Agenda Item F.1.a
NMFS Report 2
March 2017

# SUPPLEMENTARY MATERIALS

TO THE

# CALIFORNIA CURRENT INTEGRATED ECOSYSTEM ASSESSMENT (CCIEA) CALIFORNIA CURRENT ECOSYSTEM STATUS REPORT, 2017

Appendix A: List of Contributors and Affiliations

Appendix B: List of Figure and Data Sources for the Main Report

Appendix C: Changes in this Year's Report, in Response to Council and Advisory Body Comments

Appendix D: Conceptual Models of the California Current

Appendix E: Climate and Ocean Indicators

Appendix F: Habitat Indicators: Snow-Water Equivalent and Streamflow

Appendix G: Regional Forage Availability Indicators

Appendix H: Chinook Salmon Escapement Indicators

Appendix I: Demersal Community Structure

Appendix J: The 2016 Rhinoceros Auklet Mortality Event

Appendix K: State-by-State Fishery Landings and Revenues

Appendix L: Fishing Gear Contact with Seafloor Habitat

Appendix M: Other Non-Fisheries Human Activities Indicators

Appendix N: Social Vulnerability of Commercial Fishing-Dependent Communities

Appendix O: Fleet Diversification Indicators for Major West Coast Ports

Appendix P: References

Appendix Q: List of Acronyms Used in this Report

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## APPENDIX B. LIST OF FIGURE AND DATA SOURCES FOR THE MAIN REPORT

Figure 3.1: Newport Hydrographic (NH) line temperature data are from Dr. Bill Peterson (NOAA). CalCOFI hydrographic line data are from http://calcofi.org/data.html. CalCOFI data before 2016 are from the bottle data CSV database, while 2016 data are preliminary data from the CTD CSV database.

Figure 3.1.1: Oceanic Niño Index information and data are from the NOAA Climate Prediction Center (http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_change.shtml). Pacific Decadal Oscillation data are from Dr. Nate Mantua (NOAA) and are served by the University of Washington Joint Institute for the study of the Atmospheric and Ocean (JISAO; http://research.jisao.washington.edu/pdo/). North Pacific Gyre Oscillation data are from Dr. Emanuele Di Lorenzo (Georgia Institute of Technology) (http://www.o3d.org/npgo/).

Figure 3.1.2: Sea surface temperature maps are optimally interpolated remotely-sensed temperatures (Reynolds et al. 2007). The daily optimal interpolated AVHRR SST can be downloaded using ERDDAP (http://upwell.pfeg.noaa.gov/erddap/griddap/ncdcOisst2Agg.html).

Figure 3.2.1: Cumulative Upwelling Index curves are calculated from the six-hourly upwelling index product (http://upwell.pfeg.noaa.gov/erddap/tabledap/erdUI216hr.html).

Figure 3.3.1: Newport Hydrographic (NH) line dissolved oxygen data are from Dr. Bill Peterson (NOAA). CalCOFI hydrographic line data are from http://calcofi.org/data.html. Note: CalCOFI data before 2016 are from the bottle data CSV database, while 2016 data are preliminary data from the CTD CSV database.

Figure 3.3.2: Aragonite saturation state data were provided by Dr. Bill Peterson (NOAA).

Figure 3.4.1: Snow-water equivalent data were derived from the California Department of Water Resources snow survey (http://cdec.water.ca.gov/) and the Natural Resources Conservation Service's SNOTEL sites in WA, OR, CA and ID (http://www.wcc.nrcs.usda.gov/snow/).

Figure 3.4.2: Minimum and maximum streamflow data were provided by the US Geological Survey (http://waterdata.usgs.gov/nwis/sw).

Figure 4.1.1: Copepod biomass anomaly data were provided by Dr. Bill Peterson (NOAA).

Figure 4.2.1: Pelagic forage data from the Northern CCE were provided by Dr. Ric Brodeur (NOAA) and were derived from surface trawls conducted as part of the BPA Plume Survey.

Figure 4.2.2: Pelagic forage data from the Central CCE were provided by Dr. John Field (NOAA) from the SWFSC Rockfish Recruitment and Ecosystem Assessment Survey (https://swfsc.noaa.gov/textblock.aspx?Division=FED&ParentMenuId=54&id=20615).

Figure 4.2.3: Pelagic forage data from the Southern CCE were provided by Dr. Andrew Thompson (NOAA) and were derived from spring CalCOFI surveys (http://calcofi.org/).

Figure 4.3.1: Chinook salmon escapement data were derived from the California Department of Fish and Wildlife (http://www.dfg.ca.gov/fish/Resources/Chinook/CValleyAssessment.asp), from Pacific Fishery Management Council pre-season reports (http://www.pcouncil.org/salmon/stock-assessment-and-fishery-evaluation-safe-documents/preseason-reports/2016-preseason-report-i/) and from the NOAA Northwest Fisheries Science Center's "Salmon Population Summary" database (https://www.webapps.nwfsc.noaa.gov/sps).

Table 4.3.1: Stoplight table of indicators and 2016 salmon returns provided by Dr. Bill Peterson (NOAA).

Figure 4.4.1: Groundfish stock status data were provided by Dr. Jason Cope (NOAA) and were derived from NMFS stock assessments.

Figure 4.4.2: Biomass ratio data are from the NMFS U.S. West Coast Groundfish Bottom Trawl Survey (http://www.nwfsc.noaa.gov/research/divisions/fram/groundfish/bottom_trawl.cfm) and were provided by Dr. Todd Hay and Ms. Beth Horness (NOAA).

Figure 4.5.1: California sea lion data were provided by Dr. Sharon Melin (NOAA).

Figure 4.6.1: Seabird abundance data from the Northern CCE were collected and provided by Dr. Jeannette Zamon (NOAA).

Figure 4.6.2: Seabird abundance data from the Southern CCE are from CalCOFI surveys, courtesy of Dr. Bill Sydeman of the Farallon Institute (wsydeman@faralloninstitute.org).

Figure 5.1.1: Data for commercial landings are from PacFIN (http://pacfin.psmfc.org). Data for recreational landings are from RecFIN (http://www.recfin.org/).

Figure 5.2.1: Data for total benthic habitat distance disturbed by bottom-contact fishing gears were provided by Mr. Jon McVeigh, NOAA Northwest Fisheries Science Center West Coast Groundfish Observer Program. Weightings for benthic habitat sensitivity values come from PFMC's Pacific Coast Groundfish 5-Year Review of Essential Fish Habitat.

Figure 5.3.1: Shellfish aquaculture production data are from the Washington Department of Fish and Wildlife, Oregon Department of Agriculture and California Department of Fish and Game. The only marine net-pen finfish aquaculture operations in the CCE occur in Washington State, and data came from the Washington Department of Fish & Wildlife.

Figure 5.3.2: Data for total (imported and domestic) edible and nonedible seafood consumption are from NOAA's "Fisheries of the United States" annual reports describing the utilization of fisheries products (http://www.st.nmfs.noaa.gov/st1/publications.html).

Figure 6.1.1: Fishery dependence and community social vulnerability index (CSVI) data were provided by Dr. Karma Norman (NOAA) and were derived from the U.S. Census Bureau (http://www.census.gov), the American Community Survey (ACS; https://www.census.gov/programs-surveys/acs/) and PacFIN (http://pacfin.psmfc.org).

Figure 6.1.2: Fishery dependence and community social vulnerability index (CSVI) data were provided by Dr. Karma Norman (NOAA) and were derived from the U.S. Census Bureau (http://www.census.gov), the American Community Survey (ACS; https://www.census.gov/programs-surveys/acs/) and PacFIN (http://pacfin.psmfc.org).

Figure 6.2.1: Fishery diversification estimates were provided by Dr. Dan Holland and Dr. Stephen Kasperski (NOAA).

## APPENDIX C. CHANGES IN THIS YEAR'S REPORT, IN RESPONSE TO COUNCIL AND ADVISORY BODY COMMENTS

In March 2015, the Council approved FEP Initiative 2, "Coordinated Ecosystem Indicator Review" (Agenda Item E.2.b), by which the Council, advisory bodies, the public, and the CCIEA team would work jointly to refine the indicators in the annual CCIEA Ecosystem Status Report to better meet Council objectives. The Initiative was implemented by an ad-hoc Ecosystem Working Group (EWG). The EWG coordinated several processes by which the CCIEA team was able to receive feedback from Council advisory bodies (including the SSC Ecosystem Subcommittee and several management teams, working groups, subcommittees and panels, including direct meetings in March and September, and also a series of webinars to provide details on key sections of the report. The EWG compiled and provided the collective feedback from these processes. We also received direct feedback from the Council following our presentation to the Council in March 2016.

Below we summarize changes and improvements in the 2017 Ecosystem Status Report, in response to the requests and suggestions received from the Council, EWG and advisory bodies. We will continue to address and integrate requests and suggestions already received, as well as new requests and suggestions in regard to this Ecosystem Status Report.

| Request | Response, location in document |
|---|---|
| Provide maps of sampling locations. | Summary maps are presented in Figure 2.1 (Main Report) for nearly all field sampling. |
| Continue to focus attention on specific climate events as appropriate (e.g., "The Warm Blob"). | Throughout the Report, we attempt to provide a narrative that links indicators to key climate (and other) drivers. |
| Provide time series of 3-D temperature information, in addition to sea surface temperature. | Figure 3.1 (Main Report) provides time series of temperature anomalies at depth off Newport, OR and San Diego, CA. Figure E.6 (Appendix E) provides a time series of temperature anomalies at depth averaged over a 10° x 10° area of the Northeast Pacific. |
| Plot annual and seasonal indicator data in a more consistent manner. | In the Main Report, oceanographic plots (Section 3) and copepod biomass anomaly plots (Section 4.1) contain all data at the finest temporal scale possible. Seasonal averages are presented in Appendix E for oceanographic indicators and Appendix G for copepods. |
| Provide more specific information in the report on the potential effects of upwelling on particular species (improved productivity, changes in temperature, dissolved oxygen, ocean acidification, etc.). | We have begun to more fully integrate upwelling into the narrative of the document, with specific mention of its broad role in primary production (Main Body, Section 3.2), hypoxia and ocean acidification (Section 3.3, Section 7.6), and forage community dynamics (Section 4.2). We will continue to further integrate this essential ecosystem process, for example how it may relate to ultimate recruitment success for recent year classes of rockfish. |

| Request | Response, location in document |
|---|---|
| Present snowpack indicators at regional scales, rather than summarized by the entire system.<br><br>Include other indicators of freshwater habitat, such as streamflow, at ecologically relevant scales. | Figure 3.4.1 (Main Report) shows snowpack indicators at ecoregional scales (ecoregions mapped in Figure 2.1), and a map of snowpack from 2015-2017 is provided in Appendix F, Figure F.1.<br><br>Streamflow indicators are plotted at the scale of Chinook salmon ESUs in Figure 3.4.2 (Main Report) and at ecoregional scales in Appendix F. |
| Present forage indicators by region and individual species, and specify the age classes of the data. | For space considerations, we summarized the status and trends of forage species by region in quad plots in the Section 4.2 of the Main Body. Full time series appear in Appendix G. Age structure is denoted where possible, although this may require further discussion with the SSCES due to our concerns about catchability of juvenile age classes of sardines, anchovy and other fishes. |
| Make the groundfish biomass and fishing mortality plot larger. | The plot (Figure 4.4.1, Main Body) is now a full page wide. |
| Include seabird diversity data from the Northern California Current, to accompany the data from the CalCOFI region in the south. | We were unable to obtain full seabird community biodiversity data for either region for this report, but we do have abundance time series for three key seabird species from both regions (Figures 4.6.1 and 4.6.2, Main Body). |
| Present commercial landings of market squid separately from the rest of the CPS landings. | We now distinguish commercial landings of market squid from the rest of the CPS species at the coastwide level (Figure 5.1.1, Main Body) and at the state-by-state level (Appendix K.1). |
| Include more information on recreational fishery landings. | In addition to total recreational fishery take (Figure 5.1.1, Main Body), we now include time series of total recreational fishery take (landings + dead discard) from each state (Appendix K.1) and also summarize how that take is distributed across species from different FMPs (Appendix K.2). |
| Include information on commercial fishing revenues. | We now present time series of commercial fishery revenues by state and by target species groupings (Appendix K.3). |
| Report gear contact with sea floor by gear type and area. | We developed an index of total fishery gear contact with the seafloor, weighted by total effort by different gear types and by the depths and habitat types in which the gear fished (Main Body, Section 5.2). This index is broken out in more spatial detail in Appendix L. We will do additional analyses to further break it out by specific gear types for future reports. |

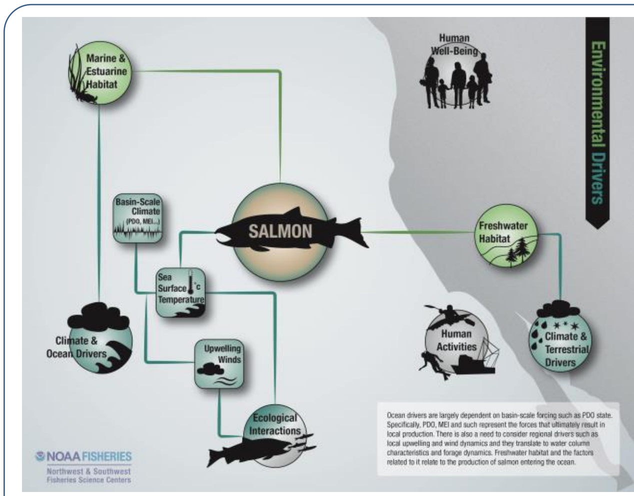
| Request | Response, location in document |
|---|---|
| Present the community social vulnerability index (CSVI) and the fishery dependence index radar plots at state-level spatial scales. | CSVI scores and fishery dependence indices are broken out into five regions (WA, OR, N CA, Cen CA and So CA) in Appendix N. The ten most commercial fishing-dependent communities are plotted for each region. |
| Present the community social vulnerability index (CSVI) and the fishery dependence index in x-y space, for ease of interpretation. | The CSVI and fishery dependence index are now plotted in x-y space (Fig. 6.1.2, Main Body), which allows clear distinction of communities that are both highly dependent on commercial fishing and highly social vulnerable. |
| Include a short section of "Research Recommendations." | The Main Body ends with Section 7, a list of seven Research Recommendations, with short justifications and proposed products and benefits. |
| Include a reference section. | Citations of published research now appear throughout the document, and a Reference section is in Appendix P. |

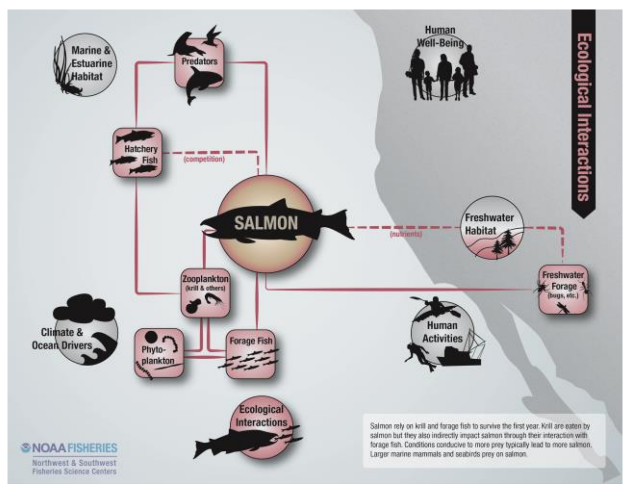
**APPENDIX D. CONCEPTUAL MODELS OF THE CALIFORNIA CURRENT**

The CCE is a socio-ecological system in which human and naturally occurring components and processes are inextricably linked. Recognizing these links is critical to understanding the dynamics of the CCE and to managing its resources, benefits and services in an informed way. We have developed a series of conceptual models to illustrate these key components, processes and links. The figures below show a series of conceptual models developed specifically for salmon (Fig. D.1) and groundfish (Fig. D.2).

The benefits of conceptual models are multifold:

- They put indicators into context; *each box or line corresponds to one or more indicators*.
- They facilitate discussion around which issues are thought to be most important in the CCE.
- They can be readily simplified or made more in-depth and complex as desired.
- Relating the focal component (e.g., salmon or groundfish) to its linked components and processes may help us anticipate how changes in the ecosystem will affect managed species.
- Conceptual models with up-to-date information on status and trends of relevant indicators could provide information for "ecosystem considerations" sections of stock assessments.
- They serve as consistent reminders to account for human dimensions and potential management tradeoffs in different human sectors.



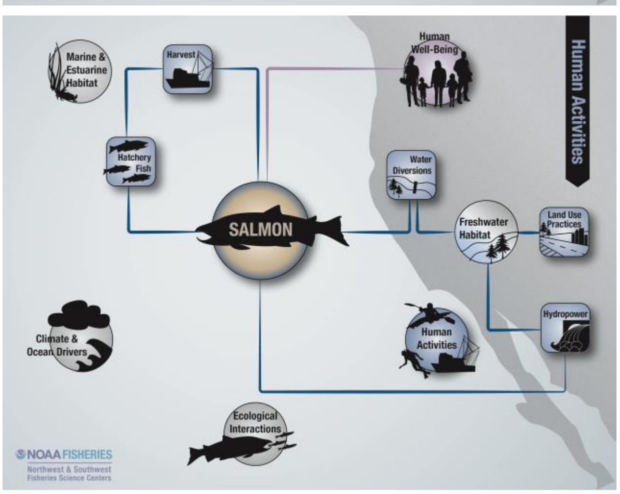
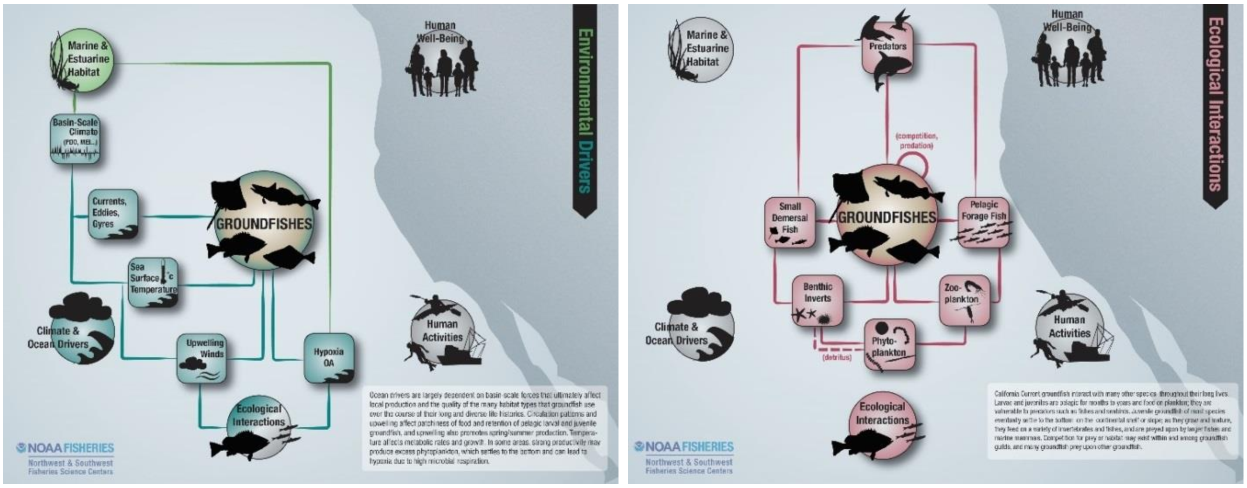




*Figure D.1. Conceptual models of CCE salmon in relation to their physical environments and habitats (upper left); their interactions with prey, predators, competitors and other species in their communities (upper right); and their interactions with humans (lower left).*

*Illustrations by Su Kim, NWFSC.*



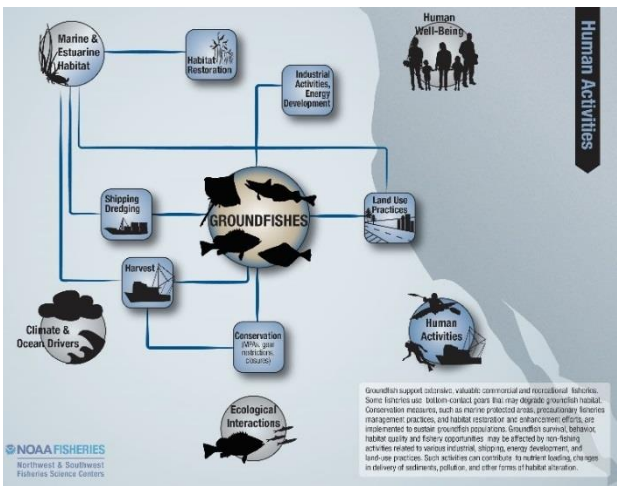




*Figure D.2. Conceptual models of CCE groundfish in relation to their physical environments and habitats (upper left); their interactions with prey, predators, competitors and other species in their communities (upper right); and their interactions with humans (lower left).*

*Illustrations by Su Kim, NWFSC.*

Similar conceptual models are available for coastal pelagic species, marine mammals, seabirds, habitats, and the full socio-ecological system. For high-resolution versions of all models, please contact Su Kim (Su.Kim@noaa.gov) or Chris Harvey (Chris.Harvey@noaa.gov).

