



NMFS Science Center Report to the Pacific States Marine Fishery Commission

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> > Photo: Octavio Aburto









Outline:

- About us
- Physical Conditions
- Ecological Responses
- Forecasting Tools
- Human Dimensions
- Preparation for Change

rtist: Leslie Bel



What We Do

- Conduct scientific monitoring of marine ecosystems (distribution, abundance).
- Conduct research on biological and ecological processes (foraging habits, stock structure, movement patterns).
- Conduct conservation and fisheries economic studies.
- Provide information on impacts of climate variability and change.
- Develop technology (acoustics, optics, genetics).
- Serve ocean and biological data to the public.
- Provide science-based advice for management of living marine resources.
- Support our science mission's administrative and IT needs.













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Key Legislative Mandates

- Magnuson-Stevens Fishery Management Reauthorization Act (MSA)
- Marine Mammal Protection Act (MMPA)
- Endangered Species Act (ESA)
- International Agreements and Partnerships

Responsibilities:

- Maintain healthy fish stocks for commercial, recreational, and subsistence fishing.
- Conserve and recover populations of protected species.
- Sustain ecosystem services.
- Coordinate with domestic and international organizations to implement and monitor fishery agreements and treaties.





120+ MSA MANAGED SPECIES, 35+ ESA MANAGED SPECIES





SWFSC Mission



Generate the science necessary to manage and conserve the living marine resources of the California Current, the eastern tropical Pacific, and portions of the California watershed ecosystems, the N. Pacific, Pacific Islands, and Southern Ocean.





SWFSC by the Numbers: FY17

\$40 million 'base' funding\$11 million temporary funding

Staffing: FTEs: 178 Contractors and Cooperative Institute employees: 140 (approx.)





Faces of SWFSC

Over 300 federal, contractor, and Cooperative Institute employees, students, visiting scientists, and more...











































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NWFSC Mission

Our mission is to conduct the science necessary to conserve marine and anadromous species and their habitats off the Washington, Oregon, and northern California coasts and in the freshwater rivers of Washington, Oregon, and Idaho.

Our research provides reliable, relevant, and credible information to help decision-makers and natural resource managers build sustainable fisheries, recover endangered and threatened species, maintain healthy ecosystems, and protect human health.

We are also dedicated to enhancing public awareness, education, and stewardship of our marine resources.







NOAA Outside



Faces of NWFSC

Our federal employees, contractors, associates, interns, and volunteers work in six locations in WA and OR.







How We Do It

- Acoustic & net fish surveys
- Marine mammal & seabird surveys
- Oceanographic & meteorological sampling
- Habitat mapping
- Sampling technology development





California Current Integrated Ecosystem Assessment









Physical Conditions: Goodbye Blob and El Niño; Hello...?



Artist: Leslie Bell

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Five Years of Wild Environmental Conditions

- 2013-2015 were dominated by the marine heat wave named "the blob."
- 2015-2016 was a huge El Niño that had a modest impact on the California Current Large Marine Ecosystem.
- Winter 2016-2017 was dominated by a string of atmospheric rivers that ended the drought, produced record rainfall, and filled reservoirs.



Basin-scale Climate Indices Have Shifted

Oceanic Niño Index (ONI)

 Related to upwelling, coastal currents, storm tracks.



- Positive ONI = El Niño; Negative ONI = La Niña.
- Became strongly positive in 2015-2016.
- Shifted to neutral or slightly negative by late 2016 (weak La Niña in winter 2016-17, slightly positive ONI in summer 2017)



North Pacific Surface Temperature Anomalies





ONI, Pacific decadal oscillation (PDO) & North Pacific gyre oscillation (NPGO) Updated Through June 2017





Temp. at Depth

- Plots show temp.
 anomalies at depth off
 Newport (NH25) and San²⁵⁰
 Diego (CalCOFI 93.90).
- El Niño years: dotted lines.
- 2014-2015: "Blob" dominated at the surface (upper ~100 m).
- 2016: El Niño penetrated deeper but was short-lived, and had little impact in the North.





2006

2008

2010

2012

2014

2016

Snowpack:

Worst (2015) Average* (2016) Abundant (2017)

- 2015: Record poor snowwater equivalent in all freshwater ecoregions.
- 2016: Snow Water Equivalent (SWE) near long-term average coastwide.
- *Warm spring and summer in 2016 caused rapid melt.
- 2017: Average or better snowpack for most of the western U.S., especially parts of California.





