Gabriel, L. Low, A. MacCall, R. Methot, J. Powers, B. Taylor, P. Wade, and J. Witzig. 1998. Technical guidance on the use of precautionary approaches to implementing National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act. NOAA Technical Memorandum NMFS-F/SP0-31. 54 pp. Available from: http://www.nmfs.noaa.gov/sfa/NSGtkgd.pdf

[2]Restrepo, V., and J. Powers. 1999. Precautionary control rules in US fisheries management: specification and performance. ICES Journal of Marine Science 56:846-852. Available from: http://icesjms.oxfordjournals.org/content/56/6/846.full.pdf

Topic 2.4.B. Given the conditions discussed in the previous table, what management responses (in general terms) might be advisable and what are the risks associated with taking or not taking management action?	
Potential Actions	**Discussion Points: Brown Rockfish**
What possible management actions might be considered?	❖ No specific management response is suggested. Modification of Rockfish Conservation Areas or expanded seasons as a result of sequestered rockfish would not be appropriate. ❖ Consider whether any select conservation measures can be considered replaced by MPAs. ❖ Consider relaxing existing depth restrictions, which are primarily in place for species of concern. ❖ TACs are increasing, so more fish will be available for fishery participants. ❖ Since the species is managed under federal groundfish FMP, the HCR threshold is 40/10; a drop below 10 is constrained by federal precept.
What are the potential risks with taking or not taking management actions? ❖ Stock ❖ Fishery ❖ Ecosystem conservation	❖ Over-harvest of sensitive species within the assemblage may be a concern. MPAs will protect uniformly, so there will be less potential for over-harvest of sensitive species.

Session 3. Can we incorporate the presence of a network of marine protected areas (MPAs) into stock evaluation, designation of harvest control rules, and other processes related to defining fishery yields? When should we do so?

Topic 3.1. How do MPAs affect the way stock assessments are developed for both assessed and unassessed stocks? Consider risk. Do MPAs alter stock productivity?

Topic 3.2. Under what conditions should harvest control rules/strategies change and what kind of data are needed to implement control rules? Do MPAs alter the risk of overfishing, or a stock becoming overfished?

Topic 3.3. How does the network of MPAs affect local populations, and what does that mean for management?

Topic 3.1. How do MPAs affect the way stock assessments are developed for both assessed and unassessed stocks? Consider risk. Do MPAs alter stock productivity?

Stock Assessments	General Discussion	Cabezon	Red Abalone	Brown Rockfish	California Spiny Lobster
Data Rich Scenario:					
Biomass ❖ Area models ❖ Data ❖ Parameters	Two-Area Model ❖ If an MPA is significantly affecting a species, then the MPA should be taken into consideration. The two-area model might help to inform the assessment on the effects of MPAs on biomass, but size or age data provides more useful information. If assessments are marginal then it probably will be less precise for the portion of the stock within an MPA. ❖ For current nearshore assessments, is it critical to consider the differences between biomass inside versus outside of MPAs? o Catch Per Unit Effort (CPUE): Currently used in assessments will	❖ Recommend two-area model o Need information from closed areas to prevent biased results o Need sex stratified ages for accurate mortality estimates (currently not enough data for most stocks)			

Topic 3.1. How do MPAs affect the way stock assessments are developed for both assessed and unassessed stocks? Consider risk. Do MPAs alter stock productivity?					
Stock Assessments	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
	not reflect abundance in the whole area – it will only reflect abundance in fished areas. Option: To reduce bias, use fishery-dependent CPUE and survey data in only the fished areas if a two-area model is used. o A two-area model is potentially biased because of: 1) species movement and ontogenic movement effects; 2) some surveys conducted primarily in MPAs; and 3) lethal sampling not allowed in some MPAs. Single-Area Model ❖ Exclude MPA data until there are better tools to measure MPA effects. This could take a very long time (10 to 20 years). o Historical catch in the MPAs is needed (information not presently available). ❖ Perhaps MPA fish should not be considered part of the assessment, as they are sometimes considered a "different stock." ❖ Federal surveys do not take into consideration Rockfish Conservation Areas; similarly model MPAs (i.e., no change in assessments). ❖ Current tools to measure two-area models are not always highly accurate. It is most likely that traditional methods for assessment				

Topic 3.1. How do MPAs affect the way stock assessments are developed for both assessed and unassessed stocks? Consider risk. Do MPAs alter stock productivity?					
Stock Assessments	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
	will perpetuate until an alternative is introduced that proves that MPAs have a significant effect. However, in order to prove this, historical catch data is required. ❖ Be wary of assuming depletion due to initial effort displacement (so no management changes should be made initially). o Depletion outside of MPAs may be an effect of migration. This could be a scaled effect, and may result in a reduction of CPUE.				
Do MPAs represent additional sources of uncertainty that could be included in decision tables?	❖ Trying to break the data down into pieces would be extremely complex. ❖ Could management just be adjusted? Decision tables are not being used right now, but are not beyond the realm of possibility.				
Data Moderate and Data Poor Scenario:					
Density ratios: Do density ratios work for one type of stock and not another?	❖ Recruitment level in the MPA will not reflect that of an unfished population. However, population structure in the MPA could represent an unfished population. ❖ The density method predicts a drop in CPUE due to effort shifts. This has not been seen on the central California coast. This would indicate that shifts in fishing effort have not		❖ We currently have eight index sites for which we calculate density annually, and they are all outside of MPAs. This raises two questions: 1) Do we continue with these sites in the fished areas and presume that MPA benefits will show up in future recruitments, or 2) begin to collect density		

Topic 3.1. How do MPAs affect the way stock assessments are developed for both assessed and unassessed stocks? Consider risk. Do MPAs alter stock productivity?					
Stock Assessments	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
What type, quality, and quantity of data are needed?	affected populations. Trap fisheries tend to be clean, which is an advantage. Bycatch compounds problems and complexity. It is more expensive to manage on a finer scale; that is why a season was used. Critical questions: What kind of geographic scale? Can you aggregate across all the MPAs? Answers will depend on the species. Radar monitoring of recreational vessels could provide some information on effort, but it only assesses the boats and their movement, not what they are doing. ❖ Ratio is affected by level of effort, so the ratios in and out of MPAs are not equivalent. ❖ MPA Monitoring – what data are needed? o MPAs represent the baseline. We need data that will signal shifts in the baseline. This requires monitoring to begin "at time zero" to order to standardize inside versus outside of MPAs to a common metric. o Standardize for differences in potential productivity, but consider that changes in productivity may change inside versus outside of MPAs. o Ignoring standardization reflects		estimates in MPAs (where it is possible to get density ratios)? ❖ Recruitment is not consistent. Good recruitment is once every 5-7 years or longer. ❖ Creation of new index sites within MPAs is advised. Just get size comps inside and outside. A fixed size limit makes it easier to work with the size comps. o Jeremy Prince was arguing this for San Miguel; wanted to explore alternatives in how to use the size comps. o Index sites within and outside of MPAs will help show the exploitation rate. ❖ Aggregation considerations – need an average aggregation size of four animals (or more) to increase the probability that each aggregation has at least one male and one female. The probability of at least one of each sex in each aggregation declines dramatically below 2000 animals/hectare = minimum viable population density (equates to average aggregation size of four animals). If the average aggregation size is less than		

Topic 3.1. How do MPAs affect the way stock assessments are developed for both assessed and unassessed stocks? Consider risk. Do MPAs alter stock productivity?					
Stock Assessments	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
	poorly on the management/science of MPAs. o If the present control rule is based on achieving a sustainable level of take, then climate change will be the most useful as a measure of what we are facing. That is, MPAs will be best used to measure what climate is doing to the stock, so that the management targets could be adjusted accordingly.		four animals, then there is the concern that each sex will not be present. Then the decline in reproductive output is compounded. This is also consistent with our experience in the south coast; when densities dropped below 2000/hectare those populations did not recover. ❖ Surveying inside the MPAs: one could pick up an environmental effect and then adjust the fished areas. ❖ Density estimates and size frequencies can be used as a means for adjusting the proscribed reduction on total catch when density thresholds are reached, or, raising the floor for minimum densities in the management areas.		
Others: Do MPAs create potential bias or require adjustment in other kinds of data-poor (or moderate) assessment approaches? Examples?	❖ The underlying reason for changes in abundance is important to know. By comparing changes in abundance inside MPAs versus outside, it shows what can be attributed to fishing (outside) versus environmental conditions (inside). ❖ It's unlikely that MPAs are going to give an estimate for all species. All data should be collected now for				

Topic 3.1. How do MPAs affect the way stock assessments are developed for both assessed and unassessed stocks? Consider risk. Do MPAs alter stock productivity?					
Stock Assessments	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
	species of interest, then later determining what data and species needs to be continued.				

Topic 3.2. Under what conditions should harvest control rules/strategies change, and what kind of data are needed to implement control rules? Do MPAs alter the risk of overfishing, or a stock becoming overfished?					
Harvest Control Rules	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
When setting harvest catch targets and limits, should the biomass inside of an MPA be treated differently for the Optimum Yield (OY) or Annual Catch Limit (ACL)?	❖ The present nearshore control rule (i.e., 60/20) is based on sound concepts. ❖ Continue to use data-poor management systems when abundance is unknown. Numbers are unlikely to be recalculated unless you discover your catch history has changed. ❖ Apply the Restrepo method (Restrepo et al. 1998[1], Restrepo and Powers 1999[2]) the way it was originally intended — make an expert judgment on the status of resources, which translates into varying degrees of downward adjustment from historical catches, depending upon perceived stock status. Very rarely has		❖ Abalone may have effort shifts because we need to curtail some of the fishing at Ft. Ross where density levels are falling. MPAs will make serial depletion more likely to occur because effort becomes forced into other areas. Fishermen are headed for the closest (and safest) point of entry, putting too much pressure on that area. Think of abalone effort as effort/hectare. Then effort will be managed in very small areas. How would rotating beaches work? They would need to be closed 5-7 years.		