**Appendix E. Climate and Ocean Indicators**

Section 3 of the 2017 CCIEA Ecosystem Status Report describes indicators of basin-scale and region-scale climate and ocean drivers. Here we present additional plots to allow a more complete picture of these indicators.

**E1. Basin-Scale Climate/Ocean Indicators at Seasonal Time Scales**

The first group of plots in this section shows seasonal summaries of the time series indicators. The final plots are maps of seasonal SST anomalies from 1982-2016.

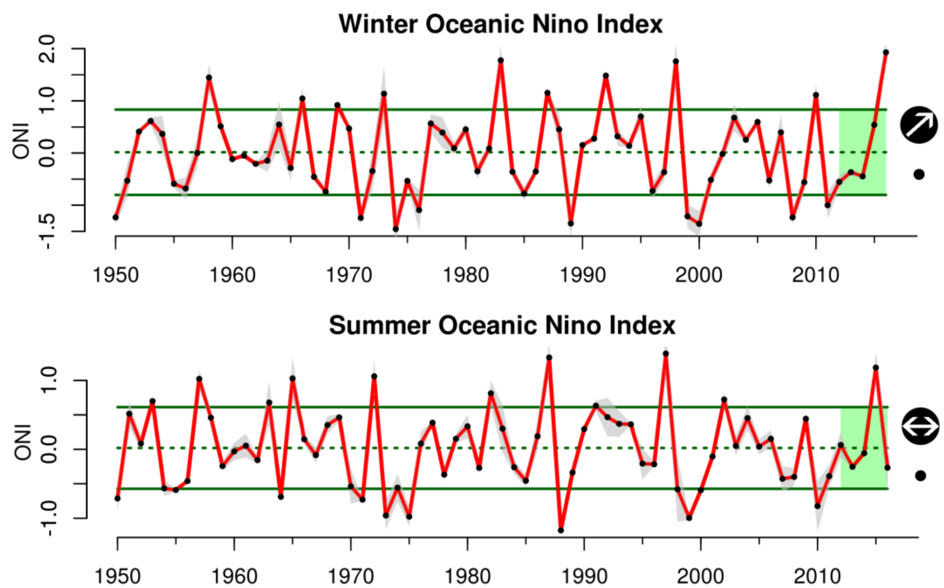



*Figure E1. Winter (top; Jan-Mar) and summer (bottom; Jul-Sep) values of the Oceanic Nino Index (ONI), 1950-2016. Lines, colors, and symbols are as in Figure 1.1a.*

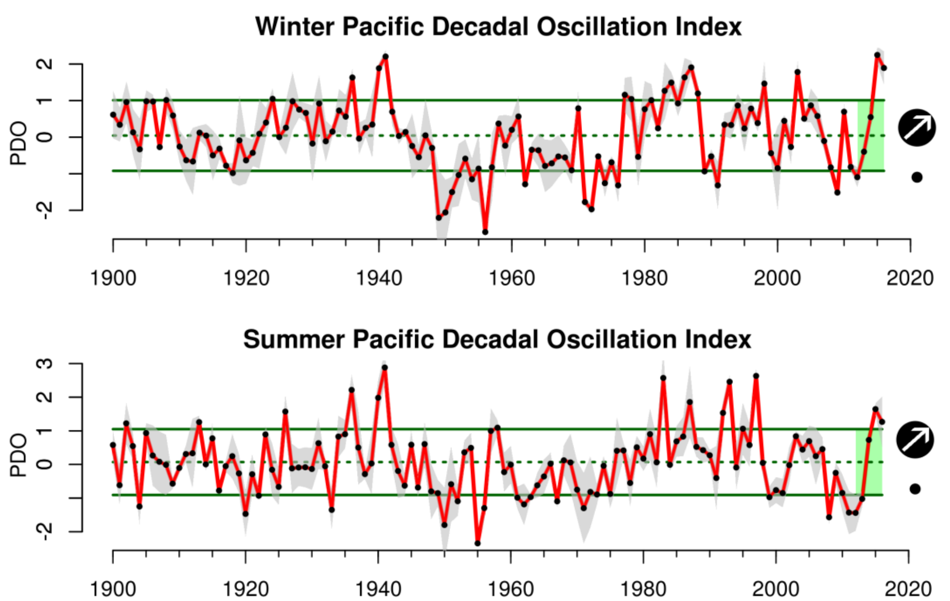



*Figure E2. Winter (top; Jan-Mar) and summer (bottom; Jul-Sep) values of the Pacific Decadal Oscillation (PDO), 1900-2016. Lines, colors, and symbols are as in Figure 1.1a.*

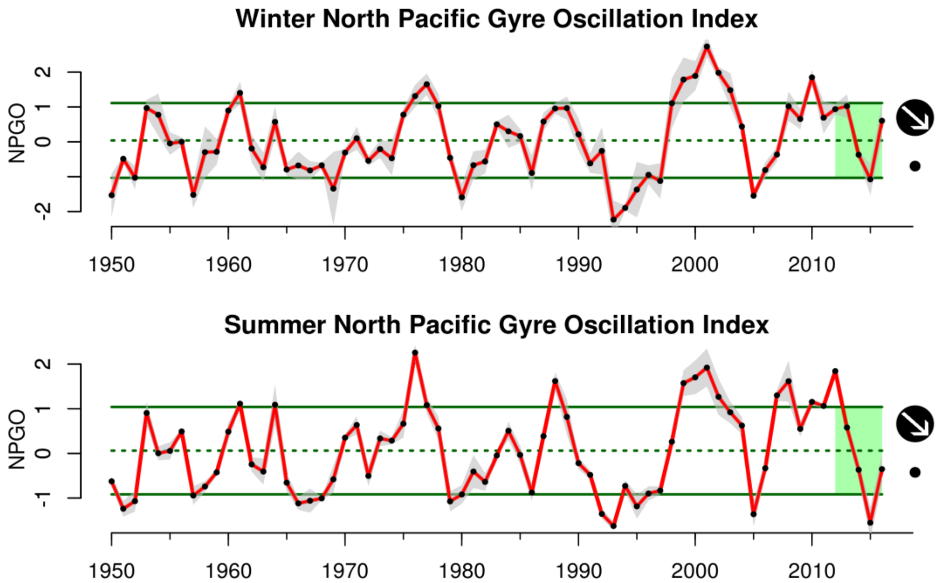



*Figure E3. Winter (top; Jan-Mar) and summer (bottom; Jul-Sep) values of the North Pacific Gyre Oscillation (NPGO), 1950-2016. Lines, colors, and symbols are as in Figure 1.1a.*

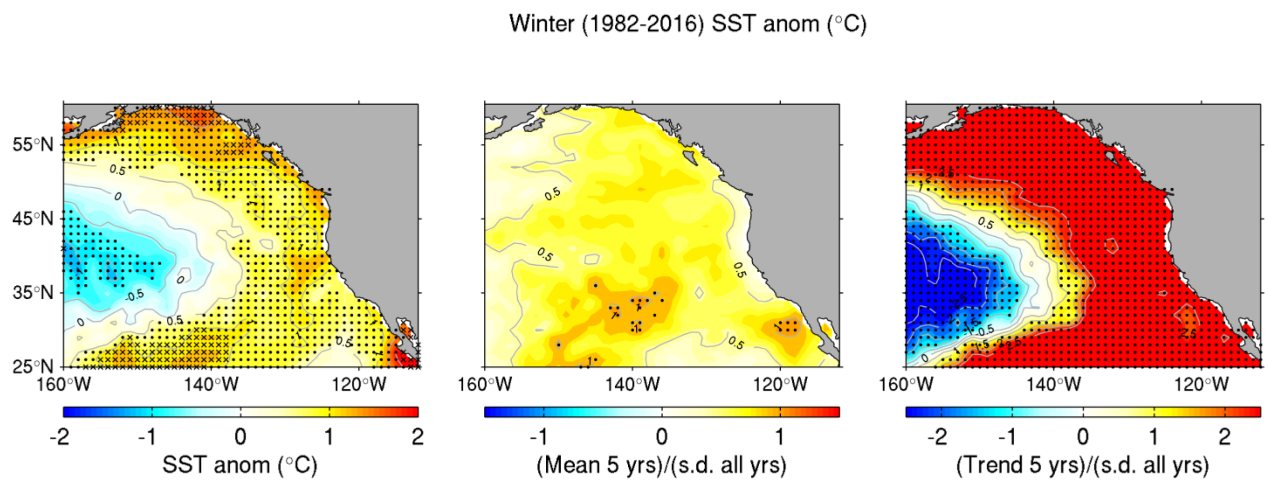



*Figure E.4: Optimum interpolated sea surface temperature (sst) observed from Advanced Very High Resolution satellite radiometers. Left: 2016 winter (Jan-Mar) SST anomalies; a black X marks a cell where the 2016 anomaly was a record high. Middle: 2012-2016 winter SST means relative to the long-term s.d. Right: 2012-2016 winter SST trends relative to the long-term s.d. Values for cells in the mean/trend maps have been normalized by the long-term s.d. of the winter time series at that cell. In all maps, a black circle marks a cell with an anomaly/mean/trend >1 s.d. or <1 s.d. from the long-term mean.*

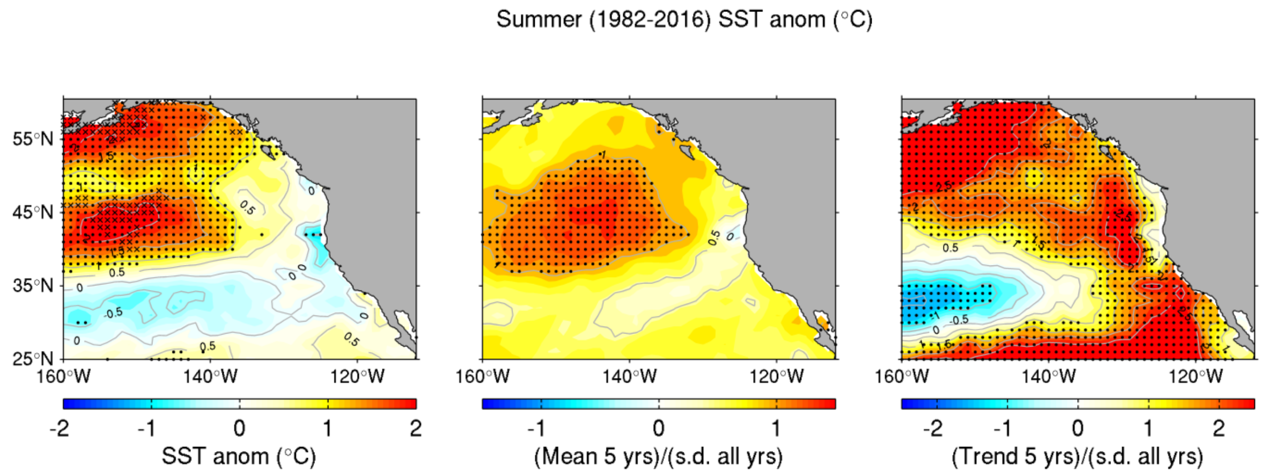



*Figure E.5: Optimum interpolated sea surface temperature (sst) observed from Advanced Very High Resolution satellite radiometers. Left: 2016 summer (Jul-Sep) SST anomalies; a black X marks a cell where the 2016 anomaly was a record high. Middle: 2012-2016 summer SST means relative to the long-term s.d. Right: 2012-2016 summer SST trends relative to the long-term s.d. Values for cells in the mean/trend maps have been normalized by the long-term s.d. of the summer time series at that cell. In all maps, a black circle marks a cell with an anomaly/mean/trend >1 s.d. or <1 s.d. from the long-term mean.*

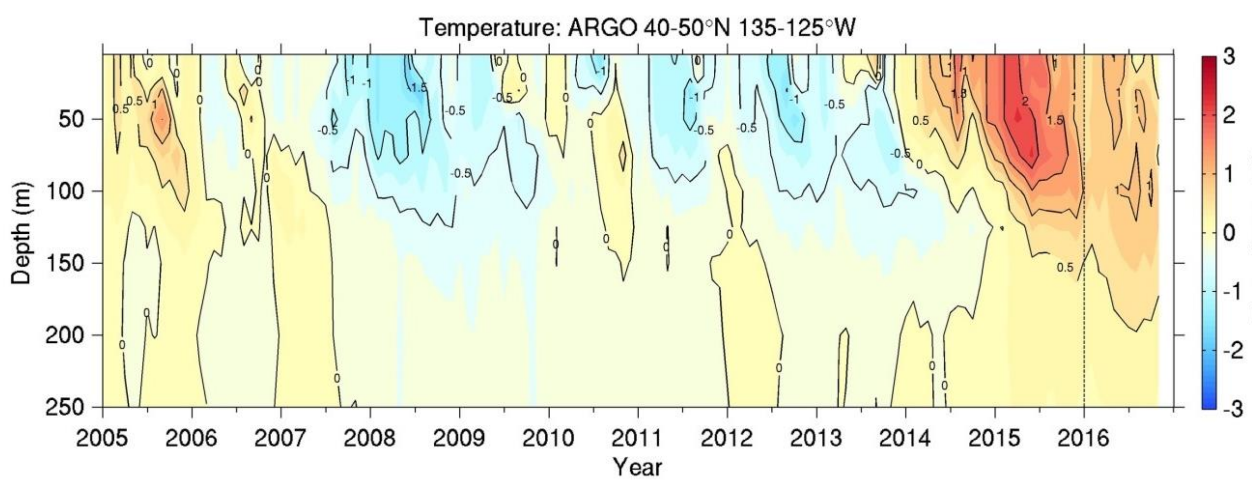



*Figure E.6: Time-depth contour of temperature anomalies measured from ARGO floats. The time/depth development of the large marine heat wave and the 2015-2016 El Niño event are noticible from late 2013 to the end of the 2016 data.*

### E2. Regional-Scale Climate/Ocean Indicators at Spatial and Temporal Scales

The plot in this section shows spatiotemporal variation in upwelling intensity and anomalies from 2012-2016.

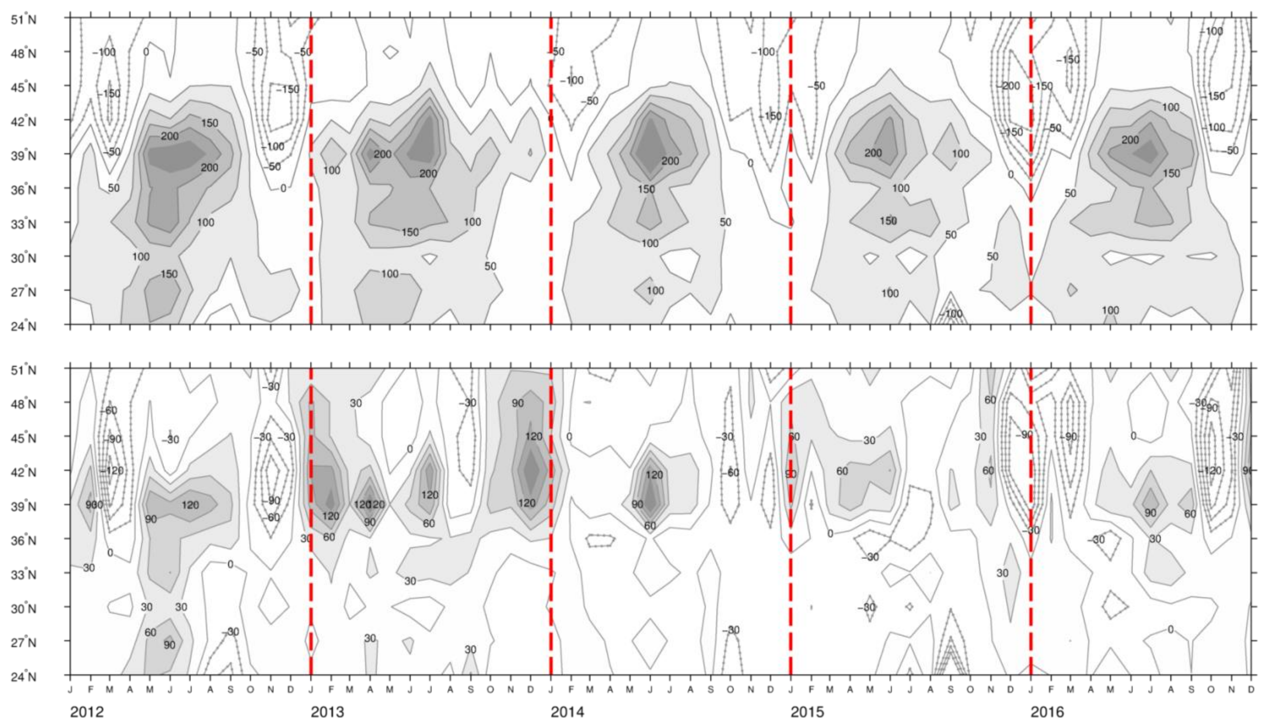



*Figure E.7: Monthly means of daily upwelling index (top) and anomalies (bottom) for January 2012–Sep 2016. Shaded areas denote positive (upwelling-favorable) values in upper panel, and positive anomalies (generally greater than normal upwelling) in lower panel. Anomalies are relative to 1967–2015 monthly means. Units are in $m^3 s^{-1}$ per 100 m of coastline. Daily upwelling index data obtained from http://upwell.pfeg.noaa.gov/erddap/.*

### E3. Seasonal Trends in Dissolved Oxygen and Ocean Acidification Indicators

The first series of plots in this section shows time series of summer and winter averages for dissolved oxygen data off Newport, OR and in the Southern California Bight. The second series shows summer and winter averages of aragonite saturation state (an ocean acidification indicator) off Newport.

