*Changes in species distribution*

* 1. Anomalous occurrences of tropical species reported farther north
  2. Ocean warming alters whale migration routes and feeding grounds
     1. Secondary effects:
        1. Increased whale entanglement and mortality in commercial trap fisheries
        2. Dungeness seasons shortened to reduce overlap with whales
        3. CDFW establishment of ‘whale-safe fisheries’ (<https://www.wildlife.ca.gov/Conservation/Marine/Whale-Safe-Fisheries>)
  3. Ocean warming shifts HMS migration and feeding grounds, leading to significantly enhanced recreational offshore fishing opportunities in the Southern California Bight
  4. Changes in CPS spawning grounds
  5. Grunion (Karen Martin’s 2019 paper)
  6. California market squid fishery moved north to Monterey and San Francisco

<https://www.wildlife.ca.gov/Conservation/Marine/Pelagic/Market-Squid-Landing>

* + 1. Secondary effects: Led to underutilized quota because no landings infrastructure exists in NorCal

*Changes in species production*

1. Ocean warming and reduced upwelling causes mass kelp forest die-off
   * 1. Secondary effects
        1. led to red abalone starvation, mass mortality, subsequent fishery closure, and expansion of urchin barrens
        2. Impacts on red urchin populations (GSI, affecting marketability in fishery)
2. Ocean warming produced increases in HABs

<https://www.psmfc.org/wp-content/uploads/2018/08/psmfc_annualreport_2017_web_single.pdf>

“A significant HAB event was detected in 2015. Scientists were able to track its extent from the Channel Islands in California to Alaska. There appears to be a nexus between the HAB occurrences and ocean acidification and warming ocean trends. The HABs are suspected of contributing to Unusual Mortality Events (die-off of 30 large whales in the Western Gulf of Alaska; sea lion strandings in California); lethal levels of toxins (10 to 30 times higher in Monterey Bay, California); shellfish closures (Puget Sound and Northern California razor clams; West Coast Dungeness crab); and fishery closures (anchovy and sardines in California). NOAA is still calculating the economic impacts of these closures.”

* + 1. Secondary effects
       1. multiple closures in CA spiny lobster at the Northern Channel Islands, and Dungeness Crab closures along the CA and OR coast
       2. Federal disaster relief funds declared for commercial Dungeness fishery
       3. Sea bird and marine mammal mortality statewide

1. Invertebrate disease outbreaks (sea star wasting disease)
2. Pacific Sand Lance population decline/degradation
   * 1. Had cascading effects for Pacific Cod fisheries, salmon, etc.
3. Salmon and negotiating with wineries over water (Jameal)…..also virtually all salmon stocks were considered highly vulnerable in the NOAA CVA
4. NOAA declared “unusual mortality event” in 2019 for gray whales on west coast

<https://www.fisheries.noaa.gov/national/marine-life-distress/2019-gray-whale-unusual-mortality-event-along-west-coast>

**“LSIESP researchers monitoring the gray whales in Laguna San Ignacio and Bahía Magdalena, Baja California Sur, Mexico** detected indications an impending UME as early as last year (2018) and again in 2019. LSIESP long-term monitoring and research program allows the detection of departures from the “normal” abundance and mortality trends for gray whales in their winter Baja breeding lagoons. Specifically, they documented declining calf counts, increasing percentages of “skinny” and “emaciated” whales, and the late arrival of the whales to the Baja lagoons.” <https://www.sanignaciograywhales.org/unusual-mortality-event-ume-determined-for-nep-gray-whales/>

1. BOOK: Calderon-Aguilera, L. E. (2018). Fisheries: Interaction with—or Exploitation of—Nature?. In *Widening the Scope of Environmental Policies in North America* (pp. 111-127). Palgrave Macmillan, Cham. “….mass stranding of the brown Booby (Sula leucogaster), the Tristram’s storm petrel (Oceanodroma tristrami), and the Guadalupe fur seal (Arctocephalus townsendi). There were also shifts in the distribution of many tropical species—farther north than ever—and in the abundance of pollock, tuna, and krill stocks, while repeating unusual records for other species were identified (Cavole et al. [2016](https://link.springer.com/chapter/10.1007%2F978-3-319-56236-0_7#CR6)).”
2. Ocean warming produced mass west coast CPS recruitment failure (primarily Pacific sardine)
   * 1. Secondary effects
        1. Closure of west coast CPS fishery
        2. Mass starvation and mortality events of California sea lions
        3. Brown pelican reproductive failure

*Fisheries Impacted/Closed*

* 1. Pacific Sardine (closed)
  2. Red abalone (closed)
  3. Dungeness Crab (spatial closures, seasons impacted, Federal Disaster approved)
  4. CA Spiny Lobster (spatial closures, seasons impacted)
  5. Salmon (multiple species, fisheries, seasonal changes/closures, CA to AK)
     1. <https://cdfgnews.wordpress.com/2014/01/29/cdfw-puts-closures-in-effect-on-some-rivers-recommends-further-changes-to-the-fish-and-game-commission/>
     2. “New evidence supports previous observations of negative effects of climate change on salmon in all life stages.” (Crozier 2015)
  6. Red Urchin (Federal Disaster request pending)
  7. Razor Clam (closed, Oregon: Cape Blanco to CA border)
  8. Shellfish (closed, Washington: clams, geoduck, scallops, mussels, oysters, snails and other invertebrates (not crab or shrimp))
  9. Aquaculture growing area closures (Washington shellfish)