2020 California Current Ecosystem Status Report

NOAA California Current IEA Team

Presented to the Pacific Fishery Management Council
March 5, 2020, Rohnert Park, CA
Summary

• Large-scale climate indices in 2019 were consistent with low productivity
  • Along the equator, weak El Niño conditions transitioned to neutral conditions in June 2019
  • Negative NPGO and neutral/positive PDO in 2019 indicate lower productivity
  • A new large marine heatwave emerged in May, reached a maximum in October and lasted through December

• Regional climate and oceanography indicators were mixed
  • Surface and subsurface temperatures generally above average
  • Upwelling was average to above average, but upwelling habitat was compressed
  • Snowpack in 2019 was below average in north, generally above average elsewhere
• Many ecological indicators were average or above average
  • Lipid-rich copepods off Newport
  • Highly abundant anchovy off CA
  • Average densities of juvenile salmon off OR & WA
  • Above-average abundance and growth of CA sea lion pups

• Signs of concern in the central California Current
  • Poor catches of krill, high densities of pyrosomes (warm-water tunicates)
  • Poor production of several seabird species off central and northern California
  • Poor outlook for naturally produced fall Chinook salmon returns to Central Valley

• Fisheries landings and revenue dipped in 2018, and probably again in 2019*
Physical Conditions

Warm, weak circulation, and a short but significant marine heatwave
Basin-scale climate indices consistent with poor productivity

Oceanic Niño Index (ONI)

Positive ONI = El Niño conditions
Negative ONI = La Niña conditions

- Strong El Niño, 2015-2016
- Variable since then
- Weak El Niño from Sept 2018 to June 2019
- ONI is neutral at present
- 50% chance of neutral conditions persisting through Summer 2020

Monthly ONI through January, 2020

Basin-scale climate indices consistent with poor productivity

North Pacific Gyre Oscillation (NPGO)

Positive NPGO = stronger circulation, higher productivity in CCE
Negative NPGO = weaker circulation, lower productivity in CCE

- Varied between negative and neutral from 2015-2017
- Strongly negative in 2018-2019
Basin-scale climate indices consistent with poor productivity

Pacific Decadal Oscillation (PDO)

Positive PDO = warm, lower productivity in CCE
Negative PDO = cool, greater productivity in CCE

- Strongly positive from 2014-2016
- Returned to neutral in July 2016
- Neutral in most of 2019
  - But, positive in April-June
Sea surface temperatures were above average

- **2019 SST** was warm in both winter and summer in the California Current
  - And in most of the NE Pacific

- **Summer-fall:** a marine heatwave similar in size and intensity to “Blob”

- NE Pacific warmer than average over last 5 years
- Cooling trend in winter, mixed trend in summer
2019 large marine heatwave

- Mapped using criteria IEA team members developed
- **2019 event: lasted from May to December, reached coast July-September, then weakened:**

  ![Maps showing 2019 event](image)

- **Compare to similar period of evolution of the Blob:**

  ![Maps showing Blob](image)

Blob, 2014-2015:
Subsurface temperatures warm for much of 2019

- Temperature anomalies at depth off Newport, OR & San Diego
- Last 5 years: surface warming events and stored heat at depth

- Newport: extreme warming in upper 25 m, summer/fall
- Warmer than average in all of water column
- San Diego: extreme warming in upper 50 m, winter/spring
- Warmer than average at greater depths for first half of year, then cool except at surface
Upwelling of water and nitrate

Coastal Upwelling Transport Index (CUTI): vertical water flux

Biologically Effective Upwelling Transport Index (BEUTI): vertical nitrate flux

- **North**: average/above average in spring 2019, average/below average in summer
- **Central and South**: average/below average in spring 2019, above average in summer
- Nitrate flux greatest by far in central region
Coastal “habitat compression” between 35-40°N

- The upwelling zone is not fixed in space, time or area; it’s influenced by regional and basin-scale drivers
- When upwelling habitat is “compressed” along coast, ecological interactions can intensify (Santora et al. 2020)

- Starting with “Blob” in 2014, Habitat Compression Index declined
- Decline = greater habitat compression
- These levels of compression are not unprecedented, but large onshore-offshore temperature gradient is
- Impacts like whale entanglement are driven by a suite of factors
  - Compression, onshore/offshore temp gradient, prey fields, HAB, delay in fishery opening, whale population, etc.
Dissolved oxygen: low in north, average in south

Hypoxia threshold: below 1.4 ml O₂ / L

- **DO values off Newport were hypoxic in summer 2019**
- **Extensive hypoxia on shelf in late summer (yellow/orange/red on map)**

Benthic DO maps from NWFSC groundfish trawl survey, late summer 2015-2019 (P. Frey, NOAA)
Dissolved oxygen: low in north, average in south

Hypoxia threshold: below 1.4 ml O₂ / L

- DO values off Newport were hypoxic in summer 2019
- Extensive hypoxia on shelf in late summer (yellow/orange/red on map)

- DO off San Diego was fairly typical of the past 20 years, and above the hypoxia threshold
- Typical DO throughout CalCOFI region as well