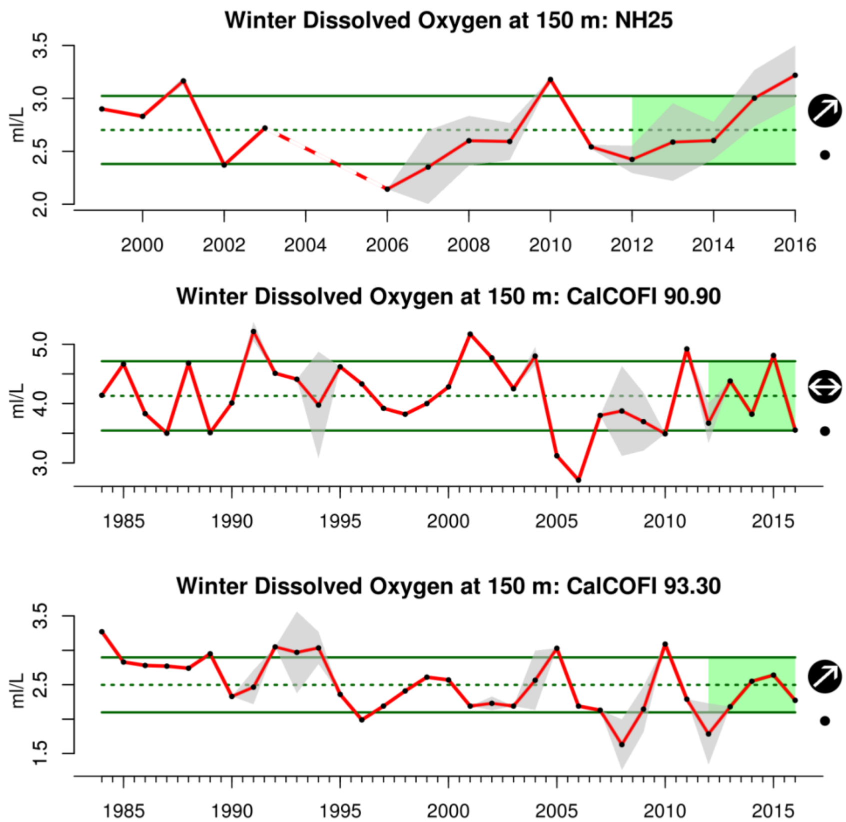



*Figure E8. Winter (Jan-Mar) dissolved oxygen (DO) at 150 m depth off Oregon, 1998-2016, and southern California, 1984-2016. Stations NH25 and 93.30 are <50 km from the shore; station 90.90 is >300 km from shore. Lines, colors and symbols are as in Figure 1.1a; dashed red lines indicate missing years.*

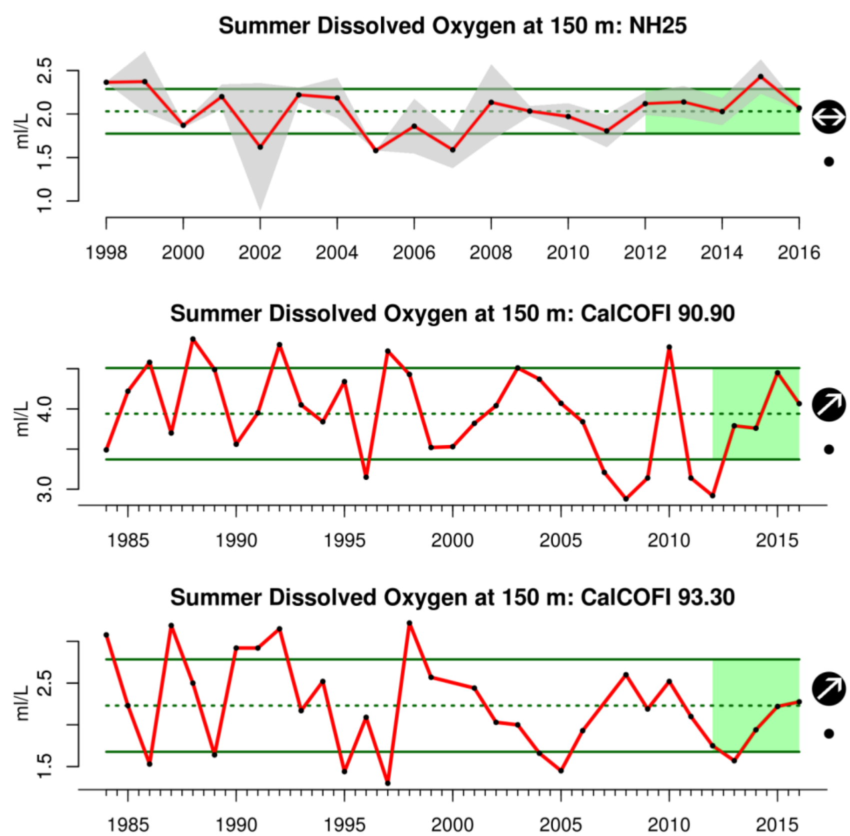



*Figure E9. Summer (Jul-Sep) dissolved oxygen (DO) at 150 m depth off Oregon, 1998-2016, and southern California, 1984-2016. Stations NH25 and 93.30 are <50 km from the shore; station 90.90 is >300 km from shore. Lines, colors and symbols are as in Figure 1.1a; dashed red lines indicate missing years.*

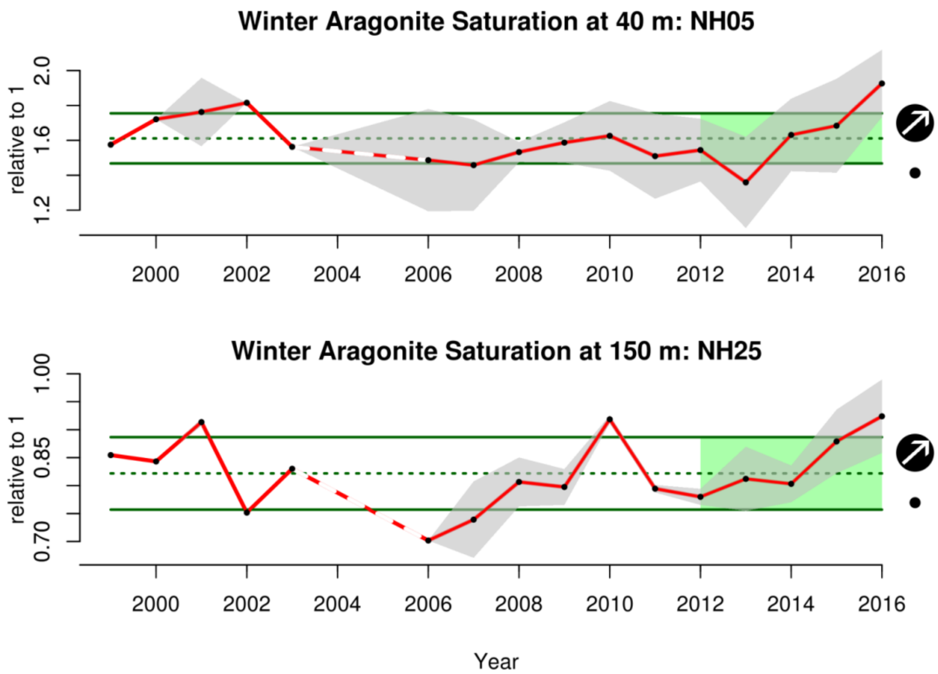



*Figure E10. Winter (Jan-Mar) aragonite saturation values off of Newport, OR, 1998-2016. Lines, colors and symbols are as in in Figure 1.1a; dashed red lines indicate missing years.*

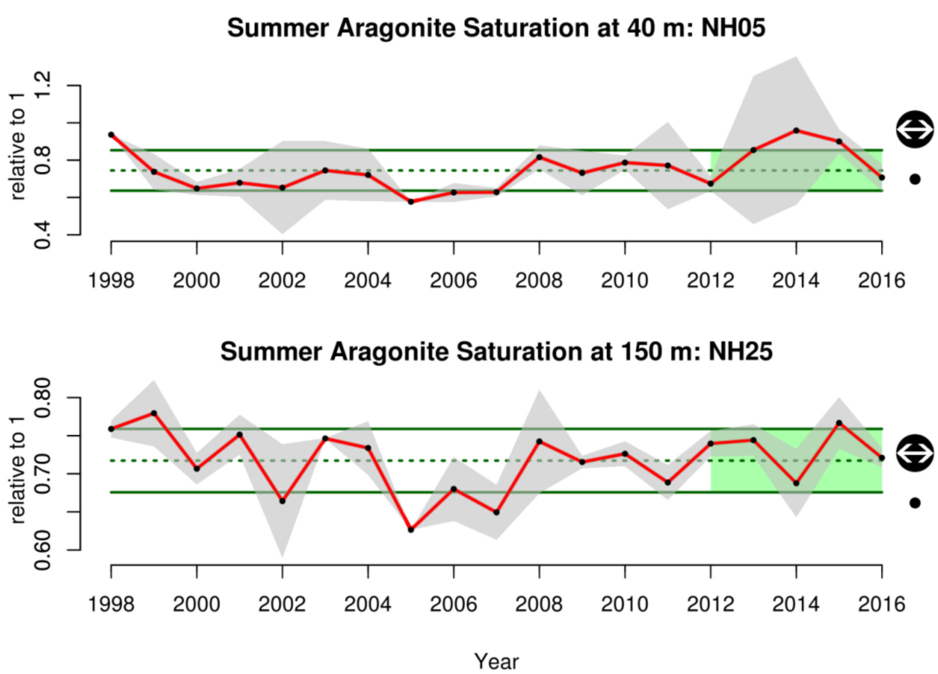



*Figure E11. Summer (Jul-Sep) aragonite saturation values off of Newport, OR, 1998-2016. Lines, colors and symbols are as in in Figure 1.1a; dashed red lines indicate missing years.*

**APPENDIX F. HABITAT INDICATORS: SNOW-WATER EQUIVALENT AND STREAMFLOW**

Development of habitat indicators in the CCIEA has focused on freshwater habitats. All habitat indicators are reported based on a hierarchical spatial framework. This spatial framework facilitates comparisons of data at the right spatial scale for particular users, whether this be the entire California Current, ecoregions within these units, or smaller spatial units. The framework we use divides the region encompassed by the California Current ecosystem into ecoregions, and ecoregions into smaller physiographic units. Freshwater ecoregions are based on the biogeographic delineations in Abell et al. (2008; see also www.feow.org), who define six ecoregions for watersheds entering the California Current, three of which comprise the two largest watersheds directly entering the California Current (the Columbia and the Sacramento-San Joaquin Rivers). Within ecoregions, we summarized data using 8-field hydrologic unit classifications (HUC-8).

Snow-water equivalent (SWE) is measured using two data sources: a California Department of Water Resources snow survey program (data from the California Data Exchange Center http://cdec.water.ca.gov/) and The Natural Resources Conservation Service's SNOTEL sites across Washington, Idaho, Oregon, and California (http://www.wcc.nrcs.usda.gov/snow/). Snow data are converted into SWEs based on the weight of samples collected at regular intervals using a standardized protocol. Measurements at April 1 are considered the best indicator of maximum extent of SWE; thereafter snow tends to melt rather than accumulate. Standardized average anomalies of data for each freshwater ecoregion are presented in Section 3.4 of the main report.

The outlook for 2017 is limited to examination of current SWE, an imperfect correlate of SWE in April due to variable atmospheric temperature. Current SWE (on January 1, 2017) exceeds the depth and spatial extent of both 2016 and 2015 (Fig. F.1), which suggests that conditions may be better this year compared to the previous two years.

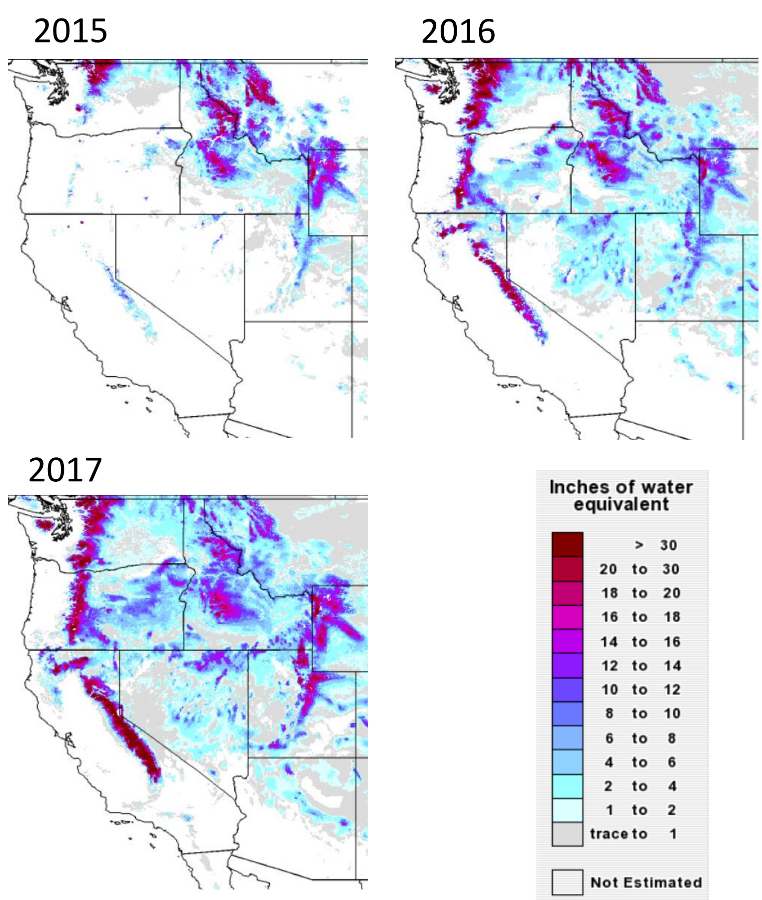



*Figure F.1. Snow-water equivalents in the western United States on January 1, illustrating the differences for snowpack during the very warm winter of 2015, the snowmelt rebound in 2016, and the current state in 2017.*

Streamflow is measured using active USGS gages (http://waterdata.usgs.gov/nwis/sw) with records that meet or exceed 30 years in duration. Average daily values from 213 gages were used to calculate both annual 1-day maximum and 7-day minimum flows. These indicators correspond to flow parameters to which salmon populations are most sensitive. Standardized anomalies of time series from individual gages were then averaged to obtain weighted averages for ecoregions (for which HUC-8 area served as a weighting factor) and for the entire California current (weighted by ecoregion area).

Across the California Current, both minimum and maximum streamflow anomalies have exhibited strong variability in the most recent five years. Minimum streamflows have exhibited fairly consistent patterns across all ecoregions (Fig. F.2). Most all ecoregions demonstrated a decline in low flows over the last 5-8 years, although little variation exists for rivers in the Southern California Bight. For maximum streamflows (Fig. F.3), 5-year trends were particularly pronounced for the Salish Sea and Washington Coast (increased high flows) and the Southern California Bight (high flows were historically low).

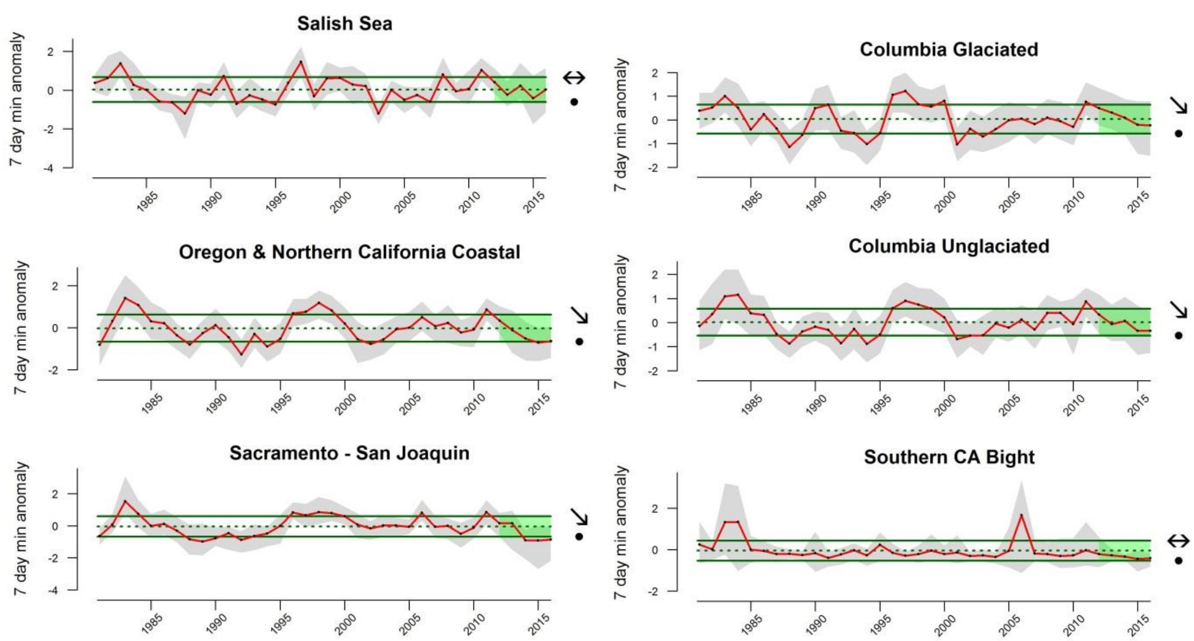



*Figure F.2. Anomalies of 7-day minimum streamflow measured at 213 gages in six ecoregions. Gages include both regulated (subject to hydropower operations) and unregulated systems, although trends were similar when these systems were examined separately.*