Topic 3.2. Under what conditions should harvest control rules/strategies change, and what kind of data are needed to implement control rules? Do MPAs alter the risk of overfishing, or a stock becoming overfished?					
Harvest Control Rules	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
	it been used in that manner. This exercise is separate from MPAs. With MPAs, that may affect views on where the status of the resource is relative to the target. ❖ Changes in total mortality could be evaluated. o There are no catch curve analyses conducted on a regular basis, but a change in mortality would be a useful response variable. However, total mortality for stocks would be lower because of reduced probability of being caught due to the restrictive nature of MPAs. ❖ Increasing the catches could be expected in the outside areas due to effort shift; no obvious correction is needed.				
Assessed stocks: Should the control rules change because of MPA interactions. If so, how?	❖ There is reason to consider adjusting the 60/20 harvest control rule (HCR) to 60/10 now that we have MPAs. It is a management model based on something that can not be measured. The public is interested in less				❖ In upcoming FMP, set contingency plan to end season if catch falls below certain level (or shorten season to one month). ❖ Stock assessment results expected in a

Topic 3.2. Under what conditions should harvest control rules/strategies change, and what kind of data are needed to implement control rules? Do MPAs alter the risk of overfishing, or a stock becoming overfished?					
Harvest Control Rules	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
Do the Nearshore Fishery Management Plan or Groundfish Fishery Management Plan control rules need to be modified?	stringent HCRs. There should be more concern about a misestimated biomass. ❖ As stocks become assessed, they tend to be healthy or not overfished. ❖ Fishing at a rate greater than MSY is generally not a significant issue. o When we created the 60/20 HCR, part of the rationale was that we did not expect that the network of MPAs would sequester more than 20% of the biomass of the nearshore finfishes. When a stock is within the precautionary zone (< B40%; >B25%) (B% of spawning biomass prior to fishing); we would still not exceed the MSY rate in the open area due to the precautionary nature of the 60/20 HCR. o When this was created, was it viewed as transitional? If we sequestered more than 20% of the biomass, then we should revisit the HCR. ❖ The production curve assumes that a population is at B40%.				month or two (May); then will launch into FMP process covering all this ground again

Topic 3.2. Under what conditions should harvest control rules/strategies change, and what kind of data are needed to implement control rules? Do MPAs alter the risk of overfishing, or a stock becoming overfished?					
Harvest Control Rules	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
	o If the assumption is correct, then the federal 40/10 HCR for west coast groundfish equilibrates at B40 below that level catch is being reduced faster than the population is falling. o If the assumption is incorrect, then the graph becomes an upside down "U". That system goes to a good place almost anywhere the curve goes. However, populations do not behave based on those deterministic rules.				
Unassessed stocks / precautionary management: For a data poor stock managed using the Restrepo-type approach (fraction of previous landings to set OY) or the Depletion Corrected Average Catch (DCAC) approach, is it advisable to modify the way catch limits are set? (Risk management decision to take 50% of historic catch; do MPAs alter perception of that risk?)	❖ A logic argument, but not quantitative argument, can be made with Restrepo-type management versus MPAs. ❖ Essentially an effort adjustment is made by not adjusting the OY or ACL downward for MPAs. ❖ Density ratio is a good way to ensure consistency in abundance over time and avoid collapse, but it does not help in finding the optimal yield. Because density is so important to stakeholders, standardizing the measurements inside				

Topic 3.2. Under what conditions should harvest control rules/strategies change, and what kind of data are needed to implement control rules? Do MPAs alter the risk of overfishing, or a stock becoming overfished?					
Harvest Control Rules	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
	and outside of MPAs is necessary.				
Regulation restrictions: Is there reason to modify an unassessed fishery that does not set harvest limits but for example manages on season, size, restricted access, sex?					❖ Currently there are no limits on effort and total catch. Is there a reason to modify any current regulations due to MPAs? o To the extent that Mexico is subsidizing recruitment (i.e., larval immigration), decreasing the minimum size limit might be considered. This change may have potential for recreational effort to increase, but we do not know the level of recruitment being supplied. o Control effort in terms of season and traps (i.e., gear type). Possible scenarios include a recruitment decline due to a cold-water regime and becoming critical if combined with increased

Topic 3.2. Under what conditions should harvest control rules/strategies change, and what kind of data are needed to implement control rules? Do MPAs alter the risk of overfishing, or a stock becoming overfished?					
Harvest Control Rules	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
					recreational fishing. ❖ Assuming current regulations are correct (e.g., minimum size limit), there is some logic to reducing the minimum size because of an MPA if it is in place for growth fishing purposes. If lobster are not recruitment-limited, then one could argue for limiting minimum size. ❖ Consider Puerulus collectors such as those used in Australia.

[1]Restrepo, V., G. Thompson, P. Mace, W. Gabriel, L. Low, A. MacCall, R. Methot, J. Powers, B. Taylor, P. Wade, and J. Witzig. 1998. Technical guidance on the use of precautionary approaches to implementing National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act. NOAA Technical Memorandum NMFS-F/SP0-31. 54 pp. Available from: http://www.nmfs.noaa.gov/sfa/NSGtkgd.pdf

[2]Restrepo, V., and J. Powers. 1999. Precautionary control rules in US fisheries management: specification and performance. ICES Journal of Marine Science 56:846-852. Available from: http://icesjms.oxfordjournals.org/content/56/6/846.full.pdf

Topic 3.3. How does the network of MPAs affect local populations, and what does that mean for management?					
Regional Approach	**General Discussion**	**Cabezon**	**Red Abalone**	**Brown Rockfish**	**California Spiny Lobster**
Incorporating a regional approach into stock evaluations: Does the network of MPAs affect local populations or fishing behavior? What does that mean for management? Does fishing effort need to be controlled to account for edge effects?	❖ Carey's method (McGilliard et al. 2011[3]) provides more opportunity for fine-tuning regional management. ❖ There are some nearshore fishery permits by region. That is a management improvement, but management cost must also be considered to be realistic. ❖ MPAs provide the opportunity to study regional effects, but resources should be dispersed appropriately between regional versus statewide issues. Currently, financial resources are not available to conduct regional assessments neither recreationally nor commercially. ❖ Model suggestion: Use "no exchange" as one model. It can be profiled over the exchange rate/spillover rate as a way to characterize MPA effectiveness. Effort Shifts ❖ Serial depletion could happen with or without MPAs. (Serial depletion and MPAs are independent factors.) ❖ MPAs exacerbate the risk of serial depletion because they reduce the available area where effort shifts occur. From		❖ In the case of abalone, it would be problematic to reduce the bag limit because fishery participants from outside areas would be disproportionately affected; it would be allocative. ❖ In Washington, management measures result in the frequent opening and closing of beaches. How would this work for abalone? Given the life cycle of abalone, we may have to do closure cycles of extended periods. (The commercial urchin fishery had rotations of 5-7 years.)		

Topic 3.3. How does the network of MPAs affect local populations, and what does that mean for management?					
	a management standpoint, MPAs create additional complexity to potential causes of serial depletion. ❖ Estimates and geographic distribution of effort change over time. Increased effort in different locations can occur, while for the overall fishery, effort remains relatively constant (i.e., focal points change). ❖ Shorter closures help to show/track effort shifts. Outstanding Questions ❖ Do we have to incorporate MPAs in the assessment, or can we allow for management uncertainty? ❖ Could it be taken into consideration in the probability of overfishing discussion?				

[3]McGilliard, C., R. Hilborn, A. MacCall, A. Punt, and J. Field. 2011. Can information from Marine Protected Areas be used to inform control rule-based management of small-scale, data-poor stocks? ICES Journal of Marine Sciencies 68:201-211.

Marine Protected Areas and Fisheries Integration Workshop

Intersection between the Marine Life Management Act and Marine Life Protection Act

March 29-30, 2011 • San Diego

Steve Wertz
Marine Region
California Department of Fish and Game

Overview

- Management Challenges
- Marine Life Management Act (MLMA)
- Marine Life Protection Act (MLPA)
- Intersection between the MLMA and MLPA

Marine Region and Management Challenges

"To protect, maintain, enhance, and restore California's marine ecosystems for their ecological values and their use and enjoyment by the public."

Management Challenges

- New technologies and demands which have encouraged expansion of fishing activities and capacity
- Coastal development
- Water pollution
- Other human activities that threaten the health of marine habitats and biodiversity

Resulting Legislation

- Marine Life Management Act
- Marine Life Protection Act

Overview of MLMA

- Signed into California state law in 1998
- Broadened fisheries management to include ecosystem considerations
- Established policy guidelines for a marine fishery conservation program in order to:
  - Achieve sustainable uses of fisheries
  - Ensure conservation
  - Promote habitat protection
  - Prevent overfishing
  - Develop information for management decisions
  - Produce fishery management plans

Overview of MLPA

- Signed into California State law in 1999
- Mandates an improved system of marine protected areas (MPAs) that function as a cohesive network
- Encompasses ecosystem-based goals that are not limited to underlying fishery management goals within the MLMA
- Requires:
  - Master plan for MPAs
  - Use of "best readily available science"
  - Adaptive management
  - Cyclic review and report on the networks efficacy in meeting designated goals and objectives

4

Marine Life Protection Act Goals

1. To protect the natural diversity and function of **marine ecosystems**.
2. To help sustain and restore **marine life populations, including those of economic value or need rebuilding**.
3. To improve **recreational, educational, and study opportunities** in areas with minimal human disturbance.
4. To protect representative and unique **marine life habitats**.
5. Clear objectives, **effective management**, adequate enforcement, and sound science for all MPAs.
6. To ensure that MPAs are designed and managed as **a network**.

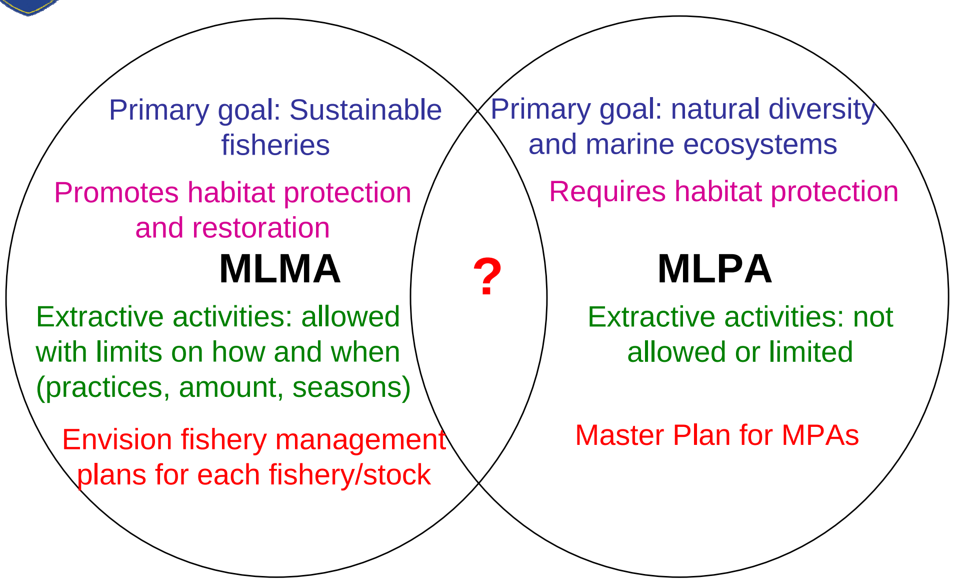
** Note that this language paraphrases the MLPA goals*

MPA Designations

- To achieve the overarching goal to protect natural diversity and marine ecosystems, the MLPA recognizes various MPA designations:
  - State marine reserve
  - State marine conservation area
  - State marine park



Intersection between the MLMA and MLPA



Marine Protected Areas and Fisheries Integration Workshop

Overview of the Marine Life Protection Act Planning Process and MPA Design Guidelines

