Unique and Rare Features in Monterey Bay National Marine Sanctuary:

Summary of the 2011 Workshop to Inform the Ecosystem–based Management Initiative

convened

May 24th, 2011

at the

Southwest Fisheries Science Center, Santa Cruz, California

Monterey Bay National Marine Sanctuary

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I. Introduction and Background Information

Ecosystem-based Management Initiative
The National Marine Sanctuary System is mandated to "maintain for future generations the habitat and ecological services of the natural assemblages of living resources that inhabit these areas." To achieve this mission, sanctuaries must identify and pursue innovative, proactive ways to manage and protect valuable marine resources.

The Monterey Bay National Marine Sanctuary (MBNMS) has embarked upon a new initiative to improve ecosystem-based management (EBM) in the sanctuary by applying best available science and coordinating with partner agencies and stakeholders. The EBM Initiative has four primary goals:

- Maintain and restore marine ecosystem health, services and function;
- Ensure protection of unique and/or rare features (URF);
- Facilitate research to differentiate between natural variation and human impacts;
- Facilitate ecologically and economically sustainable uses, including fisheries.

By working collaboratively with partner agencies and stakeholders, information related to these four goals has been and will continue to be gathered and evaluated to identify and implement actions to improve ecosystem-based management in the sanctuary.

Unique and Rare Features
MBNMS management has outlined a multi-phase process to address the EBM Initiative goal of ensuring protection of URF. This process is described on the URF website at http://montereybay.noaa.gov/resourcepro/ebmi/rare.html. Gathering information to identify unique and/or rare features, and evaluating threats to those features, is the focus of the first phase of the URF process.

On May 24th, 2011 MBNMS staff convened a workshop to gather information on unique and/or rare features in the sanctuary. The workshop, held at the NMFS-SWFSC Santa Cruz Laboratory, was attended by 31 invited participants, 2 members of the public, and 14 sanctuary program staff (see Appendix I for list of attendees). Invited participants included members of the regional research community, representatives of regional, state and national agencies, representatives of non-profit organizations, representatives of stakeholder groups, and members of the MBNMS Sanctuary Advisory Council.

The goal of the workshop was to gather information on biological, oceanographic and geological features and submerged cultural resources that are unique and/or rare in MBNMS and to identify supporting data sources and information gaps. The specific objectives were to:

1. Identify features in MBNMS that are unique and/or rare.
2. Identify supporting data and information gaps.
3. Determine from what threat(s), if any, the identified features need protection.
4. If needed, identify management actions that could provide protection.

Definitions

MBNMS staff identified the following definitions of key terms:

A **feature** is a particular component of MBNMS. A feature includes, but is not limited to, species (individuals, populations), biological communities, ecosystems, biological diversity, habitats, geological structures (e.g., rocky reefs, seamounts), processes (e.g., succession, upwelling), submerged cultural resources (e.g., ship wrecks), and human activities (e.g., fishing, research, tourism).

A feature that is **unique** is one of a kind, remarkable or unusual.

A feature that is **remarkable** is worthy of attention, extraordinary, or striking

A feature that is **rare** has a low frequency of occurrence in space and/or time.

An **attribute** is a quality, characteristic, or inherent part of a feature. Attributes can be used to further describe a feature, and in some cases can be used to prioritize among multiple examples of a certain feature. Examples include spatial scale (geographic extent), temporal scale (likelihood of persistence), exposure to threats, and resilience.

Workshop Preparation

In preparation for the workshop, MBNMS staff compiled information as background and for use during workshop discussion sessions. Staff identified potential URF in the four major resource categories – Oceanography, Geology, Biology, and Submerged Cultural Resources - used in the Office of National Marine Sanctuary Condition Reports[1]. The potential URF for each resource category were compiled in a 'draft feature list' (available in Appendices A-D). The draft list of submerged cultural resource features was compiled in consultation with Bob Schwemmer (NOAA/ONMS/West Coast Region Maritime Heritage Program Coordinator) and was posted at the workshop for participants to view and provide comments. The oceanographic, geologic and biological draft features lists were distributed to workshop participants at the beginning of the morning break-out group session and served as a 'strawman' for participants to react to and refine during workshop discussion sessions.

Managed species, defined as those managed under the state or federal Endangered Species Act, the Marine Mammal Protection Act and federal Fisheries Management Plans, were not included as URF on the draft features list and were not intended to be a main focus of discussion at the workshop. Managed species were set aside because we already know that they are remarkable and, for some species rare, in the MBNMS. All managed species have been deemed worthy of attention from management agencies (e.g., NMFS, USFWS, CDFG) and because the abundance of these species is monitored by the managing agency, it is already known where they fall along the continuum from common to rare. A list of managed species (available in Appendix E) was posted at the workshop for participants to view and provide comments.

To facilitate the workshop goal of identify supporting data sources and information gaps, MBNMS staff identified the Geographical Information System (GIS) data already in the MBNMS database for each biological, geological and oceanographic feature in draft features lists.

[1] More information on Office of National Marine Sanctuary Conditions Reports is available online at http://sanctuaries.noaa.gov/science/condition/welcome.html

Information on the available GIS data was compiled in tables (available in Appendices F-H) that were distributed to workshop participants during the morning break-out group session. Workshop participants were asked to identify additional relevant datasets that were not in the MBNMS database.

Workshop Structure and Agenda

The purpose of this workshop was to receive information from the participants on unique and rare features in the MBNMS, to identify potential threats to those features and to identify relevant data sources and information gaps. The one-day agenda consisted of four sessions: background information, two breakout group sessions, and one large group discussion (agenda available in Appendix J). The workshop began with MBNMS Superintendent Paul Michel introducing the Ecosystem-based Management Initiative, including the goals, strategies for implementation, and the role of workshops in the information-gathering phase of the process. Staff provided definitions of relevant terms and concepts, introduced the draft features lists and GIS data tables, and described the overall process for the work sessions.

Two break-out discussion sessions were held, a morning session focused on vetting the draft features list and identifying supporting data and data gaps, and an afternoon session focused on identifying threats to the features discussed in the morning session and sources of information on those threats. Workshop attendees were divided into four groups – Oceanography, Geology, Biology 1 and Biology 2. The Biology 1 group focused on plants, algae, and invertebrates while Biology 2 focused on fishes, birds and mammals. During the large group discussion at the end of the day, MBNMS gathered feedback from the participants on the URF process and the EBM initiative. During the workshop, there was no intention to achieve consensus, but rather to capture the range of considerations reflected in the presentations and discussions.

II. Summary by Break-out Session

A large amount of information on unique and rare features in MBNMS was gathered during the break-out group discussions. An overall summary of the information gathered in each discussion session is provided below. Detailed information for each feature, including remarkable attributes, potential threats, data sources and information gaps, is available in Tables 1-4.

Oceanographic Features

During the first break-out session, workshop participants in the oceanography group revised the draft oceanographic feature list. The revised list and detailed information on each of the oceanographic features is available in Table 1.

Revisions to the draft features list were made primarily by lumping features and adding more specific identifiers. For example:

- Frontal zones were combined with tidal fronts and convergence zones, and deemed remarkable in terms of the concentration of nutrients and biological resources. Frontal zones are numerically common but spatially rare since they are relatively narrow. They are very important relative to the area they occupy.
- The feature “Currents” was split into two features “California Undercurrent” and “Rip Currents.” Rip currents were identified as remarkable because they tend to concentrate toxins.

Features highlighted during the discussion were:

- Upwelling features
- Seasonal upwelling shadow in northern Monterey Bay
- Promontory-induced upwelling centers
- Topographically-induced upwelling
- Curl-induced upwelling
- Meandering-Eddy (Me-Eddy)
- Mixing zones
- Canyon mixing zones
- Davidson Seamount mixing zone

Participants provided many data provider names, mainly local researchers, for follow-up.

Geological features, such as the shape of the bay and canyons, have important influence on shaping some physical oceanographic features.

Chemical oceanographic features were absent from the draft features list. MBNMS should work with chemical oceanographers to determine if any chemical features should be included.

Lack of information (data) presented a challenge in determining the uniqueness of some features. For example, is unclear if the upwelling shadow in northern Monterey Bay is unique because there may be a second upwelling shadow at Point Sur.

Many features (e.g., Langmuir cells, internal wave slicks, packets, solitons, wind relaxation events) were identified as remarkable because of their contribution to the biological communities of the MBNMS.

Rarity can be considered a function of spatial variation, temporal variation, or intensity of an oceanographic feature.

Participants suggested adding extreme events, such as climate change, Pacific Decadal Oscillation and tsunamis, to the feature list.

Geological Features

During the first break-out session, workshop participants in the geological features group discussed the draft features lists that had been compiled by MBNMS staff. Table 2 contains more detail, but features discussed by this group fell into the following categories:

- Canyons – Canyons should be subdivided into finer resolution categories, such as active and passive. Active canyons are relatively common in MBNMS (3 active canyons) but uncommon beyond MBNMS. One method for further identifying areas of interest would be to overlay substrate type with slope; areas of high slope and hard substrate tend to have interesting associated biology.
- Seamounts and Ridges – Davidson Seamount is unique in MBNMS, but there are 1000's globally. The biology is very different from other seamounts with similar origins (e.g., Gumdrop and Pioneer). Smooth Ridge is an inter-canyon ridge covered with sediment, and is considered unusual.
- Sur Platform is an area near shore with exposed sedimentary rock; at least one participant considered it rare.
- Ledges - Portuguese Ledge is a unique carbonate structure on the shelf slope, providing relatively high relief in an area that lacks such structures.
- Fault zones – There are several interesting fault zones but do they need protection? They may add another level of interest for particular types of areas that generally lack faults zones.
- Vents and chemosynthetic biological communities – Not enough data to determine if these features are unique or are. A few locations in MBNMS (e.g., Extrovert Cliff, Clam Acres) have been regularly visited.
- Landslides – Big Sur is unique in that a mountain ridge is actively sliding into the ocean, part of being a transform continental margin.
- Sediment accumulation zones – These areas have high nutrient and possibly contaminant loads, and are a source of iron for the upwelling system.

Yellowbank Bench near Davenport is the largest exposed sandstone injectite (aka, clastic intrusion) in the world. Point Lobos has a gravel deposit in a submarine canyon that is unique in the world and frequently visited.

Key attributes of geological features: Slope, relief, rugosity, age (lithology), and substrate type, and influence on local biology and oceanography.

Other 'take-home' messages:

- Data gaps are significant in the sanctuary north and south of Monterey Bay.
- Most geologic features are not threatened by anticipated activities.
- Geologic features may not warrant additional management attention on their own, but in combination with certain biological and oceanographic conditions may create distinctive features worthy of management consideration.

Biological Features 1 [plants, algae and invertebrates]

During the first break-out session, workshop participants in the Biology 1 group revised the draft list of biological features with a focus on plants, algae and invertebrates. The specific information gathered for each of the biological features discussed by this group is available in Table 3.

The group first identified general habitat categories as features (highlighted in gray in Table 3). They used the same habitat categories that were defined in the Marine Life Protection Act MPA process, which includes both benthic and pelagic habitats. Benthic habitats were delineated by substrate type (hard or soft bottom) and depth.

Then features within a habitat category were identified and discussed (Table 3). For example:

- General habitat category = estuary. Elkhorn Slough was identified as a unique, rare and remarkable biological feature in MBNMS.
- Both eelgrass beds and native oysters were identified as features within the estuary habitat category that are remarkable, and possibly rare, in MBNMS.

Benthic features - the features that dominated discussions generally had one or more of the following attributes:

- Primary producers (base of the food web). Examples: eelgrass, *Postelsia*, kelp beds, drift kelp, chemosynthetic biological communities
- Biogenic habitats – due to their role as habitat for other species and susceptibility to damage from various human activities. Examples: eelgrass, native oyster beds, kelp beds, sand dollar beds, sea pens, deep water corals and sponges
- Elevated biomass/density. Examples: whale falls, squid egg beds
- Elevated biodiversity. Examples: chemosynthetic biological communities, whale fall communities, kelp beds
- Reduced abundance. Examples: black and red abalone, eelgrass beds, native oysters

Pelagic features – this category was covered last as time was running out so follow-up is needed. Preliminary list of URF for pelagic invertebrates includes:

- Hot spots or aggregations of krill and jellies are remarkable due to their importance as foraging destinations for fish, birds, mammals and turtles.
- The invertebrate community in the upwelling shadow in northern Monterey Bay is remarkable and may be unique within the MBNMS.

Participants provided many data provider names, mainly local researchers, for follow-up.

Biological Features 2 [fish, birds and mammals]

During the first break-out session, workshop participants in the Biology 2 group revised the draft list of biological features with a focus on fish, birds and mammals. Specific information gathered for each of the biological features discussed by this group is available in Table 4.

Participants primarily discussed pelagic features given the taxonomic groups, but some benthic features were discussed as well.

Many features were identified as important for ecosystem health and may be candidates for special protection or other management actions (see Table 4). These features fall into the following categories:

- Nursery habitat
- Areas of high productivity - areas with oceanographic conditions that contribute to high concentrations of zooplankton and forage species. High concentrations of forage species (base of food chain) attract and concentrate species at higher trophic levels. Features that are predictable in space and/or time (e.g., upwelling centers) are especially important.
- Hot spots for large mobile predators – locations where large mobile predators are observed repeatedly over time, which will overlap with areas of high productivity in some cases. There is a high level of concern for those hot spots threatened by by-catch, unsustainable fishing, or aggregate human activities.
- Discrete populations, such as sea otters and genetically distinct populations of harbor porpoise. There is a high level of concern due to threats from water pollution, ship strikes, and food limitation.
- Migratory corridors. Some corridors are tied to forage species and areas of high productivity, while other corridors (grey whales) are not tied to a resource. The timing (year, season, frequency) and placement (spatial distribution and predictability) of some migration corridors is threatened by climate change and ocean acidification. Corridors associated with feeding can be affected by any stressors that affect prey base.

The group did not discuss some features because of either time limitation or because the URF framework was not appropriate for dealing with the particular feature types.

It would be useful to consider a URF framework that examines the functional role of organisms, such as forage species, apex predators, endemic species and discrete populations. Forage species are not unique or rare but are extremely important for ecosystem health and function. Apex predators play unique roles in ecosystem health.

Summary of workshop sessions on threats

In the second break-out group session, each of the groups discussed current and emerging threats to features and provided sources of data on threats if available (available in Tables 1-4). Information gathered on threats to URF in MBNMS is summarized here.

Fewer types of threats were identified for geologic and oceanographic features than biological features.

Of the 22 oceanography features discussed, threats related to climate change were identified for 17.

Most biological features were considered subject to multiple threats. Many of the threats identified were specific to the feature (see Tables 3 and 4 for more details on specific threats to biological features). However, a few threats, including anthropogenic marine debris, noise, shipping and vessel activities, potentially impact many of the biological features.

Overarching threats - The following were identified as threats to many features in two or more resource categories:

- Current overarching threats include oil spills, degradation of water quality (e.g., nutrients, pollutants, oxygen levels) and fishing (e.g., removal of organisms, physical damage, marine debris). Related to fishing, it was noted that it might be important to differentiate between the impacts of recreational and commercial fishing and that fishing impacts were more intense historically.
- Emerging overarching threats include climate change (e.g., rising sea level, increased frequency and intensity of storms, acidification), offshore aquaculture, and new forms of energy development.

Research is needed to understand the potential impacts of emerging threats to URF. For example:

- How will climate change affect upwelling?
- How will wind or wave energy farms potentially impact oceanographic features such as surface waves, Langmuir cells, and rip currents?

Management must anticipate issues that may not pose a threat now but are likely to become important in the future. Marine spatial planning is critical to planning for these shifts.

It was suggested that we think about threats by categories and associated management strategies. Examples categories included:

- climate change related
- pollution related
- coastal development, debris deposition
- extraction
- structural, such as submerged cables
- chronic vs. episodic

III. Summary by Topic

An overall summary of the information gathered in both break-out sessions and combined sessions for the main topics discussed at the workshop is provided below.