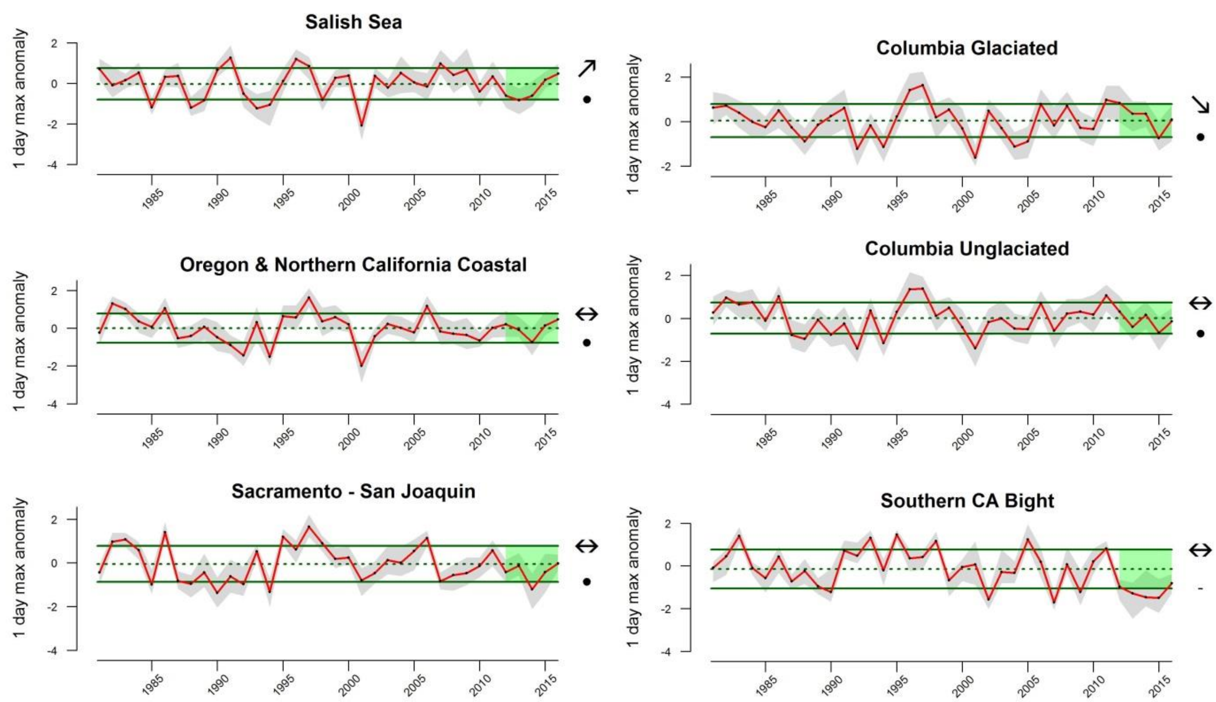



*Figure F.3. Anomalies of 1-day maximum annual streamflow measured at 213 gages in six ecoregions. Gages include both regulated (subject to hydropower operations) and unregulated systems, although trends were similar when these systems were examined separately.*

**APPENDIX G. REGIONAL FORAGE AVAILABILITY**

Species-specific trends in forage availability are based on research cruises in the northern, central, and southern portions of the CCE (Fig. 2.1c). Section 4.2 of the main body of this report describes forage community dynamics using quad plots to summarize recent status and trends relative to full time series. These plots are useful for summarizing large amounts of data, but they may hide informative short-term variability in these dynamic species. The full time series through 2016 are therefore presented here. As noted in the main report, we consider these to be regional indices of relative forage availability and variability; these are not indices of absolute abundance of coastal pelagic species (CPS). Collection details and format are indicated in the respective figure legends.

**G.1. NORTHERN CALIFORNIA CURRENT FORAGE**

The Northern CCE survey (known as the "BPA Plume Survey") occurs in June and targets juvenile salmon in surface waters off Oregon and Washington, but also collects adult and juvenile (age 1) pelagic forage fishes, market squid, and gelatinous zooplankton (*Aequorea* sp., *Chrysaora* sp.) with regularity. In 2016, most forage taxa were caught at levels within the long-term range of the survey (Fig. G.1). One exception was jack mackerel catch, which exceeded long-term averages for the second year in a row. Catches of both age 1+ sardine and age 1+anchovy were relatively poor, with sardine only captured at a single station. Catch rates of both gelatinous zooplankton taxa in 2016 were below or near long term averages, reflecting a decline from 2015 levels for *Aequorea* sp.

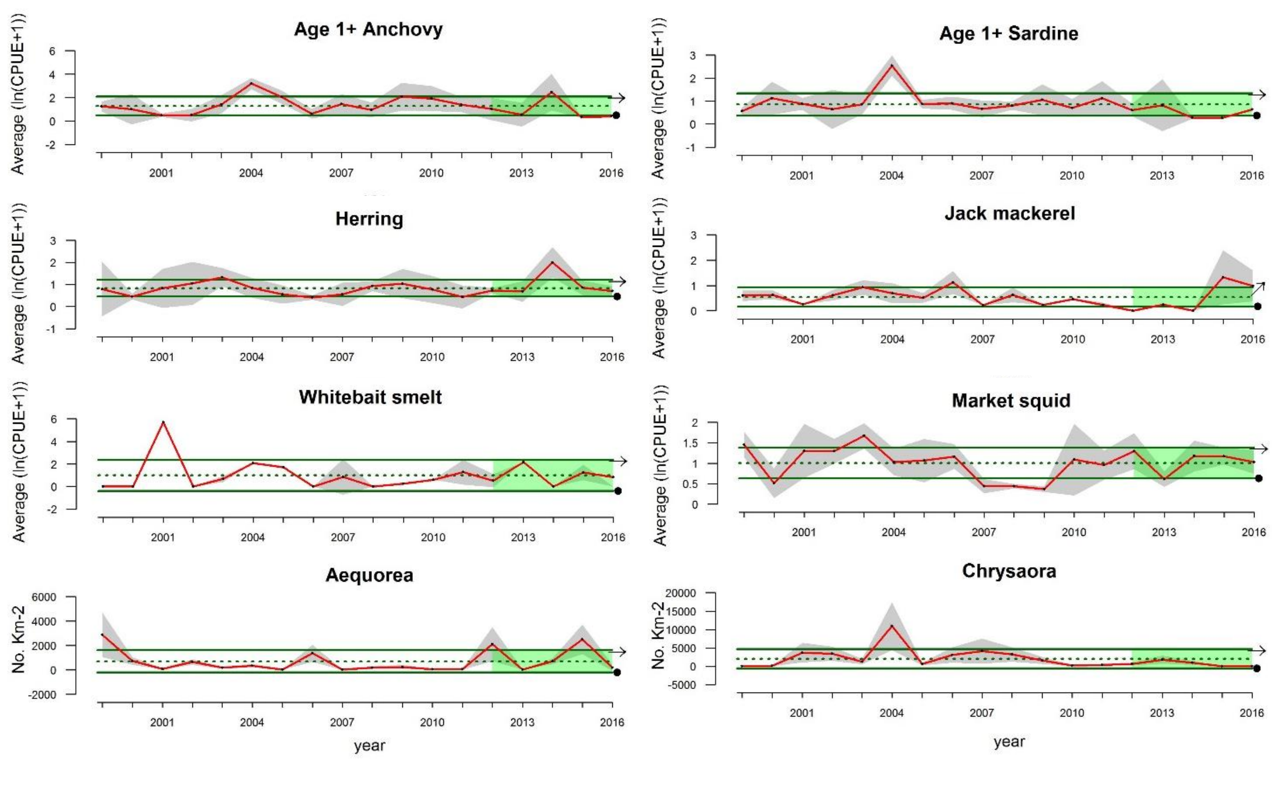



*Figure G.1. Geometric mean CPUEs (#/km²) of key forage groups in the Northern CCE, from surface trawls conducted as part of the BPA Plume Survey, 1999-2016. Lines, colors and symbols are as in Figure 1.1a. Note different units for gelatinous zooplankton data (bottom row).*

## G.2. Central California Current Forage

The Central CCE forage survey (known as the "Juvenile Rockfish Survey") samples this region using midwater trawls, which not only collect young-of-the-year (YOY) rockfish species, but also a variety of other YOY and adult forage species, market squid, adult krill, and gelatinous zooplankton. Time series presented here are from the "Core Area" of that survey (see Fig. 2.1c in the Main Report). In 2016, catches of adult anchovy and sardine remained near zero, whereas YOY rockfish, YOY hake and YOY sanddabs continued recent patterns of exceptionally high catch (Fig. G.2). (Note: YOY anchovy and sardine are not included in the data below.) Market squid catches declined into 2016, while krill returned to near the long-term mean after a steep decline in 2015. Finally, two jellyfish taxa (*Aurelia* sp., *Chrysaora*) enumerated over most of this survey appeared to show average to below-average catch rates, although these signals may actually be masked by abandonment of tows at stations where exceptional catches of jellyfish and tunicates (pyrosomes and salps, not presented here) have clogged survey nets in the past.

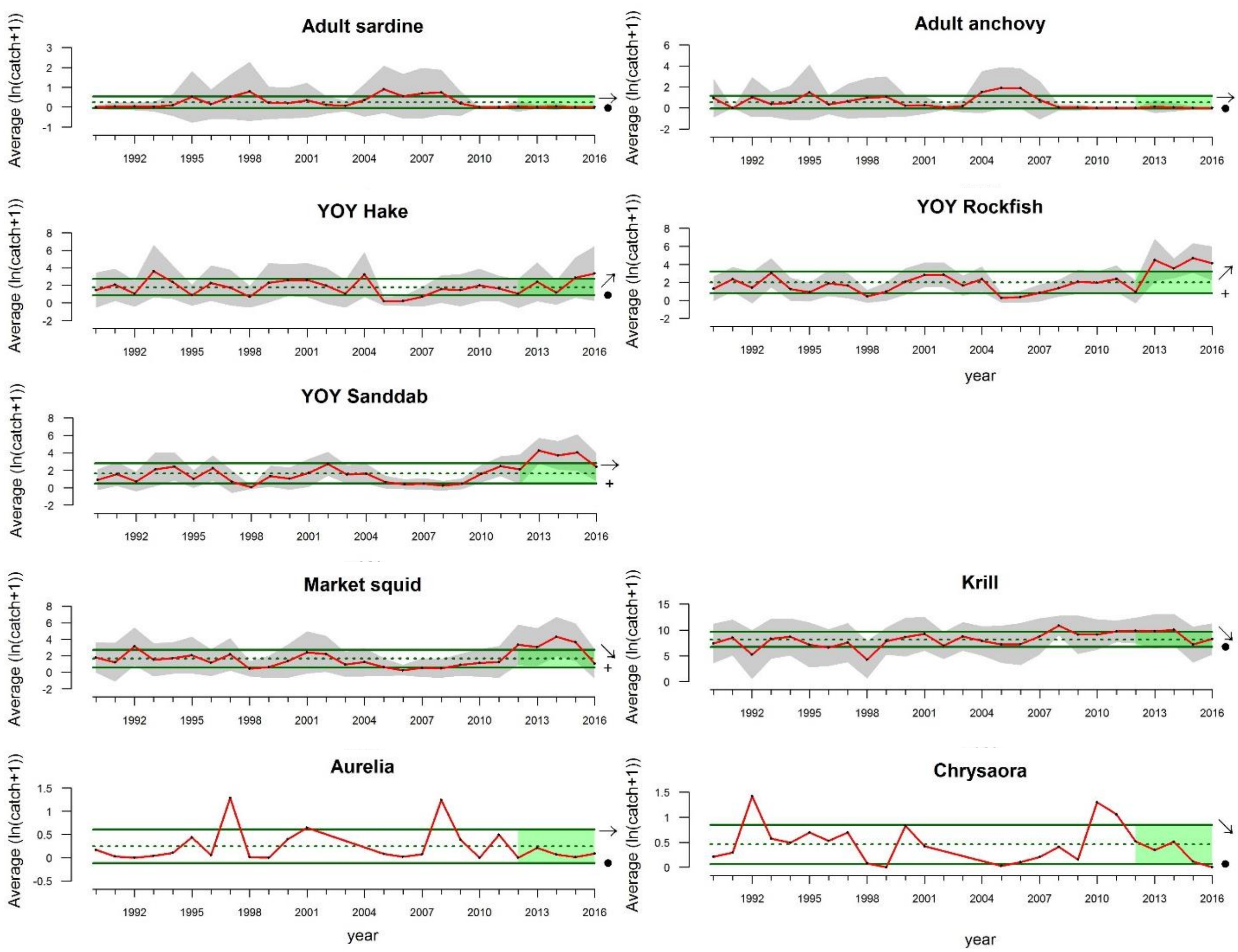



*Figure G.2. Geometric mean CPUEs (#/15 min haul) of key forage groups in the Central CCE, from the SWFSC Rockfish Recruitment and Ecosystem Assessment Survey during 1990-2016. Lines, colors and symbols are as in Figure 1.1a, with the exception that shaded errors in these figures represent standard deviations of log transformed catches; no errors presented for gelatinous zooplankton spp. (bottom figures).*

### G.3. Southern California Current Forage

The abundance indicators for forage in the Southern CCE come from fish and squid larvae collected in the spring across all core stations of the CalCOFI survey using oblique vertical tows of fine mesh Bongo nets to 212 m depth. The survey collects a variety of fish and invertebrate larvae (<5 d old) from several taxonomic and functional groups. Larval data are indicators of the spawning stock biomass of forage species such as anchovy and sardine. They likely also reflect the relative abundance of some other fish species, including mesopelagic species. At the time of this report, samples from 2016 have been processed and enumerated for only the four taxa presented below; other species groups (e.g., shortbelly rockfish, myctophids) are forthcoming. Noteworthy observations from 2016 surveys include the increase in relative abundance of anchovy, the total absence of sardine in all survey tows, and the decline of hake and market squid (Fig. G.3).

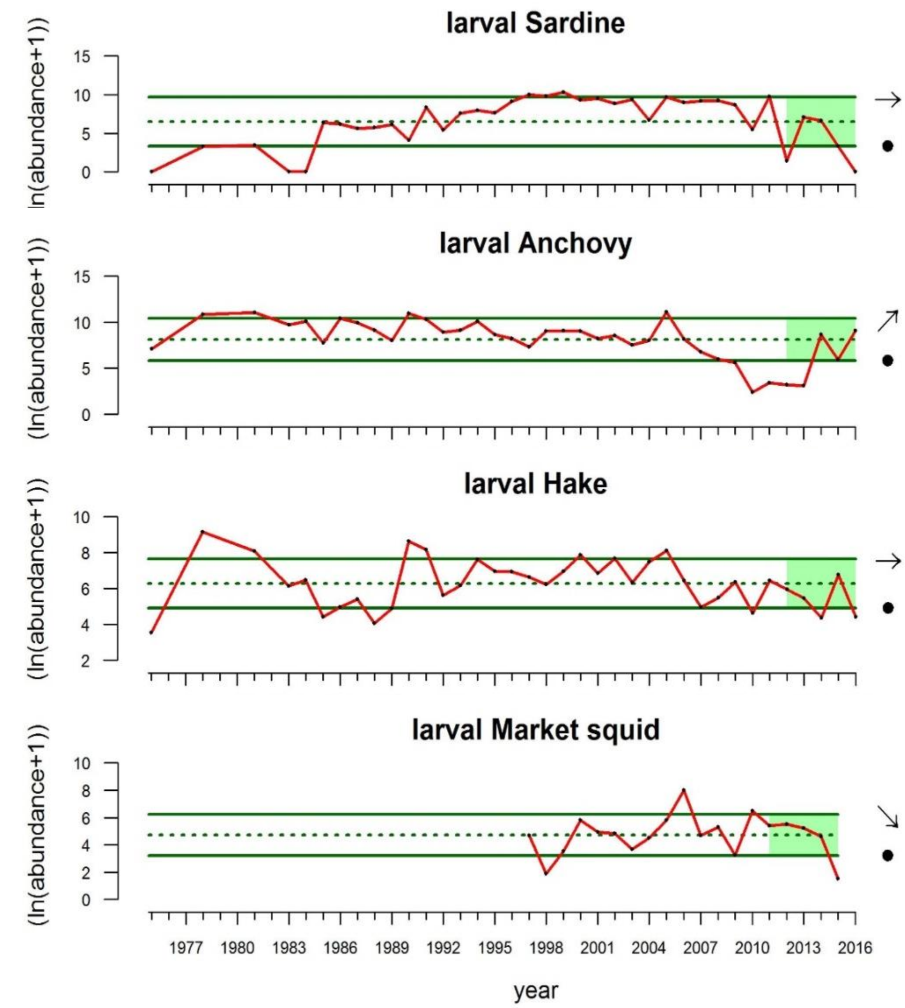



*Figure G.3. Average larval abundance (ln(abundance+1)) of key forage species in the Southern CCE, from spring CalCOFI surveys during 1975-2016. Lines, colors and symbols are as in Figure 1.1a.*

## Appendix H: Chinook Salmon Escapement Indicators

Population-specific status and trends in Chinook salmon escapement are provided in Section 4.3 of the Main Report. Figure 4.3.1 uses quad plots to summarize recent escapement status and trends relative to full time series. These plots are useful for summarizing large amounts of data, but they may hide informative short-term variability in these dynamic species. The full time series for all populations are therefore presented here. We note again that these are escapement numbers, not run-size estimates, which take many years to develop. Status and trends are estimated for the most recent 10 years of data (unlike 5 years for all other time series in this Report) in order to account for the spatial segregation of successive year classes of salmon.

### H.1. California Chinook Salmon Escapements

The Chinook salmon escapement time series from California include data from as recent as 2015 extending back over 20 years, with records for some populations (Central Valley Late Fall; Southern Oregon/Northern California Coastal; Klamath Fall) stretching back to the 1970s. Most near-term trends showed no trend, with the exception of Central Valley Winter Chinook, which reflected a declining escapement trend that is due to the very influential point from the relatively large escapement in 2006 (Fig. H.1). Escapement estimates for all populations in 2015 were below the long-term mean for their respective time series, and many populations have experienced decreasing escapements from 2013-2015 after some increases in the preceding years.

