Monterey Bay National Marine Sanctuary Condition Report Addendum 2015

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Comment [N1]: Kudela: First, I congratulate the report writers and participants on putting together a very thorough report. There were very few instances where I was aware of new/better data, and the data/findings reported were generally accurately depicted (at least for areas where I have enough knowledge to comment). I found the structure a bit difficult to follow but I realize that is a mandated format for the report. I made a comment somewhere in the document but I think it would be useful to elevate the discussion (i.e. perhaps include something at the beginning, separate from the report criteria for each region) of how decadal (and perhaps secular climate change) trends influence reporting when a particular time period, such as the last 5 years, is discussed. Overall I thought it was addressed where appropriate, but given the unprecedented warm anomaly, the drought, and other multi-year factors that influencing the ...

Comment [N2]: Lindley:
Review of "Monterey Bay National Marine Sanctuary Condition Report Addendum 2015"

Steve Lindley, NMFS SWFSC
20 Aug 2015

The condition report addendum follows up on an original 2009 condition report by answering a series of 18 questions for each of 4 areas within the MBNMS. Within this structure, the addendum reviews a broad and diverse set of information to characterize the status, and trends in status or sanctuary resources and threats to those resources. The report authors did a good job of marshaling this information within the structure of the report, and ...

Comment [N3]: Lindholm:

I was asked to review and comment on the recent update to the MBNMS Condition Report. I undertook this review as one who participated in both the original 2009 report as well as the recent update; as the Chair of the MBNMS Research Activities Panel and Research Seat on the Sanctuary Advisory Council; as a long-time researcher in the MBNMS; and as a former ONMS employee who participated in the development of the Sanctuary Wide Integrated Monitoring (SWiM) document on which the Condition Reports have been derived. Against that backdrop I found the updated report ...

Comment [N4]: Field: Overall I found the condition report to be a very comprehensive evaluation of status and trends; while the interpretation was not necessarily always to the rigor that one might expect in research papers or assessments, this is understandable given the range and breadth of the data sources and contributions (many of which are unpublished, which makes their inclusion timely and I felt very informative). There is considerable redundancy, but this seems somewhat unavoidable given the document, similarly the data sources and figures range widely in their presentation and graphics; in an ideal world they might be standardized a bit more for consistency but this is a fairly low priority. Most of my comments relate to fisheries trends and datasets that are mor ...

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About this Addendum

This document is an addendum to the *Monterey Bay National Marine Sanctuary 2009 Condition Report* (ONMS 2009). The 2009 report provided a summary of resources in the National Oceanic and Atmospheric Administration Monterey Bay National Marine Sanctuary (sanctuary), pressures on those resources, current conditions and trends, and management responses to reduce or mitigate human pressures. Specifically, the 2009 Condition Report presented responses to a set of 17 questions posed to all sanctuaries. These responses provided information on the status and trends of water quality, habitat, living resources and maritime archaeological resources, and the human activities that affect them. These 17 questions were completed for three marine environments: estuarine, nearshore, and offshore. The 2009 report can be downloaded from the Office of National Marine Sanctuaries website at http://sanctuaries.noaa.gov/science/condition.

This addendum updates the 2009 Condition Report (ONMS 2009). The 16[1] questions found in the "State of Sanctuary Resources" section of the Condition Report have been re-evaluated for accuracy and completeness given new data sets, published literature, and expert opinion that have become available since 2009. For those that have new information to report, new status and trend ratings and updated narratives are provided. Trend ratings are generally based on trends since 2009. This re-evaluation was completed for three marine environments: estuarine, nearshore, and offshore. A fourth marine environment, seamount, is evaluated for the first time in the 2015 Condition Report due to the addition of the Davidson Seamount Management Zone to the sanctuary in 2009 (Figure 'MBNMS Environments').

In order to address the set of 16 questions, sanctuary staff consulted with outside experts familiar with the resources and with knowledge of previous and current scientific investigations in the sanctuary. Evaluations of status and trends are based on interpretation of quantitative and, when necessary, qualitative assessments, and the observations of scientists, managers and users. The ratings reflect the collective interpretation of the status of local issues of concern among sanctuary system staff and outside experts based on their knowledge and perception of local problems. The final ratings were determined by sanctuary staff. This report has been peer reviewed and complies with the White House Office of Management and Budget's peer review standards as outlined in the Final Information Quality Bulletin for Peer Review.

This is the second effort to comprehensively describe the status and trends of resources at Monterey Bay National Marine Sanctuary. The report helps identify gaps in current monitoring efforts, as well as causal factors that may require monitoring and potential remediation in the

[1] In 2012 the Office of National Marine Sanctuaries led an effort to review and revise the set of questions and their possible responses posed in the Condition Reports. As part of this effort some questions were combined, new questions were added, and other questions were removed. Question 10, What is the status of environmentally sustainable fishing and how is it changing? was removed from the set of questions. This decision was made because of all the questions it was the only one that focused on a single human activity. The issue of fishing is sufficiently addressed in other questions found the in report, including those related to biodiversity, the status and health of key species, and the status of human activities. For a complete list of the new, revised set of questions see ONMS 2015. Note that the revised questions are not reflected in the 2015 Monterey Bay National Marine Sanctuary Condition Report Addendum. However, because of the aforementioned reasons, Questions 10 was not answered. The new set of questions will be addressed when the Condition Report in its entirety is revised in the future.

years to come. The data discussed will not only enable resource managers and stakeholders to acknowledge prior changes in resource status, but will provide guidance for future management challenges, including the revision of the Monterey Bay National Marine Sanctuary Management Plan.

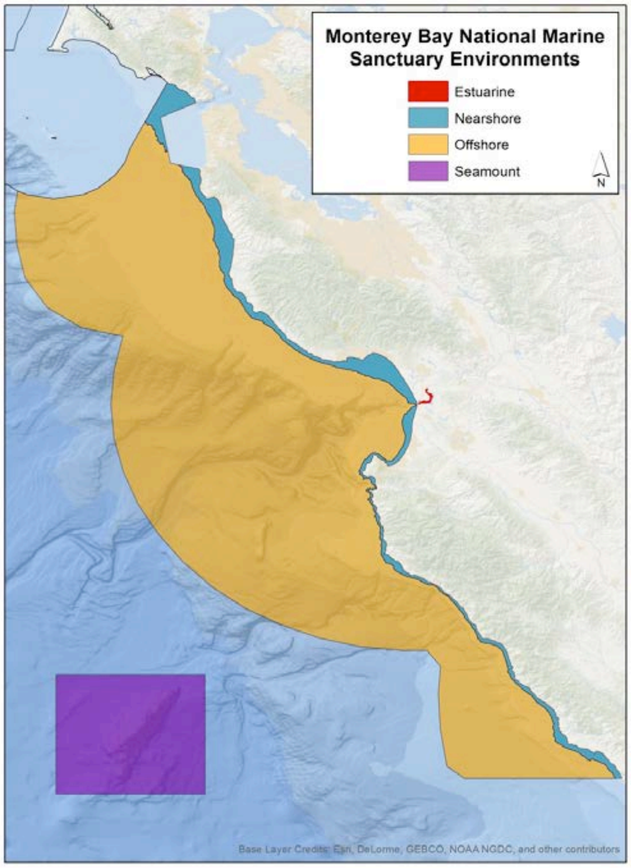
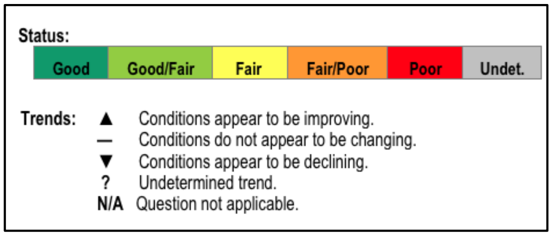


Figure: 'MBNMS Environments'
Caption: Monterey Bay National Marine Sanctuary was subdivided into estuarine, nearshore (shoreline to 30 m depth), and offshore (30 m depth to seaward boundary) environments for the purpose of assessment in the 2009 MBNMS Condition Report due to the considerable differences in these environments. All 17 standardized questions were assessed separately for each of these environments. In the 2015 Condition Report, a fourth environment, seamount, has been assessed for the first time. The seamount environment is defined by the boundaries of the Davidson Seamount Management Zone, which was added to Monterey Bay National Marine Sanctuary in March 2009 (effective date of regulations).
Credit: S. De Beukelaer, MBNMS

Monterey Bay National Marine Sanctuary
Condition Summary Tables

The following four tables summarize the “State of Sanctuary Resources” sections of this report for the Estuarine, Nearshore, Offshore, and Seamount environments. In each table, the first two columns list 17 questions used to rate the condition and trends for qualities of water, habitat, living resources, and maritime archaeological resources. The Rating column consists of a color, indicating resource condition, and a symbol, indicating trend (see key for definitions). The confidence column consists of a rating experts agreed represented their level of certainty (see Appendix B for additional information). The Basis for Judgment column provides a short statement or list of criteria used to justify the rating. The Description of Findings column presents the statement that best characterizes resource status, and corresponds to the assigned color rating. The Description of Findings statements are customized for all possible ratings for each question (see Appendix A for further clarification of the questions and the Description of Findings statements). The Response column describes current or proposed management responses to pressures impacting sanctuary resources. Questions that have new information to report since the 2009 Monterey Bay National Marine Sanctuary Condition Report (ONMS 2009) are those with red numbers.



Estuarine Environment Condition Summary Table

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
WATER					
1	Stressors	▼	Status: N/A (not updated) Trend: N/A (not updated)	Major alterations to tidal, freshwater, and sediment processes has increased the level of pollution and eutrophication; inputs of pollutants from agricultural and urbanized land sources.	Selected conditions have caused or are likely to cause severe declines in some but not all living resources and habitats.
2	Eutrophic Condition	▼	Status: Very High Trend: Very High	General trend of increasing nitrate in Elkhorn Slough. Frequent occurrence of depressed DO and hypoxic events. High percent cover of algal mats in summer.	Selected conditions have caused or are likely to cause severe declines in some but not all living resources and habitats.
3	Human Health	?	Status: N/A (not updated) Trend: N/A (not updated)	Elkhorn Slough and connected waterbodies are impaired by pesticides and pathogens. High levels of contaminants in harvested crustaceans and bivalves could pose a risk to human health. SWAMP BOG fish results.	Selected conditions have caused or are likely to cause severe impacts, but cases to date have not suggested a pervasive problem.
4	Human Activities	▲	Status: High Trend: High	Substantial inputs of pollutants from non-point sources, especially agriculture. Less agriculture around Elkhorn Slough due to land acquisition by ESF thereby reducing nutrient loading from agriculture. No evidence yet of improving water quality due to changes in land management practices.	Selected activities have resulted in measurable resource impacts, but evidence suggests effects are localized, not widespread.
HABITAT					
5	Abundance/ Distribution	–	Status: Very High Trend: Very High	Over 150 years of hydrologic alteration has resulted in substantial erosion and habitat conversion. Recent stability with little change in relative abundance of habitat types.	Selected habitat loss or alteration has caused or is likely to cause severe declines in some but not all living resources or water quality.
6	Biologically-Structured	▲	Status: Very High Trend: Very High	Severe reductions in the abundance of native structure-forming organisms from historic levels. Recent slight increases in eelgrass and native oysters.	Selected habitat loss or alteration has caused or is likely to cause severe declines in most if not all living resources or water quality.
7	Contaminants	▼	Status: Medium Trend: Medium	Numerous contaminants present and at high levels at localized areas with some evidence of accumulation in top predators (sea otters).	Selected contaminants have caused or are likely to cause severe declines in some but not all living resources or water quality.
8	Human Impacts	▲	Status: Medium Trend: Medium	Past hydrologic changes and maintenance of water diversion structures, and continued input of nutrients from agriculture.	Selected activities warrant widespread concern and action, as large-scale, persistent and/or repeated severe impacts have occurred or are likely to occur.

Comment [N5]: Field: "Swamp bog fish results" are listed without any context, I'm guessing that is a placeholder for something meaningful? In the same line, under description of findings it reads 'selected conditions have caused or are likely to cause severe impacts, but cases to date have not suggested a pervasive problem"- isn't harvest (or most harvest) prohibited in the primary estuary of interest? The extent to which it is or is not should probably be described in the documentation.

Jenn: this has been handled by Bridget

				Management activities have the potential to reduce agricultural runoff and reduce erosion in some areas.	
LIVING RESOURCES					
9	Biodiversity	—	Status: Medium Trend: Medium	Changes in the relative abundance of some species associated with specific estuarine habitats. No significant recent changes in species richness or relative abundance.	Selected biodiversity loss may inhibit full community development and function and may cause measurable but not severe degradation of ecosystem integrity.
11	Non-Indigenous Species	—	Status: Medium Trend: Medium	High percentage of non-native species, no known recent introductions or significant changes in abundance	Non-indigenous species have caused or are likely to cause severe declines in ecosystem integrity.
12	Key Species Status	▲	Status: Very High Trend: Very High	Abundance of native oyster, eelgrass, and salt marsh are substantially reduced compared to historic levels. Salt marsh appears to be stable and slight increases in eelgrass and native oysters.	The reduced abundance of selected keystone species has caused or is likely to cause severe declines in some but not all ecosystem components, and reduce ecosystem integrity; or selected key species are at substantially reduced levels, and prospects for recovery are uncertain.
13	Key Species Condition	?	Status: Low Trend: Low	Limited information on health or condition suggests eelgrass, oysters and sea otters are fairly healthy.	The condition of selected key resources is not optimal, perhaps precluding full ecological function, but substantial or persistent declines are not expected.
14	Human Activities	?	Status: Medium Trend: Medium	Many human activities that Impact living resources (e.g., hydrologic modifications, inputs of pollutants from agriculture and development, introduction of non-indigenous species. Overall trend in human activities difficult to determine.	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.
MARITIME ARCHAEOLOGICAL RESOURCES					
15	Integrity	?	Status: N/A (not updated Status: N/A (not updated	Very little is known about the integrity of the few known maritime archaeological resources in Elkhorn Slough.	Not enough information to make a determination.
16	Threat to Environment	—	Status: N/A (not updated Status: N/A (not updated	No known environmental hazards.	Known maritime archaeological resources pose few or no environmental threats.
17	Human Activities	—	Status: N/A (not updated Status: N/A (not updated	Existing human activities do not influence known maritime archaeological resources.	Few or no activities occur that are likely to negatively affect maritime archaeological resource integrity.

Nearshore Environment Condition Summary Table

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
WATER					
1	Stressors	▼	Status: N/A (not updated Status: N/A (not updated	Elevated levels of contaminants (e.g., POPs, heavy metals), nutrients, sediments, pathogens in some locations; on-going input of established and emerging pollutants. Acidification and hypoxia conditions increasing.	Selected conditions may inhibit the development of assemblages, and may cause measurable but not severe declines in living resources and habitats.
2	Eutrophic Condition	▼	Status: High Trend: High	Increasing nutrient enrichment and occurrence of HABs. New information regarding prevalence of microcystis in major river systems and coastal waters. HABs directly impacting fish, birds, and mammals.	Selected conditions may inhibit the development of assemblages, and may cause measurable, but not severe declines in living resources or habitats.
3	Human Health	?	Status: Very High Trend: Very High	Continue to have warnings at some beaches and lagoons due to high fecal indicator bacteria; declining dieldrin levels in mussels, contaminated shellfish at some locations and during some seasons. Mercury in fish.	Selected conditions have resulted in isolated human impacts, but evidence does not justify widespread or persistent concern.
4	Human Activities	▲	Status: Medium Trend: Medium	More regulations on human activities that can cause pollution, but evidence is lacking regarding improvements. Efforts to reduce pollution may be offset by intensification of human activities in coastal watersheds.	Selected activities have resulted in measurable resource impacts, but evidence suggests effects are localized, not widespread.
HABITAT					
5	Abundance/ Distribution	▼	Status: Very High Trend: Very High	Localized modification of coastal habitat and reduced habitat quality, primarily through armoring, erosion, landslide, and accumulation of marine debris and contaminants.	Selected habitat loss or alteration has taken place, precluding full development of living resource assemblages, but it is unlikely to cause substantial or persistent degradation in living resources or water quality.
6	Biologically-Structured	■	Status: Very High Trend: Very High	Monitoring programs indicate healthy populations and no major perturbations.	Habitats are in pristine or near-pristine condition and are unlikely to preclude full community development.
7	Contaminants	▼	Status: High Trend: High	Declines in some persistent contaminants (dieldrin), but new contaminants being added to the system; some evidence showing	Selected contaminants have caused or are likely to cause severe declines in some but not all living resources or water quality.

Comment [N6]: Field: basis for judgments reads “evidence is lacking regarding improvements” – yet trend suggests increasing condition with “medium” confidence? If anything trend should be neutral and/or confidence low based on the basis for judgment. This is particularly true as later on page 12, living resources, number 9, biodiversity, the basis reads “most key species and faunal groups with available data are stable or increasing” yet the trend rating is of no trend with medium confidence- if “most” groups with available data are stable or increasing I would say the trend should be towards improving. The same comment holds with line number 12, key species status, on the same page.

Jenn: Bridget handled first comment. Notes on the following comments to Offshore Questions 9, 12, 13 will be provided in those sections.

				contaminants are accumulating in shellfish and resident fish and are impacting health of living resources (e.g., mammals)	
8	Human Impacts	?	Status: Medium Trend: Medium	Trampling, visitation, and coastal armoring can have measurable, localized impacts; trash and contaminants present and accumulating slowly despite management efforts.	Some potentially harmful activities exist, but they do not appear to have had a negative effect on habitat quality.
LIVING RESOURCES					
9	Biodiversity	---	Status: Very High Trend: Very High	Fishing, collecting, and poaching have altered biodiversity from what would be expected in a natural state. Most assemblages appear to be fairly stable except for sea stars and urchins.	Selected biodiversity loss may inhibit full community development and function and may cause measurable but not severe degradation of ecosystem integrity.
11	Non-Indigenous Species	▼	Status: Very High Trend: Very High	A few non-indigenous species have been identified, and some appear to be spreading.	Non-indigenous species are not suspected or do not appear to affect ecosystem integrity (full community development and function).
12	Key Species Status	▼	Status: Very High Trend: Very High.	Abundance of some key species in each habitat type is lower than would be expected in a natural state. Many key species stable or increasing,.but substantial change for sea stars and sea urchins.	Selected key or keystone species are at reduced levels, perhaps precluding full community development and function, but substantial or persistent declines are not expected.
13	Key Species Condition	▼	Status: Very High Trend: Very High	Continuing health problems in sea otters and black abalone. New severe health issue for sea stars.	The condition of selected key resources is not optimal, perhaps precluding full ecological function, but substantial or persistent declines are not expected.
14	Human Activities	▼	Status: Very High Trend: Very High	Variety of visitation, extraction, and coastal development activities, some of which are increasing in frequency.	Selected activities have resulted in measurable living resource impacts, but evidence suggests effects are localized, not widespread.
MARITIME ARHCAOELOGICAL RESOURCES					
15	Integrity	?	Status: N/A (not updated) Trend: N/A (not updated)	Divers have looted sites, but few sites have been studied to determine trend.	The diminished condition of selected archaeological resources has reduced, to some extent, their historical, scientific or educational value and may affect the eligibility of some sites for listing in the National Register of Historic Places.
16	Threat to Environment	▼	Status: Medium Trend: Medium	Known resources containing hazardous material continue to deteriorate	Selected maritime archaeological resources may cause measurable, but not severe, impacts to certain sanctuary resources or areas, but recovery is possible.
17	Human Activities	?	Status: N/A (not updated) Trend: N/A (not updated)	Activities, such as recreational diving occurs on wreck sites, but activity level is unknown.	Some potentially relevant activities exist, but they do not appear to have had a negative effect on maritime archaeological resource integrity.

Offshore Environment Condition Summary Table

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
WATER QUALITY					
1	Stressors	▼	Status: High Trend: Very High	Elevated levels of contaminants (e.g., persistent organic pollutants), and ocean temperature and chemistry changes, some of which have been linked to changes in the offshore ecosystem.	Selected conditions may inhibit the development of assemblages and may cause measurable but not severe declines in living resources and habitats.
2	Eutrophic Condition	▼	Status: Very High Trend: Medium	Nutrient enrichment in selected areas, increased nutrient loading, and increased frequency and intensity of harmful algal blooms.	Selected conditions may preclude full development of living resource assemblages and habitats, but are not likely to cause substantial or persistent declines.
3	Human Health	?	Status: N/A (not updated) Trend: N/A (not updated)	Measurable levels of biotoxins and contaminants in some locations that have the potential to affect human health; no reports of human impacts.	Selected conditions that have the potential to affect human health may exist but human impacts have not been reported.
4	Human Activities	▲	Status: N/A (not updated) Trend: N/A (not updated)	Inputs of pollutants from agriculture and urban development; reduced risk of impacts from vessels due to regulation of traffic patterns and discharges, removal of oil from sunken ships.	Selected activities have resulted in measurable resource impacts, but evidence suggests effects are localized, not widespread.
HABITAT					
5	Abundance/ Distribution	▲	Status: High Trend: Medium	Benthic habitat loss and modification due to fishing with bottom-contact gear; recovery of seafloor habitats likely occurring in some locations following reductions in this activity.	Selected habitat loss or alteration may inhibit the development of assemblages, and may cause measurable but not severe declines in living resources or water quality.
6	Biologically-Structured	?	Status: High Trend: Medium	Damage to and loss of structure-forming and structure-building taxa due to trawl fishing. Recovery likely occurring in some locations and for some taxa following reductions in this activity, however concerns that ocean acidification is negatively impacting these species.	Selected habitat loss or alteration has caused or is likely to cause severe declines in some but not all living resources or water quality.
7	Contaminants	▼	Status: High Trend: High	Exponential increase in amount of PCBs in water samples from two sites. Marine mammals are contaminated by PCBs. No evidence of strong ecosystem level effects. No	Selected contaminants may inhibit the development of assemblages and may cause measurable but not severe declines on living resources or water quality.

				additional information on contaminant levels in ocean sediments.	
8	Human Impacts	▲	Status: High Trend: High	Decreases in both overall effort and spatial extent of fishing with bottom trawl gear. Inputs of marine debris and contaminants continues. Impacts of submerged cables and marine debris appear to be localized.	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.
LIVING RESOURCES					
9	Biodiversity	—	Status: Medium Trend: Low	Reduced relative abundance of targeted, by-catch, and sensitive species. Most assemblages and faunal groups with available data appear to be stable.	Selected biodiversity loss may inhibit full community development and function and may cause measurable but not severe degradation of ecosystem integrity.
11	Non-Indigenous Species	■	Status: N/A (not updated) Trend: N/A (not updated)	Very few non-indigenous species identified in offshore waters.	Non-indigenous species are not suspected or do not appear to affect ecosystem integrity (full community development and function).
12	Key Species Status	—	Status: Medium Trend: Low	Some key species at reduced abundance levels due to past or on-going harvest. Most key species with data available appear to be stable or slightly increasing.	Selected key or keystone species are at reduced levels, perhaps precluding full community development and function, but substantial or persistent declines are not expected.
13	Key Species Condition	▼	Status: Medium Trend: Low	Some key species have compromised health due to exposure to neurotoxins produced by HABs, entanglement in active and lost fishing gear, ingestion of marine debris, and accumulation of persistent contaminants.	The condition of selected key resources is not optimal, perhaps precluding full ecological function, but substantial or persistent declines are not expected.
14	Human Activities	—	Status: Medium Trend: Medium	Recent management actions helping recover overfished stocks and impacted habitats, but inputs of marine debris and contaminants have measurable impacts; ocean acidification and hypoxia increasing.	Selected activities have resulted in measurable living resource impacts, but evidence suggests effects are localized, not widespread.
MARITIME ARHCAEOLOGICAL RESOURCES					
15	Integrity	?	Status: N/A (not updated Status: N/A (not updated	To date, only one of potentially hundreds of archaeological site inventories has been conducted.	Not enough information to make a determination.

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16	Threat to Environment	▼	Status: Medium Trend: Medium	Known resources containing hazardous material located inside and immediately adjacent to the sanctuary continue to deteriorate.	Selected maritime archaeological resources may cause measurable, but not severe, impacts to certain sanctuary resources or areas, but recovery is possible.
17	Human Activities	?	Status: N/A (not updated Status: N/A (not updated	Archaeological resources, particularly those that are undocumented, are vulnerable to degradation from trawling and looting.	Some potentially relevant activities exist, but they do not appear to have had a negative effect on maritime archaeological resource integrity.

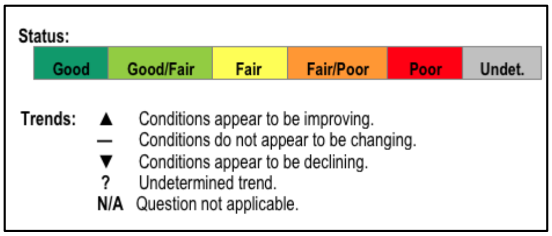
Seamount Condition Summary Table

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
WATER QUALITY					
1	Stressors	?	Status: N/A Trend: N/A	No information available specific to DSMZ; however, see the open ocean section of this report.	Not enough information to make a determination.
2	Eutrophic Condition	?	Status: N/A Trend: N/A	No information available specific to DSMZ.	Not enough information to make a determination.
3	Human Health	?	Status: N/A Trend: N/A	No information available specific to DSMZ.	Not enough information to make a determination.
4	Human Activities	?	Status: Medium Trend: Medium	Large vessel, particularly tankers, transiting through DSMZ poses a threat to water quality but no known impacts from this activity. More information needed on levels and trends of other potential threats.	Some potentially harmful activities exist, but they do not appear to have had a negative effect on water quality.
HABITAT					
5	Abundance/ Distribution	—	Status: very high Trend: high	Offshore location, existing level of protections, and limited access to the seafloor may limit impacts.	Habitats are in pristine or near-pristine condition and are unlikely to preclude full community development.
6	Biologically-Structured	?	Status: very high Trend: medium	Biogenic species appear abundant; organisms larger, more robust than coastal canyon areas. Trend information unavailable.	Habitats are in pristine or near-pristine condition and are unlikely to preclude full community development.
7	Contaminants	?	Status: N/A Trend: N/A	Contaminant concentrations in the DSMZ are poorly understood. There have been very few sediment samples collected within the DSMZ for the purpose of contaminant studies.	Not enough information to make a determination.
8	Human Impacts	?	Status: high Trend: medium	Harmful activities exist, but offshore location, existing level of protections, and limited access to the seafloor may limit impacts.	Some potentially harmful activities exist, but they do not appear to have had a negative effect on habitat quality.
LIVING RESOURCES					
9	Biodiversity	?	Status: very high Trend: medium	Relatively pristine area with few removals; but data are sparse	Biodiversity appears to reflect pristine or near-pristine conditions and promotes ecosystem integrity (full community development and function).
11	Non-Indigenous Species	—	Status: medium Trend: medium	No known non-indigenous species; but data are sparse	Non-indigenous species are not suspected or do not appear to affect ecosystem integrity (full community development and function)
12	Key Species Status	▲	Status: high Trend: high	Abundance and diversity of corals, stable fish stocks, and existing protections.	Key and keystone species appear to reflect pristine or near-pristine conditions and many promote ecosystem integrity

				Federally endangered marine mammals (e.g., Fin Whale), appear to be increasing.	(full community development and function).
13	Key Species Condition	—	Status: high Trend: medium	Key species appear healthy, and are protected or otherwise regulated.	The condition of key resources appears to reflect pristine or near-pristine conditions.
14	Human Activities	?	Status: high Trend: medium	Offshore location, existing level of protections, and few existing threats may limit impacts to living resources.	Some potentially harmful activities exist, but they do not appear to have had a negative effect on habitat quality.
MARITIME ARCHAEOLOGICAL RESOURCES					
15	Integrity	**N/A**	Status: N/A Trend: N/A	No known maritime archaeological resources	**N/A**
16	Threat to Environment	**N/A**	Status: N/A Trend: N/A	No known maritime archaeological resources	**N/A**
17	Human Activities	**N/A**	Status: N/A Trend: N/A	No known maritime archaeological resources	**N/A**

State of Sanctuary Resources

This section provides summaries of the condition and trends within four resource areas: water, habitat, living resources, and maritime archaeological resources. Sanctuary staff and selected outside experts considered a series of questions about each resource area. The set of questions derive from the mission of the Office of National Marine Sanctuaries, and a system-wide monitoring framework (NMSP 2004 http://sanctuaries.noaa.gov/library/national/swim04.pdf) developed to ensure the timely flow of data and information to those responsible for managing and protecting resources in the ocean and coastal zone, and to those that use, depend on, and study the ecosystems encompassed by the sanctuaries. Appendix A (Rating Scheme for System-Wide Monitoring Questions) clarifies the set of questions and presents statements that were used to judge the status and assign a corresponding color code on a scale from Good to Poor. These statements are customized for each question. In addition, the following options are available for all questions:



" N/A" - the question does not apply; and "Undetermined" - resource status is undetermined. In addition, symbols are used to indicate trends: "▲" - conditions appear to be improving; "▬" - conditions do not appear to be changing; "▼" - conditions appear to be declining; and "?" – trend is undetermined.

This section of the report provides answers to 16 questions[2]. Based on an evaluation of new data, published literature, and expert opinion that have become available since the publication of the 2009 report (ONMS 2009), new ratings have been determined for some of the questions (Estuarine Questions 2, 4, 6, 8, 12, and 13). Answers are supported by specific examples of data, investigations, monitoring, and observations, and the basis for judgment is provided in the text and summarized in the table for each resource area. Where published or additional information exists, the reader is provided with appropriate references and web links.

This addendum updates the 2009 Condition Report for Monterey Bay National Marine Sanctuary (ONMS 2009). For the 16 questions asked below, the temporal reference frame is 2009 through the end of 2014. For example, when addressing Question #1, "Are specific or multiple stressors, including changing oceanographic and atmospheric conditions, affecting water quality?," the 2015 Condition Report Addendum for MBNMS examines potential stressors affecting water quality since 2009. Specifically, are there new stressors or have existing stressors changed (disappeared, diminished or increased) and have these differences since 2009 altered either the rating status or trend? If there is no change in the rating status, then the color will remain the

[2] In 2012 the Office of National Marine Sanctuaries led an effort to review and revise the set of questions and their possible responses posed in the Condition Reports. As part of this effort some questions were combined, new questions were added, and other questions were removed. *Question 10, What is the status of environmentally sustainable fishing and how is it changing?* was removed from the set of questions. This decision was made because of all the questions it was the only one that focused on a single human activity. The issue of fishing is sufficiently addressed in other questions found the in report, including those related to biodiversity, the status and health of key species, and the status of human activities. For a complete list of the new, revised set of questions see ONMS 2015. Note that the revised questions are not reflected in the 2015 Monterey Bay National Marine Sanctuary Condition Report Addendum. However, because of the aforementioned reasons, Questions 10 was not answered. The new set of questions will be addressed when the Condition Report in its entirety is revised in the future.

same. If new information suggests the status has changed, then the color will change to reflect the new status. Similarly, if the trend remains the same (i.e. still improving, stable, declining or unknown), the symbol will not change. If new information suggests that the trend has changed, then the trend symbol will be changed to reflect the new trend.

Some of the questions refer to the term “ecosystem integrity.” When responding to these questions external experts and sanctuary staff judged an ecosystem's integrity by the relative wholeness of ecosystem structure, function, and associated complexity, and the spatial and temporal variability inherent in these characteristics, as determined by its natural evolutionary history. Ecosystem integrity is reflected in the system’s “ability to generate and maintain adaptive biotic elements through natural evolutionary processes” (Angermeier and Karr 1994). It also implies that the natural fluctuations of a system’s native characteristics, including abiotic drivers, biotic composition, symbiotic relationships, and functional processes are not substantively altered and are either likely to persist or be regained following natural disturbance.

Questions 4, 8, 14, and 17 examine the levels of human activities that may influence resources in the sanctuary. While each question has received a status and trend rating and an associated basis for judgment explanation, it should be noted that trend data are lacking for many of the human activities that were considered. In addition, the relationship between impacts resulting from an increased population in the area with the various management and educational efforts that are designed to mitigate the impacts of anthropogenic pressures was difficult to assess.

Because of the considerable differences within the sanctuary between seamount, offshore, nearshore, and estuarine environments, each question was answered separately for each of these environments. Though many small estuaries occur along the central California coastline, Elkhorn Slough is the only large estuary located inside the boundaries of the Monterey Bay National Marine Sanctuary. The nearshore environment is defined as extending from the shoreline boundary of the Monterey Bay National Marine Sanctuary (mean high water) to the 30-meter isobath and includes the seafloor and water column. The offshore environment is defined as extending from the 30-meter isobath out to the offshore boundary of the Monterey Bay National Marine Sanctuary and includes the seafloor and water column. The seamount environments, includes the Davidson Seamount Management Zone.

State of Sanctuary Resources: Estuarine Environment

Estuarine Environment: Water Quality

Elkhorn Slough is the only large estuary on the central California coast located within the boundaries of the Monterey Bay National Marine Sanctuary. The following information provides an assessment of the status and trends pertaining to water quality since 2009 and its effects on the estuarine environment in Elkhorn Slough.

1. Are specific or multiple stressors, including changing oceanographic and atmospheric conditions, affecting water quality?

Stressors on water quality continue to be measured and documented in Elkhorn Slough, particularly high levels of agricultural inputs such as nutrients and sediment. These pollutants may inhibit the development of assemblages and may cause measurable but not severe declines in living resources and habitats. For this reason, the question remains rated "fair/poor" with a "declining" trend.

A main cause of water and sediment quality degradation is agricultural non-point source pollution (Caffrey 2002, Phillips et al. 2002, ESNERR et al. 2009 http://www.elkhornslough.org/download/ESNERR_Final_Management_Plan.doc). Relatively high levels of nutrients and legacy agricultural pesticides, such as DDT, have been documented within the Elkhorn Slough wetlands complex, with the highest concentrations measured in areas that receive the most freshwater runoff (Phillips et al. 2002, ESNERR et al. 2009 http://www.elkhornslough.org/download/ESNERR_Final_Management_Plan.doc). Pathogens, pesticides, sediments, low dissolved oxygen levels and ammonia have impaired sections of Elkhorn Slough and waterbodies adjacent to the slough (Moro Cojo Slough and Moss Landing Harbor). ESNERR researchers and volunteers have been monitoring water quality at 26 sites in and around the reserve since 1988 (see text box). Data collected from 2004-2009 was used to determine if nutrient loading causes negative impacts to particular areas of the Elkhorn Slough estuarine complex. Of the 26 sites monitored, more than half fell into the "hyper" threshold category for nitrate as N, phosphate as P, and ammonia as N indicating that the Elkhorn Slough is highly impacted by nutrient loading (Hughes et. al. 2010).

Elkhorn Slough Volunteer Water Quality Monitoring

Elkhorn Slough National Estuarine Research Reserve (ESNERR), the Elkhorn Slough Foundation (ESF), and the Monterey County Water Resources Agency have been supporting a volunteer water monitoring program since 1988. Twenty-six stations in and around Elkhorn Slough, Moro Cojo Slough, and the mouth of the Salinas River are sampled monthly for temperature, salinity, dissolved oxygen, pH, turbidity, nitrate, ammonium, and dissolved inorganic phosphate.
http://elkhornslough.org/research/waterquality_volunteer.htm

Comment [N7]: Clark: In addition to the one large estuary within the boundaries of the Monterey Bay Sanctuary there are more than 80 small river and creek mouth estuaries (bar built estuaries) that play important roles in supporting a number of brackish water, marine and anadromous fish species as well as numerous bird and mammal species important to the sanctuary.

The Central Coast Wetlands Group at Moss Landing Marine Labs had assessed the current condition of more than 50 of these systems and has completed a comprehensive evaluation of their condition, human induced impacts and stressors, special status species that these systems support and for some ongoing evaluation of natural and human induced (breaching).

Current projects with US fish and wildlife Service are looking to identify conservation priorities for these systems based on their current condition and capacity to adapt to future sea level rise.

These data can be updated periodically to provide a statistical trends analysis of these smaller yet critical habitats.

Comment [JB8]: See Bridget's version for some added text to explain that all the smaller estuaries are not within the boundaries of MBNMS and to limit the size and scope of this already large report they are not covered here but their influence on NS WQ is included in the NS section of the report.

Comment [N9]: Field: are there studies that consider the impact of increasing marine mammal abundance in estuarine waters on water quality by virtue of fecal contamination? There are a lot of sea lions (and other mammals) and they create a lot of waste, perhaps the scale is insignificant relative to nutrient loading from other sources but I would think that it's possible that the contribution is not trivial.

Comment [N10]: Note to reviewers – all highlighting will be removed following the peer review.

2. What is the eutrophic condition of sanctuary waters and how is it changing?

In 2009, the eutrophic condition of the estuarine environment within the sanctuary was rated as "fair" and "not changing" based on impaired conditions in Elkhorn Slough and the adjacent water bodies that drain into the slough (see 2009 MBNMS Condition Report for specifics). The 2015 rating has been changed to "fair/poor" with a "declining" trend based on increased nitrate concentrations, frequent occurrence of depressed dissolved oxygen and hypoxic events, and high percent cover of algal mats in the summer at some monitoring stations.

Over recent years, Elkhorn Slough researchers have detected high phytoplankton concentrations, abundant and persistent macroalgal mats, and hypoxia events that they believe are due to high dissolved nutrient concentrations (Hughes et al. 2010). The goal of the 2010 Elkhorn Slough eutrophication report card was to provide an assessment of the eutrophic condition of the 26 sites that have been monitored since 1988 (Hughes et al. 2010). The report card used nutrient data collected from 2004 – 2009. Other indicators of eutrophic condition included percent cover of algal mats, dissolved oxygen readings at 15-minute intervals over 2 week periods, unionized ammonia, and sediment surface to anoxia layer depth. The results indicate that just over half (57.1%) of the estuary is moderately eutrophic (most of the area within the sanctuary), and 41.4% is highly or hyper eutrophic (Figure ES WQ1). Most of the sites were characterized as hyper (62%) or high (27%) for freshwater nutrient inputs. Hypoxia and anoxia conditions are also widespread throughout Elkhorn Slough, but primarily occur behind water control structures where there is little flushing of water and organic matter. More than half of the estuarine complex is behind water control structures making hypoxia problematic in Elkhorn Slough (Hughes et al. 2010).

The majority of the main channel of Elkhorn Slough, the part within MBNMS, shows moderate eutrophication mostly because there is unrestricted tidal exchange allowing for regular mixing of relatively clean ocean water with relatively older estuarine water and replenishment of dissolved oxygen. Even with the mixing, the Monterey Bay Aquarium Research Institute's Land/Ocean Biogeochemical Observatory (LOBO; http://www.mbari.org/lobo/) network shows that nutrient concentrations are increasing in the lower estuary (Hughes et al. 2010).

Comment [N11]: Clark: Some wetland scientists and managers do not see the regular mixing of clean ocean water to be strictly a positive condition for Elkhorn slough. Resources within the Estuary continues to be impacted by an enhanced tidal range provided by the artificial harbor mouth. The diurnal loss of sediment and fresh water from the estuary due to full tidal action do in my opinion pose serious threats to the longterm health and function of the estuary and will reduce the systems capacity to respond to Sea Level Rise.

Low dissolved oxygen in Elkhorn Slough can cause reduced abundance and diversity of some species of fish and benthic invertebrates (Oliver et al. 2009, Hughes et al. 2015). Hughes et al. (2015) found that reductions in species diversity during hypoxic periods were driven by a complete loss of 12 rare species and declines in several species of flatfish. Populations of the two most common flatfish species, English sole and speckled sanddab, are reduced during hypoxic conditions as is the amount of suitable habitat. Elkhorn Slough is an important nursery habitat for English sole in Monterey Bay so reductions in the nursery function of this estuary could have consequences to the offshore adult population (Brown 2006, Hughes et al. 2014, Hughes et al. 2015).

Hughes et al. (2010) recommends continued efforts to reduce nutrient inputs into Elkhorn Slough. The Elkhorn Slough Foundation (ESF) as well as other partners through the Agriculture Water Quality Alliance (AWQA) coordinated by the MBNMS Water Quality Protection Program has been working to incorporate more conservation easements and encourage more sustainable agriculture practices throughout central coast watersheds. This is a long-term effort and will take time to produce results. ESF believes that more rapid improvements are possible by improving management of the water control structures to increase tidal exchange and reduce water stagnation.

Comment [N12]: Clark: This recomended action may threaten the funtions and services of some estuary systems, specifically the Moro Cojo and Old Salinas Rivers. Increasing tidal exchange within brackish water estuaries poses a serious threat to non-marine estuaries. Many resources managers including some within National Marine Fisheries Service are now working on guidance to better guide management of brackish water systems to address multiple objectives (fish passage and rearing, water quality, unique lagoonal habitat conditions) whithout initiating the transition "type change" of brackish water marshes to fully marine systems.

Land/Ocean Biogeochemical Observatory in Elkhorn Slough (LOBO)

The Land/Ocean Biogeochemical Observatory (LOBO) observing system is designed to monitor the flux of nutrients (nitrate, phosphate and inorganic carbon) through the Elkhorn Slough ecosystem. The environmental sensor network, developed by the Monterey Bay Aquarium Research Institute (MBARI), is capable of continuous, autonomous monitoring of key processes that regulate primary production, eutrophication, and hypoxia in coastal environments. http://www.mbari.org/lobo/

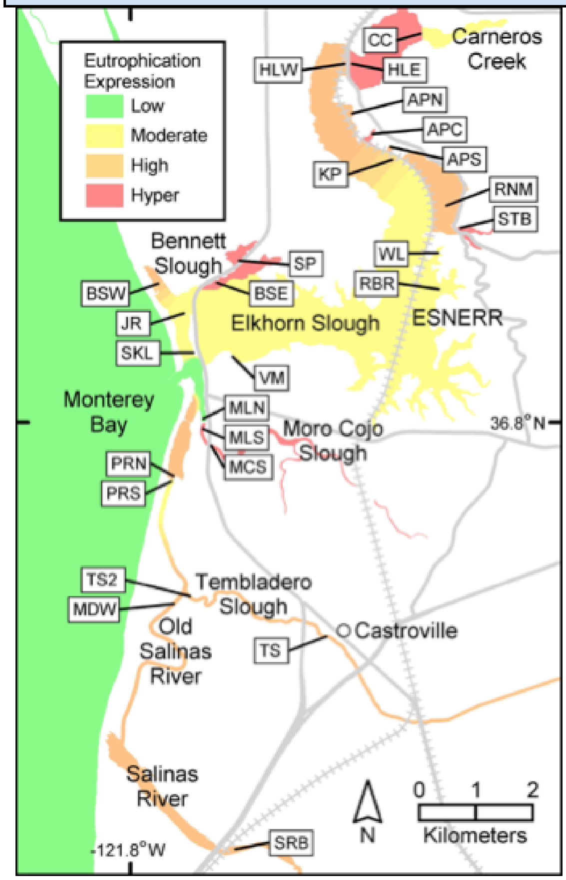


Figure ES WQ1
Caption: Water quality monitoring stations with eutrophication expression score results (2004-2009) in the Elkhorn Slough watershed.
Source: Hughes et al. 2010

Comment [N13]: Clark: Researchers at Moss Landing are also suporting water quality monitoring of these resources and have documented similar nutrient loading and eutrophication issues. It is important to note that the Moro Cojo supports habitat for brackish water snails, tidewater gobies, redlegged frogs and tiger salamanders. All these species are theatened by an increase of "flushing" with marine water. Therefore some local partners are working to reduce nutreint loading within the watersheds rather than flush the systems at the lower end.

3. *Do sanctuary waters pose risks to human health?*

In terms of posing a risk to human health, the estuarine waters of the sanctuary remain the same as in the 2009 Condition Report rated "fair/poor" and the trend is "undetermined". Elkhorn Slough and adjacent water bodies, including Moro Coho Slough, Moss Landing Harbor, Salinas River Lagoon, and Old Salinas River Estuary, are impaired by pesticides, sediment, pathogens, and other pollutants (SWRCB 2010, http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/category5_report.shtml).

New information supports the previous rating of "fair/poor". The California Surface Water Ambient Monitoring Program documented elevated concentrations of persistent organic pollutants in fish tissue over a two-year period (Davis et al. 2012) (Table NS WQ2) . All four of the fish types collected in Elkhorn Slough exceeded at least one of the EPA Subsistence Fisher Screening Values for PCBs, DDTs, and dieldrin (USEPA 2000). The trend remains undetermined because of the persistent nature of contaminants that are found in the fish tissue and sediments within the Elkhorn Slough, which will take many years to change even with significant management strategies being implemented (refer to the 2009 MBNMS Condition Report for more information).

Surface Water Ambient Monitoring Program (SWAMP)

California's Surface Water Ambient Monitoring Program (SWAMP) is tasked with assessing water quality in all of California's surface waters and coordinates all water quality monitoring conducted by the State and Regional Water Boards. The program conducts monitoring directly and through collaborative partnerships; and provides numerous information products designed to support water resource management in California. The Stream Pollution Trends program (SPoT) and the Bioaccumulation Monitoring program are funded by SWAMP.
http://www.waterboards.ca.gov/water_issues/programs/swamp/

4. *What are the levels of human activities that may influence water quality and how are they changing?*

In 2009, human activities that can influence water quality were rated "fair" and the trend was "undetermined" based on poorly understood sources of non-point source pollution that threaten water quality in Elkhorn Slough from multiple sources, including substantial agricultural runoff from inputs along the Salinas River, Tembladero Slough, and the Elkhorn Slough watershed (see 2009 MBNMS Condition Report for specifics).

The 2015 rating remains "fair", because there is no evidence yet of improved water quality, but the trend has been upgraded to "improving" based on stricter regulation of agriculture land management and conservation activities in the watershed (refer to the response to Nearshore Question 4 for more information on increased state regulatory requirements). The Elkhorn Slough Foundation (ESF) has active farming operations totaling 113.5 acres and one grazing area totaling 290 acres. The present farmed area represents a reduction of approximately 90%

Comment [N14]: Clark: This is true but does not suggest there has been no effect. Researchers including Gage Dayton and Fred Watson have documented significant water quality improvements being achieved within subdrainages of the Moro Cojo and Old Salinas River (both tributaries of the greater elkhorn Slough system). While the Sanctuary boundaries do not include the Moro Cojo Slough nor the Old Salinas, efforts in these drainages should be recognized as well as those in the Elkhorn. A summary of work completed in the Moro Cojo and the water quality improvements associated with these efforts is available at https://ccwg.mlml.calstate.edu/sites/default/files/documents/MoroCojoReport2013.pdf

Comment [JB15]: This additional information provides support for change to improving trend and hopefully will not be too hard to add a brief summary of it of what had been farmed in the watershed prior to ESF ownership. As of 2005, all of the farmed areas in the watershed have been certified as organic farmland. The grazing area has been managed using a Holistic Rangeland Management (HRM) approach since about 1998. HRM is an approach to managing cattle that never allows a pasture to be "overgrazed" that might result in a significant amount of bare soil and/or little vegetative cover. There are currently 17 sediment basins and 8 grassed waterways or swales that are on-farm practices to slow water and remove suspended sediment, nutrients and other contaminants that might otherwise flow into the Elkhorn Slough. More information about ESF land management can be found at http://www.elkhornslough.org/landmanagement/index.htm

Over the past fifteen years, management agencies have worked with local stakeholders to create regulatory, monitoring, education, and training programs and to implement better agricultural and urban management practices aimed at reducing or eliminating pollution sources. However, there continues to be a poor understanding of the relationships between the cumulative effects of behavioral changes within the Elkhorn Slough watershed and changes in water quality conditions. Gee et al. (2010), did show improved water quality on a micro watershed scale after an upland restoration occurred. A comprehensive plan needs to be designed to measure effectiveness of land-based management practices along with a commitment to analyze and report the results.

Estuarine Environment Water Quality Status & Trends

Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

▲ = Improving — = Not changing ▼ = Declining

? = Undetermined trend **N/A** = Question not applicable

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
1	Stressors	▼	Status: N/A (not updated) Trend: N/A (not updated)	Major alterations to tidal, freshwater, and sediment processes has increased the level of pollution and eutrophication; inputs of pollutants from agricultural and urbanized land sources.	Selected conditions have caused or are likely to cause severe declines in some but not all living resources and habitats.
2	Eutrophic Condition	▼	Status: Very High Trend: Very High	General trend of increasing nitrate in Elkhorn Slough. Frequent occurrence of depressed DO and hypoxic events. High percent cover of algal mats in summer.	Selected conditions have caused or are likely to cause severe declines in some but not all living resources and habitats.
3	Human Health	?	Status: N/A (not updated) Trend: N/A (not updated)	Elkhorn Slough and connected waterbodies are impaired by pesticides and pathogens. High levels of contaminants in harvested crustaceans and bivalves could pose a risk to human health. SWAMP BOG fish results.	Selected conditions have caused or are likely to cause severe impacts, but cases to date have not suggested a pervasive problem.
4	Human Activities	▲	Status: High Trend: High	Substantial inputs of pollutants from non-point sources, especially agriculture. Less agriculture around Elkhorn Slough due to land acquisition by ESF thereby reducing nutrient loading from agriculture. No evidence yet of improving water quality due to changes in land management practices.	Selected activities have resulted in measurable resource impacts, but evidence suggests effects are localized, not widespread.

Questions that have new information to report since the 2009 Monterey Bay National Marine Sanctuary Condition Report (ONMS 2009) are those with red numbers.

Estuarine Environment: Habitat

The following information provides an assessment of the status and trends pertaining to the current state of estuarine habitat since 2009.

5. What is the abundance and distribution of major habitat types and how is it changing?

The 2009 rating status for the abundance and distribution of major habitat types in the estuarine environment of the sanctuary was "fair/poor" and "declining." This rating was based on an analysis of a chronological series of maps and aerial photos by the Elkhorn Slough National Estuarine Research Reserve that revealed dramatic changes in the relative abundance of estuarine habitats over 130 years. In 1870 approximately 65% of Elkhorn Slough habitat was dense salt marsh, with less than 5% mud and sparse salt marsh habitat. By 2000, the amount of estuarine habitat composed of dense salt marsh had decreased to less than 20% and the amount of mud or sparse salt marsh habitat had increased to approximately 50%.

The analysis in the 2009 condition report (ONMS 2009) used data collected through 2000. Data are now available through 2009, which shows relative stability in the system between 2000 and 2009 with very little change in the relative abundance of estuarine habitats (Figure ES Hab1). Recent analyses (Wasson et al. 2013) show that salt marsh extent has remained stable since 2009, with minor losses balanced by gains. We are not aware of any new stressors or threats to the abundance and distribution of major habitats in Elkhorn Slough, therefore the 2015 status rating remains 'fair/poor' and the trend is "not changing."

Since 2009, the Tidal Marsh Restoration Project has been launched (http://www.elkhornslough.org/tidalwetland/downloads/Tidal_Marsh_Restoration_Project_Overview_and_FAQ.pdf) and has developed plans to restore salt marsh at the Minhoto site, as site which subsided during a diked period. This project, slated for 2016, will likely increase suitable habitat through soil addition. It is expected that salt marsh plants will be added to these areas, survive, and thereby increase the overall population within Elkhorn Slough. According to ESNERR staff, a comprehensive monitoring plan will be developed and implemented as part of the project to verify achievement of project goals and to increase understanding of ecosystem processes, including monitoring via aerial photography. Ecotone establishment will be assessed using quantitative field methods and the displacement of tidal prism will be assessed using LiDAR topographic measurements. These efforts will be critical to assessing how well the goals were achieved and whether the restoration project had the intended effect of increasing tidal marsh and associated species in Elkhorn Slough.

Comment [N16]: Clark: I question this assumption. While referenced studies may not have documented significant changes in acreage of salt marsh habitat since 2009, ongoing imbalances in sediment budgets continue to cause a loss in the soft bottom habitat composition. Sediment sources for the mass export from the system due to tidal scour continue to fluctuate between main channel erosion, Marsh edge failure and marsh plain loss.

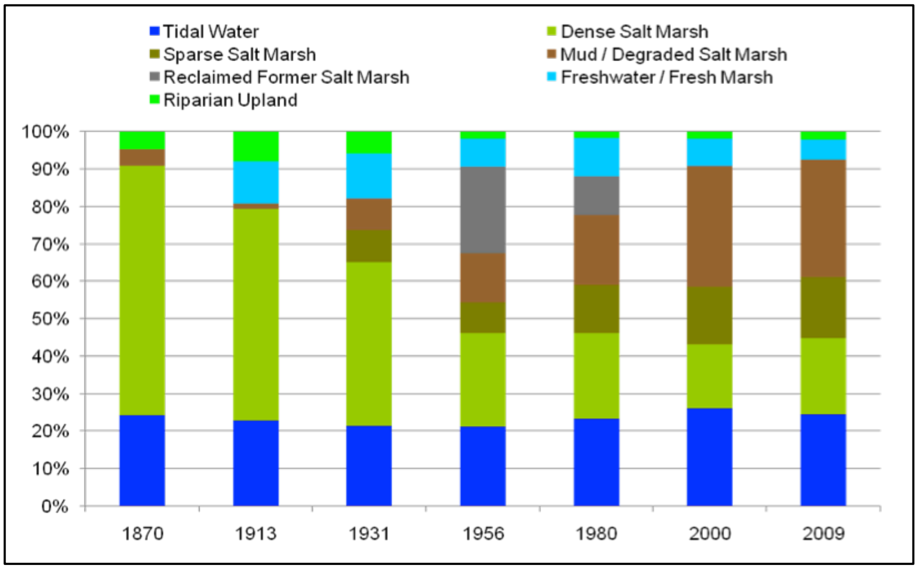


Figure ES Hab1
Caption: The relative abundance of seven different habitat types in Elkhorn Slough from analysis of a chronological series of maps and aerial photographs. The trend has been relative stability in the system between 2000 and 2009 with very little change in the relative abundance of estuarine habitats (the 2009 data was not available for use in the 2009 condition report).
Source: Wasson et al. 2013

6. What is the condition of biologically-structured habitats and how is it changing?

The rating status for biologically-structured habitats remains "poor" but the trend has been changed from "declining" to "improving" due to recent increases in eelgrass abundance and restoration efforts associated with native oysters. The rating status and trend in the 2009 report was based on severe reductions in abundance of the two native species that form biogenic habitat in the main channel of Elkhorn Slough, eelgrass (*Zostera marina*) and native oyster (*Ostrea lurida*, also referred to as *Ostreola conchaphila*) compared to historic levels. Additionally, there were concerns that a non-native reef-forming tubeworm (*Ficopomatus enigmaticus*) from Australia, which was initially identified in Elkhorn Slough in 1994 (Wasson et al. 2001), was spreading and possibly competing with native oysters for attachment sites.

Comment [N17]: Clark: The most recent State of the State wetland report completed by the State water board and submitted to USEPA includes an assessment of vegetated intertidal estuary habitat. That probabilistic survey describes the ambient condition of tidal estuaries within California.

The CRAMWetlands.org website includes data on the current condition of more that twenty marsh areas of the greater Elkhorn Slough which can be used to provide a quantitative analysis of current habitat condition relative to regional and state populations.