Unique

Unique features (one of a kind) were identified in each resource category:

- Elkhorn Slough, the only estuary within the boundaries of the MBNMS, was identified as a unique feature in all resource categories.
- Unique geological features in MBNMS include Yellowbank Bench (near Davenport), Monterey Submarine Canyon, submarine gravel deposits at Pt. Lobos, Portuguese Ledge (southern Monterey Bay), and Davidson Seamount.
- The upwelling shadow in northern Monterey Bay is a unique feature given the combination of oceanography and biology.
- A genetically distinct population of harbor porpoise is contained within MBNMS boundaries.
- The *Eisenia* (kelp) bed at Pt. Lobos is one of a kind.

Loss or degradation of unique features would have a negative impact on resource quality and diversity of MBNMS:

- Unique features, especially those that are unique at larger spatial scales, have intrinsic value. A principle of ecosystem management is to identify and retain all ecosystem components.
- The potential ecosystem health impacts from degradation of some unique features in MBNMS are not well understood.

Rare

Determining rarity proved to be very difficult in the workshop setting:

- Using general criteria for rarity was not feasible - criteria need to be specific to each feature type.
- Rarity was not well understood for many features, and consultation with subject experts and data holders is needed. MBNMS will need to follow up with experts for features related to priority management issues or concerns.
- Many features are not rare, but extreme events within a feature can be rare or the combination of two or more factors can produce a feature that is rare.

Remarkable

This classification of features seemed to resonate best with many workshop participants. Many features in the sanctuary may not be one of a kind or particularly rare, but are worthy of management attention.

Attributes associated with features identified as remarkable include: elevated biomass, diversity/heterogeneity, productivity, aggregation, low resistance and/or resilience, and reduced abundance.

A feature that may not be remarkable when examined through the lens of a single resource category (e.g., geology or biology) may be remarkable when examined across resource categories.

- Geology structures habitat for living systems, so many unique, rare or remarkable features are created by the interaction between geology and biology. One method for identifying

features of interest would be to overlay substrate type with slope; areas with high slope and hard substrate tend to have interesting associated biology
- Many of the pelagic biological features identified as unique, rare, or remarkable are strongly linked to oceanographic features.

Features that are remarkable across disciplines (i.e., features identified as remarkable by two or more break-out groups) include:

- Elkhorn Slough - entire estuary
- Kelp canopy
- Upwelling shadow in northern Monterey Bay
- Foraging aggregations
- Davidson Seamount
- Monterey Submarine Canyon
- Portuguese Ledge
- Chemosynthetic biological communities

Follow-up is needed with experts from a variety of disciplines to help identify additional cross-discipline unique and/or remarkable features. Those combinations are likely to be some of the top priority features for extra attention and management.

Ecosystem Health

Several participants suggested it is preferable to examine Unique/Rare/Remarkable qualities through the lens of ecosystem health. If a feature disproportionately contributes to ecosystem health (relative to other features) in the MBNMS, then the feature should be classified as URF. Examples include:

- Estuaries: estuaries in MBNMS contribute disproportionately to ecosystem health
- Upwelling shadow in N. Monterey Bay
- Areas of high productivity

The co-occurrence of multiple URF helps identify locations for management consideration.

In many cases, however, the relative contribution of a feature to ecosystem health may not be known.

Threats

Fewer types of threats were identified for geologic and oceanographic features than biological features and most biological features were considered subject to multiple threats

Overarching threats - Current and emerging threats to many features in two or more resource categories include:

- Current Threats: Fishing impacts (e.g., removal of organisms, physical damage, marine debris), oil spills, and degradation of water quality (e.g., nutrients, pollutants, oxygen levels).
- Emerging threats: Climate change (including rising sea level, increased frequency and intensity of storms, acidification), offshore aquaculture, and new energy development.

IV. Key Findings and Next Steps

Key points from workshop discussions include:

- Unique, rare and remarkable features were identified in each resource category (i.e., geology, oceanography, biology) in MBNMS.
- All break-out session groups covered many features for which they had specific knowledge or for which there was general agreement about status as unique, rare, or remarkable. Some features were not addressed because of time constraints or because participants deferred to future opportunities to discuss the feature with additional subject experts.
- A number of URF are created through the interaction of geologic, oceanographic, and biological features. Follow-up with cross-disciplinary expert groups is needed to further identify and understand the attributes of cross-category URF.
- A priority attribute in evaluating a feature is its contribution to ecosystem health. It was frequently suggested that features contributing disproportionally to ecosystem health should be identified as remarkable. Research is needed to better understand the roles that many of the identified features play in maintaining the structure, function and services of the ecosystem in MBNMS.
- The workshop provided substantial information on threats to a large number of features. The threats identified were often general in nature (e.g., climate change, pollution), and expert group feedback will be useful in evaluating specific threats to features related to priority management issues.
- Threats to certain features are well understood. Other threats, particularly those that are long-term, indirect and/or emerging, must be addressed through future research.
- There is a need for continued development of an ecosystem-based approach to research and sanctuary management.

Estuaries, forage aggregations and benthic habitats are three topics of continuing management interest for MBNMS and partner agencies, and these were discussed frequently by workshop participants. The information gathered related to these topics will be valuable in the formulation of research questions and the evaluation of management alternatives as part of the EBM Initiative:

- Estuaries were identified as important to numerous aspects of ecosystem health. There are numerous small estuaries adjacent to the sanctuary, and Elkhorn Slough is partly contained within the sanctuary. Elkhorn Slough was identified as a remarkable feature in every resource category, and contains specific features, such as oyster populations and eelgrass beds, that were identified as URF. Numerous threats to estuaries and estuarine features were identified, including pollution from nutrients and toxic chemicals, sedimentation, coastal development and invasive species.
- Forage aggregations were discussed as a type of cross-category URF critical for ecosystem health. These important biological aggregations are linked to various geologic and oceanographic URF such as canyons, upwelling shadows, and frontal zones.

- Specific combinations of geologic, oceanographic and biological features create benthic habitats that support ecologically important communities, biodiversity and high productivity. A number of threats to benthic habitat were identified, including marine debris, fishing activities, submerged cables, climate change, ocean acidification, and dissolved oxygen reduction.

The workshop discussions highlighted research needs for the on-going information gathering phase of the EBM Initiative. Participants identified gaps in our understanding of the connection between URF and ecosystem structure, function and services. Participants also identified the need for research on specific threats, feature sensitivities to threats, and thresholds associated with changes in state and resilience. MBNMS is coordinating with partners to address some of the identified research needs.

A main effort of the EBM Initiative will be to focus research, data synthesis and analysis on improving our understanding of the ecological roles, vulnerability to threats, and resilience of priority features. Features highlighted at the workshop will be further evaluated by expert groups associated with MBNMS and its partners.

The EBM Initiative, as a distinct MBNMS project, is characterized by attention to the complexity of both ecosystems and related management efforts. The workshop reinforced the need to align management efforts by the many agencies responsible for water quality, fisheries, seabed alteration, vessel traffic, coastal development and other activities that potentially threaten URF and their contributions to the broader sanctuary ecosystem.

Table 1: Modified list of oceanographic features in Monterey Bay National Marine Sanctuary. A draft list of oceanographic features in MBNMS (see Appendix A) was discussed and modified by scientific experts at the workshop. MBNMS staff summarized the information received from workshop participants in the table below. During the morning break-out session, participants discussed whether the feature type was unique, rare or remarkable in MBNMS and at larger spatial scales (e.g., California Current, globally). Participants reviewed the GIS data available in the MBNMS database (see Appendix F) for each feature and provided additional sources. In the afternoon break-out session, threats to the feature and sources of data on threats were discussed. Potential follow-up questions or next steps have been identified by staff for some features.

Feature Type	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature	Sources of data on threats	Follow-up/ next steps
Upwelling: Seasonal Upwelling Shadow (N. Monterey Bay)	Yes - Unique and Rare. Unique because it is much different from the one South of Pt. Reyes. Rare given current knowledge. May be rare at the scale of CA current system, (there's one at Pt. Reyes and potentially at Pt. Sur). Upwelling-dependent so probably rare globally (False Bay in South Africa is similar to N. Monterey Bay)	Yes. Upwelling system fronts create small-scale structure and dynamics that influence plankton ecology (Ryan et all 2010)	MLPA documentation; HF Radar Surface currents (CeNCOOS); block fish data since they like upwelling shadows; Raphael Kudela Satellite data (climatological radar should show low circulation)	Yes-climate change	Not addressed	Follow-up on data and with data sources; Research Question: Is there a Pt. Sur shadow?
Upwelling: Promontory-induced Upwelling Centers	Not Unique. They're not unique since they occur where they are predicted but they are seasonal. Extreme events are rare.	Yes, it is remarkable because of ecosystem impact in terms of ecosystem function	Dave Foley; MLPA MPA process notes from meetings	Yes-climate change	Not addressed	Follow up with Dave Foley for conditional average of upwelling onset based on derived wind data; determine if extreme events should be separated out; consider temporal aspects. Research Questions: Does global change make upwelling more ubiquitous? Monitor to detect changes in seasonal strength since there are feedback loops, for example, if upwelling increases, acidification increases.

Feature Type	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature	Sources of data on threats	Follow-up/ next steps
Upwelling: Topographically-induced upwelling	Not Unique. They're not unique since they occur where they are predicted but they are seasonal. Extreme events are rare.	Yes (same as above)	Satellite data, MLPA MPA process notes from meetings	Yes-climate change	Not addressed	Same as above
Upwelling: Curl-induced upwelling	Not Unique. They're not unique since they occur where they are predicted but they are seasonal. Extreme events are rare.	Yes (same as above)	Not addressed	Yes-climate change	Not addressed	Same as above
Currents: CA Undercurrent/ Polar Undercurrent	Yes undercurrents are rare in the MBNMS and at larger spatial scales. (disagreement in group) Not unique.	Yes. Influence of the undercurrents allows the type of intertidal species we have here to flurish	Jeff Paduan; Collins (suggested by Jeff Paduan), Ramp et al 1999	Yes-climate change; nutrient ratio changes because of source water is changing	Steve Bograd- undercurrent changing its nutrient ratios affecting diatom and dino-flagellate blooms.	Follow-up with data sources; get agreement on rarity. Research Questions: Are undercurrents rare? At what scales are undercurrents rare?
Currents: Rip currents	Not unique or rare in MBNMS.	Yes. Significant because it tends to concentrate toxins	Data on surface currents: HF Radar (CeNCOOS), Steve Morgan at Bodega Bay, Alan Shanks at Oregon, Jamie McMann at NPS	Yes-climate change, source wave energy farms could cause weaker waves, water flow changes, wind energy farms	Data on wave energy- OPC (State level); Oregon project, MMS; smart from the start; N. of Falmouth residents complained about low frequency noise from wind farms	Follow up with data sources
Frontal Zones (combined with tidal fronts and convergence zones)	Yes they are rare, not unique. These features are spatially rare, numerically common.	Yes. Supply nutrients, very important in terms of the area they occupy	Erica Mac-Phee, Larry Breaker; MLM work in Elkhorn Slough, Bill Brenkow	Yes-climate change	Not addressed	Follow-up on data sources
Mixing zones: Canyon mixing zone	Rare; not unique	Yes. Extreme events can influence albacore and swordfish fisheries	Steve Ramp, marleen Noble at DRI (generation of internal waves) use analogies	Not threatened	Not addressed	Follow up with data sources; Research Question: What constitutes extreme events?

Feature Type	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature	Sources of data on threats	Follow-up/ next steps
Mixing zones: Davidson Seamount mixing zone	Rare; not unique	Yes. Influential on the biology, albacore and swordfish fishermen fish there because of it	Steve Ramp (on fiberling circulation), Marleen Noble at DRI (generation of internal waves) use analogies	Not threatened	Not addressed	Follow up with data sources; Research Question: Study Davidson Seamount mixing (expensive study).
Mixing zones: Pycnocline at mouth of Monterey Bay	Rare, not unique. Rare strong pycnocline above continental shelf and canyon intersection; 7 sites like it on the west coast based on satellite data so rare on west coast.	Yes. Influence Algal blooms	John Ryan, Raphael Kudela, Erica Mcphee-shaw; Rick Castle and Rick Fiesh	Yes-climate change	Not addressed	Follow-up with data sources
Freshwater Plumes	Rare in the MBNMS and in CA, but not rare globally. Not Unique.	Yes; create temporal circumstance of moving nutrients into the sanctuary, also consider spatial influence (size of plume), plume has important localized influence; influence algal blooms	Not addressed	Yes-climate change; desal projects, road ways and other human induced threats e.g. invasive species, pollutants, water diversion ; sediment supply; excessive nutrients in slough are causing fish to "hyperventilate"	Not addressed	Follow-up how algal blooms are influenced
Oxygen minimum layers	Not unique or rare. There is evidence that the OMZ's are expanding their depth ranges.	Not addressed	COS, MBARI (Bruce Robertson), new sensors from MBARI (OA1, OA2) See websites; international group (check with Kuleda-Apoxia and HABs) John Harrison from WA and Bowman from Netherlands funded by UNESCO	Yes-climate change; pollution which can decrease oxygen levels	COS working group, Erica at aquarium, John Harrison in WA leading international research; Erika McPhee-Shaw's student re: nutrient loading/oxygen minimum	Follow-up with data sources

Feature Type	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature	Sources of data on threats	Follow-up/ next steps
Internal wave slicks, Internal wave packets, Internal solitons	Not Unique. Yes, they are rare in MBNMS and at a larger scale. The MBNMS is a rare setting due to abrupt topography; seasonal changes in abundance of feature (more common in summer).	Yes. They bring nutrients to the surface (so nutrient redistribution), sediment resuspension; important for larval transports	Steve Ramp student's unpublished data; Erica Mcphee-Shaw, AUV transects by John Ryan, pacific data by Tim Stanton	Not threatened	Not addressed	Follow-up with data sources
Meandering Eddy (Me-Eddy)	Not rare in MBNMS but may be rare globally. Uniqueness was not addressed.	Yes. They can influence down to 1000 m, strong influence on the upwelling surface water	Roosenfelt et al. 1994, John Ryan 2005- meander flushing the bay, RAMP- 2003 and 2006 results	Yes-climate change	Not addressed	Follow-up with data sources; Research Question: Focused eddy study in MBNMS.
Lagmuir cell	Not rare or unique	Yes. Biologically important	Pinkle and Jerome Smith studies	Yes-climate change; wind farms	Not addressed	Follow-up with data sources
Surface waves	Not rare, however, extreme events that influence rip tides are rare, but critical (moving sand, eroding beach); unknown if unique in MBNMS because only few studies have been done	Yes. Important when associated with topographical features because can create some unique spots	NDBC, CDIP (State of CA program); buoys	Yes-climate change; wave generators and wave energy which can change wind and wave potential	Not addressed	Follow-up with data sources; Research Question: combine wave studies with geology discussion to look for features such as unique surfing spots.
Extreme weather events	Not addressed	Not addressed	Francisco Chavez (MBARI), Jeff Paduan (NPS)	Yes-climate change	Not addressed	Follow-up with data sources
El Nino/La Nina	Not addressed	Not addressed	Not addressed	Yes-climate change	Not addressed	None identified
Lagoons (Brackish water)	Not addressed	Not addressed	CCAMP, SPOT (WQ data), Karen Worcester	Yes-climate change; diversion wells for desalination projects, road ways (highway /bridge development and replacement) and other human induced threats e.g., invasive species, pollutants, water diversion upstream; sediment supply and deposition	Not addressed	Follow-up with data sources
Tsunami (seiche)	Yes it is rare, not unique.	Not addressed	Not addressed	Not threatened	Not addressed	None identified

Feature Type	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature	Sources of data on threats	Follow-up/ next steps
Wind relaxation event (On-shore transport)	Not addressed	Yes. Important for recruitment	Roughgarden and Roosenfelt	Yes-climate change	Not addressed	Follow-up with data sources
Sea level	Not addressed	Not addressed	Not addressed	Yes-climate change; threats depend on PDO/El Nino years- but Larry Breaker mentioned to Steve S. that it wouldn't effect us much on this coast	Not addressed	None identified

Table 2: Modified list of geologic features in Monterey Bay National Marine Sanctuary. A draft list of geologic features in MBNMS (see Appendix B) was discussed and modified by scientific experts at the workshop. MBNMS staff summarized the information received from workshop participants in the table below. During the morning break-out session, participants discussed whether the feature type was unique, rare or remarkable in MBNMS and at larger spatial scales (e.g., California Current, globally). Participants reviewed the GIS data available in the MBNMS database (see Appendix G) for each feature and provided additional sources. In the afternoon break-out session, threats to the feature and sources of data on threats were discussed. Potential follow-up questions or next steps have been identified by staff for some features.