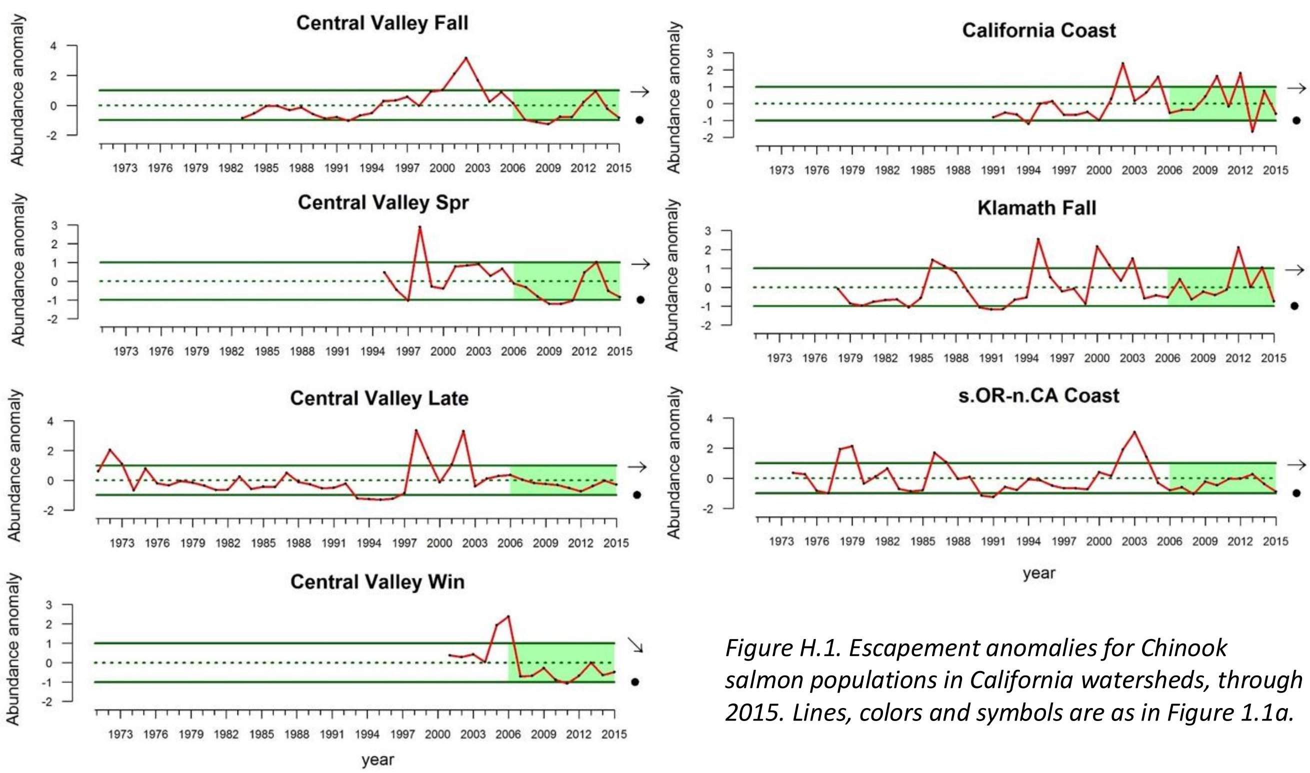



*Figure H.1. Escapement anomalies for Chinook salmon populations in California watersheds, through 2015. Lines, colors and symbols are as in Figure 1.1a.*

## H.2. WASHINGTON/OREGON/IDAHO CHINOOK SALMON ESCAPEMENTS

The escapement time series used for Chinook salmon populations from Washington, Idaho, and Oregon extend back over 40 years, but because the stocks are often co-managed and the surveys conducted by a variety of state and tribal agencies, the most recent data are currently only available through 2014 (Fig. H.2). Three of five stocks have shown improving escapement trends in the last ten years, including both Snake River populations and the Lower Columbia populations. Snake River Fall Chinook in 2014 were at their highest level of the time series, and the recent average is significantly greater than the long-term mean. Other populations' recent averages are within 1 s.d. of long-term means.

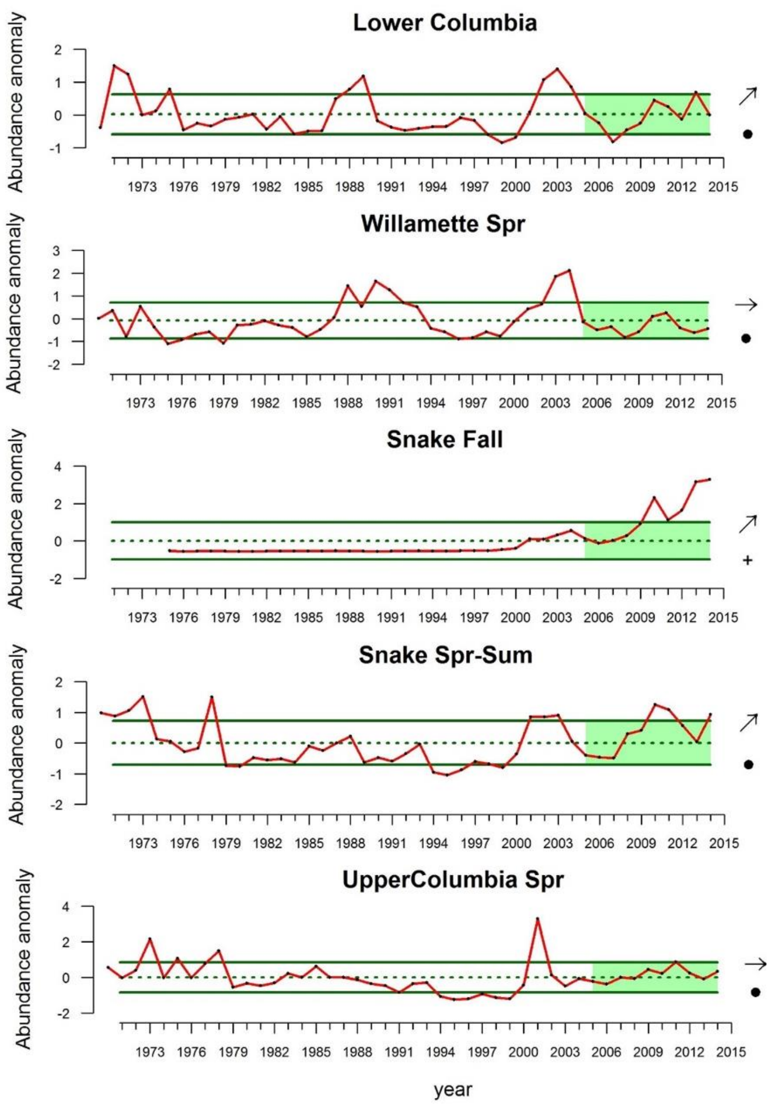



*Figure H.2. Escapement anomalies for Chinook salmon populations in Washington/Oregon/Idaho watersheds, through 2014. Lines, colors and symbols are as in Figure 1.1a.*

**APPENDIX I: DEMERSAL COMMUNITY STRUCTURE**

We are tracking the abundance of groundfish relative to Dungeness and Tanner crabs as a metric of seafloor community structure and trophic status. It may also relate to opportunities for vessels to participate in different fisheries.

Data are area-weighted mean crab:finfish biomass ratios from NMFS trawl survey sites north and south of Cape Mendocino (Fig. I.1). The ratio has varied by region and time, and peaked in the south in 2010, a year earlier than in the north. Following those peaks, the crab:finfish ratio declined, but increases in 2015 stabilized the recent trend in the south.

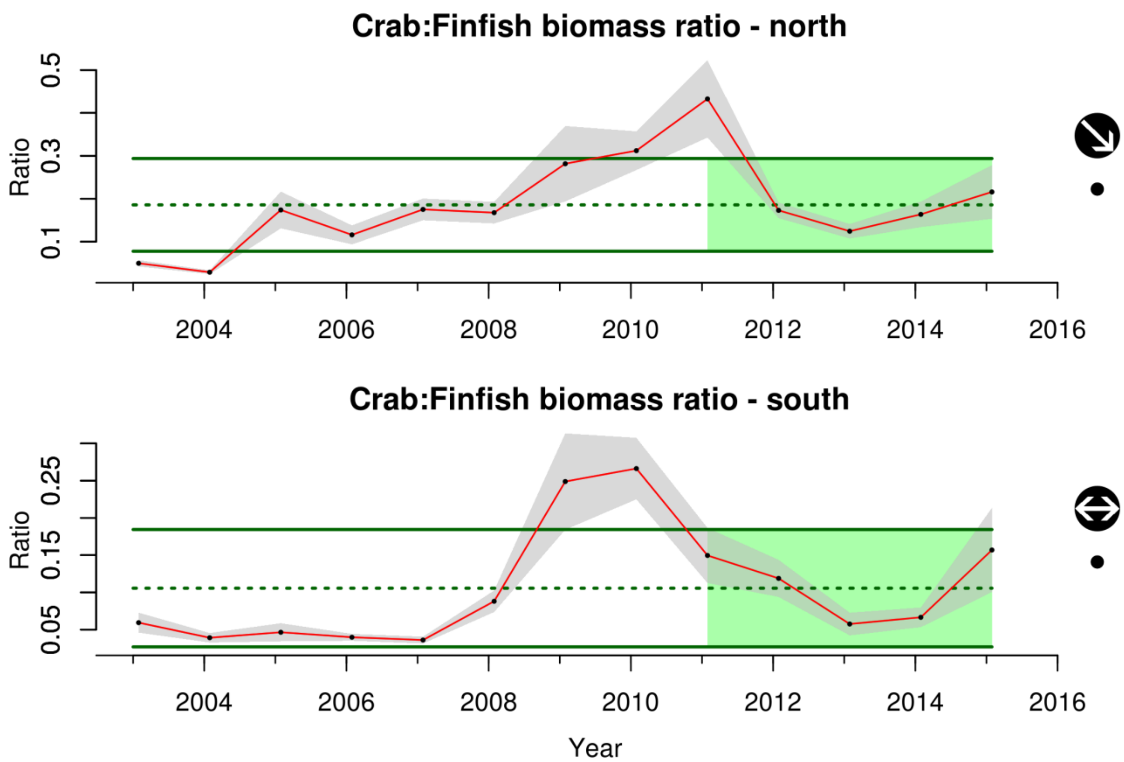



*Figure I.1: Ratio of crabs to finfish biomass from the NMFS West Coast Groundfish Bottom Trawl Survey through 2015. Lines, colors and symbols are as in Fig. 1.1a.*

## Appendix J. The 2016 Rhinoceros Auklet Mortality Event

In 2016, elevated numbers of rhinoceros auklets washed up on beaches in the northern CCE. The timing of this "wreck" of dead birds was atypical, as the mortality pulse began during the summer/fall breeding season, rather than the post-breeding period when mortalities often are observed. The density of dead rhinoceros auklets in the summer months reached ~70 times normal in the Salish Basin, ~50 times normal in the Western Strait of Juan de Fuca, ~20 times normal along the northern and southern Washington coast, and ~4 times normal along the northern Oregon coast (Fig. J.1). Mortalities in southern Oregon and northern California in 2016 were at or below the long-term average.

The breeding season signal was picked up via colony monitoring as well. On Protection Island in Puget Sound, egg-laying and hatching success (# chicks/egg) did not differ from past years, but chick growth was delayed and fledging success (# fledglings/egg) was the lowest seen in a decade of monitoring. Causes apart from productivity, such as harmful algal blooms or avian influenza, have not been identified. The auklet carcasses showed signs of emaciation, and some showed indications of bacterial infection; however assigning causation to either of those factors has not been possible.

Rhinoceros auklet mortality has been observed in past warm-water years, particularly in El Niño events, but are were largely confined to the post-breeding period. The mechanisms for these continuing events (the Cassin's auklet wreck in 2014 and common murre wreck in 2015) may be linked to warm ocean conditions arose in this region in late 2014 and continued into 2016. Rhinoceros auklets are primarily piscivores like common murres, while Cassin's auklets are planktivores. Given the likely connection of these die-offs to the ecosystem state, explorations of forage availability and condition as well as foraging patterns by these upper-trophic-level consumers are warranted.

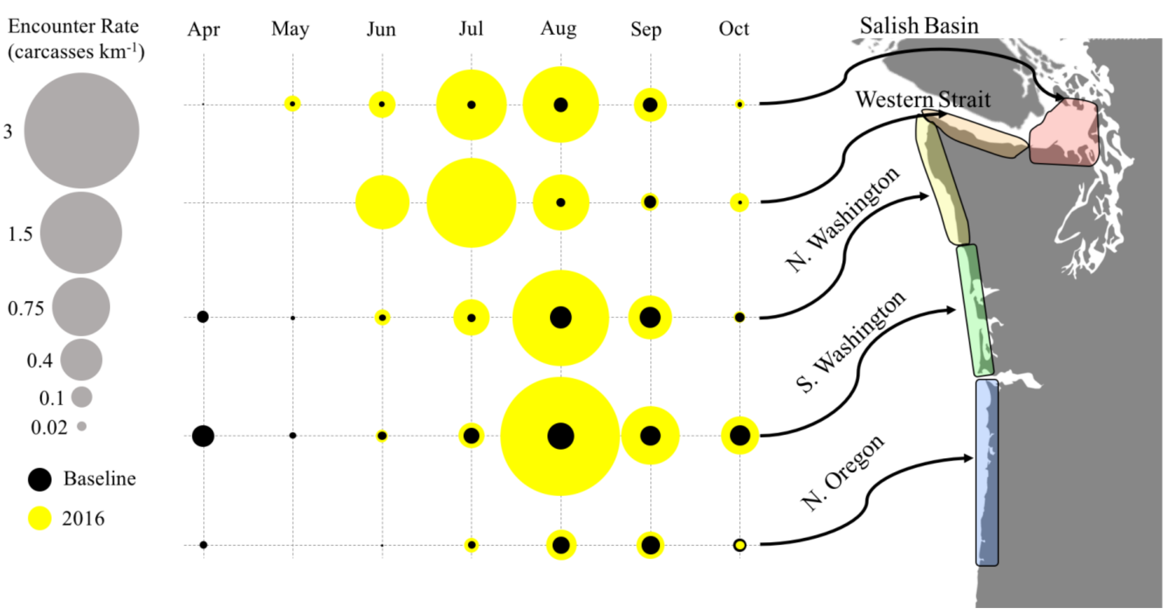



*Figure J.1. Rhinoceros auklet mortality (carcasses/km) along beaches in the northern CCE. Circle diameters are proportional to long-term baseline (black) and 2016 (yellow) by month*

**APPENDIX K. STATE-BY-STATE FISHERY LANDINGS AND REVENUES**

The Council and the EWG have requested information on state-by-state landings and revenues from fisheries, including recreational fishing; these values are presented here. Fishery removal data are derived from assessments for species assessed through 2015; the Pacific Fisheries Information Network (PacFIN, http://pacfin.psmfc.org) for commercial landings; and the Recreational Fisheries Information Network (RecFIN, http://www.recfin.org) for recreational landings. Landings provide the best long-term indicator of fisheries removals. The best information on revenue is also summarized in PacFIN. Revenue was calculated based on consumer price indices for 2015.

**K.1. STATE-BY-STATE LANDINGS**

Total fisheries landings in California decreased over the last five years and these patterns were driven almost completely by decreases in landings of market squid (Fig. K.1). Landings of groundfish (excluding hake), CPS (excluding squid) and recreationally caught species have been consistently at historically low levels over the last five years, while landings of crab decreased greatly in 2015 from historically high levels over the same period. Landings of shrimp, salmon and HMS have been relatively unchanged over the last five years.

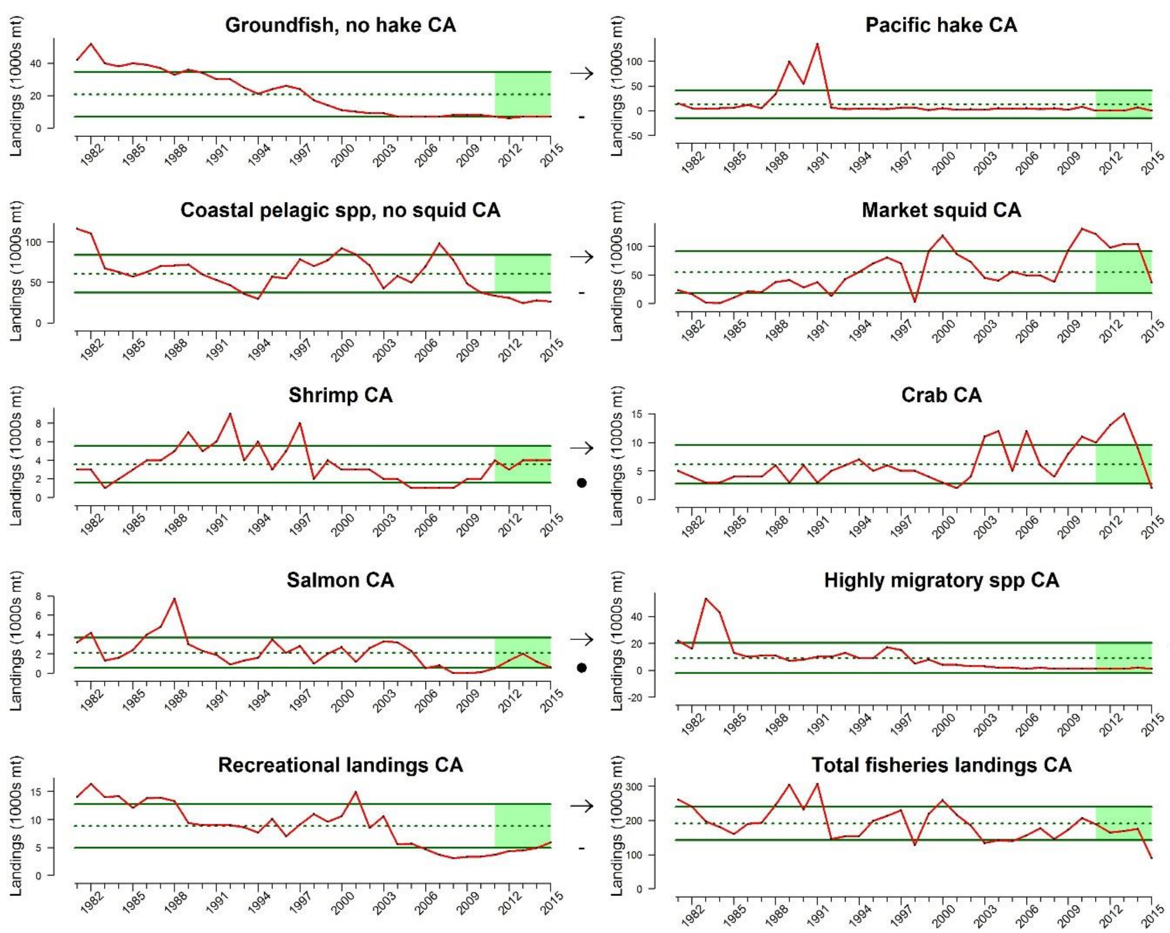



*Figure K.1. Annual landings of commercial (data from PacFIN and NORPAC) and recreational fisheries (data from RecFIN), including total landings across all fisheries from 1981-2015 in California (CA). Lines and symbols are as in Figure 1.1a.*

Total fisheries landings in Oregon have varied widely with historically high levels of landings and a relatively large decrease in landings within the last five years (Fig. K.2). These patterns were driven by interactions in landings of Pacific hake, which have varied over the last five years, and coastal pelagic species (excluding squid) and crab, which have both decreased over the last five years. Landings of groundfish (excluding hake) have been consistently near historically low levels, while landings of shrimp were at historically high levels over the last five years. Landings of highly migratory species and salmon have been within historical averages over the last five years.

In contrast to commercial fisheries landings, recreational fisheries landings in Oregon have increased over the last five years. Neither of the other states experienced an increase in recreational fishing in recent years.