March 29, 2011 • San Diego

Adam Frimodig
Marine Region
California Department of Fish and Game

2

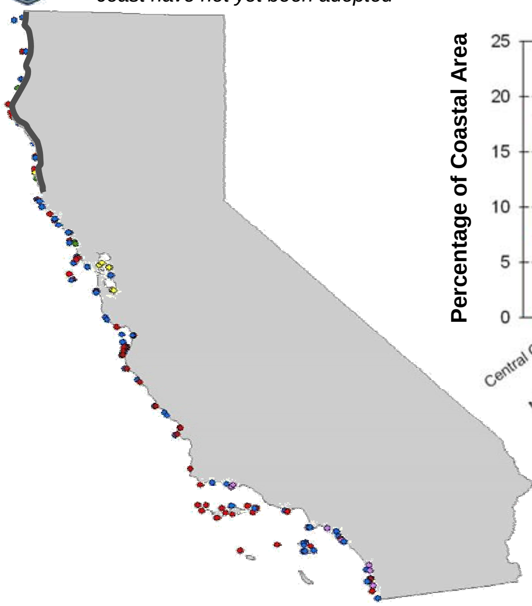
Presentation Topics

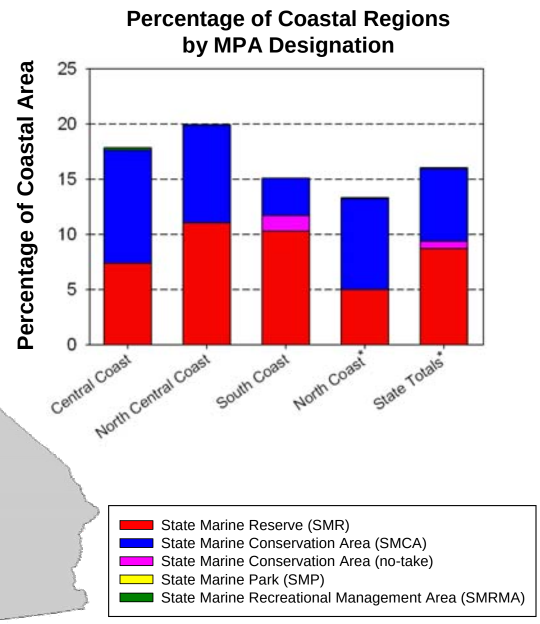
- Marine protected areas (MPAs) adopted pursuant to the Marine Life Protection Act (MLPA)
- Goals and objectives of the MLPA
- Science guidelines developed in the MLPA planning process

3

MPAs Adopted Pursuant to the MLPA

** MPAs proposed on the north coast have not yet been adopted*





4

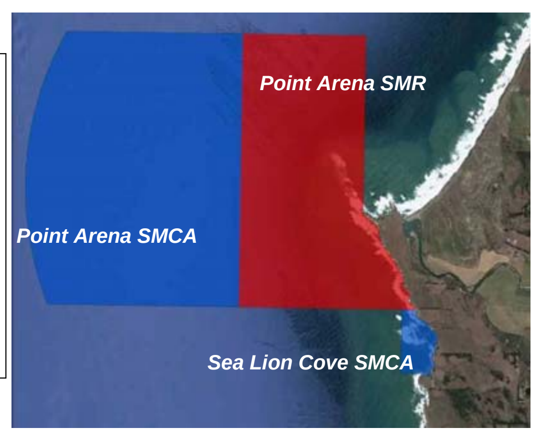
Individual MPA Objectives

- Each MPA has objectives focused on MLPA goals, however only a few have specific fishery resource objectives despite the implications of the MPA network on marine fisheries

- Point Arena SMR objectives:

"Improve fish productivity in SMR to benefit local rockfish fishing outside"

"Restore declining yelloweye, canary, & china rockfish populations"



5

MLPA Science Advisory Team Evaluations

MPA proposals were evaluated for:

- **Levels of protection**
- **Habitat representation**
- **Habitat replication**
- **MPA size**
- **MPA spacing**
- Potential impacts to fisheries
- Bioeconomic modeling*
- Marine birds and mammals
- Water quality

** May be used to investigate MPAs and fisheries interactions*

6

Levels of Protection

Key question:

"How much might an ecosystem differ from an unfished ecosystem if one or more activities are allowed?"

- Each harvest method was designated, and only the three highest levels of protection contributed towards habitat replication, MPA size and MPA spacing evaluations
  - *Outcome: Of 16% of state waters now in MPAs, 12.3% is designated at the three highest levels of protection**

** Includes Channel Islands MPAs (adopted in 2003) and MPAs from the Revised North Coast Regional Stakeholder Group Proposal; does not include MPAs in the San Francisco Bay or special closures.*

7

Habitat Representation *(Goals 1 and 4)*

Guideline: Every "key habitat" should be represented in each bioregion in the MPA network

- Identify key habitats and their availability
  - Beaches, rocky shores, kelp, hard bottom (0-30m, 30-100m, 100-3000m), soft bottom (0-30m, 30-100m, 100-3000m), and several estuarine habitats
- Evaluation metrics: Percentage of each key habitat and the associated levels of protection in MPA proposals

8

Habitat Replication *(Goals 1 and 4)*

Guideline: 3-5 replicates of each key habitat per biogeographic region (1 replicate per bioregion)

- Protect the greater diversity of species/communities, and protect species from environmental fluctuations
- Provide analytical power for comparisons

Table: Example thresholds for habitat replication in the south coast region

Habitat	Required amount
Kelp, rock 0-30m, soft 0-30m, beaches	1.14 linear miles
Soft bottom 30-100	2.24 square miles
Deep rock 0-1000m	0.2 linear miles
Rocky shores, surfgrass	0.48 linear miles
Estuary	0.12 square miles

9

MPA Size *(Goals 2 and 6)*

Guideline: MPA alongshore span = 3-6 square miles, and MPAs should extend from intertidal out to 3 miles

- Yields that MPAs should have a minimum area of 9-18 square miles (preferred = 18-36 square miles)
- Developed to provide for persistence of bottom-dwelling fish and invertebrates within MPAs
- *Outcome: Average MPA size**
  - *Pre-MLPA process (1999) = **1.4** sq mi*
  - *Current redesigned network = **7.0** sq mi*

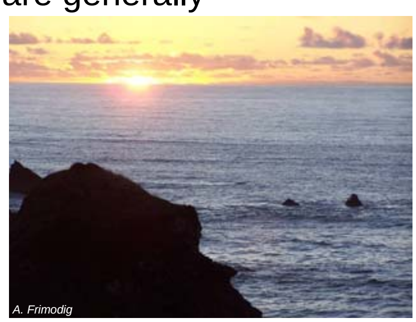
** The current figure includes Channel Islands MPAs (adopted in 2003) and MPAs from the Revised North Coast Regional Stakeholder Group Proposal; and neither figure includes MPAs in the San Francisco Bay or special closures.*

10

MPA Spacing *(Goals 2 and 6)*

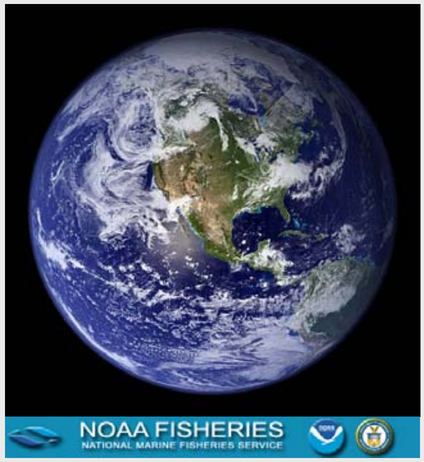
Guideline: MPAs should be placed within 31-62 miles (50-100 km) of each other

- Provide for larval dispersal between MPAs and promote connectivity
- Spacing evaluation was conducted for **each** key habitat since marine populations are generally habitat specific
- *Outcome: Some open coast habitats met the guideline or came close, but highly variable across regions and habitats*



A. Frimodig

A Brief Overview of the NOAA MPA Science Integration Working Group



Convening Authorities

- NOAA National Marine Fisheries Service
  - Southwest Fisheries Science Center, Fisheries Ecology Division
- NOAA National Ocean Service
  - National MPA Center Science Institute
- Pacific Fishery Management Council – partner in planning

Planning Committee

- NMFS
  - Sustainable Fisheries
  - Protected Resources
  - Habitat and Conservation
  - Science & Technology
- NOS National MPA Center Science Institute
- NOS National Marine Sanctuary Program
- Pacific Fishery Management Council
- MPA Federal Advisory Committee

Funded by NMFS Office Science & Technology ~$80K

Working Group Objectives

- The overall aim of the working group was to develop the scientific information necessary to integrate MPAs within the broader context of fishery science and management, including especially ecosystem based fishery management.
- Specific objectives were to:
  - Discuss the important concepts and issues
  - Engage in scientific research and modeling to develop a rational approach for integration of MPAs with traditional fishery management
  - Produce peer reviewed papers, technical reports, posters and presentations for scientific and professional meetings, that we hope will be useful information to fishery managers

Areas of Expertise of Working Group Members

- Marine ecology
- Population ecology and stock assessment
- Economics
- Sociology
- Management
- Private sector
- Participants approved by Planning Committee

Series of Workshops with Multiple Working Groups

- Initial workshop
  - Introductions
  - Terms of Reference
  - Review and modify draft questions from Planning Committee
  - Breakout into smaller working groups
- WG1 - Fisheries / MPA Ecosystem Modeling Group
- WG2 - Connectivity Working Group
- WG3 - MPAs for Natural Heritage Working Group
- NMFS Santa Cruz Laboratory and NMPAC Science Institute provided logistical support

Connectivity Working Group

- Loo Botsford - UC Davis
- Dan Brumbaugh - Museum Natural History
- Dave Fluharty - University Washington
- Churchill Grimes - NMFS SWFSC
- Julie Kellner - UC Davis
- John Largier - UC Davis
- Michael O'Farrell - NMFS SWFSC
- Steve Ralston - NMFS SWFSC
- Elaine Soulanille - NMFS SWFSC (team coordinator)
- Vidar Wespestad - Resource Analysts International

Natural Heritage Working Group

- Peter Auster - University of Connecticut
- Rikki Dunsmore - NOS NMPAC-SI (team coordinator)
- Andy Rosenberg - University of New Hampshire
- Charles Wahle - NOS NMPAC-SI
- Bob Warner - UC Santa Barbara
- Mary Yoklavich - NMFS SWFSC

Maternal Effects and MPAs Team

Formed later to elucidate links between maternal age dependent processes and spatial fisheries management

- Steve Berkeley - UC Santa Cruz
- Selina Heppell - Oregon State University
- Lisa Krigsman - NOS NMPAC-SI
- Yasmin Lucero - UC Santa Cruz
- Steve Munch - SUNY Stonybrook
- Michael O'Farrell - NOS NMPAC-SI
- Steve Ralston - NMFS SWFSC
- Wade Smith - Oregon State University
- Paul Spencer - NMFS AFSC

Some Working Group Publications

Does MPA mean 'Major Problem for Assessments'? Considering the consequences of place-based management systems

FISH and FISHERIES, 2006, **7**, 284–302

John C. Field[1], André E. Punt[2], Richard D. Methot[3] & Cynthia J. Thomson[1]*

Connectivity, sustainability, and yield: bridging the gap between conventional fisheries management and marine protected areas

Rev Fish Biol Fisheries (2009) 19:69–95

Louis W. Botsford · Daniel R. Brumbaugh · Churchill Grimes · Julie B. Kellner · John Largier · Michael R. O'Farrell · Stephen Ralston · Elaine Soulanille · Vidar Wespestad

Spatial variation in fishing intensity and its effect on yield

Can. J. Fish. Aquat. Sci. **65**: 588–599 (2008)

Stephen Ralston and Michael R. O'Farrell

When do marine reserves increase fishery yield?