Feature Type	Examples	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature	Sources of data on threats	Follow-up/ next steps
Seamounts	Davidson Seamount	Unique and Rare in MBNMS. Not rare on west coast. Globally rare type of seamount (plate setting)	1 of 10 on west coast on abandoned spreading center; biology different from other seamounts within CCLME; proximity to land/research institution makes it "unique"	30 ROV dives (2nd best studied in world to Loihi, Hawaii)	Yes - bottom contact fishing (but currently protected from this threat), bioprospecting for pharmaceuticals, submerged cables	None identified	
Estuaries	Elkhorn Slough	Unique and Rare - only one in MBNMS	None identified	None identified	sea level rise	None identified	
River mouths		Not addressed	Not addressed	Not addressed	sea level rise	None identified	Feature not addressed - follow-up needed
Estuarine Habitat	salt marsh, mudflat, soft bottom, clay bottom	Not addressed	Not addressed	Not addressed	sea level rise	None identified	Feature not addressed - follow-up needed
Hard substrate in intertidal and subtidal, high relief		Not addressed	Not addressed	Not addressed	sea level rise	None identified	Feature not addressed - follow-up needed
Subsurface vents	Extrovert Cliff (900 m; off Monterey Canyon in slide scar)	Unique and/or Rare - maybe, not enough data to determine.	CBCs; Unequivocal fluid flow. Uniquely rich and abundant CBCs of clams. It's a geologically stable portion of the ocean floor.	None identified	Not convinced it is threatened. Turbidity current can wipe them out; changes in sediment budget	None identified	
Subsurface vents	end of Monterey Canyon	Same as above	CBCs: densest bed of clams on west coast	None identified	Same as above	None identified	

Feature Type	Examples	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature	Sources of data on threats	Follow-up/ next steps
Fault zones	San Gregorio-Palo Colorado	Unique - No. Rare - at MBNMS scale (it is rare to be sitting at these fault zones). Not rare along the California coast. Transform continental margins (e.g., on shelf) are rare globally.	MBNMS has a unique tectonic setting. San Andreas (mother fault, very close to the shore) and San Gregorio are connecting and affecting a lot of the morphology in central CA. Controls orientation of Carmel Canyon and Año Nuevo.	None identified	None identified	None identified	
Fault zones	Monterey Bay Fault zone	Same as above	Not much relief in this fault zone.	None identified	None identified	None identified	
Fault zones	Hosgri (near San Simeon)	Same as above	This fault zone offsets Franciscan rocks against sand banks.	None identified	None identified	None identified	
Canyon: Active	Monterey	Rare ~3 active of 12 passive	Nearshore; ephemeral; active (disproportionate amount sand moving down canyon); tap into inner shelf. 3 in one sanctuary is unusual	Greene; Calstate waters mapping project; new Paull data	None identified	None identified	
Canyon: Active	Carmel	Rare ~3 active of 12 passive	Nearshore; ephemeral; active; tap into inner shelf, slope, rock exposure	Same as above	Yes - sediment budget will change and accumulated pesticides (DDT) in sediments will enter canyon when San Clemente Dam removed.	None identified	
Canyon: Active	Partington	Rare ~3 active of 12 passive	Nearshore; ephemeral; active; tap into inner shelf	Same as above	None identified	None identified	
Canyon: Passive		No	No; quite common	None identified	None identified	None identified	
Canyon	South of Partington (closer to southern MBNMS	Unknown - not much information	None identified	None identified	None identified	None identified	

Feature Type	Examples	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature	Sources of data on threats	Follow-up/ next steps
	boundary)						
Classify into types of rocks (e.g., by size categories)	Islands - Rocks	Not addressed	Not addressed	Not addressed	sea level rise	None identified	
Ridges	Sur Ridge	No	Yes; rocky relief, fault-formed (faulted block), interesting geology/biology	MBARI: bathymetery, acoustic backscatter, ROV; NOAA Okeanos (2011): multibeam and backscatter	Yes - bottom contact fishing; bioprospecting for pharmaceuticals; submerged cables	None identified	
Ridges	Smooth Ridge	No	Yes; inter-canyon sedimentary ridge between Cabrillo and Monterey canyons	MBARI	None identified	None identified	
Ridges	Santa Lucia Bank (south of MBNMS)	Unknown - very little information	Geologically interesting (landslides; tsunami; outcrops recruitment)	None identified	None identified	None identified	
Capes and headlands	Point Sur, Point Lobos	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Feature not addressed - follow-up needed
Turbidity Flows (process)		Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Feature not addressed - follow-up needed
Pinnacles		Not addressed	Not addressed	Not addressed	trawling; infrastructure (anchors, piers, jetties)	None identified	Feature not addressed - follow-up needed
Mobile sand sheets (RSD is	Pt. Pinos, Pt. Sur	Neither	Sand sheets from Golden Gate (resulting from human activity	None identified	dams, coastal armoring, dredging;	None identified	

Feature Type	Examples	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature	Sources of data on threats	Follow-up/ next steps
type of)			since the gold rush) are migrating and changing sediment budgets (bedrock is exposed and other areas covered). Sediment is caught and taken away in the canyon. At Pt. Piños - migration around Pt. Piños to Carmel Canyon. At Pt. Sur - a lot of mobile sand sheets in this area. They migrate around the point and lost to canyons. This movement will change forage fish (sand lance).		other SF bay management activities that could affect this? Aggregate mining; SF sediment contribution is 1/5 of total contribution to MBNMS		
Hard feature off Point Sur	Sur Platform	Rare	Global sand sheet	None identified	None identified	None identified	
Erosion-resistant remnant on shelf	Portuguese Ledge	Neither	Unique carbonate formation within shelf of bay; high relief/rugosity, historically important to fishers	None identified	None identified	None identified	
Terrestrial landslides impacting nearshore	Big Sur	Rare in US; maybe not rare globally.	None identified	None identified	climate change (rainfall, storm intensity, frequency)	None identified	
Sediment accumulating basins/deposits	Bench on side of canyon	Neither	Sediment accumulation is a key process that can affect management. Accumulated sediment sequences are important because they determine where carbon is going, where are the nutrients, etc. These places are extremely important. They are source of iron for the entire upwelling system.	None identified	None identified	None identified	
Sediment accumulating basins/deposits	Floor of inactive canyons	Neither	Same as above	None identified	None identified	None identified	

Feature Type	Examples	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature	Sources of data on threats	Follow-up/ next steps
Sediment accumulating basins/deposits	Pt. Lobos submarine gravel deposits	Unique in world	Same as above	None identified	None identified	None identified	
Mid-shelf mud belts (shallow and deep)		Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Feature not addressed - follow-up needed
Conduits (geol process/organic movement)		Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Feature not addressed - follow-up needed
Ripple scoured depressions		Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Feature not addressed - follow-up needed
Shore Beds	Halfmoon Bay	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Feature not addressed - follow-up needed
Shore Beds	Año Nuevo	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Feature not addressed - follow-up needed
Geologic diversity		Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Feature not addressed - follow-up needed

Table 3: Modified list of biological features related to plants, algae, and invertebrates in Monterey Bay National Marine Sanctuary. A draft list of biological features in MBNMS (see Appendix C) was discussed and modified by scientific experts at the workshop. The Biology 1 group [which focused on biological features related to plants, algae, and invertebrates] identified general habitat categories (shaded gray in table) as features and then additional features within each habitat category were identified. MBNMS staff summarized the information received from workshop participants in the table below. During the morning break-out session, participants discussed whether the feature type was unique, rare or remarkable in MBNMS and at larger spatial scales (e.g., California Current, globally). Participants reviewed the GIS data available in the MBNMS database (see Appendix H) for each feature and provided additional sources. In the afternoon break-out session, threats to the feature and sources of data on threats were discussed. Potential follow-up questions or next steps have been identified by staff for some features.

Feature Type	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature?	Sources of data on threats	Follow-up/ next steps
Estuary - Elkhorn Slough	Unique and rare - Elkhorn Slough is only estuary inside boundary of MBNMS.	Yes - estuaries contain highly productive and diverse communities of plants/algae/invertebrates	K. Wasson (ESNERR)	Yes - sea level rise, erosion control structure, oil or chemical spill, sea otters	R. Stamski and K. Wasson (erosion control); Tinker & Estes, Jim Harvey, Costa lab (sea otters)	Follow-up with data sources. Follow-up with local experts to determine if there are additional URF in this habitat category.
Eelgrass beds	Not unique - many eelgrass beds in Elkhorn Slough. Rare - Undetermined. Abundance has increased over last few decades, but not to levels in the 1920s.	Yes - provides habitat for many species. Acts as "ecosystem engineer", trapping sediment and slowing water velocity.	K. Wasson - for more recent data from ESNERR	Yes- nutrient loading, tidal scour, sedimentation, gear damage (from boating, fishing, research), crabs	Wasson, van Dyke, Zimmerman	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.
Native oyster beds	Not unique - many native oyster beds in Elkhorn Slough. Rare - maybe. Less abundant than in 1920s.	Yes - serves as "ecosystem engineer" by providing reef structure, increasing local biodiversity.	K. Wasson - for more recent data from ESNERR	Yes - entrainment in power plant intake, invasive spp., sedimentation, nutrient loading/hypoxia, pollutants, ocean acidification	Wasson 2010, Johnson, Flegal, CDFG	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.
Mudflat community	Not addressed	Not addressed	K. Wasson - for more recent data from ESNERR	Not addressed	Not addressed	Mudflats were brought up as another estuarine feature, but group was not certain if this feature is inside MBNMS boundary. Follow-up needed.

Feature Type	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature?	Sources of data on threats	Follow-up/ next steps
Rocky intertidal community	Not unique or rare in MBNMS. Rare at the global scale.	The place where most people visit the ocean, but one of the smallest habitats by area	Pete Raimondi, John Pearse; Andrew D., Steve L.,	Yes - trampling, collection (for fishing and consumption), oil spill, invasive spp (*Sargassum*, *Nereis virens*), road maintenance (smothering), effluent, coastal armoring	P. Raimondi (PISCO), K. Wasson, Murray (S. Cal info), R. Kvitek (CSUMB), RWQCB, Mussel Watch, D. Hardin (CCLEAN), Stamski report	Follow-up with data sources. Follow-up with local experts to determine if there are additional URF in this habitat category.
Postelsia	Not unique. Rare - unknown. Check with data holders.	Yes. Biogenic habitat	managed spp (CDFG); PISCO	Yes - poaching, rising ocean temperatures	CDFG, P. Raimondi, C. Blanchette	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.
Black abalone	Not unique. Rare in MBNMS and at larger spatial scales. Listed as endangered under federal ESA	None identified	managed spp (CDFG; NMFS) - Raimondi and Lonhart data sources	Yes - disease (withering syndrome), poaching, rising ocean temperatures, sea otters	P. Raimondi (PISCO), CDFG, M. Neuman (OPR-NMFS), C. Friedman (UW), T. Tinker (USGS-WERC)	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.
Red abalone	Not unique. Rare in MBNMS and at larger spatial scales. Protected from harvest in MBNMS because of low abundance	None identified	managed spp (CDFG)	Yes - poaching, sea otters, invasive sabellid worm	CDFG, T. Tinker, P. Raimondi	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.
Rocky subtidal community (0-20 m)	Not unique or rare in MBNMS. Rare at the global scale.	Yes. Popular destination for diving	PISCO, Reef check, CRANE, NMFS subtidal surveys; ASBS	Yes - invasive species (*Undaria*), sea urchin outbreaks, smothering (from road work), dredging/ dredge spoil, fishing impacts (removing organisms, physical damage, marine debris), anchoring by cruise ships, brine discharge (from desalination plants)	J. Vasquez (CDFG), R. Starr (Sea Grant)	Follow-up with data sources. Follow-up with local experts to determine if there are additional URF in this habitat category.

Feature Type	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature?	Sources of data on threats	Follow-up/ next steps
Kelp beds (*Macrocystis* and *Nereocystis*)	Not unique or rare in MBNMS. Rare at the global scale.	Yes. Iconic; popular destination for diving; highly productive; habitat for otters	CDFG aerial surveys; Landsat (LTER at UCSB); J. Pearse, M. Foster	Yes - harvesting (for aquaculture), rising ocean temperatures, increasing storm intensity, effluent	CDFG log books, M. Beck (TNC), D. Ebert (US Abalone), D. Reed, M. Foster, R. Zimmerman	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.
Eisenia bed	Unique and rare - only occurs at Pt. Lobos. Rare at the global scale.	None identified	Diver surveys	None identified (located in a protected area)	None identified	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.
Rocky subtidal community (20-100 m)	Not unique. Yes rare and becomes rarer as you get deeper. Rare at larger spatial scales.	Yes. Low resistance and resilience communities	VARS database; NMFS; MLPA database (Yoklavich/Starr); Lindholm; CDFG Rikk Kvitek (CSUMB)	Yes - fishing impacts (removing organisms, physical damage, marine debris), marine debris, submerged cables, climate change	J. Vasquez (CDFG), R. Starr (Sea Grant), M. Yoklavich & D. Watters (NMFS), MARS cable EIS	Follow-up with data sources. Follow-up with local experts to determine if there are additional URF in this habitat category.
Rocky shelf community (100 -300 m)	Not unique. Yes rare and becomes rarer as you get deeper. Rare at larger spatial scales.	Yes. Low resistance and resilience communities	VARS database; NMFS; MLPA database (Yoklavich/Starr)	Yes - same threats as rocky subtidal community (20-100 m)	see rocky subtidal community (20-100 m)	Follow-up with data sources. Follow-up with local experts to determine if there are additional URF in this habitat category.
Rocky slope community (>300 m)	Not unique. Yes rare and becomes rarer as you get deeper. Rare at larger spatial scales.	Yes. Low resistance and resilience communities	VARS database	Yes - same threats as rocky subtidal community (20-100 m)	see rocky subtidal community (20-100 m)	Follow-up with data sources. Follow-up with local experts to determine if there are additional URF in this habitat category.
Deep water sponges - erect form (>20 m)	Not unique. Rarity is variable by region in MBNMS (more common at DSMZ, less so in canyon). Also MBARI is finding many new species so the geographic range is not known.	Yes. Biogenic habitat; receive management attention; very long lived; low resistance and resilience spp; new species discovered at DSMZ;	see Lonny for additional data (VARS database)	Yes - fishing impacts (removing organisms, physical damage, marine debris), ocean acidification, hypoxia, sedimentation	None identified	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.

Feature Type	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature?	Sources of data on threats	Follow-up/ next steps
Deep water corals (>20m)	Not unique. Not enough data to determine if rare. Some species may be rare and others not (e.g., *Paragorgia* is very abundant in some areas).	Yes. Biogenic habitat; receive management attention; very long lived; low resistance and resilience spp	VARS database; see Lonny for additional data	Yes - same threats as deep water sponges	None identified	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.
Brachiopod beds (>20 m)	Not unique. Rare - unknown. Check with data holders. Unclear how to determine suitable habitat - sometime they appear to be in soft bottom area, but maybe hard substrate below a superficial layer of soft sediment.	Yes. Biogenic habitat	MBNMS ROV and Camera sled surveys?; VARS database NMFS/MLPA	Yes - same threats as deep water sponges	None identified	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.
Sandy beach community	Not unique or rare.	None identified	Jenny Dugan, Karina Neilson (CDFG/MPA ME); John Oliver	Yes - oil spill, breach grooming, beach nourishment (esp. dredge spoils), thermal effluent	NRDA, OSPR, J. Dugan, K. Nielsen (Sonoma State), J. Oakden	Follow-up with data sources. Follow-up with local experts to determine if there are additional URF in this habitat category.
Shallow subtidal sand community (0-30 m)	Not unique or rare.	None identified	John Oliver; Jim Oakden; CCLEAN; NMFS triennial trawl surveys; Stacy Kim (MLML)	Yes - adding rocky substrate (e.g., Kaiser outfall), aquaculture pens, fishing impacts (removing organisms, physical damage, marine debris),	MLML	Follow-up with data sources. Follow-up with local experts to determine if there are additional URF in this habitat category.
Sand dollar beds	Not unique. Rare - unknown. Check with data holders.	Yes. Biogenic habitat.	Rikk Kvitek; Burke; J.E. Kastendiek	Yes - anchoring	None identified	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.
Market squid egg beds	Not unique. Rare - unknown. Check with data holders.	Yes. Breeding aggregation; food source for predators	Roger Hanlon (Hanlon et al 2004); William Gilly; Kenneth Foote (Foote et al. 2006)	Yes - artificial reef, fishing (removing adults before then can spawn)	J. Vasquez, Hanlon	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.