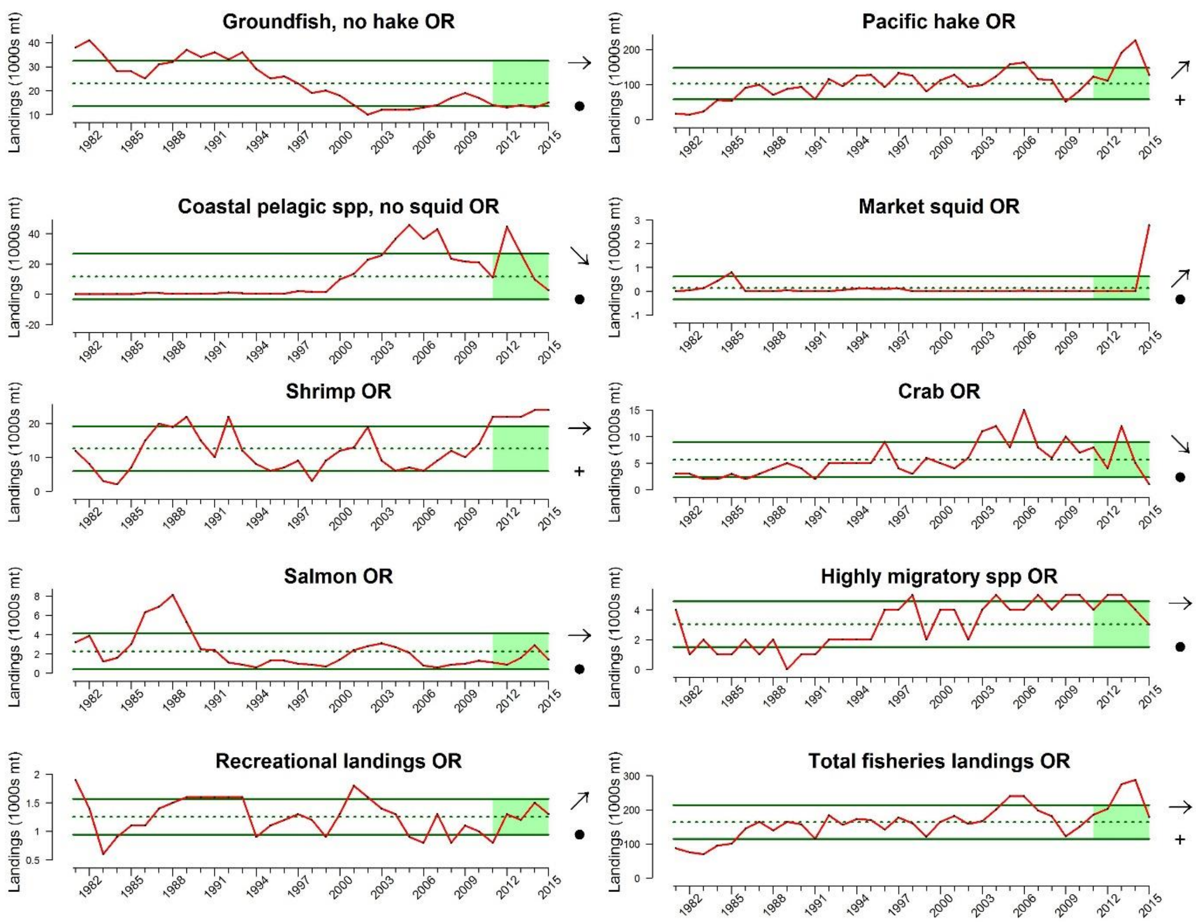



*Figure K.2. Annual landings of commercial (data from PacFIN and NORPAC) and recreational fisheries (data from RecFIN), including total landings across all fisheries from 1981-2015 in Oregon (OR). Lines and symbols are as in Figure 1.1a.*

Total fisheries landings in Washington decreased over the last five years, with particularly low landings in 2015 (Fig. K.3). These patterns were driven primarily by large decreases in the landings of Pacific hake and coastal pelagic species (excluding squid) over the same period. Landings of groundfish (excluding hake) were consistently at historically low levels over the last five years, while landings of crab and salmon varied within historical levels. Landings of shrimp increased to historically high levels and landings of highly migratory species have remained at historically high levels over the last five years.

Landings of recreational catch were consistently within historical averages over the last five years. The anomalously large recreational catch in 2002 is possibly a data error in Pacific halibut landings, and should be viewed with caution.

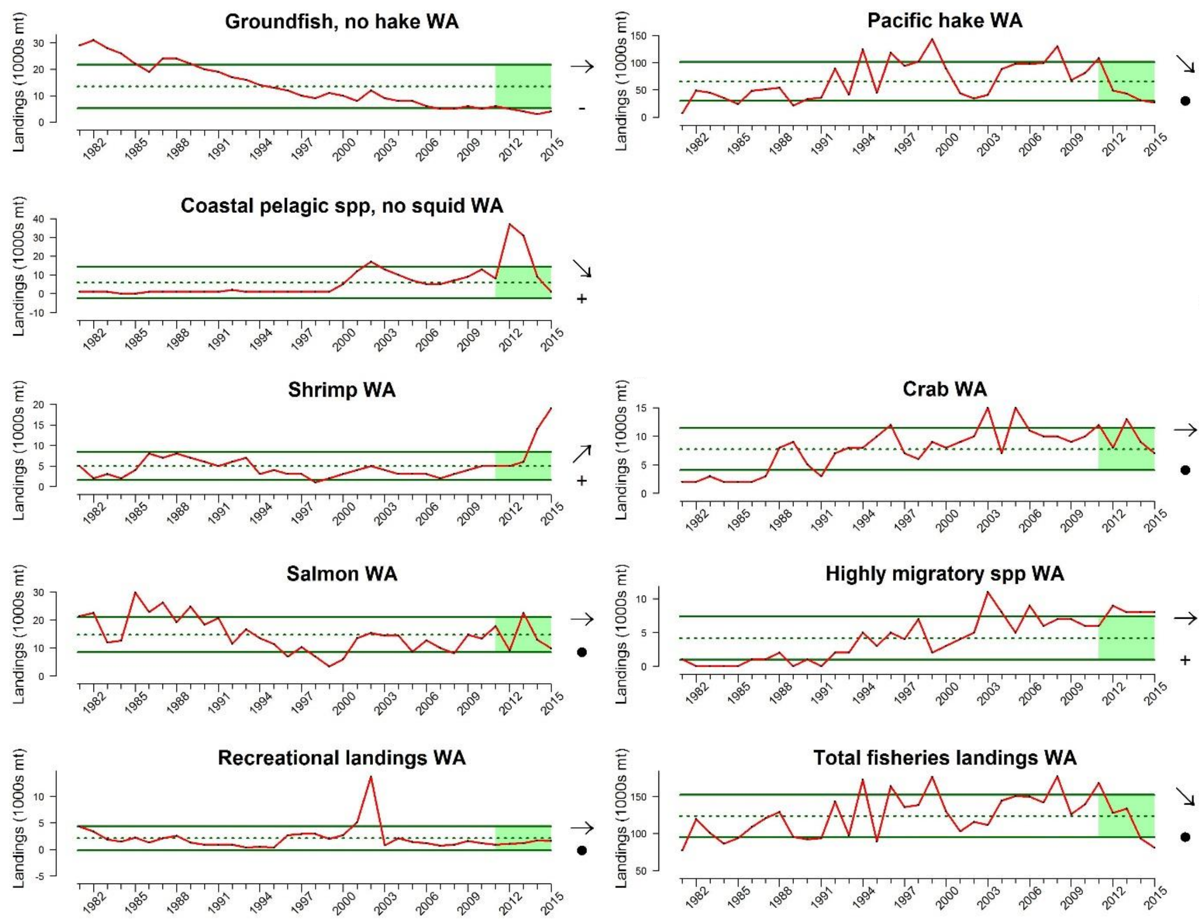
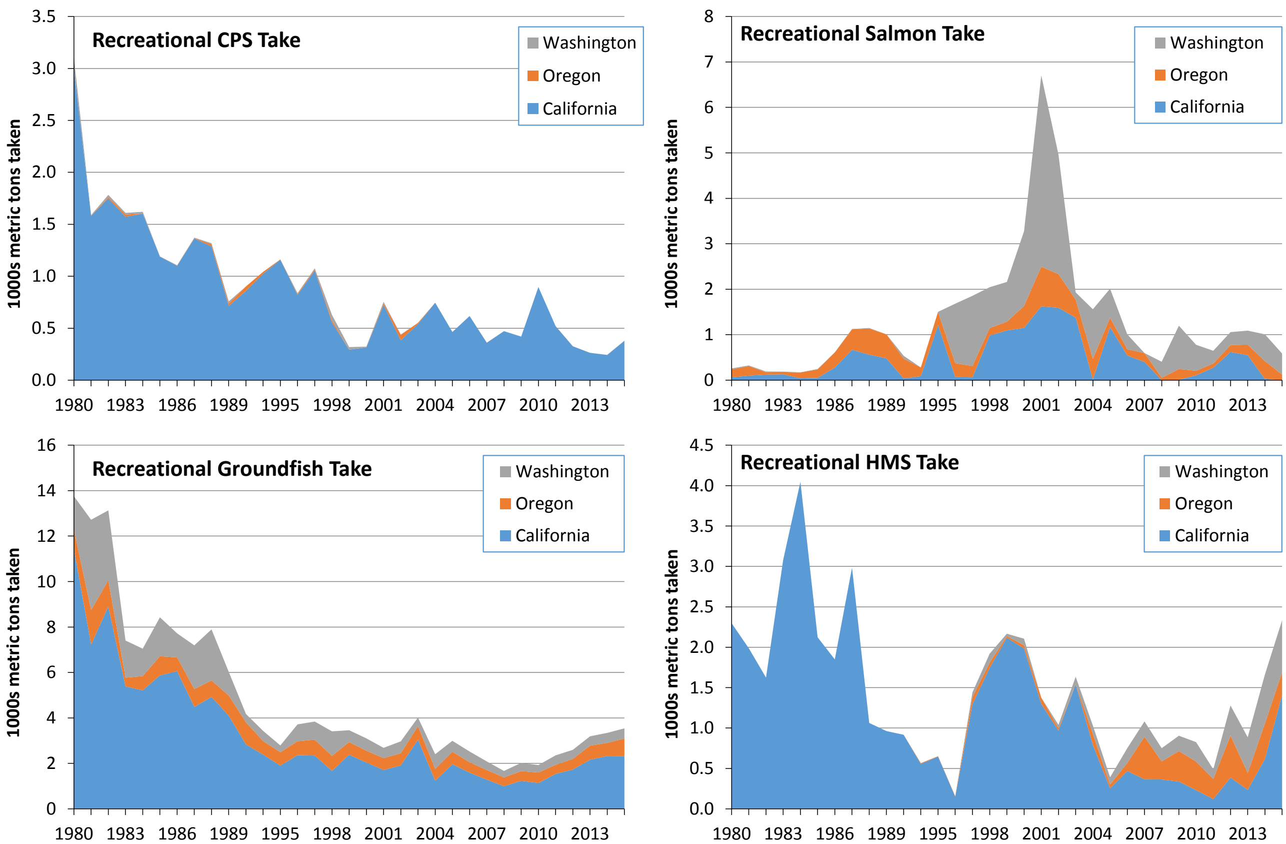



*Figure K.3. Annual landings of commercial (data from PacFIN and NORPAC) and recreational fisheries (data from RecFIN), including total landings across all fisheries from 1981-2015 in Washington (WA). Lines and symbols are as in Figure 1.1a.*

### K.2. Recreational Take by State and FMP

We further broke down the available RecFIN data on state-by-state recreational take (landings plus dead discard) from 1980-2015, and summarized them by how the species group under the FMPs. California was the location of the clear majority of recreational take in all species groupings except for salmon (Fig. K.4). Recreational take of CPS and groundfish has declined long-term, although groundfish take has increased since 2008. Recreational HMS take has been highly variable; most recently, it rose sharply from 2011-2015, and the data imply that proportions of total recreational HMS caught in Oregon and Washington have increased since 2005. Recreational catch of salmon has also been highly variable at both the scale of the entire coast and among individual states. Peaks in recreational take in all states occurred in the late 1990s and early 2000s; since then, recreational salmon take has declined, particularly in California.

Recreational take of "other" species that do not fall directly under an FMP is dominated by California (Fig. K.4). Key species include California and Pacific halibut, barred sand bass, kelp bass, barracuda, yellowtail and surfperches. Take of these "other" species declined steeply between 2003 and 2010, but has been increasing slightly since then.



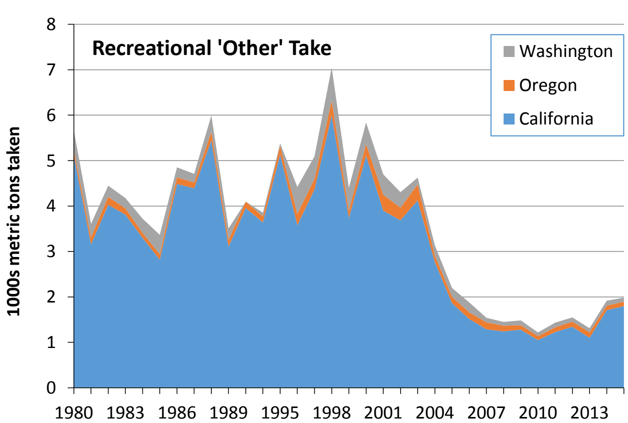




*Figure K.4. Annual take by recreational fisheries (landings plus dead discard; data from RecFIN) from 1980-2015, summarized by state and by species groupings under the FMPs.*

## K.3. Commercial Fishery Revenues

Total revenue across U.S. West Coast commercial fisheries decreased from 2011–2015, primarily due to large decreases in 2015 (Fig. K.5). This pattern was driven by decreases in crab, market squid and Pacific hake revenue over the last five years and, in particular, in 2015. The only fishery that increased revenue over the last five years was shrimp. Revenue of groundfish (excluding hake) remained consistently near historically low levels from 2011-2015, while revenue from salmon, highly migratory species and other species were relatively unchanged and within historical averages over the last five years.

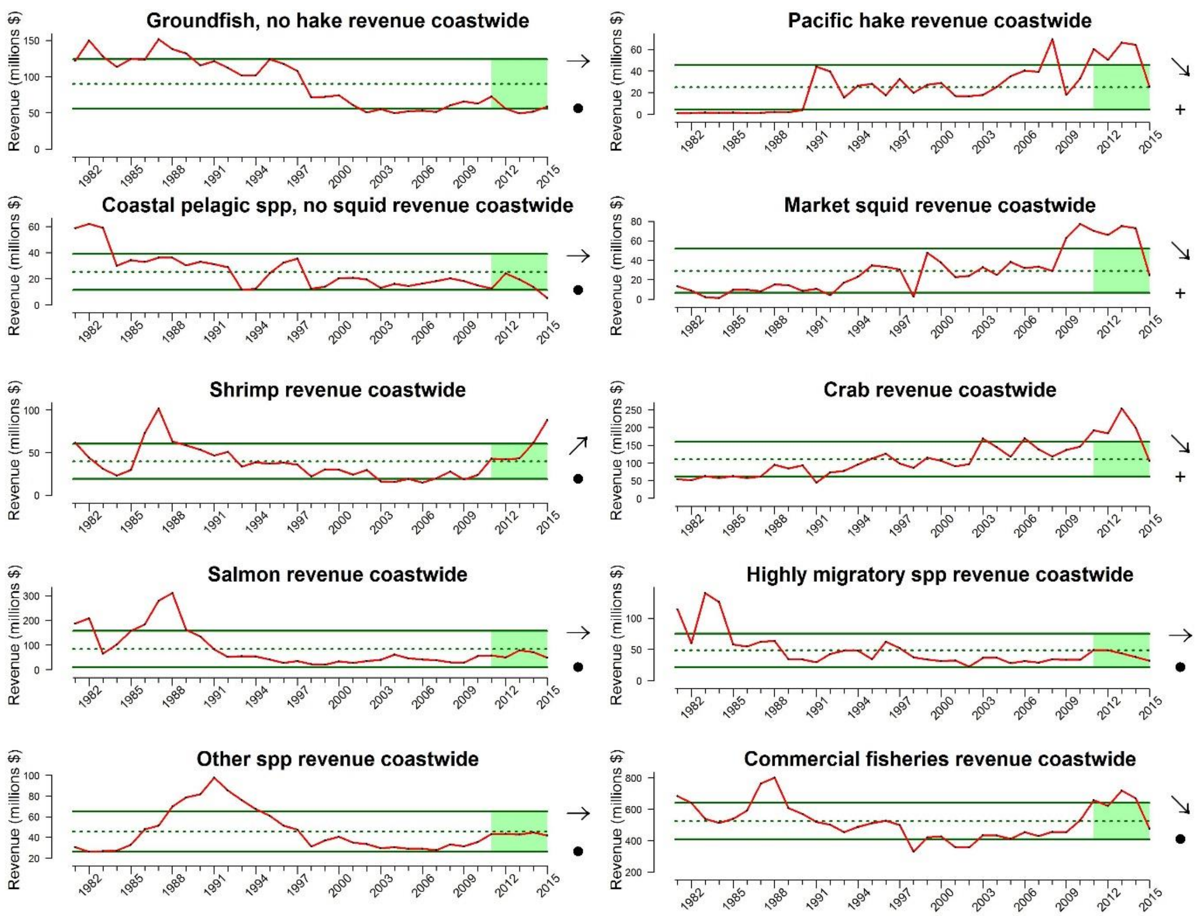



*Figure K.5. Annual revenue (Ex-vessel value in 2015 dollars) of West Coast commercial fisheries (data from PacFIN) from 1981 - 2015, including at-sea hake revenue (data from the North Pacific Database Program (NORPAC)) from 1990-2015. Lines and symbols are as in Figure 1.1a.*

Total revenue across commercial fisheries in California decreased from 2011–2015, primarily due to large decreases in 2015 (Fig. K.6). This pattern was driven by decreases in crab and market squid in 2015. The only fishery that increased revenue over the last five years was shrimp. Revenue of groundfish (excluding hake) and highly migratory species remained consistently near historically low levels from 2011-2015, while revenue from Pacific hake, salmon and other species were relatively unchanged and within historical averages over the last five years.