New information on the aerial extent of eelgrass beds in the main channel of Elkhorn Slough shows a slight increase in size since 2009 (Figure ES Hab2). Hughes et al. (2013) present evidence indicating "complex top-down effects of sea otter predation have resulted in positive benefits to eelgrass beds…in Elkhorn Slough." A recent study of the abundance of native oyster at nine sites in Elkhorn Slough reveals that oyster populations in Elkhorn Slough are smaller and have more frequent recruitment failure than populations in San Francisco Bay (Wasson et al. 2014). Oysters in the Slough remain very rare and have frequent years of zero recruitment estuary-wide, but very slight gains have been made due to restoration efforts on the Elkhorn Slough National Estuarine Research Reserve (ESNERR). Continued monitoring has revealed no major changes in the spread and spatial coverage of *Ficopomatus* or other invasive species (K. Wasson, ESNERR, pers. com.).

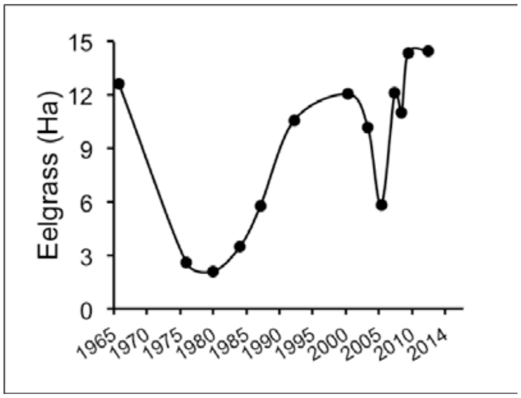


Figure ES Hab2
Caption: Historical analysis of eelgrass in Elkhorn Slough. Eelgrass cover and change through time were interpreted using low altitude vertical aerial imagery acquired between 1966 and 2012. Only years through which eelgrass cover could be determined with high confidence based on historical descriptions and recent ground surveys of distribution were used (N = 13).
Source: Hughes et al. 2013

7. *What are the contaminant concentrations in sanctuary habitats and how are they changing?*

Based on the available information on contaminant concentration in estuarine habitats of the Elkhorn Slough watershed the 2009 rating was "fair" because numerous contaminants from a variety of sources have been identified, sometimes appearing at high levels in localized areas (ONMS 2009). In this largely rural watershed, the main source of water and sediment quality degradation appears to be agricultural non-point source pollution (Caffrey et al. 2002). Significant concentrations of legacy agricultural pesticides such as DDT have been documented in some watershed wetlands, with highest levels in the areas receiving the most freshwater runoff (Caffrey et al. 2002). The trend in contaminants in Elkhorn Slough habitats was "declining" because of the lack of attenuation of legacy pesticides and the continued input of currently applied pesticides (refer to the 2009 MBNMS Condition Report for more information).

The 2015 rating for contaminants in estuarine habitats of Elkhorn Slough has been changed to "Fair/Poor" and "declining" due the fact that legacy pesticides and newer pesticides are found in the waterbodies that drain to Elkhorn Slough and that limited studies indicate that these contaminants are being detected, sometimes at high concentrations, in animals in these systems.

Comment [N18]: Clark: detection does not suggest trends. There are many sediment and water quality studies that can be used to better interpret trends.

Historically, organochlorines such as DDT, were applied on farms, and though now banned, these compounds are long-lived because they adhere to soil particles. These legacy contaminated soils can enter Elkhorn Slough habitats through runoff from agricultural lands. Legacy pesticides can accumulate in habitat and associated benthic organisms and ultimately accumulate in higher trophic level marine organisms. Jessup et al. (2010) compared contaminants loads in sea otters from the Monterey Bay area and Alaskan coast. They found high levels of legacy compounds in male sea otters from Elkhorn slough, 5-20 times higher than in Alaskan sea otters (Figure ES Hab3)The sea otters likely get these contaminants from eating contaminated benthic invertebrates.

In addition to legacy pesticides, newer pesticides have been found in the water column and sediment in many locations in the Salinas Valley watershed and Salinas River, which drain to Elkhorn Slough (TNC 2015). Toxicity and persistence of newer compounds vary, but their effects can be additive and concentrations at many sample sites in the Salinas River watershed are found in doses lethal to test organisms (TNC 2015). Studies of the effects of these compounds on estuarine species and on higher trophic level organisms are needed, but based on the studies in the watershed, these compounds could be impacting the health of lower and high trophic levels species in Elkhorn Slough. A study of contaminant levels, both legacy and some newer use compounds, in sea otters in Elkhorn Slough is currently underway (T. Tinker, USGS, pers .comm.). The results of this study should help determine the types of contaminants that are accumulating in sea otters and are likely present in the benthic invertebrates on which they feed.

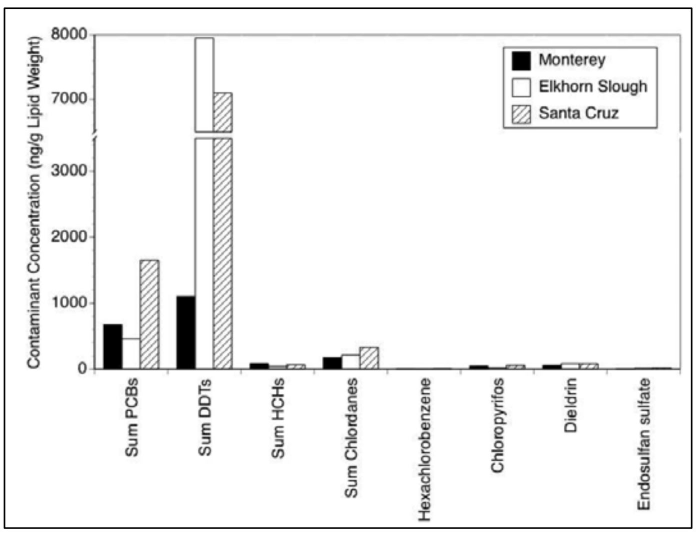


Figure ES Hab3
Caption: The sum totals of several major classes of persistent organic pollutants (POPs) and other chemicals of ecologic or environmental concern (COECs) in blood of live healthy southern sea otter in three locations in Monterey Bay, California. Levels of most POPs and COECs were 10–20 times higher in the otters in Monterey Bay than those sampled of the coast of Alaska in this study.
Source: Jessup et al. 2010

Comment [N19]: Clark: Mark stevenson and others at the Marine Pollution studies lab and Karen Worchester from the Regional Board have collected otter tissues to study legacy pesticides and more recent algal bloom impacts. These data should be used to cross reference with the cited Jessop study before trends are suggested.

Comment [JB20]: I contacted Tim Tinker as I know that he is involved with a current study of contaminants in sea otters. Here is his response to this reviewer's comments:

"I suspect they are referring to archived tissue samples at CDFW from stranded (dead) sea otter necropsies. Some of these have been analyzed recently, or are currently being analyzed, as part of a major review project on factors affecting sea otter mortality based on 15 years of necropsy data (I am a collaborator on that project, but it is actually being led by Dr. Melissa Miller, the Pathologist at CDFW: the Marine Pollution lab and Water board are collaborating or helping with the analyses, but they did not collect the tissues). We have also collected live animal tissues from wild otters as part of our population studies (Monterey, Elkhorn Slough and elsewhere), many of these sample have also been analyzed by the Marine Pollution lab, and currently analyses are being conducted of contaminant exposure by the Wildlife Health lab at UC Davis. The results from both of these initiatives are not yet available, hopefully within the year though

8. *What are the levels of human activities that may influence habitat quality and how are they changing*

The rating status and trend in the 2009 report for the levels of human activities that may influence habitat quality was "poor" and "not changing" based on past hydrologic changes, continued dredging, maintenance of water diversion structures, and input of agricultural non-point source pollution. The 2015 status remains "poor" because, although most of the structural changes were made decades ago, habitat quality in the slough is still severely degraded by those changes. In addition, on-going maintenance of water control structures and dredging of the harbor mouth continue to alter habitat quantity and quality in Elkhorn Slough. Extremely high levels of nitrate continue to be added to the system.

Although the status remains "poor", the trend in human activities that influence habitat quality has been changed from "not changing" to "improving" due to newly implemented restoration efforts by the Elkhorn Slough Foundation (ESF) and ESNERR. More property in the Elkhorn watershed has been acquired by the ESF and ESNERR, and agricultural runoff has presumably declined as a result (see response to Estuarine Question 4 for more details).

The Parsons Slough Sill (Figure ES Hab4), a restoration project that was completed in February 2011, is an apparent success according to early monitoring (http://www.elkhornslough.org/tidalwetland/parsons.htm). This project, managed by the Tidal Wetland Project in a joint effort with ESNERR, was identified as the most efficient and lowest risk approach to reducing erosion and wetland loss in Elkhorn Slough. The sill is expected to significantly reduce erosive tides in Elkhorn Slough and prevent thousands of cubic yards of sediment from washing into the bay each year. The project is anticipated to restore an additional seven acres of tidal marsh around the perimeter of the Parsons Slough Complex.

Data gaps continue to exist. Data on human activities that may influence habitat quality are sparse. Purchasing land surrounding the estuary and either changing farming practices or reducing them has been shown to have a positive impact on habitat quality (Gee et al. 2010).

While positive changes have occurred due to restoration activities, there has been no reduction of nutrient concentrations entering the estuary via the old Salinas River channel. Indeed, nitrate concentrations have been higher than average in the past years (Wasson et al. 2015). Agricultural pollution leading to eutrophication in the estuary has enormous ecological impacts on sanctuary habitats in the estuary, and there has been no change in this trend (see response to Estuarine Question 2 for more details on nutrients and eutrophication). However, because water quality is covered in other questions, and to highlight the positive human activities due to restoration, which have had small beneficial impacts in selected areas, we have chosen a positive trend for this question.

Comment [N21]: Clark: The largest threat to many Elkhorn Slough habitats and services is the continued daily flushing of the system caused by the artificial opening at the Harbor mouth. Marine ecological services and habitats however will benefit from this continued flushing. Therefore I recommend listing habitat quality as fair but changing from one type of estuary to another.

Comment [N22]: Clark: This statement is not technically correct, as cited in tidal wetland project notes and the report from the engineers.

Comment [N23]: Clark: Dr. Aiello and C. Endris have documented an increase in erosion west of the sill that that I believe has not bee taken into consideration before drafting these statements.

Comment [N24]: Clark: Concentration trends within these systems are increasing but loading trends have not been thoroughly documented. Because of increased use of water efficient agriculture practices, less water is being discharged into the old Salinas watershed. Therefore concentration trends do not fully reflect the possible success that may be occurring within the watershed to reduce nutrient loading. Current studies by TNC and led by Dr Kim Null at Moss Landing Marine Labs are working to better understand the relationships between farming practices, nutrient concentrations and loads in surface waters draining to Elkhorn and the benefits of watershed restoration efforts to reduce both.

Figure ES Hab4
Caption: Aerial photo of a sill that was installed at the mouth of Parson's Slough in 2011. The purpose of this restoration project was to reduce erosion and wetland loss in Elkhorn Slough. Source: Gabi Estill, Elkhorn Slough Foundation

Estuarine Environment Habitat Status & Trends

Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

▲ = Improving — = Not changing ▼ = Declining

? = Undetermined trend **N/A** = Question not applicable

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
5	Abundance/ Distribution	–	Status: Very High Trend: Very High	Over 150 years of hydrologic alteration has resulted in substantial erosion and habitat conversion. Recent stability with little change in relative abundance of habitat types.	Selected habitat loss or alteration has caused or is likely to cause severe declines in some but not all living resources or water quality.
6	Biologically-Structured	▲	Status: Very High Trend: Very High	Severe reductions in the abundance of native structure-forming organisms from historic levels. Recent slight increases in eelgrass and native oysters.	Selected habitat loss or alteration has caused or is likely to cause severe declines in most if not all living resources or water quality.
7	Contaminants	▼	Status: Medium Trend: Medium	Numerous contaminants present and at high levels at localized areas with some evidence of accumulation in top predators (sea otters).	Selected contaminants have caused or are likely to cause severe declines in some but not all living resources or water quality.
8	Human Impacts	▲	Status: Medium Trend: Medium	Past hydrologic changes and maintenance of water diversion structures, and continued input of nutrients from agriculture. Management activities have the potential to reduce agricultural runoff and reduce erosion in some areas.	Selected activities warrant widespread concern and action, as large-scale, persistent and/or repeated severe impacts have occurred or are likely to occur.

Questions that have new information to report since the 2009 Monterey Bay National Marine Sanctuary Condition Report (ONMS 2009) are those with red numbers.

Estuarine Environment: Living Resources

Biodiversity is variation of life at all levels of biological organization, and commonly encompasses diversity within a species (genetic diversity) and among species (species diversity), and comparative diversity among ecosystems (ecosystem diversity). Biodiversity can be measured in many ways. The simplest measure is to count the number of species found in a certain area at a specified time. This is termed species richness. Other indices of biodiversity couple species richness with a relative abundance to provide a measure of evenness and heterogeneity. When discussing "biodiversity" we primarily refer to species richness and diversity indices that include relative abundance of different species and taxonomic groups. To our knowledge no species have become extinct within the sanctuary, so native species richness remains unchanged since sanctuary designation in 1992. Researchers have described previously unknown species (i.e., new to science) in deeper waters, but these species existed within the sanctuary prior to their discovery. The number of non-indigenous species has increased within the sanctuary. We do not include non-indigenous species in our estimates of native biodiversity.

Key species, such as keystone species, indicators species, sensitive species and those targeted for special protection, are discussed in the responses to questions 12 and 13. Status of key species will be addressed in question 12 and refers primarily to population numbers. Condition or health of key species will be addressed in question 13. Key species in the sanctuary are numerous and all cannot be covered here. Emphasis is placed on examples from various primary habitats of the sanctuary for which some data on status or condition are available.

The following information provides an assessment of the status and trends pertaining to the current state of the sanctuary's living resources in the estuarine environment since 2009.

9. What is the status of biodiversity and how is it changing?

The 2015 rating status for biodiversity remains "fair" and the trend is "not changing" as there is no evidence of significant increases or decreases since 2009. Elkhorn Slough contains several estuarine habitats that support a diverse species assemblage. Though species richness in the estuary is high, the status of native biodiversity in Elkhorn Slough is rated "fair" based on changes in the relative abundance of some species associated with specific estuarine habitats. Human actions (e.g., altered tidal flow by dikes and channels) have altered the tidal, freshwater, and sediment inputs, which has led to substantial changes in the extent and distribution of estuarine habitat types.

We are not aware of any new stressors or threats to biodiversity that have emerged since 2009. We are not aware of any new data that indicates species additions or losses since 2009. Relative abundances of several species are likely to vary from 2009 to 2014, but we know of no particular drivers for such changes.

There are multiple indices for species biodiversity (e.g., species richness and evenness) that can easily be calculated for Elkhorn Slough from monitoring data collected by ESNERR. However, knowing the appropriate target can be challenging; for instance marine richness is always higher than estuarine richness, so increases in richness may not be a good indicator of estuarine health.

Comment [N25]: Clark: Changes in Freshwater inputs through greater extraction and reuse for human needs and reductions associated with drought and climate change are leading to an ever increasing loss of brackish and fresh water wetland habitat. This may not be fully reflected in this report because the brackish and freshwater habitats are not within the boundaries of the Sanctuary. Nonetheless, these adjacent habitats provide important services and habitat for estuarine and marine species.

Freshwater habitats that support migratory birds have been greatly reduced and degraded within the greater Elkhorn watershed. Recent increases in freshwater habitat (through restoration activities) within the Moro Cojo Slough on parcels owned by the Elhorn Slough Foundation and PG&E provide unique and valuable high quality habitat for migratory birds.

Comment [N26]: Clark: brackish water species abundance has not been systematically surveyed but are expected to be in decline due to loss of brackish water habitats.

10. What is the status of environmentally sustainable fishing and how is it changing?

We are no longer assessing this Question in ONMS Condition Reports so content for this question was not updated.

11. What is the status of non-indigenous species and how is it changing?

The rating status for non-indigenous species (NIS) remains "poor" and the trend remains "not changing". Elkhorn Slough is highly invaded, with 11% known NIS among invertebrates, as compared to the open coast which has 1% known NIS (Wasson et al. 2005). The Japanese mud snail (*Batillaria attramentaria*) is the numerically dominant invertebrate on the surface of mudflats in Elkhorn Slough, while the native horn snail (*Cerithidea californica*), an ecological equivalent, is locally extinct (Byers 1999, 2000). The non-native, reef-forming tubeworm (*Ficopomatus enigmaticus*), which was initially identified in Elkhorn Slough in 1994 (Wasson et al. 2001), has spread to a number of sites in the northern half of Elkhorn Slough, with reefs observed in the most northern locations. The reefs greatly increase the amount of complex hard structure in the slough and create a new, unique habitat that has been shown to enhance the local abundance of invasive species, particularly non-native amphipods and polychaete worms (Heiman 2006, Heiman et al. 2008).

ESNERR updates surveys for NIS every two years in internal reports. Recent surveys have seen minor increases and decreases in abundance of some NIS species. For example, *Caulacanthus* (an invasive red turf alga) had increased in 2011, but had decreased somewhat by the time of the next survey in 2013. *Batillaria* (the Japanese mud snail) appears to have decreased in abundance in the past years at some sites (K. Wasson, ESNERR, pers. comm.). European green crab (*Carcinus maenas*) abundance is highly variable over time with no clear trend (Figure ES LR1). Overall, given the high richness and abundance of NIS in Elkhorn Slough, we consider that the changes observed probably have not had a significant net change on impacts of NIS in the estuary, and thus conclude that the trend is not changing.

ESNERR Early Detection for Aquatic Invaders
The Elkhorn Slough National Estuarine Research Reserve, in partnership with the Elkhorn Slough Foundation and the Monterey Bay National Marine Sanctuary, and with funding from California Sea Grant, has established an early detection program for aquatic alien invaders. The goal of this program is to detect new invasions of problematic non-native aquatic organisms early enough to allow for successful eradication. http://elkhornslough.org/research/biomonitor_invasion.htm

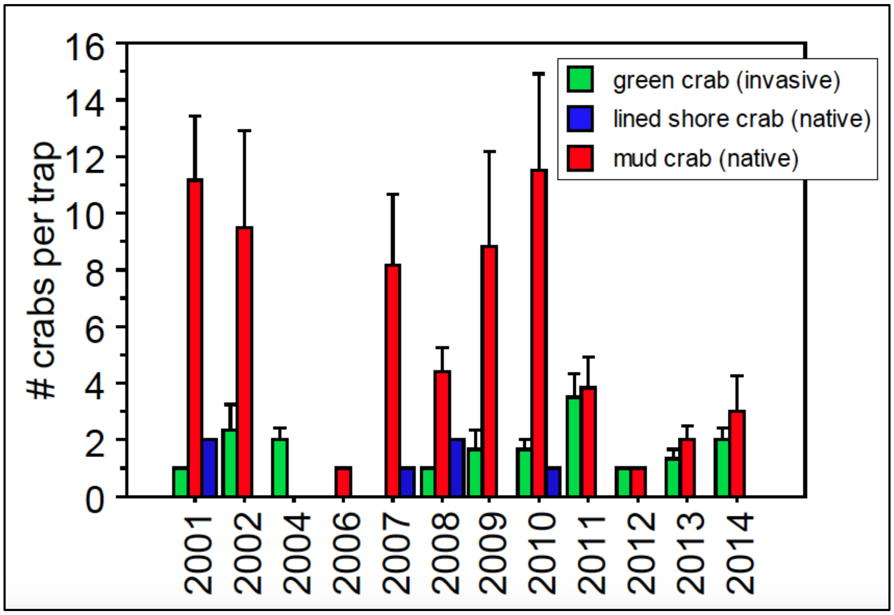


Figure ES LR1
Caption: Abundance of the European green crab *Carcinus maenas* (a non-indigenous species) compared to two native crab species, the lined shore crab *Pachygrapsus crassipes* and the mud crab *Hemigrapsus oregonensis*, in Elkhorn Slough based on monitoring using baited crab pots. The invasion of the European green crab into Elkhorn Slough continues, with high variability in both native and invasive crab numbers over time.
Source: Wasson et al. 2015

12. What is the status of key species and how is it changing?

The status of key species in the estuarine environment remains "fair/poor" but the trend has been changed from "declining" to "improving." Key species include native oysters, eelgrass beds, sea otters, and salt marsh plants. Native oyster populations increased in ESNERR since 2009 due to restoration efforts (http://www.elkhornslough.org/research/conserv_oysters.htm), but remain challenged by frequent years with zero oyster recruitment in the estuary. Eelgrass beds have expanded slightly during this period (see Figure ES Hab2). Salt marsh plants have undergone no significant changes in this period (see Figure ES Hab1). There are no new stressors or threats to these key species.

The number of sea otters in Elkhorn Slough has been increasing since 2009 (Figure ES LR2). Sea otters were first observed in Elkhorn Slough in 1984 and until recently the slough was mostly populated by transient, non-territorial male sea otters. However, starting in about 2008, the predominantly transient male population was joined by reproducing females (T. Tinker, USGS-WERC, pers. comm.). The number of resident sea otters has been growing due to this influx of females and the birth of their pups, as well as the presence now of territorial males who are yearround residents (T. Tinker, USGS-WERC, pers. comm.). It is unknown exactly how many resident and transient sea otters can be sustained by the resources available in Elkhorn Slough. Use of salt marsh habitats by sea otters appears to be increasing, with more otters spending more time further up the estuary (USGS, unpublished data).

This growing population appears to be influencing the abundance of other species in Elkhorn Slough through complex ecological interactions. Recently, Hughes et al. (2013) found that complex top-down effects of sea otter predation on crabs in Elkhorn Slough have resulted in positive benefits to eelgrass. Sea otter predation has led to a decrease in crabs, which has allowed for an increase in the number of herbivore grazers in the system. These grazers, such as the sea slug *Phyllaplysia taylori* and isopod *Idotea resecata*, remove algae from the surface of seagrass blades, which in the absence of herbivory can harm eelgrass through shading and smothering. Recent increases in this top predator appears to be mediating species interactions at the base of the food web and counteracting the negative effects of anthropogenic nutrient loading is this highly impacted system (Hughes et al. 2013).

Looking forward, there are plans to restore salt marsh at the Minhoto site via the Tidal Marsh Restoration Project (http://www.elkhornslough.org/tidalwetland/downloads/Tidal_Marsh_Restoration_Project_Overview_and_FAQ.pdf). The project's planned addition of sediment to restore the marsh as the Minhoto site, a site that subsided during a diked period, is designed to increase tidal marsh habitat, reduce tidal scour, and improve water quality. The marsh restoration, slated to begin in 2016, will be thoroughly monitored. These monitoring efforts will be critical to assessing how well the goals were achieved and whether the restoration project had the intended effect of increasing salt marsh and other associated key species in Elkhorn Slough.

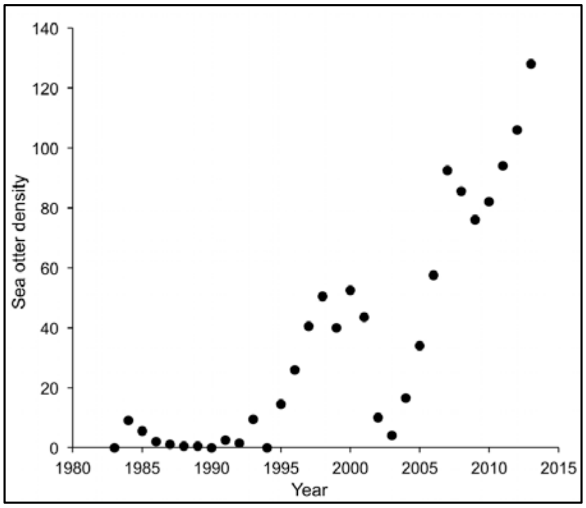


Figure ES LR2
Caption. Long-term trend in sea otter density in Elkhorn Slough. Annual density calculated from the
standardized biannual census counts from the US Geological Survey (USGS) (www.werc.usgs.gov) in which sea otter abundance in Elkhorn Slough is estimated from 1 day surveys in the spring and fall from 1985 to 2014. Sea otters first entered Elkhorn Slough in 1984, so, for this year, Kvitek et al. (1988) was used to estimate the number of otter arrivals in the estuary.
Source: B. Hughes

13. What is the condition or health of key species and how is it changing?

The status of the condition or health of key species was designated as "undetermined" in 2009 but now is considered "fair/good," based on recent studies. The trend remains "undetermined." The key species in Elkhorn Slough are eelgrass, native oysters, sea otters, and salt marsh plants. Eelgrass condition in the estuary is generally better in terms of having lower epiphyte cover on the blades than in other comparable estuaries, as a result of a sea otter-induced trophic cascade (Hughes et al. 2013). Native oyster health or condition is not monitored, but survivorship of adults is high, suggesting no major issues with disease (Wasson et al. 2014). Salt marsh plants appear to have been stressed by the 2012-2014 drought (K. Wasson, ESNERR, pers. comm.), but no quantitative monitoring of their condition has been conducted. Low marsh plants appear stressed by excessive inundation, but high marsh plants appear healthy.

Veterinary assessments of 25 animals during radio-tagging in 2013-15 has revealed that body condition of slough animals is significantly better than in some other areas of the central coast, including Monterey and Big Sur, likely reflecting the relatively abundant prey resources (particularly crabs and bivalve molluscs) that are available to otters in Elkhorn Slough. This hypothesis is supported by preliminary results of foraging observations of tagged otters that show a high biomass intake rate (USGS, MBA and ESNERR, unpublished data), although forage success is somewhat lower in the areas of the slough used by otters for the longest, and thus it is to be expected that continued utilization of Elkhorn Slough habitats by sea otters will eventually result in decreased prey abundance.

Figure NS WQ 3 provides information on the recent observation of microcystin intoxication in sea otters in Monterey Bay and indicates that some of these animals used habitats in or adjacent to Elkhorn Slough. Domoic acid toxicity is another contributing source of mortality for sea otters in Elkhorn Slough. Two sea otters that were part of a recent monitoring study in the slough, died and were determined to have high domoic acid levels that probably contributed to their mortality (USGS, unpublished data). An assessment of contaminant-loading in sea otters that reside in Elkhorn Slough is currently underway and the results will provide insight into the condition and health of this key member of the estuarine community.

Comment [N27]: Kudela: Recent data suggests that a large proportion of the otters are exposed to these toxins; but don't you need to link those toxins to changes in habitat (i.e. eutrophication) to consider that an impact?

Jenn –This question has to do with health so we do not need to link toxin exposure to eutrophication for this question. I am requesting more information about this data from Raph.

14. What are the levels of human activities that may influence living resource quality and how are they changing?

The status of the levels of human activities that may influence living resource quality remains "fair/poor" and the trend remains "undetermined." A wide variety of human activities occur in and around the Elkhorn Slough (e.g., ecotourism, research, restoration, agriculture, fishing), but few data are available to quantify the level of these activities and how they have changed over time. Because many human activities, especially agricultural pollution and maintenance of dikes to "reclaim" wetlands for human uses, exert negative pressures on living resources in the slough, the level of human activities is rated fair/poor. Different human influences show contrasting trends: for instance agricultural pollution has not diminished but restoration activities are increasing. However, it is not clear how to combine this information to identify an overall trend, thus the trend in human activities was undetermined.

Comment [N28]: Clark: Work by Fred Watson has documented the water quality values of restored wetlands, CCWG had documented the habitat value of restoration projects within the drainage and Dr Null is currently working to estimate the cumulative effect of these efforts on the water quality and wetland habitat conditions.

To address this question requires a concerted effort to list past and current activities that may influence living resource quality, assign a relative importance to each, and then attempt to combine them in an analytical framework to generate an overall status. This effort could then be updated every five years and generate a pattern that might lead to a trend. However, to our knowledge there is no such effort underway, nor is it likely given the complexity of the task.

Comment [N29]: Clark: Bridget Hoover at the Sanctuary has worked to develop the analytical framework (the conservation project tracker) necessary to compile and estimate the cumulative effect of all the current activities to benefit the estuarine ecosystem. Cara Clark from Moss Landing Marine Labs has populated the State ecoatlas website with information on the implementation of wetland restoration projects throughout the central coast which can provide valuable information on current and past restoration projects within the greater elkhorn slough watershed.

Dr Null is working to construct a watershed nutrient fate transport model for the Gabilan watershed to quantify the cumulative effects of changing agricultural practices and restoration of upland habitats within the watershed.

A recommendation of this report should be to support the efforts of these groups to compile and report on the status of overall management efforts for the next five year report.

Estuarine Living Resources Status & Trends

Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

▲ = Improving — = Not changing ▼ = Declining

? = Undetermined trend **N/A** = Question not applicable

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
9	Biodiversity	—	Status: Medium Trend: Medium	Changes in the relative abundance of some species associated with specific estuarine habitats. No significant recent changes in species richness or relative abundance.	Selected biodiversity loss may inhibit full community development and function and may cause measurable but not severe degradation of ecosystem integrity.
11	Non-Indigenous Species	—	Status: Medium Trend: Medium	High percentage of non-native species, no known recent introductions or significant changes in abundance	Non-indigenous species have caused or are likely to cause severe declines in ecosystem integrity.
12	Key Species Status	▲	Status: Very High Trend: Very High	Abundance of native oyster, eelgrass, and salt marsh are substantially reduced compared to historic levels. Salt marsh appears to be stable and slight increases in eelgrass and native oysters.	The reduced abundance of selected keystone species has caused or is likely to cause severe declines in some but not all ecosystem components, and reduce ecosystem integrity; or selected key species are at substantially reduced levels, and prospects for recovery are uncertain.
13	Key Species Condition	?	Status: Low Trend: Low	Limited information on health or condition suggests eelgrass, oysters and sea otters are fairly healthy.	The condition of selected key resources is not optimal, perhaps precluding full ecological function, but substantial or persistent declines are not expected.
14	Human Activities	?	Status: Medium Trend: Medium	Many human activities that Impact living resources (e.g., hydrologic modifications, inputs of pollutants from agriculture and development, introduction of non-indigenous species. Overall trend in human activities difficult to determine.	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.

Questions that have new information to report since the 2009 Monterey Bay National Marine Sanctuary Condition Report (ONMS 2009) are those with red numbers.

Estuarine Environment: Maritime Archaeological Resources

The following information provides an assessment of the status and trends pertaining to the current state of the maritime archaeological resources in the offshore environment.

15. What is the integrity of known maritime archaeological resources and how is it changing?

In the 2009 MBNMS Condition Report the status and trend was rated "undetermined" for this question because little was known about the integrity of the few maritime archaeological resources (e.g., Native American midden sites, historic pier) located in Elkhorn Slough (ONMS

2009). There is no new information on the integrity of maritime archaeological resources in Elkhorn Slough, therefore the 2015 status and trend rating remain "undetermined".

16. Do known maritime archaeological resources pose an environmental hazard and is this threat changing?

As was determined in the 2009 MBNMS Condition Report (ONMS 2009), this question is rated "good" and "not changing" because there are no known maritime archaeological resources in Elkhorn Slough that pose an environmental hazard.

17. What are the levels of human activities that may influence maritime archaeological resource quality and how are they changing?

Our 2015 assessment remains the same as in the 2009 MBNMS Condition Report (ONMS 2009). This question is rated "good" and "not changing" because existing human activities do not pose a threat to the quality of known maritime archaeological resources in Elkhorn Slough. However, as the main channel in Elkhorn Slough widens and deepens because of erosion, the risk of impact to the Native American midden sites increases and is likely to become an issue in the future.

Comment [N30]: Clark: The continued erosion of the elkhorn slough should be identified as a problem for archaeological resources as for estuary habitat.

Deleted: may

Estuarine Environment Maritime Archaeological Resources Status & Trends

Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

▲ = Improving — = Not changing ▼ = Declining
? = Undetermined trend **N/A** = Question not applicable

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
15	Integrity	?	Status: N/A (not updated Status: N/A (not updated	Very little is known about the integrity of the few known maritime archaeological resources in Elkhorn Slough.	Not enough information to make a determination.
16	Threat to Environment	—	Status: N/A (not updated Status: N/A (not updated	No known environmental hazards.	Known maritime archaeological resources pose few or no environmental threats.
17	Human Activities	—	Status: N/A (not updated Status: N/A (not updated	Existing human activities do not influence known maritime archaeological resources.	Few or no activities occur that are likely to negatively affect maritime archaeological resource integrity.

Questions that have new information available since the 2009 Monterey Bay National Marine Sanctuary Condition Report (ONMS 2009) are those with red numbers.

State of Sanctuary Resources: Nearshore Environment

Nearshore Environment: Water Quality

The following information provides an assessment of the status and trends pertaining to water quality and its effects on the nearshore environment.

1. ***Are specific or multiple stressors, including changing oceanographic and atmospheric conditions, affecting water quality?***

Information regarding stressors on water quality in the nearshore environment, particularly inputs of contaminants (e.g., POPs, heavy metals), nutrients, sediments, and pathogens has not changed the rating for this question in the last five years. Their presence may inhibit the development of assemblages and may cause measurable but not severe declines in living resources and habitats. For this reason, the rating for this question remains "fair" and the trend remains "declining". Measurements of ambient toxicity due to pesticides (e.g., toxaphene, DDT, diazinon, chlorpyrifos, pyrethroids, neonicotinoids) in waterways that drain to the sanctuary indicate a potential problem in the adjacent nearshore environment (Anderson et al. 2003, Hunt et al. 1999, Phillips et al. 2014, Starner and Goh 2012). Please see 2009 MBNMS Condition Report for additional information.

Current monitoring is insufficient to allow an accurate determination of sanctuary water quality and its effects on biological resources. Only a small fraction of known contaminants are measured, and even these are measured infrequently. Whole contaminant categories are essentially unmeasured, including endocrine disrupters, personal care products, and most current-use pesticides. There is a critical need for a coordinated regional water quality monitoring program to provide an integrated assessment across the range of stressors, jurisdictions and information needs.

In regard to changing oceanographic and atmospheric conditions, Booth et al. (2012) shows an increasing frequency of decreased pH and decreased dissolved oxygen conditions at the Monterey Bay Aquarium seawater intake in 17m depth. Ocean acidification and decreasing dissolved oxygen is discussed in more detail in Offshore Question 1. More directed study on the effects of climate driven changes in pH, temperature, and dissolved oxygen on nearshore water quality will become increasingly important for understanding and tracking the status and condition of living resources in the sanctuary in the future.

California is invested in a coastwide effort, the West Coast Ocean Acidification and Hypoxia Science Panel (http://www.oceansciencetrust.org/project/west-coast-ocean-acidification-and-hypoxia-science-panel/), which is scheduled to release a suite of products throughout 2015. These products, which are intended to help inform decision makers and managers, include a synthesis of the drivers of ocean and coastal acidification and hypoxia and a monitoring framework to track changing ocean chemistry .

2. *What is the eutrophic condition of sanctuary waters and how is it changing?*

In 2009, the basis for judgment for a "good/fair" rating and a "declining" trend was clear evidence of frequent, localized, and enhanced nutrient enrichment in the nearshore environment of the sanctuary, due to both point and non-point sources. These conditions may preclude full development of living resource assemblages and habitats, but are not likely to cause substantial or persistent declines (see 2009 MBNMS Condition Report for specifics). The 2015 rating has been changed to "fair" with a "declining" trend due to continued nutrient enrichment; increasing frequency of blooms of *Pseudo-nitzschia*, in addition to recent new species; and harmful algal blooms' (HABs) negative effects on fish, birds and mammals. These new data indicate that HABs are having measurable impacts on nearshore water quality and living resources.

While upwelling is believed to initiate macro-scale algal blooms, the Monterey Bay seems to have a bloom incubator "hot spot" in the northeast corner in an upwelling shadow that is influenced by runoff from nearby rivers with significant nutrient loads (Ryan et al. 2008). This phenomenon is described in other areas of the central coast as well, such as the Santa Maria River to the south (Frolov et al. 2013).

Ortho-phosphate concentrations have increased significantly in the Pajaro and Salinas watersheds in recent years. Figure NS WQ1 shows concentrations of nitrate and ortho-phosphate at the lower ends of Pajaro (305THU), Old Salinas (309OLD), and Salinas (309DAV) rivers (CCAMP 2015). Inputs to the sanctuary from the Salinas and Pajaro Rivers do not show increasing trends in nitrogen compounds. Nitrate concentrations increased in the Old Salinas River through approximately 2011, but have shown recent signs of decline. Regardless of trend, the nitrate concentrations remain high.

Primary land-based loading of nutrients to Monterey Bay comes from the Pajaro and Salinas River watersheds. Annual loads from the rivers are highly variable and highly influenced by flow. Because of relatively high flows and concentrations, the Pajaro River contributes the largest loads of nutrients to the sanctuary. San Lorenzo River and Carmel River contribute nutrient loads that are typically an order of magnitude lower. For example, in 2004-5, the Central Coast Long-Term Environmental Assessment Network (CCLEAN) estimated average annual loads of nitrate from the Pajaro, Salinas, San Lorenzo and Carmel Rivers as 271,000 kg/yr, 214,000 kg/yr, 28,300 kg/yr and 34,000 kg/yr, respectively (CCLEAN 2005). The Pajaro River TMDL estimates that 1.3 million kg/year of total nitrogen on average is loaded to streams of the Pajaro River Basin (RWQCB 2015, in draft).

Loading of nutrients may be more important than concentration when considering potential impacts of freshwater inputs on the marine environment and especially when considering the extended period of recent drought. CCAMP has estimated loads using modeled daily flows paired with monthly concentration data, and applying a dilution model to estimated concentrations in watersheds where measured data shows a significant relationship between flow and concentration CCAMP 2015). Old Salinas River mouth has shown significant decreases in both concentration and load of nitrate since 2011, and Pajaro River also has decreasing nitrate loads (Figure NS WQ2). In some locations data from recent years indicate there may be declines

Comment [N31]: Field: With respect to eutrophic conditions and toxic phytoplankton blooms, note that there s some paleo-evidence (from the Santa Barbara Basin, outside of Sanctuary boundaries) that indicates that the frequency and prevalence of Pseudo-nitzschia blooms (those that produce domoic acid and lead to amnesic shellfish poisoning) have become more frequent in very recent years (this is also relevant to the discussion on page 96). See Baron et al. 2013.

Deleted: judgement

in loads of total ammonia, Kjeldahl nitrogen, total suspended solids, and turbidity. Again, low flows in 2013 and 2014 may be influencing these observations.

Harmful algal bloom (HAB) events have been linked with freshwater runoff events (Kudela and Chavez 2004) and may be associated with nutrient loading from coastal watersheds in the Monterey Bay (Kudela et al. 2008a; Kudela et al. 2008b). However, most studies indicate that the primary trigger for phytoplankton blooms is upwelling. In a 2012 study, the effects of upwelling events, storm water discharge and local circulation on phytoplankton blooms in southern and central California were analyzed using 10 years (1997-2007) of sea surface chlorophyll concentration, sea surface temperature and modeled freshwater discharges (Nezlin et al. 2012). Along the central coast, blooms persisted from spring to autumn during seasonal intensification of upwelling. As described in Offshore Question 2, Nezlin et al. (2012) concluded that nutrient contributions from terrestrial sources could be negligible at a large scale, but could have a pronounced effect at a local scale in regard to duration and size of bloom, especially near river mouths and areas characterized by extended residence time.

Comment [N32]: Kudela: Note that Howard et al. 2015 (Howard, M. D., Sutula, M., Caron, D. A., Chao, Y., Farrara, J. D., Frenzel, H., ... & Sengupta, A. (2014). Anthropogenic nutrient sources rival natural sources on small scales in the coastal waters of the Southern California Bight. Limnology and Oceanography, 59(1), 285-297.) found that anthropogenic N could be a dominant source in the same region, but it was from POTWs, not from rivers

An analysis performed for CCLEAN (2015) also shows that municipal discharge is comparable to river inputs. So there is a significant "missing" source of nutrients there.

The microcystin toxin was determined to affect wildlife in the marine environment in 2007, when 11 southern sea otters were poisoned by microcystin, a toxin produced by the toxic form of *Microcystis aeruginosa,* which is a freshwater cyanobacterium. This particular cyanobacterium has historically been a problem in freshwater systems affecting wildlife on land. As of 2010, at least 21 sea otters have died, most found near embayments, harbors or river mouths (Figure NS WQ3). Microcystin was detected flowing from three nutrient-impaired rivers (San Lorenzo, Salinas River, Pajaro River) into Monterey Bay. But of most interest, it was traced from a freshwater lake (Pinto Lake) with a connection to the Pajaro River and ultimate discharge into Monterey Bay. Results within this land-sea interface had microcystin concentrations as high as 2,900 ppm (Miller et al. 2010). The suggested action level to reduce potential adverse health effects for microcystin is 0.0008 ppm (OEHHA 2012). Miller et al. (2010) demonstrated marine invertebrates, consumed by humans and sea otters, are capable of uptake and retention of microcystin. Even with continual flushing of sea water beginning at 96 hours post-exposure, gastrointestinal microcystin concentrations remained 30.5 ppb wet weight 21 days after initial exposure in mussels.

In 2010, twenty-one freshwater, estuarine, and marine locations in California were surveyed using Solid Phase Adsorption Toxin Tracking (SPATT) samplers (Gibble and Kudela 2014) at the land-sea interface to determine the presence and concentration of microcystin. During this initial study, 15 of 21 sites were positive for microcystin toxin. Four watersheds were identified to have persistent concentrations of microcystin toxin (Big Basin, Pajaro, Salinas, Carmel) and were further studied for two more years to determine a correlation between other environmental factors. Results indicated that coastal nutrient loading was a statistically significant predictor of microcystin concentrations and those concentrations appeared to have large peaks, especially in the spring and fall. The patterns of microcystin presence and concentration observed during this study suggest that microcystins are likely present throughout the year (Gibble and Kudela 2014) in the nearshore environment.

A surfactant producing bloom occurred in Monterey Bay in 2007 but was not documented in the 2009 Condition Report. It affected 14 species of seabirds by coating their feathers with a slimy yellow-green material that caused them to be severely hypothermic. The algal bloom, made up of the dinoflagellate *Akashiwo sanguinea,* produced foam made of surfactant-like proteins that coated the birds' feathers, effects similar to an oil spill. This was the first documented case of its kind. A total of 550 stranded live birds were rescued and 207 fresh dead birds were collected over a two month period (Jessup et al. 2009). While there is no evidence that this event was linked to terrestrial sources of nutrient loading, it does illustrate that new species of HABs are occurring in MBNMS and have negative impacts on living resources.

Comment [N33]: Kudela: It was suggested by John Ryan (MBARI) that the bloom was linked to river runoff from the Salinas/Pajaro but I don't believe that is published

Comment [N34]: Kudela: Note that there is also evidence for increasing high-biomass events in the autumn (using satellite data, or the MBARI time-series), driven predominantly by dinoflagellates (i.e. red tides). We showed that the red tides are providing an organic carbon source for bacteria (presumably) and that the probability of FIB increased with increasing chlorophyll. This was associated with a medical case where a female diver was hospitalized after diving in a red tide. Therefore there is an indirect connection between more algae, more FIB, therefore more pathogenic bacteria, and increasing probability of humans being impacted.

Honner, S., Kudela, R. M., & Handler, E. (2012). Bilateral mastoiditis from red tide exposure. The Journal of emergency medicine, 43(4), 663-666.

Central Coast Ambient Monitoring Program (CCAMP)

The Central Coast Ambient Monitoring Program (CCAMP) is the Central Coast Regional Water Quality Control Board's regionally scaled water quality monitoring and evaluation program. The purpose of the program is to provide scientific information to Regional Board staff and the public, to protect, restore, and enhance the quality of the waters of central California (http://www.ccamp.us/ccamp_org/). More information is available on the Sanctuary Integrated Monitoring Network website:

Central Coast Long Term Environmental Assessment Network (CCLEAN)

The Central Coast Long-term Environmental Assessment Network (CCLEAN) is a long-term monitoring program that is designed to help municipal agencies and resource managers protect the quality of nearshore marine waters in the Monterey Bay area. CCLEAN, which began in 2001, is determining the sources, amounts and effects of contaminants reaching nearshore waters. More information is available on the Sanctuary Integrated Monitoring Network website: http://sanctuarymonitoring.org/projects/project_info.php?projectID=100147

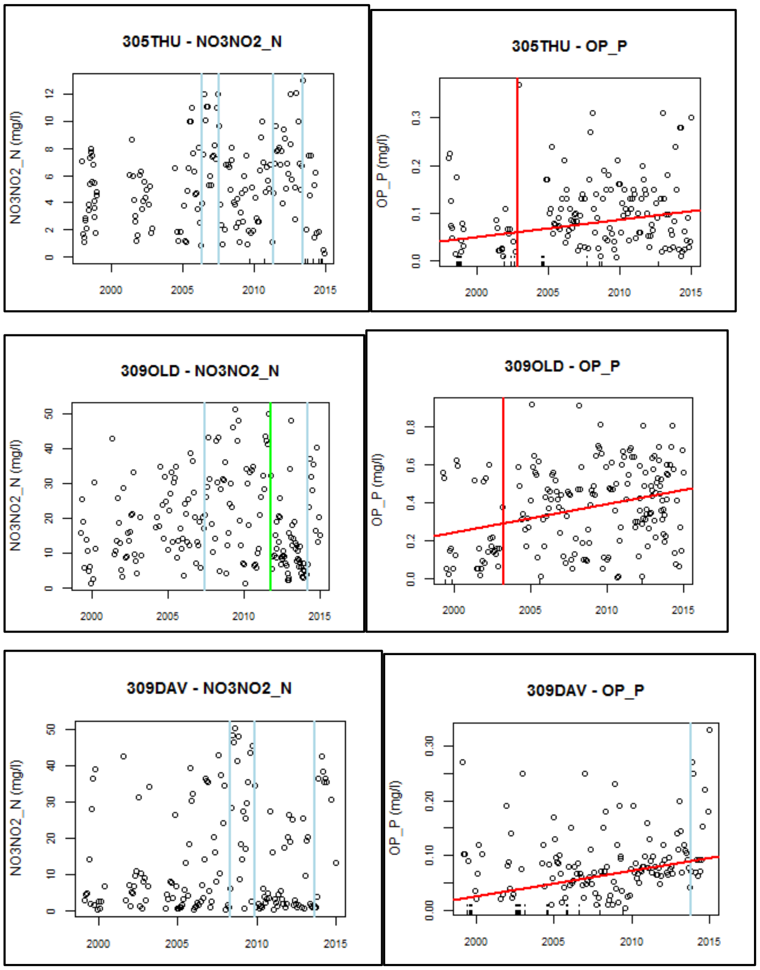


Figure NS WQ1

Caption: Change analysis graph for Nitrate-Nitrite as N (NO3NO2_ N) and Orthophosphate as P (OP_ P) concentrations at Central Coast Ambient Monitoring Program (CCAMP) sites Pajaro River at Thurwatcher Road (305THU), Old Salinas River Channel at Monterey Dunes Way (309OLD), and Salinas River at Davis Road (309DAV). Bayesian change point analysis, shown as vertical lines, shows specific points in time when there is a high probability that measurements taken before a certain date are different from measurements taken after that date. Statistically significant change points are identified as green (for decreasing data values) or red (for increasing data values) vertical lines, when comparing data collected before and after the change point. Blue lines indicate change points that are not statistically significant when comparing all data collected before to all data collected after the change point. Sloped lines

indicate significant linear regression relationships based on Mann Kendall analysis; red indicates significantly increasing trends.
Source: Central Coast Ambient Monitoring Program (CCAMP 2015)

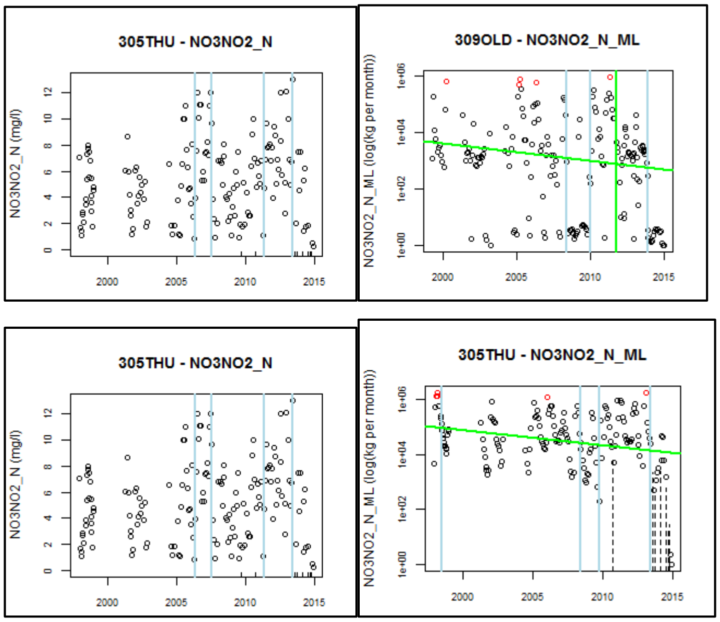


Figure NS WQ 2.
Caption: Change analysis graph for Old Salinas River (309OLD) and Pajaro River (305THU) for Nitrate-N concentration (mg/L) and modeled monthly load (kg/month). Load estimates are derived from modeled daily flows and monthly concentration data, applying a watershed specific dilution model to estimate concentrations where appropriate. Statistically significant change points identifying decreasing group means are identified as green vertical lines, when comparing data collected before and after the change point. Sloped lines indicate significant linear regression relationships based on Mann Kendall analysis; green indicates significantly decreasing trends.
Source: CCAMP 2015

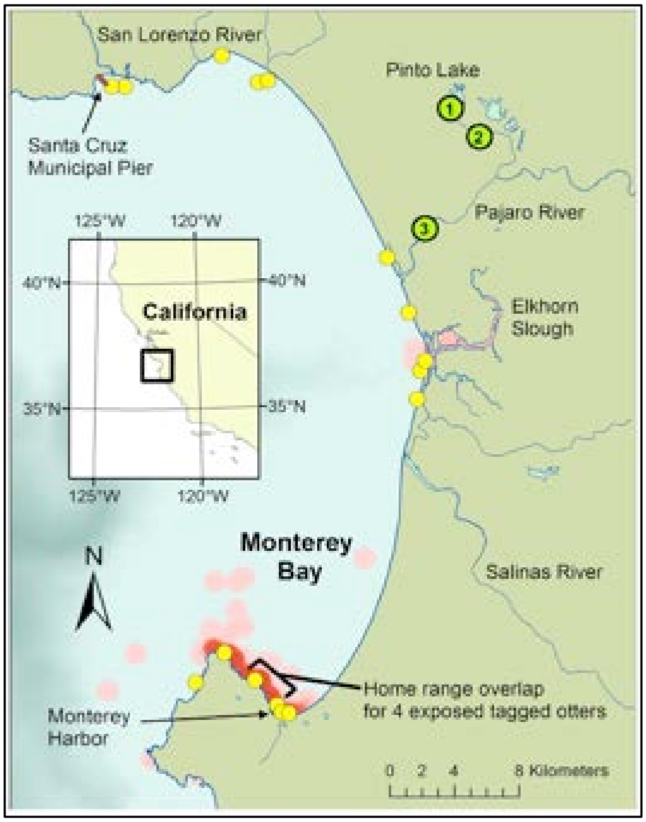


Figure NS WQ 3.
Caption: Map of Monterey Bay showing distribution of sea otters dying due to microcystin intoxication (yellow circles). Note spatial association of sea otter strandings with coastal locations of river mouths, harbors, coastal ponds and embayments. Habitat utilization distributions for 4 radio-tagged, microcystin-poisoned otters are plotted as kernel density distributions fit to daily re-sighting locations (red shading, with regions of most intense shading corresponding to the habitats most frequently utilized by affected animals). Locations of freshwater samples collected during a ''Superbloom'' of *Microcystis* in 2007 are indicated by green circles.
Source: Miller et al. 2010

3. Do sanctuary waters pose risks to human health?

In 2009, the basis for judgment for a "fair/poor" rating and an "undetermined" trend was because of health risks in nearshore waters where selected conditions have caused or are likely to cause severe impacts, but cases had not suggested a pervasive problem. Although the majority of the sanctuary's nearshore waters generally did not pose risks to human health, there were localized areas and isolated impacts that posed serious health risks (see 2009 MBNMS Condition Report for specifics). The 2015 rating has been changed to "fair" because of declines in persistent organic pollutants measured in mussels and improvements to sanitary sewer infrastructure in coastal cities resulting in improved beach water quality. An "undetermined" trend is based on a risk of consuming contaminated seafood and water quality at some beaches continuing to be unsafe for human contact. Selected conditions have resulted in isolated human impacts, but evidence does not justify widespread or persistent concern.

Indicator bacteria such as fecal coliform, *Escherichia coli* (*E. coli*), and *Enterococcus* do not usually cause illness in humans. Instead, their presence indicates the potential for water contamination with other pathogenic microorganisms such as bacteria, viruses and protozoa that do pose a health risk to humans (see Atwill study below). Figure NS WQ4 shows that three of the four counties with beaches in the sanctuary have an A or B grade at least 80% of the time when sampled during the dry weather averaged over the last 5 years. Please see the full report to understand the grading system (HTB 2014).

We evaluated *E. coli* data from January 2009 through November 2014 for eight sites from Carmel, CA, to Montara, CA, using data from the State Water Resources Control Board (SWRCB [1]) *My Water Quality* data portal: http://www.mywaterquality.ca.gov/safe_to_swim/). Four of the eight sites have been designated as 'Beach Bummers' by Heal the Bay at least one time in the last five years. A regression analysis on the log transformed E. coli MPN found two sites demonstrated a statistically significant trend (p-value < 0.05), although both had a low adjusted R-squared value due to the high variability of this data. Both of these sites showed a downward trend (Pillar Point Harbor and Cowell's Beach (Table NS WQ1).

Pathogenic bacteria are of major concern for their effects on human and marine mammals. According to a report produced by FoodNet and the Center for Disease Control and Prevention (CDC 2009), 41% of reported human bacterial infections are caused from *Salmonella* and 4% are caused by *E. coli* 0157:H7. This strain of *E. coli* is known to cause harm to humans. Over a twelve month period from April 2009 through April 2010, a study of 23 rivers, creeks and estuaries along the central coast of California were sampled 56 times to determine if *E.coli* 0157:H7 and *Salmonella* were present in those waterbodies and sediment. Included in the study was an investigation to determine if there were seasonal trends and/or a correlation with fecal coliform (*or E.coli*) concentrations. *Salmonella* was detected in 31% of the water samples and 20 of the 23 sampling sites had at least one sample test positive for *Salmonella*. Scott Creek Lagoon, Soquel Creek and the Salinas River consistently tested negative. *Salmonella* in the water column was strongly associated with *Salmonella* in the sediment. In addition, the concentration of fecal coliform was significantly associated with the concentration of *Salmonella*.

Deleted: judgement

Comment [35]: Note to reviewers – following review of the report, the authors will confirm that all acronyms are defined first time mentioned.