Deborah R. Hart

Can. J. Fish. Aquat. Sci. **63**: 1445–1449 (2006)

Fisheries • VOL 33 NO 12 • DECEMBER 2008

Vertical Zoning in Marine Protected Areas: Ecological Considerations for Balancing Pelagic Fishing with Conservation of Benthic Communities

Rikki Grober-Dunsmore, Grober-Dunsmore was a marine ecologist with NOAA Fisheries, Southwest Fisheries Science Center (SWFSC) in Santa Cruz, California, and is presently an associate professor at the University of the South Pacific, Fiji. She can be contacted at dunsmore_L@usp.ac.fj.

Lisa Wooninck, Wooninck is a resource protection specialist with Monterey Bay National Marine Sanctuary in Monterey, California.

John Field, Field is a fisheries biologist with NOAA Fisheries, SWFSC.

Cameron Ainsworth, Ainsworth is now a post-doctoral fellow at the National Marine Fisheries Service in Seattle, Washington.

Jim Beets, Beets is a professor at University of Hawaii—Hilo.

Steve Berkeley, Berkeley's contribution as a research biologist at the University of California Santa Cruz Long Marine Laboratory was invaluable.

Jim Bohnsack, Bohnsack is a fisheries biologist with NOAA Fisheries, Southeast Fisheries Science Center in Miami, Florida.

Rafe Boulon, Boulon is the chief of resource management at Virgin Islands National Park/Coral Reef National Monument.

Richard Brodeur, Brodeur and Brodziak are fisheries biologists with NOAA Fisheries, Northwest Fisheries Science Center in Newport, Oregon.

John Brodziak,

Larry Crowder, Crowder is a professor at the Duke Center for Marine Conservation in Beaufort, North Carolina.

Danny Gleason, Gleason is a professor in the Biology Department at Georgia Southern University in Statesboro.

Mark Hixon, Hixon is a professor in the Zoology Department at Oregon State University in Corvallis.

Les Kaufman, Kaufman is a professor in the Biology Department of Boston University.

Bill Lindberg, Lindberg is a professor in the Fisheries and Aquatic Sciences Department at University of Florida in Gainesville.

Marc Miller, Miller is a professor in the School of Marine Affairs at University of Washington in Seattle, Washington.

Lance Morgan, Morgan is chief scientist for the Marine Conservation Biology Institute in Glenn Allen, California.

and Charles Wahle Wahle is a scientist with the National Marine Protected Areas Center in Monterey, California.

COOPERATIVE STRATEGIES IN FISHERIES MANAGEMENT: INTEGRATING ACROSS SCALES

R. M. Fujita, K. T. Honey, A. Morris, J. R. Wilson, and H. Russell

BULLETIN OF MARINE SCIENCE, 86(2): 251–271, 2010

Journal of Applied Ecology 2009, **46**, 735–742 doi: 10.1111/j.1365-2664.2009.01667.x

A framework for assessing the biodiversity and fishery aspects of marine reserves

Phillip S. Levin*[1], Isaac Kaplan[1], Rikki Grober-Dunsmore[2], Paul M. Chittaro[1], Seichi Oyamada[3], Kate Andrews[3,4] and Marc Mangel[3]

Density-Ratio Working Group

ICES Journal of Marine Science (2011), 68(1), 201–211. doi:10.1093/icesjms/fsq151

Can information from marine protected areas be used to inform control-rule-based management of small-scale, data-poor stocks?

Carey R. McGilliard[1*], Ray Hilborn[1], Alec MacCall[2], André E. Punt[1], and John C. Field[2]

How useful is the ratio of fish density outside versus inside no-take marine reserves as a metric for fishery management control rules?

Elizabeth A. Babcock and Alec D. MacCall Can. J. Fish. Aquat. Sci. **68**: 343–359 (2011)

Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 2:14–27, 2010
© Copyright by the American Fisheries Society 2010
DOI: 10.1577/C08-026.1
[Special Section: Data-Poor Fisheries]

A Management Strategy for Sedentary Nearshore Species that Uses Marine Protected Areas as a Reference

JONO R. WILSON*
Bren School of Environmental Science and Management, University of California–Santa Barbara, Santa Barbara, California 93106-5131, USA

JEREMY D. PRINCE
Biospherics, Post Office Box 168, South Fremantle, Western Australia 6162, Australia

HUNTER S. LENIHAN
Bren School of Environmental Science and Management, University of California–Santa Barbara, Santa Barbara, California 93106-5131, USA

Density-Ratio Working Group

ICES Journal of Marine Science (2011), 68(1), 201–211. doi:10.1093/icesjms/fsq151

Can information from marine protected areas be used to inform control-rule-based management of small-scale, data-poor stocks?

Carey R. McGilliard[1*], Ray Hilborn[1], Alec MacCall[2], André E. Punt[1], and John C. Field[2]

How useful is the ratio of fish density outside versus inside no-take marine reserves as a metric for fishery management control rules?

Elizabeth A. Babcock and Alec D. MacCall Can. J. Fish. Aquat. Sci. **68**: 343–359 (2011)

Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 2:14–27, 2010
© Copyright by the American Fisheries Society 2010
DOI: 10.1577/C08-026.1
[Special Section: Data-Poor Fisheries]

A Management Strategy for Sedentary Nearshore Species that Uses Marine Protected Areas as a Reference

JONO R. WILSON*
Bren School of Environmental Science and Management, University of California–Santa Barbara, Santa Barbara, California 93106-5131, USA

JEREMY D. PRINCE
Biospherics, Post Office Box 168, South Fremantle, Western Australia 6162, Australia

HUNTER S. LENIHAN
Bren School of Environmental Science and Management, University of California–Santa Barbara, Santa Barbara, California 93106-5131, USA

Marine Protected Areas and Fisheries Integration Workshop

Brown Rockfish

March 29-30, 2011 San Diego, CA

Tom Mason – Biologist

Marine Region

California Department of Fish and Game

Brown Rockfish Distribution & Diet

- Occur state-wide, primarily at depths less than 55 m
- Residential, but may migrate to deeper waters during the winter
- Benthic carnivores – eat small crustaceans and fish
- Life span – ~ 20 yrs
- Max size – 55 cm


T. Mason


Kim Mitchell

Brown Rockfish Life History

- Mature (50%) at 4 yrs and ~ 27 cm
- Viviparous – live young with 3 mo. pelagic stage
- Recruits settle in shallow nearshore waters
- Critical habitats
  - Bays and estuaries
  - Eelgrass and kelp beds
  - Shallow and deep rocky reefs

State and/or Federally-Managed Nearshore Species

State-managed nearshore species (CGS)

Cabezon | Greenlings | CA Sheephead

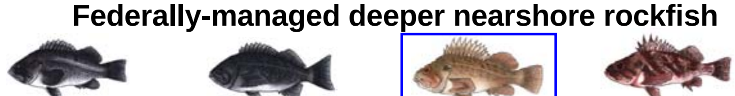
Federally-managed nearshore species

CA Scorpionfish (sculpin)

Federally-managed shallow nearshore rockfish

Black-and-yellow rockfish | China rockfish | Gopher rockfish | Grass rockfish | Kelp rockfish

Federally-managed deeper nearshore rockfish



Black rockfish | Blue rockfish | Brown rockfish | Calico rockfish

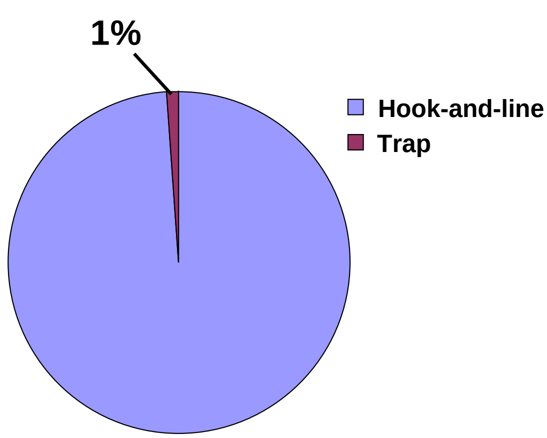
Copper rockfish | Olive rockfish | Quillback rockfish | Treefish

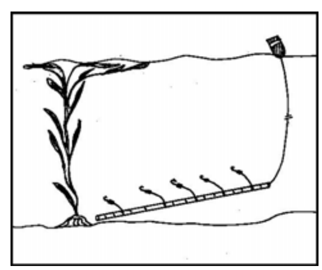
Current Management Measures

Commercial fishery

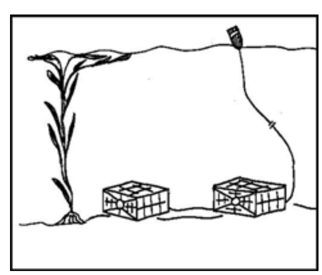
- Restricted access program (implemented in 2003)
  - Permit system for deeper nearshore group (state-wide and nontransferable)
- Harvest guidelines and Annual Catch Limit (ACL) – managed as a group
- Two-month trip limits
- Depth restrictions (30-150 fm) and (60-150 fm)
- Gear restrictions (hook-and-line and trap)

Gear Used to Land Brown Rockfish (2010)





Hook-and-line (“stick gear”)



Trap Gear

Data source: CFIS/CMASTR commercial fishery database

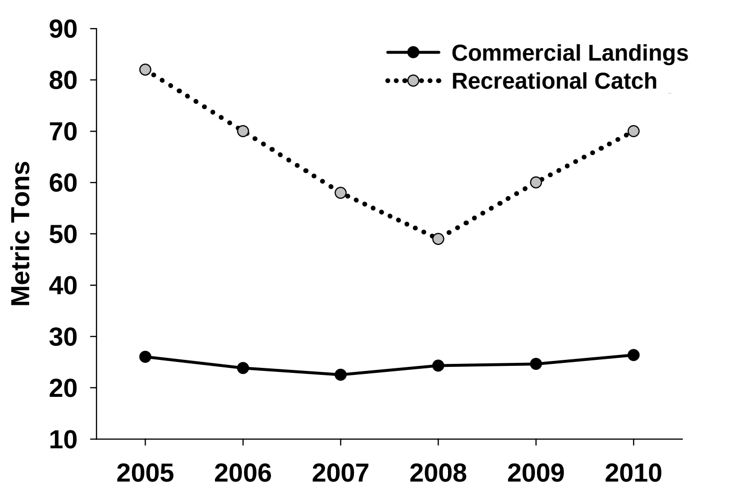
Current Management Measures

Recreational fishery

- Depth (20, 30, 40 or 60 fm) restrictions and seasonal closures
- Bag limit (10)
- Gear restrictions (2 hooks)

Brown Rockfish Recent Landings

State-wide Commercial and Recreational Landings



Data source: CFIS (commercial) and CRFS (recreational)- extracted Feb 25, 2011

Status of the Stock

- Trends in average size landed
  - 1990s – ½ of commercial catch at or below size at 50% maturity
  - 2005-2010 – Commercial: 35 cm; Recreational:33 cm
- Stock has not been assessed (data-poor species)
  - Previously the ACL was set at 50% of historic landings
  - Recently the Depletion-based stock reduction analysis
- Identified as a species likely to benefit from MPAs

Marine Protected Areas and Fisheries Integration Workshop

Photo by: Steve Lonhart

CABEZON

(*Scorpaenichthys marmoratus*)

March 29, 2011 San Diego, CA
Meisha Key
Marine Region
California Department of Fish and Game