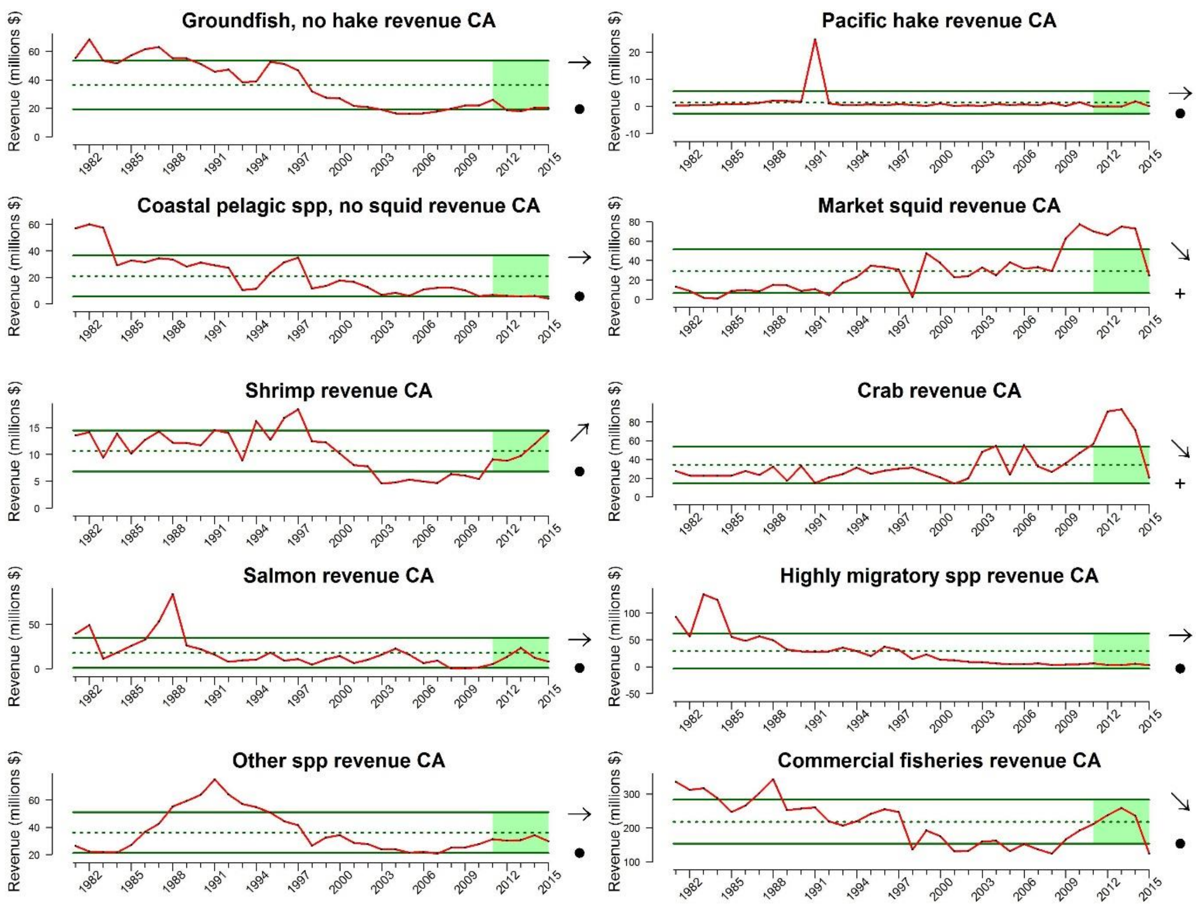



*Figure K.6. Annual revenue (Ex-vessel value in 2015 dollars) of West Coast commercial fisheries (data from PacFIN) from 1981 - 2015, including at-sea hake revenue (data from the North Pacific Database Program (NORPAC)) from 1990-2015 in California (CA). Lines and symbols are as in Figure 1.1a.*

Total revenue across commercial fisheries in Oregon was at historically high levels from 2011–2015 despite a large decrease in 2015 (Fig. K.7). This pattern was driven by decreases in Pacific hake and crab revenue in 2015. The only fishery that increased revenue over the last five years was shrimp. Revenue of groundfish (excluding hake) remained consistently near historically low levels from 2011-2015, while revenue from salmon and other species were relatively unchanged and within historical averages over the last five years. Revenue from highly migratory species has decreased gradually over the last five years.

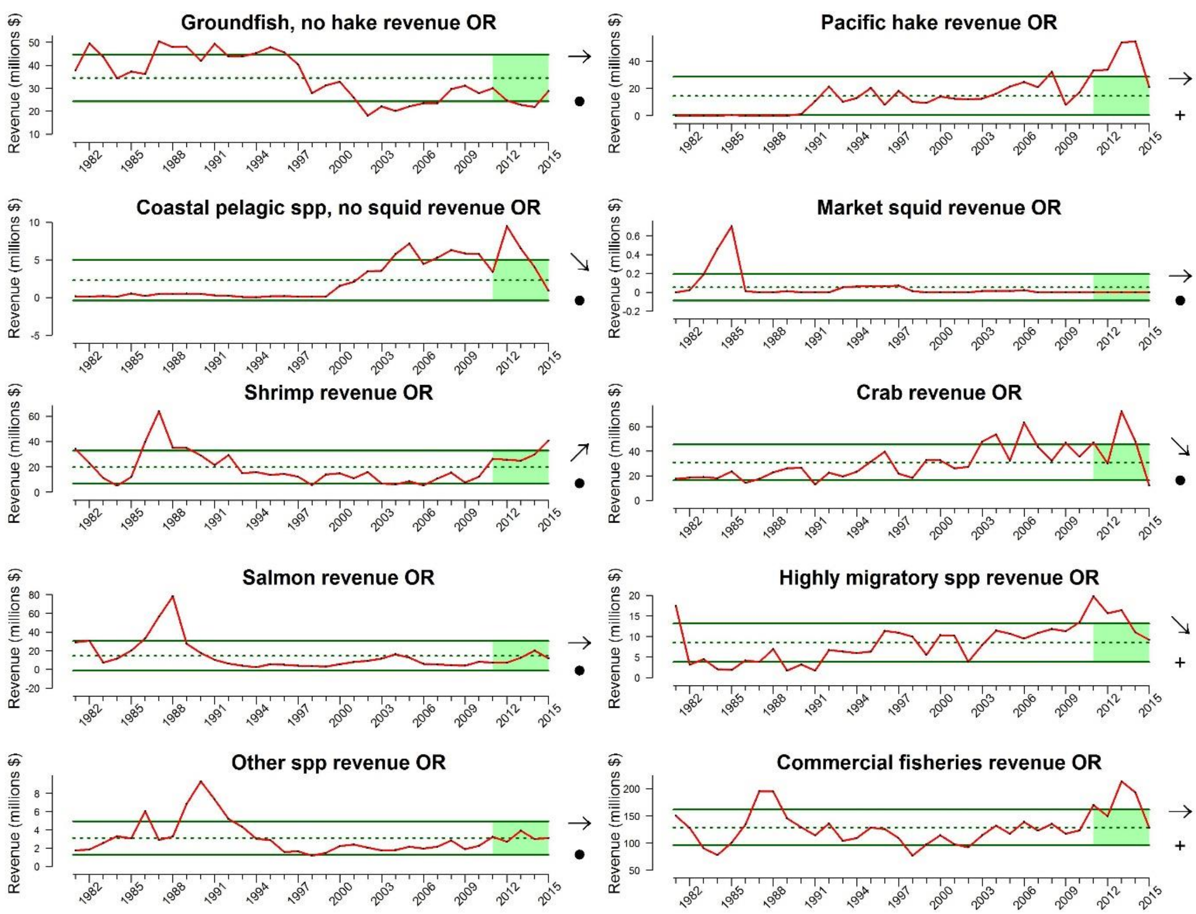



*Figure K.7. Annual revenue (Ex-vessel value in 2015 dollars) of West Coast commercial fisheries (data from PacFIN) from 1981 - 2015, including at-sea hake revenue (data from the North Pacific Database Program (NORPAC)) from 1990-2015 in Oregon (OR). Lines and symbols are as in Figure 1.1a.*

Total revenue across commercial fisheries in Washington remained relatively unchanged and at historically high levels from 2011–2015 (Fig. K.8). This is in sharp contrast with the decreases in revenue observed across the entire coast and in California and Oregon in 2015. Decreases in revenue in the Pacific hake and coastal pelagic species fisheries were offset by increases in revenue in the shrimp fishery in Washington over the last five years. Revenue of groundfish (excluding hake) remained consistently near historically low levels from 2011-2015, while revenue from salmon and other species were relatively unchanged and within historical averages over the period. Revenue from highly migratory species remained unchanged and at historically high levels over the last five years.

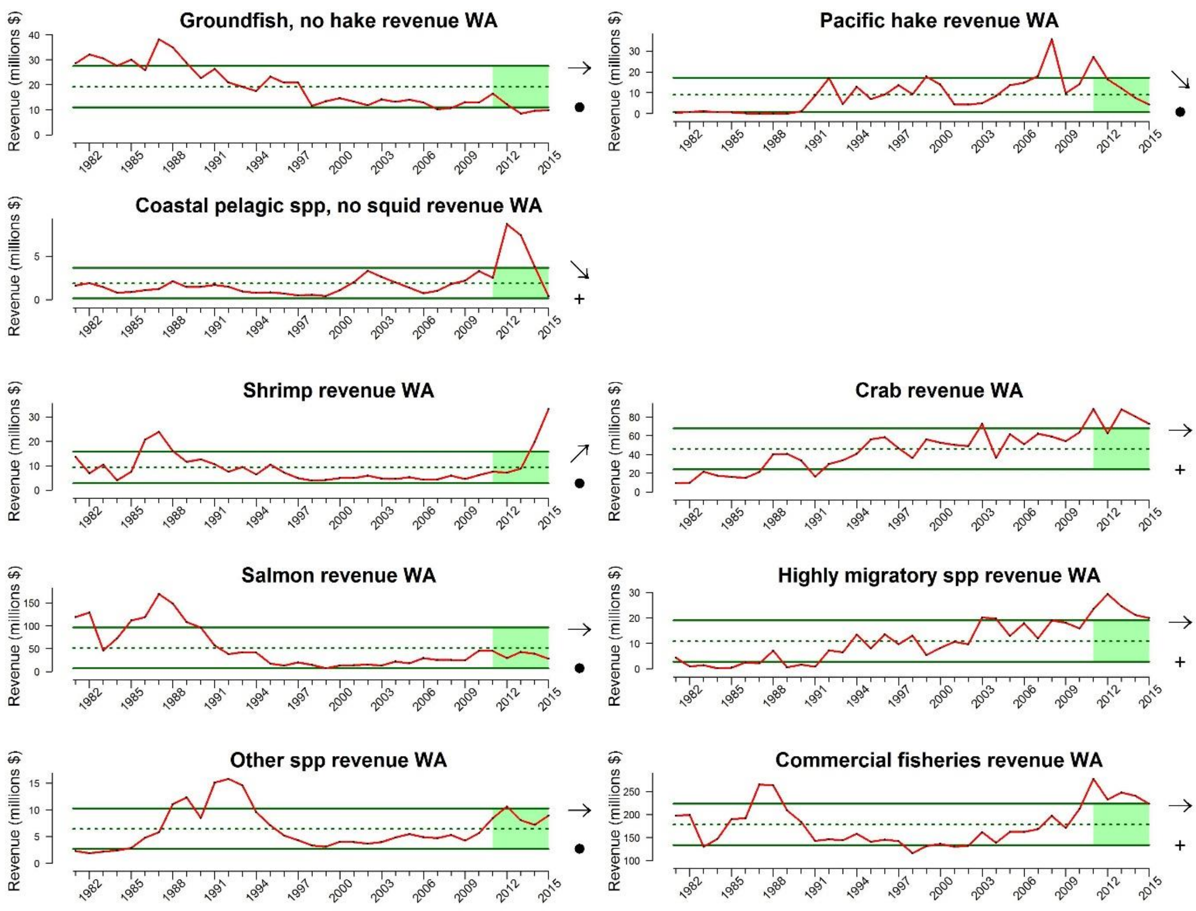



*Figure K.8. Annual revenue (Ex-vessel value in 2015 dollars) of West Coast commercial fisheries (data from PacFIN) from 1981 - 2015, including at-sea hake revenue (data from the North Pacific Database Program (NORPAC)) from 1990-2015 in Washington (WA). Lines and symbols are as in Figure 1.1a.*

## APPENDIX L. FISHING GEAR CONTACT WITH SEAFLOOR HABITAT

In Section 5.2 of the main body of this report, we presented the summary information for all distances (weighted) of fishing gear contact with seafloor habitat. Here, we present the data broken out by ecoregions ("Northern": north of Cape Mendocino; "Central": between Cape Mendocino and Point Conception; and "Southern": south of Point Conception); substrate types (hard, mixed, soft); and depth zones (shelf, upper slope, lower slope).

Benthic marine habitats can be disturbed or destroyed by geological (e.g., earthquakes, fractures and slumping) and oceanographic (e.g., internal waves, sedimentation and currents) processes as well as various human activities (e.g., bottom contact fishing, mining, dredging), which can lead to declines or extirpation of vulnerable benthic species and disruption of food web processes. These effects may differ among physiographic types of habitat (e.g., hard, mixed or soft) and be particularly dramatic in sensitive environments (e.g., seagrass meadows, algal beds and coral or sponge reefs). The exploration of resources (e.g., oil, gas and minerals) and marine fisheries often tend to operate within certain habitat types more than others, and long-term impacts of these activities may cause negative changes in biomass and the production of benthic communities.

We used estimates of coastwide distances trawled along the ocean bottom from 1999 – 2015. Estimates from 2002 – 2015 include estimates of gear contact with seafloor habitat by bottom trawl and fixed fishing gear, while estimates from 1999 – 2002 include only bottom trawl data. We calculated trawling distances based on set and haul-back locations and fixed gear distances based on set and retrieval locations of pot, trap and longline gear. We weighted distances by gear type and fishing habitat according to sensitivity values described in Table A3a.2 of the 2013 Groundfish EFH Synthesis Report to PFMC. Data come from logbook data collected and reported by the Northwest Fisheries Science Center's West Coast Groundfish Observer Program.

At the scale of the entire U.S. West Coast, gear contact with seafloor habitat remained at historically low levels from 2011–2015 (Fig. L.1). During this period, the vast majority of fishing gear contact with seafloor habitat occurred in soft-bottomed habitats on the upper slope and shelf. Moreover, the vast majority of this contact was by bottom trawl gear (data by gear type not shown). The Northern ecoregion experienced the most fishing gear contact with seafloor habitat, with nearly four times the magnitude as observed in the Central ecoregion and >40 times the magnitude observed in the Southern ecoregion, where very little bottom trawling has occurred within the time series. A shift in trawling effort from shelf to upper slope habitats was observed during the mid-2000's, which in part corresponded to depth-related spatial closures implemented by the Pacific Fishery Management Council. When compared to the mean for the entire time series, gear contact with seafloor habitats across all habitats has been within historic levels (statistics not shown due to space limitations). Reduced fishing gear contact may not coincide with recovery times of habitat depending on how fast recovery happens, which is likely to differ among habitat types (e.g., hard and mixed habitats will take longer to recover than soft habitat).

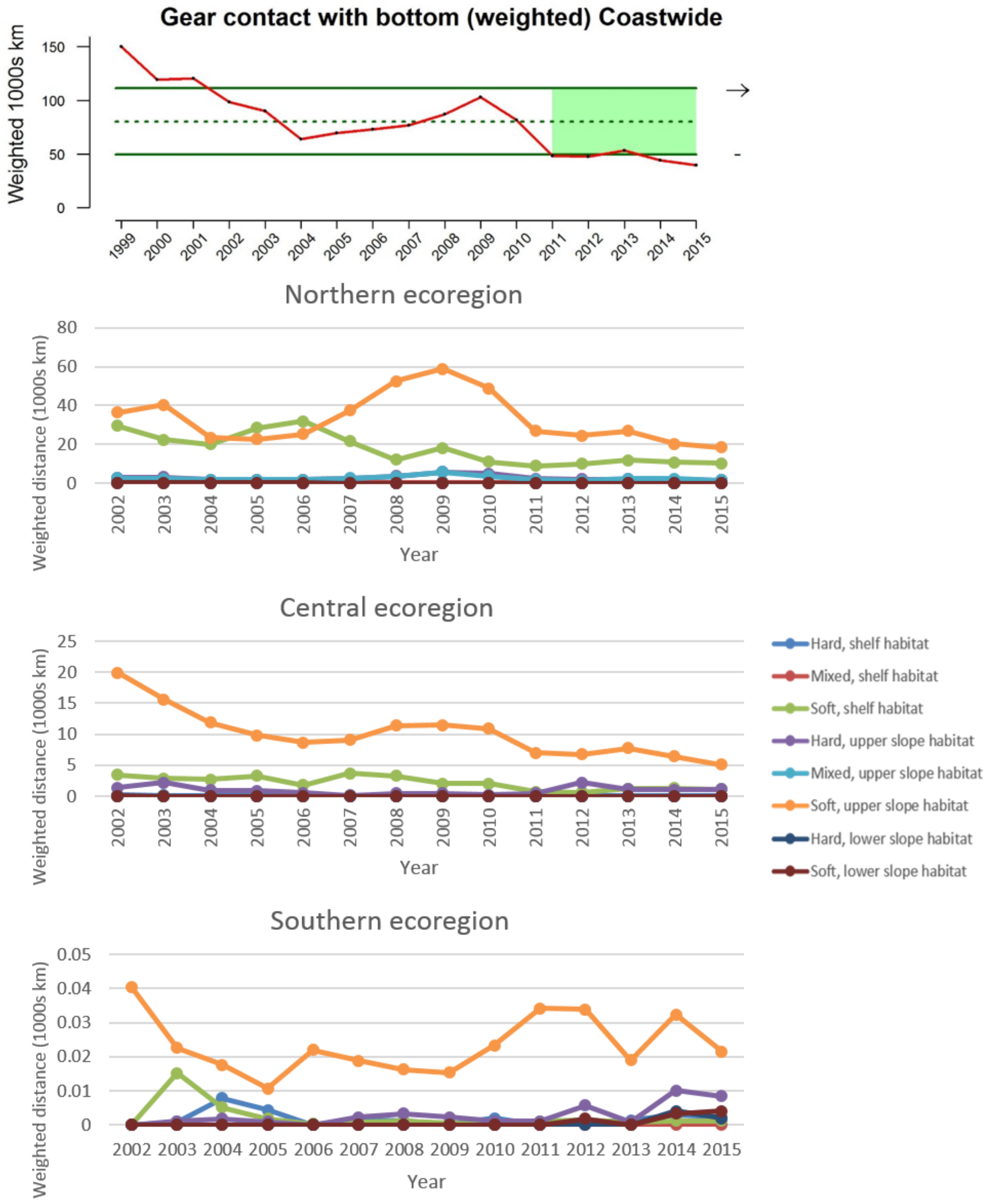



*Figure L.1: Weighted distance (1000s km) of fishing gear contact with seafloor habitat across the entire CCE (top; 1999-2015) and within each ecoregion (bottom three panels; 2002-2015). Lines, colors and symbols in top panel are as in Fig. 1.1a.*

## APPENDIX M. OTHER NON-FISHERIES HUMAN ACTIVITIES INDICATORS

Approximately 90% of world trade is carried by the international shipping industry. The volume of cargo moved through U.S. ports is expected to double between 2001 and 2020. Fisheries impacts associated with commercial shipping include interactions between fishing and shipping vessels; ship strikes of protected species; and underwater noise that affects fish spawning, recruitment, migration, and communication. Commercial shipping activity in the CCE was at historically low levels over the last five years of the dataset (through 2013; Fig. M.1). This contrasts with global estimates of shipping activity increasing nearly 400% over the last 20 years. Regional differences, lagging economic conditions and different data sources may be responsible for the observed differences.