Deleted: We evaluated *E. coli* data from January 2009 through November 2014 for eight sites from Carmel, CA, to Montara, CA, using data from the State Water Resources Control Board (SWRCB) *My Water Quality* data portal: http://www.mywaterquality.ca.gov/safe_to_swim/). Four of the eight sites have been designated as 'Beach Bummers' by Heal the Bay at least one time in the last five years. Seven of the eight sites showed a slight downward trend in *E.coli* concentrations during that time period. Of the seven sites with a downward trend, two (Cowell's Beach and Pillar Point Harbor) showed statistically significant declining trends (Table NS WQ1). The one site with a very slight increasing, but not statistically significant, trend was at Carmel Beach (Table NS WQ1). That said, this site had just one posting for *E.coli* in the last six years. ¶

Approximately 2.4% of the samples tested positive for *E. coli* 0157:H7. Four sites tested positive one time and one site tested positive 2 times (Atwill et al. 2011). This study confirmed that human pathogens are common in central coast waterbodies and fecal indicator bacteria are a reasonable proxy for potential human illness when in contact at coastal beaches and streams.

Sampling of mussels by CCLEAN was reduced in 2007 from wet and dry season to just wet season because that was historically when the greatest concentration of persistent organic pollutants (POPs) were detected. While concentrations of some POPs continue to exceed or nearly exceed various alert levels for the protection of human health, several POPs have declined over recent years (CCLEAN 2014). Since 2008, dieldrin has remained below the USEPA recreational fisher screening value at most sites, but concentrations remain above the USEPA subsistence fisher screening level (Figure NS WQ 5a). Significant dieldrin declines were observed at Laguna Creek, the Hook and Carmel River Beach. DDT has also declined over the past 11 years with downward trends being significant at all sites (Figure NS WQ 5b). PBDE concentrations have generally declined in mussels since 2008, with significant declines detected at Carmel River Beach (Figure NS WQ 5c) (Figure NS WQ6).

Methylmercury is the pollutant that poses the most widespread potential health concerns to consumers of fish caught in California coastal waters (Figure NS WQ7). The California Office of Environmental Health Hazard Assessment (OEHHA) No Consumption Advisory Tissue Level (ATL) of 0.44 ppm provides an upper bound threshold for assessment of methylmercury in California sport fish. This value represents a relatively high concentration above which frequent consumption might not be safe for the most sensitive fish consumers (children and women of childbearing age). In a two-year study conducted by the California Surface Water Ambient Monitoring Program, 3,483 fish representing 46 species were collected from 68 locations on the California coast. On the central coast of California near Carmel, average concentrations >0.44 ppm methylmercury were found in gopher rockfish and lingcod. Similar findings for lingcod off the Cambria /Northern San Luis Obispo coast and leopard shark in Elkhorn Slough were reported. Eleven types of fish caught on the central coast fell within the moderate range of contamination <0.44 and >0.07 ppm methylmercury including black, blue, brown, gopher, and China rockfish; cabezon, and five shark species (Davis et al. 2012). Table NS WQ2 provides POP results for central coast samples collected during this study (CCLEAN 2014). While several species from Elkhorn Slough had exceedences of subsistence fisher screening values for more than one contaminant, most species caught along the central coast did not reflect the exceedances of the Ocean Plan observed in the CCLEAN monitoring.

Comment [N36]: Field: a study evaluating methylmercury concentrations found that average concentrastions exceeded 0.44 ppm in gopher rockfish and lingcod, near Carmel, with similar findings for other species in other areas. If feasible, a quick reporting of sample size for the high values might be informative.

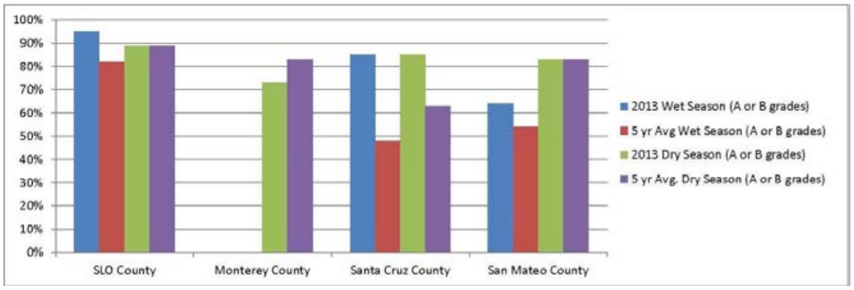


Figure NW WQ4.
Caption: Data from the 2014 Heal the Bay Beach Report Card showing percentage of A and B grades for 2013 and past five year average for dry and wet weather monitoring. Monterey County did not report sufficient wet weather data to be included.
Source: Heal the Bay Beach Report Card 2014

Table NS WQ1.
Caption: Regression data from log transformed values for *E.coli* from 2009 - 2014 at eight monitoring sites arranged from south to north along the central coast of California. Positive slope values indicate an increasing trend; negative slope values indicate a decreasing trend. Lower p-values indicate greater statistical significance of the trends.
Source: Data downloaded from SWRCB *My Water Quality* data portal
http://www.mywaterquality.ca.gov/safe_to_swim/

Site	Intercept	Slope	Adj-Rsquare	p-value
Carmel Beach	0.24	0.000060	0.00620	0.1350
Stillwater Cove	5.58	-0.000054	0.00360	0.6580
Lovers Point	7.60	-0.000087	-0.00272	0.5450
Capitola Beach	10.58	-0.000176	0.00357	0.1456
Cowell Beach	15.01	-0.000247	0.01029	0.0225
Natural Bridges	7.60	-0.000120	0.00033	0.2940
Pillar Point Harbor #7	13.73	-0.000240	0.00775	0.0078
Montara State Beach	4.16	-0.000044	0.00349	0.1593

Comment [N37]: Field: the line "Lower p-values indicate greater statistical significance of the trends" – the way this reads, to a layperson, might infer that all p-values infer statistical significance- probably some threshold ($p < 0.05$ or at most 0.1) should be defined and it should be clearly stated that p values above those levels are not statistically significant and therefore there are no significant trends. Given just how low the R-squared values are, I'm quite surprised that any of those trends were statistically significant, the trends explain very very little of the variance.

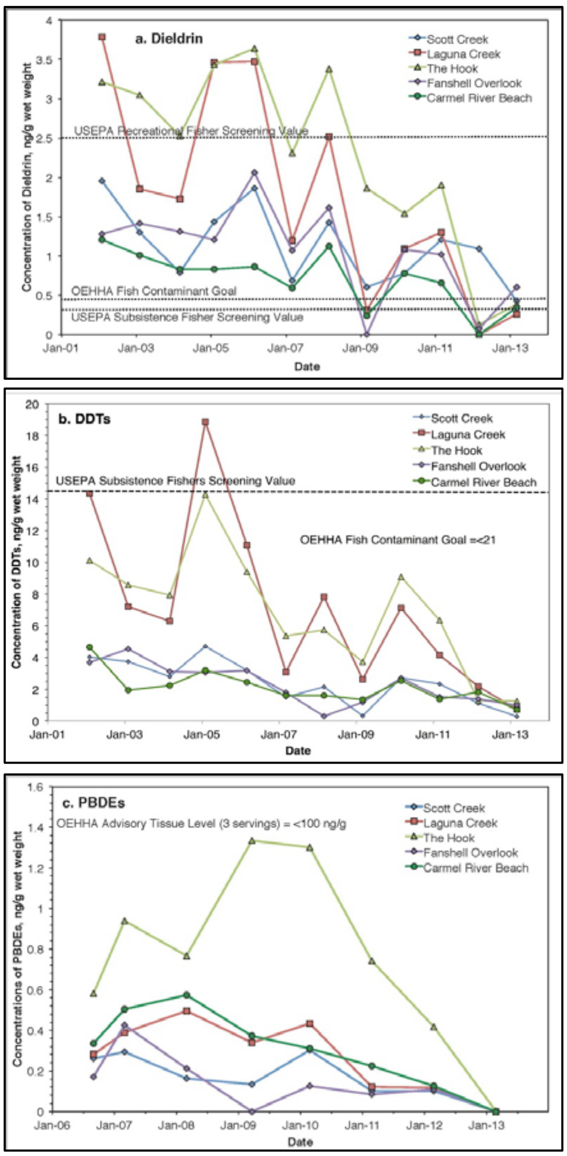


Figure NS WQ5.

Caption: Wet-weight concentrations of (a) Dieldrin, (b) DDTs, and (c) PBDEs measured in mussels during the wet season from five CCLEAN sites in the Monterey Bay area.

Source: CCLEAN 2014

Figure NS WQ6.
Caption: Locations of CCLEAN sampling sites for municipal wastewater effluent, receiving water, sediment, mussels, and rivers.
Source: CCLEAN 2014

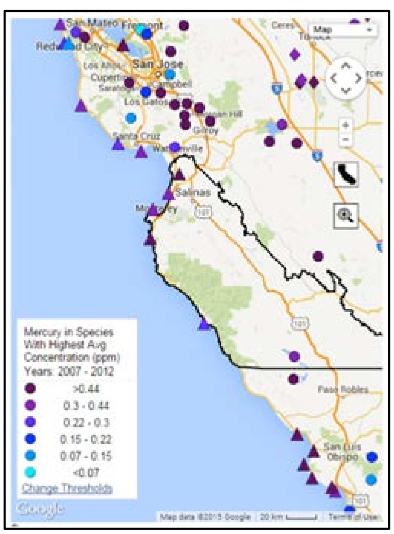


Figure NS WQ7.
Caption: Map from My Water Quality Portal on SWRCB website showing mercury concentrations in fish caught along the central coast from 2007 – 2012.

Source: SWRCB My Water Quality Portal accessed on (4/18/15)
http://www.mywaterquality.ca.gov/safe_to_eat/data_and_trends/index.shtml?county=Monterey
Table NS WQ2.
Caption: POP concentrations (ng/g, wet weight) in fish collected along the central coast of California during 2010. Each sample consisted of a composite of filets from 4–6 fish. Values in red exceeded EPA Subsistence Fisher Screening Values (USEPA 2000).
Source: Davis et al. 2012

Station Name	**Species**	**Sum of PCBs**	**Sum of DDTs**	**Dieldrin**
Santa Cruz Coast Area	Black Rockfish	0.0	0.92	0.00
Santa Cruz Coast Area	Blue Rockfish	0.0	1.14	0.00
Santa Cruz Coast Area	Cabezon	0.0	0.87	0.00
Santa Cruz Coast Area	Gopher Rockfish	0.0	2.29	.
Santa Cruz Coast Area	Kelp Greenling	0.3	3.84	.
Santa Cruz Coast Area	Lingcod	0.7	5.7	0.00
Santa Cruz Coast Area	White Croaker	0.3	3	0.00
Santa Cruz Area Wharfs/Beaches	Cabezon	0.0	1.3	.
Santa Cruz Area Wharfs/Beaches	Gopher Rockfish	0.2	1.67	0.00
Santa Cruz Area Wharfs/Beaches	Kelp Greenling	0.0	4.77	0.00
Santa Cruz Area Wharfs/Beaches	Lingcod	2.0	10.98	.
Santa Cruz Area Wharfs/Beaches	White Croaker	0.0	1	0.00
Elkhorn Slough	Bat Ray	0.5	3.54	**0.89**
Elkhorn Slough	Leopard shark	**3.0**	3.87	**0.59**
Elkhorn Slough	Shiner Surfperch	**4.9**	**34.37**	**0.80**
Elkhorn Slough	Top Smelt	**2.5**	**18.05**	**1.29**
Moss Landing/Marina Coast	Black and Yellow Rockfish	0.0	2.4	.
Moss Landing/Marina Coast	Black Rockfish	0.0	0.87	0.00
Moss Landing/Marina	Brown Rockfish	**3.9**	2.53	0.00

Comment [N38]: Field: table has a formatting issue- need to make columns wider or font smaller.

Coast				
Moss Landing/Marina Coast	China Rockfish	**2.8**	1.04	.
Moss Landing/Marina Coast	Gopher Rockfish	0.5	2.23	0.00
Monterey/Pacific Grove Coast	Black Rockfish	**2.7**	4.05	0.00
Monterey/Pacific Grove Coast	Blue Rockfish	0.0	1.28	0.00
Monterey/Pacific Grove Coast	Gopher Rockfish	0.0	0.76	0.00
Monterey/Pacific Grove Coast	Kelp Rockfish	0.9	1.86	.
Monterey/Pacific Grove Coast	Rainbow Surfperch	0.2	3.1	0.00
Carmel Coast	Blue Rockfish	0.0	1.02	0.00
Carmel Coast	Cabezon	0.3	0	.
Carmel Coast	Gopher Rockfish	0.2	1.31	0.00
Carmel Coast	Lingcod	**8.2**	**22**	.
Carmel Coast	Olive Rockfish	**2.5**	3.02	0.00
Carmel Coast	Rainbow Surfperch	0.3	2.49	0.00
Carmel Coast	Vermillion Rockfish	0.0	2.07	0.00

4. What are the levels of human activities that may influence water quality and how are they changing?

In 2009, human activities detrimental to water quality conditions in the nearshore environment were rated "fair" with an "undetermined" trend, based on activities that had resulted in measurable resource impacts, but evidence suggested effects were localized and not widespread (see 2009 MBNMS Condition Report for specifics). The 2015 rating remains "fair" but with an "improving" trend based on anticipated reductions in urban and agricultural runoff in response to state regulations. In addition, Special Protections for Areas of Special Biological Significance (ASBS) are being enforced. Efforts to change human behaviors that cause pollution have strong potential to lead to improvement in water quality. Some improvements in water quality have been observed, however data on the specific levels of human activities are lacking. Below we describe the current landscape related to population increases, reduced water availability, and regulatory changes.

The population in Monterey and Santa Cruz counties has increased by 3.3% (13,769 people) and 2.7% (7,043 people) respectively from April 2010 – June 2013 (http://census.gov). This is consistent with the state of California population increase of 2.9% and the national increase of 2.4% over the same time period. So while the population is increasing, construction and new development have slowed because of the limits on water availability.

On March 15, 2012, the Central Coast Regional Water Quality Control Board (CCRWQCB) adopted a Conditional Waiver of Waste Discharge Requirements (Agricultural Order No. R3-2012-0011) that applies to owners and operators of irrigated land used for commercial crop production. The CCRWQCB regulates discharges from irrigated agricultural lands to protect surface water and groundwater. The CCRWQCB is targeting priority water quality contaminants, such as pesticides, nutrients, and sediments – especially nitrate impacts to drinking water sources. More information can be found at http://www.waterboards.ca.gov/centralcoast/water_issues/programs/ag_waivers/index.shtml

The CCRWQCB also oversees a Stormwater Program to prevent stormwater runoff from conveying of pollutants to surface waterbodies. The Stormwater Program is a National Pollutant Discharge Elimination System (NPDES) Program implemented in two phases based on the size of the jurisdiction (Phase I and Phase II). The City of Salinas (population greater than 155,000 in 2013) holds the only individual Phase I municipal stormwater permit in the central coast region. On March 10, 2003, coastal cities that met the definition of Phase II Regulated Small Municipal Separate Storm Sewer Systems (MS4s) were required to obtain permit coverage. It wasn't until February 5, 2013, that a proposed final draft of the Phase II Small MS4 General Permit was adopted and became effective on July 1, 2013 (Order No. 2013-0001). More information can be found at: http://www.waterboards.ca.gov/water_issues/programs/stormwater/municipal.shtml.

In addition to the agriculture and stormwater regulations, the State Water Resource Control Board (SWRCB) also took action regarding implementation of Special Protections for Areas of Special Biological Significance (ASBS). The California Ocean Plan states that: "Waste shall not be discharged to areas designated as being of special biological significance. Discharges shall be located a sufficient distance from such designated areas to assure maintenance of natural water quality conditions in these areas." This absolute discharge prohibition in the Ocean Plan applies unless an "exception" is granted. On March 20, 2012, the State Water Resources Control Board adopted Resolution 2012-0012 approving exceptions to the CA Ocean Plan for selected discharges into Areas of Special Biological Significance, including special protections for beneficial uses. Dischargers are now developing ASBS Compliance Plans that addresses stormwater discharges (wet weather flows) and how pollutant reductions in stormwater runoff will be achieved through best management practices. As of this report, no monitoring results have been released so it is too soon to determine effectiveness of the Special Protections.

Reference site monitoring was required by the ASBS Special Protections to establish reference conditions that would establish natural water quality numeric values for each of the parameters measured at 28 sites along the entire California coast. All eleven of the central coast reference sites are located within the sanctuary. Preliminary results collected in 2013, indicate there was no toxicity at any of the sites and one reference site within the sanctuary reported detectable levels of anthropogenic constituents (i.e., synthetic pesticides). On average, the ocean receiving water concentrations at reference sites were comparable in pre- to post-storm samples indicating that the stormwater runoff was not contributing anthropogenic pollutants to the receiving water at the reference sites. These were the first year results of the required two years of monitoring reference sites. More information is needed to confirm these results (Schiff et al. 2015).

On the central coast, multiple cities from Santa Cruz to Carmel have received state funding to build dry weather diversions which collect urban runoff from April through November and pump it to a wastewater treatment plant. These facilities reuse the water, usually for landscape watering or groundwater replenishment, and reduce the amount of untreated water flowing to the ocean. Other examples of human activities that reduce pollutant runoff include use of drip irrigation, retention ponds/swales, nutrient management, integrated pest management, and erosion control measures.

Boat marinas are also doing their part to reduce pollution from vessels. Most marinas adjacent to MBNMS have bilge pumpouts to remove oily water from vessels. They also have sewage pumpouts that are used on a daily basis by boaters to pump sewage from vessel holding tanks to the wastewater treatment plant (ML Asst. Harbormaster, per. comm.), thereby reducing the amount of nutrients, pathogens, and chemicals entering the sanctuary. In a two year period, Moss Landing Harbor District recycled over 5000 gallons of oily water and crankcase oil from vessels in that harbor.

With the adoption of ASBS Special Protections, the Agricultural Order and the MS4 Storm Water permits, there is much more regulatory oversight to reduce pollutant loads from these sources into surface waters of the state. The challenge now is to develop a regional monitoring program designed to measure changes in nearshore water quality resulting from these regulatory requirements and management practices. Currently, each program has its own specific monitoring requirements. The limited number of samples, analytes, and geographic scope reduces the confidence and statistical rigor that is needed to determine if efforts being implemented are effective in improving water quality.

Nearshore Environment Water Quality Status & Trends

Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

▲ = Improving — = Not changing ▼ = Declining

? = Undetermined trend **N/A** = Question not applicable

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
1	Stressors	▼	Status: N/A (not updated Status: N/A (not updated	Elevated levels of contaminants (e.g., POPs, heavy metals), nutrients, sediments, pathogens in some locations; on-going input of established and emerging pollutants. Acidification and hypoxia conditions increasing.	Selected conditions may inhibit the development of assemblages, and may cause measurable but not severe declines in living resources and habitats.
2	Eutrophic Condition	▼	Status: High Trend: High	Increasing nutrient enrichment and occurrence of HABs. New information regarding prevalence of microcystis in major river systems and coastal waters. HABs directly impacting fish, birds, and mammals.	Selected conditions may inhibit the development of assemblages, and may cause measurable, but not severe declines in living resources or habitats.
3	Human Health	?	Status: Very High Trend: Very High	Continue to have warnings at some beaches and lagoons due to high fecal indicator bacteria; declining dieldrin levels in mussels, contaminated shellfish at some locations and during some seasons. Mercury in fish.	Selected conditions have resulted in isolated human impacts, but evidence does not justify widespread or persistent concern.
4	Human Activities	▲	Status: Medium Trend: Medium	More regulations on human activities that can cause pollution, but evidence is lacking regarding improvements. Efforts to reduce pollution may be offset by intensification of human activities in coastal watersheds.	Selected activities have resulted in measurable resource impacts, but evidence suggests effects are localized, not widespread.

Questions that have new information to report since the 2009 Monterey Bay National Marine Sanctuary Condition Report (ONMS 2009) are those with red numbers.

Nearshore Environment: Habitat

The following information provides an assessment of the status and trends pertaining to the current state of nearshore marine habitats since 2009, which include beaches, rocky intertidal, the sandy seafloor, and subtidal rocky reef and kelp forest. The bulk of current long-term monitoring occurs in rocky intertidal and subtidal rocky reef and kelp forest so the assessments rely heavily on the status of those two habitats. More long-term monitoring is needed on the status of beaches and sandy seafloor habitats.

5. What is the abundance and distribution of major habitat types and how is it changing?

The abundance and distribution of nearshore habitats was rated "good/fair" in the 2009 report based on localized modification and degradation of coastal habitat, primarily through armoring of coastal bluffs and beaches, erosion of sandy shoreline, and landslide disposal on rocky reef. The trend in habitat modification was "not changing" because coastal armoring was occurring at a slow pace while dams were being removed in some locations. The status in 2015 has been changed to "fair" because of localized modification and loss of coastal habitat (mostly along shoreline) through landslide disposal, armoring, and erosion. New information provides additional details on subtidal benthic habitat complexity but does not change status. The trend is changed to "declining" due to the continued impacts of human activities (e.g., marine debris, coastal development, sand mining) that are altering and degrading habitat, albeit at a very slow pace. Impacts of marine debris on habitat is discussed further in response to Nearshore Question 8.

New seafloor habitat maps indicate more structural complexity and variability than previously understood. The California Seafloor Mapping Program (CSMP), a collaborative program funded in 2007, has since mapped California's state waters, including most of the nearshore environment inside the sanctuary using remote sensing, GIS and video technologies coupled with field sampling (http://walrus.wr.usgs.gov/mapping/csmp/index.html). In portions of the nearshore environment previously believed to contain fairly uniform soft bottom habitat, CSMP has found that depressed deposits of coarse-grained sediment, also called rippled scour depressions (RSDs) are more abundant and widespread than previously understood, comprising a total of 4.6% of seafloor type on the shelf in central California (Davis et al. 2013, CSMP 2012). RSDs add complexity and patchiness to relatively homogeneous unconsolidated sedimentary substrates on the inner continental shelf and differences have been observed in the faunal communities found inside and outside of RSDs. Hallenbeck et al. (2012) found that the densities of suspension feeders, invertebrate predators, and fishes, as well as the richness of suspension feeders and invertebrate predators, were significantly greater outside. However, young-of-the-year rockfish *(Sebastes* spp.) and smaller flatfish were more abundant inside RSDs and this habitat may be functioning as a nursery habitat for these groups.

Finescale benthic habitat mapping information is not yet available in most of the 'white zone' in Monterey Bay sanctuary. The white zone is the area along the immediate coastline where obstacles such as fog, high surf, rocky shoals, cloudy water and floating kelp have prevented these areas from being mapped using traditional mapping technology. Currently researchers are developing new techniques for mapping this zone and hopefully habitat data will be available for the white zone in the coming years (CSMP 2012, OST & CDFW 2013).

Armoring of coastal bluffs and cliffs can alter the natural processes of erosion, sediment transport, and deposition (http://www.montereybay.noaa.gov/resourcepro/resmanissues/coastal.html). Armoring alters the type of habitat in a given location, converting soft-sediment habitats (e.g., sandy beaches) to hard substrates (e.g., rock, cement, steel), which support very different biological communities. In the 2009 report, we reported that an estimated 32.43 kilometers, or approximately 7%, of the sanctuary's coastline has been armored (California Coastal Commission 2005). Since 2009, there have been ten authorizations issued by the sanctuary for new armoring and maintenance of existing structures, primarily in Santa Cruz county (MBNMS permit database). This number of authorizations is similar to the 13 issued by the sanctuary over the previous six year period (2003-2008) suggesting that the rate of armoring has not changed substantially. However, the exact location and coastal extent of new armoring projects was not available so we could not update our 2009 estimates of the extent of coastal armoring in the sanctuary.

Sand mining along the coast in the city of Marina has been identified as the main cause of high erosion rates of beaches and adjacent dune habitat in the southern Monterey Bay (SMB) region (ESA PWA 2012). The SMB region was identified by the USGS (Hapke et al. 2006) as the most erosive shore on average in California. A conclusion of the Coastal Regional Sediment Monitoring Plan (CRSMP) for southern Monterey Bay was that a primary cause of high erosion rates in SMB is the sand mine operated by CEMEX (who bought the mine in 2000) within the City of Marina (PWA et al. 2008). The amount of sand mined in Marina by CEMEX is approximately 200,000 cubic yards per year.) It was recently estimated that cessation of this sand mining activity would reduce erosion rates by at least 60% across the entire SMB region (ESA PWA 2012). The ecological impact of cessation of sand mining is expected to be strongly positive because erosion rates will slow to natural levels and the adverse impacts caused by mining will not continue to accumulate. Cessation of sand mining was identified as the most significant erosion mitigation measure that should be the highest priority for all jurisdictions in the southern Monterey Bay region (ESA PWA 2012). However, a mechanism for cessation of the CEMEX commercial sand mining operation has not been identified.

Occasionally, rocky intertidal and subtidal habitat along the Big Sur coast is buried by sediment due to landslide disposal, but this activity has been less in recent years likely due to fewer significant winter storms (http://montereybay.noaa.gov/resourcepro/resmanissues/landslide.html). The only new landslide disposal occurred in 2011 at Alder Creek. This area was monitored for three years to evaluate any impacts to the subtidal and intertidal habitats (http://sanctuarysimon.org/projects/project_info.php?projectID=100312). A full summary of the results of this study is not yet available, but preliminary results indicate that some localized impacts, such as sand accumulation and lower biodiversity, were observed in the rocky intertidal habitat just south of the slide area (Bell et al. 2015). Past study of impacts from landslide disposal activities along the central coast found impacts to be localized, and strongly dependent on the type of nearshore habitats (rocky vs. sandy) present at, and immediately adjacent to, the site of the slide (Oliver et al. 1998).

6. What is the condition of biologically-structured habitats and how is it changing?

Existing data on the condition of biologically-structured habitats in the nearshore environment over the last five years indicate that, similar to the assessment in 2009, these resources are in "good" condition with an "not changing" trend. A number of on-going monitoring studies in the rocky intertidal and kelp forest indicate that a variety of ecologically important structure-forming species appear to be healthy and no major perturbations have been observed. No data is available on condition and recent trend for biogenic species on the sandy seafloor.

In the rocky intertidal, mussels *(Mytilus californianus)* are an important structure-forming species in the mid zone. On-going monitoring of abundance of mussels on intertidal platforms by LiMPETS (Long-term Monitoring Program and Experiential Training for Students) at Davenport Landing, Natural Bridges, and Almar Avenue shows quite a bit of stability in the abundance of mussels over the last 40 years with recent abundances (2009-present) being similar to the long-term average (Figure NS Hab1; J. Pearse, unpubl. data). The abundance of mussels has been reduced at some locations due to repeated harvest for consumption by humans (P. Raimondi, PISCO/MARINe, pers. comm.). Repeated human visitation to the rocky intertidal can results in lower coverage of some types of algae in the upper intertidal zone and around the margins of tidepools due to chronic trampling (Tenera Environmental 2003). However, the sites with reduced abundance from trampling and harvest comprise a small percentage of habitat in the entire nearshore environment.

Kelp beds persist from year to year, but the extent of kelp beds does exhibit seasonal and annual variation, with the extent of giant kelp (*Macrocystis pyrifera*) off central California ranging from a low of 6.5 square kilometers to a high of 47 square kilometers (OST & CDFW 2013). The amount of giant kelp canopy along the central California coast, calculated from Landsat satellite images, shows that since 2009, kelp canopy has fluctuated within the range that is expected based a longer time series that started in 1984 (Figure NS Hab2) (P. Raimondi, PISCO/MARINe, unpubl. data). The abundance of two other important structure-forming groups in kelp forests, the understory kelp *Pterygophora californica* and erect red algae, also appears to be in good and stable condition based on long-term monitoring by the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) (Figure NS Hab3; M. Carr, PISCO, unpubl. data). Similar trends in the density of giant kelp and *Pterygophora* have been observed by Reef Check California (RCCA), a citizen science group composed of SCUBA divers that have been monitoring kelp forests at 17 sites in MBNMS since 2006 (Jan Freiwald, RCCA, unpubl. data).

Looking forward, some recent events could result in substantial changes in the abundance of nearshore structure-forming species. Starting in 2014, sea surface temperatures have been anomalously high all along the U.S. West Coast and some indicators suggest that the Pacific Decadal Oscillation started shifting from conditions promoting high primary productivity (observed in 2008-2013) to less productive conditions in 2014 (see response to Offshore Question 1 for more details). If these less productive conditions or anomalously high temperatures persist in the region, they could result in declines in abundance of canopy-forming kelp and understory algae. Abundance of kelp and understory algae also may be negatively impacted by the recently observed increase in abundance of red and purple sea urchins, which consume kelp and understory algae (see Figure NS LR11). This increase in sea urchins began in 2014 concurrent with a dramatic reduction in abundance of some sea star, such as the ochre star (Figure NS LR 10). Predation by ochre stars on mussels limits the mussels abundance in the lower intertidal zone. The absence of ochre star predation may allow mussel beds to expand their lower limit resulting in an increase their overall abundance at some location (S. Lonhart,

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Comment [N39]: Kudela: The kelp in some regions (Santa Barbara in particular) are more sensitive to the NPGO and NPO than the PDO. That is demonstrated in Cavanaugh et al 2011 (below) and was recently shown by a NASA summer student analyzing LANDSAT data…. Not sure if that would also be true for MBNMS but it may be worth analyzing.

Cavanaugh, K. C., Siegel, D. A., Reed, D. C., & Dennison, P. E. (2011). Environmental controls of giant-kelp biomass in the Santa Barbara Channel, California. Marine Ecology Progress Series, 429, 1-17.

Jenn – I looked through this paper, but didn't think it was necessary to add information from this paper focused on kelp forests in Southern California. They found regional heterogeneity in response of kelp to different factors (including NPGO and other factors). Understanding how this study related to kelp forests in MBNMS would require a similar study as the one noted above. We do not have the time or resources to do such a study.

MBNMS, pers. comm.). On-going monitoring efforts in the sanctuary, including PISCO, RCCA, and LiMPETS, will be key to tracking these potential changes in the status and condition of structure-forming species in nearshore habitats in the next few years.

Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)

PISCO is a long-term monitoring and research program designed to understand the dynamics of the coastal ocean ecosystem along the U.S. west coast. In 1999, PISCO began a large-scale, long-term study of the patterns of species diversity in rocky shore and kelp forest habitats and the physical and ecological processes responsible for structuring these communities. PISCO is led by scientists from core campuses: Oregon State University (OSU); Stanford University's Hopkins Marine Station; University of California, Santa Cruz (UCSC); and University of California, Santa Barbara (UCSB).

Reef Check California (RCCA)

Reef Check California (RCCA) is a network of trained volunteers who carry out surveys of nearshore reefs providing data on the status of key indicator species. The goal of the RCCA program is to support the sustainable use and conservation of our nearshore marine resources.

Long-term Monitoring Program and Experiential Training for Students (LiMPETS)

LiMPETS (Long-term Monitoring Program and Experiential Training for Students) is an environmental monitoring and education program for students, educators, and volunteer groups. This hands-on program was developed to monitor the coastal ecosystems of California's National Marine Sanctuaries to increase awareness and stewardship of these important areas. Two distinct monitoring programs make up the core of the network: the Rocky Intertidal Monitoring Program and the Sandy Beach Monitoring Program. Approximately 5,500 teachers and students are involved with the collection of data as part of the LiMPETS network.

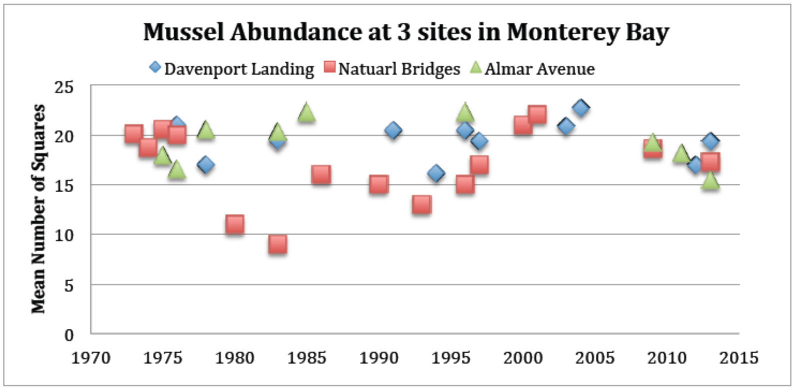


Figure NS Hab1

Caption: Estimates of abundance of mussels (*Mytilus californianus*) from counts made in quarter-meter-square quadrats randomly placed within plots on mussel-dominated mid-zone, intertidal platforms at Davenport Landing (blue diamond), Natural Bridges (red square) and Almar Avenue (green triangles).

Source: J. Pearse, LIMPETS, unpublished data

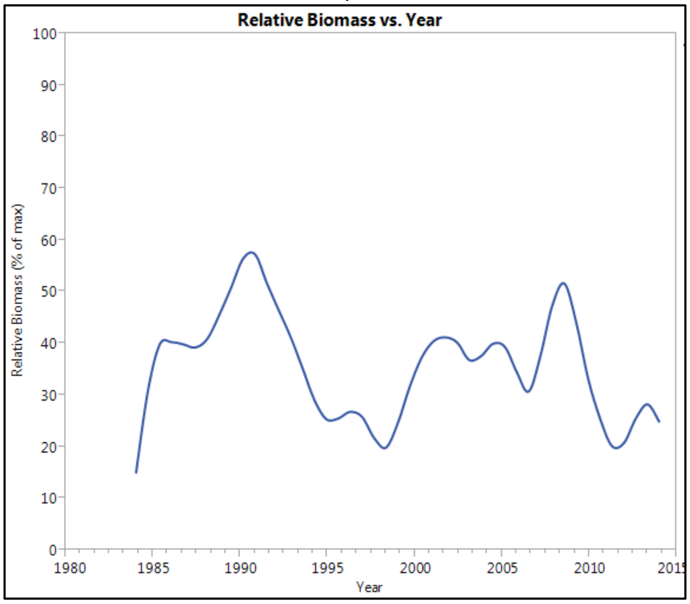


Figure NS Hab2

Caption: Relative abundance of giant kelp (*Macrocystis pyrifera*) canopy along the central California coast (from Pt. Año Nuevo to Pt. Conception) since 1984. Aerial extent of the kelp

canopy was calculated from Landsat satellite images and the mean annual relative biomass was calculated as a percentage of the maximum extent observed during the study period.
Source: P. Raimondi, PISCO/MARINe, unpublished data

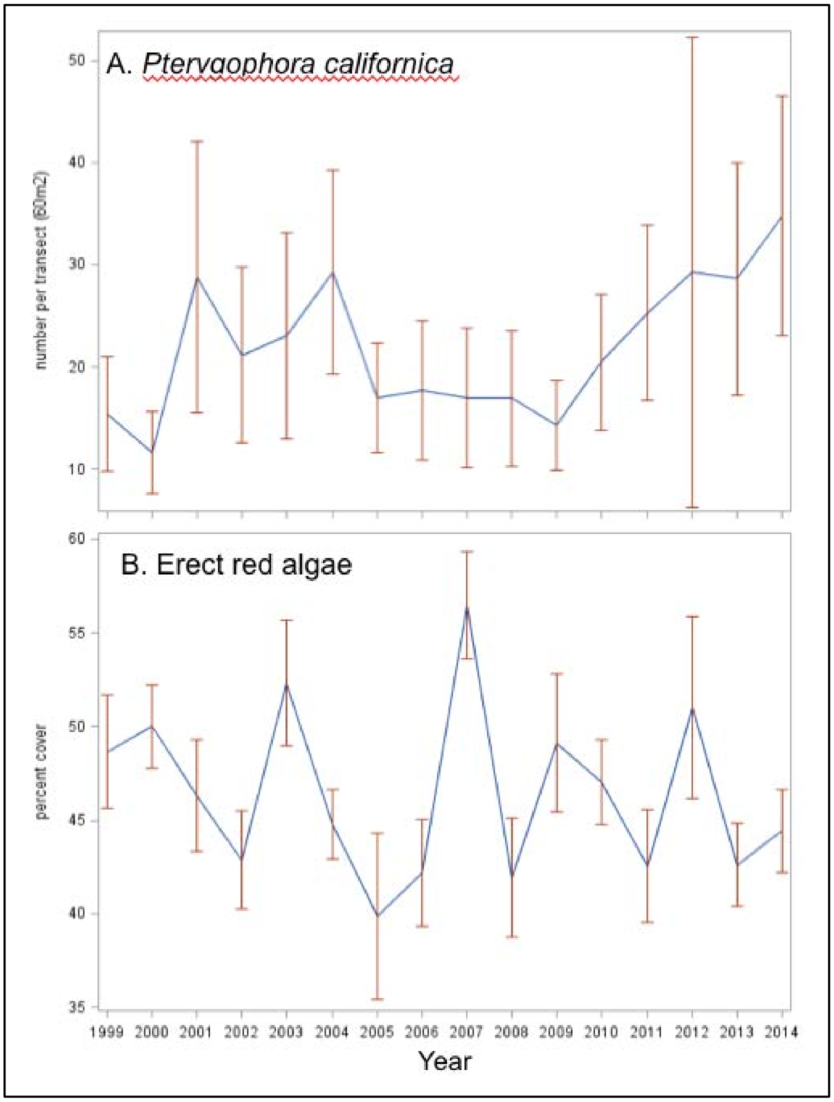


Figure NS Hab3
Caption: Mean annual abundance (and standard error) estimates of the understory kelp *Pterygophora californica* (top) and the erect red algae complex (bottom) from 12 long-term monitoring sites in kelp forest around Monterey and Pt. Lobos. At each site SCUBA divers swim

along transects recording the number of *Pterygophora* encountered and use point contact along a transect tape to calculate percent cover of erect red algae.
Source: M. Carr, PISCO, unpublished data

7. *What are the contaminant concentrations in sanctuary habitats and how are they changing?*

The condition of nearshore habitats was rated "fair" and "declining" in 2009 due to elevated contaminants at locations near urban, maritime, or agricultural activities and the continued input of contaminants into coastal waters from point and non-point sources (see 2009 report for specifics). The 2015 rating has been downgraded to "fair/poor" with a "declining" trend based on new contaminants being detected, contaminants exceeding regulatory objectives, and evidence that some contaminants are accumulating in sea otters, shellfish and resident fish that have caused or are likely to cause severe declines in some but not all living resources or water quality.

Throughout the Nearshore Environment Water Quality section we have given examples of land based contaminants detected in the water column, sediment, flora and fauna. While some of the contaminants that were a concern in 2009 have concentrations that are decreasing, such as dieldrin, DDT and PBDEs found in mussels at five sites around Monterey Bay (see Figure NS WQ5 and detailed discussion in response to Nearshore Question 3), other legacy POPs such as PCBs and PAHs remain in the water and sediment at levels of concern for marine organisms. A recent study found that sea otters from three sites in Monterey Bay (Santa Cruz, Elkhorn Slough, and Monterey) had mean POP levels 5-20 times higher than sea otters from locations in Alaska (Jessup et al. 2010). In particular, sea otters from Santa Cruz had high levels of both PCBs and DDT (see Offshore Question 7 for more information on PCBs in marine mammals).

New current use pesticides have been detected in the sanctuary in tissues of marine organisms. In a study by Smalling et al. (2013), current use pesticides (CUPs) and legacy pesticides (DDT) were studied to determine their presence in water, sediment, and tissues of sand crabs (*Emerita analoga*), starry flounder (*Platichthys stellatus*) and staghorn sculpin (*Leptocottus armatus*) in a coastal estuary. This was the first study to document the occurrence of CUPs in the tissue of marine organisms. Water samples were analyzed for a suite of 68 CUPs; 24 were detected including 6 fungicides, 8 herbicides, 5 insecticides, and 5 pesticide degradates. Sediment was analyzed for 34 fungicides and 57 CUPs; 22 were detected including 4 fungicides, 7 herbicides, 7 insecticides and 4 pesticide degradates. Fish and crab tissue samples were analyzed for 98 CUPs; 13 CUPs and DDT were detected in the fish tissue. Total DDT concentrations were an order of magnitude higher than individual CUPs in the fish tissue. Ten contaminants, including 3 fungicides, 4 insecticides and DDT, DDD and DDE were detected in the sand crab tissue. Many of the most frequently detected compounds in the fish and crab tissue were typically observed in the water and sediment samples with the exception of pyrethroids, which were present in both sediment and tissue but at non-correlated concentrations (Smalling et al. 2013).

As described in the response to Nearshore Question 2, microcystin toxicity has become a serious threat in the last five years. A 2010 study surveyed twenty-one freshwater, estuarine, and marine locations using Solid Phase Adsorption Toxin Tracking (SPATT) samplers (Kudela 2011) at the land-sea interface to determine the presence and concentration of microcystin. Fifteen of 21 sites were positive for microcystin toxin. These blooms have been common in freshwater systems throughout California, but it wasn't until recently that we now understand the widespread occurrence at low to moderate levels throughout the year in the marine environment. Coastal nutrient loadings were statistically significant predictors of the microcystin concentrations with clear evidence for seasonality at some sites (Gibble and Kudela 2014). As described in the nearshore Water Quality section above, microcystin was determined to have poisoned 11 southern sea otters in 2007.

8. What are the levels of human activities that may influence habitat quality and how are they changing

The level of human activities that influence habitat quality in the nearshore environment remains the same as the 2009 Condition Report and is rated "good/fair" because some human activities can have substantial, localized negative impacts on habitat quality. However, the trend was "undetermined" in 2009 due to a lack of information for many of the activities and uncertainty in how to combine the available information into a cumulative trend. Based new information since 2009, the status is changed to "fair" because some on-going activities have substantial, localized negative impacts on habitat quality (e.g., coastal armoring, coastal development, sand mining) and some activities (e.g., release of contaminants and marine debris) are more widespread, but there are efforts to reduce impacts (beach cleanups, management of contaminant sources).

The 2015 trend remains "undetermined" due to uncertainty in how to combine the available information into a cumulative trend. Some activities with negative impacts - sand mining, coastal armoring, dredging, and landslide disposal - are continuing at rates similar to the last assessment period (see Nearshore Question 5 for more details). Human visitation to the shoreline is increasing which could lead to increasing impacts to intertidal habitat. Contaminants and marine debris are present and likely accumulating, but at an unknown rate, and some activities are occurring to offset negative impacts (coastal cleanups, management of contaminant sources, implementation of best management practices).

Beaches and rocky shores that are easily accessed from roads and parking areas can receive a high level of human visitation, especially at sites near population centers. Visitors to the rocky intertidal zone may negatively impact the habitat by trampling animals or algae or by collecting structure-forming organisms and turning over rocks and boulders. Visitors to beaches may negatively impact habitat quality by littering or causing disturbance of critical habitat for sensitive species such as the Western Snowy Plover. In 2011, the Otter Project began training volunteers to survey human activities along the central California coast at beaches and accessible rocky shores in a citizen science program called "MPA Watch" (http://www.otterproject.org/what-we-do/programs/habitat/marine-protected-areas/). The types of activities they record include both extractive (hand collection, line-fishing) and non-extractive (tidepooling, wildlife watching, playing) activities. Based on the first four years of survey data, the average amount of shoreline activities observed during a survey increased from 2011 to 2013 and then remained similar between 2013 and 2014 (Figure NS Hab4). The increase in shoreline activity rates were observed at both beaches and rocky shores (J. Natov, Otter Project, unpubl. data).

A variety of land-based and water-based human activities result in the introduction of contaminants, including pesticides, microbial contaminants, and plastic debris, into the nearshore habitats of the sanctuary. Contaminants continue to enter the sanctuary due to human activities in the watersheds with agriculture and urban runoff being leading sources (see response to Nearshore Question 7 for detailed information). A recent study of the types of litter on beaches around the Monterey Bay found that small pieces of styrofoam (5 mm - 5 cm in size) and fragmented plastics (2 mm - 2 cm) were the two most common types of litter (Rosevelt et al. 2013). Both types of items are persistent in the environment and are a hazard for animals foraging in nearshore habitats (Arthur et al. 2009, Donnelly-Greenane et al. 2014, Nevins et al. 2014, NOAA-MDP 2014). Deposition of styrofoam, fertilizer pellets, and fragmented plastics was highest in winter and in central bay locations especially after storm events, which may indicate transport of debris by rivers. The fertilizer pellet casings are the remains of time-release fertilizer applications on land uses such as agriculture or nurseries.

Since 2007, Save Our Shores (SOS) a non-profit marine conservation organization in Santa Cruz, has led 1,886 beach and river cleanups in Santa Cruz and Monterey counties. Currently, they host monthly cleanups at 53 beaches on Monterey Bay and less frequent cleanups on the San Lorenzo River, Elkhorn Slough and several other creeks in Santa Cruz County. Despite these frequent cleanup efforts, trash continues to be found and removed from both beaches and rivers. Volunteers at beaches are collecting smaller loads of trash per hour than volunteers in rivers (Figure NS Hab5), which may be due to volunteers at the less frequent river cleanups encountering more and larger trash. It appears that more clean-up effort in the rivers could substantially reduce inputs of trash to the sanctuary from the watersheds (B. Patterson, SOS, unpubl. data). The number of plastic grocery bags found per hour during cleanups has declined every year since 2008 while the number of other types of plastic bags has not declined over the period in which data was collected (Figure NS Hab5). The decline in number of single-use plastic grocery bags found may be due in part to the banning of plastic grocery bags in local communities, including Santa Cruz (2011) and Monterey (2014) counties.

These pressures to sanctuary habitats are likely to increase with continued coastal development and population growth. Management programs at the local, regional, and state level attempt to reduce impacts, but it is unknown whether these programs will be able to offset the increasing pressure of development and population growth on sanctuary habitats. One human activity that has the potential to increase substantially over the next few years, especially given the severe drought in California, is desalination (http://montereybay.noaa.gov/resourcepro/resmanissues/desalination.html). There are a variety of concerns associated with desalination facilities, including additional coastal development, significant volumes of greenhouse gas emissions from the energy intensive desalination process, and construction of new pipelines that can disturb the seafloor, surf zone and dunes, and have the potential to change coastal hydrology (NOAA 2010). As of early 2015, there are multiple desalination facilities being considered within the sanctuary, with all but one located within Monterey Bay. The first new project completed a test well in March 2015 to study effectiveness of a sub-surface well intake to minimize negative impacts on sanctuary resources.

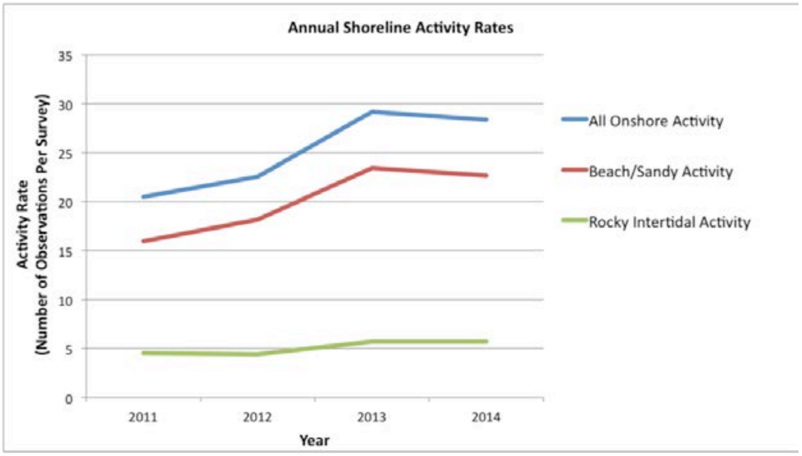


Figure NS Hab4
Caption: Average number of people engaged in shoreline-based activity during multiple surveys each month by MPA Watch Volunteers at ten sites in central California from March 2011 through mid-2014. Activities levels are shown for all shoreline activity (blue) as well as the proportion engaged in activities on beaches (red) versus rocky shores (green). In all cases, the general level of human activity at these shoreline sites has increased over the study period.
Source: MPA Watch, unpublished data

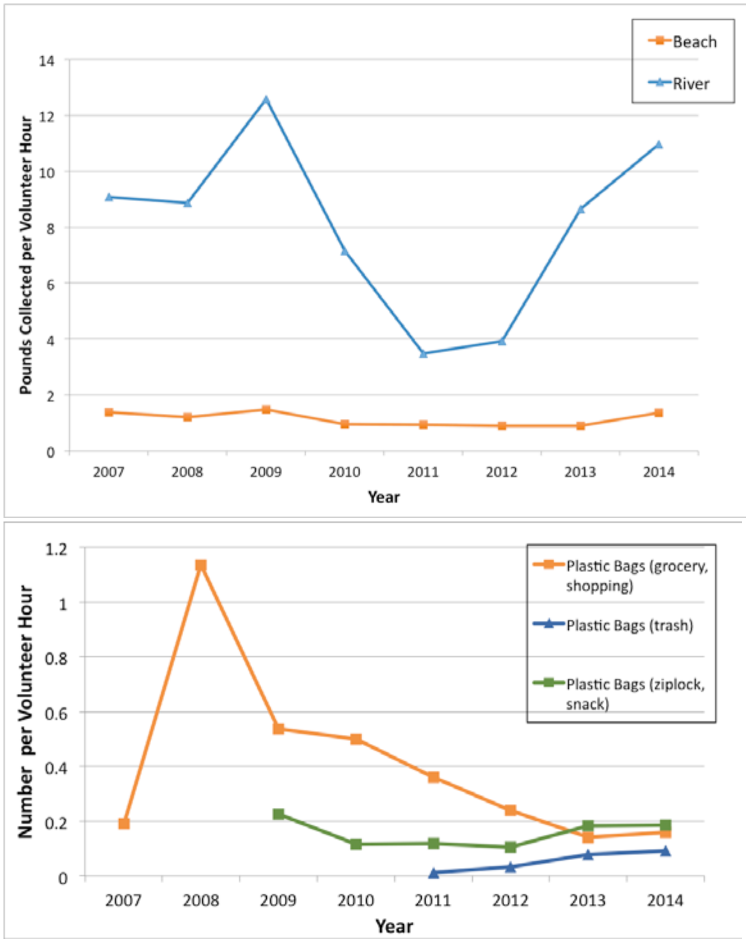


Figure NS Hab5

Caption: (Top) Average pounds of trash collected per hour by volunteers at cleanup events at beaches (orange) and rivers (blue) in Santa Cruz and Monterey counties since 2007. (Bottom) Number of plastic grocery (orange), plastic trash (blue) and plastic snack/ziplock (green) bags collected per hour by volunteers.

Source: Save our Shores, unpublished data

Nearshore Environment Habitat Status & Trends

Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

▲ = Improving — = Not changing ▼ = Declining
? = Undetermined trend **N/A** = Question not applicable

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
5	Abundance/ Distribution	▼	Status: Very High Trend: Very High	Localized modification of coastal habitat and reduced habitat quality, primarily through armoring, erosion, landslide, and accumulation of marine debris and contaminants.	Selected habitat loss or alteration has taken place, precluding full development of living resource assemblages, but it is unlikely to cause substantial or persistent degradation in living resources or water quality.
6	Biologically-Structured	■	Status: Very High Trend: Very High	Monitoring programs indicate healthy populations and no major perturbations.	Habitats are in pristine or near-pristine condition and are unlikely to preclude full community development.
7	Contaminants	▼	Status: High Trend: High	Declines in some persistent contaminants (dieldrin), but new contaminants being added to the system; some evidence showing contaminants are accumulating in shellfish and resident fish and are impacting health of living resources (e.g., mammals)	Selected contaminants have caused or are likely to cause severe declines in some but not all living resources or water quality.
8	Human Impacts	?	Status: Medium Trend: Medium	Trampling, visitation, and coastal armoring can have measurable, localized impacts; trash and contaminants present and accumulating slowly despite management efforts.	Some potentially harmful activities exist, but they do not appear to have had a negative effect on habitat quality.

Questions that have new information to report since the 2009 Monterey Bay National Marine Sanctuary Report (ONMS 2009) are those with red numbers.

Nearshore Environment: Living Resources

Biodiversity is variation of life at all levels of biological organization, and commonly encompasses diversity within a species (genetic diversity) and among species (species diversity), and comparative diversity among ecosystems (ecosystem diversity). Biodiversity can be measured in many ways. The simplest measure is to count the number of species found in a certain area at a specified time. This is termed species richness. Other indices of biodiversity couple species richness with a relative abundance to provide a measure of evenness and heterogeneity. When discussing "biodiversity" we primarily refer to species richness and diversity indices that include relative abundance of different species and taxonomic groups. To our knowledge no species have become extinct within the sanctuary, so native species richness remains unchanged since sanctuary designation in 1992. Researchers have described previously unknown species (i.e., new to science) in deeper waters, but these species existed within the sanctuary prior to their discovery. The number of non-indigenous species has increased within the sanctuary. We do not include non-indigenous species in our estimates of native biodiversity.

Key species, such as keystone species, indicators species, sensitive species and those targeted for special protection, are discussed in the responses to questions 12 and 13. Status of key species will be addressed in question 12 and refers primarily to population numbers. Condition or health of key species will be addressed in question 13. Key species in the sanctuary are numerous and all cannot be covered here. Emphasis is placed on examples from various primary habitats of the sanctuary for which some data on status or condition are available.

The following information provides an assessment of the status and trends since 2009 pertaining to the current state of the sanctuary's living resources in the nearshore environment based on studies of faunal communities in the sandy and rocky intertidal and the sandy and rocky subtidal. Much more research occurs in rocky intertidal and subtidal rocky reef and kelp forest so the assessments are based mostly on that status of living resources in these two habitats. More research and long-term monitoring is needed on the status and trends of faunal communities associated with beaches and sandy seafloor habitats.

9. What is the status of biodiversity and how is it changing?

Native species richness in the nearshore habitats of the sanctuary has been unchanged over the last few decades with no known local extinctions of native species. However, the relative abundance of native species in the intertidal and nearshore subtidal zones has been altered throughout the sanctuary by a variety of factors including human activities, such as trampling and harvest. The recent implementation of many marine reserves and conservation areas in California's state waters may facilitate recovery of reduced populations in those locations. Based on these patterns, the status of native biodiversity in the nearshore environment of the sanctuary was rated "fair" in 2009, but the overall trend in biodiversity in nearshore habitats was "undetermined."

On-going monitoring in rocky intertidal and subtidal reef habitats provides new information to further characterize patterns in community composition in nearshore habitats and examine trends in abundance of key species and assemblages. We are only aware of one substantial change to nearshore biodiversity - a recent dramatic decline in sea stars and concurrent increase in sea urchins (see response to Nearshore Questions 12 and 13 for details). This change occurred very recently and more time is needed to determine if this change in biodiversity will persist and 'cause or be likely to cause severe declines in other ecosystem components' (which would be consistent with a 'fair/poor' rating). Therefore, the status for 2015 remains "fair" . The trend is "not changing" due to the apparent stability of most components of the rocky shore and kelp forest assemblages.

The sanctuary's rocky intertidal community is biologically rich, with 567 native species documented based on surveys of the more conspicuous species (Wasson et al. 2005). Analysis of the long-term monitoring data from 26 sites in the rocky intertidal of central California by the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) and Multi-Agency Rocky Intertidal Network (MARINe), identified six distinct communities that can be differentiated based on the percent of the available space occupied by certain types of invertebrates, marine plants and algae, and the physical substrate (Figure NS LR1; summarized in OST & CDFW 2013). These patterns of relative abundance and diversity of species in the rocky intertidal appear to be strongly influenced by physical features including swell and wave exposure, rock roughness, substrate slope, and water temperature. For example, sites with Communities 3 and 4 experience higher swell and wave exposure than sites with Communities 1, 2, 5, and 6 (OST & CDFW 2013). Though Community 6 was not observed inside Monterey Bay sanctuary, it may occur in the sanctuary at sites with similar physical attributes. Relative abundance and diversity at a given location also can be influenced by the level of human activities, such as harvest or trampling, at that site. However, specific information on trends in biodiversity and the relative importance of changes in physical factors and human use patterns are not currently available.