Cabezon Distribution & Diet

- Central Baja California to Sitka, Alaska
- Intertidal (jetty rocks), kelp forests and rocky reefs
- Depth up to 110m (360ft); mainly < 55m (180ft)
- Sub-stocks *(Villablanca and Nakamura 2008)*
  - 3 north and 3 south
    (of Point Conception)
- Diet: mainly crustaceans
  also abalone, small fish (including rockfish) and fish eggs

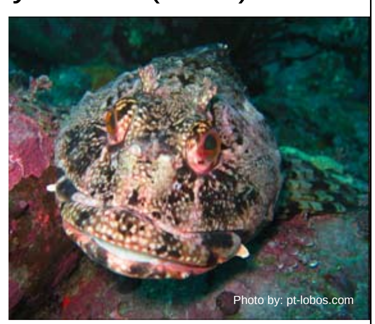


Photo by: pt-lobos.com

Cabezon Life History

- Spawning
  - Natural/manmade objects
  - California – peaks in January/February
  - Multiple times in a season
- Males guard nests

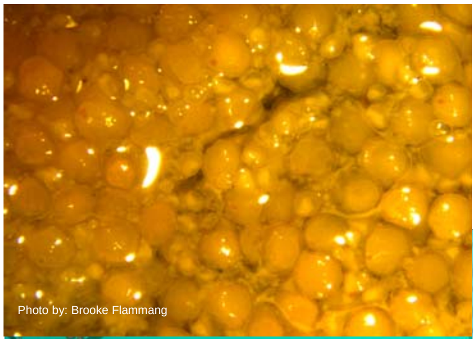
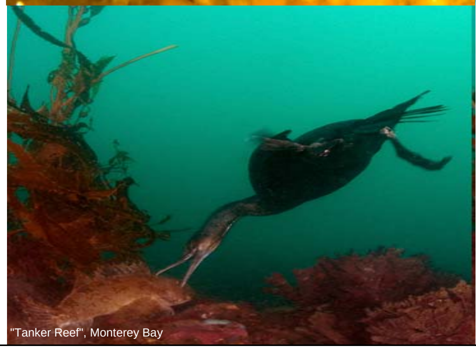


Photo by: Brooke Flammang



"Tanker Reef", Monterey Bay

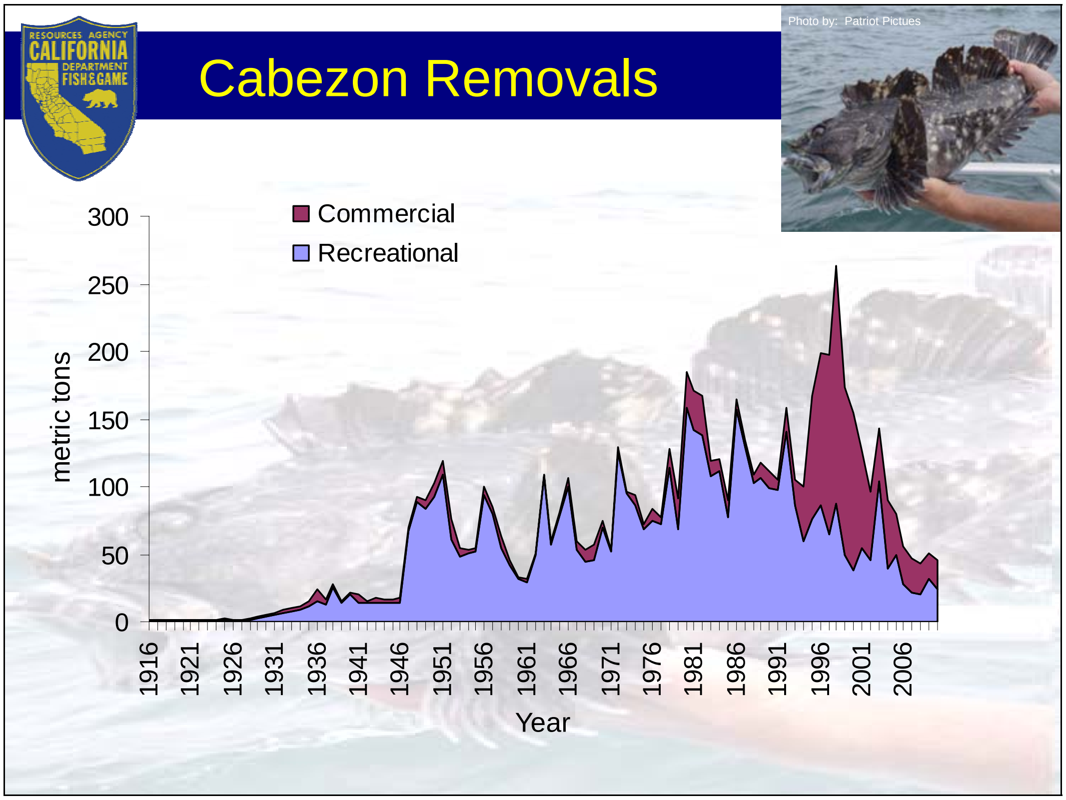
Cabezon Life History

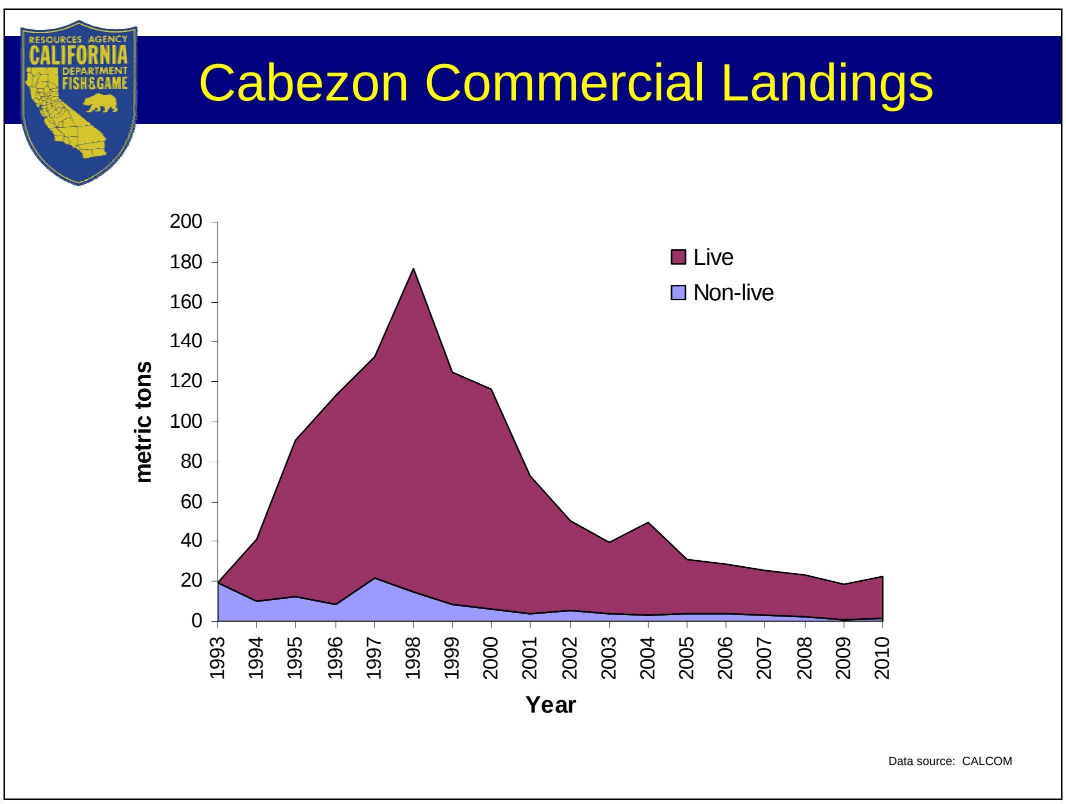
- Young of the year (YOY)
  - 3-4 months as pelagic larvae and juveniles

Photo by: Diane Haas

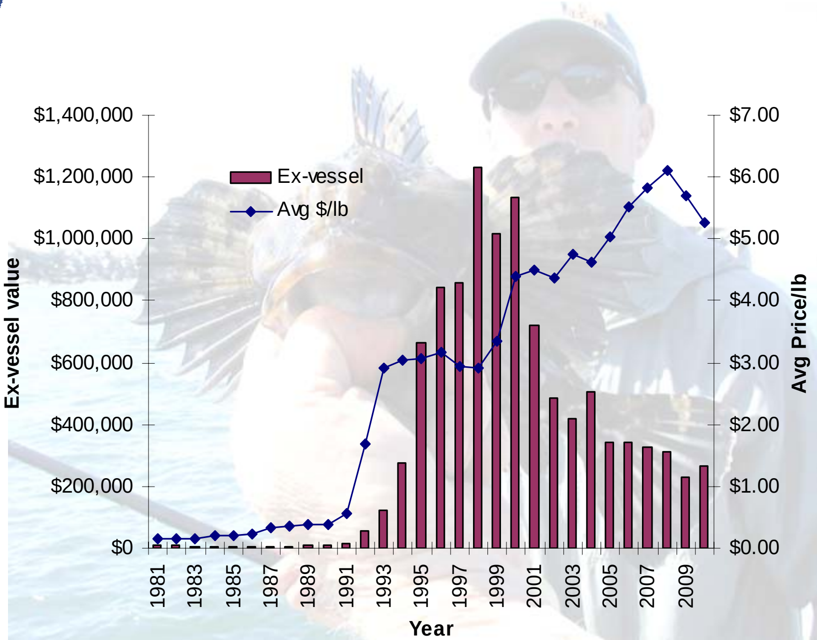
Photo by: Diane Haas

- Mature (50%) ~ 4 yrs ; 35cm
- Max Age ~ 17 yrs


Cabezon Removals
Photo by: Patriot Pictues
Commercial
Recreational
metric tons
300
250
200
150
100
50
0
1916
1921
1926
1931
1936
1941
1946
1951
1956
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
Year


Cabezon Commercial Landings
Live
Non-live
metric tons
200
180
160
140
120
100
80
60
40
20
0
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year
Data source: CALCOM

Cabezon Commercial Live-Fishery



Data sources: CFIS and PacFIN (2000s)

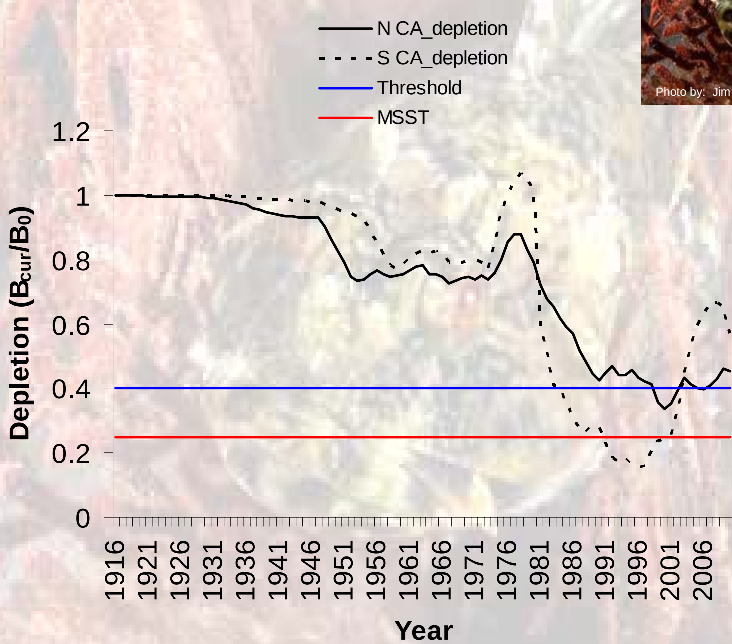
Current Management

- Minimum Size Limit
  - Since 2001: * **15 in** (recreational and commercial)
- Recreational Bag Limit
  - Since 2005: * **1/day**
- Commercial Trip Limits
  - * **2 month cumulative trip limits with inseason adjustments**