Feature Type	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature?	Sources of data on threats	Follow-up/ next steps
Shelf soft bottom community	Not unique or rare.	None identified	None identified	Yes - natural storm events, downweliing, submerged cables	C. Storlazzi, R. Kvitek, MARS cable EIS, Kogan et al	Follow-up with data sources. Follow-up with local experts to determine if there are additional URF in this habitat category.
Sea pens	Not unique or rare.	Yes. Biogenic habitat, susceptible to damage from human activities	deep water coral program	Yes - fishing impacts (removing organisms, physical damage, marine debris), ocean acidification	None identified	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.
Deep soft bottom community	Not unique or rare.	None identified	Barry, Paull, Vrijenhoek); VARS	Yes - fishing impacts (removing organisms, physical damage, marine debris), lost shipping containers	None identified	Follow-up with data sources. Follow-up with local experts to determine if there are additional URF in this habitat category.
Chemosynthetic biological communities	Not unique. Common - occurring in 9% of 25 m2 grid cells in which there have been bottom observations below 550 m (Paull et al. 2005)	Yes. Chemosynthetic primary production; 10+ obligate species (Barry et al. 1996)	Barry et al. 1996, Paull et al. 2005; VARS data base; Bob Vrijenhoek	None identified	None identified	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.
Whale fall communities	No unique. Rare - unclear to participants how to determine rarity - this community occurs on all whale falls, but whale falls are not often observed in MBNMS	Yes. There was a brief discussion of how the community on a whale fall goes through predictable stages of succession; some species in the community may be unique/rare because limited in distribution to whale falls	VARS data base; Bob Vrijenhoek	None identified	None identified	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.
Drift algae	Not unique. Rare - unknown. Check with data holders.	Source of primary productivity in deep benthic habitats.	VARS data base; Harrold paper	None identified	None identified	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.

Feature Type	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature?	Sources of data on threats	Follow-up/ next steps
Canyon community	Not unique or rare.	None identified		Yes - flushing events	None identified	Follow-up with data sources. Follow-up with local experts to determine if there are additional URF in this habitat category.
Pelagic invertebrate community	Not unique or rare.	None identified	VARS database; Bruce Robison,	Yes - ocean acidification, El Niño events, unusual seasonal upwelling intensity, trophic cascade (e.g., Humboldt squid), expanding oxygen minimum zones, microplastics (may be a threat)	F. Chavez (MBARI), B. Marinovic (USCS), J. FIeld (NMFS), Gilly & Zeidberg (Hopkins), Brewer & Peltzer (MBARI)	Follow-up with data sources. Follow-up with local experts to determine if there are additional URF in this habitat category.
Krill aggregations	Not unique or rare.	Yes. Forage for many species of fish, seabird, marine mammal; foundation species	Santora and Field (krill hotspots); Baldo Marinovic; VARS database (Robison); other data might be appropriate: blue whale: ESI 2006; turtle: MBNMS 2010; Primary Productivity: Coastwatch, Don Croll (UCSC)	Yes - same threats as pelagic invertebrate community	None identified	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.
Jellyfish hotspots	Not unique. Rare - unknown. Check with data holders.	Yes. Forage for leatherback turtles, ocean sunfish	Baldo Marinovic; Scott Benson; VARS database (Robison)	Yes - same threats as pelagic invertebrate community	None identified	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.
Upwelling shadow community	May be unique - only one upwelling shadow known in the MBNMS	Yes.	MBARI biospace program (J. Ryan, F. Chavez; Julio Harvey)	Yes - same threats as pelagic invertebrate community	None identified	Follow-up with data sources. Follow-up to determine if there are additional remarkable

Feature Type	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature?	Sources of data on threats	Follow-up/ next steps
						attributes for this feature.
HABs	Not unique. Rare - unknown. Check with data holders. Might be becoming more common.	Yes. Toxic versions of this feature is a concern for resource managers		Yes - fertilizers can make HABs more toxic	R. Kudela (UCSC)	Follow-up with data sources. Follow-up to determine if there are additional remarkable attributes for this feature.

Table 4: Modified list of biological features related to fish, birds, and mammals in Monterey Bay National Marine Sanctuary. A draft list of biological features in MBNMS (see Appendix C) was discussed and modified by scientific experts at the workshop. The Biology 2 group focused on biological features related to fish, birds and mammals. MBNMS staff summarized the information received from workshop participants in the table below. During the morning break-out session, participants discussed whether the feature type was unique, rare or remarkable in MBNMS and at larger spatial scales (e.g., California Current, globally). Participants reviewed the GIS data available in the MBNMS database (see Appendix H) for each feature and provided additional sources. In the afternoon break-out session, threats to the feature and sources of data on threats were discussed. Potential follow-up questions or next steps have been identified by staff for some features.

Feature Type	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature	Sources of data on threats	Follow-up/ next steps	Level of Concern
Nursery habitat: estuarine mudflat for juvenile fishes	Unique and Rare. Rare at CCLME scale, except S Coast; clearly role is different because different suite species. Yes, has a distinct role relative to others	Yes, Special- Chris Harrold, Paul Reilly-- except that there are other sloughs that play same role along W coast	Elkhorn Slough, Estuarine Research Reserve, MLML	Yes. Entrainment, impingement, pollution- Point and non-point, Erosion in Slough, Invasive species, Illegal harvesting, Structural modification- sill control- mucking about-Sea level rise (moorings out there- Kerstin Wasson)	Entrainment, impingement, pollution- Point and non-point, Erosion in Slough, Invasive species, Illegal harvesting, Structural modification- sill control- mucking about-Sea level rise (moorings out there- Kerstin Wasson)	Not addressed	High
Nursery habitat: kelp canopy for nearshore rockfishes	Depends on criteria for rarity-footprint is small- less than 20% of MBNMS, Nursery role for those species that depend on it for nursery role- Provides key nursery role for those species- other habitats do not provide that nursery role (5-6 species that rely on nursery habitat)	Yes, number of species that use it as nursery, not just fishes, invertebrates, kelp cover provides critical - habitat area of particular concern (HAPC); very important to connectivity subsidy to other habitats- sea otters rely on this for key core habitat- dependency of particular species on this habitat.	Flyover CDFG data, Landsat data, Ocean Images- private group doing kelp canopy survey, MC Landsat images, Flyover of DFG, Ocean Images	Yes	Not addressed	Not addressed	Moderate
Hotspots of productivity as a refuge	Yes it is Rare	Important for ecosystem health, critical foraging areas in specific (sometimes predictable) locations during low productivity periods	Not addressed	YES, Fisheries and vessel traffic in tiny area, climate change	Benson et al 2002, Baldo,	Can we identify where these areas would be?	Moderate

Feature Type	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature	Sources of data on threats	Follow-up/ next steps	Level of Concern
Hotspots: headlands and capes	No	Yes, highly productive areas, important for ecosystem health	Use same data as hotspots for canyons	Not addressed	oil spills, loss of prey base	Identify special areas	Low-Moderate depends on threat
Hotspots: shelf and canyon walls (aggregation mechanisms-water column associated with benthic feature) (physical mechanism or the community?)	Depends on definition of rarity	Important role for ecosystem health and function	Unknown	yes fishing bottom disturbance	Offshore aquaculture-Potential threats include: Pots, derelict gear, potential bycatch-other gear types-fishing methods-Climate change & current change-- greater threat than fishing- Potential threats from aggregated human activities-Interaction from suites of fishing activities-Seismic activity and earthquakes	Not addressed	Low-Moderate depends on threat
Breeding aggregation: mammal rookeries	Depends on definition; species occupies <20% of suitable rookery habitat (# rookeries/ # suitable locations)	Yes	Not addressed	Not addressed		Need to follow up with Karin Forney	Not addressed
Breeding aggregation: beach nesting birds	Depends on definition	Yes- habitat been degraded so much, concern that species-agreement that it is remarkable- real threats from human uses- but above high tide mark-	ESI 2006, CA State Parks, PRBO, US Fish and Wildlife Service	Not addressed	Oil Spills, Introduced species, disturbance-rats-Fisheries (hook line, gill nets (limited in past)), Pollutants-- not chronic but one time can wipe it out- highly vulnerable to episodic threats-	Follow up seabird biologists	Not addressed

Feature Type	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature	Sources of data on threats	Follow-up/ next steps	Level of Concern
Breeding aggregation: cliff, rock, island nesting birds	Disagreement as to rarity beyond MBNMS, need to consider ecosystem function as a function of rarity- because we should be defining it based on	Important role for ecosystem health and function	ESI 2006, PRBO, US Fish and Wildlife Service, Universities- PRBO, USFWS, MLL, CA Coastal NM, BirdLife INternationalUCSC- National Monument, Seabird Tour groups, Birdlife Intl-	Not addressed	Oil Spills, Introduced species, disturbance-rats-Fisheries (hook line, gill nets (limited in past)), Pollutants-- not chronic but one time can wipe it out- highly vulnerable to episodic threats-	Follow up with bird biologists	Not addressed
Forage aggregations	Depends on definition; Disagreement on defining- unique wherever they occur	Important role for ecosystem health and function, but spatially and temporally variable	Ask Geoff Shester	Not addressed	Not addressed	Follow up on data sources, where are they predictably, where are they fished,	Not addressed
Non-breeding aggregations: bird roosts, feeding areas	Yes, in places of steep bathymetry area- Cassins Auklet- that are unique in MBNMS- steep shelf break	depends on the species- for large aggregations just like forage fish, but there are some species that do depend on particular roosts- some areas within MBNMS- that are important.	NCCOS 2007; Seabird Colony Protection Program 2006, TNC 2004, PRBO, Scott Benson, Ship transects- data available-	Not addressed	Not addressed	None identified	Not addressed
Fish diversity	Yes; certain areas that are high abundances of fishes- like Portuguese Ledge - extraordinarily high diversity and abundance	Important role for ecosystem health and function	Not addressed	Fishing pressure (uncontrolled) - If all of Portuguese Ledge no bottom fishing through MLPA- then no threat to feature, Climate change, Any kind of physical structure (oil rigs, wave energy, cable)	Not addressed	Discuss with NCCOS	Low

Feature Type	Unique and/or Rare?	Remarkable?	Additional sources of data on features	Threats to Feature	Sources of data on threats	Follow-up/ next steps	Level of Concern
Genetically distinct population feature- Harbor Porpoise	Yes, Harbor porpoise wholly contained within the Sanctuary- it is a species that has been extremely vulnerable to bycatch	Not addressed	Not addressed	Vulnerable to anthropogenic impacts including bycatch and disturbance (vessel traffic) but no currently active threats- for harbor porpoise- but many for sea otters-	Not addressed	Meet with experts	Low
Genetically distinct population featureS-Sea Otter	At scale of California or west coast wide	Important role for ecosystem health	Not addressed	Water quality, ship strikes, white sharks, pollutants, Oil pollution, food limitation, resource competition directing shooting, Land based pathogens	Not addressed	Meet with sea otter experts	High
Migration Corridors	Depends on criteria	Important role for ecosystem health	Not addressed	Not the corridor threatened (but timing and placement threatened by climate change- cumulative impact of climate change)- Increased ocean acidification will increase noise in the ocean), Acoustic pollution- potential-they move- are displaced- Vessel strikes, offshore development, vertical migrations of zooplankton (if there are threats to them, then that would threaten species)	Not addressed	Jim Harvey, Meet with Karin Forney, Scott Benson and marine mammalogists	High-Moderate
Hot spots of Mammal Diversity	Depends on scale	YES	Not addressed	Climate change, prey availability, historic fisheries, oil spills	Not addressed	Not addressed	Low

Appendix A. Draft list of oceanographic features

MBNMS staff created a draft list of oceanographic features to use as a starting point for discussions in the Workshop on Unique and/or Rare Features in the Monterey Bay National Marine Sanctuary held on May 24, 2011. Each feature type was assigned a unique feature number. The GIS Data Reference column provides the names of the available GIS data for that feature type (see Appendix F for more detailed information).

Feature				Existing Data	
#	**Type**	**Examples**	**Definition**	**GIS Data Reference**	**Other data source**
O1	**Upwelling shadow**	N. Monterey Bay	recurrent buoyant, warm-water feature about 10 m thick, 20km wide, lasting from weeks to months during upwelling events (Graham 1993)		Graham & Largier 1997, Ryan et al. 2010
O2	**Upwelling Centers**	Upwelling Centers: Año Nuevo upwelling zone, Point Sur Upwelling, Seamount Induced upwelling, Canyon Induced upwelling	avg. SST < 15 degrees C through Upwelling Season (March-Sept) or upwelling rate due to Ekman pumping is >1 m d-1 or chla levels > than x through Upwelling Season (March-Sept)	TNC 2003, MMS 1983	Satellite data
O3	**Currents**	Davidson Current, California Current, Surface currents	water movement >x cm/day	NCCOS 2005	
O4	**Frontal Zones**	upwelling shadow frontal zone	SST change of x degrees	Coastwatch 2007a, Coastwatch 2007b	Ryan et al. 2010
O5	**Mixing**		Caused by the wind or by convection in circulation and creates a distinct signature from the water surface to the density-stability discontinuity.		
O6	**Mixed Zone**		The upper water layer in a two-layer system that is mixed by the wind or by convection in circulation from top to bottom of the layer, extending from the water surface to the density-stability discontinuity.		

Feature				Existing Data	
#	Type	Examples	Definition	GIS Data Reference	Other data source
O7	**Euphotic zone**		The zone in which there is sufficient sunlight for photosynthesis to occur, in MBNMS: X meters deep		
O8	**Pycnocline**	Thermocline, Chemocline, Halocline	The transitional zone in the water column between layers of two densities		
O9	**Turbulence**				
O10	**Freshwater Plumes**	Density Fronts	salinity < 30 ppt	NHD 2006	
O11	**Oxygen minimum layers**	seasonal Oxygen depleted zones (biologically induced hypoxic zones), benthic OMZ, water column OMZ	In MBNMS from X to X meters	MBNMS 2007	
O12	**Convergence Zones (Downwelling)**				
O13	**topographically induced upwelling**	Seamount Induced upwelling, Canyon Induced upwelling			
O14	**Internal wave slicks**				
O15	**Internal wave packets**				C.B Woodson et al. 2011
O16	**Internal solitons**				
O17	**Eddies**	warm core eddies, cold core eddies			
O18	**Lagmuir cell**		wind-driven vertical circulation		RadarSAT
O19	**Surface waves**				HF Radar
O20	**Upwelling filaments**			MMS 1983	
O21	**Tidal fronts**				
O22	**Meteorological pressures**	ENSO, PDO, Climate Change			

Appendix B. **Draft list of geologic features.**
MBNMS staff created a draft list of geologic features to use as a starting point for discussions in the Workshop on Unique and/or Rare Features in the Monterey Bay National Marine Sanctuary held on May 24, 2011. Each feature type was assigned a unique feature number. The GIS Data Reference column provides the names of the available GIS data for that feature type (see Appendix G for more detailed information).