A similar analysis of long-term monitoring data collected by PISCO from 25 kelp forests in central California, identified six distinct communities that can be differentiated based on relative density of canopy and understory kelps and certain species of invertebrates and fishes (Figure NS LR 2; summarized in OST & CDFW 2013). The black boxes surround the species that were identified as important for distinguishing among the communities. The type and relief of the substrate was found to strongly influence abundance and diversity of kelp forest communities. For example, Community A was found in areas dominated by bedrock with flat relief, Community C was associated with habitats with more moderate and high relief than the others, and Community E was found in habitats with the most boulder and cobble substrates (OST & CDFW 2013). Though Community E was not observed inside Monterey Bay sanctuary, it may occur in the sanctuary at sites with similar physical attributes. Additional analysis by PISCO of their long-term monitoring data for kelp forest fishes provides some information on trends in diversity of nearshore fish assemblage (Figure NS LR3). Mean species richness and diversity (Shannon Diversity Index) of the kelp forest fish assemblage at multiple sites in the sanctuary varies quite a bit over time, but appears to be fairly stable over the time series available (1999-2014).

Comment [N40]: Field: The text on page 67 that corresponds with Figure NS LR3, the sharp drop in Shannon diversity index in 2013 is striking, if the contributors have a short, simple explanation (e.g., hyperabundance of one species or another that year) it might be helpful to readers. Aside from that, I seat least very general patterns associated with patterns in upwelling and productivity (cool, productive vs. warm/unproductive) in the data, which is interesting.

Jenn – asked PISOC (Mark Carr and Dane Malone) for some explanatory text but received no response.

Less is known about biodiversity patterns in the sandy bottom habitats of the sanctuary. Some observed changes in biodiversity in the soft bottom habitats of the nearshore environment are likely in response to large-scale, long-term climatic shifts (e.g., Pacific Decadal Oscillation), but data detecting this pattern are limited to a small area (MLML 2006). Additional long-term monitoring data would be useful to further explore status and trends in this faunal community.

As is discussed above, patterns in biodiversity in rocky shore and kelp forest communities are strongly influenced by physical factors. Changes in physical factors, driven by global climate change, will influence patterns of biodiversity in the sanctuary. Warming of air temperature should lead to ocean warming which will lead to changes in species distribution along the north-south coastline of in the Monterey Bay sanctuary. A subset of the species that occur in the sanctuary are ‘southern’ species whose range extends only into the southern or central portions of Monterey Bay sanctuary. Some other species are ‘northern’ species whose range only extends into the northern or central portions of the sanctuary. As ocean temperatures warm, we would expect to see the range of some southern species expand northward while the range of some northern species contracts. Sagarin et al. (1999) found some evidence that the ranges of some southern species were expanding northward along the California coast. We are not aware of any new examples of range expansions and contractions of nearshore species in the sanctuary due to climate warming, but we expect this to be a driver of change in nearshore biodiversity in the future.

Multi-Agency Rocky Intertidal Network (MARINe)
The Multi-Agency Rocky Intertidal Network (MARINe) is a partnership of agencies, universities and private groups committed to determining the health of the rocky intertidal habitat along the west coast of North America and providing this information to the public. MARINe monitors over 100 coastal sites and many of the sites have been monitored by for periods of 15 to over 25 years. MARINe represents the largest program of its kind. http://www.marine.gov/index.htm

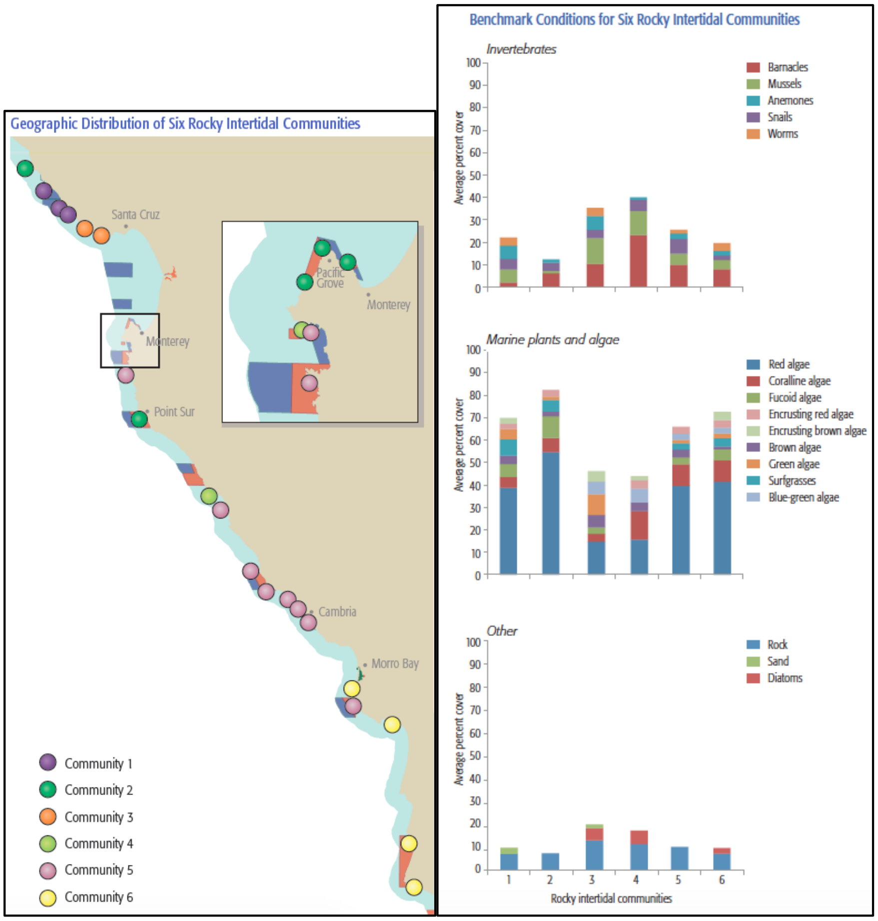


Figure NS LR1

Caption: Analysis of long-term monitoring data from 26 sites in the rocky intertidal in central California, identified six distinct communities (left panel) that can be differentiated based on the percent of the available space occupied by invertebrates, marine plants and algae, and the physical substrate (right panel). Species included in the graphs (right) are those that characterize the community groups (i.e., have the highest density), rather than those that distinguish among the community groups. Physical features, such as swell and wave exposure, rock roughness, substrate slope, and water temperature, are found to influence the abundance and diversity of species in the rocky intertidal.

Data: PISCO/MARINe/UCSC. Figures from OST & CDFW 2013

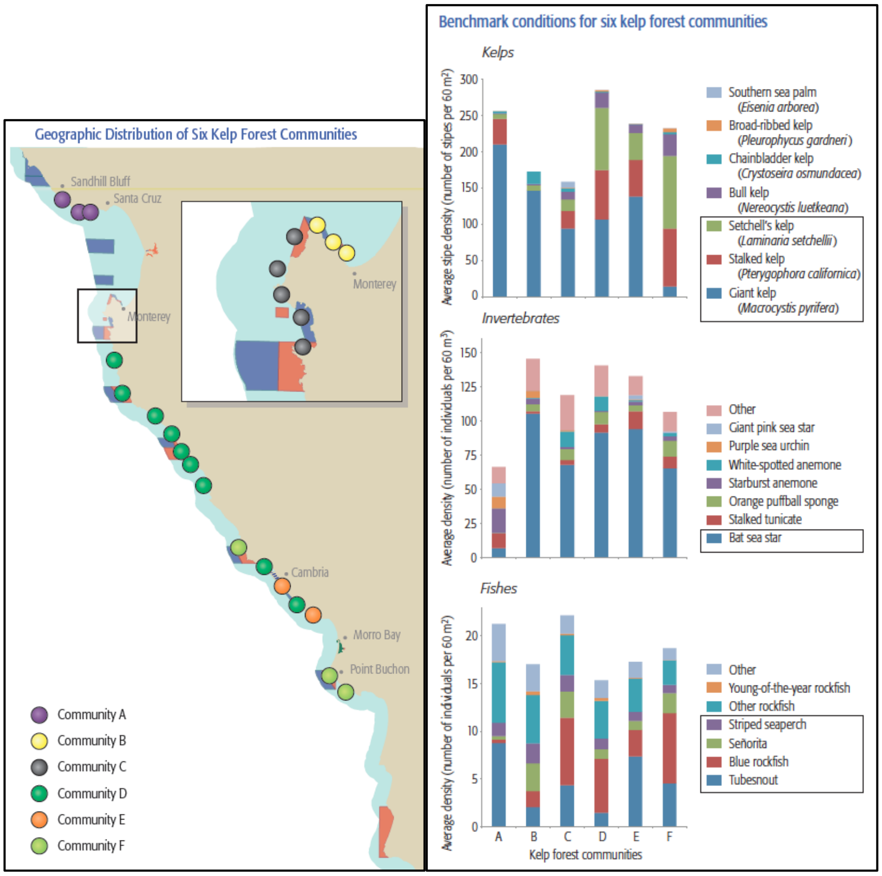
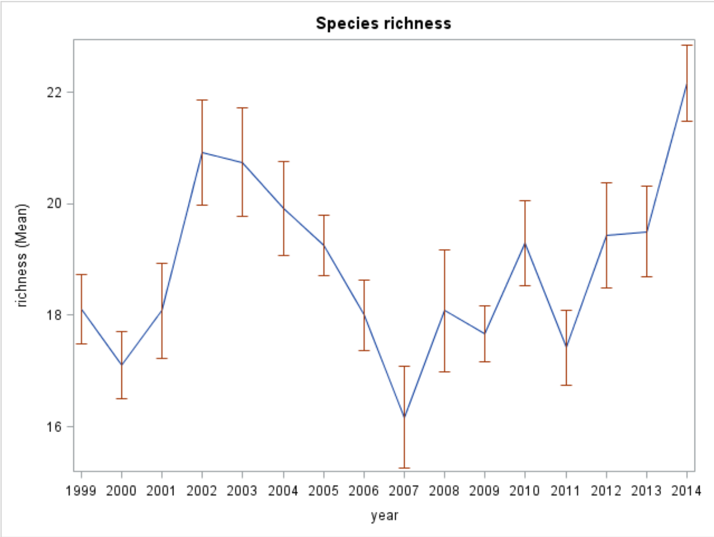


Figure NS LR2

Caption: Analysis of long-term monitoring data from 25 sites in the kelp forests along the central California coast, identified six distinct communities (left panel) that can be differentiated based on the relative density of Canopy and understory kelps, invertebrates, and fishes. All species included in the graphs (right) are those that characterize the communities. The black boxes surround the species that were identified through the clustering analyses to distinguish among the communities. Physical features, such rock type and relief, were found to have a strong influence on abundance and diversity of kelp forest communities.

Data: PISCO/UCSC. Figures from OST & CDFW 2013



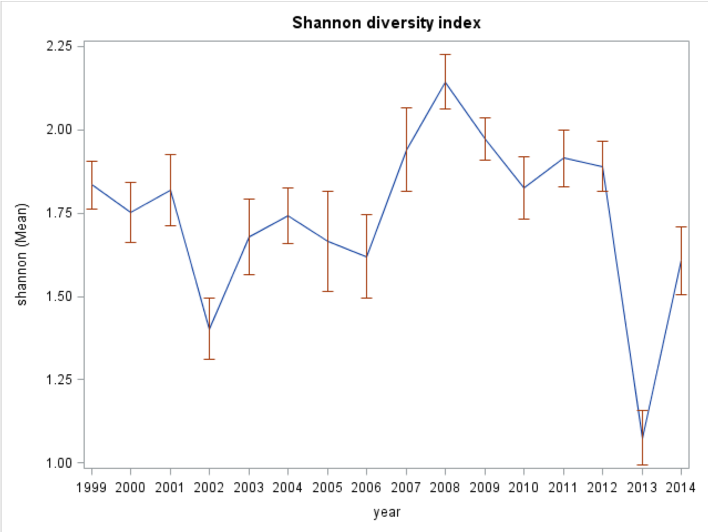


Figure NS LR3

Caption: Mean species richness (number of species) and diversity (Shannon Diversity Index) of the kelp forest fish assemblage was calculated using long-term monitoring data of abundance of all non-cryptic fish species along transects at multiple sites in the sanctuary. The Shannon Diversity Index (H') takes into account the number of species (species richness) and the relative abundance of those species (evenness). The value of H' increases both when the number of

types increases and when evenness increases, and is maximized when all species are equally abundant. Red bars = standard error.
Source: PISCO, unpublished data

10. What is the status of environmentally sustainable fishing and how is it changing?

We are no longer assessing this Question in ONMS Condition Reports so content for this question was not updated.

11. What is the status of non-indigenous species and how is it changing?

In the 2009 report, the status of non-indigenous species (NIS) was rated "good" with a "declining" because some NIS had been identified in the nearshore habitat of the sanctuary and a few of those species appeared to be spreading. Surveys in sandy and rocky intertidal and sandy and rocky subtidal had detected NIS in all habitats types, but the percentage of NIS was low (1-2%; Wasson et al. 2005, Maloney et al. 2006). The 2015 status remains "good" with a "declining" trend because new information on NIS in nearshore habitats of the sanctuary is consistent with the basis for judgment from 2009.

NIS (e.g., *Caulacanthus ustulatus, Endocladia muricata*. *Sargassum muticum, Colpomenia* spp. *Hymeniacidon*, *Sargassum muticum)* continue to be observed at low abundance levels by monitoring programs in the nearshore habitats of the sanctuary and we are not aware of evidence of strong ecological impacts from these species (P. Raimondi, PISCO/MARINe, pers. comm.; Zabin et al. unpubl. data; http://www.sanctuarysimon.org/projects/project_info.php?projectID=100419&site=true). Recent surveys in Moss Landing and Monterey Harbors by California's Marine Invasive Species Program found that the percentage of NIS was low (<2%; CDFW 2014), which is consistent with the past studies noted above. One species of concern, the Asian kelp *Undaria pinnatifida*, continues to be abundant in Monterey Harbor, but has not spread outside the harbor (S. Lonhart, MBNMS, pers. comm.; http://www.sanctuarysimon.org/projects/project_info.php?projectID=100184&site=true). A second species of concern, the Japanese bryozoan *Watersipora subtorquata,* shows patterns of slowly spreading away from Monterey Harbor along the rocky intertidal and subtidal habitats of the Monterey peninsula (http://www.sanctuarysimon.org/projects/project_info.php?projectID=100419&site=true).

In 2009, we reported that surveys had documented the spread of *Watersipora* from Monterey Harbor to the open coast at the Hopkins Marine Life Refuge. (S. Lonhart, MBNMS, unpubl. data). Surveys in October 2014, recorded *Watersipora* from four subtidal sites (Breakwater Cove, McAbee Beach, Hopkins Marine Station, and Lovers Point) and from three intertidal sites (Breakwater Cove, McAbee Beach, and Hopkins Marine Station) along the Monterey peninsula, but was not found at the sites furthest away from the harbor on the peninsula (Coral Street) or in Carmel Bay. The colonies observed were typically small, representing between 0.1-2.5% cover across study transects, but were widely distributed within transects in some locations (i.e., found

in 23% of quadrats at Breakwater Cove and 10% of quadrats at McAbee Beach). The bryozoan was attached to a wide variety of substrates, including rock, barnacles, algae and crabs. It was found on both horizontal and vertical surfaces subtidally, but appears to be limited to vertical surfaces in the intertidal zone.
(http://www.sanctuarysimon.org/projects/project_info.php?projectID=100419&site=true)

12. What is the status of key species and how is it changing?

The status of key species in the nearshore environment was rated "good/fair" and the trend was "not changing" in 2009 because of the reduced abundance of a limited number of key species in each habitat type. Although monitoring data indicates that many key species are stable or increasing, the 2015 status is changed to "fair" and "declining" because of the recent, significant changes in the abundance of sea stars and sea urchins. Both sea stars and sea urchins can influence ecological structure and function of rocky reef and kelp forest habitats, and this dramatic change in their relative abundance will likely have measurable impacts to ecosystem integrity in the nearshore environment.

Below we briefly provide updated information on the status of a number of key species that play important ecological roles in the nearshore ecosystem.

Key species in the rocky intertidal include black abalone, owl limpets, surf grass, mussels, algae, and Black Oystercatchers. In the response to Nearshore Question 6, we reported that the status of the habitat-forming species (e.g., mussels, surf grass, algae) is generally good and stable sanctuary-wide, but show reduced abundance at some sites because of high levels of human impacts (trampling, harvest) (PISCO/MARINe, unpublished monitoring data). As was reported in 2009, black abalone populations are severely reduced in abundance in the southern portion of the sanctuary due to disease (i.e., withering syndrome) and in the rest of the sanctuary due to over-harvesting and predation, but disease is not prevalent (ONMS 2009). Since 2009, abundance has not changed substantially at any sites in the sanctuary (P. Raimondi, PISCO/MARINe, pers. comm.)

The California population of Black Oystercatcher (*Haematopus bachmani)* was assessed for the first time in 2011 during the early breeding season when observers surveyed approximately 18% of the state's mainland suitable habitat (Weinstein et. al. 2014). Density of individuals in mainland survey areas averaged 3.14 birds/km, but were quite variable across survey sites with high densities observed at some locations in Monterey Bay sanctuary (Figure NS LR 4). Analysis of Audubon's Christmas Bird Count (CBC) data suggests that the California population has been increasing slightly in recent years (2007–2011) (Weinstein et al. 2014**)**.

The kelp forest community is monitored at many sites in the Monterey Bay sanctuary by PISCO, Reef Check California (RCCA), and sanctuary staff. In the response to Nearshore Question 6, we reported that the status of some key structure-forming species (e.g., canopy-forming kelp and understory algae) is generally good and stable sanctuary-wide. Another key kelp forest species, the red abalone *Haliotis rufescens,* appears to be increasing in abundance (Jan Freiwald, RCCA, unpubl. data). Since 2007, when RCCA began monitoring red abalone density at 16 sites in the sanctuary, average density has slowly increased from 0.2 to 1.3 abalone per transect (60 m^2) (Figure NS LR5).

Rockfishes, cabezon, lingcod, kelp greenling and surfperches are important residents on nearshore subtidal reefs. Recreational and commercial harvest of these targeted species has reduced the overall abundance of these fish stocks compared to unfished levels (to varying extents depending on the species). Some nearshore fish stocks that were previously overfished, such as canary rockfish, bocaccio, and lingcod, are rebuilding or fully recovered (P. Reilly, CDFW, pers. comm.; Wallace and Cope 2013; Field 2014). Monitoring by both PISCO and RCCA at multiple sites in the sanctuary indicates that generally fish populations appear to have stable or increasing trends in abundance (for example see Figure NS LR6; PISCO, unpubl. data). In addition, strong recruitment of young-of-the-year rockfish has been observed in kelp forests in the sanctuary in both 2013 and 2014 (Figure NS LR7).

Sea otters are considered a keystone species of the kelp forest ecosystem because they are highly effective predators that are capable of limiting herbivorous invertebrate (e.g., sea urchins) populations, that if otherwise left unchecked, can decimate kelp beds and the associated community of fish and invertebrates. Since the 1980s, USGS scientists have calculated a population index each year for the southern sea otter (*Enhydra lutris nereis).* In 2014, the population index is 2,944, which continues the gradual increase that has been observed since 2010 (Figure NS LR8). The population of sea otters in the sanctuary is composed of three regions with different demographic patterns; the north coast region (extending from Santa Cruz northward) stable or slowly growing, with further growth and range expansion limited primarily by deaths attributable to non-consumptive shark bites, which have increased sharply in the last 5 years; the Monterey Bay region (Santa Cruz to Monterey, but excluding Elkhorn Slough) is growing slowly because it is comprised of mostly non-reproducing individuals (transient males and subadult females) and has higher rates of mortality due to water quality issues, and more recently by increased rate of shark bites; and the central coast region (extending from Monterey southward to Cambria) has shown variable growth rates from year to year, but over the last decade has been more or less stable because it is at or near carrying capacity; in the last 5-10 years there has also been a significant increase in shark bite mortality near Cambria (T. Tinker, USGS-WERC, pers. comm.). Although the demographics in these three regions are quite different, the population trend of otters in all three regions is stable or weakly positive (Figure NS LR8).

A major concern for status of key species in both rocky intertidal and subtidal habitats is the drastic decline of sea star populations along the Northeast Pacific coast due to an extensive outbreak of sea star wasting syndrome. Similar die-offs have occurred in the past, but never before at this magnitude and over such a wide geographic area (http://www.eeb.ucsc.edu/pacificrockyintertidal/data-products/sea-star-wasting/). Twenty affected species have been documented, including the ochre star *Pisaster ochraceus* (Figure NS L9), the giant star *Pisaster giganteus* and the sunflower star *Pycnopodia helianthoides* (Figure NS LR 10). Ochre and sunflower stars are considered to be keystone species in the nearshore environment because they have a disproportionately large influence on other species in their ecosystem. Declines in sea star populations in nearshore habitats may lead to changes in biodiversity at affected sites, for example through release of prey species that are commonly eaten by sea stars. However, it is too soon to understand the severity or persistence of any such changes. Substantial recruitment of baby sea stars has been observed in a few areas severely affected by wasting disease (http://www.eeb.ucsc.edu/pacificrockyintertidal/data-products/sea-star-wasting/index.html). This could indicate that replenishment of affected populations will be more rapid than expected. However, for recovery to occur the new sea stars must be relatively unaffected by wasting disease and they must arrive at many of the locations that have been affected by wasting disease (http://www.eeb.ucsc.edu/pacificrockyintertidal/data-products/sea-star-wasting/index.html). This is and will continue to be a topic of intense study along the west coast and the ecological implications will be better understood in a few years.

A second concern for the status of key species is the recent dramatic increase in the observed abundance of sea urchins in kelp forests. RCCA divers have observed a dramatic increase in the number of purple sea urchins (*Strongylocentrotus purpuratus)* and red sea urchins *(Mesocentrotus franciscanus)* that are visible during SCUBA surveys (Figure NS LR 11). It is unlikely that their abundance in the kelp forest system has increased this quickly, but instead that sea urchins have emerged from hiding in cracks and crevices in the reef now that one of their predators, the sunflower star, is absent or at very low abundance. Sea urchins consume canopy-forming kelp and understory algae and are capable of quickly removing most fleshy algal biomass from a site (Estes and Palmisano 1974). The ecological impacts of this recent change in sea urchin abundance and behavior could be substantial in kelp forest habitats, but will require more time and monitoring to understand.

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Very little monitoring occurs for key species in beach and sandy seafloor habitats. The exception is the Western Snowy Plover for which monitoring is required due to its status as a threatened species under the Endangered Species Act. The estimated number of nesting birds observed each year from 2010 to 2014 ranged from 382 to 431 which significantly exceeded the target of 338 breeders recommended for the Monterey Bay area in the USFWS Recovery Plan (Page et al. 2015). While the number of nesting snowy plovers in the Monterey Bay area is currently meeting the USFWS Recovery Goal target, predator pressure is increasing in frequency and magnitude and continues to be one of the greatest management challenges. The status of snowy plovers in the Monterey Bay region is good but “management reliant” (C. Esyter, Point Blue Conservation Science, pers. comm.).

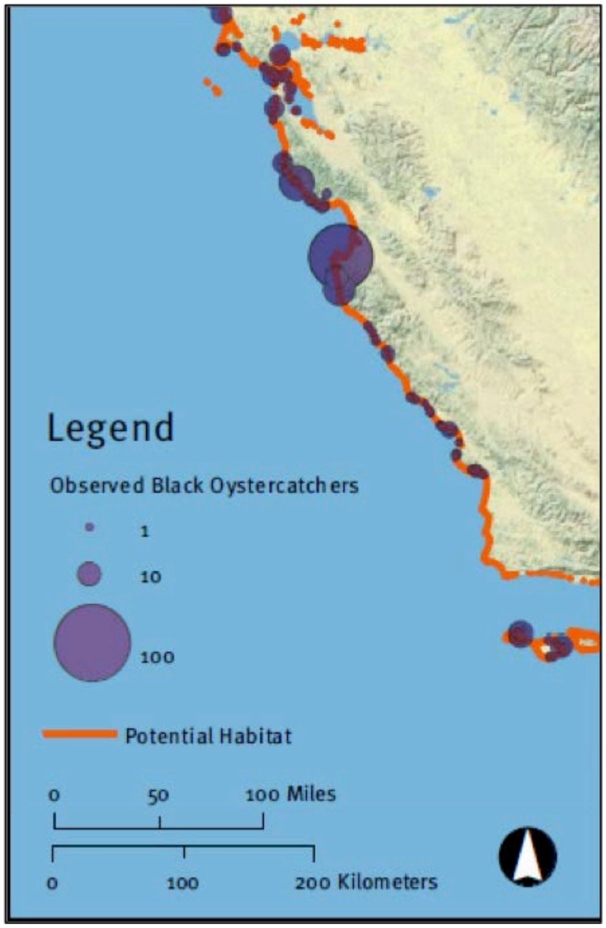

Figure NS LR4
Caption: Distribution of Black Oystercatchers (*Haematopus bachmani)* observed during a state-wide population assessment in 2011 in the early breeding season. Number of birds observed at a location reflected in the size of the purple circle on the map. Observers surveyed approximately 9% of the mainland California coast, equaling approximately 18% of the state's mainland suitable habitat. The Black Oystercatcher is a special status species because of a small global population size, low overall reproductive success and complete dependence on rocky intertidal shorelines, which are easily disturbed by humans and vulnerable to rising sea level.
Source: Weinstein et al. 2014

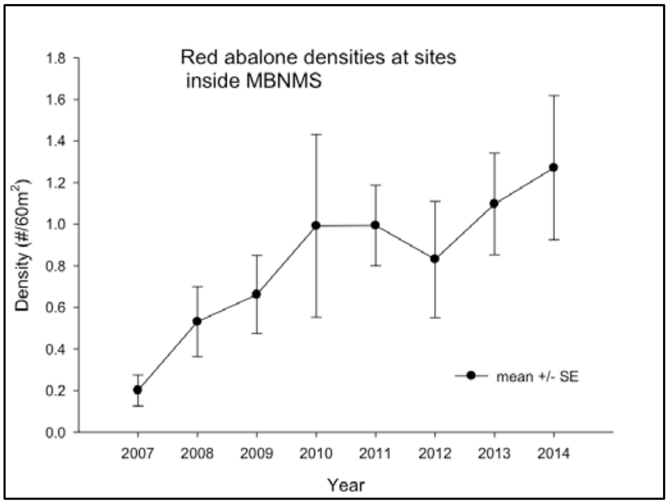

Figure NS LR5

Caption: Annual mean density (and standard error) estimates for red abalone *Haliotis rufescens* from 16 long-term monitoring sites in Monterey Bay National Marine Sanctuary (MBNMS). Since 2007, average density has slowly increased from 0.2 to 1.3 abalone per transect (60 m^2).

Source: Reef Check California monitoring data

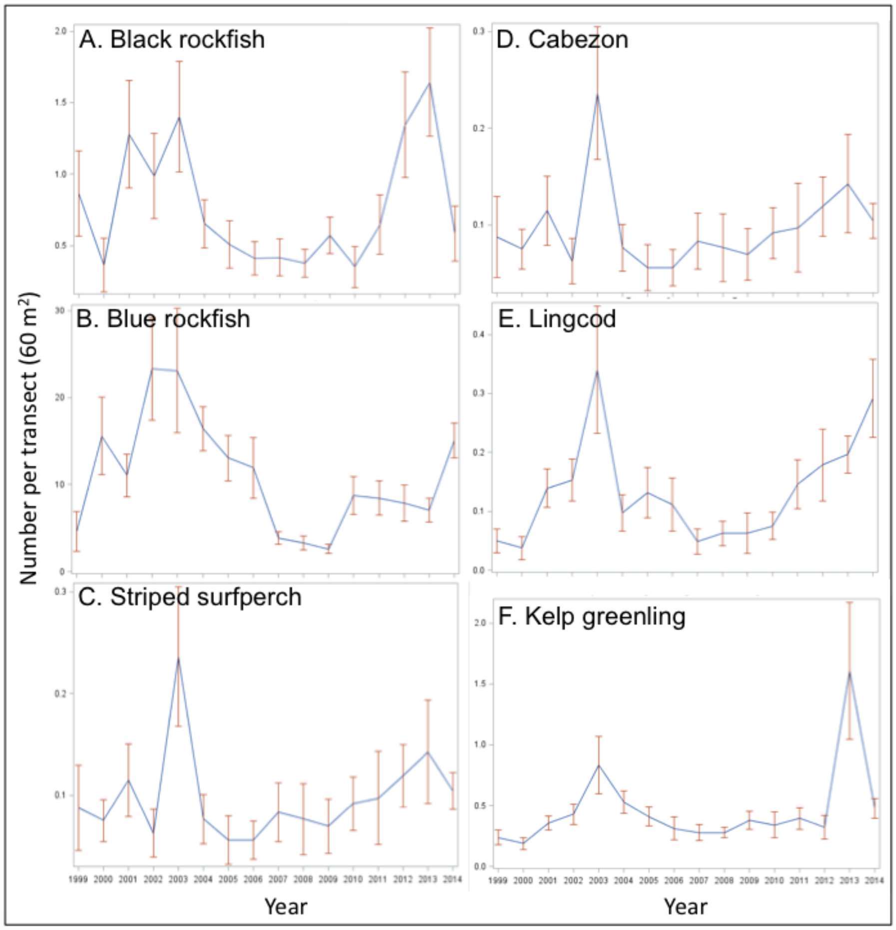

Figure NS LR6

Caption: Annual mean abundance (and standard error) estimates from 12 long-term monitoring sites around Monterey and Pt. Lobos for six species of kelp forest fish: (A) black rockfish *Sebastes melanops*, (B) blue rockfish *S. mystinus*, (C) striped surfperch *Embiotoca lateralis*, (D) cabezon *Scorpaenichthys marmoratus*, (E) lingcod *Ophiodon elongatus*, and (F) kelp greenling *Hexagrammos decagrammus.* Fish are measured by counting the number of fish observed as SCUBA divers swim along a transect.

Source: PISCO monitoring data

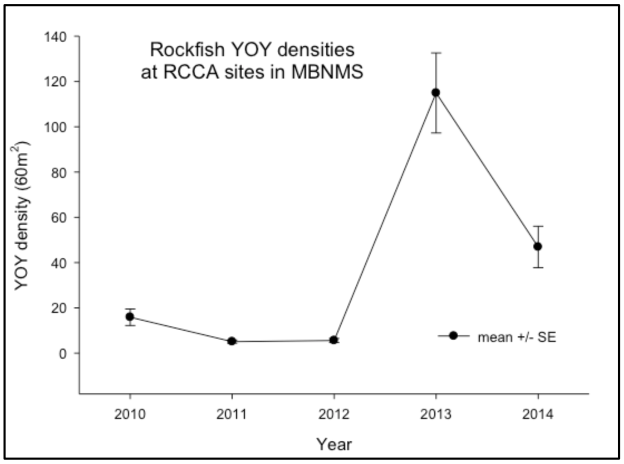

Figure NS LR7
Caption: Annual mean density (and standard error) estimates for young-of-the-year (YOY) rockfish from 16 long-term monitoring sites in Monterey Bay National Marine Sanctuary (MBNMS). Number of YOY are counted as SCUBA divers swim along a transect.
Source: Reef Check California monitoring data

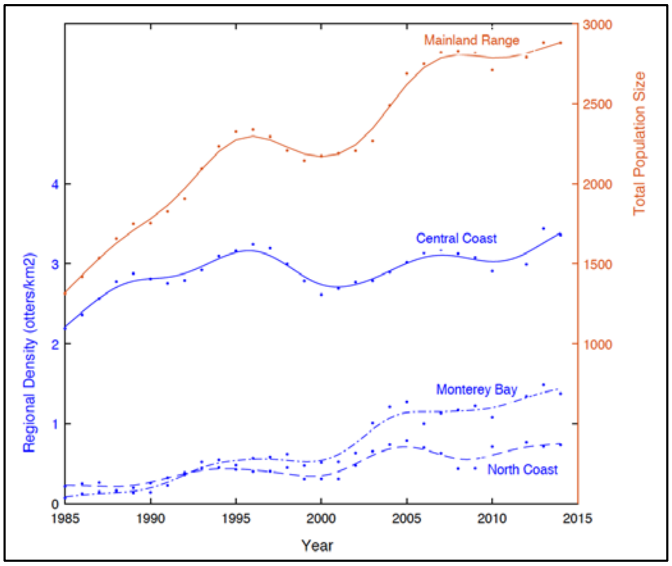

Figure NS LR8
Caption: Since the 1980s, USGS scientists have calculated a population index each year for the mainland range of the southern sea otter *Enhydra lutris nereis.* In 2014, the population index is 2,944, which continues the gradual increase that has been seen since 2010 (red line). The

population of sea otters in the sanctuary can be divided into three regions with different demographic patterns: the north coast region extending from Santa Cruz northward (dashed blue line); the Monterey Bay region extending Santa Cruz to Monterey (dash-dot blue line); and the central coast region extending from Monterey southward to Cambria (solid blue line). Although the demographics in these three regions are quite different, the regional density of sea otters has been stable or increasing very slowly in all three regions in recent years.
Source: USGS-WERC monitoring data

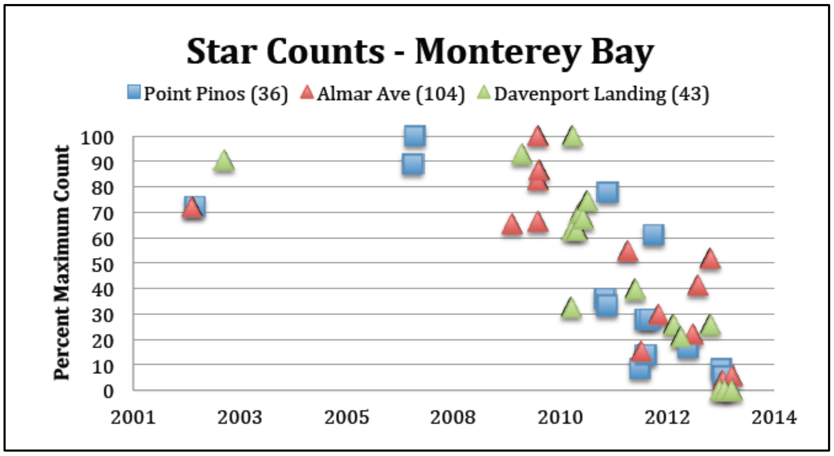

Figure NS LR9
Caption: Abundance of ochre star *Pisaster ochraceus* is shown as percent of maximum number counted at three rocky intertidal sites in Monterey Bay sanctuary (number in parentheses is the maximum number counted at that site): Point Pinos (blue square), Almar Avenue (red triangle) and Davenport Landing (green triangle). Monitoring data collected by the LiMPETS citizen science program suggest that the decline in ochre stars at these sites occurred over a period of 3-5 years before the mass mortality event that began in late 2013. The disease may have been present at lower levels for several years (J. Pearse, LiMPETS, pers. comm.).
Source: LiMPETS monitoring data

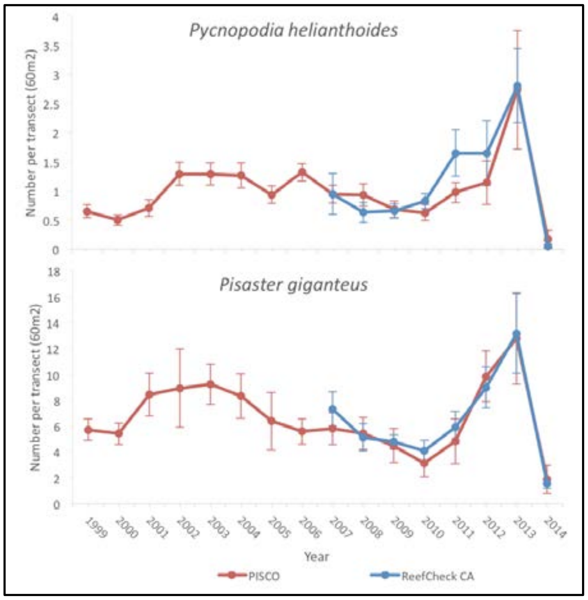

Figure NS LR10
Caption: Annual mean abundance (and standard error) estimates for the sunflower star *Pycnopodia helianthoides* (top) and giant stars *Pisaster giganteus* (bottom) from 12 PISCO (red) and 16 RCCA (blue) long-term subtidal monitoring sites around Monterey and Pt. Lobos. Abundance is measured by counting the number of stars observed as SCUBA divers swim along a transect. Annual abundance peaked in summer 2013 and then dropped to very low abundance by summer 2014.
Source: PISCO monitoring data and RCCA monitoring data

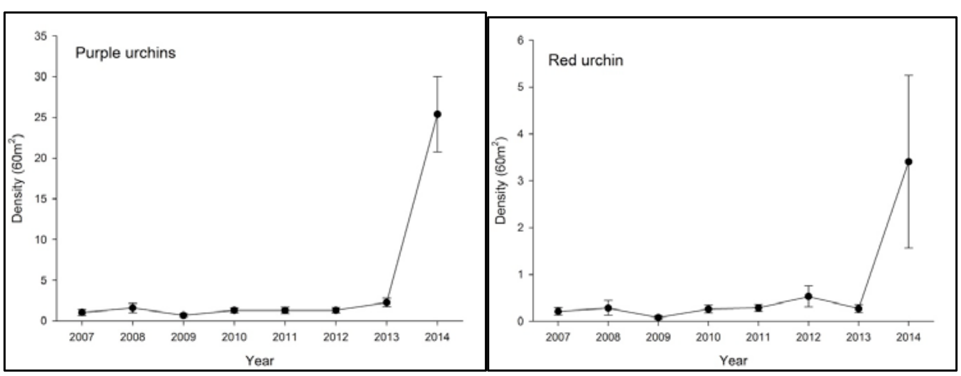

Figure NS LR11
Caption: Annual mean abundance (and standard error) estimates for the purple sea urchin *Strongylocentrotus purpuratus* and red sea urchin *Mesocentrotus franciscanus* at 16 RCCA long-

term subtidal monitoring sites around Monterey and Pt. Lobos. Annual abundance of sea urchins has increased dramatically in 2014, the same time that sea star abundance declined dramatically.
Source: RCCA monitoring data

13. What is the condition or health of key species and how is it changing?

The health of key species in the nearshore environment was rated "fair" in 2009. The 2015 status will remain **"fair"** due to the health of some key species being negatively impacted by disease or contamination, which may cause measurable reductions in ecological function of those species but recovery is possible. The trend was rated "not changing" in 2009 because impacted populations were generally not declining in the sanctuary, but health appeared to be one reason they were not recovering from depressed levels. The recent outbreak of a wasting syndrome that has resulted in significant population declines in many species of sea stars in both intertidal and subtidal habitats is a new serious health issue for these key species and the reason for a change to a "declining" trend in 2015.

Sea stars inhabiting the U.S. West Coast, both in rocky intertidal and subtidal habitats, started showing signs of wasting syndrome in mid-2013 and by the end of 2014 an extensive outbreak had severely reduced sea star numbers at many sites up and down the coast (see Figures NS LR 6 and 7). Wasting syndrome has been documented in sea stars along the west coast in the past, but this is the largest event ever observed (http://www.eeb.ucsc.edu/pacificrockyintertidal/data-products/sea-star-wasting/). Wasting syndrome typically causes lesions to appear in the ectoderm followed by decay of tissue surrounding the lesions, which leads to eventual fragmentation of the body and death. Scientists with the MARINe monitoring program have documented 20 affected species including the giant star *Pisaster giganteus*, the bat star *Patiria miniata*, and the rainbow star *Orthasterias koehleri* (Figure NS LR 9; http://www.eeb.ucsc.edu/pacificrockyintertidal/data-products/sea-star-wasting/species_affected_2014_0708.pdf). Hewson et al. (2014) provided evidence for a link between a densovirus and sea star wasting syndrome, however, there are likely to be additional contributing factors such as warm water events. Densovirus is found in other echinoderms (e.g., urchins, sand dollars, brittle stars) and recent observations of wasting in sea urchins at some locations in southern California is being monitored closely (http://www.eeb.ucsc.edu/pacificrockyintertidal/data-products/sea-star-wasting/index.html). However, wasting has been observed in sea urchins in the past so it is unclear if these observations are due to a spread of the current outbreak to other echinoderm species or if it is due to increased monitoring effort at this time (S. Lonhart, MBNMS-SIMoN, pers. comm.).

Black abalone (*Haliotis cracherodii*) was listed as 'Endangered' under the Endangered Species Act in 2009 (74 FR 1937; (http://www.nmfs.noaa.gov/pr/species/invertebrates/blackabalone.htm). This species is ecologically extinct in the southern portion of the sanctuary (south of Point Sierra Nevada) where the population was reduced dramatically in the mid-2000s by withering syndrome (summarized in ONMS 2009) and has not show any recent signs of recovery (P. Raimondi, PISCO/MARINe, pers. comm.). The disease is not resulting in population declines in populations

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north of Point Sierra Nevada, however, the current reduced densities in this region hinders reproduction and population growth (P. Raimondi, PISCO/MARINe, pers. comm.).

Over the last six years, the number of stranded sea otters has been generally increasing, with 2012 having the highest numbers ever observed (both for the entire range and for the portion of the population in Monterey Bay sanctuary; http://www.werc.usgs.gov/ProjectSubWebPage.aspx?SubWebPageID=7&ProjectID=232). The leading causes of sea otter mortality is different for the three regions in the sanctuary. In the north coast region, there is high mortality from shark attack which is likely associated with the close proximity to pinniped rookeries in the region. In the central coast region, there is high mortality in breeding-age females likely due to food resource limitation because this portion of the population is likely at or near "carrying capacity," the maximum population size that can be sustained by the resources available in the area. In the Monterey Bay region, disease and water quality issues impact sea otter health including high pollutant loads, protozoal infections (including *Toxoplasma gondii* and *Sarcocystis neurona*), bacterial infections, the microbial toxin microcystin and domoic acid intoxication from harmful algal blooms (Tinker et al. 2006, Miller et al. 2007, Miller et al. 2010, Tinker et al. 2013). Sea otters appear to be a very good indicator species for water quality issues (T. Tinker, USGS-WERC, pers. comm). For more details on water quality impacts to sea otters see the response to Nearshore Question 2.

Figure NS LR9
Caption:Twenty species of sea star have been observed to suffer from seastar wasting syndrome (SSWS) including the giant star *Pisaster giganteus* (left), the bat star *Patiria miniata* (middle), and the rainbow star *Orthasterias koehleri* (right). Wasting disease typically causes lesions to appear on the body surface followed by decay of tissue surrounding the lesions, which leads to eventual fragmentation of the body and death. Curling of the arms (left) is one early sign of SSWS.
Source: SIMoN photo database [image credits to be added]

14. What are the levels of human activities that may influence living resource quality and how are they changing?

The status of human activities that may influence living resource quality in the nearshore environment remains "fair" with a "declining" trend because, consistent with our findings in 2009, a number of human activities have localized, negative impacts on living resources in the nearshore environment and most of these activities are continuing at current levels or are increasing in intensity. Human activities, such as agriculture and urban development, can increase levels of contaminants in the nearshore environment and negatively impact the health of nearshore species, including mussels, some fish, and sea otters, as was discussed in Nearshore Questions 2, 3 and 7.

Recently collected data on human activity levels along the coastline show that more people are visiting both beaches and the rocky shore (Figure NS Hab4). Increased access and activity along the shore can increase damage due to non-extractive activities, such as trampling, turning over rocks, flushing birds and marine mammals (Tenera Environmental 2003). Surveys of breeding pairs of Black Oystercatchers in Monterey County in 2012 found that breeding success is reduced directly by humans and pinnipeds trampling nests and indirectly by humans flushing adults, which leaves eggs and hatchlings vulnerable to predation from gulls (http://creagrus.home.montereybay.com/MTYbirdsBLOY2012.html).

Increasing recreational use of beaches can have negative impacts on beach organisms. For example kite flying, horseback riding and dogs off leash can disturb birds (as was noted for Snowy Plovers in Nearshore Question 12), while picnicking can increase trash. Small pieces of trash in nearshore habitats may be ingested by foraging animals or animals may become entangled in larger debris such as lost fishing gear, ropes and packing straps (see response to Offshore Questions 8 and 14 for additional information). Litter cleanup activities on popular beaches and in rivers, as discussed in the response to Nearshore Question 8, helps to reduce the amount of debris entering the nearshore environment.

Poaching (illegal harvest) continues to be a problem in Monterey Bay sanctuary, both inside and outside of the Marine Protected Areas implemented by California in state water in 2007 (north of Pigeon Point) and 2010 (South of Pigeon Point) (OST & CDFW 2013). While only a small number of people knowingly violate regulations, even a single poaching event can have a significant impact on a sensitive local population. For example, wardens caught a poacher who had taken 60 black abalone from a central coast MPA in 2009 (OST & CDFW 2013), which was a major impact to this endangered species at that site. Of the violations in central California MPAs (Figure NS LR10), 94% occurred within 65 kilometers of Morro Bay, which is the base port for one of the large patrol vessels in the region, which suggests that an increased rate of patrol results in high detection of violations (OST & CDFW 2014). More funding and personnel are needed to increase enforcement and public education efforts. Additional restrictive measures on fishing in nearshore habitats, including seasonal closures, bag limits, and area closures may result in decreases in the overall fishing effort, but could also lead to redistribution of fishing effort and increased pressure in areas open to fishing. More monitoring of distribution and intensity of extractive human activities is needed to better understand the impacts of recent area closures.

A recent analysis of fishing effort in the sanctuary through 2012 looked at trends in shore fishing, private/rental boat, and Commercial Passenger Fishing Vessels (CPFV) activities (Schwarzmann and Leeworthy 2015). Shore fishing in the sanctuary shows no obvious trend from 2004-2012, but there is more variability in recent years (2010 was lowest and 2011 was highest in the time series). Private/rental boat activity declined, then increased 2005 through 2012, with the minimum number of person-days having occurred in 2008 and the highest number in 2012. The number of CPFV fishing person-days declined from 2004 through 2008, but from 2008 through 2012 the number of person-days increased. It is likely that the decline in private boat and CPFV fishing effort to a low in 2008 was strongly influenced by the absence of a salmon fishery due to low abundance of salmon in ocean waters (P. Reilly, CDFW, pers. comm.). However, the total number of person-days in 2012 was roughly two-thirds of the level in 2004. Overall, fishing effort appears to have remained the same or slightly increased since the 2009 report.

Organisms living in sandy beach and subtidal habitats are impacted by several types of human activities. These include coastal armoring to reduce bluff erosion and protect buildings, coastal development, grooming of the sand at popular beaches, sand mining (in the city of Marina), disposal of harbor dredge spoils, and the placement of outfalls from storm drains, sewage treatment facilities, desalination plants, and power plants. Most of these activities are at similar levels to those reported in the 2009 Condition Report. However, given the extreme drought facing California, it is likely that desalination activity will increase in the next few years.

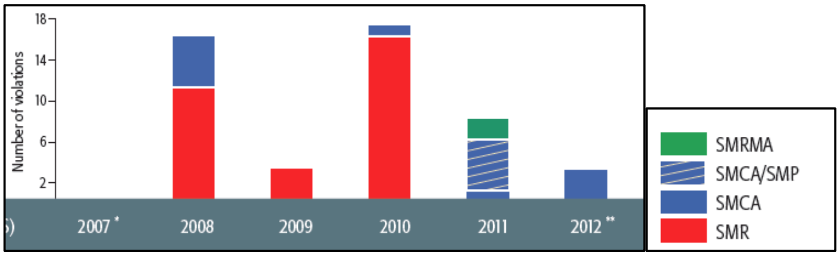

Figure NS LR9
Caption: Number of violations of marine protected area (MPA) regulations in the Central Coast region recorded by California Department of Fish and Wildlife wardens from September 2007-March 2012. MPA types: State Marine Reserve (SMR - red); State Marine Conservation Area (SMCA - blue); SMCA/State Marine Park (SMP - blue hatch); and State Marine Recreational Management Area (SMRMA - green)
Source: OST & CDFW 2013

Nearshore Environment Living Resources Status & Trends

Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

▲ = Improving — = Not changing ▼ = Declining

? = Undetermined trend **N/A** = Question not applicable

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
9	Biodiversity	---	Status: Very High Trend: Very High	Fishing, collecting, and poaching have altered biodiversity from what would be expected in a natural state. Most assemblages appear to be fairly stable except for sea stars and urchins.	Selected biodiversity loss may inhibit full community development and function and may cause measurable but not severe degradation of ecosystem integrity.
11	Non-Indigenous Species	▼	Status: Very High Trend: Very High	A few non-indigenous species have been identified, and some appear to be spreading.	Non-indigenous species are not suspected or do not appear to affect ecosystem integrity (full community development and function).
12	Key Species Status	▼	Status: Very High Trend: Very High.	Abundance of some key species in each habitat type is lower than would be expected in a natural state. Many key species stable or increasing,.but substantial change for sea stars and sea urchins.	Selected key or keystone species are at reduced levels, perhaps precluding full community development and function, but substantial or persistent declines are not expected.
13	Key Species Condition	▼	Status: Very High Trend: Very High	Continuing health problems in sea otters and black abalone. New severe health issue for sea stars.	The condition of selected key resources is not optimal, perhaps precluding full ecological function, but substantial or persistent declines are not expected.
14	Human Activities	▼	Status: Very High Trend: Very High	Variety of visitation, extraction, and coastal development activities, some of which are increasing in frequency.	Selected activities have resulted in measurable living resource impacts, but evidence suggests effects are localized, not widespread.

Questions that have new information to report since the 2009 Monterey Bay National Marine Sanctuary Condition Report (ONMS 2009) are those with red numbers.

Nearshore Environment: Maritime Archaeological Resources

The following information provides an assessment of the status and trends pertaining to the current state of the maritime archaeological resources in the nearshore environment.

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15. What is the integrity of known maritime archaeological resources and how is it changing?

The integrity of the known maritime archaeological resources in nearshore habitats was rated "fair" with an "undetermined" trend in the 2009 Condition Report (ONMS 2009). This status assessment was based on limited information as only one nearshore archaeological site location inventory has been conducted in the nearshore environment of Monterey Bay sanctuary (1979-1981 National Park Service inventoried the California Gold Rush passenger steamship *Tennessee* lost 1853) (Schwemmer 2006). However, anecdotal information indicated that recreational divers and beachcombers had removed artifacts from some shipwrecks and that some sites were reported in various stages of degradation due to their exposure to waves, shifting sands, and strong currents.

In 2015, there is no new information on the integrity of known maritime archaeological resources in the nearshore environment, so this questions continues to be rated "fair". There is no baseline monitoring information available to detect a change or impact to the resources, therefore, the trend in their integrity remains "undetermined". It is assumed there is less relic hunting occurring today due to education, and most of the accessible sites have already been pilfered. Yet some of the less impacted sites are becoming well known due to an increase in information exchange among enthusiasts.

16. Do known maritime archaeological resources pose an environmental hazard and is this threat changing?

In 2009 this questions was rated "good" and the trend was "not changing" because the known maritime archaeological resources in the nearshore environment were believed to pose few or no environmental threats. The Monterey Bay National Marine Sanctuary's inventory of known maritime archaeological resources in shallow water (50 feet or 15 meters, or less) suggested an unlikelihood that the remains of shipwrecks inside the sanctuary boundary hold hazardous cargos and/or bunker fuels. This was also true for most shipwrecks located near the entrance to San Francisco Bay (just beyond the sanctuary boundary).

New information gathered since 2009 indicates that at least one nearshore shipwreck located just outside the sanctuary boundary, the freighter *Fernstream* lost 1952 (Figure NS MAR1), has the potential to pose an environmental hazard to sanctuary resources due to deterioration that would result in the release of hazardous cargo and/or bunker fuel and that prevailing currents have a high likelihood of carrying hazardous materials released from this source into the Monterey Bay sanctuary (Vessel 2 on Figure OS MAR1). Due to the fact that the *Fernstream* is the highest ranked potentially polluting wreck that occurs in U.S. Coast Guard District 11, and the structural integrity of the vessel is reduced, this question is now rated "fair" with a "declining" trend.

In 2013 NOAA completed a risk assessment of the *Fernstream* (NOAA 2013), and followed up with three surveys of opportunity which allowed for a more detailed assessment of the wreck (NOAA 2014). The *Fernstream* is the highest ranked potentially polluting wreck in U.S. Coast Guard District 11, which includes the coastal and offshore waters off California to South America (NOAA 2013). For the Worst Case Discharge scenario, the *Fernstream* scored High; for the Most Probable Discharge scenario, the *Fernstream* scored Medium (NOAA 2013). Surveys in 2013 suggest the structural integrity of the vessel is reduced (Figure NS MAR2) and the vessel most likely contains some diesel bunker fuel and oil lubricants, although it is likely trapped beneath sediments (NOAA 2014). Under the National Contingency Plan, the U.S. Coast Guard and the Regional Response Team have the primary authority and responsibility to plan, prepare for, and respond to oil spills in U.S. waters. NOAA recommended that this site be included within the Area Contingency Plan and active monitoring programs should be implemented based on the results of the three surveys of opportunity in 2013. Outreach efforts with the technical and recreational dive community, as well as commercial and recreational fishermen who frequent the area, would be helpful to gain awareness of changes in this site. The final determination of what type of action, if any, rests with the U.S. Coast Guard.

Figure NS MAR1
Caption: MV *Fernstream's* bow still visible above the water just before sinking in 1952 off Lime Point Lighthouse in San Francisco Bay after the collision with the SS *Hawaiian Rancher*.
Photo Credit: Robert Schwemmer, Maritime Library
Source: http://sanctuaries.noaa.gov/shipwrecks/fernstream/fernstream_sinking_robert-schwemmer-maritime-library.jpg

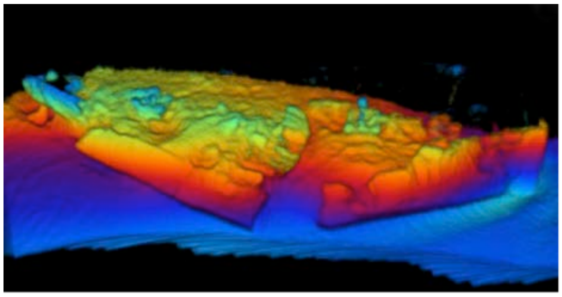

Figure NS MAR2
Caption: Coda Octopus 3-D Echoscope sonar image of the shipwreck MV *Fernstream*, looking south. The bow is located to the right in red, with the stern to the left in dark blue. A severe breach in the starboard hull forward of the bridge-house is visible.
Photo Credit: Coda Octopus
Source: http://sanctuaries.noaa.gov/shipwrecks/fernstream/fernstream-coda-octopus-03.jpg

17. What are the levels of human activities that may influence maritime archaeological resource quality and how are they changing?