Current Management

- Recreational
  - Rockfish, Cabezon and Greenling (RCG) complex
  - Subject to seasonal closures
- Commercial
  - Cabezon, Greenlings and California sheephead (CGS) complex
  - Trip limits

2009 Stock Assessment



Current Management

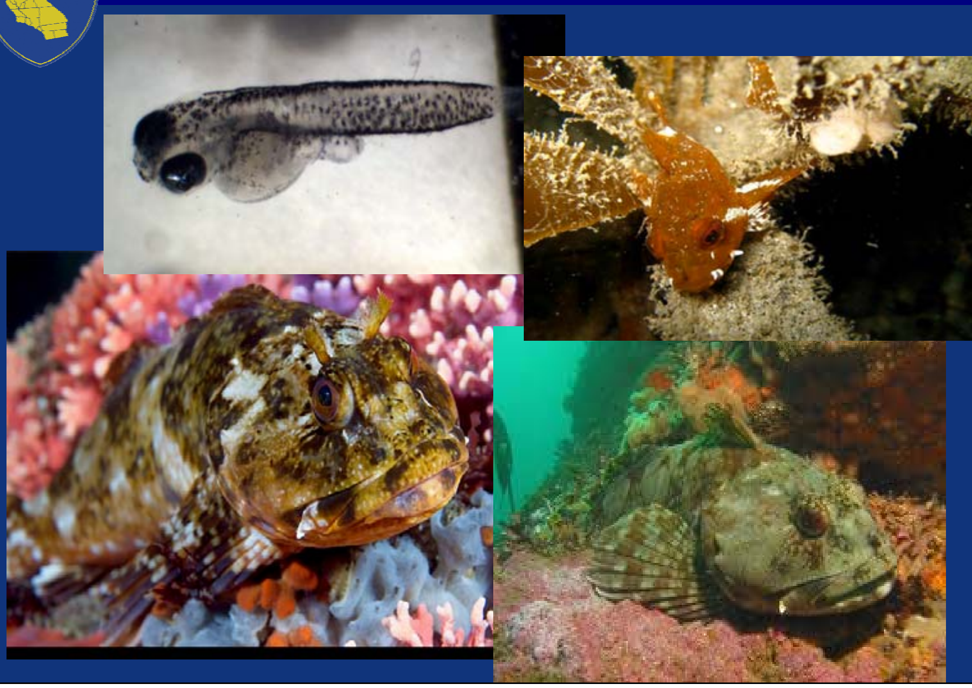
- Since 2000:

  69t (151,712 lbs)

- In 2011, based on 2009 assessment:

YEAR	Council (GFMP) ACL	State (NFMP) TAC
2011	179t	148t
2012	168t	148t

THANK YOU



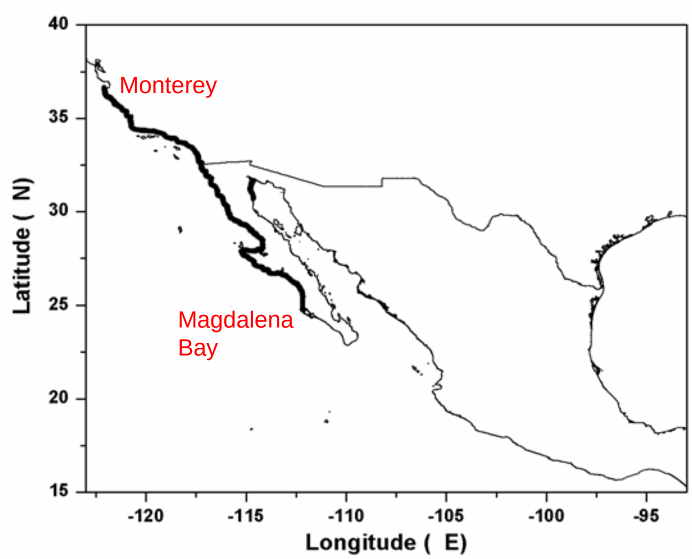
Marine Protected Areas and Fisheries Integration

California Spiny Lobster

March 29-30, 2011, San Diego, CA

Kristine Barsky
Marine Region
California Department of Fish and Game

Geographical Range

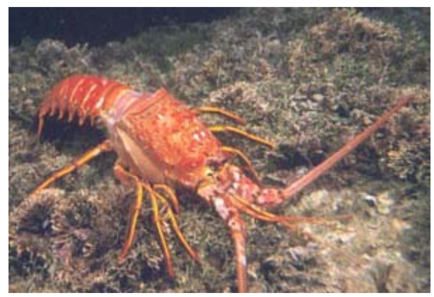


Growth and Maturity

PHYLLOSOMA LARVA

PUERULUS LARVA

LOBSTER MOLTING



Habitat, Food, and Predators

Commercial Lobster Fishery

<u>Restricted Access Fishery</u>

200 trap permits

142 permits are transferable

No trap limits

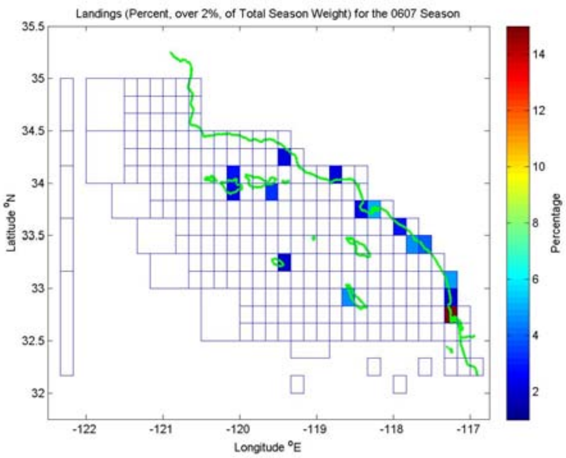
Escape ports and destruct devices required

3-1/4 in. (83 mm) carapace length

Either sex fishery

Daily fishing log

No quota or trip limits



Landings for the 2006/07 Season

Lobster Sport Fishing Regulations

<u>Daily bag limit</u> = 7 lobster

<u>Minimum Size</u> = 3-1/4 inch (83 mm) carapace length

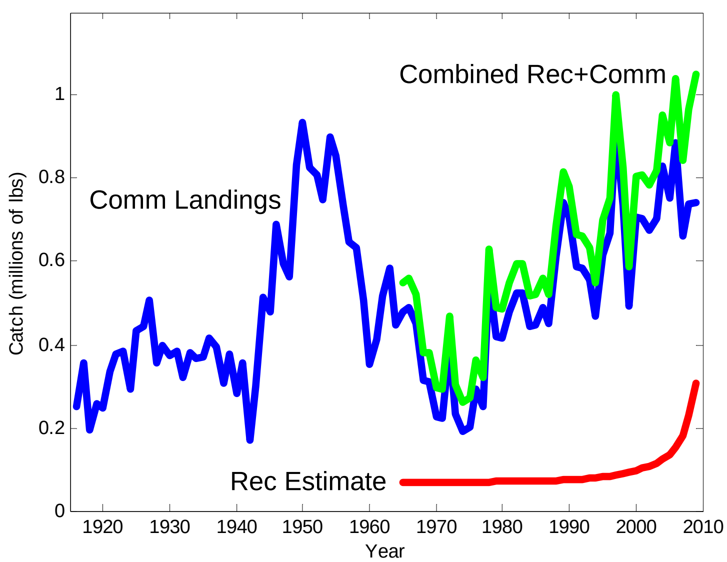
Must carry a <u>lobster report card</u> and a <u>fixed gauge</u>

<u>Season:</u> From the Saturday preceding the first Wednesday in October through the first Wednesday after the 15th of March

<u>Maximum</u> 5 hoop nets per person and 10 per vessel

Recreational Hoop Netting and Diving

Commercial and Recreational Harvest



Lobster Fishery Summary

- Long-lived and slow-growing
- Lengthy, planktonic larval stage
- Southern species, affected by cold water
- Recreational fishery is growing
- Commercial fishery will lose some prime areas due to new MPAs
- Stock assessment is underway
- Invertebrate species for MPA monitoring

Marine Protected Areas and Fisheries Integration

California's Abalones

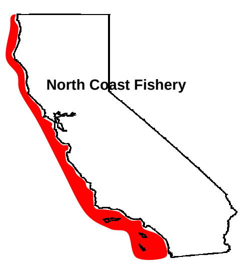
April 29-30, 2011, San Diego, CA

Kristine Barsky

Marine Region

California Department of Fish and Game

California's Seven Species of Abalone



Red Abalone *(H. rufescens)*
Intertidal to ~100 ft. (30.5 m)

Endangered Species Under Federal ESA

White Abalone (*H. sorenseni*)

Black Abalone (*H. cracherodii*)

Federal List for Species of Concern

Pink Abalone (*H. corrugata*)

Green Abalone (*H. fulgens*)

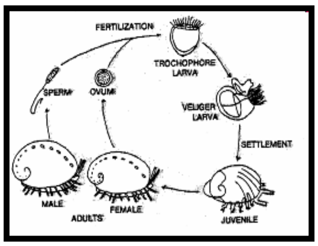
Pinto Abalone (*H. kamtschatkana*)

Status Unknown

Flat Abalone (*H. walallensis*)

General Life History

- Broadcast breeders
- Increased spawning success in close groups (~4.9 ft. (1.5 m) apart)
- Can reproduce yearly in favorable conditions
- Planktonic larvae settle in 4-15 days
- Juveniles cryptic
- Adults emerge at 3-4 in. (76-102 mm) when sexually mature, age 3-5 years
- Slow growth, 7 in. (178 mm) red is 6-12 years in south & 9-13 years in north



Abalone Recovery and Management Plan (ARMP)

ARMP adopted by Fish and Game Commission in '05

Goals for recovery
Goals for management

- **Institute an interim management plan - done**
  - *** Minimum Viable Population (MVP) = 2,000 abalone/ha**
  - *** Sustainable Fishery Level = 6,600 abalone/ha**
    (hectare = 2.5 acres)
- **Implement a long term management plan – not yet done**