Snowpack Rebound









Precipitation Departure from Average (in.) 10/1/2016 - 8/14/2017



NOAA Regional Climate Centers



Precipitation Rebound Was Due to Atmospheric Rivers

Atmospheric rivers are sinews of moisture from the tropics. The one pictured below appeared over the Northern Pacific on Jan. 3, 2017. (NOAA)



Overall Snowpack & Streamflow Over the Past 10 Years Have Been Discouraging for Salmon

- Streamflow anomaly time series through 2016, at the scale of Chinook salmon ESUs.
- Some ESUs are experiencing increasing magnitude of spring maximum flow events.
- *Many ESUs had worsening trends* for low-flow periods in summer & fall, esp. in CA.











Ecological Responses



NOAA biologists sort pelagic red crabs, which were unusually abundant off Central California in 2015-2016 (John Field, SWFSC).



Biological Response to Warm Oceans off WA/OR 2015 2016



Record low spring Chinook & steelhead returns to Columbia.





Crab and clam fisheries still closed.

Caspian terns abandon East Sand Island colony in mid-season.



Pyrosomes explode!



Marine Heat Wave + Massive HAB of 2015

The pre-operational C-HARM system provides a nowcast, 3-day forecast, and hindcast of *Pseudo-nitzschia* blooms, Particulate Domoic Acid, and Cellular Domoic Acid



NWFSC cruise, June-Sept 2015

Dungeness Crab Closure! Recreational and Commercial Harvests (Nov-May)

Santa Cruz Sentinel NEWS

* Sports* Business* Entertainment* Lifestyle* Opinion* Obituaries* Place

Home News

By Aaron Kinney akinney@bayareanewsgroup.con

California's crab-season delay claims Christmas





Why no toxic event in Southern California? TOO WARM!







Northern Copepod Biomass Anomaly off of Newport

• "Northern" copepods are cool-water, lipid-rich species.



 Northern copepods typically lag PDO shifts
 by ~6 months, so recovery from positive PDO conditions may not occur until well into 2017.



NWFSC Ocean Salmon Survey: Juvenile Salmon at Low Abundance in 2017



Research supported by:









Pyrosomes (*Pyrosoma atlanticum*)



'rc





Sardine Assessment Survey Models: Near-Realtime Habitat Maps Can Provide Adaptive Sampling (Predicted "Optimal Habitat")

 Northward shift/extension of sardine spring habitat, from 2011 to 2015 and 2016.

Sardine
 compression
 toward the
 northern edge of
 the habitat.





California Sea Lion Production: Poor in **Recent Years**

- 2015 pup count (born in June) was down; poor growth from fall 2015 to early 2016, leading to high stranding/mortality rates.
- This indicates poor foraging conditions for mothers in 2015 and early 2016.
- Similar findings for other pinniped colonies in this region.
- However, preliminary 2017 data indicate better abundance and growth for pups born in June 2016.



Photo: Sharon Melin, NOAA



Sea lion pup count, San Miguel Isl.







Forecasting Tools: EcoCast and JSCOPE

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Dynamic Ocean Management



EcoCast

- Fishing zones predicted based on oceanic features, catch potential, and weighted by bycatch risk.
- Estimated good fishing zones served via web and mobile devices.
- Models to include: target and bycatch species, risk weightings, seasonal forecasting.









JSCOPE: Seasonal Forecasts of Oceanography & Fish Distributions

- JISAO's <u>Seasonal Coastal Ocean Prediction of the Ecosystem</u>.
- Partnership between NOAA, the University of Washington, and regional members of IOOS.
- Model can make skilled forecasts of oceanographic conditions 6 to 9 months ahead.
 - Temperature, oxygen, chlorophyll, and ocean acidification.
 - These conditions can be associated with key fish and other species.
 - Siedlecki et al. 2016, Scientific Reports 6:27203.





JSCOPE: Seasonal Forecasts of Oceanography & Fish Distributions

• Based on the oceanographic forecasts, model can predict likelihood of presence/absence of sardines (Kaplan et al. 2016, *Fisheries Oceanography* 25:15-27).



• Next species to be forecast in JSCOPE will be:

AA FISHERIES

- Pacific hake distributions (NOAA FATE-funded project).
- Dungeness crab distributions and meat quality (NOAA MAPP-funded project, partnering with WDFW, ODFW, Quinault Tribe).