Several human activities that occur in the sanctuary may influence the quality of maritime archaeological resources in the nearshore environment, including the removal of artifacts from archaeological sites, diving, anchoring, and fishing activities (e.g., historic trawling, other gear impacts). For the known archaeological sites in the nearshore environment, human activities did not appear to have a significant negative impact on the integrity of these resources so this question was rated "good/fair" in the 2009 condition report (ONMS 2009). Given that these potential impacts had not been measured, the trend in 2009 was "undetermined." There is no new information available on the levels of human activities that influence maritime archaeological resources, therefore the 2015 ratings remains "good/fair" with an "undetermined" trend

Nearshore Environment Maritime Archaeological Resources

Status & Trends

Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

▲ = Improving — = Not changing ▼ = Declining
? = Undetermined trend **N/A** = Question not applicable

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
15	Integrity	?	Status: N/A (not updated) Trend: N/A (not updated)	Divers have looted sites, but few sites have been studied to determine trend.	The diminished condition of selected archaeological resources has reduced, to some extent, their historical, scientific or educational value and may affect the eligibility of some sites for listing in the National Register of Historic Places.
16	Threat to Environment	▼	Status: Medium Trend: Medium	Known resources containing hazardous material continue to deteriorate	Selected maritime archaeological resources may cause measurable, but not severe, impacts to certain sanctuary resources or areas, but recovery is possible.
17	Human Activities	?	Status: N/A (not updated) Trend: N/A (not updated)	Activities, such as recreational diving occurs on wreck sites, but activity level is unknown.	Some potentially relevant activities exist, but they do not appear to have had a negative effect on maritime archaeological resource integrity.

Questions that have new information to report since the 2009 Monterey Bay National Marine Sanctuary Report (ONMS 2009) are those with red numbers.

State of Sanctuary Resources: Offshore Environment

Offshore Environment Water Quality

The most abundant habitats in the Monterey Bay sanctuary are the offshore waters - three-dimensional habitats not associated with the seafloor. The total volume of open waters of the sanctuary is 12.026 trillion cubic meters or approximately 4.8 billion Olympic-sized swimming pools. Open water can be subdivided into three zones by depth. The epipelagic zone, which includes the upper 200 meters of the water column, comprises 18% of the open water habitat. The mesopelagic zone, from 200 to 1,000 meters, makes up nearly half of the open water. The remaining 35% of the volume of the open water is deeper than 1,000 meters and is called the bathypelagic zone.

Changes in the quality of open water habitats is the focus of the offshore water quality section of this report. The quality of these open water habitats is influenced by natural and anthropogenic factors. The recent patterns in natural cycles (e.g., El Nino, Pacifica Decadal Oscillation) are reviewed in our response to question 1 below. The timing of the 2015 condition report update and how it aligns with these natural cycles may have some influence on the apparent health of sanctuary resources, especially water quality and living resources. We have tried to account for whether current conditions of these resources are within the range expected due to these natural fluctuations in climate and ocean conditions when long-term monitoring information is available.

The following information provides an assessment of the status and trends pertaining to offshore water quality and its effects on habitat and living resources in that environment.

1. *Are specific or multiple stressors, including changing oceanographic and atmospheric conditions, affecting water quality?*

Stressors on water quality in the offshore environment, specifically changing ocean conditions, pollutants, and toxin-producing harmful algal blooms (HABs), may inhibit the development of assemblages and may cause measurable declines in some living resources and habitats. For this reason the rating in the 2009 condition report was "fair" with a "declining" trend. The 2015 status for stressors in offshore waters remains "fair" and "declining" based on changing ocean chemistry, increasing levels of pollutants (detailed in Offshore Questions 3 and 7), and continued occurrence of toxin-producing HABs (details in Offshore Question 2), all of which are having measurable impacts to offshore water quality and appear to be influencing the health and composition of pelagic faunal communities.

Extensive research over the last few decades has helped provide a better understanding of the natural cycles in oceanographic and atmospheric conditions that occur in the eastern Pacific ocean, such as the El Nino/Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). Time series data are available to describe recent conditions relative to these natural cycles. However, these fluctuations in offshore conditions relative to natural cycles are not the basis for the "fair" and "declining" trend. Instead, the ratings are based on stressors linked to human activities which are not part of the natural cycling of the system, such as inputs of pollutants and global climate change. These stressors will be discussed after a brief summary of natural variation in climate and ocean conditions.

Comment [N41]: Field: A general comment in the "offshore waters" section is that many of the problems described are "overarching" problems and challenges facing the world's oceans- obviously those are fine and reasonable to include, but it might be reasonable to point out (yes, it's obvious) where such problems are wide spread (e.g., ocean acidification, prevalence of persistent organic pollutants in marine mammals and other organisms) as well as (where available) any information that might inform readers of the relative (more or less vulnerable) threat to central California/Sanctuary waters.

Jenn: we have tried to provide some of this context when readily available, but do not have time for an extensive comparison. We will have the note in the front matter that MBNMS is in general good health compared to much of the world's oceans. This is a good comment to keep in mind for the next update.

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Oceanographic monitoring data collected by the Monterey Bay Aquarium Research Institute (MBARI) shows that the period from 2009-2013 was mostly a productive time during a cool phase of Pacific Decadal Oscillation (PDO), which is associated with strong upwelling, cooler sea surface temperatures, and some very high chlorophyll anomalies (Figure OS WQ1; F. Chavez, MBARI monitoring data). These cooler productive conditions are linked to high abundance of many forage groups, including krill and young-of-the-year fishes (see Offshore Questions 9 and 12 for additional detail) and can help support higher reproductive success of locally breeding seabirds and pinnipeds, higher seasonal abundance of foraging baleen whales and migratory seabirds, and higher productivity of juvenile and adult salmon (Santora et al. 2012, Wells et al. 2012).

Starting in 2014, sea surface temperatures were anomalously high all along the U.S. West Coast. At the M1 buoy in Monterey Bay, unusually high sea surface temperatures (2-4 degrees higher than usual) began in August 2014 and persisted into 2015. The Multivariate ENSO Index (MEI), PDO index and North Pacific Gyre Oscillation (NPGO) (Figure OS WQ2), all of which can be used to track climate and ocean conditions the North Pacific Basin, shifted from conditions that generally promote high primary productivity in 2008-2013 to less productive conditions in 2014 (Harvey et al. 2014, Hazen et al. 2014). Decreased upwelling, warm temperatures, and decreased productivity in 2014 and early 2015 have likely affected abundance and distribution of some types of forage fish and invertebrates and resulted in mass stranding of emaciated Cassin's Auklets and California sea lions (see Offshore Question 13 for more information). This unusually warm water also coincided with increased sightings of warmer-water species (e.g., tropical sea butterflies (pteropods), blue buoy barnacles, a green sea turtle, and common dolphins) not usually observed in MBNMS except during El Niño events (http://www.mercurynews.com/science/ci_26851300/unusual-warm-ocean-conditions-off-california-west-coast?source=infinite). If the warming persists well into 2015, some of the species that do well in a colder, more productive ocean could experience reduced growth, poor reproductive success and population declines. At the same time, species that do well in warmer conditions may experience increased growth, survival and abundance. We will need a few more years of observation to determine if this is a short-term anomaly (possibly due to El Niño) or the beginning of a longer-term shift to a warm phase of the PDO.

Despite the fact that most of 2009-2014 has been a productive time in the sanctuary, continuing shifts in ocean chemistry due to global climate change are leading to increasingly stressful conditions for many species in the offshore environment (reviewed in Doney et al. 2012). Oceanographic monitoring data collected by MBARI in offshore waters of Monterey Bay (Figure OS WQ1) show that ocean CO_2 is increasing while pH and dissolved oxygen are decreasing (F. Chavez, MBARI monitoring data). Ocean acidification describes a decrease in ocean pH levels caused by an increase in dissolved CO_2. The natural process of upwelling that occurs along the central California coast results in this area being higher in dissolved CO_2 because upwelling brings already CO_2-rich waters from the deep ocean to the shelf environment, which adds to the human-caused CO_2 contribution in these waters (Doney et al 2012).

Increasingly acidic ocean water is a stressor on marine organisms, particularly those with body parts made of calcium carbonate. Phytoplankton and zooplankton are the base of the pelagic food web, and many types of phytoplankton and zooplankton have calcium carbonate shells that are vulnerable to dissolution from increasing acidity. For example, a recent study of shell thickness of pteropods (planktonic snails; Figure OS WQ 3) along the U.S. West Coast found the incidence of severe shell dissolution has more than doubled relative to pre-industrial conditions (Bednarsek et al. 2014). The authors project that severe shell dissolution could increase to as

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Comment [N42]: Field: the Wells et al. 2012 paper actually referred to salmon early life history and ocean survival, so salmon might be mentioned as well.

Jenn - done

Comment [JB43]: Need to add some text to account for MEI and NPGO

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Comment [N44]: Field: again it should be obvious but it could be pointed out that these are natural cycles to which the ecosystem and the important components of the ecosystem have (mostly) adapted to (although such climate impacts could possibly be increasing in magnitude with climate change, but that's another story). For example, groundfish recruitment often increases substantially following strong El Niño events.

Jenn: I added some text above to emphasis that some cycles are natural and some of the observed changes are human caused. I think that we do good job in this questions of clarifying that we are first describing the natural cycles and then discussing the human-caused changes responsible for the rating.

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Comment [N45]: Kudela: This is more a matter of interpretation and you may want to ignore this comment, but Figures OS WQ2 and OS WQ1 are not entirely consistent. Chavez defines the warm/cool phases primarily on the inflection of the PDO in 1999, while Hazen's figure suggests that 2014 entered a "warm phase" because it crossed zero. Depending on how you interpret the data, if I used WQ1 as a template I would say the warm phase ended in 1999 (Chavez) and then began again in 2008 or 2011, when the TREND went positive.

Jenn: changed the Figure OS WQ2 to a graph showing the PDO, MEI and NPGO much as 70% by 2050 along in the central onshore region of the California Current Ecosystem, which include the entire coast of Monterey Bay Sanctuary out to the 200m isobath. Pteropods are important prey for a number of pelagic species including salmon, mackerel, and herring, and reductions in this food source could be affecting other components of the pelagic food web.

Another potential stressor to inhabitants of deep shelf and slope habitats is a shoaling of the oxygen minimum zone (Gilly et al. 2013). The oxygen minimum zone (OMZ) is a midwater depth range where the oxygen concentration is less than 20 µmol/kg in the Pacific and the OMZ typically occurs at depths from 600 to 1000 m deep in the sanctuary. Oxygen concentration in the water column decreases rapidly approaching the upper boundary of the OMZ, continues to decline until a minimum is reached in the middle of the OMZ, and then gradually increases with depth to the lower boundary of the OMZ and beyond. The OMZ influences both the vertical distribution of pelagic fauna, and where the OMZ intersects the seafloor, the depth distribution of benthic fauna (Gilly et al. 2013). Shoaling of the upper OMZ boundary has been observed over the past several decades in the eastern Pacific (Bograd et al. 2008). Shoaling of the OMZ is causing vertical habitat compression for those species that occur in waters above the upper OMZ boundary and cannot tolerate reduced oxygen levels. These species may respond to shoaling of the OMZ with a shift in vertical distribution to shallower depths, while those species that reside within the OMZ will experience a vertical expansion of their habitat (Gilly et al. 2013). For example, the shoaling of the OMZ has been associated with a reduction in abundance of mesopelagic fish larvae possibly due to mesopelagic fishes having to move to shallower depths which makes them more vulnerable to visually-oriented predators (Koslow et al. 2011). OMZ shoaling may also restrict usable habitat for high trophic level, migratory fishes (e.g., swordfish, sharks, and tunas) and make them more vulnerable to surface fishing gear, as has been observed in the tropical northeast Atlantic Ocean (Stramma et al. 2012). The northern expansion of the range of the jumbo squid along the west coast of North America also appears to be facilitated by shoaling of the OMZ (Stewart et al. 2014).

Comment [N46]: Field: it could be worth mentioning that impacts have been described for key high trophic level, highly migratory fishes (such as swordfish, sharks and tunas) as well (e.g., Stramma et al. 2012)

Jenn - done

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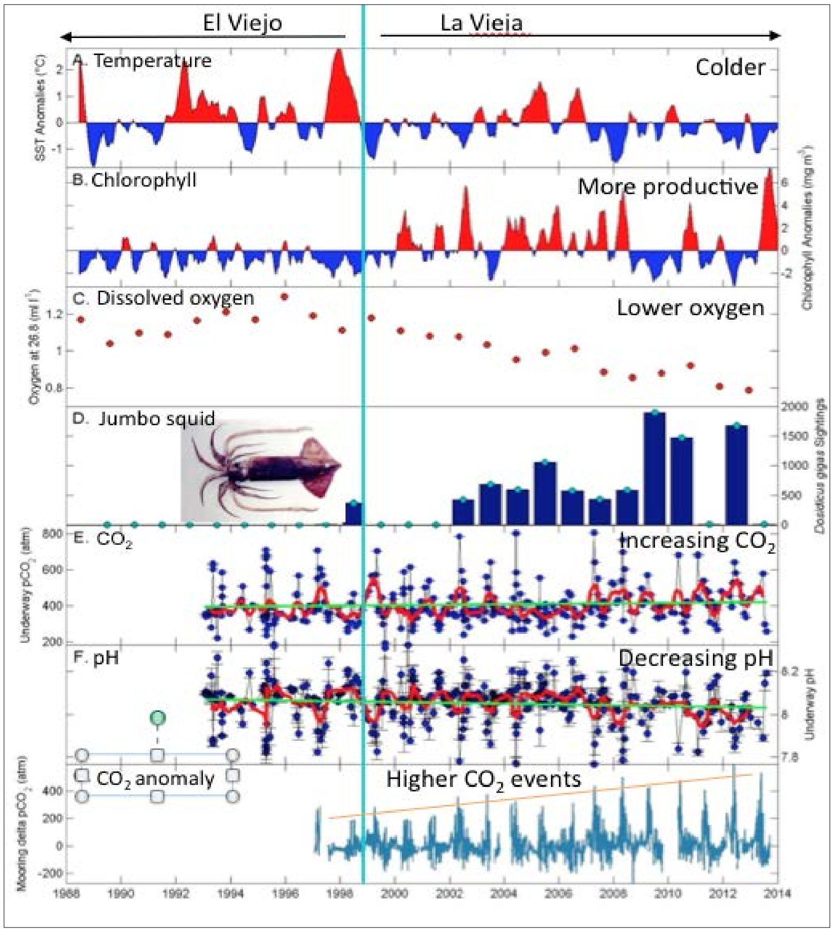

Figure OS WQ1

Caption: Monitoring data collected by the Monterey Bay Aquarium Research Institute (MBARI) were used to create a time series of ocean conditions observed in Monterey Bay since 1988 which includes a warm phase (i.e., "El Viejo") and cool phase (i.e., "La Vieja") of the Pacific Decadal Oscillation. Anomalies in surface temperature (A) and productivity (B) with higher [or lower] than average values in red [or blue] indicate the recent phase is generally cooler and more productive. (C) Dissolved oxygen levels have been declining and (D) sightings of jumbo squid have been increasing. Long-term trends of increasing CO_2 (E) and decreasing pH (F) are consistent with changes expected due to global climate change. The magnitude of high CO_2 events is also increasing (G). Panels A, B, C show averages from three MBARI stations - C1, M1 and M2. Panel D shows data collected during MBARI ROV dives in Monterey Bay. Panels E and F show data collected along an onshore-offshore transect line between stations C1 and M2. Panel G shows data collected at mooring M1.

Credit: F. Chavez, MBARI

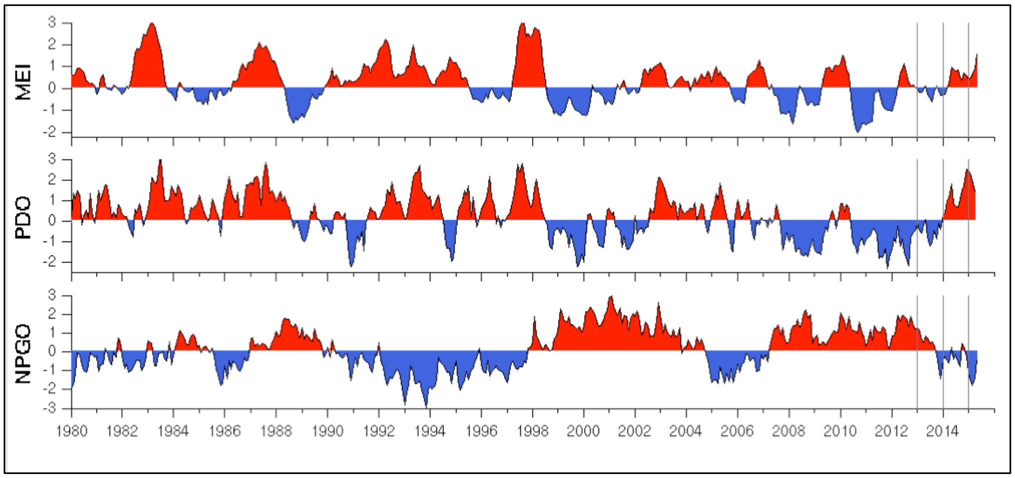

Figure OS WQ2

Caption: Three indices of climate and ocean conditions in the North Pacific Basin shifted in 2014 from conditions promoting high primary productivity to less productive conditions. The Multivariate ENSO Index (MEI) indicates the intensity of an ENSO event with positive anomaly values (red) denoting El Niño conditions and negative values denoting La Niña conditions. The Pacific Decadal Oscillation (PDO) index is related to North Pacific sea surface temperature with cold regimes (blue) associated with higher productivity and warmer regimes (red) associated with lower productivity. The North Pacific Gyre Oscillation (NPGO) is influenced by sea level and circulation patterns. Positive values of the NPGO (red) are linked to stronger currents and higher productivity while negative values (blue) are linked to weaker currents and lower productivity. The graphs show the long-term mean (0) ± 3.0 standard deviations based on the full time series.

Data Credit: NPGO data from http://www.o3d.org/npgo/; PDO data from http://jisao.washington.edu/pdo/; MEI data from http://www.esrl.noaa.gov/psd/enso/mei/
Graph: I. Schroeder, NMFS-SWFSC

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Credit: Hazen et al. 2014¶

Figure OS WQ3
Caption: (Left) A healthy pteropod (planktonic marine snail) collected during the U.S. West Coast survey cruise. (Right) Many of the pteropod, such as this one, collected during the study had signs that shells are dissolving.
Credit: NOAA (downloaded from http://www.noaanews.noaa.gov/stories2014/20140430_oceanacidification.html)

2. What is the eutrophic condition of sanctuary waters and how is it changing?

Experts agree that the eutrophic condition in the offshore environment rating remains "good/fair" relative to this question because monitoring data suggests that selected conditions may preclude full development of living resource assemblages and habitats, but are not likely to cause substantial or persistent declines. The 2009 "declining" trend continues to be supported by additional evidence of nutrient enrichment and increasing frequency and intensity of harmful algal blooms in selected areas of the offshore environment. Two types of marine HABs pose the most significant threats to California's coastal ecosystem. They include dinoflagellates of the genus *Alexandrium* that cause paralytic shellfish poisoning (PSP) and diatoms of the genus *Pseudo-nitzschia* that produce domoic acid (DA), which causes amnesic shellfish poisoning (ASP) in humans. Other HABs that are less common but potentially may occur more frequently in the future include; *Cochlodinium, Akashiwo sanguinea, Microcystis*, and *Dinophysis* (Lewitus 2012). There is little evidence to support anthropogenic factors as the primary cause of *Alexandrium* blooms in most areas along the west coast. In California, blooms are strongest in the drier seasons and typically appear offshore and move onshore when upwelling relaxes (Langois and Smith 2001, Anderson et al. 2008). Research on phytoplankton productivity in ammonium-rich discharges from San Francisco Bay indicate there is a possibility that elevated ammonium levels prevent nitrate uptake by diatoms which then allows dinoflagellates to bloom (Glibert et al. 2011). However, Kudela et al. (2010) looked at nutrient use by harmful algae in upwelling systems and determined that chain forming HABs (including *Alexandrium*) are well adapted to use upwelling derived nitrate.

Comment [N47]: Kudela: Note that this is a freshwater HAB so the chances of getting cells/toxin from the nearshore to the open water is minimal

Comment [N48]: Kudela: That paper also shows that Pseudo-nitzschia grows well on ammonium

After many domoic acid (DA) events caused harm to humans, monitoring efforts and regulations were increased and have been successful in preventing the harvesting of toxin-contaminated shellfish. However, there continue to be many cases of documented DA toxicity of finfish, marine mammals, and birds (Bargu et al. 2012). In Monterey Bay, DA levels were exceptionally high in California mussels during fall 2010. Lewitus et al. (2012) concluded that the two primary types of HABs, those causing paralytic shellfish poisoning (PSP) and amnesic shellfish poisoning (ASP) originate in offshore waters and are carried inshore. It is then possible that nutrients flowing from the land can affect these blooms, either by increased magnitude and/or prolonged duration.

The Global Ecology and Oceanography of Harmful Algal Blooms (GEOHAB) program was established to better understand the dynamics of HABs. One of their core research projects is to better understand highly stratified systems such as in northeastern Monterey Bay. The northeastern bight of Monterey Bay was identified as a study site and there is significant documentation of recurring blooms of toxic *Pseudo-nitzschia*. DA is of particular concern in Monterey Bay during upwelling because of the high productivity; food chains are short, which allows DA to be rapidly transferred to higher trophic levels (Kvitek et al 2008). In 2010 a study was conducted to better understand the interrelationships between nutrients and HAB dynamics. Timmerman et al. (2014) used profilers and towed instruments to describe the physical and biogeochemical conditions of the site and to characterize the bloom. Discrete water samples were collected above, within and below a sub-surface layer of *Pseudo-nitzschia*. It was determined that a high total nitrogen to total phosphorus ratio is driving the formation of toxic blooms. They concluded that if additional studies indicate that phosphate stress (or nitrogen enrichment) is found to be critical in bloom toxicity, there could be more toxic blooms from anthropogenic nutrient inputs (Timmerman et al. 2014).

Please see the 2009 MBNMS Condition Report for additional information.

3. Do sanctuary waters pose risks to human health?

The rating of "good/fair" with an "undetermined" trend and the accompanying explanation has not changed since the 2009 report. Selected conditions in offshore waters, including low levels of a number of toxic pollutants and toxins produced by HABs have the potential to affect human health. While there is some evidence of increasing loads of biotoxins and contaminants, a clear trend in the risk to human health could not be determined. Please refer to Offshore Question 2 for updated information on harmful algal blooms and Offshore Question 7 for more information on contaminant concentrations in offshore habitats.

4. What are the levels of human activities that may influence water quality and how are they changing?

We have no new information to change the status rating or trend for this question so the information remains the same as in the 2009 report. The level of human activities that directly influence offshore water quality are considered to be "fair" in that they result in measurable local impacts to the ocean and are "improving" due to increased regulation and remediation efforts since establishment of the sanctuary. In many instances it is difficult or impossible to directly measure the impacts of human activity on offshore water quality conditions, but select activities have notable impacts (see 2009 MBNMS Condition Report for more details). The main contributor from land-based activities is inputs of contaminants and nutrients linked to urban development and agriculture. The main activity occurring in the offshore waters of the sanctuary is vessel traffic, which can result in acoustic impacts and discharge of ballast water, bilge oil, and trash.

Offshore Environment Water Quality Status & Trends

Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

▲ = Improving — = Not changing ▼ = Declining
? = Undetermined trend **N/A** = Question not applicable

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
1	Stressors	▼	Status: High Trend: Very High	Elevated levels of contaminants (e.g., persistent organic pollutants), and ocean temperature and chemistry changes, some of which have been linked to changes in the offshore ecosystem.	Selected conditions may inhibit the development of assemblages and may cause measurable but not severe declines in living resources and habitats.
2	Eutrophic Condition	▼	Status: Very High Trend: Medium	Nutrient enrichment in selected areas, increased nutrient loading, and increased frequency and intensity of harmful algal blooms.	Selected conditions may preclude full development of living resource assemblages and habitats, but are not likely to cause substantial or persistent declines.
3	Human Health	?	Status: N/A (not updated) Trend: N/A (not updated)	Measurable levels of biotoxins and contaminants in some locations that have the potential to affect human health; no reports of human impacts.	Selected conditions that have the potential to affect human health may exist but human impacts have not been reported.
4	Human Activities	▲	Status: N/A (not updated) Trend: N/A (not updated)	Inputs of pollutants from agriculture and urban development; reduced risk of impacts from vessels due to regulation of traffic patterns and discharges, removal of oil from sunken ships.	Selected activities have resulted in measurable resource impacts, but evidence suggests effects are localized, not widespread.

Questions that have new information to report since the 2009 Monterey Bay National Marine Sanctuary Condition Report (ONMS 2009) are those with red numbers.

Offshore Environment: Habitat

The offshore environment of the sanctuary can be divided into pelagic habitats (i.e., the water column) and benthic habitats (i.e., the seafloor). Generally less information is available for offshore habitats than nearshore habitats. This is due in part to the fact that the offshore environment covers a much larger area of seafloor and a much larger volume of water than the nearshore environment and in part due to the logistical and economic hurdles that must be overcome to study the offshore environment. Offshore research often requires using large vessels to deploy nets, remotely operated vehicles or submersibles to sample and explore the vast volume of water and deep seafloor habitats. Nevertheless, it is widely recognized that the productivity of the offshore ecosystem supports a great diversity and abundance of invertebrates, fishes, seabirds, and marine mammals. It should be noted, that because the physical and chemical oceanography of the offshore pelagic habitat was covered in the Water Quality section (Questions 1-4), the offshore habitat status and trends are focused primarily on benthic habitats, except for Question 7 in which we discuss contaminants in both seafloor and open water habitats.

The following information provides an assessment of the status and trends pertaining to the current state of offshore benthic habitats.

5. What is the abundance and distribution of major habitat types and how is it changing?

In the 2009 report, the abundance and distribution of major benthic habitat types in the offshore environment of the sanctuary was rated "fair" based on past and on-going levels of human activities, in particular fishing with mobile bottom-contact gear, that influenced the distribution, abundance, and quality of benthic habitats and associated living resources (ONMS 2009). There is limited new information available to directly assess offshore habitat condition in the sanctuary. The status remains **"fair"** based on the known physical impacts that bottom trawling can have on habitats (Engel and Kvitek 1998, Auster and Langton 1999, NRC 2002, Lindholm et al. 2004, de Marignac et al. 2009) and that fishing with bottom trawl gear continues inside the sanctuary in areas open to this activity

Comment [N49]: Field: it is noted that the status "fair" was assigned based on impacts bottom trawling can have on habitats and the observation that bottom trawl gear continues to be used within Sanctuary waters. I agree with the decision to assign the trend as "improving" based on the use of less destructive gear types (e.g., small footrope gear).

In 2009, the trend was "undetermined" due to a lack of information on both the rate and degree of recovery of habitat and associated living resources inside areas recently closed to bottom-contact fishing gear and the associated changes in the distribution and intensity of fishing activities in the remaining open areas. New information suggests that trawling activity has decreased in intensity and spatial extent, moved to areas likely to have less sensitive habitats, and is now using less destructive gear types (e.g., small footrope gear (see Offshore Question 8 for specific details on this human activity). In addition, given some new information that unconsolidated habitats may be able to recover relatively quickly from physical modifications, we can infer that recovery from trawling impacts is likely occurring in the portion of the sanctuary that is no longer subject to this activity. Though the magnitude and speed at which condition may be improving is unknown, the likelihood that habitat condition has improved and will continue to improve in areas where trawling effort has been reduced or prohibited is the basis for an "improving" trend in 2015.

Most of Monterey Bay sanctuary has not received the detailed characterization and monitoring necessary to quantify the impact of human activities on habitat condition. Since 2009, the amount of the offshore benthic environment that has received finescale characterization increased by a small amount based on research and characterization by USGS, CSUMB, MBARI, and MBNMS (see IfAME and MBNMS 2009, USGS/CSUMB Seafloor Mapping Program). This new information is consistent with the 2009 summary that most of the benthic seafloor is composed of soft sediments (various mixtures of sand, mud and silt), with hard substrates, such as deep reef, rock and gravel, occurring in patches of various sizes (ONMS 2009).

Recently, Lindholm et al. (2015) examined impacts of high and low intensity bottom trawling with small-footrope gear on soft-bottom habitats at 160-170 m depth off Morro Bay, an area just south of Monterey Bay sanctuary. They found that trawling had measurable local impacts on sediments, such as leaving scour marks in soft sediments, (measuring up to 20 cm wide and 10 cm deep) that can persist for at least a year. However, they found minimal reductions in bioturbated sediments in trawled plots, and they did not detect significant change in micro-topographic structure or the composition of the infaunal invertebrates assemblage between trawled and control plots. Most of the invertebrate groups had relatively low densities in the study area, but showed very high spatio-temporal variability. Overall, this study indicated that bottom trawling with small-footrope gear may have limited impacts in some soft-bottom habitats.

Accumulation of marine debris in deep sea habitats is a concern for habitat quality. Marine debris on the seafloor can impact both physical habitat and community composition, but impacts appear to be localized. In 2011, researchers measured the impacts of a shipping container that was lost at sea in early 2004 and came to rest on a sediment-covered seabed at 1,281 m depth in Monterey Bay National Marine Sanctuary (Taylor et al. 2014). They found higher sediment grain-size near the container, which is very likely related to the hydrodynamic effects of the container on local flow patterns leading to net removal of fine sediments. These changes in sediments may be the cause of a drop in diversity and richness of the benthic infaunal community near the container site. Additionally, the surface of the container provides hard substrate for colonization by taxa usually found in association with rocky habitat, not sediment-covered seabed (Figure OS Hab1). However, some key taxa that dominate rocky habitat at this depth were absent or rare on the container, perhaps related to potential toxicity of the paint or limited time for colonization and growth. Overall, results indicate that the container has conferred a mild disturbance in a 10 m halo around the 30 m^2 container (an area of 600 m^2), which has lead to increased abundance for some species and lower abundance for others. Future study of the container and other debris on the seafloor is needed to determine the cumulative impact of debris on habitat quality and whether debris is a significant source of contaminants to sediments or local fauna.

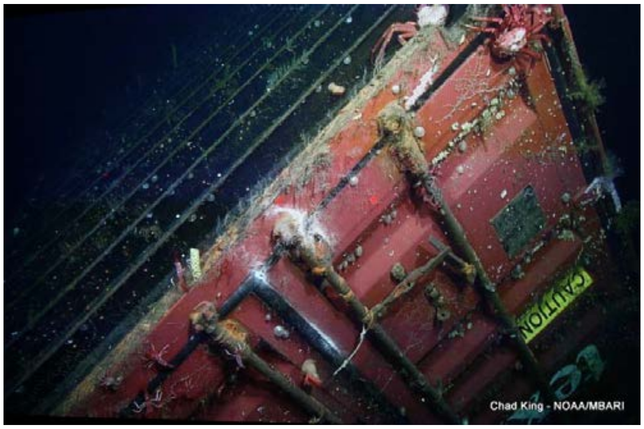

Figure OS Hab 1
Caption: Image of the lost shipping container located on a sediment-covered seabed at 1,281 m depth in Monterey Bay National Marine Sanctuary. A recent study found that the container has conferred a mild, local disturbance to the sediments and infauna in a 10 meter halo around the container (Taylor et al. 2014). The surface of the container has been colonized by many organisms including many types of structure-forming invertebrates such as crinoids, sponges and anemones.
Credit: Chad King, NOAA/MBARI

6. What is the condition of biologically-structured habitats and how is it changing?

The condition of offshore, biologically-structured habitats, including soft-corals, gorgonians, sponges, brachiopods was rated as "fair/poor" in 2009 based on the known negative impacts of bottom-contact fishing gear on biologically-structured habitats and the extensive use of these gears in the offshore environment in the past where these sensitive resources were likely to occur. As of 2009 there was very limited study of structure-forming species and the impact of trawling and other human activities had not been assessed broadly. The 2015 status rating remains "fair/poor**"** because the available new information provides mostly initial characterization of previously unexplored locations and there has been little repeated observation of sites to assess temporal changes in status of biologically-structured habitats.

The trend was "undetermined" in 2009 because it was unclear if resources had begun to recover in the portions of the sanctuary that had been recently closed to trawling. The trend in 2015 remains "undetermined" because there has been little additional information on the status of structure-forming species that may be improving in the areas closed to trawl gear. Condition of structure-forming species may be improving in the sanctuary because bottom trawling effort has declined, moved to areas with less sensitive habitat, and switched to less destructive gear. However, there are concern of declining condition of corals and other species with calcified body parts, due to ocean acidification, but limited information to assess this issue. More information is needed on both recovery from trawling and impacts of acidification to better assess this question.

Information on the distribution and condition of these organisms is limited, especially in more remote areas and in comparison to historic abundance and distribution patterns. The existing data was augmented by recent towed camera sled and ROV video surveys in limited areas of the outer shelf, upper slope, submarine canyons, and at Sur Ridge. For example, the sanctuary, in collaboration with MBARI, was able to explore Sur Ridge for the first time in 2013, and again in 2014. These first views of this large submerged rocky ridge revealed areas covered in extensive beds of deep sea corals and sponges (Figure OS Hab 2) and the unexpected discovery, on the south side, of some chemosynthetic biological communities (http://sanctuarysimon.org/news/2014/06/sur-ridge-and-lost-shipping-container-cruise-log-june-5-9-2014/).

Structure-forming species are generally slow growing and patchily distributed organisms that are sensitive to human activities that contact the seafloor. Lindholm et al. (2008) studied patterns in the distribution of the sea whip in an area impacted by mobile fishing gear off the central California coast and found that the marked difference in the occurrence of upright sea whips among video transects may be attributable to water depth and/or impacts from otter trawling. In a recent study of trawling impacts and recovery of soft bottom habitat at a depth of approximately 170 m off central California (Morro Bay area), Lindholm et al. (2015) found little to no detectable impact of trawling on the physical topography and biological community, except for persistent scour marks from trawling gear. In addition, the invertebrate assemblage in the study area was found to be highly variable in both space and time, suggesting that aspects of this habitat can be dynamic, making it difficult to understand and predict the impacts of trawling on the benthic community. These and additional recent publications on the impacts of bottom trawling on soft bottom habitat have noted that little has been written about recovery of seafloor habitat from the effects of fishing and that there is a lack of long-term studies to fully evaluate impacts.

Given that many areas that were previously trawled have been closed to trawling by a number of fisheries management actions (e.g., Trawl Rockfish Conservation Area, Essential Fish Habitat closures, California statewaters), it is likely that structure-forming invertebrates have been recovering and recolonizing formerly trawled areas. In addition, structure-forming species are likely receiving less impacts now that fishing effort with bottom trawl gear has declined overall in the sanctuary and the gear being used (i.e., small-footrope trawl gear) is less damaging to benthic resources. Bottom trawling also appears to have shifted to less sensitive habitat types and locations (see Offshore Question 8 for additional detail). Though it is likely that some recovery has and will continue to occur, these biologically-structured habitats may recover slowly

Comment [N50]: Field: In fact, most of the shelf break habitats (approximately 100 to 250 meters) have been closed as part of the rockfish conservation areas (RCAs) since 2003 (actually late 2002), the RCAs are discussed later with respect to question 8, it's not clear why 2007 was mentioned rather than 2003. Note too that references for those closures include Mason et al. (2012) who documents the closures and associated declines in effort, and Keller et al. (2014), who defines the increase in abundance of fishes within the closed areas.

Jenn: changed some text to remove the reference to a specific year. A number of actions were implemented in different years but including those specifics are not necessary to make the general point.

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or may never re-establish to their original abundance or composition even in the absence of future pressures.

The addition of hard structure to the seafloor – such as unburied submerged cables or marine debris composed of plastic, metal and glass – is a disturbance to the physical habitat and local abundance and distribution of benthic invertebrates. Recent studies of a lost shipping container and the unburied section of a submerged cable found an increase over time of the number of structure-forming species that require physical structure for attachment, such as crinoids and anemones, on and immediately adjacent to the structures (Figure OS Hab 1) (Kuhnz et al. 2011, Taylor et al. 2014).

One increasing concern about the condition of biogenic species is the potential impacts of changing ocean conditions on these species, many of which have calcified structures. We are not aware of specific studies of impacts of acidification on biogenic species in the sanctuary, but recent meta-analysis shows that acidification has a strong negative effect on calcification rates and abundance of corals (Kroeker et al. 2013). Directed study of the effects of climate driven changes in pH, temperature, and dissolved oxygen on structure-forming species will become increasingly important for understanding and tracking the status and condition of structure-forming species in the sanctuary in the future.

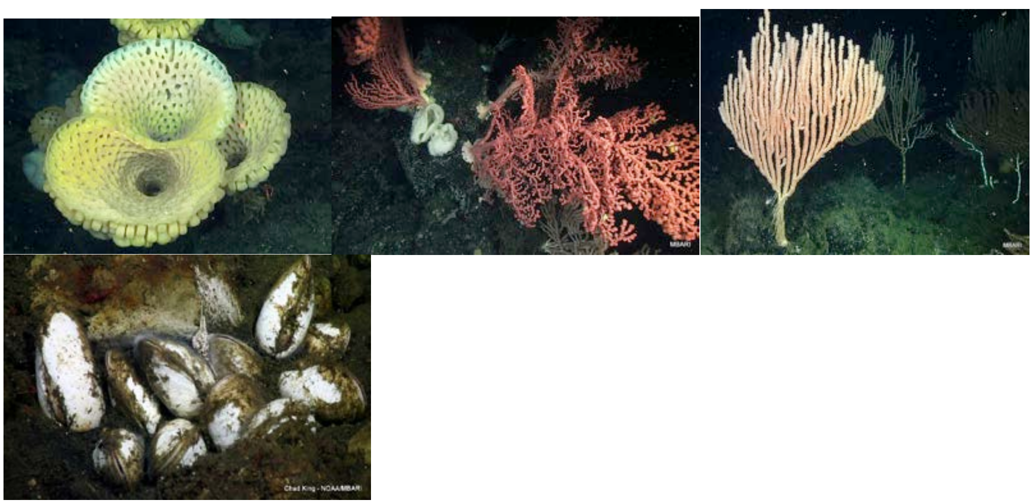

Figure OS Hab2
Caption: Two recent expeditions, which used video cameras on Remotely Operated Vehicles to explore the surface of Sur Ridge, found an abundance of structuring-forming invertebrates at this previously unexplored site, including goiter sponges (upper left), bubblegum corals (upper right), bamboo corals (lower left), and vesicomyid clams half-buried within a "cold seep" (lower right). Credit: MBARI

7. What are the contaminant concentrations in sanctuary habitats and how are they changing?

Based on elevated levels of pesticides in shelf and canyon sediments at sites offshore of urban and agricultural pollution sources the condition of offshore habitats was rated as "good/fair" in the 2009 report. The basis for this judgment was that trends in contaminant concentrations in offshore habitats had not been well studied. There was, however, limited research to suggest little to no attenuation in the concentration of some persistent contaminants in sediments on the continental shelf and continued inputs and delivery of some contaminants to deep sea habitats, such as submarine canyons (see 2009 MBNMS Condition Report for specifics). This limited information suggested an overall "declining" trend for this question.

There is no new information on contaminants in sediments, but given the rationale from the 2009 rating, there is no reason to believe that there has been a substantial decrease in the contaminant levels in sediments. New information does suggest that PCBs may be an even bigger problem than previously realized given new data that indicates an exponential increase in the amount of PCBs measured in the water column at two CCLEAN monitoring sites. For this reason, the new rating has been changed to "fair" with the same "declining" trend as in 2009.

In 2012-2013, the analysis of PCBs in water and wastewater treatment plant effluent was expanded from 71 congeners historically measured by CCLEAN to all 209 PCB congeners in order to better determine the source of the elevated PCBs. Measurement of all 209 congeners resulted in 60-70% higher total PCB concentrations compared to the 70 previously measured. This new information indicates that the historical total PCB concentrations could have been substantially higher. The Monterey Bay results were then compared to a site monitored just outside of San Francisco Bay by the Regional Monitoring Program (RMP) (http://www.sfei.org/tools/wqt) and the results were similar. However, the highest Monterey Bay results exceeded those at the Golden Gate (CCLEAN 2014, Figure OS Hab3). Even though total concentrations of PCBs were similar at the two sites, results for all 209 congeners were very different. There were much higher percentages of low-chlorine homologs in the Monterey Bay samples compared to the Golden Gate samples. Monterey Bay congeners were also more consistent than what was measured at the Golden Gate site, which were highly variable. This suggests different sources of PCBs at the two sites (CCLEAN 2014).

Several studies were reviewed to determine if there was a connection between PCBs found in sanctuary waters with PCB contamination in killer whales (*Orcinus orca*) and the marine mammals on which they feed. Ross et al. (2000a) divided the eastern North Pacific killer whales into three populations; northern resident, southern resident and transient. Whales seen on the Central Coast that primarily consume other marine mammals are generally from the transient population. The total PCB concentrations were surprisingly high in all three populations, but especially high in the transients. Even with the contrasting diets of the resident and transient killer whales, the mean congener-specific PCB profiles were similar among the three populations. The profiles were dominated by higher chlorinated congeners, with most of the lower congeners being absent or present at very low levels. The role of age, sex, and dietary preference is strongly related to contaminant accumulation and it is unclear how and if the lower PCBs congeners are metabolized or are absent. Adult females showed lower PCB concentrations during reproductive years beginning at 15 years old and showed increases again at 50 years old. Females transfer approximately 60% of organochlorines to their offspring through reproduction and lactation (Ross et al. 2000a).

After better understanding the PCB signature in transient killer whales, an attempt was made to research the PCB signature in the food they eat and its effects. Persistent organic pollutants (POPs) are found in lipid rich blubber layers of marine mammals around the world (O'Shea et al.

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Comment [N51]: Field: discussion of PCB levels in the food web, it is pointed out that there are frequently consumption advisories for lakes, rivers, bays and coastal areas- my understanding is that bays with much more limited circulation or exchange (and more substantive anthropogenic impacts), such as San Francisco Bay or San Diego Bay are far more likely to have such warnings than more open Bays, such as Monterey Bay- this could be worth pointing out (assuming it is true).

1999). PCB levels have been associated with a high prevalence of cancer in California sea lions (*Zalophus californianus*) including immunotoxic and reproductive impacts (Ross et al. 2000b, Ylitalo et al. 2005). In a study by Hall et al. (2008) they measured changes in blubber contaminant concentrations in California sea lions associated with weight loss and weight gain during rehabilitation. They found that total DDTs dominated the contaminant profiles followed by total PCBs and total PBDEs. During mass loss, the lower chlorinated PCB congeners, chlordanes and hexachlorocyclohexanes were lost at a higher rate than the other contaminant classes such as PBDEs. The preferential mobilization of the lesser chlorinated PCBs has also been reported in gray seals (*Halichoerus grypus*) during lactation fasting (Debier et al. 2003) and in gray and Northern elephant seals (*Mirounga angustirostris*) during post-weaning fast (Debier et al. 2006).

Because of the different PCB profiles between water and sediment samples, as well as natural degradation and physiological processes, it is difficult to make a direct connection between sources of PCBs and their uptake and effects on marine organisms. A Stream Pollution Trends (SPoT) program report measured PCBs and found low concentrations and no acute invertebrate toxicity due to PCBs in sediments from central coast watersheds (Phillips et al. 2014). The negative effects occur as the PCBs begin to bio-accumulate in the food web as demonstrated above. While concentrations in fish do not often exceed thresholds of concern (Davis et al. 2010), numerous fish consumption advisories have been issued for lakes, rivers, bays, and coastal areas within California due to these contaminants. While we cannot make a definitive linkage between PCBs coming off the land, measured in sanctuary waters and sediment, and found in killer whale tissues, we can state that: (1) PCBs are elevated in the offshore waters of Monterey Bay, (2) PCBs are elevated in marine mammal tissues, (3) the congener profiles are different in water and mammal tissues, with lesser chlorinated congeners in water and more highly chlorinated congeners in mammals, (4) lower chlorinated congeners appear to be excreted or metabolized in smaller mammals preyed upon by killer whales, and (5) marine mammals in Monterey Bay are highly contaminated by persistent organic pollutants, including PCBs.

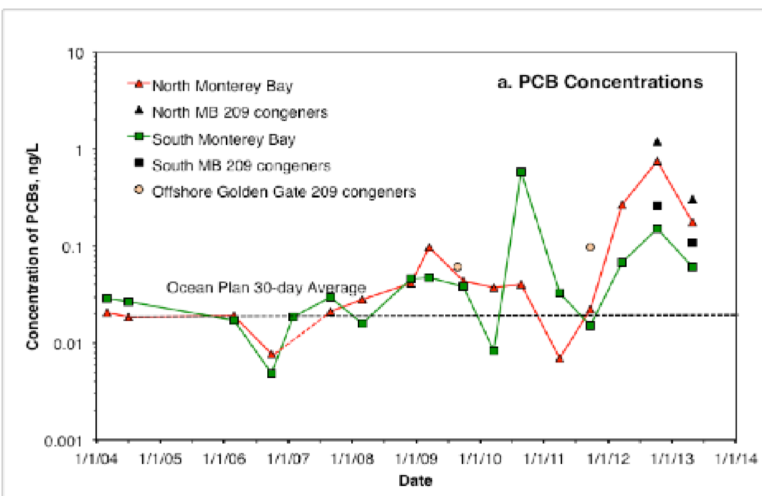

Figure OS Hab3.
Caption: Concentrations of PCBs historically measured in nearshore waters at two CCLEAN sites in Monterey Bay, compared with results from measurement of 209 congeners in program year 2012–2013 and two samples collected off the Golden Gate Bridge.
Source: CCLEAN 2014

8. What are the levels of human activities that may influence habitat quality and how are they changing

The level of human activities that influence habitat quality in the offshore environment was rated as "fair/poor" in the 2009 Condition Report primarily because bottom-contact fishing gear had been employed widely for many decades and additionally because marine debris had been accumulating for decades in offshore habitats. The 2015 status rating is changed to "fair" based on decreases in both overall effort and spatial extent of fishing with bottom trawl gear as compared to the past when it was more widespread and occurred in areas with more sensitive habitats. In addition, new studies indicate that impacts of bottom trawling gear, submerged cables, and marine debris on soft bottom habitats are localized. The trend in 2009 was "improving" because level of fishing with bottom contact fishing gear had been reduced by landing restrictions, gear restrictions, and area closures. The trend in 2015 remains "improving" because bottom trawling, which is the most damaging human activity in the offshore environment, has decreased in spatial distribution and intensity, especially in areas with most sensitive resources. Inputs of marine debris and contaminants continues, but unclear if there has been an increase in the rate of these activities.

Overall trawling effort, as evidenced by catch from bottom trawl fishing inside the sanctuary boundary, appears to be much lower recently as compared to the higher levels that occurred 2000-2003 and appears to have stabilized between 2009-2012 at around 1 million pounds (Figure OS Hab 4; Leeworthy et al. 2014). These decreases in the overall trawling and bottom fishing effort are likely due in part to changes in fisheries management. In the 2009 condition report, there were concerns that area closures might lead to redistribution of fishing effort and increased fishing pressure in areas open to bottom trawl fishing. New information on the general distribution of change in fishing effort using bottom trawl gear along the U.S. West Coast before (2002-mid-2006) and after (mid-2006-2010) implementation of Essential Fish Habitat area closures shows that effort has been redistributed inside the sanctuary (Figure OS Hab 5; NMFS 2013a, b). Decreases in effort mostly occurred in or adjacent to the state waters off the San Mateo county coast and in northern Monterey Bay, and the outer shelf off Point Sur. The majority of large or moderate increases in effort occurred in soft-bottom habitat on the outer shelf and upper slope flanking the Trawl Rockfish Conservation Area in the northern half of Monterey Bay sanctuary.

In 2011, the Pacific Fisheries Management Council implemented an individual fishing quota (IFQ) program in the federal west coast bottom trawl fishery. Goals of IFQ management included decreased bycatch and increased catch accountability, profitability, and efficiency. In addition, each vessel is now required to carry a federal observer on all fishing trips. This additional change in fisheries management has likely lead to shifts in bottom trawl fishing effort within the sanctuary. Somers et al. (2015) summarized some changes in distribution and intensity of bottom trawl effort since the implementation of the IFQ program. However, little of the log book data on changes in bottom trawl effort could not be shown in Monterey Bay sanctuary due to confidentiality limitations on public access to the data.

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A recent study off central California of impacts to benthic habitat and living resources from high and low intensity trawling with small footrope gear found that, although there were some detectable impacts to seafloor sediment structure, changes in associated infauna, epifauna, and structure-forming species were difficult to detect (Lindholm et al. 2015). The invertebrate assemblage in the study area was found to be highly variable in both space and time, suggesting that aspects of this habitat can be dynamic, making it difficult to understand and predict the impacts of trawling on the benthic community. Impacts of trawling appear to be specific to the time and location of the activity. The magnitude and duration of any impacts will likely be dependent on the faunal community and the physical and ecological processes occurring at the site at the time of impact.

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Three other concerns about negative impacts of human activities on the quality of offshore benthic habitats are installation of submerged cables, accumulation of contaminants and marine debris (e.g., trash, lost fishing gear) on the seafloor. Studies of submerged cables in the sanctuary have shown little measurable impacts of the cable on physical habitat after the initial installation phase is complete and some increases in local abundance of structure-forming invertebrates, such as anemones and crinoids, that use exposed segments of the cable as hard substrate for attachment (Kogan et al. 2006, Kuhnz et al. 2011). Contaminants in offshore habitats is still a concern as was discussed in the 2009 MBNMS Condition Report (ONMS 2009). The limited new information on contaminants in habitats, with a focus on increasing PCB levels in the offshore waters of the sanctuary, and possible impacts to living resources is discussed in Offshore Question 7.

Recent studies of marine debris in offshore habitats have found that marine debris can be quite abundant on portions of the deep-sea floor in the sanctuary. Schlining et al. (2013) reviewed patterns in marine debris observed using 22 years of video footage from Monterey Bay covering depths from 25-3,971 meters. The majority of debris was plastic (33%) and metal (23%) and debris was most abundant in Monterey Canyon, suggesting that submarine canyons act as conduits for debris transport from coastal to deep-sea habitats (Figure OS Hab 6). This study, as well as two others of marine debris in shallower (15-450 m; Aiken et al. 2014) and deeper (1,281 m; Taylor et la. 2014) habitats, suggest that impacts of marine debris on habitats and associated animals communities are fairly localized and can be negative for some faunal groups (e.g., some soft-bottom associated infauna and epifauna) and positive for others (increased abundance of fish and invertebrate taxa found in association with rocky habitat and structure-forming species).

There are some efforts to reduce inputs of debris into the sanctuary through little clean ups on beaches and in watersheds (see Nearshore Question 8 for more detailed information). In addition, over three years (2009-2011) Monterey Bay sanctuary staff, working with partners, removed more than 1,000 pounds of lost fishing gear from the offshore habitats in the sanctuary that posed hazards to benthic and pelagic marine organisms (De Beukelaer and Grimmer 2014; http://montereybay.noaa.gov/resourcepro/resmanissues/lostgear.html).

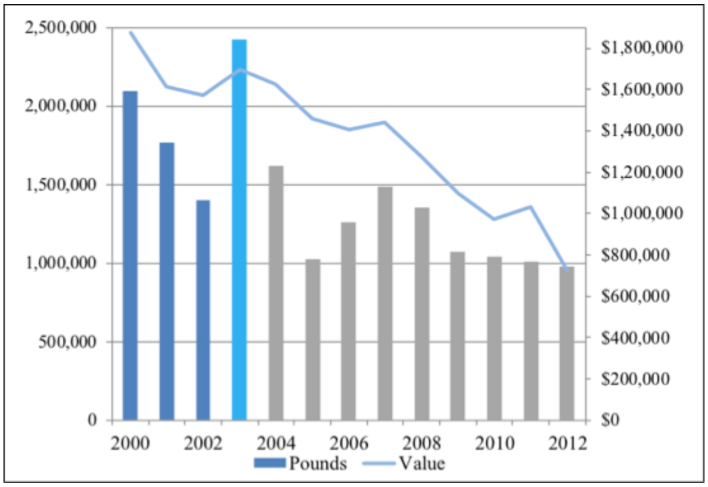

Figure OS Hab 4
Caption: Volume (bars) and value (line) of trawl catch from reporting blocks in Monterey Bay sanctuary from 2000 to 2012. Recent catch volume is much lower than the high that occurred in 2003 of 2.4 million pounds. Catch appears to have stabilized, hovering around 1 million pounds, and just below $1 million in value since 2009. [Note: need to change bars to all one color]
Credit: Leeworthy et al. 2014

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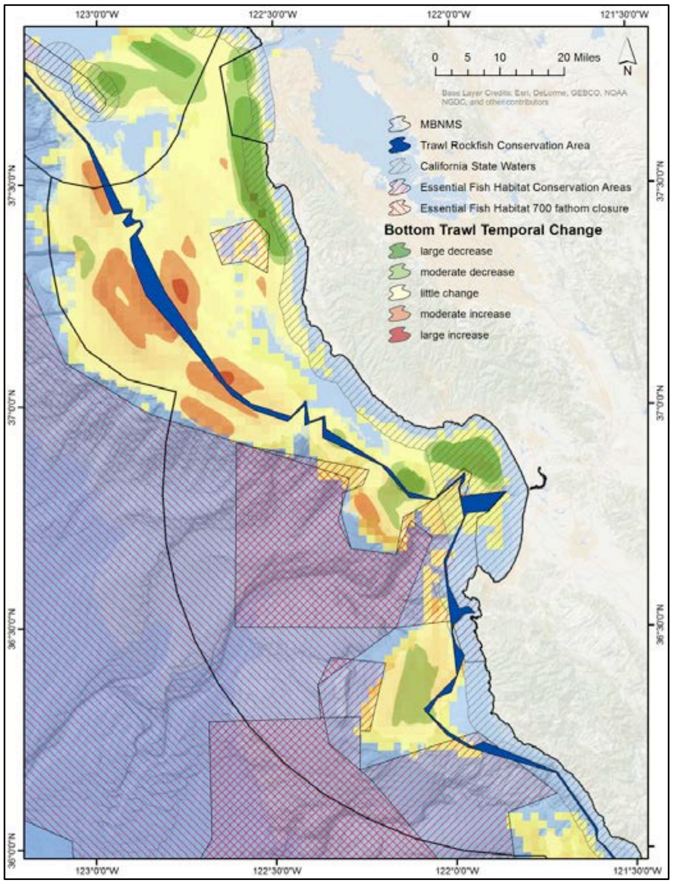

Figure OS Hab 5

The generalized distribution of change in fishing effort using bottom trawl gear in MBNMS (black boundary) before and after implementation of Essential Fish Habitat closures in mid-2006 (red hatched areas) that prohibit the use of bottom trawl gear. This data layer was created by the National Marine Fisheries Service using trawl logbook data which can be used to show the general locations of increased and decreased fishing effort, but not the exact footprint of actual fishing. 'Before' data is from January 2002 to mid-2006 and 'After' data is from mid-2006 to December 2010. The map does not show change in fishing effort south of 36º latitude because, due to confidentiality, little of that information is publicly available. Additional areas closed to bottom trawling are shown: Trawl Rockfish Conservation Area (Trawl RCA) (blue) which was implemented in 2003 and California state waters (gray hatching) where trawling has been banned since 2006 however prohibition of bottom trawling in statewaters began in 1953 in this area. The minimum extent of the Trawl RCA has been 100-150 fathoms (shown on map), but the extent of this boundary has fluctuated with a maximum extent of 0-200 fathoms.