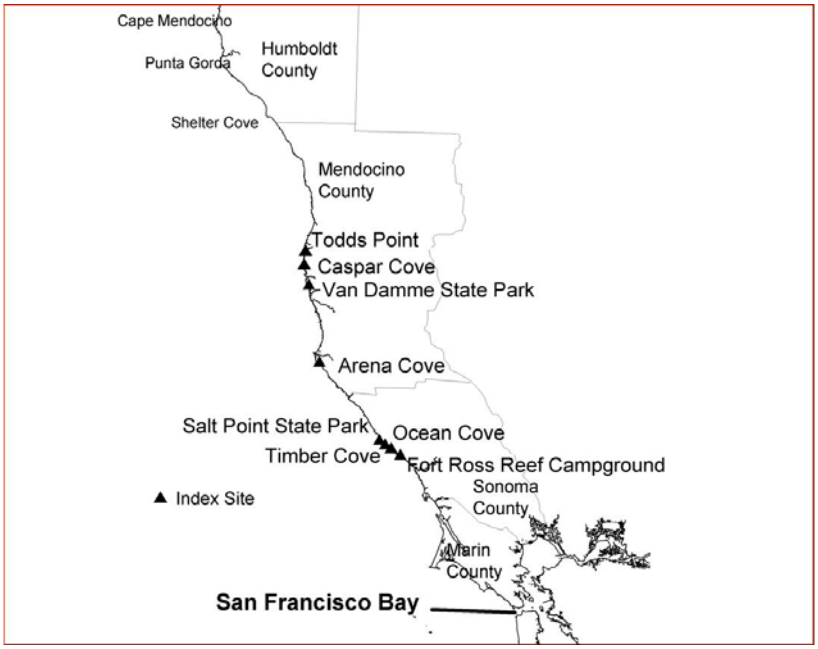
Option was included in the ARMP that allows the Commission to consider a fishery in southern California

Regulations for Recreational Fishery

North of San Francisco Bay

- **Free diving or shore picking only**
- **7-month season**
- **Minimum size limit of 7 in. (178 mm)**
- **Daily bag limit of 3 abalone**
- **Annual limit of 24 abalone**
- **Abalone report card, each animal tagged**

ARMP Index Site Survey Locations



ARMP TAC Adjustment Table

CRITERIA					ACTION
Recruitment		*Density (ab/ha)* Deep (refuge)	- emergent surveys -	All Depths	
N/A		3300/ha	AND	6600/ha	2) Maintain TAC (280,000 ab/yr or revised TAC)
No	AND	< 2500/ha	OR	< 5000/ha	3) Reduce TAC by 25% increments
N/A		*N/A*		< 3000/ha	4) Close Fishery

Densities (2008-10): Deep = 2800/ha; All Depths = 5400/ha
Good recruitment > 4500/ha

Abalone Resources and MPAs

- **ARMP identifies MPAs as a potential abalone fishery management tool**
- **MPAs useful for abalone management in north and recovery in south**

*** South California: 22 out of 50 MPAs**

*** North Central: 8 out of 30 MPAs**

*** Northern California: 3 out of 22 MPAs proposed**

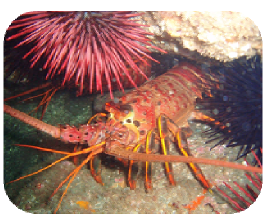
mpa MONITORING ENTERPRISE

Informing fisheries management through MPA monitoring

March 29-30, 2011

Marine Protected Areas & Fisheries Integration Workshop, San Diego

Outline



1. What is the focus of MPA monitoring?
2. How can MPA monitoring be useful for fisheries management?
3. How could MPA monitoring be extended to be more useful for fisheries management?

Focusing MPA monitoring

MLPA Goals

'protect the natural abundance & diversity of marine life'

'protect structure, function & integrity of marine ecosystems'

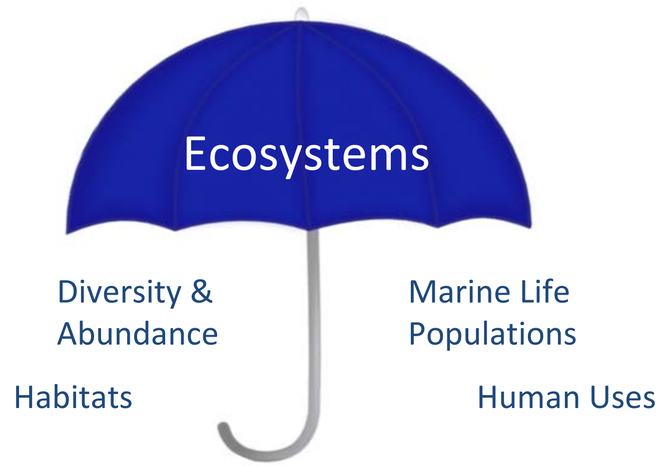
'protect marine life populations'

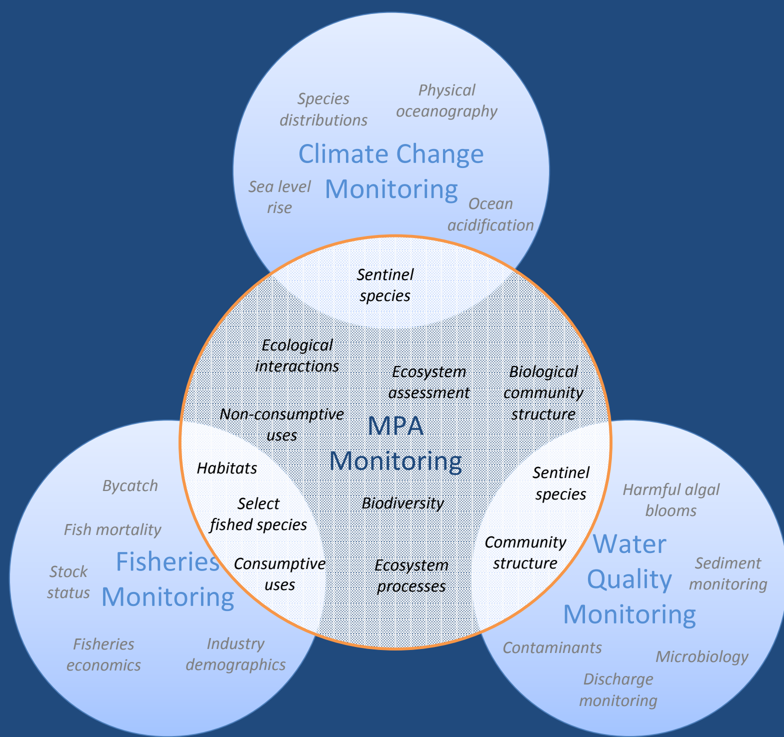
'rebuild depleted populations'

'improve recreational opportunities'

'protect natural marine heritage'

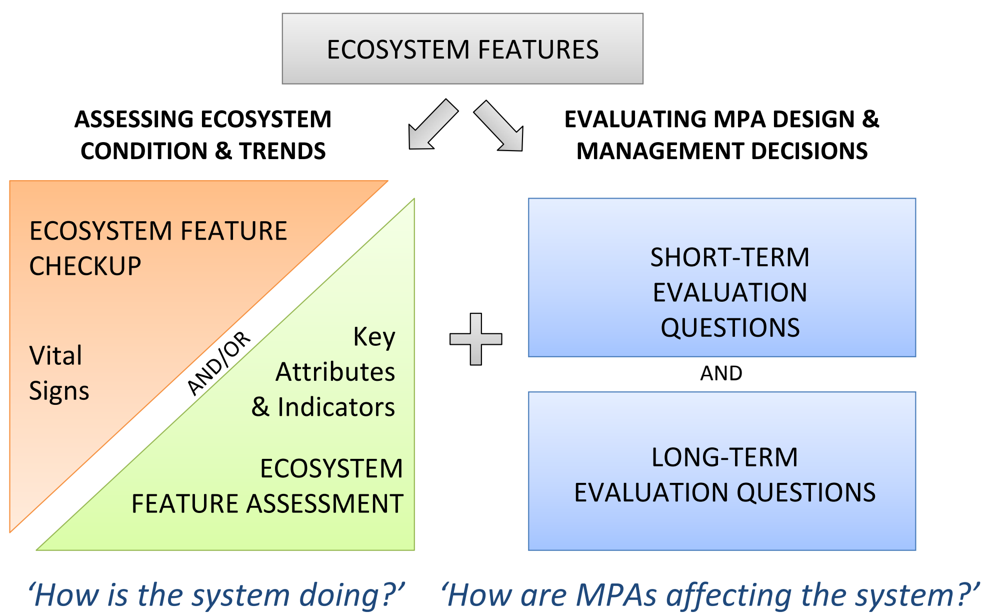
An ecosystem-based approach





Informing fisheries management

MPA Monitoring Framework



Assessing ecosystem condition

Kelp & Shallow Rock

- Biogenic habitat: Macroalgae
- Strong Ecological Interactors
- Trophic Structure: Predatory fishes
- Trophic Structure: Predatory invertebrates
- Trophic Structure: Planktivorous fishes
- Trophic Structure: Herbivorous invertebrates

Assessing ecosystem condition

Key Attribute	Indicators
Strong Ecological Interactors	Sheephead density, size structure, sex ratio
	Red sea urchin density & size structure
	Purple sea urchin density & size structure
	Spiny lobster abundance & size structure

Assessing ecosystem condition

Consumptive Uses

- Commercial fishing
- Recreational fishing – CPFV, incl. dive charters
- Recreational fishing – private vessels, incl. kayaks
- Recreational fishing – shore-based
- Recreational fishing – diving, SCUBA & free-diving

Assessing ecosystem condition

Consumptive Uses

- Commercial fishing
- Recreational fishing – CPFV, incl. dive charters
- Recreational fishing – private vessels, incl. kayaks
- Recreational fishing – shore-based
- Recreational fishing – diving, SCUBA & free-diving

Indicators

1. Number of people or vessels engaged in the activity
2. Level of activity per location, vessel, port & region
   a) Number of fishing trips
   b) Landings of key species
   c) CPUE
3. Economic value or quality of activity
   a) Landings value
   b) Ex-vessel value of key species (commercial fisheries)
   c) Net revenue (commercial) or expenditure (recreational)
4. Knowledge, Attitudes and Perceptions of participants

Consumptive Uses

Commercial fishing:

- Nearshore rockfish
- Spiny lobster
- California halibut
- Red sea urchin
- Market squid
- Crab

Photo: NOAA

Evaluating MPA design & management

Photo: DFG

Example:

How frequent are MPA **boundary-crossings by targeted species** and does the frequency of boundary crossing differ between **MPAs that encompass a reef and those that split a reef**?

Evaluating MPA design & management

Example :

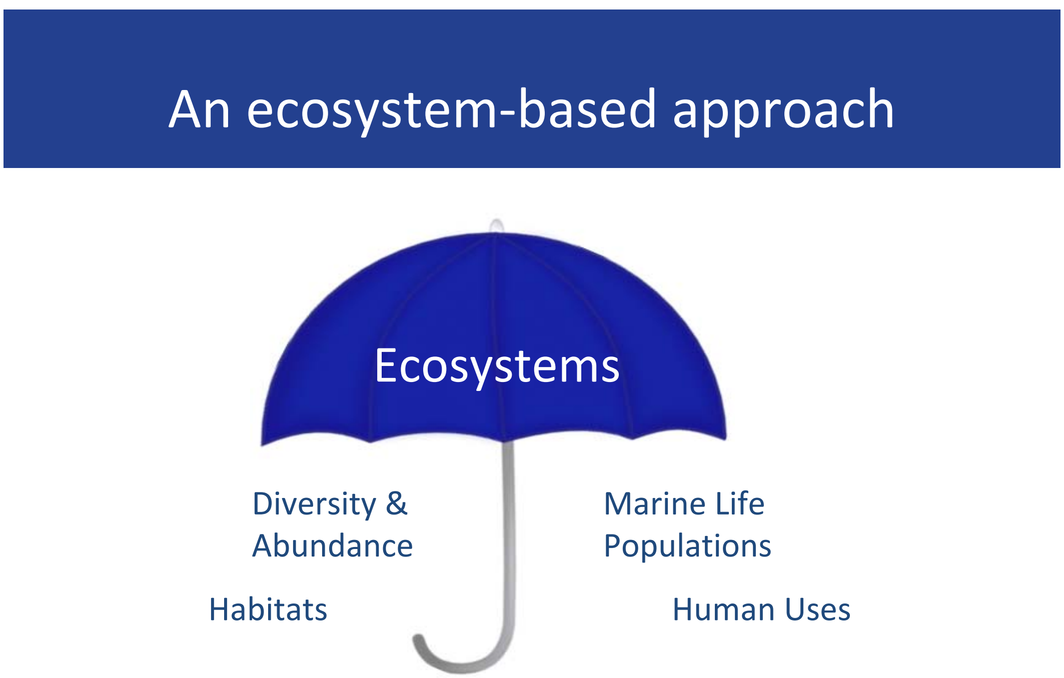
What are the **economic effects** (e.g., fuel costs, time spent at sea) **of MPA placement**, specifically distance from ports and location relative to fishing grounds, and what are the implications for siting MPAs to minimize adverse economic impacts and to prevent serial depletion?