Feature			**Existing Data**	
#	Type	**Examples**	**GIS Data Reference**	**Other data**
G1	Seamounts	**Davidson Seamount**	MLML 2003, MPA Center 2010, MBARI 1998	
G2	geologic diversity		MLML 2003, CSUMB 2006	
G3	Estuaries	Elkhorn Slough	Terralogic 2004	
G4	River mouths		Rivers 100k	
G5	Estuarine Habitat	salt marsh, mudflat, soft bottom, clay bottom	ESI 2006, CSUMB 2003, CSUMB 2005, CSUMB??	
G6	hard natural substrate in intertidal zone	bench, boulder	ESI 2006	
G7	soft substrate in intertidal zone	gravel beach, coarse-grained sand beach, tidal flat, etc.	ESI 2006	
G8	hard substrate in nearshore subtidal (<30 m) zone	shale beds, shallow rocky reef	CSUMB 2006	
G9	soft substrate in nearshore subtidal (<30 m) zone	sand, mud	CSUMB 2006	
G10	hard substrate of continental shelf zone (30 m -150 m)		CSUMB 2006	
G11	soft substrate continental shelf zone (30 m -150 m)	sand, mud, gravel, Kvitek ripple-scour data	CSUMB 2006	
G12	soft substrate of shelf break (150 - 300 m)		CSUMB 2006	
G13	hard substrate of shelf break (150 - 300 m)		CSUMB 2006	
G14	soft substrate of continental slope (300 - 3000 m)		MLML 2003	
G15	hard substrate of continental slope (300 - 3000 m)		MLML 2003	
G16	subsurface vents			
G17	fault zones		CGS 2005	
G18	soft substrate of continental rise (>3000 m)		MLML 2003	
G19	hard substrate of continental rise (>3000 m)		MLML 2003	
G20	canyon heads	nearshore, active, offshore	MPA Center 2010, CSUMB 2006	
G21	Classify into types of rocks (e.g., by size categories)	Islands - Rocks	BLM 2000	

Feature			Existing Data	
#	Type	**Examples**	**GIS Data Reference**	**Other data**
G22	Ridges	Sur Ridge, Smooth Ridge	MLML 2003	
G23	Capes and headlands	Pt. Sur, Point Lobos	US Topo	
G24	Turbidity Flows			

Appendix C. **Draft list of biological features.**
MBNMS staff created a draft list of Biological features to use as a starting point for discussions in the Workshop on Unique and/or Rare Features in the Monterey Bay National Marine Sanctuary held on May 24, 2011. Each feature type was assigned a unique feature number. The GIS Data Reference column provides the names of the available GIS data for that feature type (see Appendix G for more detailed information).

Feature			GIS Data Reference	
ID #	**Type**	**Examples**	**GIS Data Reference**	**Other data source**
B1	ephemeral/ opportunistic communities	e.g., chemosynthetic biological communities, whale fall communities	MBARI 2005	Barry et al. 1996, Paull et al. 2005
B2	sponges - erect form		TerraLogic, Inc 2004 (NMFS trawl data), MBARI 2006	PISCO UPC data; Starr et al. MLPA surveys
B3	deep water corals		MCBI 2010, NMFS 2004, MBNMS 2010 (Davidson Seamount Corals), MBARI 2006 (Soft corals), NMFS 2008. NMFS???	
B4	brachiopod beds		MBARI 2006	MBNMS ROV and Camera sled surveys?
B5	marshes		TNC 2005, ESI 2006, MMS 2007	
B6	seagrass beds	e.g., eelgrass, surfgrass	ESI 2006,Eelgrass TNC 2004, ESNERR 2000; surfgrass PISCO 2006, MMS 2007	
B7	native oyster beds		Heiman 2006	
B8	nursery habitat: estuarine mudflat for juvenile fishes	e.g., English sole, California halibut, leopard shark, bat ray		
B9	nursery habitat: kelp canopy for nearshore rockfishes			
B10	nursery habitat: benthic habitat for harvested species		Habitat Suitability Maps PFMC 2005; HSM from CINMS Biogeo NCCOS 2005; Nearshore Fish Ranges from CDFG 2004; NCCOS 2003	

Feature			GIS Data Reference	
ID #	**Type**	**Examples**	**GIS Data Reference**	**Other data source**
B11	breeding aggregation: mammal rookeries	e.g., elephant seal, harbor seal, Steller sea lion	NCCOS 2007	
B12	breeding aggregation: beach nesting birds	e.g., Snowy Plover	ESI 2006	
B13	breeding aggregation: cliff, rock, island nesting birds	e.g., Rhinosaurus Auklet, Common Murre	ESI 2006	
B14	breeding aggregation: beach spawning fish	e.g., grunion	ESI 2006	
B15	breeding aggregation: subtidal soft bottom inverts	e.g., market squid		
B16	foraging aggregations: zooplankton	e.g., leatherback turtle, blue whales, krill, primary productivity	Krill hot zones from the Farallon Institute (need to acquire)	Other data might be appropriate: blue whale: ESI 2006; turtle: MBNMS 2010; Primary Productivity: Coastwatch
B17	foraging aggregations: jellies	e.g., leatherback turtle		
B18	foraging aggregations: forage fish			
B19	non-breeding aggregations: bird roosts	e.g., Brown Pelican	NCCOS 2007; Seabird Colony Protection Program 2006, TNC 2004	
B20	non-breeding aggregations: migration stop over	e.g., shorebirds, phalaropes (especially in ESNERR)		
B21	non-breeding aggregations: mammal haul outs	e.g., elephant seal, harbor seal, Steller sea lion, California sea lion	NCCOS 2007	
B22	migration corridors	e.g., gray whale, Sooty Shearwater	ESI 2006	
B23	ontogenetic movement corridor			
B24	endemic species			
B25	rocky intertidal community			

Feature			GIS Data Reference	
ID #	**Type**	**Examples**	**GIS Data Reference**	**Other data source**
B26	keystone species	e.g., ochre star, sea otter	MMS 2007; UCSC 2001, UCSC 2002a, UCSC 2002b	
B27	ecosystem engineer	e.g., mussels, owl limpets	Mussel Watch 2011	
B28	foundation species	e.g., kelp, krill	See above	
B29	apex predator	e.g., white shark	MBNMS 2010 (White shark hotspots)	Jorgensen et al. 2009 (philopatry and migration of Pacific white sharks)
B30	macrophyte beds	e.g., bull kelp, giant kelp, *Postelsia*	DFG 1989 to 2008; PISCO 2006; MMS 2007	
B31	biodiversity		NCCOS 2003	
B32	bird diversity		NCCOS 2003	
B33	fish diversity		NCCOS 2003	
B34	zooplankton diversity			
B35	phytoplankton diversity			
B36	ecosystem function	succession?		
B37	ecosystem structure	trophic interaction?		

Appendix D. **Submerged Cultural Resources**
Submerged Cultural Resources in the Monterey Bay National Marine Sanctuary that meet the criteria for National Register of Historic Places nomination, or are already listed in Register (Macon and Tennessee).

Name of Vessel	Type	Nationality	Year Lost	Approximate Location
Aculeo	Ship	British	1872	Point Montara
Art Riedel Sr.	Dredge Equipped w/Gantry & A-frame	US	1990	Point Pinos
Celia	Steam Schooner	US	1906	Point Pinos Light, Point Joe
CG 256	Cutter - Coast Guard Patrol Boat	US	1933	Asilomar, Spanish Beach
City of New York	Steamer	US	1893	Point Bonita
Flavel	Steam Schooner	US	1923	Cypress Point, Carmel
Gipsy	Steam Schooner	US	1905	China Point, Monterey Bay
Harlech Castle	Bark, 3 mast	British	1869	Point Piedras Blancas, Harlech Castle Rock
J. B. Stetson	Steam Schooner	US	1934	Cypress Point
Macon, USS	Dirigible - Rigid Frame Airship	US	1935	Point Sur
New York	Ship	US	1898	Half Moon Bay
Rhine Maru	Freighter	Japanese	1930	Point Sur, Big Sur River
Roderick Dhu	Oil Barge (ex-bark)	US	1909	Moss Beach
Rydal Hall	Ship, 3 mast	British	1876	Pillar Point
Sierra Nevada	Side-wheel Passenger Steamer	US	1869	Point Sierra Nevada
St. Paul	Passenger Cargo Steamer - barkentine	US	1896	Point Joe
Tennessee	Side-Wheel Passenger Cargo Steamer	US	1853	Point Bonita
Ventura	Passenger Cargo Steamer	US	1875	Point Sur

Appendix E. Managed species.
List of species occurring in the Monterey Bay National Marine Sanctuary that are either listed under the federal or state of California Endangered Species Acts (ESA), or managed under the Marine Mammals Protection Act (MMPA) or federal Fisheries Management Plans (FMP). E = Endangered, T = Threatened, C = Candidate

Group	Common Name	Scientific Name	ESA - Federal	ESA - State	Other management
Marine Mammals					
	Sei whale (E. North Pacific stock)	*Balaenoptera borealis*	E		MMPA
	Blue whale (Eastern N. Pacific stock)	*Balaenoptera musculus musculus*	E		MMPA
	Fin whale (CA-OR-WA stock)	*Balaenoptera physalus*	E		MMPA
	Humpback whale (Eastern N. Pacific stock)	*Megaptera novaeangliae*	E		MMPA
	North Pacific right whale	*Eubalaena japonica*	E		MMPA
	Gray whale (Eastern N. Pacific stock)	*Eschrichtius robustus*			MMPA
	Sperm whale (CA-OR-WA stock)	*Physeter macrocephalus*	E		MMPA
	Short-finned pilot whale (CA/OR/WA stock)	*Globicephala macrorhynchus*			MMPA
	Baird's beaked whale (CA-OR-WA stock)	*Berardius bairdii*			MMPA
	Beaked whales (CA-OR-WA stock)	*Mesoplodon spp.*			MMPA
	Cuvier's beaked whale (CA-OR-WA stock)	*Ziphius cavirostris*			MMPA
	Killer whale (Eastern N. Pacific Southern Resident population)	*Orcinus orca*	E		MMPA
	Harbor porpoise (San Francisco-Russian River, Monterey Bay & Morro Bay stocks)	*Phocoena phocoena*			MMPA
	Steller sea lion (Eastern stock)	*Eumetopias jubatus*	T		MMPA
	Guadalupe fur seal	*Arctocephalus townsendi*	T	T	MMPA
	Northern fur seal (San Miguel Island stock)	*Callorhinus ursinus*			MMPA
	Northern elephant seal	*Mirounga angustirostris*			MMPA
	Harbor seal	*Phoca vitulina*			MMPA
	California sea lion	*Zalophus californianus*			MMPA
	Southern sea otter	*Enhydra lutris nereis*	T		MMPA
Birds					
	Short-Tailed Albatross	*Phoebastria albatrus*	E		
	California Black Rail	*Laterallus jamaicensis coturniculus*		T	
	California Clapper Rail	*Rallus longirostris obsoletus*	E	E	

Group	Common Name	Scientific Name	ESA - Federal	ESA - State	Other management
	Western Snowy Plover	*Charadrius alexandrinus nivosus*	T		
	California Least Tern	*Sterna antillarum browni*	E	E	
	Marbled Murrelet	*Brachyramphus marmoratus*	T	E	
	Xantus's Murrelet	*Synthliboramphus hypoleucus*	C	T	
Reptiles					
	Leatherback sea turtle	*Dermochelys coriacea*	E		
Invertebrates					
	Black abalone	*Haliotis cracherodii*	E		
	Market squid	*Loligo opalescens*			Coastal Pelagic Species FMP
	Krill				Coastal Pelagic Species FMP
Fishes					
	Coho salmon (Central California Coast ESU)	*Oncorhynchus kisutch*	E	E	Salmon FMP
	Steelhead (Central California Coast DPS)	*Oncorhynchus mykiss irideus*	T		
	Steelhead (South Central California Coast DPS)	*Oncorhynchus mykiss irideus*	T		
	Chinook salmon (Central Valley Spring ESU)	*Oncorhynchus tshawytscha*	T	T	Salmon FMP
	Chinook salmon (Central Valley Fall and Late Fall ESU)	*Oncorhynchus tshawytscha*			Salmon FMP
	Chinook salmon (Sacramento River Winter ESU)	*Oncorhynchus tshawytscha*	E	E	Salmon FMP
	Green sturgeon (Southern DPS)	*Acipenser medirostris*	T		
	White sturgeon	*Acipenser transmontanus*	E		
	Longfin smelt	*Spirinchus thaleichthys*		T	
	Eulachon (Southern DPS)	*Thaleichthys pacificus*	T		
	Tidewater goby	*Eucyclogobius newberryi*	E		
	Basking shark (N. Pacific subpopulation)	*Cetorhinus maximus*		E	
	Skipjack tuna	*Katsuwonus pelamis*			Highly Migratory Species FMP
	North Pacific albacore	*Thunnus alalunga*			Highly Migratory Species FMP
	Bigeye tuna (Pacific stock)	*Thunnus obesus*			Highly Migratory Species FMP
	Yellowfin tuna	*Thunnus albacares*			Highly Migratory Species FMP

Group	Common Name	Scientific Name	ESA - Federal	ESA - State	Other management
	Pacific bluefin tuna	*Thunnus orientalis*			Highly Migratory Species FMP
	Common thresher shark	*Alopias vulpinus*			Highly Migratory Species FMP
	Pelagic thresher shark	*Alopias pelagicus*			Highly Migratory Species FMP
	Bigeye thresher shark	*Alopias superciliosus*			Highly Migratory Species FMP
	Shortfin mako shark	*Isurus oxyrinchus*			Highly Migratory Species FMP
	Blue shark	*Prionace glauca*			Highly Migratory Species FMP
	Striped marlin	*Tetrapturus audax*			Highly Migratory Species FMP
	Pacific swordfish	*Xiphias gladius*			Highly Migratory Species FMP
	Mahimahi (dolphinfish)	*Coryphaena spp.*			Highly Migratory Species FMP
	northern anchovy	*Engraulis mordax*			Coastal Pelagic Species FMP
	Pacific sardine	*Sardinops sagax*			Coastal Pelagic Species FMP
	Pacific mackerel	*Scomber japonicus*			Coastal Pelagic Species FMP
	Jack mackerel	*Trachurus symmetricus*			Coastal Pelagic Species FMP
	Big skate	*Raja binoculata*			Groundfish FMP
	California skate	*Raja inornata*			Groundfish FMP
	Leopard shark	*Triakis semifasciata*			Groundfish FMP
	Longnose skate	*Raja rhina*			Groundfish FMP
	Soupfin shark	*Galeorhinus zyopterus*			Groundfish FMP
	Spiny dogfish	*Squalus acanthias*			Groundfish FMP
	Ratfish	*Hydrolagus colliei*			Groundfish FMP
	Finescale codling	*Antimora microlepis*			Groundfish FMP
	Pacific rattail	*Coryphaenoides acrolepis*			Groundfish FMP
	Cabezon	*Scorpaenichthys marmoratus*			Groundfish FMP
	Kelp greenling	*Hexagrammos decagrammus*			Groundfish FMP
	Lingcod	*Ophiodon elongatus*			Groundfish FMP
	Pacific cod	*Gadus macrocephalus*			Groundfish FMP