Data source: NMFS 2013 a, b

Map: S. De Beukelaer, MBNMS

Comment [N52]: Field: Figure OS Hab 5 (page 108) shows changes in fishing effort before and after various closed areas. It's hard to understand just where the data are from or how they were analyzed (if they are block summary data from 10' by 10' blocks reported in trawl logbooks then the degree of spatial precision is overrepresented). More to the point, the figure indicates a fairly strong increase in effort inside of the Rockfish Conservation Area (RCA) off of Pigeon Point (just south of increases in effort just inshore and offshore of the RCA off of Half Moon Bay)- I think the analyst should take a closer look at the data or methods, because if there is really an increase in effort in the RCA then there is some serious illegal fishing happening, but given the vessel monitoring systems and other enforcement mechanism I think that such an increase within the RCA is unlikely.

Jenn – created new map and caption to try to address reviewer concerns. This new map, text, and caption are under review by data provider (NMFS)

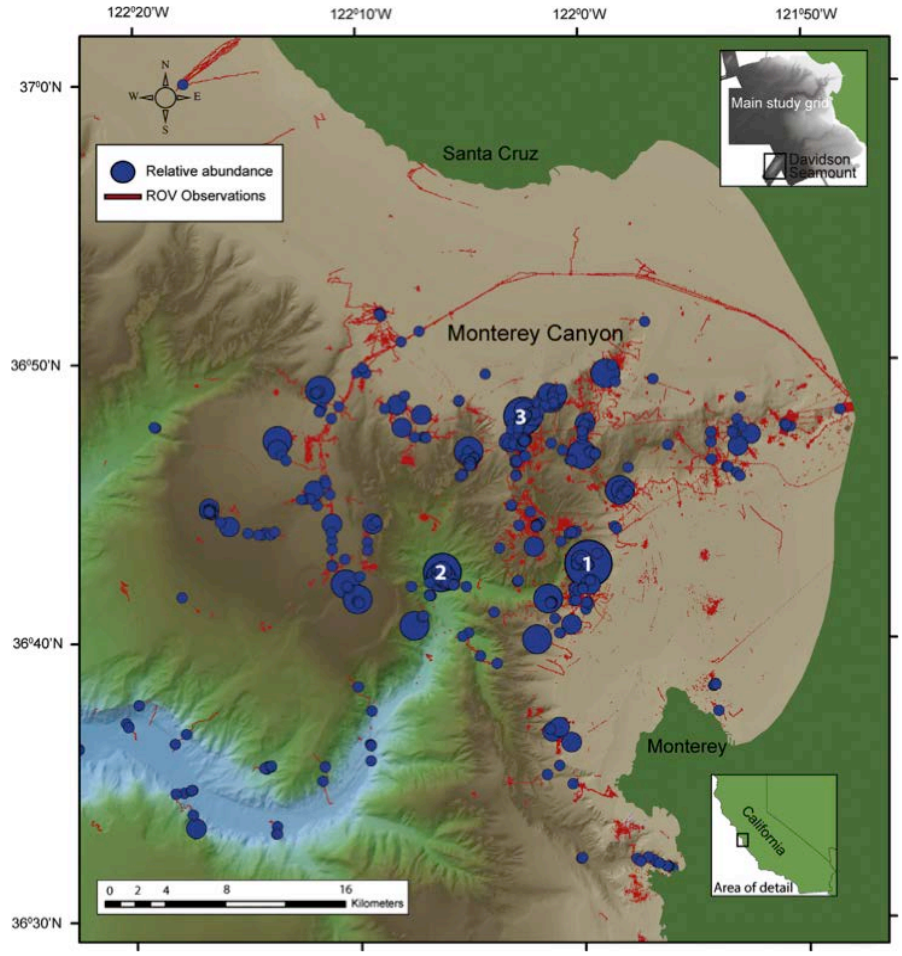

Figure OS Hab 6
Caption: Distribution and relative abundance of marine debris observed in Monterey Bay. Tracks of MBARI ROV surveys over the 22- year study period are shown in red. The relative abundance of trash was normalized by the amount of time spent searching the seafloor; the largest circles depict areas of trash accumulation which tend to occur on the outside walls of canyon meanders where high-energy water flow and erosion occur. The main study grid (upper inset) extended to the abyssal plain and included Davidson Seamount, about 130 km to the southwest.
Credit: Schlining et al. 2013 [Note: need to get permission to use figure]

Offshore Environment Habitat Status & Trends

Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

▲ = Improving — = Not changing ▼ = Declining

? = Undetermined trend **N/A** = Question not applicable

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
5	Abundance/ Distribution	▲	Status: High Trend: Medium	Benthic habitat loss and modification due to fishing with bottom-contact gear; recovery of seafloor habitats likely occurring in some locations following reductions in this activity.	Selected habitat loss or alteration may inhibit the development of assemblages, and may cause measurable but not severe declines in living resources or water quality.
6	Biologically-Structured	?	Status: High Trend: Medium	Damage to and loss of structure-forming and structure-building taxa due to trawl fishing. Recovery likely occurring in some locations and for some taxa following reductions in this activity, however concerns that ocean acidification is negatively impacting these species.	Selected habitat loss or alteration has caused or is likely to cause severe declines in some but not all living resources or water quality.
7	Contaminants	▼	Status: High Trend: High	Exponential increase in amount of PCBs in water samples from two sites. Marine mammals are contaminated by PCBs. No evidence of strong ecosystem level effects. No additional information on contaminant levels in ocean sediments.	Selected contaminants may inhibit the development of assemblages and may cause measurable but not severe declines on living resources or water quality.
8	Human Impacts	▲	Status: High Trend: High	Decreases in both overall effort and spatial extent of fishing with bottom trawl gear. Inputs of marine debris and contaminants continues. Impacts of submerged cables and marine debris appear to be localized.	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.

Questions that have new information to report since the 2009 Monterey Bay National Marine Sanctuary Condition Report (ONMS 2009) are those with red numbers.

Offshore Environment: Living Resources

Biodiversity is variation of life at all levels of biological organization, and commonly encompasses diversity within a species (genetic diversity) and among species (species diversity), and comparative diversity among ecosystems (ecosystem diversity). Biodiversity can be measured in many ways. The simplest measure is to count the number of species found in a certain area at a specified time. This is termed species richness. Other indices of biodiversity couple species richness with a relative abundance to provide a measure of evenness and heterogeneity. When discussing “biodiversity” we primarily refer species richness and to diversity indices that include relative abundance of different species and taxonomic groups. To our knowledge no species have become extinct within the sanctuary, so native species richness remains unchanged since sanctuary designation in 1992. Researchers have described previously unknown species (i.e., new to science) in deeper waters, but these species existed within the sanctuary prior to their discovery. We do not include non-indigenous species in our estimates of native biodiversity; the status of non-indigenous species in the sanctuary is addressed in question 11.

Deleted: The number of non-indigenous species has increased within the sanctuary.

Key species, such as keystone species, indicators species, sensitive species and those targeted for special protection, are discussed in the responses to questions 12 and 13. Status of key species will be addressed in question 12 and refers primarily to population numbers. Condition or health of key species will be addressed in question 13. Key species in the sanctuary are numerous and all cannot be covered here. Emphasis is placed on examples from various primary habitats of the sanctuary for which some data on status or condition are available.

The following information provides an assessment of the status and trends pertaining to the current state of the sanctuary's living resources in the offshore environment.

9. What is the status of biodiversity and how is it changing?

Thorough historic and current inventories are not available to fully measure biodiversity status and trends in the sanctuary. Based on the best available information the status of native biodiversity in the offshore habitats of the sanctuary was rated "fair" in the 2009 MBNMS Condition Report because, although native species richness remained unchanged, the relative abundance of many species and taxonomic groups had been substantially altered by both natural and anthropogenic pressures. Shifts in the relative abundance of multiple species, especially those at higher trophic levels, are indicators of compromised native biodiversity in the system and impact community and ecosystem structure and function. However, the cumulative trend in biodiversity was "undetermined" due to a lack of information on the changes in relative abundance of many deep-sea species and an uncertainty in how to combine the individual trends in species abundance into a cumulative trend in biodiversity.

Recent trends in abundance are available for a number of key species and is summarized in more detail in Offshore Question 12. Additionally, some new information on biodiversity of pelagic forage and soft-bottom infaunal groups will be discussed below. Based on the available information, the 2015 status of biodiversity will remain "fair," with a trend of "not changing" because, though some species and faunal groups have increased or decreased on average since 2009, overall biodiversity in the offshore environment does not appear to have increased or decreased significantly during this time. Many of the species and faunal groups for which we have time-series data appear to have fluctuated within the range that is expected based a longer time series.

Comment [N53]: Field: - rating this as "not changing" in the trend seems just plain wrong to me when accompanying the "not changing" designation was the recognition that "most of the key species and faunal groups for which we have data are stable or increasing," which is clearly true for many mammal, bird and fish populations.

Jenn – I have tried to provide more clear basis for judgement on the trend.

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Deleted: most of the key species and faunal groups for which we have data are

Deleted: stable or increasing.

A historical perspective suggests that many of the higher trophic level species in the offshore environment, such as marine mammals, seabirds, and predatory fishes, are at reduced abundances. The most recent stock assessments by the National Marine Fisheries Service finds that most mammal stocks in the sanctuary are stable or slowly increasing in abundance (Carretta et al. 2013). Some locally breeding seabirds have experienced average (e.g., Common Murre) to above average (e.g., Cassin's Auklet) reproductive success in recent years, while reproductive success of others (e.g., Brandt's Cormorant) has been below average (see Offshore Question 12 for more detailed information). Levin et al. (2006) found that decades of fishery extraction contributed to changes in the fish assemblage on the continental shelf and slope with the species that dominate the shelf/slope assemblage having vastly different trophic roles and life-history strategies than the species they replaced. Though recent changes in fishery management has led to improving stock status for overfished species (NMFS-CCIEA 2014), it is unclear if the

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Deleted: (e.g., Cassin's Auklets, Rhinoceros Auklets, Pigeon Guillemot, Pelagic Cormorant) relative abundance of functional groups has started to change back to those conditions observed many decades ago.

A newly derived index of species richness of the epipelagic forage community, based on the presence of 68 taxa collected in mid-water trawl nets by the National Marine Fishery Service Southwest Fisheries Science Center's (NMFS-SWFSC) Rockfish Recruitment and Ecosystem Assessment Surveys, can be used to explore spatio-temporal patterns of diversity over the last 25 years and regional ocean conditions (Figure OS LR 1; Santora et al. 2014; J. Santora, 2011-2014 unpublished data). The midwater trawl samples used to create this index have been collected each May and June since 1990 and include fixed sampling stations over the shelf and out to the 2,000 m isobath between the Monterey peninsula and the Gulf of the Farallones (Santora et al. 2012). Interannual variability of species richness largely reflects production of juvenile rockfish (*Sebastes* spp.). Observed species richness of the epipelagic forage community is slightly higher in samples collected from the Monterey Bay and Oceanic regions (offshore sites) as compared to the Shelf region (Figure OS LR 1b). In addition, species richness was lower at times during warm water conditions and higher during cool water conditions; this pattern is coherent among all three ecological regions (Shelf, Oceanic and Monterey Bay). Relatively high forage species richness was observed from 2009-2014, a period with generally cool and productive conditions (Figure OS LR1c).

Comment [N54]: Field: note that the surveys actually began in 1983, not 1990, it's just that many of the non-rockfish species were not enumerated accurately until 1990. Since 2004 the survey has included the region from the U.S./Mexico border to Cape Mendocino, prior to 2004 it was primarily a central California only survey.

Jenn: I changed some text to clarify the information provided is specific to the subset the data that was used to make the index (not the total data collected by this monitoring effort).

The abundance of jumbo squid (*Dosidicus gigas*) observed during MBARI's midwater ROV surveys in Monterey Bay has increased recently in the sanctuary (Panel D in Figure OS WQ1) which may be impacting both regional and local biodiversity. This species may affect local biodiversity by driving changes in the pelagic food web due to it being both a voracious predator of a variety of pelagic and semi-pelagic fishes (e.g., Pacific hake, Pacific herring, northern anchovy, sablefish, salmonids, various rockfishes, myctophid fishes, squids; Field et al. 2007, Field et al. 2013) and an important forage item for many higher trophic level fishes and marine mammals, including toothed whales and tunas, billfishes and sharks (Field 2008). These animals are likely to play a major role in structuring offshore ecosystems. The cause of the observed range expansion of jumbo squid has not been determined; possible contributing factors include the recent cool phase of the Pacific Decadal Oscillation, harvest of large pelagic predators, and shoaling of the OMZ due to global climate change (Stewart et al. 2014).

Biodiversity in deep-sea communities of the sanctuary is not well understood because of the logistical challenges of conducting research in deep water. A recent study compared patterns of biodiversity of infaunal communities in sediments collected from various locations on the shelf and slope of the sanctuary (Oliver et al. 2011). This study found 1,521 species of macrofaunal invertebrates in 32 m^2 of bottom sampled, which is one of the highest species density reported from soft-bottom habitats worldwide. Samples from the shelf (30-150 m) had higher species density, larger number of animals, and greater evenness of relative abundance compared to samples from the slope (250–2000 m), which suggests that the complexity of biological interactions may be higher on the shelf than on the slope. The highest number of species was observed at the shelf–slope break (100–150 m) coincident with the location of breaking internal waves in the Monterey Bay and under an upwelling plume and production hot spot. Future repeated sampling of these or similar locations would be useful to track patterns in diversity of infaunal communities over time.

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There are indications that deep-water sponge and coral communities in the sanctuary have been impacted by human activities before many aspects of their basic biology and ecology could be ascertained (J. Barry, MBARI, pers. comm.) and there is little repeated monitoring of these benthic resources to track changes in condition and potential recovery from past impacts. Overall, there is much that is unknown about the species richness and evenness of several important communities within the offshore habitats of the sanctuary.

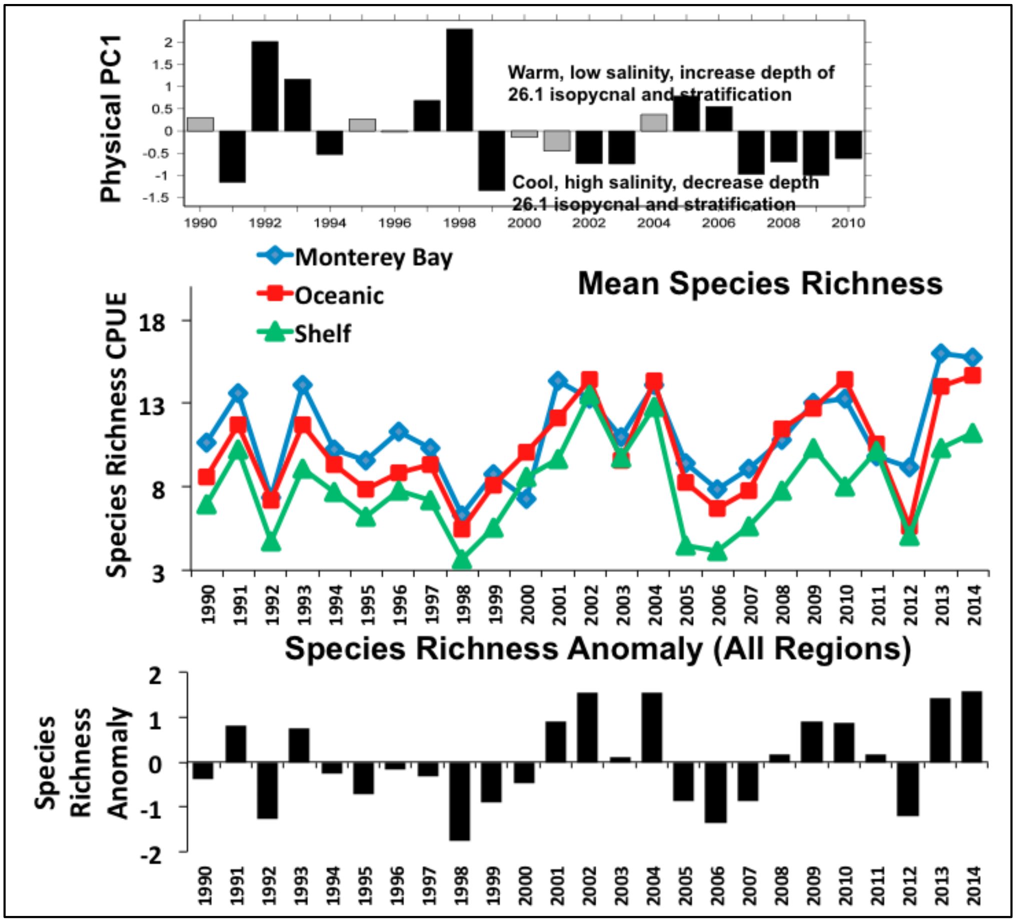

Figure OS LR1

Caption: (a) Multivariate index of regional ocean conditions off central California derived from National Marine Fishery Service Southwest Fisheries Science Center's Rockfish Recruitment and Ecosystem Assessment Surveys (RREAS) hydrographic sampling stations (values less than +0.5 and greater than -0.5 are shaded gray), (b) interannual variability of mean species richness (mean number of species per trawl station; repeated sampling during May-June at depth of 30m) catch-per-unit-effort (CPUE) among RREAS stations characterized as shelf, oceanic, and Monterey Bay, and (c) anomaly of species richness across all stations (mean removed and divided by long-term standard deviation; 1990-2014).

Source: (a) Santora et al. 2014; (b) and (c) J. Santora, unpublished data

10. What is the status of environmentally sustainable fishing and how is it changing?

We are no longer assessing this Question in ONMS Condition Reports so content for this question was not updated.

11. What is the status of non-indigenous species and how is it changing?

The status of non-indigenous species in offshore habitats was rated "good" and "not changing" in 2009 because very few non-indigenous species have been identified in offshore habitats and those that are present do not appear to affect ecosystem integrity (ONMS 2009). The rating remains "good" and "not changing" because we are not aware of substantial new information on the status of non-indigenous species in the offshore habitats of Monterey Bay sanctuary.

12. What is the status of key species and how is it changing?

The status of key species in the offshore environment was rated "good/fair" and the trend was "not changing" in 2009 based on the known population sizes of many high-profile species in the offshore environment, including marine mammals, seabirds, pelagic fishes (e.g., salmon, tunas, sharks) and sea turtles. Many of these are apex predators and play important ecological roles in the sanctuary ecosystem. On-going monitoring of many of these species, along with new data on a few other key components of the offshore ecosystem, reveal that population sizes are changing, but mostly within the range that is expected based on long-term time series. Therefore, the 2015 rating for key species remains "good/fair" and "not changing."

Below we briefly provide updated information on the status of a number of key species that play important ecological roles in the sanctuary ecosystem as either predators or the forage base for the pelagic system.

Most marine mammals (e.g., whales, dolphins, seals, sea lions) that are residents or seasonal visitors to Monterey Bay sanctuary are stable or increasing in abundance at the population level based on the most recent stock assessments by the National Marine Fisheries Service (Carretta et al. 2013). The local abundance of mammal species that migrate to the sanctuary to forage (e.g., humpback, blue and fin whales) is strongly influenced by the abundance and distribution of their prey, such as krill, sardine and anchovy. Breeding success of locally breeding seabirds has varied recently by species; Cassin's auklet has had higher than average breeding success, Common Murre breeding success has fluctuated around the long-term mean, and Brandt's Cormorant breeding success was very low until a very successful year in 2013 (Figure OS LR 2; Elliott and Jahncke 2014).

Salmon and groundfish are key species in the sanctuary due to their important role in both the offshore food web and in commercial and recreational fisheries. Many of the stocks of salmon in central California have been listed under the federal Endangered Species Act http://www.nmfs.noaa.gov/pr/species/esa/listed.htm#fish. As of 2013, the abundance of Coho and Chinook salmon stocks that use the offshore environment of Monterey Bay sanctuary are at reduced abundance levels and many show declining trends (Wells et al. 2014a). That status of groundfishes (e.g., rockfishes, flatfishes) has improved compared to 2009 based on recent stock assessments by the National Marine Fisheries Service and Pacific Fisheries Management Council (http://www.pcouncil.org/groundfish/stock-assessments/). As of 2013, three assessed stocks (canary rockfish, yelloweye rockfish, Pacific ocean perch) are in an overfished state but increasing in abundance (as compared to seven stocks in an overfished condition in 2009) and there is no recent indication of overfishing on any assessed groundfish stocks which suggests increasing relative abundance of groundfish in the offshore environment (Cope and Haltuch 2014).

Forage species directly and indirectly support the tremendous abundances and species diversity of higher trophic levels. The annual abundance of seven key forage groups has been monitored each year (May-June) off central California since 1990 by the NMFS-SWFSC Rockfish Recruitment and Ecosystem Assessment Surveys (Figure OS LR 3; Wells et al. 2014b). Notably, 2013 and 2014 had some of the highest observed densities of young-of-the-year (YOY) rockfish, sanddab and market squid ever observed by this survey. Krill abundance has been high and unusually stable since 2009 and Pacific sardine and northern anchovy has been low abundance during this same period. Years with high numbers of YOY groundfish, market squid and krill are generally associated with cooler ocean conditions and high levels of upwelling and productivity, which in turn are associated with greater breeding success and productivity of many of the higher trophic level predators that forage on this assemblage, such as seabirds and salmon (Santora et al. 2012, Wells et al. 2012). The lower abundance of anchovy and sardine during such years may reflect localized availability (these stocks may be distributed further south and/or offshore during high upwelling conditions during the period in which this survey operates (Wells et al. 2014b).

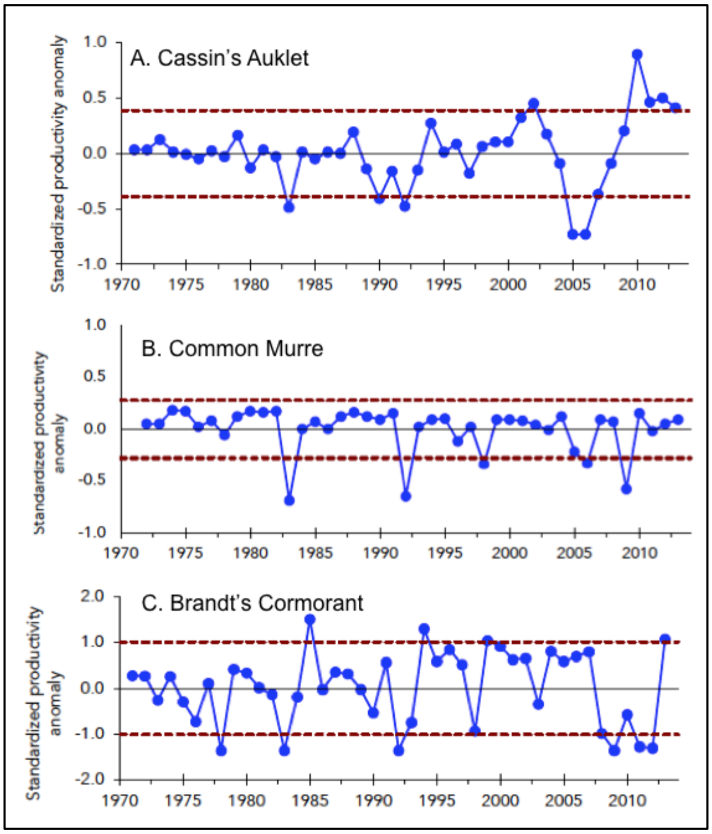

Figure OS LR 2
Caption: Breeding success anomalies for (A) Cassin's Auklet, (B) Common Murre, and (C) Brandt's Cormorant on Southeast Farallon Island, 1971-2013. Solid black line represents long-term mean, and dotted red lines represent ± 80% confidence intervals.
Source: Elliot and Jahncke 2014

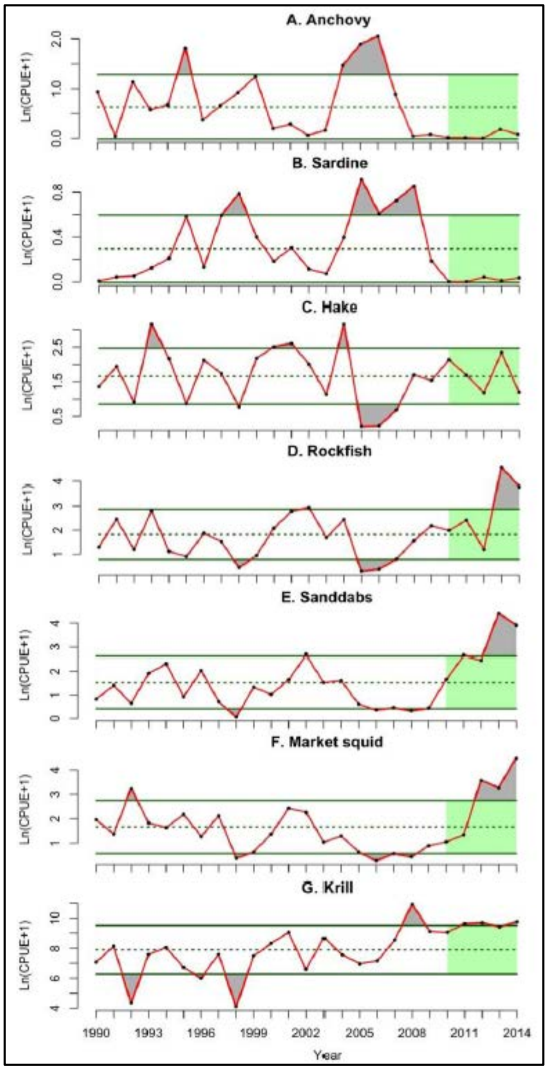

Figure OS LR 3
Caption: The annual geometric means of catch-per-unit effort (CPUE) from NMFS-SWFSC Rockfish Recruitment and Ecosystem Assessment Surveys for seven key pelagic forage groups: (A) adult northern anchovy, (b) adult Pacific sardine, (C) juvenile Pacific hake, (D) young-of-the-year rockfish, (E) juvenile sanddabs, (F) market squid (multiple life stages), and (G) adult krill. These fishery-independent midwater trawl surveys have occurred each year in May-June off central California since 1990. Horizontal lines show the mean (dashed line) ± 1.0 standard deviation (solid lines) of the full time series, gray shading = 95% confidence intervals. Light green shading highlights the most recent five years in the time series.

Figure: Wells et al. 2014b

13. What is the condition or health of key species and how is it changing?

The condition of key species in the offshore environment will continue to be rated "good/fair" and "declining" (ONMS 2009). The available new information, though limited, in consistent with the 2009 assessment that the health of several key species is impacted by exposure to neurotoxins produced by harmful algal blooms (HABs), entanglement in active and lost fishing gear, ingestion of marine debris, and accumulation of persistent contaminants. The continued input of non-biodegradable marine debris and persistent contaminants into the offshore waters of the sanctuary combined with the lack of attenuation of legacy contaminants, suggests that these threats to the condition of key species may have slowly increased over the past decades and are likely to continue to slowly increase in the future. Though the threats posed by persistent contaminants, HABs and marine debris are fairly pervasive in the world's oceans (NRC 2008, http://www.whoi.edu/redtide/regions/world-distribution, http://www2.epa.gov/international-cooperation/persistent-organic-pollutants-global-issue-global-response#resources), it is useful to highlight these issues in MBNMS and provide an update of available data to inform future research and management efforts to reduce these impacts to key species in the sanctuary.

Below we will briefly summarize some new information on health impacts to key species, except for health impacts from contaminants which is summarized in the response to Offshore Question 7 and increases in frequency of harmful algal blooms which is summarized in the response to Nearshore Questions 2.

The Marine Mammals Center, a rehabilitation center on the central California coast, tracks the cause of strandings of marine mammals including animals stranding on beaches in the Monterey Bay sanctuary. Domoic acid, a neurotoxin produced by the diatom *Pseudo-nitzschia,* has been and continues to impact the health of key species. The annual number of marine mammals that stranded on sanctuary beaches from 2008- 2014 and were determined to have died from acute domoic acid toxicity ranged from a low of eight (in years 2008, 2012, 2013) to highs of 55 (2014) and 68 (2009) animals (Figure OS LR 4; Marine Mammals Center, unpublished data). Each year marine mammals, mostly seals and sea lions, strand on beaches in the sanctuary due to interaction with active and lost fishing gear (e.g., fishing nets, crab pots, fishing hooks, monofilament line) or entanglement in other man-made debris (e.g., packing straps, plastic bags, rope) (Figure OS LR 4; Marine Mammals Center, unpublished data).

Entanglement of large whales (primarily humpback whales and gray whales) in active or lost fishing gear and other man-made lines (e.g., buoy lines) appears to be on the rise (http://sanctuarysimon.org/news/2015/09/whale-entanglements-a-summary-as-of-august-2015/). For the period from 2014 to July 2015, there were 46 large whale entanglement events confirmed along the U.S. West Coast, with 35 of those in California, (14 of which were in Monterey County). In comparison, for the entire west coast from 1990 to 2009 the number of whale entanglement reports was about 10 per year (see new Figure). The cause of the recent spike in entanglement events is not clear. Potential contributing factors include increasing whale populations, increasing public awareness of reporting of entanglements, and increasing spatial overlap of human activity (e.g., fishing, whale watching) and whale activity (e.g., foraging, migrating). Whales that migrate close to shore or come close to shore to feed enter a region

Comment [N55]: Field: describing the health of key species as "declining" here is, I think, subject to alternative interpretation of the evidence. The large stranding events of Cassin's auklets and California Sea Lions are described as indications of low prey availability and unusual ocean conditions, this is true, but the same unusual ocean conditions were responsible for the unusually high reproductive success of breeding Cassin's auklets in 2014 that likely contributed to the high profile nature of the event (this is recognized in the text). With respect to the California sea lion strandings, there have been several "unusual mortality events" of pups, and some strandings of larger, older animals, but the population trends is for increasing abundance and part of the mechanism is very likely that the population is reaching carrying capacity. Increased juvenile mortality is a direct consequence of that, it's part of the evolutionary process and based on fairly straightforward population dynamics theory (generally higher compensation or pup survival at low total population sizes, higher density dependent mortality at high population sizes). Elephant seals are increasing, most other pinnipeds are increasing or stable, several key , baleen whale stock assessments tend to show increased trends as well (particularly humpback and fin whales, most others have very little data). Figure OS LR 4 and OS LR 5 show absolutely no hint of trends. The increased frequency of ship strikes and strandings is, at least in part, an expected consequence of their increased abundance. Unless there are some sources of data or other "key species" not listed with clear signs of population declines, I would suggest reconsideration of the characterization of "key species" as declining.

Jenn –
Q13 - I have tried to address his concern about the trend by indicating that we chose to keep the rating from 2009 based on similar rationale. I have reduced confidence in the trend due to less agreement among experts.

Q12: I have clarified the basis for judgement statement for Q12 in the table to more clearly express the rationale for a not changing trend. I have reduced confidence in the trend due to less agreement among experts.

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Deleted: Large stranding events of Cassin's Auklets and California sea lions in the fall and winter of 2014-15 appears to be result of starvation of juvenile animals due to low prey availability and unusual oceanographic conditions. Although there have been significant health impacts to individuals in these populations, it is unclear if these mass strand ...

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prone to having more gear in the water. An apparent change in foraging behavior could be part of the reason there are more whale-gear interactions. The other contributing component is that of the fishing industry itself, which for certain sectors has seen an increase of landings taken from central California (largely Monterey county). This potential combination of more effort nearshore by both whales and humans may be a leading factor in the recent increase of entanglement events.

Marine mammals being injured or killed by boat strikes is an additional health concern for large whales, smaller cetaceans and pinnipeds. Each year a couple of marine mammals are found stranded on sanctuary beaches with obvious signs of interactions with boats (Marine Mammal Center, unpublished data); (http://montereybay.noaa.gov/resourcepro/resmanissues/whalestrikes.html). Between July and October 2010, two blue whales (one pregnant female that resulted in the loss of the fetus), one humpback, and two fin whales were found dead in and around Monterey Bay, Gulf of the Farallones, and Cordell Bank National Marine Sanctuaries. However, the exact number of marine mammals that are injured or killed each year from interactions with boats is very difficult to determine because many of these animals are unlikely to strand on beaches where they can be found.

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Entanglement in marine debris also is a health concern for seabirds. The sanctuary's Beach COMBERS monitoring program has documented seabird carcasses found on area beaches that are entangled in marine debris for the years 1997-2012 (Figure OS LR 5). Over the 15 year study period, a grand total of 279 entanglements were reported by surveyors affecting 24 seabird species (Nevins et al. 2014). The five species that comprised the highest percentage of entanglements were Common Murres (23%), Sooty Shearwaters (12.5%), Brandt's Cormorants (10%), Western Gulls (9%), and Brown Pelicans (7%). Alcids (24%), gulls (21.5%) and cormorants (15%) were the seabird groups most commonly affected. Monofilament fishing line was the dominant source of entanglement, and a hook or lure was often present on these lines. There were seven reports of net interactions (herring, gill, and fishing nets). Three reports mentioned entanglement via balloon string around the legs and/or wings, and one report of a balloon piece observed in the stomach of a Common Murre, and another in a fulmar.

Recent large stranding events of Cassin's Auklets and California sea lions appears to be result of starvation of juvenile animals due to low prey availability and unusual oceanographic conditions. Beached-bird surveys recorded unusually high numbers of dead Cassin's Auklets (*Ptychoramphus aleuticus*) on beaches from British Columbia through central California (Henkel et al. 2015). In central California, encounter rate peaked in November and December 2014 based on Beach COMBERS monitoring data. Most of the birds from central California were hatch-year birds with emaciated or poor body condition, and most were presumed to have died of starvation. A likely contributing cause of this mortality event is the unusually large cohort of hatch-year auklets that were apparently unable to find adequate prey resources to survive their first winter (Henkel et al. 2015). Prey shortages were likely influenced by anomalous ocean conditions (described in response to Offshore Question 1). Prey shortages also appear to be the cause of poor growth rates of California sea lion (*Zalophus californianus)* pups observed by the NMFS Monitoring program at San Miguel Island (Harvey et al. 2014) and the unusually large number of stranded, malnourished pups that have been admitted to rehabilitation centers in southern and central California in the winter and spring of 2015 (http://www.nmfs.noaa.gov/pr/health/mmume/californiasealions2013.htm). Although these events are significant health impacts to animals in these populations, it is unknown if these mass stranding events will have any lasting impacts on the overall health of these populations.

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Beach COMBERS

The Beach Coastal Ocean Mammal and Bird Education and Research Surveys (Beach COMBERS) Program uses trained volunteers to survey beached marine birds and mammals monthly at selected sections of beaches throughout the Monterey Bay area. For more information http://sanctuarysimon.org/monterey/sections/beachCombers/index.php?l=n

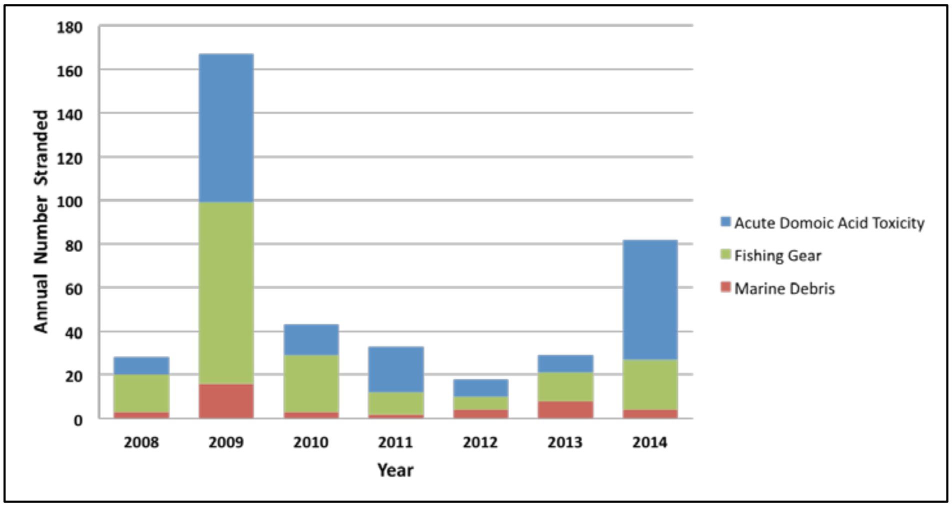
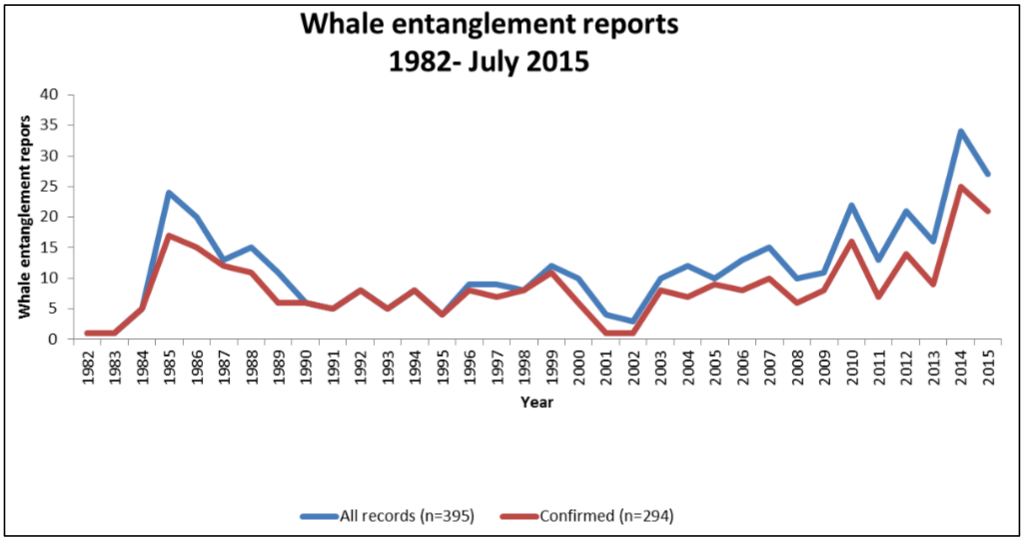


Figure OS LR 4
Caption: Annual number of marine mammals that stranded on beaches in Monterey Bay sanctuary and were treated by the Marine Mammal Center because of acute domoic acid toxicity (blue), entanglement in fishing gear (green) and (marine debris). The Marine Mammals Center, a rehabilitation center on the central California coast, tracks the cause of strandings of marine mammals including animals stranding on the beaches in the Monterey Bay sanctuary.
Source: Marine Mammal Center



Potential new Figure:

Caption: Annual number of large whale entanglements reported (blue) and confirmed (red) along the U.S. West Coast. Reports of entanglements have increased in recent years likely due to an increasing overlap of whale activities (e.g., migrating, feeding) with human activities that have the potential to entangle whales (e.g., fishing, buoy installation) and an increase in on-the-water observers likely to report entangled individuals (e.g., whale watching, recreational boating). Source: D. Lawson, NMFS-PRD, http://www.opc.ca.gov/webmaster/ftp/pdf/whale-entanglement/P1-Aug-20-Whale-Entanglement-Discussion-Management-of-Entanglement-and-Entanglement-Data.pdf

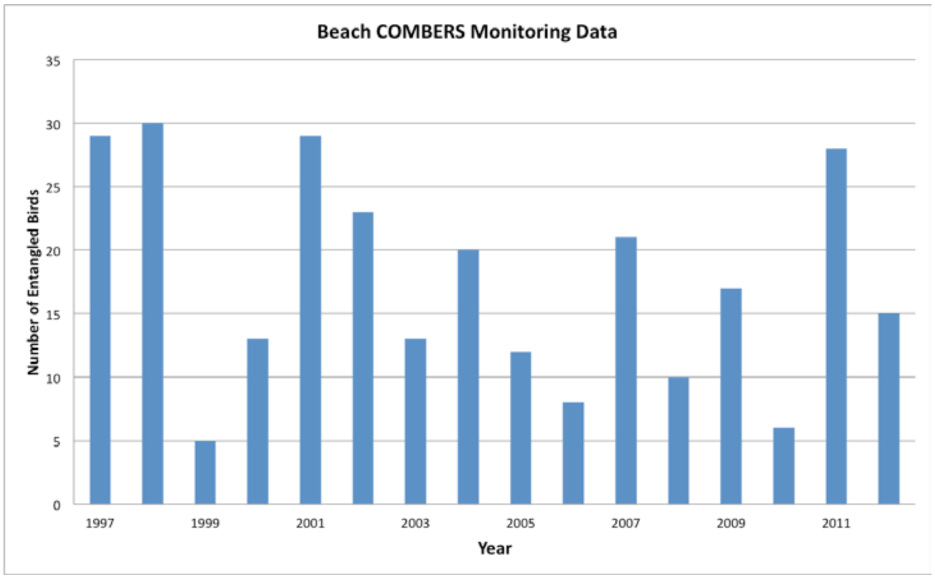


Figure OS LR 5
Caption: Annual number of seabird carcasses reported as entangled in monthly Beach COMBER surveys from 1997-2012. The survey study area began with ten beaches (1997-1998), expanded to 11 beaches (1999), then to 17 beaches including surveys in San Luis Obispo County (mid-2001-2002), and grew to 30 beaches by 2009 to present time. Note: The survey area has increased over time. The numbers reported are for total number of observation each year and have not been standardized by survey effort. Therefore, this data should not be used to examine trends in entanglement rates over time.
Source: Nevins et al. 2014

14. What are the levels of human activities that may influence living resource quality and how are they changing?

A number of human activities, including fishing, inputs of marine debris, and vessel traffic, influence the quality of living resources in the offshore portion of the sanctuary. The level of these human activities was rated "fair" in 2009 and will continue to be rated "fair" in 2015 because most of these activities have resulted in measurable impacts to living resource quality. An "improving" trend was provided in 2009 because recent changes in fisheries management was likely to result in improved status of fished species and reduced impacts to habitat and non-target species. The 2015 trend has been changed to "not-changing" because, though fished stocks and habitats continue to recover from overfishing and impacts from bottom contact fishing, marine debris and contaminants are accumulating in offshore habitats and ocean acidification is increasing.

Fishing is a human activity that influences sanctuary habitats and living resources in a number of ways beyond the removal of targeted biomass. A number of changes in fisheries management implemented prior to 2007, including gear restrictions, area closures and landing reductions, appears to have resulted in overall better management of fished stocks (as evidence by recent stock assessments), decreased impacts to biogenic habitat and non-targeted species (summarized in response to Offshore Question 8), and a lower overall level of fishing effort in central California compared the 1990s and early 2000s. Available data on recent commercial fishing activity in the sanctuary suggest that overall fishing activity has been steady, with some fishing activities increasing and others decreasing likely in response to environmental conditions and regulations (OST and CDFW 2013, Leeworthy et al. 2014).

Marine debris impacts marine life in many ways, most notably through entanglement (as discussed in the response to Offshore Question 13) and ingestion of plastic fragments that can clog the digestive tract. Although negative impacts to living resources from ingestion of plastics has been demonstrated in Monterey Bay sanctuary in the past (e.g., Northern Fulmars in Monterey Bay from 2003-2007 in Donnelly-Greenan et al. 2014), we are not aware of any new studies in the sanctuary and thus cannot determine if the problem is increasing in severity. However, the fact that many types of debris, in particular plastic debris, do not degrade raises concern that this problem will increase in severity in the future. The ability for plastics to attract and transport contaminants has been documented (Arthur et al. 2009) and this is an area that could use further study to determine potential impacts to living resources in the sanctuary.

While small-scale and acute impacts may be diminished due to the large size of the offshore ecosystem, there are large-scale phenomena that continue to impact this system. Large vessels transiting through the sanctuary can negatively impact living resources in a number of ways including pollution (http://montereybay.noaa.gov/resourcepro/resmanissues/lostshippingcontainers.html), collision with animals (http://montereybay.noaa.gov/resourcepro/resmanissues/whalestrikes.html) and noise (http://montereybay.noaa.gov/resourcepro/resmanissues/acoustic.html). Two studies of ambient ocean noise levels along the California coast found that low-frequency background noise increased from the 1960s to the 2000s by about 3 decibel per decade at the two sites studied - Pt. Sur in MBNMS (Andrews et al. 2002) and San Nicolas Island in southern California (McDonald et al. 2006). Most of this increase in low-frequency ambient noise was attributed to an increase in shipping traffic during that time.

More recent measures of ambient low-frequency noise are not available inside MBNMS to determine if this increasing trend in vessel-generated noise has continued since the early 2000s. However, recent analysis of large vessel traffic inside and adjacent to Monterey Bay sanctuary for the period 2008 to 2014 has found that there was some increase in the number of vessel transiting through MBNMS between 2008 and 2009, but no significant trend since 2009 (blue line in Figure OS LR 6). It is interesting to note that the overall distance traveled inside the sanctuary boundary decreased during this time because the vessels are transiting further to the west and spending less time overall in MBNMS (red line in Figure OS LR 6). This may mean an overall decrease in exposure of living resources inside MBNMS to some potential impacts from vessel traffic (e.g., collisions) not likely a decrease in overall noise generated by this activity.

Large vessel traffic is one of a variety of human activities in and adjacent to MBNMS that generate underwater noise. Other potential sources of underwater noise in MBNMS include smaller recreational and commercial vessels, sonars used in military training, pile drivers and

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Comment [56]: Note to reviewers – all url's will appear as footnotes in hard-copies of the report and as hyperlinks in digital copies of the report. These formatting changes will occur following the review.

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dredging used in marine construction, airguns and other seismic sources used in energy exploration, sonars and other active acoustic sources used in research activities, and aerial sources such as overflights. Noise generated by these human activities can have a detrimental effect on a variety of marine animals including marine mammals, turtles, fish, and invertebrates. Studies have documented behavioral responses, lost listening opportunities, and physical injuries in marine animals due to exposure to human-induced noise (NRC 2003, 2005). There is concern about the cumulative impacts of noise from a variety of sources on the natural 'soundscape' of the sanctuary and this is an active topic of research and management in MBNMS (http://montereybay.noaa.gov/resourcepro/resmanissues/acoustic.html). Efforts to monitor the acoustic environment in MBNMS are underway and this data should help improve our understanding of potential impacts of human-induced noise on marine mammals and other wildlife in the sanctuary.

A recent study examined the spatial overlap of human activities with the distribution of large marine predators to find areas along the U.S. west coast with a high likelihood of impacts. Maxwell et al. (2013) combined tracking data for eight species of marine predators (seabirds, whales, turtles) with data on 24 human stressors (weighted to reflect expected impacts specific to those predators) to calculate cumulative utilization and impact (CUI) scores for the entire U.S. west coast. High CUI scores were used to identify locations where important species habitat and high-risk activities are likely to coincide. The Monterey Bay sanctuary had many cells with moderate to high CUI scores, especially for marine mammals and leatherback sea turtles. Cumulative impacts were higher inshore than offshore for all species groups, and the majority of the highest cumulative impact cells were found over the continental shelf which is consistent with most human stressors being concentrated near human population centers (Figure OS LR 7).

The largest looming problem facing living resources in the offshore environment is changes in ocean chemistry due to global climate change. As was discussed in the response to Offshore Question 1, waters in the Monterey Bay sanctuary are becoming more acidic which is a stressor on living resources, especially those with calcified body parts. Some impacts to living resources from increasingly acid waters have already been observed (e.g., Bednarsek et al. 2014). Ocean acidification from climate change has also been predicted to have implications for ocean acoustics by allowing low frequency sound to travel farther (Ilyina et al. 2010). More study is needed on the impacts of acidification on both pelagic and benthic organisms to better understand the level of current impacts and predict future impacts of changing water chemistry on conditions of living resources. Global climate change is causing shifts in other physical properties of ocean waters, including increasing water temperature, hypoxia, and shoaling of the Oxygen Minimum Zone, which are likely to have significant local impacts to living resource in the offshore environment of the sanctuary. Directed study of the effects of climate driven changes in pH, temperature, and dissolved oxygen on a variety of species will become increasingly important for understanding and tracking the status and condition of living resources in the sanctuary in the future.

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Comment [N57]: Field: there is brief mention of implications of ocean acidification on noise propagation in the ocean, but I thought the issue of noise pollution more generally could have been addressed more robustly. There are several National Academy of Sciences studies of ocean noise and impacts to marine mammals and other populations for context.

Jenn – I added text earlier in this section to address these concerns.

Comment [N58]: Kudela: It's throughout this document but not stated directly—when preparing a 5-year assessment it is important to take into consideration the secular trend from climate change, but also the decadal oscillations. Some 5-year periods are going to be more or less impacted by long-term trends because they are modulated by shorter oscillations.

Jenn – I addressed this point by adding text at the beginning of the Offshore section.

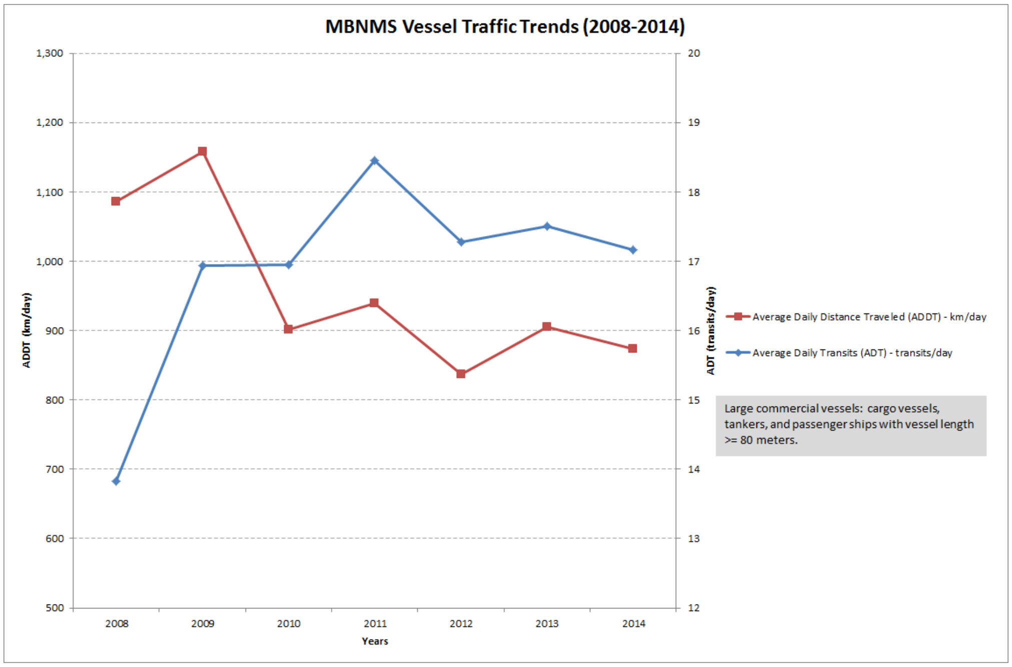

Figure OS LR 6
Caption: Average Daily Distance Traveled (ADDT; red) and Average Daily Transits (ADT; blue) inside the boundaries of Monterey Bay National Marine Sanctuary down to 36ºN, but does not include the Davidson Seamount Management Zone. The annual vessel traffic trends are based on U. S. Coast Guard NAIS data for 2008-2014 for vessels greater than or equal to 80 meters. The data do include traffic near the San Francisco Traffic Separation Scheme.
Source: NMFS-SWFSC (research in progress)

Figure OS LR 7
Caption: Maxwell et al. (2013) combined tracking data for 8 species of marine predators (seabirds, whales, turtles; Left panel) with data on 24 human stressors weighted to reflect expected impacts specific to those species (Middle panel) to calculate cumulative utilization and impact scores for the entire U.S. west coast (Right panel). Cumulative utilization and impact scores were used to determine where important species habitat and high-risk areas are likely to coincide (e.g., cells with high scores). The central coast of California had high scores, especially for marine mammals and leatherback sea turtles. Cumulative impacts were higher inshore than offshore for all species groups, and the majority of the highest cumulative impact cells are found over the continental shelf which is consistent with most human stressors being concentrated near human population centers.
Source: Maxwell et al. 2013

Offshore Environment Living Resources Status & Trends

Good	Good/Fair	Fair	Fair/Poor	Poor	Undet.

▲ = Improving — = Not changing ▼ = Declining
? = Undetermined trend **N/A** = Question not applicable

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
9	Biodiversity	—	Status: Medium Trend: Low	Reduced relative abundance of targeted, by-catch, and sensitive species. Overall biodiversity does not appear to have increased or decreased significantly during this time.	Selected biodiversity loss may inhibit full community development and function and may cause measurable but not severe degradation of ecosystem integrity.
11	Non-Indigenous Species	■	Status: N/A (not updated) Trend: N/A (not updated)	Very few non-indigenous species identified in offshore waters.	Non-indigenous species are not suspected or do not appear to affect ecosystem integrity (full community development and function).
12	Key Species Status	—	Status: Medium Trend: Low	Some key species at reduced abundance levels due to past or on-going harvest. Some monitored key species slowly increasing, but most appear to be fluctuating within the range expected based on long-term time series.	Selected key or keystone species are at reduced levels, perhaps precluding full community development and function, but substantial or persistent declines are not expected.
13	Key Species Condition	▼	Status: Medium Trend: Low	Compromised health due to exposure to neurotoxins produced by HABs, entanglement in active and lost fishing gear, ingestion of marine debris, and accumulation of persistent contaminants.	The condition of selected key resources is not optimal, perhaps precluding full ecological function, but substantial or persistent declines are not expected.
14	Human Activities	—	Status: Medium Trend: Medium	Recent management actions helping recover overfished stocks and impacted habitats, but inputs of marine debris and contaminants have measurable impacts; ocean acidification and hypoxia increasing.	Selected activities have resulted in measurable living resource impacts, but evidence suggests effects are localized, not widespread.

Questions that have new information to report since the 2009 Monterey Bay National Marine Sanctuary Condition Report (ONMS 2009) are those with red numbers.

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Deleted: Most key species with data available appear to be stable or increasing.

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Offshore Environment: Maritime Archaeological Resources

The following information provides an assessment of the status and trends pertaining to the current state of the maritime archaeological resources in the offshore environment.

15. What is the integrity of known maritime archaeological resources and how is it changing?

As we reported in 2009, there is great uncertainty regarding the integrity of submerged maritime archaeological resources in the offshore environment of the sanctuary resulting in an "undetermined" rating for both status and trend. The sanctuary's inventory of submerged cultural resources contains information on known vessel losses (Figure OS MAR 1), however, there is little to no verified location information, and few visited sites. To date, only one offshore archaeological site location inventory has been conducted in the sanctuary by NOAA (Vessel 8 on Figure OS MAR 1; *Macon* Expedition 2006; Schwemmer 2006 http://montereybay.noaa.gov/reports/2006/eco/welcome.html). No other site evaluations have been conducted by Federal, State, or private resource management agencies.