Photo: W. Folsom, NOAA

Informing fisheries management

- New, augmented data sources to use in stock assessment models
- New information on data-poor species
- New data to support ecosystem-based fisheries management e.g., habitat, food-web relationships
- Assessments of ecosystem condition (to meet broader MLMA requirements)


Extending MPA monitoring


An ecosystem-based approach
Ecosystems
Diversity & Abundance
Marine Life Populations
Habitats
Human Uses

Supplemental Fisheries Monitoring

- Tier 1. Existing fisheries indicators within the MPA monitoring framework
  - E.g. lobster, halibut, kelp bass, red urchin
- Tier 2. Additional fisheries indicators that may be added to the existing MPA monitoring framework
  - E.g. Calico rockfish, grass rockfish

Supplemental Fisheries Monitoring

- Tier 3. New framework elements and programs to address priority fisheries questions in relation to MPAs
  - E.g., MPA effects on local fisheries
  - E.g., Stock consequences of protected subpopulation
  - E.g., New, modified tools for population assessments
  - E.g., New concepts in EBFM

mpa MONITORING ENTERPRISE

Informing fisheries management through MPA monitoring

March 29, 2010

Marine Protected Areas & Fisheries Integration Workshop, San Diego

Supplemental Fisheries Monitoring

MPA Monitoring

- Ecosystem-focused
- MPA effects
- Place-based approach
- Fishing locations and impacts to fishermen

Fisheries Monitoring

- Stock focused
- Status of fisheries
- Species/population-based approach
- Fishing locations and fishery viability, economics etc

How Can Information from MPAs Be Used to Assess and Manage Fisheries?

Density ratios and other ideas

Alec MacCall

March 29-30, 2011

Outline

- The original "density ratio" proposal
- The MPA Science Integration follow-up
  - MSEs by McGilliard and Babcock
  - Independent development and MSE by Wilson
- Use of comparative compositions

How to Manage Small Fisheries?

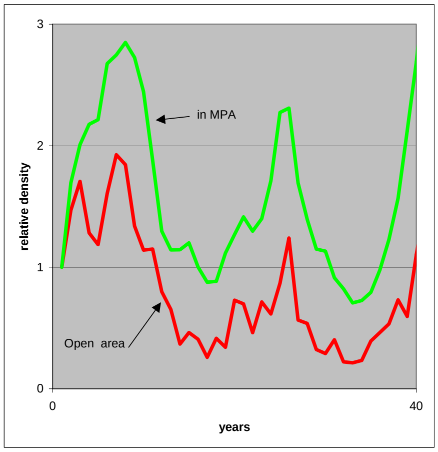
- Management is needed, even for small fisheries
  - Unless participation is severely limited
  - Localized resources can very easily be depleted
    - Especially if fleets are mobile
- Conventional approaches are problematic
  - Conventional data needs are the same, large or small
    - But not affordable for small fisheries
  - Catch-based management doesn't work locally
    - Geographic scale of conventional information doesn't match scale for local management
    - Micro-managing quotas is undesirable and maybe impossible

An MPA Reference-Based Approach for Data-Poor Fishery Management

Basic scheme:

- Use fish densities in MPAs as an index of potential unfished levels
- Compare with fish densities in fished areas
- Restrict fishing season (or TAC, if required) progressively as fish densities in the open areas decline relative to protected areas

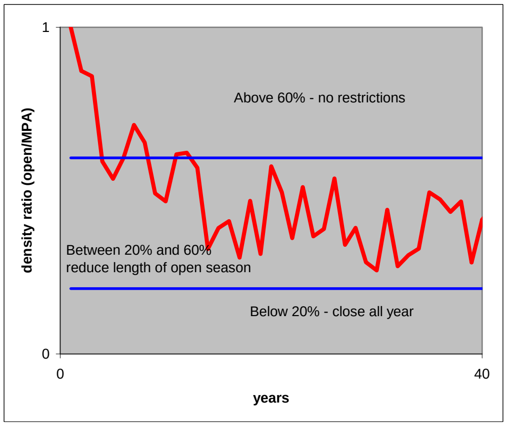
Open vs. Protected Areas



This is a cartoon – Not real data

- Density in each area is scaled to unit value ca. time zero
- Density is estimated annually in pairwise survey design
- If estimates are noisy, time-averaging may be helpful

Manage for Relative Density



- Track relative density in the fished area, with references
  - Here, references reflect California's 60-20 policy
  - Response is to vary season length
- Gentle phase-in
  - No initial restrictions on fishery (init above 60%)
  - MSEs by both McGilliard and Babcock showed some risk from initial effort displacement

Adaptive Management Policies

- Alternative management controls
  - Catch-based controls (e.g., TAC) tend to focus on single species and require expensive monitoring
  - Effort-based controls (e.g., length of open season, or effort quota in vessel-days) may be better for multiple species, and may be less expensive, but are less precise
  - As always, smaller fleets require less restriction
- Controls can be relative or absolute
  - MSEs by McGilliard and Babcock used relative controls
    - Increase fishing if above target, decrease if below target
    - Finds its way to the target, but tends to oscillate
  - Absolute control may be difficult to calibrate initially

Multispecies Management

- This can be a multispecies management system
  - Season closures apply to all fishing, and protect all species
  - Density index used to determine season closures would reflect a mix of species
  - This management system works only for “resident” species
- No exemption for separately-managed OY species
  - e.g., PFMC managed species
  - Would have to be taken only in the open season

Ad Hoc Follow-on Group

(Good use of left-over MPA Science Integration money)

- Initiated by MacCall's proposal that MPAs can be used directly for fishery management, in lieu of assessment
  - An alternative to conventional management
- An ad-hoc "Density Ratio Working Group" spontaneously formed to explore the idea
  - There was no formal membership or chairmanship
  - 1960's organizational model
  - Three meetings (UW Seattle, Santa Cruz, UCSB)
- Partial list of "core" participants (more than 1 mtg):
  - Beth Babcock, John Field, Rod Fujita, Kristen Honey, Meisha Key, Alec MacCall, Carey McGilliard, Jono Wilson

The Density Ratio Idea

- Resource status can be tracked by ratio of density outside vs. inside MPAs
  - Requires initial and ongoing monitoring
  - Can use industry cooperative research
    - Conventional fishing gear – maximum relevance
    - Live fish capture technology could minimize impact
  - Alternatively, can use visual methods
- Requires a pre-agreed management policy
  - Relates observed ratios to harvest controls
  - Can be single species or multispecies

Two Recent Papers

- Carey McGilliard examined performance of a density ratio control rule for single-species management in a variety of habitat and movement scenarios

ICES Journal of Marine Science (2011), 68(1), 201–211. doi:10.1093/icesjms/fsq151

Can information from marine protected areas be used to inform control-rule-based management of small-scale, data-poor stocks?

Carey R. McGilliard[1*], Ray Hilborn[1], Alec MacCall[2], André E. Punt[1], and John C. Field[2]

Two Recent Papers

- Beth Babcock examined performance of a density ratio control rule for multi-species management

How useful is the ratio of fish density outside versus inside no-take marine reserves as a metric for fishery management control rules?

Elizabeth A. Babcock and Alec D. MacCall

Can. J. Fish. Aquat. Sci. **68**: 343–359 (2011)

Jono Wilson had independently developed a similar approach

- A “decision-tree” approach incorporating MPA comparisons

A Management Strategy for Sedentary Nearshore Species that Uses Marine Protected Areas as a Reference

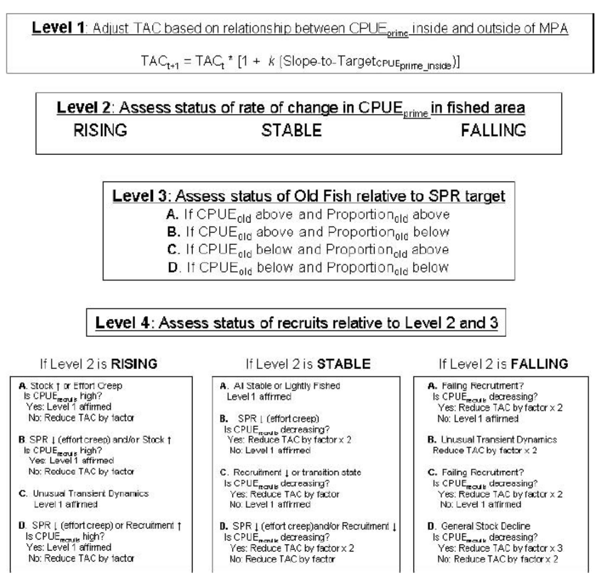
JONO R. WILSON*
Bren School of Environmental Science and Management, University of California–Santa Barbara, Santa Barbara, California 93106-5131, USA

JEREMY D. PRINCE
Biospherics, Post Office Box 168, South Fremantle, Western Australia 6162, Australia

HUNTER S. LENIHAN
Bren School of Environmental Science and Management, University of California–Santa Barbara, Santa Barbara, California 93106-5131, USA

Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 2:14–27, 2010

Wilson et al’s Decision Tree



Another MPA Approach

- Length or age compositions can be compared inside vs. outside MPAs
  - Related to the "Transitional SPR" approach of 1990's, but solves the drift problem
- Initial simulations show strong ability to estimate both F and M from this information
- Currently being worked on by Kristen Honey and Xi He
  - Rumors suggest that other people are also investigating this or similar approaches

Where We Stand

- There is interest in use of these approaches
  - Central California
    - Desire for local management
  - Caribbean Fishery Management Council
    - Extremely data-poor
    - Problems with transboundary stocks
- Unclear if and how to initiate the change
  - Requires MPAs and commitment to monitoring
    - Is it cost-effective?
  - Requires dedicated access privileges
  - Control rules may be difficult to reconcile with federal management requirements (ACLs etc.)

How Long Would It Take?

- Composition-based approaches should require less than 1 generation time
  - Time depends on fishing intensity outside
  - My guess: 5 years would be sufficient in most cases
- Density-based approaches will take longer
  - Density response takes closer to 1 or more generation times
  - MSEs indicate10 or more years may be required
- Approach has a natural phase-in, unlike most fishery regulations
  - Be wary of initial depletion due to effort displacement