Group	Common Name	Scientific Name	ESA - Federal	ESA - State	Other management
	Pacific whiting (hake)	*Merluccius productus*			Groundfish FMP
	Sablefish	*Anoplopoma fimbria*			Groundfish FMP
	Aurora rockfish	*Sebastes aurora*			Groundfish FMP
	Bank rockfish	*Sebastes rufus*			Groundfish FMP
	Black rockfish	*Sebastes melanops*			Groundfish FMP
	Black and yellow rockfish	*Sebastes chrysomelas*			Groundfish FMP
	Blackgill rockfish	*Sebastes melanostomus*			Groundfish FMP
	Blue rockfish	*Sebastes mystinus*			Groundfish FMP
	Bocaccio	*Sebastes paucispinis*			Groundfish FMP
	Bronzespotted rockfish	*Sebastes gilli*			Groundfish FMP
	Brown rockfish	*Sebastes auriculatus*			Groundfish FMP
	Calico rockfish	*Sebastes dallii*			Groundfish FMP
	California scorpionfish	*Scorpaena gutatta*			Groundfish FMP
	Canary rockfish	*Sebastes pinniger*			Groundfish FMP
	Chameleon rockfish	*Sebastes phillipsi*			Groundfish FMP
	Chilipepper	*Sebastes goodei*			Groundfish FMP
	China rockfish	*Sebastes nebulosus*			Groundfish FMP
	Copper rockfish	*Sebastes caurinus*			Groundfish FMP
	Cowcod	*Sebastes levis*			Groundfish FMP
	Darkblotched rockfish	*Sebastes crameri*			Groundfish FMP
	Dusky rockfish	*Sebastes ciliatus*			Groundfish FMP
	Dwarf-red rockfish	*Sebastes rufinanus*			Groundfish FMP
	Flag rockfish	*Sebastes rubrivinctus*			Groundfish FMP
	Freckled rockfish	*Sebastes lentiginosus*			Groundfish FMP
	Gopher rockfish	*Sebastes carnatus*			Groundfish FMP
	Grass rockfish	*Sebastes rastrelliger*			Groundfish FMP
	Greenblotched rockfish	*Sebastes rosenblatti*			Groundfish FMP
	Greenspotted rockfish	*Sebastes chlorostictus*			Groundfish FMP
	Greenstriped rockfish	*Sebastes elongatus*			Groundfish FMP
	Halfbanded rockfish	*Sebastes semicinctus*			Groundfish FMP
	Harlequin rockfish	*Sebastes variegatus*			Groundfish FMP
	Honeycomb rockfish	*Sebastes umbrosus*	E		Groundfish FMP
	Kelp rockfish	*Sebastes atrovirens*			Groundfish FMP
	Longspine thornyhead	*Sebastolobus altivelis*			Groundfish FMP
	Mexican rockfish	*Sebastes macdonaldi*			Groundfish FMP
	Olive rockfish	*Sebastes serranoides*			Groundfish FMP
	Pink rockfish	*Sebastes eos*			Groundfish FMP
	Pinkrose rockfish	*Sebastes simulator*			Groundfish FMP

Group	Common Name	Scientific Name	ESA - Federal	ESA - State	Other management
	Pygmy rockfish	*Sebastes wilsoni*			Groundfish FMP
	Pacific ocean perch	*Sebastes alutus*			Groundfish FMP
	Quillback rockfish	*Sebastes maliger*			Groundfish FMP
	Redbanded rockfish	*Sebastes babcocki*			Groundfish FMP
	Redstripe rockfish	*Sebastes proriger*			Groundfish FMP
	Rosethorn rockfish	*Sebastes helvomaculatus*			Groundfish FMP
	Rosy rockfish	*Sebastes rosaceus*			Groundfish FMP
	Rougheye rockfish	*Sebastes aleutianus*			Groundfish FMP
	Sharpchin rockfish	*Sebastes zacentrus*			Groundfish FMP
	Shortbelly rockfish	*Sebastes jordani*			Groundfish FMP
	Shortraker rockfish	*Sebastes borealis*			Groundfish FMP
	Shortspine thornyhead	*Sebastolobus alascanus*			Groundfish FMP
	Silvergray rockfish	*Sebastes brevispinis*			Groundfish FMP
	Speckled rockfish	*Sebastes ovalis*			Groundfish FMP
	Splitnose rockfish	*Sebastes diploproa*			Groundfish FMP
	Squarespot rockfish	*Sebastes hopkinsi*			Groundfish FMP
	Starry rockfish	*Sebastes constellatus*			Groundfish FMP
	Stripetail rockfish	*Sebastes saxicola*			Groundfish FMP
	Swordspine rockfish	*Sebastes ensifer*			Groundfish FMP
	Tiger rockfish	*Sebastes nigrocinctus*			Groundfish FMP
	Treefish	*Sebastes serriceps*			Groundfish FMP
	Vermilion rockfish	*Sebastes miniatus*			Groundfish FMP
	Widow rockfish	*Sebastes entomelas*			Groundfish FMP
	Yelloweye rockfish	*Sebastes ruberimus*			Groundfish FMP
	Yellowmouth rockfish	*Sebastes reedi*			Groundfish FMP
	Yellowtail rockfish	*Sebastes flavidus*			Groundfish FMP
	Arrowtooth flounder (turbot)	*Atheresthes stomias*			Groundfish FMP
	Butter sole	*Isopsetta isolepis*			Groundfish FMP
	Curlfin sole	*Pleuronichthys decurrens*			Groundfish FMP
	Dover sole	*Microstomus pacificus*			Groundfish FMP
	English sole	*Parophrys vetulus*			Groundfish FMP
	Flathead sole	*Hippoglossoides elassodon*			Groundfish FMP
	Pacific sanddab	*Citharichthys sordidus*			Groundfish FMP
	Petrale sole	*Eopsetta jordani*			Groundfish FMP
	Rex sole	*Glyptocephalus zachirus*			Groundfish FMP
	Rock sole	*Lepidopsetta bilineata*			Groundfish FMP
	Sand sole	*Psettichthys melanostictus*			Groundfish FMP
	Starry flounder	*Platichthys stellatus*			Groundfish FMP

Appendix F. GIS Data for oceanographic features.

This table identifies the available Geographical Information Systems (GIS) data for the oceanographic features identified in the pre-workshop draft features list. In order to reduce repetitious information and save space, the comments/metadata were not duplicated for a GIS Data Reference (e.g. MMS 1983) that applied to two or more features. Instead "see above" was added to the "Comments" column so that one could refer to the comments/metadata for the same "GIS Data Reference" in a preceding row. 'Feature #' = feature numbers assigned in the draft oceanographic features list (Appendix A).

Feature #	Feature Type	GIS Data Reference	GIS data name	Published Date	GIS Data Source	Comments
O2	**Upwelling Centers**	TNC 2003	Upwelling Zones	2003	TNC/Northern California Ecoregional Assessment	To identify recurring patterns of cold water as indicators of upwelling zones, we utilized 1999-2002 AVHRR (Advanced Very High Resolution Radiometer, 1.1 km resolution) data compiled by NOAA Coast Watch (west coast node) to derive average sea surface temperatures during the upwelling season (March - September). For this analysis we used the High Resolution Monthly Composites product from NOAA which compiles AVHRR data by month for scene footprints that are approximately 300,000 Km2. The composites were created using night time images only, computing median values. A monthly composite for each month (March - September) and each year 99-02 was downloaded making for a total of 96 files (6mo * 4years * 4 scenes).
O2	**Upwelling Centers**	MMS 1983	Seasonal Evolution of Upwelling Zone	1983	MMS (Larry Breaker)	The characteristics of the filaments are based on Level 1.5 AVHRR satellite images from 1980 to 1983. The seasonal growth rate for the filaments was estimated by plotting filament length versus month for all four years. The evolution of the filaments over the upwelling season is somewhat arbitrarily broken down into three categories: a restricted phase (March-April), an intermediate phase (May-June) and an extended phase (July-October.)
O3	**Currents**	NCCOS 2005	Ocean Currents for 1999 per month	1999	Biogeographic Assessment of the Channel Islands NMS	ERS-1 and Topex/Poseidon altimetry at a 0.25 degree resolution; see chp. 2 in Biogeographic Assessment of CINMS
O4	**Frontal Zones**	Coastwatch 2007a	Mean Persistence of Frontal Probability Index > 0.2	2007	Coastwatch	No Metadata
O4	**Frontal Zones**	Coastwatch 2007b	Frontal Probability Index > 20% per quarter	2007	Coastwatch	The CoastWatch Oceanic Front Probability Index measures the probability of sea surface temperature front formation based on data from NOAA's GOES satellites.; Jan-March, April-June, July-Sept., Oct-Dec
O10	**Rivers**	NHD 2006	Rivers	2006	EPA	National Hydrography Dataset (NHD)
O11	**Oxygen Minimum Layer**	MBNMS 2007	Oxygen Minimum Zone (530 and 1020 m Contours)	2007	MBNMS	Developed from 10 meter contours GIS data to illustrate the upper and lower boundaries of the OMZ
O20	**Upwelling Filaments**	MMS 1983	Seasonal Evolution of Upwelling Zone	1983	MMS (Larry Breaker)	See above

Appendix G. **GIS data for geological features.**

This table identifies the available Geographical Information Systems (GIS) data for the geological features identified in the pre-workshop draft features list. In order to reduce repetitious information and save space, the comments/metadata were not duplicated for a GIS Data Reference (e.g. MLML 2003) that applied to two or more features. Instead "see above" was added to the "Comments" column so that one could refer to the comments/metadata for the same "GIS Data Reference" in a preceding row. A "???" in the "Published Date" column signifies that the MBNMS knows of the GIS data but has not yet acquired it. 'Feature #' = feature numbers assigned in the draft geological features list (Appendix B).

Feature #	Feature Type	GIS Data Reference	GIS data name	Published Date	GIS Data Source	Comments
G1	**Seamounts**	MLML 2003	CA benthic Habitat	2003	Center for Habitat Studies, Moss Landing Marine Laboratories	California Benthic Habitat - this is a subset of a larger dataset, the data for California has been extracted and re-projected to the California Albers NAD83 (Teale) projection. This data set delineates geological seafloor characteristics of the continental margin of the United States West Coast. Seafloor types are classified according to Greene et. al. (1999) deep-water marine benthic habitat scheme. Seafloor feature interpretation was performed by West Coast geologic mapping experts as a synthesis of various source data sets, including side-scan sonar, bottom samples, seismic data, and multibeam bathymetry. The Active Tectonics and Seafloor Mapping Lab, College of Oceanic and Atmospheric Sciences, Oregon State University developed the data for Oregon and Washington. The Center for Habitat Studies, Moss Landing Marine Laboratories developed the data for California. These data were developed for Pacific States Marine Fisheries Commission in cooperation with the National Marine Fisheries Service Northwest Region and the Pacific Fishery Management Council in support of an Environmental Impact Statement (EIS) to consider the designation and conservation of Essential Fish Habitat (EFH) for Pacific Coast Groundfish. These data were consolidated and integrated in a GIS format to support spatially explicit groundfish habitat modeling and impacts assessment on a coastwide scale. The level of detail in seafloor type boundary delineation varies across the data set, based on the quantity and quality of original data sources.
G1	**Seamounts**	MBARI 1998	MBARI West Coast Seamounts and Ridges Multibeam Survey	1998	MBARI	In June, 1998, MBARI completed surveys of selected areas offshore of the Monterey Bay California. MBARI used the recently developed Simrad EM300 multibeam system to collect bathymetry and backscatter data. MBARI contracted with C&C Technologies to run the system because they had installed the EM300 system on a contracted vessel, the M/V Ocean Alert. The 30 kHz EM300 system, because it is hull-mounted, allowed MBARI to collect georeferenced high-resolution bathymetric and sidescan data at high speeds in water ranging from shelf to abyssal depths.

Feature #	Feature Type	GIS Data Reference	GIS data name	Published Date	GIS Data Source	Comments
G1	**Seamounts**	MPA Center 2010	Seamounts and Banks	NP (made in 2010)	Marine Protected Areas Center	A polygon shapefile showing the location of seamounts, mounds and banks off the coast of California. Features were manually digitized using the ETOPO - 1 km bathymetry dataset as a base layer, and a derived slope surface and derived 50 m contour lines for visualization. Only elevated features greater than 30 square kilometers in area and 250 meters in height were digitized. The ETOPO-1 bathymetry layer was chosen for its complete spatial coverage and constant accuracy over all depths. Finer-scale bathymetry layers exist in the study area, but their accuracy was questionable below 2000 m. Features were digitized at 1:200000. The placement of lines used to distinguish each feature was chosen to reflect the greatest change in slope between the feature and the surrounding seascape. Existing relevant GIS datasets developed by Greene (1999) and NOAA NCCOS (2007) were used as templates and modified based on features observed in the bathymetry data. Feature definitions were taken from Madden et al. (2009). The shapefile includes major named seamounts and banks such as Davidson, San Juan, Taney, Guide and Gumdrop, as well as 89 other smaller features.
G2	**Geologic diversity**	MLML 2003	CA benthic Habitat	2003	Center for Habitat Studies, Moss Landing Marine Laboratories	see above
G2	**Geologic diversity**	CSUMB 2006	CSUMB- 2 m habitat and contours	2006	CSUMB	The Seafloor Mapping Lab at California State University Monterey Bay produced high-resolution marine habitat maps of nearshore sites deemed critical to the implementation of the Marine Life Protection Act (MLPA) and Marine Life Management Act (MLMA) by the California Department of Fish and Game (DFG) Marine Region management team. The main goal was to provide high-resolution (1-3m grid) multibeam bathymetry and sonar-derived habitat map products for Central California and Southern Mainland California. Marine habitat mapping survey for Cooper Point, Big Sur, California. Surveys were conducted from April 1-29, 2005 (4/1,4/6, 4/22-24, 4/29).
G3	**Estuaries**	Terralogic 2004	Estuaries	2004	TerraLogic, Inc.	These data depict the boundaries of estuaries along the West Coast of the United States. The estuary boundaries are delineated according to the U.S. Fish and Wildlife Service National Wetlands Inventory (NWI). These data were originally compiled for the 1998 West Coast Groundfish EFH Appendix and have not been modified from that source.
G4	**River mouths**	Rivers 100k	1:100k hydrography	2003	CDFG/PSMFC	This is a 1:100,000 scale stream based routed hydrography shapefile and ArcInfo coverage covering the state of California developed by California Department of Fish & Game (CDFG) and Pacific States Marine Fisheries Commission (PSMFC). The shapefile and coverage utilizes existing National Hydrography Database (NHD) 1:100,000 linework and attributes as well as Geographic Names Information System (GNIS) identifiers as guidelines to determine the stream networks that were combined into routes.

Feature #	Feature Type	GIS Data Reference	GIS data name	Published Date	GIS Data Source	Comments
G5	**Estuarine habitat**	ESI 2006	ESI shoreline	2006	NOAA	Environmental Sensitivity Index (ESI) maps provide a concise summary of coastal resources that are at risk if an oil spill occurs nearby. Examples of at-risk resources include biological resources (such as birds and shellfish beds), sensitive shorelines (such as marshes and tidal flats), and human-use resources (such as public beaches and parks).
G5	**Estuarine habitat**	CSUMB 2005	1 m bathy	2005	Seafloor Mapping Lab, California State University Monterey Bay	This project was conducted to determine changes in the pattern of erosion and deposition in Elkhorn Slough since surveys conducted in 1993, 2001 and 2003. Adjustments were made to the previously released 1m bathymetry grids to account for a 35cm data shift. Bathymetric and backscatter (sidescan) data were collected aboard the R/V VenTresca using a Reson 8101 multibeam echosounder. Prior to data collection a series of survey lines were created using Hypack Max GOLD from Coastal Oceanographics. An Applanix POS/MV was used to position the vessel during data collection and accounted for vessel motion such as heave, pitch, and roll (position accuracy ± 2m, pitch, roll and heading accuracy ±0.02°, heave accuracy ± 5% or 5cm). NobelTec Tides and Currents software provided NOAA predicted tides to account for tide cycle fluctuations and sound velocity profiles were collected with an Applied Microsystems SVPlus sound velocimeter
G5	**Estuarine habitat**	CSUMB 2003	Percent cover	2003	Seafloor Mapping Lab, California State University Monterey Bay	Several data layers were developed including tidal scour zones and percent cover data for substrate and benthic community types which was collected at 273 random locations within Elkhorn Slough. Another layer shows the same data averaged by tidal scour zone.
G5	**Estuarine habitat**	CSUMB ???	Habitat	???	Seafloor Mapping Lab, California State University Monterey Bay	Elkhorn Slough area habitat
G6	**Hard natural substrate in intertidal zone**	ESI 2006	ESI shoreline	2006	NOAA	see above
G7	**Soft substrate in intertidal zone**	ESI 2006	ESI shoreline	2006	NOAA	see above
G8	**Hard substrate in nearshore subtidal (<30 m) zone**	CSUMB 2006	CSUMB- 2 m habitat and contours	2006	CSUMB	see above
G9	**Soft substrate in nearshore subtidal (<30 m) zone**	CSUMB 2006	CSUMB- 2 m habitat and contours	2006	CSUMB	see above