Benthic DO maps from NWFSC groundfish trawl survey, late summer 2015-2019 (P. Frey, NOAA)

500 m / benthic DO map for 2019 from the CalCOFI region
Snow Water Equivalent in 2019: below average in north, well above average in central & south

- This regional SWE pattern was generally reflected in stream flows in 2019
Snowpack as of March 1, 2020

- **California**: below the median (1981-2010)
- **Oregon, Washington and Idaho**: mixed

- Official 2020 measure will be made on April 1\textsuperscript{st}
  - Approximate date of maximum snow accumulation
  - Much can change between now and then

- Nat’l Weather Service Drought Outlook for Feb-May
  - Drought expected to persist or develop anew in much of region:
    - Central Washington
    - Western/central Oregon
    - Central Idaho
    - Most of California
J-SCOPE model system forecasts physical and biological conditions off WA, OR from Jan-Sept each year

2020 forecast:
- Average temperatures; warmer-than-average SST by July/August
- Bottom hypoxia (dark purple) widespread and intense by June throughout the region (earlier than normal)
- High uncertainty for hypoxia forecast

Benthic dissolved oxygen forecast, 2020

courtesy Dr. Samantha Siedlecki, University of Connecticut
J-SCOPE model system forecasts physical and biological conditions off WA, OR from Jan-Sept each year

2020 forecast:

- Average temperatures; warmer-than-average SST by July/August
- Bottom hypoxia (dark purple) widespread and intense by June throughout the region (earlier than normal)
- High uncertainty for hypoxia forecast
- Aragonite along bottom becomes undersaturated (corrosive) throughout region by late spring

Benthic aragonite saturation forecast, 2020

courtesy Dr. Samantha Siedlecki, University of Connecticut
Ecological responses in 2019, Part 1

Average or above-average in the north and the south
Copepods off Newport: productive in 2019

- Energy-rich northern copepods were above average in the spring/summer of 2019
- They’ve been increasing overall since very low biomasses of 2014-2016
- Energy-poor southern copepods were average to below-average in 2019
Forage community in Central region: anchovy are dominant

Vertical lines = temporal breaks; horizontal lines = co-occurring forage groups

Abundance is color coded from dark blue (very rare) to dark red (abundant)

- **Community since 2018 defined by very abundant anchovy**
- **Juvenile groundfish have declined steeply relative to previous community regime**
- **Larval anchovy also major component of 2019 forage in Southern Cal Bight**
Several CPS stocks appear to be increasing

- **Acoustic-trawl estimates of CPS finfish biomass increased in 2018 & 2019:**
  - Anchovy in central and southern California
  - Jack mackerel in northern California and Oregon
  - Herring in Washington

- From Stierhoff et al. 2020, NOAA Tech Memo
Juvenile salmon catches off WA, OR were average

- **2019**: catches of juvenile Chinook and coho were at the long-term means
- This continues the rebound from the very low catches in 2017
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### “Stoplight” table for salmon returns to WA/OR in 2020: a mixed bag

Chinook counts at Bonneville Dam, coho returns to Oregon coast streams

<table>
<thead>
<tr>
<th>Scale of indicators</th>
<th>Smolt year 2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>Adult return outlook</th>
<th>Coho, 2020</th>
<th>Chinook, 2020</th>
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<tbody>
<tr>
<td>Basin-scale</td>
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<tr>
<td>PDO (May-Sept)</td>
<td>◆</td>
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<td>★</td>
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<td>ONI (Jan-Jun)</td>
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<td>Local and regional</td>
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<td>SST anomalies</td>
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<td>Deep water temp</td>
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<tr>
<td>Deep water salinity</td>
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<td>Copepod biodiversity</td>
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<td>★</td>
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<tr>
<td>Northern copepod anomaly</td>
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<td>Biological spring transition</td>
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<td>Winter ichthyoplankton biomass</td>
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<td>★</td>
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<tr>
<td>Juvenile Chinook catch (Jun)</td>
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<tr>
<td>Juvenile coho catch (Jun)</td>
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</tbody>
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- **Indicators of conditions for last 4 smolt years in the northern CCE**
- **Color = rank of all years**
  - Green: top third
  - Yellow: middle third
  - Red: bottom third
- **Consistent with average returns of Chinook to Columbia Basin**
- **Below-average returns of coho to OR coast**

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Sea lion pups indicate good feeding conditions

San Miguel California sea lion colony (arrow on map)

Maternal feeding grounds in southern and central California (rectangle on map)

- **2018 cohort:** high pup count and above-normal winter growth
- **Good feeding conditions for gestating mothers,** October ’17-June ‘18
- **Good feeding conditions for nursing mothers,** June ‘18-February ‘19
- Maternal diets: anchovy, mackerels, squid, hake, sardine
- **Preliminary info on 2019 cohort:** above-average pup count; among the highest growth ever observed
Groundfish assessment outputs: news is generally good

- This plot includes updates for multiple species in 2019
- **No assessed stocks are “overfished”**
  - Cowcod rebuilt, yelloweye not yet
- **Rougheye rockfish just above “overfishing” proxy**
  - Black and China rockfish now below overfishing proxy
  - Greenstriped in report is an error!
Ecological responses in 2019, Part 2