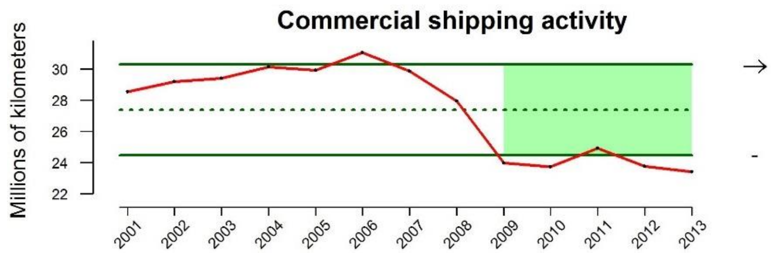



*Figure M.1: Distance transited by commercial shipping vessels in the CCE, 2001-2013. Lines and symbols are as in Figure 1.1a.*

Nutrient loading is a leading cause of contamination, eutrophication, and related impacts in streams, lakes, wetlands, estuaries, and ground water throughout the U.S. Nutrient input has been relatively constant and within historical averages over the last five years of the available dataset (2008–2012) (Fig. M.2). Applications of nitrogen and phosphorus increased steeply from 1945 until 1980, followed by a relatively sharp, stepped increase in the 2000's. However, a comparable decrease occurred in 2009, and loadings have remained within the long-term mean range through 2012.

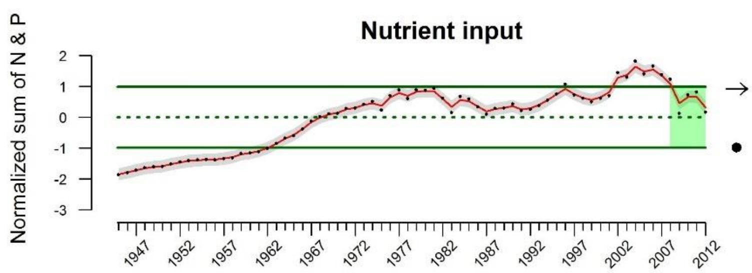



*Figure M.2: Normalized index of the sum of nitrogen and phosphorus applied as fertilizers in WA, OR and CA watersheds that drain into the CCE from 1945-2012. Lines, symbols and shading are as in Figure 1.1a.*

Risks posed by offshore oil and gas activities include the release of hydrocarbons, smothering of benthos, sediment anoxia, benthic habitat loss, and the use of explosives. Petroleum products consist of thousands of chemical compounds, such as PAHs, which may impact marine fish health and reproduction. The effects of oil rigs on fish stocks are less conclusive, as rig structures may provide some habitat benefits. Offshore oil and gas activity in the CCE occurs only off the coast of California and has been stable over the last five years, but the short-term average was more than 1 s.d. below the long-term average (Fig. M.3). Offshore oil and gas production has been decreasing steadily since the mid 1990's.

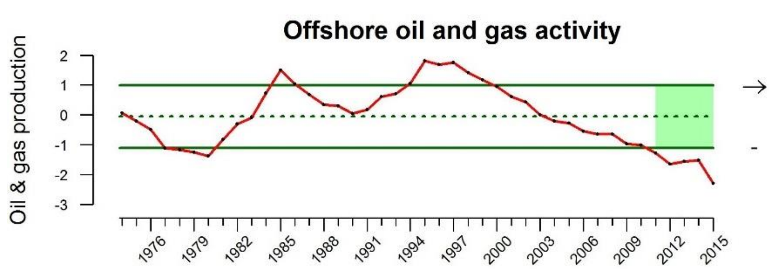
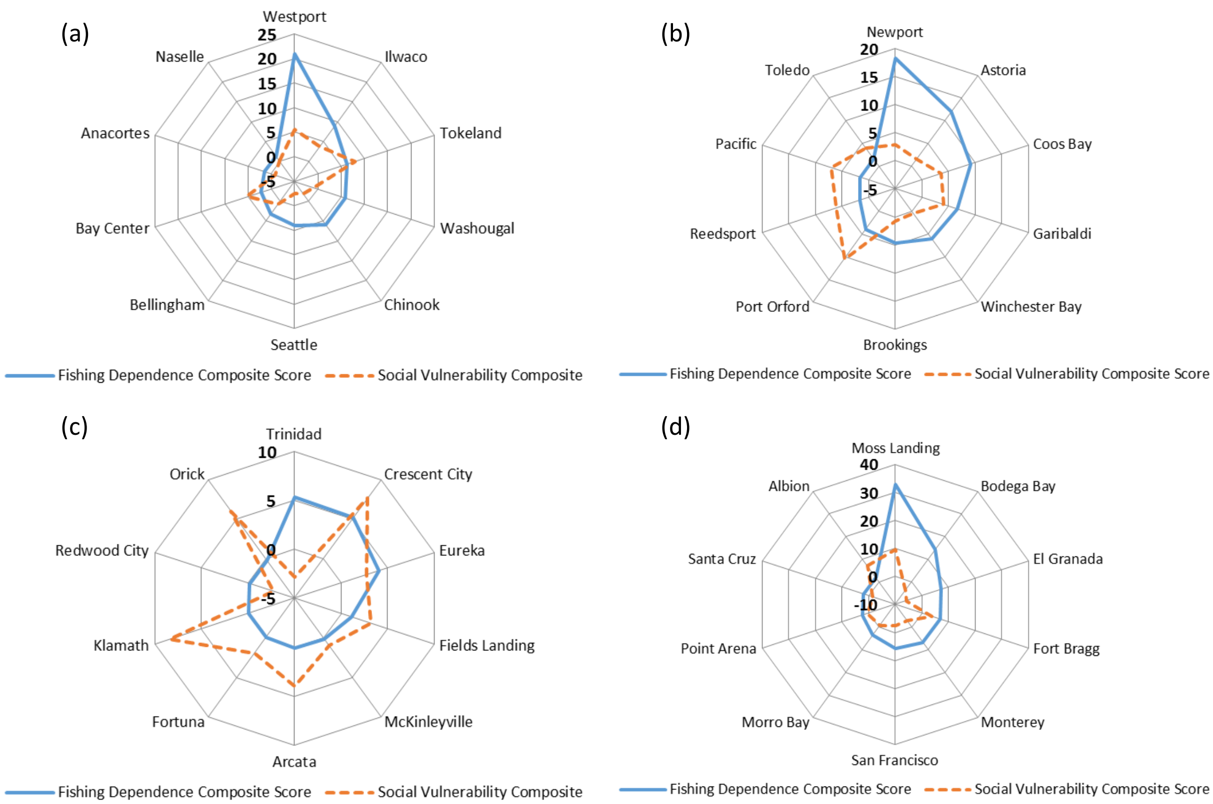



*Figure M.3: Normalized index of the sum of oil and gas production from offshore wells in CA, 1974-2014. Lines and symbols are as in Figure 1.1a.*

## APPENDIX N. SOCIAL VULNERABILITY OF COMMERCIAL FISHING-DEPENDENT COMMUNITIES

In Section 6.1 of the main report, we present information on the Community Social Vulnerability Index (CSVI) as an indicator of social vulnerability in coastal communities that are dependent upon commercial fishing in the CCE. Figure 6.1.1 presented CSVI and fishery dependence for all five regions of the CCE in the same radar plot; here, we separately present both indices for each region's ten most fishery-dependent coastal communities as of 2014. The community with the greatest commercial fishing dependency in each region is at the top of the radar plot, and other communities are plotted in clockwise descending order of fishery dependency.



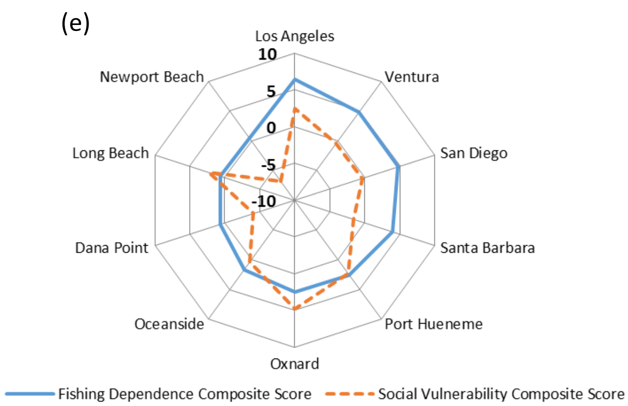




*Figure N.1. Commercial fishing dependence in 2014 (solid) and social vulnerability index in 2015 (dashed) for the ten most fishing-dependent communities in (a) Washington, (b) Oregon, (c) Northern California, (d) Central California, and (e) Southern California, expressed as standard deviations relative to all CCE communities. Communities are plotted clockwise in descending order of fishery dependence.*

In addition to the recent indices, we have now analyzed sufficient sociodemographic data from the U.S. Census and American Community Survey (ASC) of the type presented to augment a 2000-2015 time series of coastal community vulnerability in relation to commercial fishery dependence. This time series focuses on ten commercial fishing-dependent communities that consistently scored among the most socially vulnerable in all years. We plotted their CSVI composite scores for each year, and found for many communities, levels of community social vulnerability remained fairly stable over the time period examined (Fig. N.2). There were several exceptions. For example, Moss Landing, CA, experienced a steady increase in social vulnerability. Both Bay Center, WA and Tokeland, WA decreased in vulnerability from 2000 to 2005, but have seen increases since then. In contrast, Chinook, WA increased in vulnerability until 2010 but then declined sharply by 2015. Further research is needed to understand the factors causing the changes and volatility in these data.

Because this time series has only four data points, it remains difficult to interpret and subject to bias from influential data points. Furthermore, because our social vulnerability data presently underrepresents tribal communities and also may not aggregate or disaggregate certain communities in a properly representative manner, we urge caution in interpreting these results.

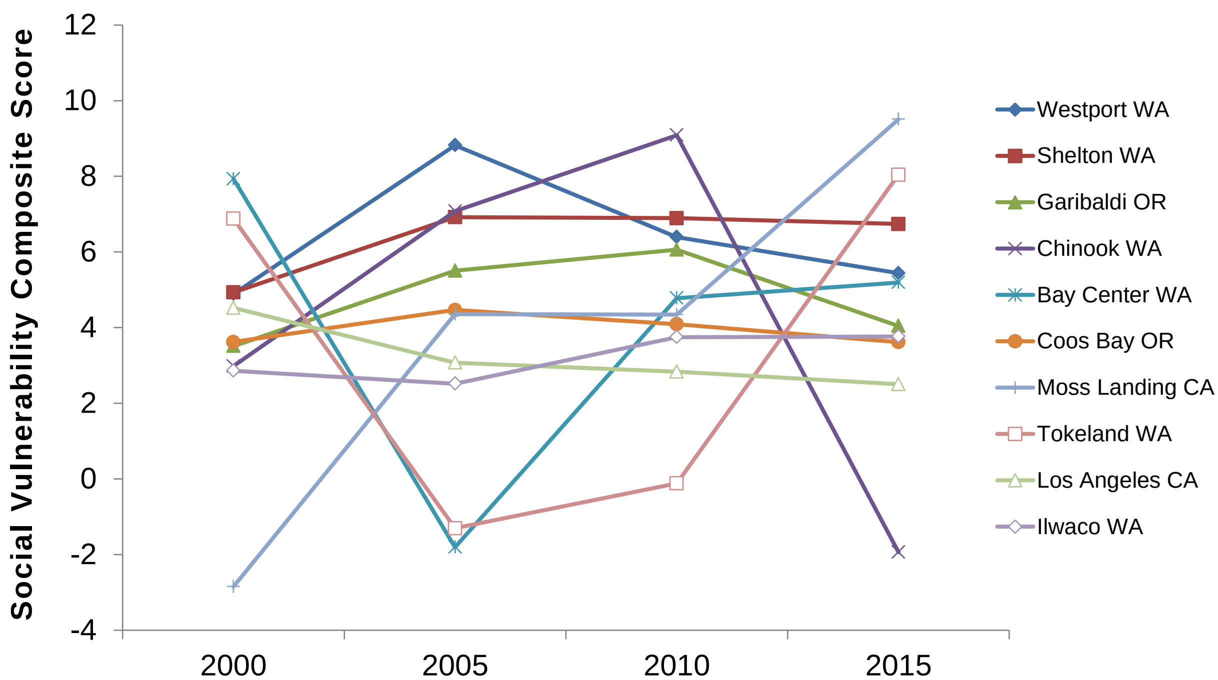



*Figure N.2. Time series of social vulnerability composite scores (derived from census data in 2000, 2005, 2010, and 2015) for ten highly vulnerable coastal communities that are dependent upon commercial fishing.*

## APPENDIX O. FLEET DIVERSIFICATION INDICATORS FOR MAJOR WEST COAST PORTS

As is true with individual vessels, the variability of landed value at the port level is reduced with greater diversification of landings. Diversification of fishing revenue has declined over the last several decades through 2015 for some ports (Fig. O.1). Examples include Seattle and most, though not all, of the ports in Southern Oregon and California. However, a few ports have become more diversified including Bellingham Bay and Westport in Washington and Astoria in Oregon. Diversification scores are highly variable year-to-year for some ports, particularly those in Southern Oregon and Northern California that depend heavily on the Dungeness crab fishery, which has highly variable landings. Several California ports have become more diversified in the last few years, but it is too early to determine whether this is a significant trend.

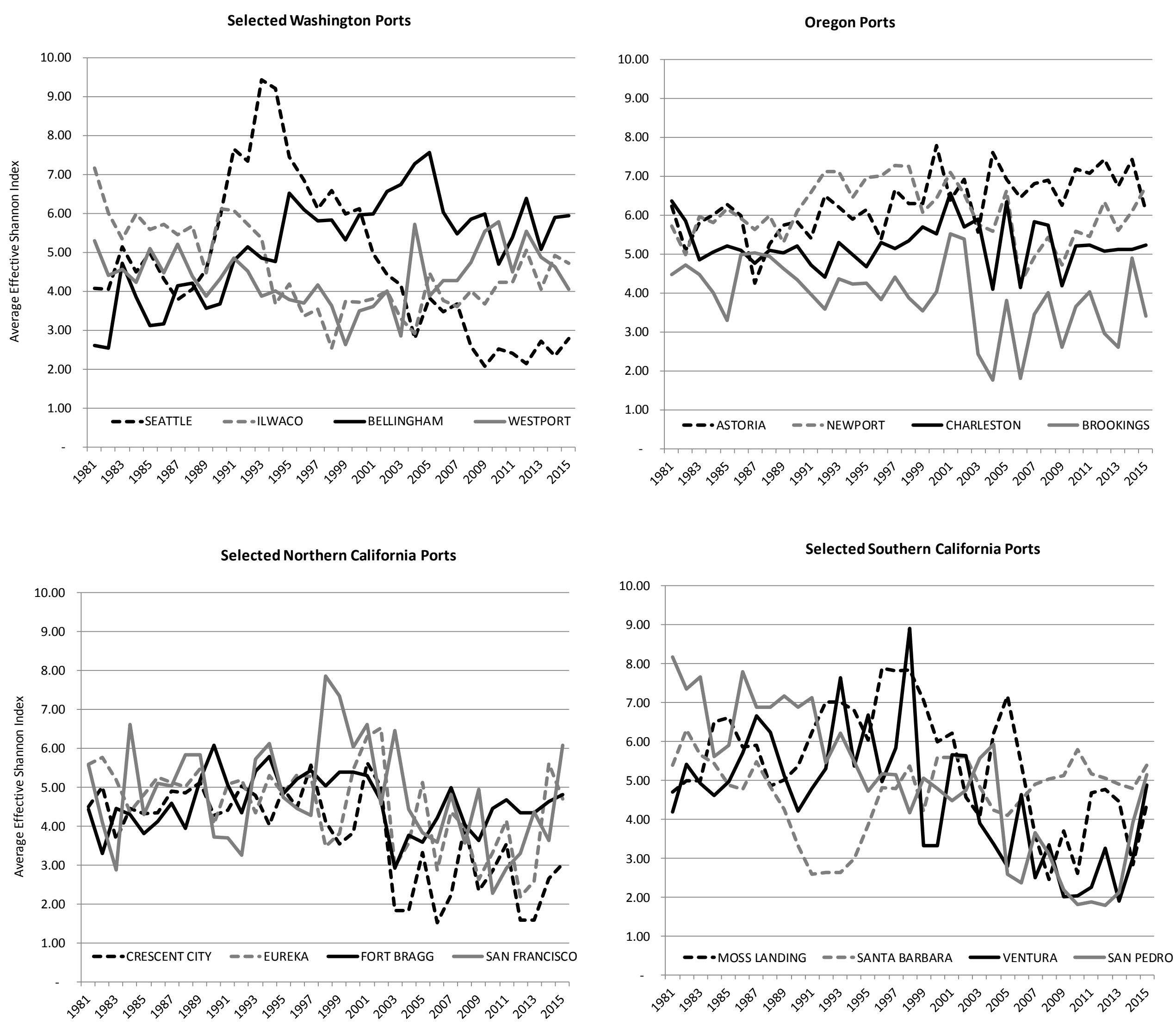



*Figure O.1. Trends in diversification for selected major West Coast ports in Washington, Oregon, and California.*

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## APPENDIX Q. LIST OF ACRONYMS USED IN THIS REPORT

| | |
|---|---|
| BMSY | Biomass when at Maximum Sustainable Yield |
| CalCOFI | California Cooperative Oceanic Fisheries Investigations |
| CCE | California Current Ecosystem |
| CCIEA | California Current Integrated Ecosystem Assessment |
| CPS | Coastal Pelagic Species |
| CPUE | Catch per Unit Effort |
| CSVI | Community Social Vulnerability Index |
| CUI | Cumulative Upwelling Index |
| DO | Dissolved Oxygen |
| DOM | Dynamic Ocean Management |
| EBFM | Ecosystem-Based Fisheries Management |
| ENSO | El Niño Southern Oscillation |
| ESI | Effective Shannon Index |
| EWG | Ecosystem Working Group (resulting from FEP Coordinated Ecosystem Indicator Review Initiative) |
| FEP | Fishery Ecosystem Plan |
| FMP | Fishery Management Plan |
| FMSY | Fishing mortality rate that produces Maximum Sustainable Yield |
| IEA | Integrated Ecosystem Assessment |
| MARSS | Multivariate Auto-Regressive State Space model |
| NOAA | National Oceanic and Atmospheric Administration |
| NPGO | North Pacific Gyre Oscillation |
| NWFSC | Northwest Fisheries Science Center |
| OA | Ocean Acidification |
| OFL | Overfishing Limit |
| ONI | Oceanic Niño Index |
| PacFIN | Pacific Fisheries Information Network |
| PDO | Pacific Decadal Oscillation |
| PFMC | Pacific Fishery Management Council |
| POP | Pacific Ocean Perch |
| RecFIN | Recreational Fisheries Information Network |
| s.d. | standard deviation |
| s.e. | standard error |
| SSC | Scientific and Statistical Committee |
| SSCES | Scientific and Statistical Committee Ecosystem Subcommittee |
| SST | Sea Surface Temperature (except Fig. 4.4.1, shortspine thornyhead) |
| SSTa | Sea Surface Temperature anomaly |
| SWE | Snow-Water Equivalent |
| SWFSC | Southwest Fisheries Science Center |
| UI | Bakun Upwelling Index |
| YOY | Young-of-the-Year |