Feature #	Feature Type	GIS Data Reference	GIS data name	Published Date	GIS Data Source	Comments
G10	**Hard substrate of continental shelf zone (30 m -150 m)**	CSUMB 2006	CSUMB- 2 m habitat and contours	2006	CSUMB	see above
G11	**Soft substrate continental shelf zone (30 m -150 m)**	CSUMB 2006	CSUMB- 2 m habitat and contours	2006	CSUMB	see above
G12	**Soft substrate of shelf break (150 - 300 m)**	CSUMB 2006	CSUMB- 2 m habitat and contours	2006	CSUMB	see above
G13	**Hard substrate of shelf break (150 - 300 m)**	CSUMB 2006	CSUMB- 2 m habitat and contours	2006	CSUMB	see above
G14	**soft substrate of Continental slope (300 - 3000 m)**	MLML 2003	CA benthic Habitat	2003	Center for Habitat Studies, Moss Landing Marine Laboratories	see above
G15	**hard substrate of Continental slope (300 - 3000 m)**	MLML 2003	CA benthic Habitat	2003	Center for Habitat Studies, Moss Landing Marine Laboratories	see above

Feature #	Feature Type	GIS Data Reference	GIS data name	Published Date	GIS Data Source	Comments
G17	**fault zones**	CGS 2005	Quaternary and Younger Faults	2005	Department of Conservation, California Geological Survey	This update to the Digital Database of Faults from the Fault Activity Map of California and Adjacent Areas (Jennings, 1994) is an interim/partially completed product that will be superseded by future updates and revisions. These updates apply to Quaternary and younger faults only - pre-Quaternary faults have not been modified or attributed. The original digital fault map (version 1.0) was scanned and digitized at 1:750,000 scale and was attributed only with line type (solid, dashed, dotted) and fault age (Historic, Holocene, late Quaternary, undivided Quaternary, pre-Quaternary). The California Geological Survey, in a cooperative agreement with the U.S. Geological Survey, began preparing compilations and fault maps for the California portion of the National Quaternary Fault and Fold database (http://earthquake.usgs.gov/qfaults/). This updated version of the fault activity map (version 2.0) was begun as part of this cooperative agreement. An attribution table associated with the digital fault traces broadens the data fields to include: fault name/fault zone name, sense of displacement, slip rate (binned category consistent with National Quaternary Fault and Fold database in mm/yr), fault id number (Jennings numbering system, if applicable), Qt fault id number (and section number and section name, if applicable), fault age (same as version 1.0), line type (same as version 1.0), source of mapping, version number, and date current version was released. About 85% of the Quaternary and younger faults have been attributed with most of the additional data fields at the time of version 2.0's release. Initially, maps of Quaternary and younger faults for the National Quaternary Fault and Fold database were to be digitally compiled at a scale of 1:250,000, using the digital fault activity map of Jennings (1994) (version 1.0) as a basic framework. Most significant late Quaternary and younger faults are now better-portrayed digitally in version 2.0, both with respect to location and the depiction of surface trace complexity. As work on the fault map progressed, it was decided to re-digitize fault locations using the original sources at the original source scale. Version 2.0 represents the beginning phase of this task and about 25% of the faults have been re-digitized from the original sources.
G18	**soft substrate of Continental Rise (>3000 m)**	MLML 2003	CA benthic Habitat	2003	Center for Habitat Studies, Moss Landing Marine Laboratories	see above
G19	**hard substrate of Continental Rise (>3000 m)**	MLML 2003	CA benthic Habitat	2003	Center for Habitat Studies, Moss Landing Marine Laboratories	see above
G20	**canyon heads**	CSUMB 2006	CSUMB- 2 m habitat and contours	2006	CSUMB	see above

Feature #	Feature Type	GIS Data Reference	GIS data name	Published Date	GIS Data Source	Comments
G20	**canyon heads**	MPA Center 2010	Canyons	2010	MPA Center	A polygon shapefile showing the location of submarine canyons and channels off the coast of California. Features were delineated using bathymetry, depth variance and 50 m contours and an existing GIS dataset developed by Greene (1999). The base bathymetry layer is a mosaic of multibeam datasets collected for the California Department of Fish and Game bathymetry development project and resampled to 200 m. This bathymetry layer was chosen for its fine-scale spatial resolution and accuracy in shallow to moderate depth waters. Features greater than 5 km long and having a central channel more than 100 m below the surrounding seascape were digitized at 1:200000. Additional features were located and digitized with the help of existing GIS datasets developed by Greene (1999) and NOAA NCCOS (2007). Feature definitions were taken from Madden et al. (2009). Features include both the central channel and sloping walls. In cases where two or more features where in close proximity and clearly part of the same benthic feature, they were united. Major named submarine canyons such as Monterey, Pioneer, Lucia and Sur canyons are included as well as 62 additional canyons and channels.
G21	**Classify into types of rocks (e.g., by size categories)**	BLM 2000	Coastal Rocks for CA Coastal National Monument	2000	BLM	This shapefile represents offshore rocks and islands that are part of the newly designated California Coastal National Monument (CCNM), under USDI Bureau of Land Management (BLM) jurisdiction. The online URL is http://pub4.caso.ca.blm.gov/news/2000/01/nr/coastal_monument_factsheet.html
G22	**Ridges**	MLML 2003	CA benthic Habitat	2003	Center for Habitat Studies, Moss Landing Marine Laboratories	see above
G22	**Ridges**	MBARI 1998	MBARI West Coast Seamounts and Ridges Multibeam Survey	1998	MBARI	see above
G23	**Capes and headlands**	US Topo	US Topo maps		USGS	US Topo maps are the next generation DFG's so I need to replace the index for Mosaicked California 7.5 Minute by 7.5 Minute 1:24,000 and 1:25,000 Digital Raster Graphic (DRG) USGS Quad Images.

Appendix H. **GIS data for biological features.**
This table identifies the available Geographical Information Systems (GIS) data for the biological features identified in the pre-workshop draft features list. In order to reduce repetitious information and save space, the comments/metadata were not duplicated for a GIS Data Reference (e.g. NMFS 2004) that applied to two or more features. Instead "see above" was added to the "Comments" column so that one could refer to the comments/metadata for the same "GIS Data Reference" in a preceding row. A "???" in the "Published Date" column signifies that the MBNMS knows of the GIS data but has not yet acquired the data. 'Feature #' = feature numbers assigned in the draft biological features list (Appendix C).

Feature #	Feature Type	GIS Data Reference	GIS data name	Published Date	GIS Data Source	Comments
B1	Ephemeral/ Opportunistic Communities	MBARI 2005	Chemosynthetic Biological Communities and MBARI ROV Locations	2005	MBARI	Locations of the CBCs by Charlie Paull et al. at the Monterey Bay Aquarium Research Institute (MBARI). The results are based on the analysis of video images and navigation from 792 benthic remotely operated vehicle dives conducted on the continental margin in Monterey Bay, California. The analysis was published in "Distribution of Chemosynthetic Biological Communities in Monterey Bay, California" in Geology in February 2005. Show with ROV effort data.
B2	Sponges - Erect form	NMFS 2004	Structure Forming Invertebrates along the US West Coast	2004	TerraLogic, Inc. (for NMFS)	This data set depicts the locations of certain structure-forming invertebrates that were found during NOAA, National Marine Fisheries Service, Alaska Fisheries Science Center's Slope and Triennial trawl surveys. These surveys were designed to sample groundfish populations, not invertebrates.
B2	Sponges - Erect form	MBARI 2006	Porifera Locations from ROV video	2006	MBARI	This file indicates locations of Porifera, a deep sea benthic invertebrate commonly referred to as a deep sea sponge. Porifera were identified by researchers at Monterey Bay Aquarium Research Institute (MBARI) from underwater video taken by Remotely Operated ehicle (ROV) research expeditions.
B3	Deep Water Corals	MCBI 2010	Habitat Forming Deep Sea Corals	2002	The Marine Conservation Biology Institute	The Marine Conservation Biology Institute gathered records on 8 habitat forming deep sea coral families from 10 different institutions to create this dataset of range and distribution for Antipathidae, Caryophylliidae, Corallidae, Isididae, Oculinidae, Paragorgiidae, Primnoidae, and Stylasteriidae in the Northeast Pacific Ocean. These shapefiles accompany a report "Occurrences of Habitat Forming Deep Sea Corals of the Northeast Pacific Ocean" by Peter Etnoyer and Lance Morgan of MCBI.
B3	Deep Water Corals	NMFS 2004	Structure Forming Invertebrates along the US West Coast	2004	TerraLogic, Inc. (for NMFS)	see above (NMFS 2004)
B3	Deep Water Corals	MBNMS 2010 (Davidson Seamount Corals)	Davidson Seamount Corals	2010	MBNMS	Coral data were collected: May 18-24, 2002, MBARI's R/V Western Flyer, MBARI's ROV Tiburon
B3	Deep Water Corals	MBARI 2006 (Soft corals)	Soft Corals Locations from ROV video	2006	MBARI	This file indicates locations of soft corals, a deep sea benthic invertebrate. Soft corals were identified by researchers at Monterey Bay Aquarium Research Institute (MBARI) from underwater video taken by Remotely Operated Vehicle (ROV) research expeditions.

Feature #	Feature Type	GIS Data Reference	GIS data name	Published Date	GIS Data Source	Comments
B3	Deep Water Corals	NMFS 2008	NMFS Coral Observations 1980-2007	2008	NMFS	This shapefile depicts the locations (in latitude, longitude and water depth) of some observations of cold-water/deep-sea corals off the west coast of the United States. Records of coral catch originate from bottom trawl surveys of groundfish conducted from 1980 to 2001 by the Alaska Fisheries Science Center (AFSC) and 2001 to 2007 by the Northwest Fisheries Science Center (NWFSC). Both science centers recorded some invertebrate catch as part of regular surveys of groundfish off the coasts of Washington, Oregon and California; however, the level of attention given to some invertebrate taxa (e.g., crabs, corals) has increased in recent years. Only records where corals were identified in the total catch are included. Each coral specimen was identified to the lowest taxonomic rank possible by the biologists onboard; therefore identification was dependent on their expertise. Each trawl "event" is represented by a point geo-referenced to either the vessel track midpoint position (for AFSC surveys) or "best position" (i.e., priority order: 1) gear track midpoint 2) vessel track midpoint, 3) vessel start point, 4) vessel end point, 5) station coordinates for NWFSC surveys). Data were compiled by the NWFSC, Fishery Resource Analysis & Monitoring Division.
B3	Deep Water Corals	NMFS???	NMFS Coral and Sponge from Fishery Observers	???	NMFS	Not yet available
B4	Brachiopod beds	MBARI 2006	Brachiopoda Locations from ROV video	2006	MBARI	This file indicates locations Brachiopoda, a type of deep sea benthic invertebrate commonly known as lamp shells. Brachiopoda were identified by researchers at Monterey Bay Aquarium Research Institute (MBARI) from underwater video taken by Remotely Operated Vehicle (ROV) research expeditions. The latitude and longitude of each organism sighting are corrolated to the location of the ROV at the time the organism was evident on the video. Location information is based on the ROV navigation, which includes an ultrashort baseline acoustic system to determine (estimate) the location of the ROV with respect to the ship.
B5	Marshes	TNC 2005	Coastal Marsh	2005	TNC	No metadata
B5	Marshes	ESI 2006	ESI shoreline	2006	NOAA	Environmental Sensitivity Index (ESI) maps provide a concise summary of coastal resources that are at risk if an oil spill occurs nearby. Examples of at-risk resources include biological resources (such as birds and shellfish beds), sensitive shorelines (such as marshes and tidal flats), and human-use resources (such as public beaches and parks).
B5	Marshes	MMS 2007	MMS (1970-1980's) common or occassional features along shoreline	2007	MMS (by Tenera Environmental)	see above
B6	Seagrass beds	ESI 2006	ESI shoreline	2006	NOAA	see above

Feature #	Feature Type	GIS Data Reference	GIS data name	Published Date	GIS Data Source	Comments
B6	Seagrass beds	MMS 2007	MMS (1970-1980's) common or occassional features along shoreline	2007	MMS (by Tenera Environmental)	see above
B6	Seagrass beds	Eelgrass (Zostera) TNC 2004	Eelgrass (Zostera)	2004	TNC	The most common type of seagrass in California is Zostera, or eelgrass, which grows under water in estuaries and in shallow coastal bays of the ecoregion.
B6	Seagrass beds	ESNERR 2000	Elkhorn Slough Seagrass	2000	ESNERR	seagrass polygons from April 4, 2000 image; used in MBNMS Condition Report
B6	Seagrass beds	PISCO 2006	surfgrass in Big Sur area from PISCO	2006	PISCO	Includes kelp, surfgrass, abaolone, postelsia, mussel beds, fed or state protections, sensitive species, species with prolonged recovery, habitat engineers, biodiversity, bench type, relief, and ESI description for modeled and predicted sites too.
B7	Native Oyster beds	Heiman 2006	Oysters	2006	Heiman dissertation	Percent cover of study site within Elkhorn Slough
B10	benthic habitat for harvested species	PFMC 2005	Habitat Suitability Maps for larvae/juv groundfish	2005	PFMC	Models for groundfish and not all species have maps for eggs, larvae, juveniles and adults. http://www.pcouncil.org/habitat-and-communities/habitat/habitat-suitability-maps/
B10	benthic habitat for harvested species	Invert HS Maps from CINMS Biogeographic assessment	HSM from CINMS Biogeo 2005	2005	NCCCOS	Habitat Suitability Models for invertebrate species (e.g. rock crabs, abalone, market squid, spot shrimp, sea cucumbers, urchins, California spiny lobster) and marine fishes (e.g. shark, sardine, northern anchovy, bocaccio, cowcod, lingcod, seabass, CA Sheephead, and CA halibut)
B10	benthic habitat for harvested species	Nearshore Fish Ranges from CDFG 2004	Nearshore Fish Ranges from CDFG 2004	2004	CDFG	Fish ranges include those for eggs, larvae, adult for various species including grass rf, kelp greenling, cabezon, brown rf, bocaccio, olive rf, treefish, widow rf, etc (about 30 species)
B10	benthic habitat for harvested species	NCCOS 2003	Fish Habitat Suitability Maps	2003	NCCOS	HSM on the adult and sub-adult stages of 14 fish species, and adult stage of 4 fish and 2 invertebrate species. See book for examples and CDROM from Phase 1 for specific Habitat Suitability maps. Due to time constraints, analysis of all 119 species individually was not feasible. Instead, all four data sets were analyzed using multivariate statistics to identify species assemblages, site groups, and the location of the species assemblages in space using GIS. For the multivariate statistics, species were included in an analysis if they were captured in at least 5% of the collections.
B11	Mammal Rookeries	NCCOS 2007	Mammal Rookeries	2007	NCCOS	Minor and Occasional Minor Rookery (El Nino years) sites for California Sea lion from 1998-2004 data from SWFSC, Rookery sites for Stellar Sea lion from SWFSC data, Pupping sites for Pacific Harbor seal from SWFSC, rookery sites for Northern Elephant seal from 2003-2004 from various sources and there's a summary dataset of pinniped rookeries showing the number of species confirmed pupping, estimated total number and number of species per site.
B12	beach nesting birds	ESI 2006	ESI shoreline	2006	NOAA	see above