Signs of concern off central and northern California
Krill off California: fewer and smaller

Krill catches in 2019 off Monterey Bay were near the lowest of the time series

Krill lengths were below average in 2019

A change after several years of improvement
Krill off Oregon: relatively low CPUE

- Some evidence that krill were present, but deeper than normal
Seabirds struggled off central & northern CA

- Poor fledgling production for several species at SE Farallon and other colonies
- Despite abundant anchovies in diets
- Wreck of common murres in northern CA
New “stoplight” for naturally produced Central Valley fall Chinook: consistent with poor returns in 2020

- Naturally produced fish only, not hatchery
- Links ecosystem drivers to key stages in a life cycle model for Sacramento/San Joaquin fall Chinook (Friedman et al. 2019)
- **Conditions unfavorable for dominant year class (2017) that will return in 2020**

<table>
<thead>
<tr>
<th>Natural spawning escapement (year t)</th>
<th>Egg incubation temperature (Oct-Dec, year t)</th>
<th>Median flow (Feb, year t+1)</th>
<th>Seabird marine predation index (year t+1)</th>
<th>Chinook age in fall 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016: 56,000 (low)</td>
<td>11.8C (poor)</td>
<td>48,200 (very high)</td>
<td>Near average</td>
<td>4</td>
</tr>
<tr>
<td>2017: 18,000 (very low)</td>
<td>11.8C (poor)</td>
<td>5,525 (very low)</td>
<td>Near average</td>
<td>3</td>
</tr>
<tr>
<td>2018: 72,000 (low)</td>
<td>11.7C (poor)</td>
<td>21,700 (high)</td>
<td>Near average</td>
<td>2</td>
</tr>
</tbody>
</table>
Pyrosomes shifted south

*Pyrosoma atlanticum*: a warm-water pelagic tunicate

- From 2014-2017, pyrosome numbers increased, became more widespread
- Greatest densities in 2016-2018 were off WA/OR
- In 2019, pyrosomes were basically absent from WA/OR
- Greatest density (★) was between SF Bay and Pt Conception
Whale entanglements remain a problem

- Whale entanglements in fishing gear were above average in 2019, though down from 2015-2018
  - May reflect precautionary management actions
- Confirmed reports were widely distributed, although most were from California
- Most entanglements: humpbacks
- Most gear: unidentified
  - ID’d gear: commercial Dungeness crab, recreational Dungeness crab, commercial Rock crab, and gillnet

*2019 data are preliminary
courtesy Mr. Dan Lawson, NMFS West Coast Region
Harmful algal blooms

Domoic acid: toxin produced by *Pseudo-nitzschia* diatom (causes paralytic shellfish poisoning)

- **WA**: Domoic acid below thresholds for razor clams, Dungeness crabs in 2019
- **OR and Northern CA**: Razor clams and Dungeness crabs well above safety thresholds for much of 2019
  - Fishery closures and delays
- **Central CA**: Dungeness crabs above safety thresholds in some areas
  - But, did not contribute to fishery delays
- **Southern CA**: no 2019 closures for rock crabs or spiny lobster (not shown)
  - But rock crab closed in much of N CA
Human activities and wellbeing
Landings through 2019*

- Landings & revenues decreased from 2017 to 2018
- In the briefing book
- 8% decrease in landings, 7% decrease in revenue relative to 2017

*Preliminary data for 2019: landings appeared to decrease further
- due to possible drops in squid, crab, salmon
- Hake similar to 2018
- **Shaded groups**: probably still underreported
Diversity of vessel revenues still low as of 2018

- Index of how broadly and evenly revenue is spread across different fisheries
  - Lowest score is 1 = all revenue from a single fishery
- Diversification remains historically low across all classifications of West Coast vessels
  - Size, state, total revenue
  - Little change from 2017 to 2018
This is a preliminary new metric for our report; possibly related to consolidation, NS-8

% of total revenue for 16 ports most commonly in the top ranks for landed revenue since 1981

**Long-term increases:** Westport, Newport

**Long-term decreases:** Bellingham, Crescent City, Fort Bragg, San Pedro, Terminal Island

Others: stable or variable trends
Seafloor contact by federal bottom trawl gear in 2018

- **Above-average and increasing activity in patches off central WA, central and northern OR, north of Cape Mendocino**

- We will follow these patterns as trawl fishery regs change, and as wind power discussions continue.

*a anomalies relative to 2002-2018 averages*
Conclusions
Conclusions

• Throughout most of 2019, water temperatures were warmer than normal at the surface and at depth in much of the system
  • It is too early to attribute impacts to the marine heatwave that occurred in summer / fall
  • The system has a lot of stored heat, so we will be monitoring for heatwave reemergence

• Despite relatively warm waters, anchovy abundance is very high, and is benefiting some but not all predators

• Ecological indicators were largely average/above average in much of the north and south, but there were average/below average signals in the central CCE
  • Krill, naturally produced salmon, seabirds, pyrosomes, whale entanglement
Thank you

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