Human Dimensions



Fishermen repair a trawl net in San Francisco (Jeremy Notch, SWFSC).



Landings Through 2016

- Data from PacFIN (commercial) and RecFIN (recreational).
- Total landings had dropped in 2015, driven by hake, CPS, squid, crab.
- Mild rebound in 2016 total landings, driven by hake, crab.
- But many other fisheries were at fairly low levels (CPS, salmon, groundfish).

OAA FISHERIES



- In 2016, 71 separate cases of entangled whales were reported off West Coast, as well as in neighboring countries, with gear from U.S. fisheries. Highest annual total for the U.S. West Coast since NOAA Fisheries started keeping records in 1982.
- A multi-stakeholder group, including state and MMFS personnel, are working with the CA Dungeness Crab Fishing Gear Working Group to develop a Risk Assessment & Mitigation Program (RAMP) on whale entanglement.

2016 West Coast Whale Entanglement Summary

Geographic location of entanglements reported in 2016

- Reports originated from throughout the U.S. West Coast but were concentrated in central and southern California
- 73% (n=52) of reports originated from central California (Marin, Monterey, San Francisco, San Mateo, San Luis Obispo, and Sonoma counties)
- 42% (n=30) of reports were made from Monterey County
- 18% (n=13) of reports originated from southern California (Santa Barbara, Los Angeles, Orange, and San Diego counties)

Figure 1. Colored dots on the map show actual or estimated locations where whales were reported as entangled in 2016. It is important to note that the entanglement report locations may not reflect where the entanglement occurred. The dots are color-coded to show the species of whale reported as entangled.

Fishery type	Number of reports for 2016	Number of reports for 2015
Dungeness crab commercial trap fishery	22 (1 killer, 2 blue, 19 humpback)	11 (9 humpback, 1 killer, 1 gray)
Gillnet fisheries	2 (humpback)	5 (3 humpback, 2 gray)
Spot prawn trap fishery	3 (humpback)	0
Sablefish trap fishery	2 (humpback)	0
Dungeness crab recreational trap fishery	0	1 (humpback)
Spiny lobster fishery	0	1 (humpback)



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All Whale Entanglement Canada Reports 2016 United States of Americ Washingto Oregon Californi Species (n=71) Blue (n=4) Gray (n=3) Mexico Humpback (n=5i4) Killer (n=1) Unidentified (n=9

Other Activities

- Gear contact with seafloor has declined steadily on most shelf and slope habitat types.
- Largely due to decline in bottom trawling effort on the slope and shelf, especially north of Cape Mendocino.
- Shellfish aquaculture production on West Coast is at record level.
- Finfish aquaculture (= Atlantic salmon) also near historic high; comparable to commercial salmon landings.





Fishery Diversification

- Measures how evenly revenues are distributed across fisheries in which vessels participate.
- Diversification continues to decline across nearly all regions, vessel sizes, and revenue classes.
- Small upticks in 2015 due in part to some non-diverse vessels opting not to fish.
- This type of information could be valuable in anticipating how fleet dynamics change in response to climate or management.





Social Vulnerability in Fishery-Dependent Coastal Communities

- Composite indices of fishing dependence and social vulnerability for 880 coastal communities.
- Top five fishing-dependent communities from WA, OR, N CA, C CA, and S CA are shown here, *updated through 2015*.
- Gives relative idea of how changes in fishing might affect overall community wellbeing at different scales.









Preparation for Change: Ecosystem Approaches



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NMFS Climate Science Strategy: Implement the Tools to Successfully Manage in a Time of Change

Climate-Informed Reference Points

Robust Management Strategies

Adaptive Management Processes

Project Future Conditions

Understand Mechanisms of Change

Track Change and Provide Early Warnings

Build and Maintain Adequate Science Infrastructure

Each region was tasked with creating a Regional Action Plan that addressed the seven objectives stated in the NCSS document. The **Western Regional Action Plan (WRAP)** was developed jointly by NWFSC, SWFSC, and the West Coast Region. There are also a Gulf of Alaska RAP and a Bering Sea RAP.



Interdependent

Marine Ecosystems Are Integrated Socio-Ecological Systems





Relation to Ongoing Ecosystem-Related Activities & Context



Ecosystem Based Management

Ecosystem Based Fisheries Management



IEA Integrated Ecosystem Assessment



Questions?





NOAA Fisheries will be climate ready.