Feature #	Feature Type	GIS Data Reference	GIS data name	Published Date	GIS Data Source	Comments
B13	cliff, rock, island nesting birds	ESI 2006	ESI shoreline	2006	NOAA	see above
B14	Beach spawning fish	ESI 2006	ESI shoreline	2006	NOAA	see above
B16	Zooplankton	Farallon Institute	Krill hot zones in the California Current	???	Farallon Institute	Need to follow up with Jarrod Santora to see if there are GIS files showing the kernel density interpolation of krill hot zones for 2000-2009
B19	Bird Roosts	NCCOS 2007	Bird breeding colonies	2007	NCCOS	Marine bird breeding colonies GIS data includes number of species per colony and number of breeding birds and the data was gathered by various sources identified on Fig.3.42.
B19	Bird Roosts	Seabird Colony Protection Program 2006	Major Breeding seabird Colonies (>100 breeding pairs as of 2006)	2006	Seabird Colony Protection Program	Internal use, not much metadata
B19	Bird Roosts	TNC 2004	Seabird Colonies	2004	TNC	This coverage is derived from the NOAA/USF&WS seabird colony data base. This point coverage shows the approximate location of seabird nesting colonies along the central and northern coast of California, including the SF Bay Area. Original data is from Carter 1980 and Sowles 2000. These data were then updated by TNC in 2004 with information mostly in Baja California from Wolfe SG 2002 using the same format.
B22	Migration corridors	ESI 2006	Offshore maps of diving birds, marine mammals and the leatherback sea turtle	2006	NOAA	Offshore polygons were developed for Central California to show whale migration routes, marine bird and cetacean hot spots and feeding areas and sea turtle concentration areas
B26	Keystone species	MMS 2007	MMS (1970-1980's) common or occasional features along shoreline	2007	MMS (by Tenera Environmental)	(covers 70's and 80's data); sea otter counts by block
B26	Keystone species	UCSC 2001	Northern Sea Otter Counts (Nov 4-20, 2001)	2001	Mike Kenner, UCSC	Sofall01 is a point shapefile of rangewide counts for the northern sea otter, off the northern/central California coast, during Fall of 2001.
B26	Keystone species	UCSC 2002a	Northern Sea Otter Counts (May 5-22, 2002)	2002	Mike Kenner, UCSC	Sospring02 is a point shapefile of rangewide counts for the northern sea otter, off the northern/central California coast, during Spring of 2002. Spring rangewide counts were conducted from 5 May to 22 May 2002.
B26	Keystone species	UCSC 2002b	Sea otter Density per 10 km	2002	Mike Kenner, UCSC	SEG is a polygon shapefile of linear densities for the northern sea otter, off the northern/central California coast, during Fall of 2001 and Spring of 2002. The fall 2001 rangewide counts were conducted from 4 November to 20 November 2001; the spring 2002 rangewide counts were conducted from 5 May to 22 May 2002.
B27	Ecosystem Engineer	Mussel Watch 2011	Mussel Watch (1986-2006)	2011	NS&T-Center for Coastal Monitoring and Assessment	The program aims to describe the current status of, and detect changes in, the environmental quality of our Nation's estuarine and coastal waters through environmental monitoring, assessment and related research. Benthic Surveillance

Feature #	Feature Type	GIS Data Reference	GIS data name	Published Date	GIS Data Source	Comments
B29	Apex predator	MBNMS 2010 (White shark hotspot)	White shark hotspot	2010	MBNMS created (data from Salvador Jorgensen at Stanford University)	Important white shark habitat, aka white shark hotspots, within the Central CA NMS were developed based on information from Salvador Jorgensen at Stanford University. Hot spots include: 1.) the entire coastline from Tomales Point (starting at the narrowest point of entrance to Tomales bay) all the way to the Point Reyes Lifeboat Station just inside Drakes Bay, 2. the waters surrounding the SE Farallon Island, and 3. the waters surrounding Ano Nuevo Island. The depth information from tagged sharks was used as a proxy for the deepest water visited during coastal foraging. Archival tags information with highly detailed depth information were recovered from seven sharks and the .95 depth quantile for each individual was calculated (39, 21, 38, 20, 24, 36, 22m respectively). This means that 95% of the time these sharks remained above these depths. The mean for these values is 28. 57 m. Goldman et al (1999) showed that white sharks frequently swam close to the bottom near the Farallon Islands. Therefore, Jorgensen suggested that it would be reasonable to use an isobath of 30 - 35m surrounding these sites for demarcation.
B30	Macrophyte Beds	DFG 1989	Kelp 1989	1989	CDFG	Aerial photos, taken in July through October 1989, were projected onto 1:24000 USGS topographic maps and kelp canopy features were delineated.
B30	Macrophyte Beds	DFG 1999	Kelp 1999	1999	CDFG	The Fall 1999 project digitally remeasured the 1989 kelp maps and established new digital methods to calculate the area of the 1999 kelp canopy based on aerial, color-infrared photographs. The objective is to create a baseline that could be used to assess the effects of current and future use of coastal kelp.
B30	Macrophyte Beds	DFG 2002	Kelp 2002	2003	CDFG	This image file was created from Digital Multi-Spectral Video image files. These are public data. The Department of Fish and Game must be credited with the collection, analysis and distribution of these data. These data represent the 2002 CDFG survey.
B30	Macrophyte Beds	TNC 2004	Kelp Persistent (3 of 4 years)	2004	TNC	Aerial videography surveys conducted in California by CDFG in 1989, 1999, 2002, and 2003 provided mapped data on extent of kelp beds (giant kelp and bull kelp). Due to the importance of kelp beds and the inter-annual variability in their distribution and abundance, the kelp coverage in each of those four years was included as a separate kelp target. In addition, we were interested in identifying areas of high coverage of kelp that were persistent over three out of four years of the surveys; these areas may be more resilient over time and were treated as a unique target we called "persistent kelp".
B30	Macrophyte Beds	DFG 2004 (Kelp Union)	Kelp Union 1989, 1999, 2002	2004	TerraLogic GIS, Inc., CDFG	Central California Kelp Summarized for 1989, 1999 and 2002
B30	Macrophyte Beds	DFG 2003	Kelp 2003	2003	CDFG	These data are used to assess the extent of kelp resources along the coast of California. This image file was created from Digital Multi-Spectral Video image files. These are public data. The Department of Fish and Game must be credited with the collection, analysis and distribution of these data. These data represent the 2003 CDFG survey.
B30	Macrophyte Beds	DFG 2004	Kelp 2004	10/10/2005	CDFG	These data are used to assess the extent of kelp canopy resources along the coast of California. This image file was created from Digital Multi-

Feature #	Feature Type	GIS Data Reference	GIS data name	Published Date	GIS Data Source	Comments
						Spectral Video image files. These are public data. The Department of Fish and Game must be credited with the collection, analysis and distribution of these data. These data represent the 2004 CDFG survey. The surveys were flown between September and November of 2004. The photographs were taken from 10,500 feet, utilizing the Departments two Partenavia aircraft. Surveys were planned to coincide with periods of minimal change between high and low tides, to avoid strong tidal induced currents. The surveys were flown during early morning or late afternoon, to avoid glare from overhead sun. These data are complete at this time, although the user should note omissions.
B30	Macrophyte Beds	DFG 2005	Kelp 2005	8/31/2006	CDFG	These data are used to assess the extent of kelp canopy resources along the coast of California. This image file was created from Digital Multi-Spectral Video image files. These are public data. The Department of Fish and Game must be credited with the collection, analysis and distribution of these data. These data represent the 2005 CDFG survey. The surveys were flown between August and November of 2005. The photographs were taken from 10,500 feet, utilizing the Departments two Partenavia aircraft. Surveys were planned to coincide with periods of minimal change between high and low tides, to avoid strong tidal induced currents. The surveys were flown during early morning or late afternoon, to avoid glare from overhead sun. These data are complete at this time, although the user should note omissions.
B30	Macrophyte Beds	DFG 2008	Kelp 2008	7/27/2009	CDFG	The dataset is used to assess the extent of kelp resources along the coast of California. The user should note this dataset was collected and created with a different camera system and software than the 2002-2007 surveys. This difference in camera system and processing software allows the collection of both surface and subsurface kelp with separate classification schemes. See associated layer file depicting the two separate classifications. The shapefile was created from Digital Multi-Spectral Camera image files. This is public data. The data was collected and processed by Ocean Imaging under contract by the California Department of Fish and Game (CDFG). The California Department of Fish and Game must be credited with the distribution of these data. The dataset represents the 2008 CDFG survey. The Northern and Central California surveys were flown October 06-08, 2008. The Southern California including the Channel Islands imagery was acquired October 20-23, 2008. The photographs were taken from an altitude of 12,500 feet, utilizing the Department's Partenavia aircraft. Surveys were planned to coincide with periods of minimal change between high and low tides, to avoid strong tidal induced currents.
B31	Biodiversity	NCCOS 2003	Top 20% Density and Diversity of Marine Birds and Fish	2003	NCCOS Biogeographic Assessment Phase 1	This polygon file represents the top 20th percentile region of highest density and diversity of marine birds and fish based on interpolated survey data from Northern/Central California coastal waters. It is equivalent to the union of the files: bird_density_top20th, bird_diversity_top20th, fish_density_top20th, fish_diversity_top20th
B30	Macrophyte Beds	DFG 2009	Kelp Presence Maximum (1989, 1999, 2002-2006, 2008)	2009	CDFG	Show kelp persistence within 7 yrs. Ecotrust created a 10 m cell size, kelp presence grid for Central Coast Study Region using kelp data from 1989, 1999, 2002-2006.

Feature #	Feature Type	GIS Data Reference	GIS data name	Published Date	GIS Data Source	Comments
B30	Macrophyte Beds	MMS 2007	MMS (1970-1980's) common or occassional features along shoreline	2007	MMS (by Tenera Environmental)	Tenera Environmental digitized MMS maps from the 1970's and 1980's for a large variety of features including, but not limited to, eelgrass, marsh, sea palm, bull kelp, surfgrass, and algae
B30	Macrophyte Beds	PISCO 2006	PISCO Intertidal Shoreline	2006	PISCO	Includes kelp, surfgrass, abalone, postelsia, mussel beds, fed or state protections, sensitive species, species with prolonged recovery, habitat engineers, biodiversity, bench type, relief, and ESI description for modeled and predicted sites too.
B32	Bird Diversity	NCCOS 2003	Marine Bird Diversity	2003	NCCOS Biogeographic Assessment Phase 1	Polygon shapefiles representing 5'x5' latitude x longitude cells that house the overall, combined species diversity (H') of 76 species of marine birds, regardless of season and/or oceanic conditions for 1980-2001; Marine Bird Diversity (warm water periods (El Nino)) animals/km2 (1981,1983-85,1987,1992-98); Marine Bird Diversity (neutral water periods) H' (1980,1982, 1986,1988,1989,1991, 1994--97); Marine Bird Diversity (Oceanic Season) H' (1980-82, 1991, 1994-2001); Marine Bird Diversity (cold water periods-La Nina) H' (1980-81,1985, 1990-91,1994,1996,1998-2001); Marine Birds Diversity (Davidson Current Period) H' (1980-1986, 1990-2001); Marine Birds Diversity (Upwelling Season) H' (1980-1982, 1985-2001)
B33	Fish Diversity	NCCOS 2003	Demersal fish diversity	2003	NCCOS Biogeographic Assessment Phase 1	Demersal Fish Diversity per NMFS trawl 1977-2001 per trawl and for a 5 minute grid, includes a separate file for rockfish

Appendix I. List of workshop participants

Name and affiliation of participants in the Workshop on Unique and/or Rare Features in Monterey Bay National Marine Sanctuary held on May 24, 2011.

Name	Affiliation
Invited Participants	
Armor, John	NOAA/ONMS/
Benson, Scott	NOAA/NMFS/SWFSC/Protected Resources Division
Carr, Mark	University of California Santa Cruz; Partnership for Interdisciplinary Studies of Coastal Oceans
Clague, David	Monterey Bay Aquarium Research Institute
Colton, Madhavi	MPA Monitoring Enterprise
Forney, Karin	NOAA/NMFS/SWFSC/Protected Resources Division
Greene, Gary	Moss Landing Marine Laboratory
Harrold, Chris	Monterey Bay Aquarium; MBNMS SAC - Research Primary
Kudela, Raphael	University of California Santa Cruz
Long, Dennis	Monterey Bay Sanctuary Foundation
Lundsten, Lonny	Monterey Bay Aquarium Research Institute
Marinovic, Baldo	University of California Santa Cruz
Monaco, Mark	NOAA/Center for Coastal Monitoring and Assessment
Opshaug, Kortney	MBNMS SAC - At-Large Alternate
Paduan, Jeff	Naval Postgraduate School
Paull, Charlie	Monterey Bay Aquarium Research Institute
Raimondi, Pete	University of California Santa Cruz; Partnership for Interdisciplinary Studies of Coastal Oceans
Ramp, Steve	SOLITON Ocean Services, Inc.
Reilly, Paul	California Department of Fish and Game
Robison, Rondi	NOAA/Marine Protected Areas Center
Scheiblauer, Steve	MBNMS SAC - Harbors
Schillinger, George	Center for Ocean Solutions
Shester, Geoff	Oceana
Starr, Rick	California Sea Grant; Moss Landing Marine Laboratory
Storlazzi, Curt	United States Geological Survey
Tribolet, Chuck	moderator of BA-Diving
Vasquez, Jason	California Department of Fish and Game
Wahle, Charlie	NOAA/Coastal and Marine Spatial Planning Program
Wasson, Kerstin	Elkhorn Slough National Estuarine Research Reserve
Worcester, Karen	Regional Water Quality Control Board
Yoklavich, Mary	NOAA/NMFS/SWFSC/Fisheries Ecology Division

Public	
McKenna, Sheila	IUCN Sargasso Sea Program
Staff	
Brown, Jennifer	NOAA/ONMS/Monterey Bay National Marine Sanctuary
Burton, Erica	NOAA/ONMS/Monterey Bay National Marine Sanctuary
Capps, Nicole	NOAA/ONMS/Monterey Bay National Marine Sanctuary
De Beukelaer, Sophie	NOAA/ONMS/Monterey Bay National Marine Sanctuary
DeVogelaere, Andrew	NOAA/ONMS/Monterey Bay National Marine Sanctuary
Dunsmore, Rikki	NOAA/ONMS/Monterey Bay National Marine Sanctuary
Frey, Oren	NOAA/ONMS/Monterey Bay National Marine Sanctuary
Hunt, John	NOAA/ONMS/Monterey Bay National Marine Sanctuary
Lonhart, Steve	NOAA/ONMS/Monterey Bay National Marine Sanctuary
Lozano, Sacha	NOAA/ONMS/Monterey Bay National Marine Sanctuary
Lurie, Lisa	NOAA/ONMS/Monterey Bay National Marine Sanctuary
Michel, Paul	NOAA/ONMS/Monterey Bay National Marine Sanctuary
Uttal, Lisa	NOAA/ONMS/Monterey Bay National Marine Sanctuary
Wooninck, Lisa	NOAA/ONMS/West Coast Region

Appendix J.

Workshop Agenda

Identifying Biological, Oceanographic, and Geological Features and Submerged Cultural Resources that are Unique and/or Rare in Monterey Bay National Marine Sanctuary

NMFS, Santa Cruz Lab

May 24th, 2011

Goal: To gather information on biological, oceanographic, and geological features and submerged cultural resources that are unique and/or rare in Monterey Bay National Marine Sanctuary and to identify supporting data sources and information gaps.

8:00-8:30 *Coffee and continental breakfast in lab foyer*

8:30-9:00 Welcome/Introductions

- Review agenda
- Ground rules
- Introductions

9:00-9:20 Background information

- What is the Ecosystem-based Management (EBM) Initiative?
- How does this workshop fit into the EBM Initiative?

9:20 -10:00 How are we going to identify features that are unique and/or rare in MBNMS?

- Define terms: feature, attribute, unique, rare
- Describe process for identifying features and characterizing attributes
- Types of information we will gather from participants

10:00-10:15 *Break (refreshments provided)*

10:15-12:00 Break-out Session 1: Facilitated discussion in groups with the goal of:

- Vetting draft features lists
- Identifying supporting data and information gaps
- Identifying features that are rare, unique, and/or remarkable

12:00-1:00 *Lunch (provided)*

1:00-1:30 Discussion of Break-out Session 1

1:30-1:45 Public Question & Answer period

1:45-2:00 Introduce process for gathering preliminary information on threats to the features

2:00-3:15 Break-out Session 2: Facilitated discussion in small groups with the goal of:

- Identifying threats to features
- Identifying sources of information on threats

3:15-3:30 *Break (refreshments provided)*

3:30-4:30 Gathering feedback on

- Break-out Session 2
- Overall process for identifying unique and/or rare features
- Parking lot issues
- Workshop evaluation form

4:30-4:45 Public Question & Answer period

4:45-5:00 Wrap up – next steps

5:00 Adjourn