Sites in deep water are naturally in better condition than those in shallow water because they are not impacted by strong currents, and the cold, deep-water environment tends to have fewer biological processes accelerating ship degradation. One probable impact in offshore waters is from bottom trawling, but because the majority of wreck locations are unknown, the impacts from historical and recent trawling are unknown

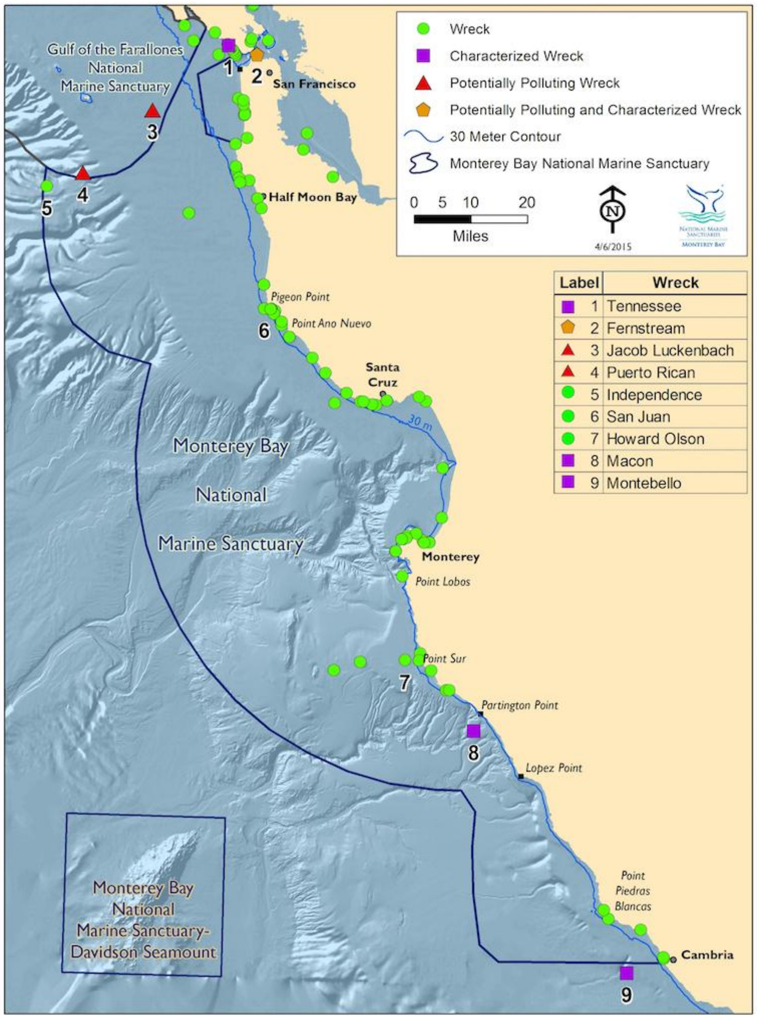

Figure. OS MAR 1
Caption: Approximate locations of known vessel losses in and adjacent to Monterey Bay National Marine Sanctuary from the sanctuary's inventory of submerged cultural resources. Three vessels have been characterized (purple square), two are considered to be "potentially polluting wrecks"[JB1] (red triangle) and one vessel has been both characterized and determined to be a "potentially polluting wreck" (orange pentagon). For the rest of the the vessels in the inventory, there is little to no verified location information (green circles)
Data Source: MBNMS inventory of known vessel losses; Map: S. De Beukelaer, NOAA/MBNMS

16. Do known maritime archaeological resources pose an environmental hazard and is this threat changing?

In 2009 this question was rated "fair" with a "declining" trend because the Monterey Bay National Marine Sanctuary's inventory of known maritime archaeological resources suggested that offshore shipwrecks have the potential to pose an environmental hazard to sanctuary resources due to deterioration that would result in the release of hazardous cargo and/or bunker fuel (e.g., U.S. Navy aircraft carrier USS *Independence* scuttled 1951, passenger steamship *San Juan* lost 1929, lumber freighter *Howard Olson* lost 1956) (Figure OS MAR 1). Additional threats to sanctuary resources were identified from shipwrecks located just outside the sanctuary boundary (e.g., cargo freighter SS *Jacob Luckenbach* lost 1953, tanker *Puerto Rican* lost 1984, and other vessels scuttled by the military to dispose of weapons) because prevailing currents have a high likelihood of carrying hazardous materials released from these sources into the Monterey Bay sanctuary. Newly available information on these previously identified hazards provides further support for a 2015 status rating of "fair" with a "declining" trend.

From 1992 to 2001 extensive tarball deposits along the coast from north of Bodega to Point Lobos (in central Monterey Bay sanctuary) were estimated to have killed over 51,000 seabirds (e.g., grebes, cormorants and Common Murres) and eight sea otters (Luckenbach Trustee Council 2006) (Figure OS MAR 2). The source of these tarballs was ultimately traced to the SS *Jacob Luckenbach* which sank off San Francisco in 1953 (located just north of the Monterey Bay sanctuary boundary and inside the Gulf of the Farallones National Marine Sanctuary; Vessel 3 in Figure OS MAR 1). The U.S. Coast Guard, California Department of Fish and Game, National Oceanic and Atmospheric Administration, and others collaborated to identify the extent of impacts and to remove the fuel. In 2002, much of the oil was removed from the SS *Jacob Luckenbach* and the remaining oil was sealed inside the vessel (NOAA 2013a, 2013c). The amount of oil left onboard is uncertain; estimates range from 11,500 gallons to 85,000 gallons (NOAA 2013c). The amount of oil released during the sinking and during the periodic mystery spills is estimated to be in excess of 300,000 gallons, suggesting that the amount still trapped in the hull would be less than 60,000 gallons. There is however, general consensus that the remaining pockets of oil on the wreck cannot be safely removed.

Recently, NOAA completed risk assessments of the SS *Jacob Luckenbach* and *Puerto Rican* (NOAA 2013a, 2013c, 2013d); shipwrecks located outside of, but adjacent to, the sanctuary boundary (Vessels 3 and 4 in Figure OS MAR 1). For the Worst Case Discharge scenario, both wrecks scored High; for the Most Probable Discharge scenario, both wrecks scored Medium (NOAA 2013a, 2013c, 2013d) (Figure OS MAR 3). Under the National Contingency Plan, the U.S. Coast Guard and the Regional Response Team have the primary authority and responsibility to plan, prepare for, and respond to oil spills in U.S. waters. NOAA recommended that these sites be reflected within the Area Contingency Plans and active monitoring programs should be implemented. Outreach efforts with the technical and recreational dive community as well as commercial and recreational fishermen who frequent the areas would be helpful to gain awareness of changes in these sites. In addition, NOAA recommended the *Puerto Rican* wreck should be considered for further assessment to determine the vessel condition, amount of oil onboard, and feasibility of oil removal action (NOAA 2013d). The final determination of what type of action, if any, rests with the U.S. Coast Guard.

The shipwreck *Montebello* had been a long-term concern due to the amount of oil on board at the time of sinking (Figure OS MAR 4). The vessel rests 900 feet below the surface of the Pacific Ocean, approximately seven miles offshore of Cambria in San Luis Obispo County (Vessel 9 in

Figure OS MAR 1). Archaeologists, historians, and biologists have visited the site several times to inspect the vessel and surrounding area for oil and wildlife (Schwemmer 2005). In October 2011, a Unified Command led by the U.S. Coast Guard and California Department of Fish and Game's Office of Spill Prevention and Response assessed cargo and fuel tanks of the SS *Montebello* to determine if oil was present. The Unified Command determined that there is no substantial oil threat from the SS *Montebello* to California waters and shorelines (http://montereybay.noaa.gov/maritime/111020montebello.pdf). What happened to the oil that was on board the vessel at the time of sinking remains a mystery. NOAA scientists conducted computer trajectory models based on a number of hypothetical oil release scenarios and concluded that a long-term release model seemed most reasonable.

With the exception of the partial bunker fuel removal from the *SS Jacob Luckenbach* and monitoring of the *SS Montebello* (both outside the sanctuary boundary), no efforts have been undertaken to locate and investigate other offshore sites. The structural integrity of steel and iron shipwrecks will deteriorate over time in a corrosive ocean environment and eventually collapse.

Figure OS MAR 2
Caption: In 2002, oil associated with several "mystery spills", including the Pt. Reyes Tarball Incidents of winter 1997-1998 and the San Mateo Mystery Spill of 2001-2002, was linked to the SS *Jacob Luckenbach*. These spills are estimated to have killed 51,569 birds between 1990 and 2003, including 31,806 Common Murres (pictured) and 45 Marbled Murrelets.
Source: http://www.dfg.ca.gov/ospr/NRDA/Luckenbach.aspx [Need to get permission from CDFW]

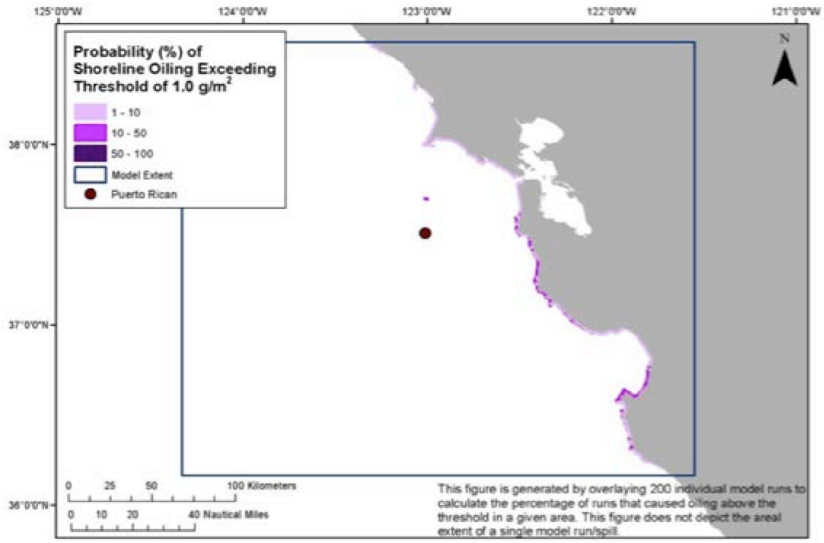

Figure OS MAR 3
Source: http://sanctuaries.noaa.gov/protect/ppw/pdfs/puerto_rican.pdf
Caption: Probability of shoreline oiling (exceeding 1.0 g/m^2) from the Most Probable Discharge of 2,100 barrels (bbl) of heavy fuel oil from the *Puerto Rican*.
Credit:

Figure OS MAR 4
Caption: Launch of the Oil Tanker *Montebello* on Jan. 21, 1921, at Southwestern Shipbuilding Company in East San Pedro, California. The ship was sunk off Cambria during World War II. In 2011, it was determined that the *Montebello* is not a substantial oil threat to California waters and shorelines.
Photo: Unocal

17. What are the levels of human activities that may influence maritime archaeological resource quality and how are they changing?

In 2009, this question was rated "Good/Fair" because a few human activities (e.g., fishing with bottom-trawl gear, technical diving) were identified as probable sources of impacts to some offshore maritime archaeological resources. Archaeological resources are not able to recover after fishing gear destroys a site or artifacts are removed by divers. There was a concern that recent changes in regulation of bottom trawling may have shifted fishing effort and increased the risk to resources that have not been impacted in the past. In addition, continued development of underwater technologies increasingly affords the public the opportunity to locate and visit deep-water archaeological resources which may result in future impacts. However, because the majority of wreck locations are unknown, the trend in impacts from historical and recent human activities were "undetermined." There is no new information available on the levels of human activities that influence offshore maritime archaeological resources, therefore the 2015 ratings remains "Good/Fair" with an "undetermined" trend.

Offshore Environment Maritime Archaeological Resources Status & Trends

Good	Good/Fair	Fair	Fair/Poor	Poor	Undet.

▲ = Improving — = Not changing ▼ = Declining
? = Undetermined trend **N/A** = Question not applicable

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
15	Integrity	?	Status: N/A (not updated Status: N/A (not updated	To date, only one of potentially hundreds of archaeological site inventories has been conducted.	Not enough information to make a determination.
16	Threat to Environment	▼	Status: Medium Trend: Medium	Known resources containing hazardous material located inside and immediately adjacent to the sanctuary continue to deteriorate.	Selected maritime archaeological resources may cause measurable, but not severe, impacts to certain sanctuary resources or areas, but recovery is possible.
17	Human Activities	?	Status: N/A (not updated Status: N/A (not updated	Archaeological resources, particularly those that are undocumented, are vulnerable to degradation from trawling and looting.	Some potentially relevant activities exist, but they do not appear to have had a negative effect on maritime archaeological resource integrity.

Questions that have new information available since the 2009 Monterey Bay National Marine Sanctuary Condition Report (ONMS 2009) are those with red numbers.

Davidson Seamount

After the 2009 Condition Report was drafted, NOAA expanded the Monterey Bay National Marine Sanctuary to include the Davidson Seamount. Davidson Seamount is the first seamount to be protected within a United States national marine sanctuary. The following information provides the first summary of conditions and trends for four resource areas in the seamount environment: water, habitat, living resources, and maritime archaeological resources.

The Davidson Seamount is an undersea mountain habitat off the coast of Central California, 70 nautical miles to the southwest of Monterey and 65 nautical miles west of San Simeon. At 23 nautical miles long and 7 nautical miles wide, it is one of the largest known seamounts in U.S. waters. From base to crest, the seamount is 7,480 feet tall, yet its summit is still 4,101 feet below the sea surface.

Davidson Seamount was the first to be characterized as a "seamount" in 1938 by the United States Board on Geographic Names, and was named in honor of the United States Coast and Geodetic Survey scientist George Davidson, a leader in charting the waters of the west coast.

New technology has only recently allowed scientists to bring back dramatic high resolution images from the deep sea, offering researchers and the public an opportunity to witness the never before seen glimpses of rare marine species living in this largely cold, dark, and mysterious habitat. The proximity of education and research institutions in the Monterey Bay region facilitate interdisciplinary collaborations that enhance research and education about this spectacular area.

The Office of National Marine Sanctuaries has determined that the Davidson Seamount requires protection from the take of or other injury to benthic organisms or those organisms living near the seafloor because of the seamount's special ecological and fragile qualities and potential future threats that could adversely affect these qualities. As part of the 2008 Management Plan for MBNMS, a boundary change includes the undersea mountain as the Davidson Seamount Management Zone (DSMZ) (Figure “MBNMS map”). The boundary change adds a 585 square nautical mile area to the MBNMS, increasing the MBNMS area to 4,601 square nautical miles.

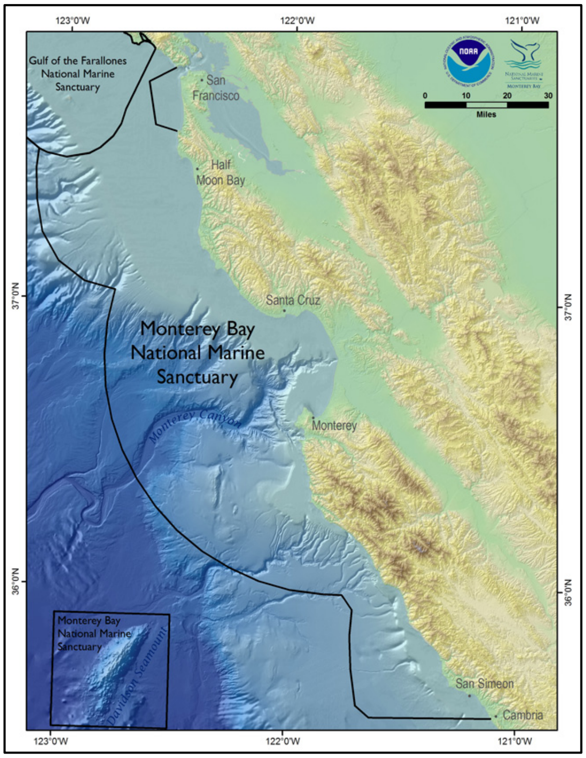

Figure: 'MBNMS map'
Caption: Monterey Bay National Marine Sanctuary including the Davidson Seamount Management Zone, which was added in March 2009 (effective date of regulations).
Credit: MBNMS

Seamount Environment: Water Quality

Though relatively close to shore (70 nautical miles to the southwest of Monterey) and one of the largest known seamounts in U.S. waters, Davidson Seamount appears to be relatively pristine, based on observations of biological communities during sea-surface and submersible explorations (2002-2010). There is no water quality monitoring occurring within the Davidson Seamount Management Zone. However, an abundance of marine mammals and seabirds at the sea surface, and large, diverse, abundant cold-water corals and sponges on the seamount may indicate that the water quality is good and that there are few, if any, risks to human health.

1. Are specific or multiple stressors, including changing oceanographic and atmospheric conditions, affecting water quality?

No information specific to the DSMZ is available on specific stressors affecting water quality. For this reason, the rating for this question is "undetermined." A trend is "undetermined" due to a paucity of data. However, see the Offshore Environment section of this report for related information.

2. What is the eutrophic condition of sanctuary waters and how is it changing?

No information specific to the DSMZ is available on eutrophic conditions. For this reason, the rating for this question is "undetermined." A trend is "undetermined" due to a paucity of data. However, see the Offshore Environment section of this report for related information.

3. Do sanctuary waters pose risks to human health?

No information specific to the DSMZ is available on risks to human health. For this reason, the rating for this question is "undetermined." A trend is "undetermined" due to a paucity of data. However, see the Offshore Environment section of this report for related information.

4. What are the levels of human activities that may influence water quality and how are they changing?

Threats exist to water quality in the Davidson Seamount Management Zone, such as vessel traffic, marine debris/dumping, and global climate change (see Table DS WQ1 for a full list of potential threats and their ratings). Vessel traffic, sea temperature rise, and ocean acidification appear to be the most severe threats to the DSMZ at this time (MBNMS 2012). The levels of large vessel traffic in and around DSMZ was recently quantified, but the activity level of other threats has not been quantified, and it is unknown if the cumulative activity level is changing. Potential impacts of these activities to water quality and other resources in DSMZ have not been studied. For these reasons, this question is rated "good/fair" with an "undetermined" trend.

Threats to water quality from vessel traffic include oil or chemical spills and discharges, loss of cargo and other marine debris, ship-based pollution (i.e., residues from tank cleaning), exchange of ballast water, and noise pollution (MBNMS 2012). Considering the offshore location of the DSMZ, the risk of accidents and spills as a result of collisions and groundings are less likely than in coastal waters. However, spills can potentially occur from any transiting vessel carrying crude oil, bunker fuel, or other hazardous materials (MBNMS 2012).

The northeast corner of the DSMZ is bisected by the Western States Petroleum Association (WSPA) recommended shipping tracks for tankers carrying crude oil, black oil, or other persistent liquid cargo in bulk (Figure DS WQ1). Miller (2011) found that the average number of vessel transits through DSMZ in 2010 was 159 per month. An analysis of vessel traffic (2009-2012) indicates a great majority of the large vessels that transit in or near MBNMS are complying with the WSPA and International Maritime Organization (IMO) recommended tracks shown in Figure DS WQ1 (De Beukelaer et al. 2014). For example, Automatic Identification Systems (AIS) data from 2011 show that the majority of tankers cross over DSMZ near the WSPA recommended track and the majority of cargo vessels transited between DSMZ and MBNMS on the western boundary of MBNMS via the IMO recommended tracks (Figure DS WQ2).

Further analysis of the AIS data for the number of vessels transiting through the DSMZ on a monthly or annual basis would be useful to look at trends in this activity. In addition, a further refinement of the analysis of the threat posed by tanker traffic would be facilitated by access to data on the association and contents of each vessel, the levels of discharge from these vessels, and how this has changed through time. However, based on known impacts of previous spills elsewhere and known levels of vessel traffic, these pressures are considered to have the potential to degrade water quality, and may preclude full function of living resource assemblages and habitats, should they occur.

Table DS WQ1

Caption: A recent threats assessment for the Davidson Seamount Management Zone (DSMZ) describes the known existing and potential threats to the DSMZ. Threat levels of "low," "medium," and "high" were assigned to the various threats. To be assigned a threat level of "low," there must be a) existing regulations to protect against that threat, or b) the activity associated with the threat must be accepted to be currently impossible or highly unlikely. To be assigned a threat level of "medium," there must be a) a possibility of threat activity occurring (either legally through a permitting process or otherwise) despite existing regulations to protect against that threat being in place, or b) no current protections against the threat, but also no known threat activity occurring. To be assigned a threat level of "high," there must be no regulatory protections in place against the threat and the threat activity is known to be presently occurring or likely to occur. Vessel traffic, sea temperature rise, and ocean acidification appear to be the most severe threats to the DSMZ at this time.
Credit: MBNMS 2012

	Threat Level		
Threat	**Low**	**Medium**	**High**
Vessel traffic			■
Submerged vessels		■	
Military activity		■	
Bio-prospecting	■		
Cumulative research collection		■	
Commercial harvesting: Waters above seamount		■	
Commercial harvesting: Deep-water fisheries	■		
Commercial harvesting: Coral harvesting	■		
Oil and gas exploitation	■		
Deep-sea mining	■		
Marine debris / dumping		■	
Underwater cables		■	
Water quality		■	
Sea temperature rise			■
Ocean acidification			■

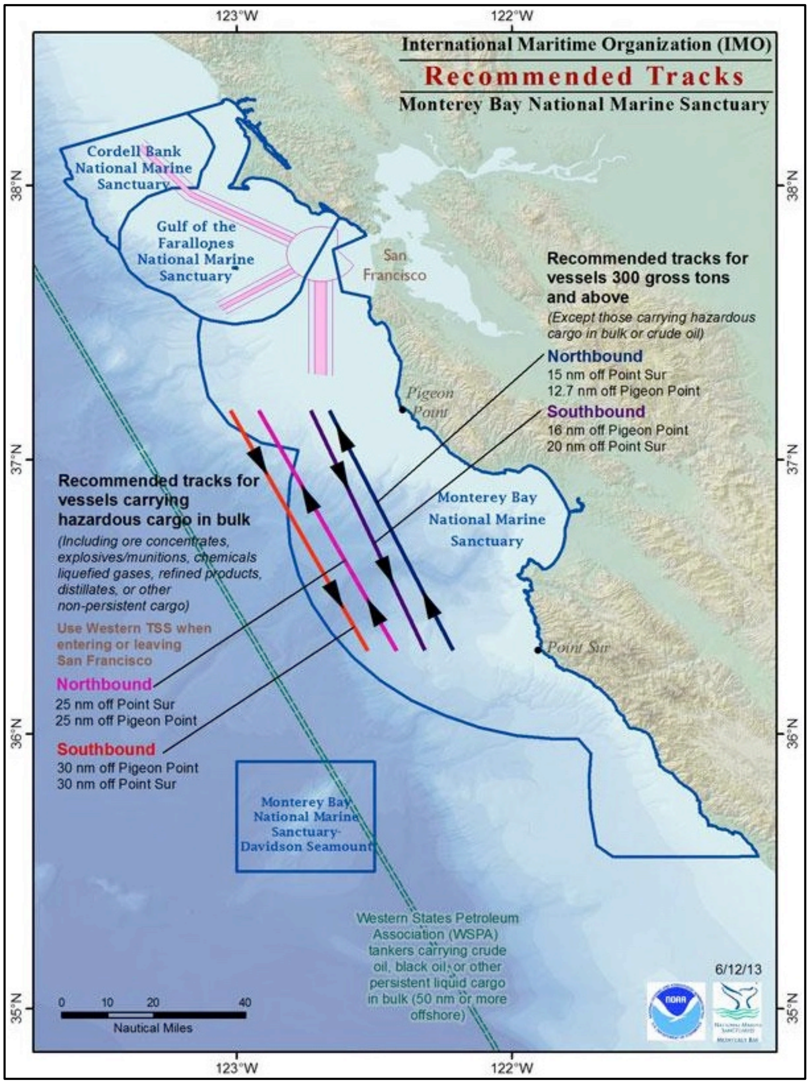

Figure DS WQ1

Caption: International Maritime Organization (IMO) recommended tracks for large shipping vessels (greater than 300 gross tons), including container ships, bulk freighters, hazardous materials carriers, and tankers. Western States Petroleum Association recommends tankers carrying crude oil, black oil, or other persistent liquid cargo in bulk to transit 50 nm or more offshore.
Source: MBNMS (http://montereybay.noaa.gov/materials/maps/vessel_lanes1_lg.jpg)

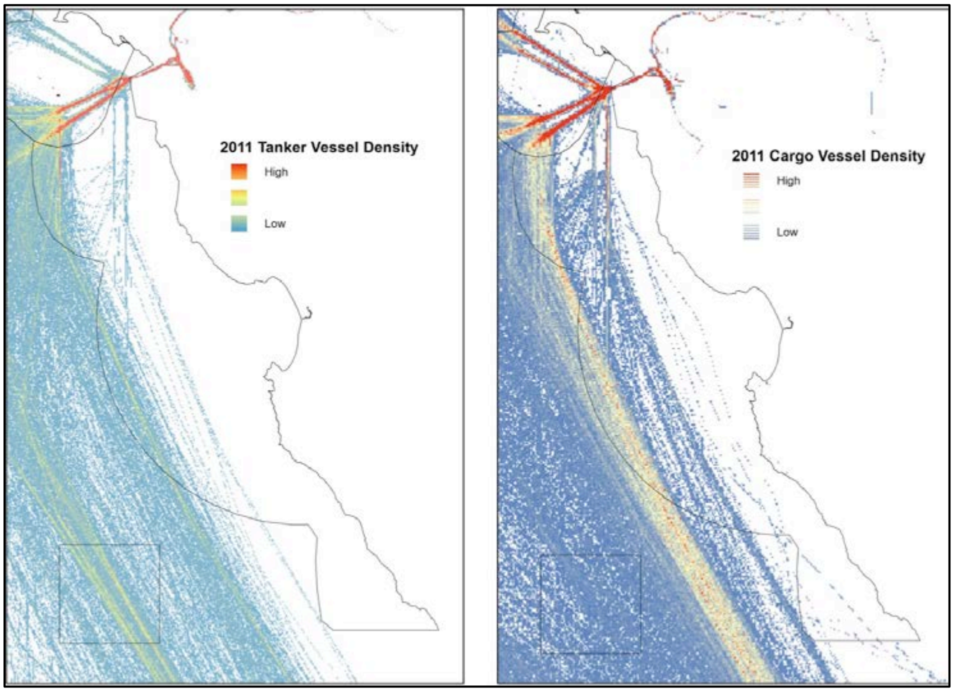

Figure DS WQ2

Caption: 2011 vessel density data for cargo vessels and tankers based on Automatic Identification Systems (AIS) data. AIS are navigation safety devices that transmit and monitor the location and characteristics of many vessels in U.S. and international waters in real-time. The map service from MarineCadastre.gov was used to represent the density of cargo and tanker vessel traffic in 2011 from vessels with AIS transponders in 100 meter grid cells. The data are best interpreted using high to low density. The map shows that the majority of the tankers cross over DSMZ, but that the majority of cargo vessels actually transit between DSMZ and MBNMS and on the western boundary of MBNMS via the IMO recommended tracks for vessels carrying hazardous cargo in bulk.

Source: created by MBNMS staff using MarineCadastre.gov

Deleted:

Seamount Environment Water Quality Status & Trends

Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

▲ = Improving — = Not changing ▼ = Declining

? = Undetermined trend **N/A** = Question not applicable

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
1	Stressors	?	Status: N/A Trend: N/A	No information available specific to DSMZ; however, see the open ocean section of this report.	Not enough information to make a determination.
2	Eutrophic Condition	?	Status: N/A Trend: N/A	No information available specific to DSMZ.	Not enough information to make a determination.
3	Human Health	?	Status: N/A Trend: N/A	No information available specific to DSMZ.	Not enough information to make a determination.
4	Human Activities	?	Status: Medium Trend: Medium	Large vessel, particularly tankers, transiting through DSMZ poses a threat to water quality but no known impacts from this activity. More information needed on levels and trends of other potential threats.	Some potentially harmful activities exist, but they do not appear to have had a negative effect on water quality.

Seamount Environment: Habitat

5. What is the abundance and distribution of major habitat types and how is it changing?

The abundance and distribution of major habitat types in the seamount environment of the sanctuary is rated "good." Habitat quality is considered to be in pristine or near-pristine condition due to limited past and current levels of human activities that could influence the distribution, abundance, and quality of benthic habitats. The trend is rated "not changing" due to the remote nature of the seamount, and current regulations by Monterey Bay National Marine Sanctuary and NOAA Fisheries that prohibit alteration of the seafloor and use of bottom-contact fishing gear, respectively.

The geological structure and origin of five central California seamounts (Davidson, Guide, Pioneer, Gumdrop, and Rodriguez) have only recently been described, as an atypical type of oceanic volcanism, having northeast-trending ridges that reflect the ridge-parallel structure of the underlying crust (Davis et al. 2002). The Davidson Seamount consists of about six subparallel linear volcanic ridges separated by narrow valleys that contain sediment. These ridges are aligned parallel to magnetic anomalies in the underlying ocean crust. The seamount is 12.2 ± 0.4 million years old and formed about 8 million years after the underlying mid-ocean ridge was abandoned. Unlike most intra-plate ocean island volcanoes, the seamounts are built on top of spreading center segments that were abandoned at the continental margin when the tectonic regime changed from subduction to a transform margin (Davis et al. 2007). Davidson Seamount is the largest of the five seamounts; it is ~42 km long, ~13 km wide, and rises ~2,280 m from the ocean floor to a water depth of ~1,250 m. It has a volume above the seafloor of ~320 km^3 (Davis et al. 2002).

The benthic habitat (775 square statute miles) of the DSMZ can be partitioned into three habitat types: summit, flanks (or slope), and base (McClain et al. 2010). In addition, the water column habitat (1,595 cubic miles) can be partitioned into three habitat types: sea surface, mid-water, and bentho-pelagic. Structure-forming invertebrates, such as the many species of corals and sponges at Davidson Seamount, hold an important ecological role in creating habitat structure; and are vulnerable to disturbance from human activities (MBNMS 2012).

To date, few institutions have conducted research activities at the seamount (i.e., MBNMS, MBARI, USGS), due to the offshore and deep location. Most of the research activities involve video surveys; however rocks and biogenic habitat have been collected, as well as the occasional placement of anchored markers for repeated measurements (e.g., coral age and growth studies). Collectively, these activities have a small footprint and do not threaten the abundance and distribution of habitat types.

During a 2006 ROV dive survey, researchers discovered a telecommunications cable that runs along the side of the seamount (MBNMS 2012). The history and current status of the cable is unknown. Submarine cables could become destructive to biogenic habitats (e.g., corals and sponges) if they become mobile.

Recent regulatory actions were taken to protect the seafloor on and around Davidson Seamount. In June 2006, fishing with bottom contact gear (or any other gear) below 3,000 feet was prohibited in the Davidson Seamount Essential Fish Habitat (EFH) Conservation Area designated by the National Marine Fisheries Service (NMFS; DOC 2006). In March 2009, Monterey Bay National Marine Sanctuary was expanded to include the Davidson Seamount Management Zone. Standard sanctuary regulations apply (including seabed alteration prohibition); and "take"[1] of biological or non-biological resources below 3,000 feet is prohibited (DOC 2008). The Davidson Seamount EFH Conservation Area and DSMZ share the same boundaries and were created to address potential threats to the seamount and natural resources (MBNMS 2012). The seamount itself is too deep for most fish trawling methods, where fish density is very low, and the species seen to date are not commercially desirable.

Footnote (1): "take" defined as: Moving, removing, taking, collecting, catching, harvesting, disturbing, breaking, cutting, or otherwise injuring, or attempting to move, remove, take, collect, catch, harvest, disturb, break, cut, or otherwise injure, any Sanctuary resource located more that 3,000 feet below the sea surface within the Davidson Seamount Management Zone. [15 CFR § 922.132 (11)(i)]

6. What is the condition of biologically-structured habitats and how is it changing?

Deep-sea corals and sponges are the primary structure-forming species occurring in the seamount environment of the sanctuary, and based on recent surveys, they appear to be in pristine or near-pristine condition. However, historic information on the distribution and abundance of these resources is not available and information on current distribution, abundance, and condition of these organisms is limited. In addition, it is unknown when global climate change (e.g., sea temperature rise, ocean acidification) will affect structure-forming species in the seamount environment. It is for these reasons that the condition of biologically-structured habitats in the seamount environment is rated "good" and the trend is "undetermined."

Most of the organisms found at seamounts are large, sessile organisms, such as corals and sponges (Figure DS Hab1). ROV surveys to Davidson Seamount have recorded a variety of corals and sponges, including black corals (Order Antipatharia), soft corals (Order Alcyonacea), sea fans (Order Gorgonacea), and sponges (Phylum Porifera); approximately 22 coral and 24 sponge taxa (Burton and Lundsten 2008). The invertebrate community at Davidson Seamount is dominated by passive suspension-feeding invertebrates (mostly corals; Lundsten et al. 2009a). The hard rock substrate and elevated current velocities often found at the seamount appear to provide habitat favorable to sessile suspension- and filter-feeding invertebrates.

Large, sessile corals and sponges are used as a habitat by other organisms. They serve as hard substrate for attachment by other sessile organisms (e.g., basket stars, sea stars, scale worms, other corals, other sponges) and as shelter or food by some mobile organisms (e.g., fishes, skate egg cases, crabs, shrimps). There is increasing evidence that many areas of deep coral and sponge habitats function as ecologically important habitats for fishes and invertebrates (Hourigan et al. 2007).

DeVogelaere et al. (2005) found that all of the deep-sea corals observed at Davidson Seamount (with the exception of *Anthomastus*) had other obvious megafauna associated with them. Living on the corals were polychaete worms, isopods, shrimps, crabs, basket stars, crinoids, brittle stars, and anemones. Fauna observed adjacent to corals were grenadier (*Coryphaenoides* spp.), thornyheads (*Sebastolobus* sp.), sponges, other corals, sea stars, clams, sea cucumbers, and octopi (*Graneledone* sp.).

Species assemblages at the summit of Davidson Seamount contain dense aggregations of corals and sponges (McClain et. 2009). These species also occur at similar depths along the rocky walls of Monterey Canyon; but at far lower densities or dominance, and their sizes are smaller than those occurring at Davidson Seamount. These preliminary results suggest that structure of seamount assemblages may differ from other deep-sea benthic habitats and may prove to be source populations for many deep-sea species.

Bubble gum coral (*Paragorgia* spp.) are the most dramatic corals at Davidson Seamount due to their size (>2 x 2 meters in height and width) and dense aggregations ("forests") on local peaks and adjacent steep slopes (DeVogelaere et al. 2005, Clague et al. 2010; Figure DS Hab2). *Paragorgia arborea* is considered to have a high rating of structural importance due to its large size, branching morphology, many associations with other species, and high relative abundance (Whitmire and Clarke 2007).

Age and growth studies of cold-water corals at Davidson Seamount indicate they are slow-growing and long-lived (Andrews et al. 2005, 2007, 2009). Radiometric ageing results for two bamboo coral colonies (*Keratoisis* sp.) converged on a radial growth rate of ~0.055 mm per yr (Figure DS Hab3). One colony was aged at 98 ± 9 yr, with an average axial growth rate of ~0.7 cm per yr. The age of a large colony was >145 yr with an estimated axial growth rate of 0.14 to 0.28 cm per yr. A linear (axial) growth rate of approximately 0.25 cm per yr led to a colony age of about 115 yr for the precious coral (*Corallium* sp.); however, based on the radial growth rate, an age of up to 200 yr is possible (Figure DS Hab4). Due to the slow growth of these habitat-forming organisms, recovery from any damage could be slow (i.e., many decades to centuries).

These slow-growing and long-lived structure-forming species are vulnerable to disturbance from human activities that impact the seafloor (see Table DS WQ1 for a summary of threats). The seamount environment of the sanctuary is currently well-protected from many activities that could alter the seafloor such as bottom-contact fishing (see Seamount Question 5). And to date, few activities have occurred on the seamount seafloor due to its remote nature (i.e., offshore and deep).

The DSMZ is bisected by shipping tracks of tankers carrying crude oil, black oil, or other persistent liquid cargo in bulk (Figure DS WQ1), but spill from these ships will not likely impact benthic habitat. Another class of threat related to vessel traffic is the possibility for cargo from container ships to be lost at sea (MBNMS 2012). Impacts of lost cargo can include the threat of habitat crushing or smothering habitat and the introduction of foreign habitat structure. Cargo vessels transit the waters immediately adjacent to the DSMZ (Figure DS WQ 2), but there have been no known impacts to structure-forming species from lost cargo in DSMZ.

Sea temperature rise and ocean acidification appear to be two of the most severe threats to the DSMZ at this time (Table DS WQ1). Rogers et al. (2007) suggest changes in ocean chemistry resulting from climate change may result in large-scale changes in the faunal composition of seamount communities, especially where corals play a role in structuring the environment and providing habitats for other species. We are not aware of any impacts of temperature or pH on condition structure-forming species at DSMZ, but there is very little information available. Monitoring of ocean temperature and chemistry, as well as condition of structures forming species, is needed.

Figure DS Hab1
File Name: DSCN7444.jpg
Caption: Primoid coral (*Narella* sp.), black coral (*Trissopathes pseudotristicha*), and feather stars (*Florometra serratissima*) on the Davidson Seamount (2,669 meters).
Credit: NOAA/MBARI

Figure DS Hab2
File Name: DSCN7161.jpg
Caption: Bubble gum coral (*Paragorgia arborea*) on the Davidson Seamount (1,313 meters).
Credit: NOAA/MBARI

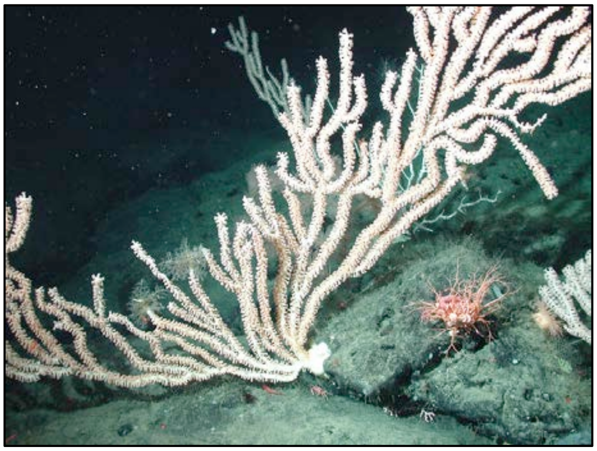

Figure DS Hab3
File Name: DSCN3547.jpg
Caption: Bamboo coral (*Keratoisis* sp.) on the Davidson Seamount (1455 meters). Coral colony age estimates exceed 200 years (Andrews et al. 2005).
Credit: NOAA/MBARI

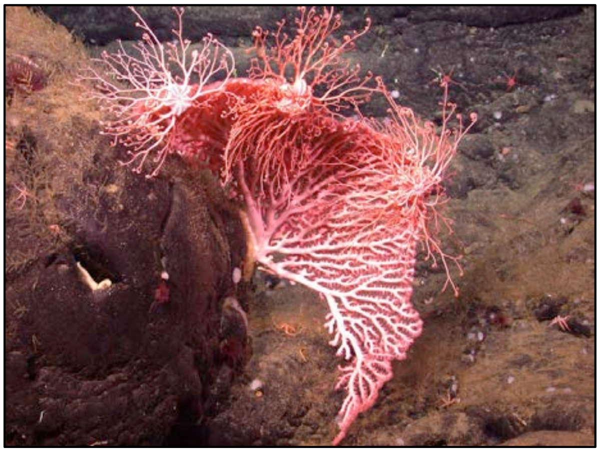

Figure DS Hab4
File Name: DSCN7489.jpg
Caption: Precious coral (*Corallium* sp.) and basket stars (*Gorgonocephalus* sp.) on the Davidson Seamount (1,692 meters).
Credit: NOAA/MBARI

7. What are the contaminant concentrations in sanctuary habitats and how are they changing?

Contaminant concentrations in the seamount environment are poorly understood. There have been very few sediment samples collected within the DSMZ for the purpose of contaminant studies. As a result, the assessment of contaminant concentrations is "undetermined" with an "undetermined" trend.

It is known, however, that the depth and distance from land do not prevent the seamount environment from being impacted by point and non-point water pollution (MBNMS 2012). For example, traces of the pesticide DDT, banned in the U.S. since 1972 but still present in watershed sediments, were detected in sediments near the base of the seamount and were probably transported through Monterey Canyon sediment flow events (C. Paull, MBARI, unpublished data; Hartwell 2008). Further work is needed to understand contaminant concentrations, transport pathways, and changes in contaminant concentrations over time.

8. What are the levels of human activities that may influence habitat quality and how are they changing

Various existing and potential threats to habitat quality at Davidson Seamount have been identified and include: vessel traffic (e.g., loss of cargo, noise pollution); sunken vessels; military activity (e.g., dumping of dangerous waste, acoustic impacts to marine mammals); bio-prospecting; cumulative research collection; commercial harvesting (e.g., deep-water fisheries, coral harvesting); oil and gas exploitation; deep-sea mining; marine debris/dumping; underwater cables; sea temperature rise; and ocean acidification (see Table DS WQ1 for a comprehensive list of threats). The activity levels of many of these threats have not been quantified, and it is unknown if the cumulative level of these threats is changing. For these reasons, this question is rated "good/fair" with an "undetermined" trend.

Davidson Seamount is one of the few seamount areas in the world to receive the level of protection afforded by Monterey Bay National Marine Sanctuary and NOAA Fisheries (see response to Seamount Question 5 for more details). Sanctuary regulations provide important – although not comprehensive – defenses against many of these identified threats to benthic habitat. Furthermore, the depth of Davidson Seamount's summit, flanks (or slope), and base habitats make some forms of exploitation impossible or highly unlikely (MBNMS 2012).

Benthic habitats within the DSMZ exhibit evidence of cumulative intentional and accidental dumping (MBNMS 2012, Schlining et al. 2013, DeVogelaere et al. 2014). During ROV surveys in 2002 and 2006, 44 pieces of marine debris were observed and documented; 41% metal and 25% plastic. Specific items included bottles, cans, brooms, newspaper, buckets, curtains, and a train wheel (Figure DS Hab5). The effects of pressure, temperature, darkness, and relatively calm waters deep within the DSMZ can preserve debris. The debris discovered thus far is likely proportional to sampling effort, and future research expeditions are bound to uncover additional materials of anthropogenic origin (MBNMS 2012).

Some of the debris observed at the seamount was likely lost or dumped from large vessel transiting through the DSMZ. The possibility of cargo containers being lost from vessels is an additional threat to benthic habitat (MBNMS 2012). Impacts of lost cargo can include the threat of habitat crushing or smothering and the introduction of foreign habitat structure (see Offshore Question 5 and Figure OS Hab1). Cargo vessels transit the waters immediately adjacent to the DSMZ (Figure DS WQ 2), but there have been no known impacts to habitat from lost cargo in DSMZ.

During a 2006 ROV dive survey, researchers discovered a telecommunications cable that runs along the side of the seamount (Figure DS Hab5; MBNMS 2012). The history and current status of the cable is unknown. Submarine cables could become destructive to biogenic habitats (e.g., corals and sponges) if they become mobile.

Sea temperature rise and ocean acidification appear to be two of the most severe threats to the DSMZ at this time (Table DS WQ1). Rogers et al. (2007) suggest changes in ocean chemistry resulting from climate change may result in large-scale changes in the faunal composition of seamount communities, especially where corals play a role in structuring the environment and providing habitats for other species. We are not aware of any impacts of temperature or pH on condition structure-forming species at DSMZ, but there is very little information available. Sea temperature rise and ocean acidification are phenomena of a global nature and will require regulation at larger geographical scales beyond the jurisdiction of sanctuary management (MBNMS 2012). However, making note of them here will allow managers within and beyond the sanctuary to anticipate and respond to these pressures.

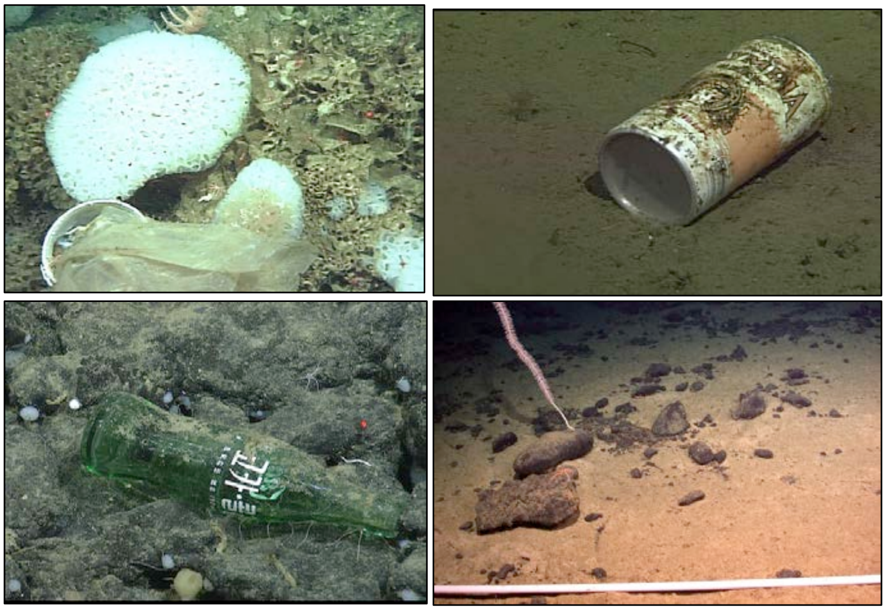

Figure DS Hab5
Caption: Examples of marine debris observed on Davidson Seamount: (top left) a plastic bag on top of a sponge limits the ability of the sponge to filter food from the water; (top right) an Olympia beer can was found at 8,589 feet; (bottom left) a Coca-Cola bottle that originated in South Korea was likely lost off an oil tanker or container ship; and (bottom right) a communications cable, of unknown origin, is visible in the lower part of this image.
Credit: NOAA/MBARI [copied from DeVogelaere et al. 2014
http://montereybay.noaa.gov/research/currsymp2014/posterpdfs/pdevo2014.pdf]

Seamount Environment Habitat Status & Trends

Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

▲ = Improving — = Not changing ▼ = Declining
? = Undetermined trend **N/A** = Question not applicable

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
5	Abundance/ Distribution	—	Status: very high Trend: high	Offshore location, existing level of protections, and limited access to the seafloor may limit impacts.	Habitats are in pristine or near-pristine condition and are unlikely to preclude full community development.
6	Biologically-Structured	?	Status: very high Trend: medium	Biogenic species appear abundant; organisms larger, more robust than coastal canyon areas. Trend information unavailable.	Habitats are in pristine or near-pristine condition and are unlikely to preclude full community development.
7	Contaminants	?	Status: N/A Trend: N/A	Contaminant concentrations in the DSMZ are poorly understood. There have been very few sediment samples collected within the DSMZ for the purpose of contaminant studies.	Not enough information to make a determination.
8	Human Impacts	?	Status: high Trend: medium	Harmful activities exist, but offshore location, existing level of protections, and limited access to the seafloor may limit impacts.	Some potentially harmful activities exist, but they do not appear to have had a negative effect on habitat quality.

Seamount Environment: Living Resources

Biodiversity is variation of life at all levels of biological organization, and commonly encompasses diversity within a species (genetic diversity) and among species (species diversity), and comparative diversity among ecosystems (ecosystem diversity). Biodiversity can be measured in many ways. The simplest measure is to count the number of species found in a certain area at a specified time. This is termed species richness. Other indices of biodiversity couple species richness with a relative abundance to provide a measure of evenness and heterogeneity. When discussing "biodiversity" we primarily refer species richness and to diversity indices that include relative abundance of different species and taxonomic groups. To our knowledge no species have become extinct within the sanctuary, so native species richness remains unchanged since sanctuary designation in 1992. Researchers have described previously unknown species (i.e., new to science) in deeper waters, but these species existed within the sanctuary prior to their discovery. The number of non-indigenous species has increased within the sanctuary. We do not include non-indigenous species in our estimates of native biodiversity.

Key species, such as keystone species, indicators species, sensitive species and those targeted for special protection, are discussed in the responses to questions 12 and 13. Status of key species will be addressed in question 12 and refers primarily to population numbers. Condition or health of key species will be addressed in question 13. Key species in the sanctuary are numerous and all cannot be covered here. Emphasis is placed on examples from various primary habitats of the sanctuary for which some data on status or condition are available.

The following information provides an assessment of the status and trends pertaining to the current state of the sanctuary's living resources in the seamount environment.

9. What is the status of biodiversity and how is it changing?

Species have probably not been lost from the marine ecosystem within the DSMZ in recent history (with the exception of occasional commercial take of swordfish, albacore, and sharks), and it is likely that species richness has not declined. A few surveys of the benthos and sea surface have occurred and can provide baseline information. For these reasons, the status of biodiversity in the seamount environment is rated as "good" with an "undetermined" trend.

Seamount benthos

In 2002 and 2006, the sanctuary led two multi-institutional expeditions to characterize the geology and natural history of Davidson Seamount. Approximately 140 hours of video and sample collections were taken during 17 remotely operated vehicle (ROV) dives. Most were primarily on the seafloor, with opportunistic dives in the water column above the seamount. At least 237 taxa were observed, including 18 previously undescribed species (Burton and Lundsten 2008; E. Burton, MBNMS, unpublished data).

The Davidson Seamount is a relatively pristine area; and is populated by a diversity of cold-water corals, most of which have other species associated with them (see Question 6; DeVogelaere et al. 2005). While most of the corals were found at the highest peak areas of the seamount, others were found deeper, and still, almost exclusively on ridge formations.

Species assemblages at the seamount summit contain dense aggregations of corals and sponges (McClain et al. 2009). These species are encountered at similar depths along rocky walls of Monterey Canyon; but at far lower densities or dominance, and their sizes are smaller than those occurring at Davidson Seamount. Preliminary results suggest that structure of seamount assemblages may differ from other deep-sea benthic habitats and may prove to be source populations for many deep-sea species.

Species diversity and density at Davidson Seamount do not significantly change with depth, and can vary greatly on a single isobath (McClain et al. 2010). Authors suggest the lack of clear bathymetric pattern in diversity or density may reflect the proximity of Davidson Seamount to highly productive coastal waters fueled by coastal upwelling. However, changes of 50% in assemblage composition were observed over as little as a ~1500 meter depth interval down the flanks of the seamount (McClain et al. 2010).

Comment [N59]: Field: Nothing factually wrong here, it's just that I don't consider a 1500 meter depth interval to be "little"- that's more than the depth of the epipelagic and mesopelagic, the relative shift would not be expected to be as great at depth, but it should still be expected. Just a wording thing.

Seamount sea surface

Several ship-based and aerial surveys have occurred at Davidson Seamount to determine occurrence of marine mammals, seabirds, or surface-swimming fishes (Benson 2002, Forney 2002, King 2010, Newton and DeVogelaere 2013; Figure DS LR1). The majority of these surveys were opportunistic, and limited in range or duration. In July 2010, sanctuary staff and regional experts conducted a dedicated, ship-based survey of the waters above and around the Davidson Seamount. Eight transect lines were surveyed for a total of 605 km of "on-effort" observations. Seventeen species of seabirds and 6 marine mammal species were observed (Newton and DeVogelaere 2013). Overall, 200 sightings of 668 individual marine mammals were observed during the 3-day survey. Fin whales (*Balaenoptera physalus*) were the most commonly encountered marine mammal (51% of all marine mammal sightings; Figure DS LR2). There were 316 sightings of 1,033 individual seabirds comprising 17 different species. Cook's Petrel

(*Pterodroma cookii*) and Leach's Storm-Petrel (*Oceanodroma leucorhoa*) were the two most commonly encountered species (77% of seabird sightings and 82% of all seabirds observed). Including off effort sightings, observers recorded the greatest number of Cook's Petrel ever observed in California waters (5,125 total birds).

Figure DS LR1
File Name: SLC_073109_2717.jpg
Caption: Black-footed Albatross (*Phoebastria nigripes*).
Credit: Steve Choy/NOAA MBNMS

Figure DS LR2
File Name: IMG_2722BORKER.jpg
Caption: Fin Whale (*Balaenoptera physalus*) above Davidson Seamount.
Credit: Abe Borker/NOAA

10. What is the status of environmentally sustainable fishing and how is it changing?

We are no longer assessing this Question in ONMS Condition Reports so content for this question was not included.

11. What is the status of non-indigenous species and how is it changing?

There are no known non-indigenous species within the seamount environment (Burton and Lundsten 2008, Lundsten et al. 2009a, 2009b). Non-indigenous species in offshore habitats are not suspected or do not appear to affect ecosystem integrity because very few non-indigenous species have been identified in these habitats. For these reasons, this question is rated "good" and the trend is "not changing."

12. What is the status of key species and how is it changing?

The status of key species in the offshore environment is rated "good/fair" and the trend is "increasing." Key species include cold-water corals (biogenic species), marine mammals (i.e., fin whale), and fisheries-targeted pelagic fishes (i.e., albacore, swordfish, common thresher shark). Cold-water corals (biogenic habitat) may represent indicators of ecosystem condition or change, marine mammals are considered charismatic species, and pelagic fishes are key species due to their important role in commercial and recreational fisheries. While coral species appear to reflect near-pristine conditions, whale and fished species do not, leading to a good-fair rating

Biogenic Species
Structure-forming invertebrates at Davidson Seamount, such as the many species of cold-water corals and sponges, hold an important ecological role in creating habitat structure for other species (Figure DS LR3). All of the deep-sea corals observed at Davidson Seamount (with the exception of *Anthomastus*) had other obvious megafauna associated with them (DeVogelaere et al. 2005). Living on the corals were polychaete worms, isopods, shrimps, crabs, basket stars, crinoids, brittle stars, and anemones. Present adjacent to corals were grenadier (*Coryphaenoides* spp.), thornyhead (*Sebastolobus* sp.), sponges, other corals, seastars, clams, sea cucumbers, and octopi (*Graneledone* sp.).

Observations from Davidson Seamount show that summit assemblages contain dense aggregations of corals and sponges (McClain et al 2009). These species are encountered at similar depths along the rocky walls of Monterey Canyon, but at far lower densities or dominance than occurs at Davidson. Lundsten et al. (2010) identified 25 coral species at Davidson Seamount. The Gorgonacea (e.g., bubble gum corals, *Paragorgia* spp.) were the most frequently observed coral group (73%) and encompassed the widest depth range. Other coral groups included Antipatharians (black corals, 21.8%), Alcyonacea (4.7%), Scleractinia (0.4%), Zoanthidea (0.09%), and Pennatulacea (0.07%).

Bubble gum corals (*Paragorgia* spp.) are the most dramatic corals observed at Davidson Seamount due to their size (>2 x 2 meters in height and width) and dense aggregations ("forests") on local peaks and adjacent steep slopes (DeVogelaere et al. 2005, Clague et al. 2010). These corals are thought to reach the largest size of any sedentary colonial animal

(Hourigan et al. 2007). Colonies of *Paragorgia arborea* in New Zealand have been reported to reach 10 meters in height (Smith 2001, Hourigan et al. 2007).

Age and growth studies of cold-water corals at Davidson Seamount indicate they are slow-growing and long-lived with some colonies aged at over 100 years old (Andrews et al. 2005, 2007, 2009; see Seamount Question 6 for more details). Due to their large size and slow growth, deep-sea corals and sponges are vulnerable to disturbance from human activities that contact the seafloor. Sanctuary regulations prohibit the take of corals, unless permitted for research purposes. In addition, the seamount is protected from bottom fishing gear through Essential Fish Habitat designation. Therefore, coral removal is unlikely and closely regulated.

Marine Mammals

Several ship-based and aerial surveys have occurred at Davidson Seamount to determine occurrence of marine mammals, seabirds, or surface-swimming fishes (Benson 2002, Forney 2002, King 2010, Newton and DeVogelaere 2013). The majority of these surveys were opportunistic, and limited in range or duration. The first dedicated, multi-disciplinary survey of marine mammal, seabird, and oceanographic conditions at the Davidson Seamount occurred during July 2010 (Newton and DeVogelaere 2013). During the 3-day ship-based survey in July 2010, there were 200 sightings of 668 individual marine mammals (Newton and DeVogelaere 2013). Fin whales (*Balaenoptera physalus*) were the most commonly encountered marine mammal (51% of all marine mammal sightings). The California/Oregon/Washington fin whale stock is listed as federally endangered, and there is some indication that the population may be growing (Carretta et al. 2013). While we have less information on other marine mammals in the area, the following species have also been observed: Dall's porpoise (*Phocoenoides dalli*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), and Northern right whale dolphin (*Lissodelphis borealis*) (Newton and DeVogelaere 2013).

Fisheries-targeted species

In recent years, two commercial finfish fisheries have operated in the top 150 feet (46 meters) of water above Davidson Seamount targeting highly migratory pelagic species: drift gillnetting for swordfish and sharks, and trolling for albacore (NOAA 2008, MBNMS 2012). Swordfish and pelagic sharks are primarily caught with drift gillnets. Albacore (*Thunnus alalunga*) are caught both commercially and recreationally by trolling lures or live bait. A local fisherman (fishing for albacore out of Morro Bay for more than 35 years) has visited the seamount 4-5 times per year for overnight sport fishing trips (MacKnight et al. 2011). Fishermen have reported that the seamount may enhance albacore fishing in some years (NOAA 2004, MBNMS 2012). The seamount itself is too deep for most fish trawling methods, where fish density is very low, and the species seen to date are not commercially desirable.

Comment [N60]: Thornyheads are in fact commercially important species, as are sablefish, I did not see explicit mention of sablefish being observed at Davidson, but would be very surprised if they were not present.

The North Pacific albacore stock area consists of all waters in the Pacific Ocean north of the equator (ALBWG 2014). Estimates of total stock biomass (age-1 and older) show a long term decline from the early 1970s to 1990 followed by a recovery through the 1990s and subsequent fluctuations without trend in the 2000s. Based on the results of the stock assessment, the North Pacific albacore stock is not experiencing overfishing and is probably not in an overfished condition. The Albacore Working Group (ALBWG) concludes that the North Pacific albacore stock is healthy and that current productivity is sufficient to sustain recent exploitation levels, assuming average historical recruitment in both the short- and long-term.

The North Pacific common thresher shark (*Alopias vulpinus*) stock has not been fully assessed. The U.S. West Coast EEZ regional catch and CPUE (catch per unit effort) demonstrates the population is increasing from estimated low levels in the early 1990s (PFMC 2014).

Comment [N61]: Field: I think "demonstrates" is a bit too strong, "indicates" or "suggests" is probably a more appropriate term.

The swordfish (*Xiphias gladius*) stock in the northeast Pacific is healthy, is not overfished, overfishing is not occurring, and biomass is greater than the biomass at which maximum sustainable yield (MSY) is produced (Marsh and Stiles 2011, ICS 2014).

Figure DS LR3)
File Name: DSCN7193.jpg
Caption: Yellow sponge (*Staurocalyptus* sp.), basket star (*Gorgonocephalus* sp.), white ruffle sponge (*Farrea occa*), and white branched sponge (*Asbestopluma monticola*) on the Davidson Seamount (1,316 meters).
Credit: NOAA/MBARI

13. What is the condition or health of key species and how is it changing?

The condition or health of key species in the offshore environment is rated "good" and the trend is "not changing." The health of coral and other biogenic species seems good. There are some concerns about impacts of ocean chemistry changes on these species, but further study is needed to determine if there have been any impacts to populations at Davidson Seamount. The response to Offshore Questions 13 provides a general summary of health concerns for marine mammals in the offshore waters including entanglement in and ingestion of marine debris and bioaccumulation of contaminants. There are some DSMZ-specific threats to marine mammal health (e.g., vessel traffic, noise), but little data is available to assess impacts of those threats in DSMZ. Fisheries-targeted species (e.g., albacore, swordfish, thresher shark) have no known DSMZ-specific health issues. These long-lived fishes can have elevated levels of contaminants such as mercury, but the DSMZ is not a source of those contaminants.

<u>Biogenic Species</u>
Age and growth studies of cold-water corals at Davidson Seamount indicate they are slow-growing and long-lived (Andrews et al. 2005, 2007, 2009). Radiometric ageing results for two bamboo coral colonies (*Keratoisis* sp.) converged on a radial growth rate of ~0.055 mm per yr.

One colony was aged at 98 ± 9 yr, with an average axial growth rate of ~0.7 cm per yr. The age of a large colony was >145 yr with an estimated axial growth rate of 0.14 to 0.28 cm per yr. A linear (axial) growth rate of approximately 0.25 cm per yr led to a colony age of about 115 yr for the precious coral (*Corallium* sp.); however, based on the radial growth rate, an age of up to 200 yr is possible. Due to the slow growth of these habitat-forming organisms, recovery from any damage could be slow (i.e., many decades to centuries).

Growth rates of bubblegum corals are not well-defined (Hourigan et al. 2007). Age estimates using skeletal cross sections from one Davidson Seamount colony (*Paragorgia arborea*; 80 cm from base to tip along main axis) suggest 9 to 14 years (Andrews et al. 2005). When translated to a linear growth rate, the estimate is relatively high (6-9 cm per year). However, counting of these growth zones was very subjective and should be interpreted with caution. Radiocarbon-dating of a very large New Zealand *Paragorgia arborea* colony resulted in preliminary age estimates ranging between 100-200 years for the tip of the colony, and between 300-500 years for the base of the colony (Tracey et al. 2003).

Sanctuary regulations prohibit the take of corals, unless permitted for research purposes. In addition, the seamount is protected from bottom fishing gear through Essential Fish Habitat designation. Therefore, coral removal is unlikely and closely regulated.

Marine Mammals

Health concerns for key marine mammal species include noise pollution and interaction with vessel traffic. The northeast corner of the DSMZ is bisected by shipping tracks of tankers carrying crude oil, black oil, or other persistent liquid cargo in bulk (http://montereybay.noaa.gov/materials/maps/vessel_lanes1_lg.jpg). Threats from vessel traffic include oil or chemical spills, loss of cargo, ship-based pollution (i.e., residues from tank cleaning), exchange of ballast water, and noise pollution.

Low frequency sounds produced by vessels have acoustic impacts that are not confined to coastal waters, but penetrate into the waters of the deep sea (MBNMS 2012). Impacts of this type of pollution on cetaceans and other species that spend a large part of their life in the deep sea and use sound to communicate, navigate, feed and sense their environment remain uncertain (UNEP 2007).

14. What are the levels of human activities that may influence living resource quality and how are they changing?

Although there are some existing and potential threats to living resources, Davidson Seamount is one of the few seamount areas in the world to receive the level of protection afforded by Monterey Bay National Marine Sanctuary and NOAA Fisheries. Sanctuary regulations provide important – although not comprehensive – defenses against various threats. Furthermore, the great depth of Davidson Seamount's summit, flanks (or slope), and base habitats make some forms of exploitation impossible or highly unlikely (MBNMS 2012). There are various levels of existing and potential threats (see Table DS WQ1 for a full list of potential threats and their ratings). The activity levels of most of the existing threats have been qualitatively described in DSMZ; some potentially harmful activities exist (i.e., vessel traffic, marine debris, sea temperature rise, ocean acidification) but they do not appear to have had a negative effect on living resource quality. It is unknown if the cumulative activity level is changing. For these reasons, this question is rated "good/fair" with an "undetermined" trend.

Vessel traffic, marine debris, sea temperature rise, and ocean acidification appear to be the most severe threats to living resources in the DSMZ at this time (MBNMS 2012). Marine debris has been found on the seafloor in DSMZ and may negatively impact benthic organisms (see Seamount Question 8 for more details). Floating marine debris impacts pelagic animals is many ways, most notably through entanglement and ingestion of plastic fragments that can clog the digestive tract (see Offshore Questions 13 and 14 for more details). However, the amounts of marine debris in DSMZ, particularly in the water column, is not well understood.

Threats to living resources from vessel traffic include oil or chemical spills and discharges, loss of cargo and other marine debris, ship-based pollution (i.e., residues from tank cleaning), exchange of ballast water, ships colliding with whales and other large animals, and noise pollution (MBNMS 2012). The northeast corner of the DSMZ is bisected by the Western States Petroleum Association (WSPA) recommended shipping tracks for tankers carrying crude oil, black oil, or other persistent liquid cargo in bulk (Figure DS WQ1). Miller (2011) found that the average number of vessel transits through DSMZ in 2010 was 159 per month. An analysis of vessel traffic (2009-2012) indicates a great majority of the large vessels that transit in or near MBNMS are complying with the WSPA and International Maritime Organization (IMO) recommended tracks (Figure DS WQ2; De Beukelaer et al. 2014). Further analysis of the AIS data for the number of vessels transiting through the DSMZ on a monthly or annual basis would be useful to look at trends in this activity.

One threat to living resources at Davidson Seamount that is of growing concern is the impacts of changing ocean chemistry on both plankton and benthic structure-forming species, many of which have calcified body parts. We are not aware of specific studies of impacts of acidification on living resources in the DSMZ. Directed study of the effects of climate driven changes in pH, temperature, and dissolved oxygen on key species in the DSMZ will become increasingly important for understanding and tracking the status and condition of living resources. Sea temperature rise and ocean acidification are phenomena of a global nature and will require regulation at larger geographical scales beyond the jurisdiction of Sanctuary management (MBNMS 2012). However, making note of them here will allow managers within and beyond the MBNMS to anticipate and respond to these pressures.

Seamount Living Resources Status & Trends

Good	Good/Fair	Fair	Fair/Poor	Poor	Undet.

▲ = Improving — = Not changing ▼ = Declining
? = Undetermined trend N/A = Question not applicable

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
9	Biodiversity	?	Status: very high Trend: medium	Relatively pristine area with few removals; but data are sparse	Biodiversity appears to reflect pristine or near-pristine conditions and promotes ecosystem integrity (full community development and function).
11	Non-Indigenous Species	—	Status: medium Trend: medium	No known non-indigenous species; but data are sparse	Non-indigenous species are not suspected or do not appear to affect ecosystem integrity (full community development and function)
12	Key Species Status	▲	Status: high Trend: high	Abundance and diversity of corals, stable fish stocks, and existing protections. Federally endangered marine mammals (e.g., fin whale), appear to be increasing.	Key and keystone species appear to reflect pristine or near-pristine conditions and many promote ecosystem integrity (full community development and function).
13	Key Species Condition	—	Status: high Trend: medium	Key species appear healthy, and are protected or otherwise regulated.	The condition of key resources appears to reflect pristine or near-pristine conditions.
14	Human Activities	?	Status: high Trend: medium	Offshore location, existing level of protections, and few existing threats may limit impacts to living resources.	Some potentially harmful activities exist, but they do not appear to have had a negative effect on habitat quality.

Seamount Environment Maritime Archaeological Resources

The following information provides an assessment of the status and trends pertaining to the current state of the maritime archaeological resources in the offshore environment.

There are no known maritime archaeological resources within the Davidson Seamount Management Zone; therefore questions #15-#17 are not applicable to this environment.

15. What is the integrity of known maritime archaeological resources and how is it changing?

There are no known maritime archaeological resources within the Davidson Seamount Management Zone.

16. Do known maritime archaeological resources pose an environmental hazard and is this threat changing?

There are no known maritime archaeological resources within the Davidson Seamount Management Zone.

17. What are the levels of human activities that may influence maritime archaeological resource quality and how are they changing?

There are no known maritime archaeological resources within the Davidson Seamount Management Zone.

Seamount Environment Maritime Archaeological Resources Status & Trends

Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

▲ = Improving — = Not changing ▼ = Declining
? = Undetermined trend **N/A** = Question not applicable

#	Issue	Rating	Confidence	Basis for Judgment	Description of Findings
15	Integrity	**N/A**	Status: N/A Trend: N/A	No known maritime archaeological resources	**N/A**
16	Threat to Environment	**N/A**	Status: N/A Trend: N/A	No known maritime archaeological resources	**N/A**
17	Human Activities	**N/A**	Status: N/A Trend: N/A	No known maritime archaeological resources	**N/A**

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Appendix A:
Rating Scheme for System-Wide Monitoring Questions

The purpose of this appendix is to clarify the 17 questions and possible responses used to report the condition of sanctuary resources in “Condition Reports” for all national marine sanctuaries. Individual staff and partners utilized this guidance, as well as their own informed and detailed understanding of the site to make judgments about the status and trends of sanctuary resources.

The questions derive from the National Marine Sanctuary System’s mission, and a system-wide monitoring framework (NMSP 2004) developed to ensure the timely flow of data and information to those responsible for managing and protecting resources in the ocean and coastal zone, and to those that use, depend on and study the ecosystems encompassed by the sanctuaries[3]. They are being used to guide staff and partners at each of the 14 sites in the sanctuary system in the development of this first periodic sanctuary condition report. Evaluations of status and trends may be based on interpretation of quantitative and, when necessary, non-quantitative assessments and observations of scientists, managers and users.

Ratings for a number of questions depend on judgments involving "ecological integrity," and an ecosystem's status with regard to it. This is because one of the foundational principles behind the establishment of marine sanctuaries is to protect ocean ecosystems. But this concept can be confusing, and is interpreted in different ways, so it is important to provide clarification of its application within this report. Ecological integrity implies the presence of naturally occurring species, populations and communities, and ecological processes functioning at appropriate rates, scales, and levels of natural variation, as well as the environmental conditions that support these attributes (modified from National Park Service Vital Signs monitoring program: http://science.nature.nps.gov/im/monitor/Glossary.cfm). Ecosystems have integrity when they have their native components intact, including abiotic components (the physical elements, such as water and habitats), biodiversity (the composition and abundance of species and communities in an ecosystem), and ecosystem processes (the engines that makes ecosystem work (e.g., space competition, predation, symbioses) (from Parks Canada at http://www.pc.gc.ca/progs/np-pn/ie-ei.aspx). For purposes of this report, the level of integrity that is judged to exist is based on the extent to which humans have altered key attributes, and the effect of that change on the ability of an ecosystem to resist continued change and recover from it. The statements for many questions are intended to reflect this judgment. Reference is made in the rating system to "near-pristine" conditions, which for this report would imply a status as near to an unaltered ecosystem as we can reasonably presume to exist, recognizing that there are virtually no ecosystems on Earth completely free from human influence.

Not all questions, however, use ecological integrity as a basis for judgment. One focuses on the impacts of water quality factors on human health. Another rates the status of key species compared with that expected in an unaltered ecosystem. One rates maritime archaeological resources based on their historical, archaeological, scientific, and educational value. Another considers the level and persistence of localized threats posed by degrading archaeological resources. Finally, four ask specifically about the levels of on-going human activity that could affect resource condition.

During workshops in which status and trends are rated, experts discuss each question, and relevant data, literature, and experience associated with the topic. They then discuss statements that are presented as options for judgments about the status. These statements have been customized for each question. Once a particular statement is agreed upon, a color code and status rating (e.g., good, fair, poor) is assigned. Experts can also decide that the most appropriate rating " N/A" (the question does not apply) or "Undet." (resource status is undetermined).

A subsequent discussion is then held about the trend and whether conditions are improving, remaining the same, or declining. Symbols used to indicate trends are the same for all questions:

[3] In 2012 the Office of National Marine Sanctuaries led an effort to review and revise the set of questions and their possible responses posed in the Condition Reports. The revised questions are not reflected in the 2015 Monterey Bay National Marine Sanctuary Condition Report Addendum. The revised questions will be addressed when the Condition Report in its entirety is revised in the future.

“▲” – conditions appear to be improving; “▬” – conditions do not appear to be changing; “▼” – conditions appear to be declining; and “?” – trend is undetermined.

Question 1 (Water/Stressors): Are specific or multiple stressors, including changing oceanographic and atmospheric conditions, affecting water quality and how are they changing?

This is meant to capture shifts in condition arising from certain changing physical processes and anthropogenic inputs. Factors resulting in regionally accelerated rates of change in water temperature, salinity, dissolved oxygen, or water clarity, could all be judged to reduce water quality. Localized changes in circulation or sedimentation resulting, for example, from coastal construction or dredge spoil disposal, can affect light penetration, salinity regimes, oxygen levels, productivity, waste transport, and other factors that influence habitat and living resource quality. Human inputs, generally in the form of contaminants from point or non-point sources, including fertilizers, pesticides, hydrocarbons, heavy metals, and sewage, are common causes of environmental degradation, often in combination rather than alone. Certain biotoxins, such as domoic acid, may be of particular interest to specific sanctuaries. When present in the water column, any of these contaminants can affect marine life by direct contact or ingestion, or through bioaccumulation via the food chain.

[Note: Over time, accumulation in sediments can sequester and concentrate contaminants. Their effects may manifest only when the sediments are resuspended during storm or other energetic events. In such cases, reports of status should be made under Question 7 – Habitat contaminants.]

Good	Conditions do not appear to have the potential to negatively affect living resources or habitat quality.
Good/Fair	Selected conditions may preclude full development of living resource assemblages and habitats, but are not likely to cause substantial or persistent declines.
Fair	Selected conditions may inhibit the development of assemblages, and may cause measurable but not severe declines in living resources and habitats.
Fair/Poor	Selected conditions have caused or are likely to cause severe declines in some but not all living resources and habitats.
Poor	Selected conditions have caused or are likely to cause severe declines in most if not all, living resources and habitats.

Question 2 (Water/Eutrophic Condition): What is the eutrophic condition of sanctuary waters and how is it changing?

Nutrient enrichment often leads to planktonic and/or benthic algae blooms. Some affect benthic communities directly through space competition. Overgrowth and other competitive interactions (e.g., accumulation of algal-sediment mats) often lead to shifts in dominance in the benthic assemblage. Disease incidence and frequency can also be affected by algae competition and the resulting chemistry along competitive boundaries. Blooms can also affect water column conditions, including light penetration and plankton availability, which can alter pelagic food webs. Harmful algal blooms often affect resources, as biotoxins are released into the water and air, and oxygen can be depleted.

Good	Conditions do not appear to have the potential to negatively affect living resources or habitat quality.
Good/Fair	Selected conditions may preclude full development of living resource assemblages and habitats, but are not likely to cause substantial or persistent declines.
Fair	Selected conditions may inhibit the development of assemblages, and may cause measurable but not severe declines in living resources and habitats.
Fair/Poor	Selected conditions have caused or are likely to cause severe declines in some but not all living resources and habitats.
Poor	Selected conditions have caused or are likely to cause severe declines in most if not all living resources and habitats.

Question 3 (Water/Human Health): Do sanctuary waters pose risks to human health and how are they changing?

Human health concerns are generally aroused by evidence of contamination (usually bacterial or chemical) in bathing waters or fish intended for consumption. They also emerge when harmful algal blooms are reported or when cases of respiratory distress or other disorders attributable to harmful algal blooms increase dramatically. Any of these conditions should be considered in the course of judging the risk to humans posed by waters in a marine sanctuary.

Some sites may have access to specific information on beach and shellfish conditions. In particular, beaches may be closed when criteria for safe water body contact are exceeded, or shellfish harvesting may be prohibited when contaminant loads or infection rates exceed certain levels. These conditions can be evaluated in the context of the descriptions below.

Good	Conditions do not appear to have the potential to negatively affect human health.
Good/Fair	Selected conditions that have the potential to affect human health may exist but human impacts have not been reported.
Fair	Selected conditions have resulted in isolated human impacts, but evidence does not justify widespread or persistent concern.
Fair/Poor	Selected conditions have caused or are likely to cause severe impacts, but cases to date have not suggested a pervasive problem.
Poor	Selected conditions warrant widespread concern and action, as large-scale, persistent, and/or repeated severe impacts are likely or have occurred.

Question 4 (Water/Human Activities): What are the levels of human activities that may influence water quality and how are they changing?

Among the human activities in or near sanctuaries that affect water quality are those involving direct discharges (transiting vessels, visiting vessels, onshore and offshore industrial facilities, public wastewater facilities), those that contribute contaminants to stream, river, and water control discharges (agriculture, runoff from impermeable surfaces through storm drains, conversion of land use), and those releasing airborne chemicals that subsequently deposit via particulates at sea (vessels, land-based traffic, power plants, manufacturing facilities, refineries). In addition, dredging and trawling can cause resuspension of contaminants in sediments.

Good	Few or no activities occur that are likely to negatively affect water quality.
Good/Fair	Some potentially harmful activities exist, but they do not appear to have had a negative effect on water quality.
Fair	Selected activities have resulted in measurable resource impacts, but evidence suggests effects are localized, not widespread.
Fair/Poor	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.
Poor	Selected activities warrant widespread concern and action, as large-scale, persistent, and/or repeated severe impacts have occurred or are likely to occur.

Question 5 (Habitat/Abundance/Distribution): What are the abundance and distribution of major habitat types and how are they changing?

Habitat loss is of paramount concern when it comes to protecting marine and terrestrial ecosystems. Of greatest concern to sanctuaries are changes caused, either directly or indirectly, by human activities. The loss of shoreline is recognized as a problem indirectly caused by human activities. Habitats with submerged aquatic vegetation are often altered by changes in water conditions in estuaries, bays, and nearshore waters. Intertidal zones can be affected for long periods by spills or by chronic pollutant exposure. Beaches and haul-out areas can be littered with dangerous marine debris, as can the water column or benthic habitats. Sandy subtidal areas and hardbottoms are frequently disturbed or destroyed by trawling. Even rocky areas several hundred meters deep are increasingly affected by certain types of trawls, bottom longlines, and fish traps. Groundings, anchors, and divers damage submerged reefs. Cables and pipelines disturb corridors across numerous habitat types and can be destructive if they become mobile. Shellfish dredging removes, alters, and fragments habitats.

The result of these activities is the gradual reduction of the extent and quality of marine habitats. Losses can often be quantified through visual surveys and to some extent using high-resolution mapping. This question asks about the quality of habitats compared to those that would be expected without human impacts. The status depends on comparison to a baseline that existed in the past - one toward which restoration efforts might aim.

Good	Habitats are in pristine or near-pristine condition and are unlikely to preclude full community development.
Good/Fair	Selected habitat loss or alteration has taken place, precluding full development of living resource assemblages, but it is unlikely to cause substantial or persistent degradation in living resources or water quality.
Fair	Selected habitat loss or alteration may inhibit the development of assemblages, and may cause measurable but not severe declines in living resources or water quality.
Fair/Poor	Selected habitat loss or alteration has caused or is likely to cause severe declines in some but not all living resources or water quality.
Poor	Selected habitat loss or alteration has caused or is likely to cause severe declines in most if not all living resources or water quality.

Question 6 (Habitat/Structure): What is the condition of biologically-structured habitats and how is it changing?

Many organisms depend on the integrity of their habitats and that integrity is largely determined by the condition of particular living organisms. Coral reefs may be the best known examples of such biologically-structured habitats. Not only is the substrate itself biogenic, but the diverse assemblages residing within and on the reefs depend on and interact with each other in tightly linked food webs. They also depend on each other for the recycling of wastes, hygiene, and the maintenance of water quality, among other requirements.

Kelp beds may not be biogenic habitats to the extent of coral reefs, but kelp provides essential habitat for assemblages that would not reside or function together without it. There are other communities of organisms that are also similarly co-dependent, such as hard-bottom communities, which may be structured by bivalves, octocorals, coralline algae, or other groups that generate essential habitat for other species. Intertidal assemblages structured by mussels, barnacles, and algae are another example, seagrass beds another. This question is intended to address these types of places, where organisms form structures (habitats) on which other organisms depend.

Good	Habitats are in pristine or near-pristine condition and are unlikely to preclude full community development.
Good/Fair	Selected habitat loss or alteration has taken place, precluding full development of living resources, but it is unlikely to cause substantial or persistent degradation in living resources or water quality.
Fair	Selected habitat loss or alteration may inhibit the development of living resources, and may cause measurable but not severe declines in living resources or water quality.
Fair/Poor	Selected habitat loss or alteration has caused or is likely to cause severe declines in some but not all living resources or water quality.
Poor	Selected habitat loss or alteration has caused or is likely to cause severe declines in most if not all living resources or water quality.

Question 7 (Habitat/Contaminants): What are the contaminant concentrations in sanctuary habitats and how are they changing?

This question addresses the need to understand the risk posed by contaminants within benthic formations, such as soft sediments, hard bottoms, or biogenic organisms. In the first two cases, the contaminants can become available when released via disturbance. They can also pass upwards through the food chain after being ingested by bottom dwelling prey species. The contaminants of concern generally include pesticides, hydrocarbons, and heavy metals, but the specific concerns of individual sanctuaries may differ substantially.

Good	Contaminants do not appear to have the potential to negatively affect living resources or water quality.
Good/Fair	Selected contaminants may preclude full development of living resource assemblages, but are not likely to cause substantial or persistent degradation.
Fair	Selected contaminants may inhibit the development of assemblages, and may cause measurable but not severe declines in living resources or water quality.
Fair/Poor	Selected contaminants have caused or are likely to cause severe declines in some but not all living resources or water quality.
Poor	Selected contaminants have caused or are likely to cause severe declines in most if not all living resources or water quality.

Question 8 (Habitat/Human Activities): What are the levels of human activities that may influence habitat quality and how are they changing?

Human activities that degrade habitat quality do so by affecting structural (geological), biological, oceanographic, acoustic, or chemical characteristics. Structural impacts include removal or mechanical alteration, including various fishing techniques (trawls, traps, dredges, longlines, and even hook-and-line in some habitats), dredging channels and harbors and dumping spoil, vessel groundings, anchoring, laying pipelines and cables, installing offshore structures, discharging drill cuttings, dragging tow cables, and placing artificial reefs. Removal or alteration of critical biological components of habitats can occur along with several of the above activities, most notably trawling, groundings, and cable drags. Marine debris, particularly in large quantities (e.g., lost gillnets and other types of fishing gear), can affect both biological and structural habitat components. Changes in water circulation often occur when channels are dredged, fill is added, coastal areas are reinforced, or other construction takes place. These activities affect habitat by changing food delivery, waste removal, water quality (e.g., salinity, clarity and sedimentation), recruitment patterns, and a host of other factors. Acoustic impacts can occur to water column habitats and organisms from acute and chronic sources of anthropogenic noise (e.g., shipping, boating, construction). Chemical alterations most commonly occur following spills and can have both acute and chronic impacts.

Good	Few or no activities occur that are likely to negatively affect habitat quality.
Good/Fair	Some potentially harmful activities exist, but they do not appear to have had a negative effect on habitat quality.
Fair	Selected activities have resulted in measurable habitat impacts, but evidence suggests effects are localized, not widespread.
Fair/Poor	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.
Poor	Selected activities warrant widespread concern and action, as large-scale, persistent, and/or repeated severe impacts have occurred or are likely to occur.

Question 9 (Living Resources/Biodiversity): What is the status of biodiversity and how is it changing?

This is intended to elicit thought and assessment of the condition of living resources based on expected biodiversity levels and the interactions between species. Intact ecosystems require that all parts not only exist, but that they function together, resulting in natural symbioses, competition, and predator-prey relationships. Community integrity, resistance and resilience all depend on these relationships. Abundance, relative abundance, trophic structure, richness, H' diversity, evenness, and other measures are often used to assess these attributes.

Good	Biodiversity appears to reflect pristine or near-pristine conditions and promotes ecosystem integrity (full community development and function).
Good/Fair	Selected biodiversity loss has taken place, precluding full community development and function, but it is unlikely to cause substantial or persistent degradation of ecosystem integrity.
Fair	Selected biodiversity loss may inhibit full community development and function, and may cause measurable but not severe degradation of ecosystem integrity.
Fair/Poor	Selected biodiversity loss has caused or is likely to cause severe declines in some but not all ecosystem components and reduce ecosystem integrity.
Poor	Selected biodiversity loss has caused or is likely to cause severe declines in ecosystem integrity.

Question 10 (Living Resources/Extracted Species): What is the status of environmentally sustainable fishing and how is it changing?[4]

Commercial and recreational harvesting are highly selective activities, for which fishers and collectors target a limited number of species, and often remove high proportions of populations. In addition to removing significant amounts of biomass from the ecosystem, reducing its availability to other consumers, these activities tend to disrupt specific and often critical food web links. When too much extraction occurs (i.e. ecologically unsustainable harvesting), trophic cascades ensue, resulting in changes in the abundance of non-targeted species as well. It also reduces the ability of the targeted species to replenish populations at a rate that supports continued ecosystem integrity.

It is essential to understand whether removals are occurring at ecologically sustainable levels. Knowing extraction levels and determining the impacts of removal are both ways that help gain this understanding. Measures for target species of abundance, catch amounts or rates (e.g., catch per unit effort), trophic structure, and changes in non-target species abundance are all generally used to assess these conditions.

Other issues related to this question include whether fishers are using gear that is compatible with the habitats being fished and whether that gear minimizes by-catch and incidental take of marine mammals. For example, bottom-tending gear often destroys or alters both benthic structure and non-targeted animal and plant communities. "Ghost fishing" occurs when lost traps continue to capture organisms. Lost or active nets, as well as lines used to mark and tend traps and other fishing gear, can entangle marine mammals. Any of these could be considered indications of environmentally unsustainable fishing techniques.

Good	Extraction does not appear to affect ecosystem integrity (full community development and function).
Good/Fair	Extraction takes place, precluding full community development and function, but it is unlikely to cause substantial or persistent degradation of ecosystem integrity.
Fair	Extraction may inhibit full community development and function, and may cause measurable but not severe degradation of ecosystem integrity.
Fair/Poor	Extraction has caused or is likely to cause severe declines in some but not all ecosystem components and reduce ecosystem integrity.
Poor	Extraction has caused or is likely to cause severe declines in ecosystem integrity.

[4] In 2012 the Office of National Marine Sanctuaries led an effort to review and revise the set of questions and their possible responses posed in the Condition Reports. As part of this effort some questions were combined, new questions were added, and other questions were removed. *Question 10, What is the status of environmentally sustainable fishing and how is it changing?* was removed from the set of questions. This decision was made because of all the questions it was the only one that focused on a single human activity. The issue of fishing is sufficiently addressed in other questions found the in report, including those related to biodiversity, the status and health of key species, and the status of human activities. For a complete list of the new, revised set of questions see ONMS 2015. Note that the revised questions are not reflected in the 2015 Monterey Bay National Marine Sanctuary Condition Report Addendum. However, because of the aforementioned reasons, Questions 10 was not answered. The new set of questions will be addressed when the Condition Report is revised in its entirety in the future.

Question 11 (Living Resources/Non-Indigenous Species): What is the status of non-indigenous species and how is it changing?

Non-indigenous species are generally considered problematic, and candidates for rapid response, if found, soon after invasion. For those that become established, their impacts can sometimes be assessed by quantifying changes in the affected native species. This question allows sanctuaries to report on the threat posed by non-indigenous species. In some cases, the presence of a species alone constitutes a significant threat (certain invasive algae). In other cases, impacts have been measured, and may or may not significantly affect ecosystem integrity.

Good	Non-indigenous species are not suspected or do not appear to affect ecosystem integrity (full community development and function).
Good/Fair	Non-indigenous species exist, precluding full community development and function, but are unlikely to cause substantial or persistent degradation of ecosystem integrity.
Fair	Non-indigenous species may inhibit full community development and function, and may cause measurable but not severe degradation of ecosystem integrity.
Fair/Poor	Non-indigenous species have caused or are likely to cause severe declines in some but not all ecosystem components and reduce ecosystem integrity.
Poor	Non-indigenous species have caused or are likely to cause severe declines in ecosystem integrity.

Question 12 (Living Resources/Key Species): What is the status of key species and how is it changing?

Certain species can be defined as “key” within a marine sanctuary. Some might be keystone species, that is, species on which the persistence of a large number of other species in the ecosystem depends - the pillar of community stability. Their functional contribution to ecosystem function is disproportionate to their numerical abundance or biomass and their impact is therefore important at the community or ecosystem level. Their removal initiates changes in ecosystem structure and sometimes the disappearance of or dramatic increase in the abundance of dependent species. Keystone species may include certain habitat modifiers, predators, herbivores, and those involved in critical symbiotic relationships (e.g. cleaning or co-habitating species).

Other key species may include those that are indicators of ecosystem condition or change (e.g., particularly sensitive species), those targeted for special protection efforts, or charismatic species that are identified with certain areas or ecosystems. These may or may not meet the definition of keystone, but do require assessments of status and trends.

Good	Key and keystone species appear to reflect pristine or near-pristine conditions and may promote ecosystem integrity (full community development and function).
Good/Fair	Selected key or keystone species are at reduced levels, perhaps precluding full community development and function, but substantial or persistent declines are not expected.
Fair	The reduced abundance of selected keystone species may inhibit full community development and function, and may cause measurable but not severe degradation of ecosystem integrity; or selected key species are at reduced levels, but recovery is possible.
Fair/Poor	The reduced abundance of selected keystone species has caused or is likely to cause severe declines in some but not all ecosystem components, and reduce ecosystem integrity; or selected key species are at substantially reduced levels, and prospects for recovery are uncertain.
Poor	The reduced abundance of selected keystone species has caused or is likely to cause severe declines in ecosystem integrity; or selected key species are severely reduced levels, and recovery is unlikely.

Question 13 (Living Resources/Health of Key Species): What is the condition or health of key species and how is it changing?

For those species considered essential to ecosystem integrity, measures of their condition can be important to determining the likelihood that they will persist and continue to provide vital ecosystem functions. Measures of condition may include growth rates, fecundity, recruitment, age-specific survival, tissue contaminant levels, pathologies (disease incidence tumors, deformities), the presence and abundance of critical symbionts, or parasite loads. Similar measures of condition may also be appropriate for other key species (indicator, protected, or charismatic species). In contrast to the question about keystone species (#12 above), the impact of changes in the abundance or condition of key species is more likely to be observed at the population or individual level, and less likely to result in ecosystem or community effects.

Good	The condition of key resources appears to reflect pristine or near-pristine conditions.
Good/Fair	The condition of selected key resources is not optimal, perhaps precluding full ecological function, but substantial or persistent declines are not expected.
Fair	The diminished condition of selected key resources may cause a measurable but not severe reduction in ecological function, but recovery is possible.
Fair/Poor	The comparatively poor condition of selected key resources makes prospects for recovery uncertain.
Poor	The poor condition of selected key resources makes recovery unlikely.

Question 14 (Living Resources/Human Activities): What are the levels of human activities that may influence living resource quality and how are they changing?

Human activities that degrade living resource quality do so by causing a loss or reduction of one or more species, by disrupting critical life stages, by impairing various physiological processes, or by promoting the introduction of non-indigenous species or pathogens. (Note: Activities that impact habitat and water quality may also affect living resources. These activities are dealt with in Questions 4 and 8, and many are repeated here as they also have direct effect on living resources).

Fishing and collecting are the primary means of removing resources. Bottom trawling, seine-fishing, and the collection of ornamental species for the aquarium trade are all common examples, some being more selective than others. Chronic mortality can be caused by marine debris derived from commercial or recreational vessel traffic, lost fishing gear, and excess visitation, resulting in the gradual loss of some species.

Critical life stages can be affected in various ways. Mortality to adult stages is often caused by trawling and other fishing techniques, cable drags, dumping spoil or drill cuttings, vessel groundings, or persistent anchoring. Contamination of areas by acute or chronic spills, discharges by vessels, or municipal and industrial facilities can make them unsuitable for recruitment; the same activities can make nursery habitats unsuitable. Although coastal armoring and construction can increase the availability of surfaces suitable for the recruitment and growth of hard bottom species, the activity may disrupt recruitment patterns for other species (e.g., intertidal soft bottom animals) and habitat may be lost.

Spills, discharges, and contaminants released from sediments (e.g., by dredging and dumping) can all cause physiological impairment and tissue contamination. Such activities can affect all life stages by reducing fecundity, increasing larval, juvenile, and adult mortality, reducing disease resistance, and increasing susceptibility to predation. Bioaccumulation allows some contaminants to move upward through the food chain, disproportionately affecting certain species.

Activities that promote introductions include bilge discharges and ballast water exchange, commercial shipping and vessel transportation. Releases of aquarium fish can also lead to species introductions.

Good	Few or no activities occur that are likely to negatively affect living resource quality.
Good/Fair	Some potentially harmful activities exist, but they do not appear to have had a negative effect on living resource quality.
Fair	Selected activities have resulted in measurable living resource impacts, but evidence suggests effects are localized, not widespread.
Fair/Poor	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.
Poor	Selected activities warrant widespread concern and action, as large-scale, persistent, and/or repeated severe impacts have occurred or are likely to occur.

Question 15 (Maritime Archaeological Resources/Integrity): What is the integrity of known maritime archaeological resources and how is it changing?

The condition of archaeological resources in a marine sanctuary significantly affects their value for science and education, as well as the resource's eligibility for listing in the National Register of Historic Places. Assessments of archaeological sites include evaluation of the apparent levels of site integrity, which are based on levels of previous human disturbance and the level of natural deterioration. The historical, scientific and educational values of sites are also evaluated, and are substantially determined and affected by site condition.

Good	Known archaeological resources appear to reflect little or no unexpected disturbance.
Good/Fair	Selected archaeological resources exhibit indications of disturbance, but there appears to have been little or no reduction in historical, scientific, or educational value.
Fair	The diminished condition of selected archaeological resources has reduced, to some extent, their historical, scientific, or educational value, and may affect the eligibility of some sites for listing in the National Register of Historic Places.
Fair/Poor	The diminished condition of selected archaeological resources has substantially reduced their historical, scientific, or educational value, and is likely to affect their eligibility for listing in the National Register of Historic Places.
Poor	The degraded condition of known archaeological resources in general makes them ineffective in terms of historical, scientific, or educational value, and precludes their listing in the National Register of Historic Places.

Question 16 (Maritime Archaeological Resources/Threat to Environment): Do known maritime archaeological resources pose an environmental hazard and how is this threat changing?

The sinking of a ship potentially introduces hazardous materials into the marine environment. This danger is true for historic shipwrecks as well. The issue is complicated by the fact that shipwrecks older than 50 years may be considered historical resources and must, by federal mandate, be protected. Many historic shipwrecks, particularly early to mid-20th century, still have the potential to retain oil and fuel in tanks and bunkers. As shipwrecks age and deteriorate, the potential for release of these materials into the environment increases.

Good	Known maritime archaeological resources pose few or no environmental threats.
Good/Fair	Selected maritime archaeological resources may pose isolated or limited environmental threats, but substantial or persistent impacts are not expected.
Fair	Selected maritime archaeological resources may cause measurable, but not severe, impacts to certain sanctuary resources or areas, but recovery is possible.
Fair/Poor	Selected maritime archaeological resources pose substantial threats to certain sanctuary resources or areas, and prospects for recovery are uncertain.
Poor	Selected maritime archaeological resources pose serious threats to sanctuary resources, and recovery is unlikely.

Question 17 (Maritime Archaeological Resources/Human Activities): What are the levels of human activities that may influence maritime archaeological resource quality and how are they changing?

Some human maritime activities threaten the physical integrity of submerged archaeological resources. Archaeological site integrity is compromised when elements are moved, removed, or otherwise damaged. Threats come from looting by divers, inadvertent damage by scuba diving visitors, improperly conducted archaeology that does not fully document site disturbance, anchoring, groundings, and commercial and recreational fishing activities, among others.

Good	Few or no activities occur that are likely to negatively affect maritime archaeological resource integrity.
Good/Fair	Some potentially relevant activities exist, but they do not appear to have had a negative effect on maritime archaeological resource integrity.
Fair	Selected activities have resulted in measurable impacts to maritime archaeological resources, but evidence suggests effects are localized, not widespread.
Fair/Poor	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.
Poor	Selected activities warrant widespread concern and action, as large-scale, persistent, and/or repeated severe impacts have occurred or are likely to occur.

Appendix B:
Consultation with Experts and Document Review

The process for preparing condition reports (and similarly, this addendum) involves a combination of accepted techniques for collecting and interpreting information gathered from subject matter experts. The approach varies somewhat from sanctuary to sanctuary, in order to accommodate differing styles for working with partners. The Monterey Bay National Marine Sanctuary approach was closely related to the Delphi Method, a technique designed to organize group communication among a panel of geographically dispersed experts by using questionnaires, ultimately facilitating the formation of a group judgment. This method can be applied when it is necessary for decision-makers to combine the testimony of a group of experts, whether in the form of facts or informed opinion, or both, into a single useful statement.

The Delphi Method relies on repeated interactions with experts who respond to questions with a limited number of choices to arrive at the best supported answers. Feedback to the experts allows them to refine their views, gradually moving the group toward the most agreeable judgment. For condition reports, the Office of National Marine Sanctuaries uses standardized questions related to the status and trends of sanctuary resources, with accompanying descriptions and five possible choices that describe resource condition (Appendix A).

In order to address the standardized questions, sanctuary staff selected and consulted outside experts familiar with water quality, living resources, habitat, and maritime archaeological resources in the estuarine, nearshore, offshore and seamount environments. A few different approaches (e.g., small group meetings, conference calls, email and individual meetings) were used to get expert input on the questions depending on the availability of experts (a list of experts who provided input is available in the ‘Acknowledgement’ section of this report).

In these meetings and calls experts were introduced to the questions and then asked to provide recommendations and supporting arguments. In small group settings and conference calls, the group converged in their opinion of the rating that most accurately described the current resource condition. In individual meetings and email correspondence, the sanctuary staff considered all input and decided on status and trend ratings. In all cases, draft status and trend ratings along with supporting narratives were made available to experts for individual comment.

Experts were also consulted to assign a level of confidence in status and trend ratings by: (1) characterizing the sources of information they used to make judgments and (2) their agreement that the available evidence supports the selected status and trend ratings. The evidence and agreement ratings were then combined to determine the overall confidence ratings, as described in the Table below.

Step 1: Rate Evidence
Consider three categories of evidence typically used to make status or trend ratings: *(1) data*, *(2) published information* and *(3) personal experience*.

Evidence Scores		
Limited	*Medium*	*Robust*
Limited data or published information, and little or no substantive personal experience	Data available, some peer reviewed published information, or direct personal experience.	Considerable data, extensive record of publication, or extensive personal experience

Step 2: Rate Agreement
Rate agreement among those participating in determining the status and trend rating, or if possible, within the broader scientific community. Levels of agreement can be characterized as *"low," "medium"* or *"high."*

Step 3: Rate Confidence
Using the matrix below, combine ratings for both evidence and agreement to identify a *level of confidence*. Levels of confidence can be characterized as as *"very low," "low," "medium" "high" or "very high."*

Agreement ↑			
	"Medium" High agreement Limited evidence	*"High"* High agreement Medium evidence	*"Very High"* High agreement Robust evidence
	"Low" Medium agreement Limited evidence	*"Medium"* Medium agreement Medium evidence	*"High"* Medium agreement Robust evidence
	"Very Low" Low agreement Limited evidence	*"Low"* Low agreement Medium evidence	*"Medium"* Low agreement Robust evidence

Evidence (type, amount, quality, consistency) →

An initial draft of the addendum, which was written by sanctuary staff, summarized the new information, expert opinions, and level of confidence expressed by the experts (who based their input on knowledge and perceptions of local conditions). Comments, data, and citations received from the experts were included, as appropriate, in text supporting the ratings. This initial draft of the addendum was made available to contributing experts and data providers which allowed them to review the content and determine if the report accurately reflected their input, identify information gaps, provide comments or suggest revisions to the ratings and text. Upon receiving those comments, the writing team revised the text and ratings as they deemed appropriate. Additional review of certain sections by those with specific expertise was requested after revision in some cases. Sometimes, additional input on confidence scores was requested if the status and trend was changed after those ratings had first been established in a small group setting.

In July 2015, a draft final report was sent to Dr. John Field (NOAA/NMFS/SWFSC), Dr. Raphael Kudela (University of California Santa Cruz), [insert others] for final review. This External Peer Review is a requirement that started in December 2004, when the White House Office of Management and Budget (OMB) issued a Final Information Quality Bulletin for Peer Review (OMB Bulletin) establishing peer review standards that would enhance the quality and credibility of the federal government's scientific information. Along with other information, these standards apply to Influential Scientific Information, which is information that can reasonably be determined to have a "clear and substantial impact on important public policies or private sector decisions." The Condition Reports are considered Influential Scientific Information. For this reason, these reports are subject to the review requirements of both the Information Quality Act and the OMB Bulletin guidelines. Therefore, following the completion of every condition report, they are reviewed by a minimum of three individuals who are considered to be experts in their field, were not involved in the development of the report, and are not ONMS employees. Comments from these peer reviews were incorporated into the final text of the report. Furthermore, OMB Bulletin guidelines require that reviewer comments, names, and affiliations be posted on the agency website, http://www.cio.noaa.gov. Reviewer comments, however, are not attributed to specific individuals. Comments by the External Peer Reviewers are posted at the same time as the formatted final document.

The reviewers were asked to review the technical merits of resource ratings and accompanying text, as well as to point out any omissions or factual errors. Following the External Peer Review, the comments and recommendations of the reviewers were considered by sanctuary staff and incorporated, as appropriate, into a final draft document. [may need to include the following text depending on peer reviewer comments 'In some cases, sanctuary staff reevaluated the status and trend ratings and when appropriate, the accompanying text in the document was edited to reflect the new ratings.'] The final interpretation, ratings and text in the draft condition report were the responsibility of sanctuary staff, with final approval by the sanctuary superintendent. To emphasize this important point, authorship of the report is attributed to the sanctuary alone. Subject experts were not authors, though their efforts and affiliations are acknowledged in the report.

Estuarine Environment - Confidence Scoring Table

Question	2015 Rating	**Evidence** *(limited, medium, or robust)*	**Agreement** *(low, medium, or high)*	**Confidence** *(very low, low, medium, high, or very high)*
Water Quality				
Question 1: multiple stressors	Status: Fair/Poor	Not updated	Not updated	Not updated
	Trend: Declining	Not updated	Not updated	Not updated
Question 2: Eutrophic condition	Status: Fair/Poor	Robust	High	Very High
	Trend: Declining	Robust	High	Very High
Question 3: risks to human health	Status: Fair/Poor	Not updated	Not updated	Not updated
	Trend: Undetermined	Not updated	Not updated	Not updated
Question 4: Human activities & WQ	Status: Fair	Medium	High	High
	Trend: Improving	Medium	High	High
Habitat				
Question 5: Major Habitat	Status: Fair/Poor	Robust	High	Very High
	Trend: Not changing	Robust	High	Very High
Question 6: biologically-structured	Status: Poor	Robust	High	Very High
	Trend: Improving	Robust	High	Very High
Question 7: Contaminants	Status: Fair/Poor	Medium	Medium	Medium
	Trend: Declining	Medium	Medium	Medium
Question 8: Human activities & habitat	Status: Poor	Medium	Medium	Medium
	Trend: Improving	Medium	Medium	Medium
Living Resources				
Question 9: Biodiversity	Status: Fair	Medium	Medium	Medium
	Trend: Not changing	Medium	Medium	Medium
Question 11: Non-indigenous species	Status: Poor	Medium	Medium	Medium
	Trend: Not changing	Medium	Medium	Medium
Question 12: Status	Status: Fair/Poor	Robust	High	Very High

Key Species	Trend: Improving	Robust	High	Very High
Question 13: Condition Key Species	Status: Good/Fair	Limited	Medium	Low
	Trend: Undetermined	Limited	Medium	Low
Question 14: Human Activities & LR	Status: Fair/Poor	Medium	Medium	Medium
	Trend: Undetermined	Medium	Medium	Medium
Maritime Archaeological Resources				
Question 15: Integrity	Status: Undetermined	Not updated	Not updated	Not updated
	Trend: Undetermined	Not updated	Not updated	Not updated
Question 16: Threat to Environment	Status: Good	Not updated	Not updated	Not updated
	Trend: Not changing	Not updated	Not updated	Not updated
Question 17: Human Activities	Status: Good	Not updated	Not updated	Not updated
	Trend: Not changing	Not updated	Not updated	Not updated

Nearshore Environment - Confidence Scoring Table

Question	2015 Rating	Evidence *(limited, medium, or robust)*	Agreement *(low, medium, or high)*	Confidence *(very low, low, medium, high, or very high)*
Water Quality				
Question 1: multiple stressors	Status: Fair	Not updated	Not updated	Not updated
	Trend: Declining	Not updated	Not updated	Not updated
Question 2: Eutrophic condition	Status: Fair	Robust	Medium	High
	Trend: Declining	Robust	Medium	High
Question 3: risks to human health	Status: Fair	Robust	High	Very High
	Trend: Undetermined	Robust	High	Very High
Question 4: Human activities & WQ	Status: Fair	Limited	High	Medium
	Trend: Improving	Limited	High	Medium
Habitat				
Question 5: Major Habitat	Status: Fair	Robust	High	Very high
	Trend: Declining	Robust	High	Very high
Question 6: biologically-structured	**Status: Good**	Robust	High	Very high
	Trend: Not changing	Robust	High	Very high
Question 7: Contaminants	Status: Fair/Poor	Medium	High	High
	Trend: Declining	Medium	High	High
Question 8: Human activities & habitat	Status: Fair	Robust	Low	Medium
	Trend: Undetermined	Robust	Low	Medium
Living Resources				
Question 9: Biodiversity	Status: Fair	Robust	High	Very high
	Trend: Not changing	Robust	High	Very high
Question 11: Non-indigenous species	**Status: Good**	Robust	High	Very high
	Trend: Declining	Robust	High	Very high
Question 12: Status	Status: Fair	Robust	High	Very high

Key Species	Trend: Declining	Robust	High	Very high
Question 13: Condition Key Species	Status: Fair	Robust	High	Very high
	Trend: Declining	Robust	High	Very high
Question 14: Human Activities & LR	Status: Fair	Robust	High	Very high
	Trend: Declining	Robust	High	Very high
Maritime Archaeological Resources				
Question 15: Integrity	Status: Fair	Not updated	Not updated	Not updated
	Trend: Undetermined	Not updated	Not updated	Not updated
Question 16: Threat to Environment	Status: Fair	Medium	Medium	Medium
	Trend: Declining	Medium	Medium	Medium
Question 17: Human Activities	Status: Good/Fair	Not updated	Not updated	Not updated
	Trend: Undetermined	Not updated	Not updated	Not updated

Offshore Environment - Confidence Scoring Table

Question	2015 Rating	Evidence *(limited, medium, or robust)*	Agreement *(low, medium, or high)*	Confidence *(very low, low, medium, high, or very high)*
Water Quality				
Question 1: multiple stressors	Status: Fair	Medium	High	High
	Trend: Declining	Robust	High	Very High
Question 2: Eutrophic condition	Status: Good/Fair	Robust	High	Very High
	Trend: Declining	Medium	Medium	Medium
Question 3: risks to human health	Status: Good/Fair	Not updated	Not updated	Not updated
	Trend: Undetermined	Not updated	Not updated	Not updated
Question 4: Human activities & WQ	Status: Fair	Not updated	Not updated	Not updated
	Trend: Improving	Not updated	Not updated	Not updated
Habitat				
Question 5: Major Habitat	Status: Fair	Medium	High	High
	Trend: Improving	Low	High	Medium
Question 6: biologically-structured	Status: Fair/Poor	Medium	High	High
	Trend: Undetermined	Low	High	Medium
Question 7: Contaminants	Status: Fair	Medium	High	High
	Trend: Declining	Medium	High	High
Question 8: Human activities & habitat	Status: Fair	Medium	High	High
	Trend: Improving	Medium	High	High
Living Resources				
Question 9: Biodiversity	Status: Fair	Medium	Medium	Medium
	Trend: Not changing	Low	Medium	Low
Question 11: Non-indigenous species	Status: Good	Not updated	Not updated	Not updated
	Trend: Not changing	Not updated	Not updated	Not updated

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Deleted: Medium

Question 12: Status Key Species	Status: Good/Fair	Medium	Medium	Medium
	Trend: Not changing	Medium	Low	Low
Question 13: Condition Key Species	Status: Good/Fair	Medium	Medium	Medium
	Trend: Declining	Medium	Low	Low
Question 14: Human Activities & LR	Status: Fair	Medium	Medium	Medium
	Trend: Not changing	Medium	Medium	Medium
Maritime Archaeological Resources				
Question 15: Integrity	Status: Undetermined	Not updated	Not updated	Not updated
	Trend: Undetermined	Not updated	Not updated	Not updated
Question 16: Threat to Environment	Status: Fair	Medium	Medium	Medium
	Trend: Declining	Medium	Medium	Medium
Question 17: Human Activities	Status: Good/Fair	Not updated	Not updated	Not updated
	Trend: Undetermined	Not updated	Not updated	Not updated

Deleted: Medium

Deleted: Medium

Deleted: Medium

Deleted: Medium

Seamount Environment - Confidence Scoring Table

Question	2015 Rating	Evidence *(limited, medium, or robust)*	Agreement *(low, medium, or high)*	Confidence *(very low, low, medium, high, or very high)*
Water Quality				
Question 1: multiple stressors	Status: Undetermined	N/A	N/A	N/A
	Trend: Undetermined	N/A	N/A	N/A
Question 2: Eutrophic condition	Status: Undetermined	N/A	N/A	N/A
	Trend: Undetermined	N/A	N/A	N/A
Question 3: risks to human health	Status: Undetermined	N/A	N/A	N/A
	Trend: Undetermined	N/A	N/A	N/A
Question 4: Human activities & WQ	Status: Good/Fair	Limited	High	Medium
	Trend: Undetermined	Limited	High	Medium
Habitat				
Question 5: Major Habitat	Status: Good	Robust	High	Very high
	Trend: Stable	Medium	High	High
Question 6: biologically-structured	Status: Good	Robust	High	Very high
	Trend: Undetermined	Limited	High	Medium
Question 7: Contaminants	Status: Undetermined	N/A	N/A	N/A
	Trend: Undetermined	N/A	N/A	N/A
Question 8: Human activities & habitat	Status: Good/Fair	Medium	High	High
	Trend: Undetermined	Limited	High	Medium

Living Resources				
Question 9: Biodiversity	Status: Good	Robust	High	Very high
	Trend: Undetermined	Medium	High	High
Question 11: Non-indigenous species	Status: Good	Limited	High	Medium
	Trend: Not changing	Limited	High	Medium
Question 12: Status Key Species	Status: Good/Fair	Robust	Medium	High
	Trend: Increasing	Medium	High	High
Question 13: Condition Key Species	Status: Good	Medium	High	High
	Trend: Not changing	Limited	High	Medium
Question 14: Human Activities & LR	Status: Good/Fair	Medium	High	High
	Trend: Undetermined	Limited	High	Medium
Maritime Archaeological Resources				
Question 15: Integrity	Status: N/A	N/A	N/A	N/A
	Trend: N/A	N/A	N/A	N/A
Question 16: Threat to Environment	Status: N/A	N/A	N/A	N/A
	Trend: N/A	N/A	N/A	N/A
Question 17: Human Activities	Status: N/A	N/A	N/A	N/A
	Trend: N/A	N/A	N/A	N/A

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