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## R Markdown

The Pacific Fishery Management Council (PFMC) is responsible for the CPS species management through a Fisheries Management Plan (FMP). Before 2000, the only fishery under a FMP was the fishery for Northern anchovy (*Engraulis mordax*). The Northern anchovy FMP started to be developed in 1977, and the final draft was approved and implemented in 1978 [@CPSFMP2021]. During these times, and for many years, the Northern anchovy was harvested for reduction. This fleet was referred to as the *wetfish* fleet, and also fished for other CPS such as Pacific sardine(*Sardinops sagax*), market squid (*Doryteuthis opalescens*), Pacific mackerel (*Scomber japonicus*), Jack mackerel (*Trachurus symmetricus*), Pacific bonito (*Sarda lineolata*), and Pacific bluefin tuna (*Thunnus orientalis*) [@SAFE2020]. In March 1995, the PFMC decided to expand the FMP through Amendment 8 to include the entire CPS complex (Pacific sardine, northern anchovy, Pacific (chub) mackerel, jack mackerel, and market squid) along the U.S. west coast. The PFMC partially approved this amendment in June 1999, and they published the final regulations in December 1999. Finally, the PFMC implemented the FMP on January 1st, 2000.

In recent years, there is no reduction capacity for the Northern anchovy fishery in California, and it is principally harvested in the Monterrey area as a substitute for sardine and squid when both are not available [@SAFE2020]. The Northern anchovy fishery has lost its importance within the CPS complex after the decline of the reduction market. However, in some particular ports like Monterrey, it is the only species that fishers can harvest when market squid is unavailable and the Pacific sardine fishery is closed [@SAFE2020]. In Oregon, the Northern anchovy fishery was categorized as “developmental fishery” between 1995 and 2009. Only 4 of the 15 developmental permits were issued for this fishery. The developmental program was suspended in 2009, as there were no funds to support it [@SAFE2020]. The Oregon Northern anchovy fishery is currently under an open-access regime but limited by gear [@SAFE2020]. A significant fishery started to grow in 2015 and 2016, but no landings was observed in Oregon during the year 2018. In Washington, the Northern anchovy fishery is restricted from developing to a high-volume fishery to protect the traditional bait fishery. Some of these regulations limit catch and limit the catch percentage allocated to reduction.

In the 60s, the Pacific sardine fishery in California closed due to the fishery’s collapse. The fishery reopened in 1986 with a precautionary quota of 906 metric tons. The Pacific sardine fishery was considered as fully recovered in 1998 with an estimated biomass of over one million metric tons [@SAFE2020]. Since 2000, after implementing the CPS FMP, the Pacific sardine has been managed under a limited entry (LE) permit with a quota management system, or Harvest Guideline (HG), that controls commercial catch of sardine biomass. If harvests are over the HG, then the commercial fishery is closed for the rest of the season. Permits are transferable and cumulative, but they are required to match the vessel tonnage, and it is uncommon to see vessels and permits sold separately. LE permits are only required if a vessel lands more than 5 tons of all CPS finfish combined in a trip. The CPS LE fleet is composed of 65 permits and 55 vessels. The LE permits program is federal but only applies south of Point Arena, California (39°N). This geographical point divides the coast into two areas which were used to allocate the total HG for the Pacific sardine during a season (changed from 35°40’N to 39°N in 2003). In 2005, the quota allocation for Pacific sardine was modified from area-based to coast-wide seasonal release that follows an allocation formula:

1. 35% of the HG to be allocated coastwide on January 1st.
2. 40% of the HG, plus any portion not harvested from the initial allocation, will be reallocated coastwide on July 1st.
3. 25% of the HG, plus any portion not harvested from earlier allocations, will be reallocated coastwide on September 15th.

The commercial fishery has been closed for the whole U.S. west coast since 2015 as the spawning stock biomass (SSB) is estimated to be below the cutoff point of 150,000 metric tons. This total closure came after many years of seasonal closures.

North of 39°N, vessels do not require federal permits. However, Oregon and Washington have implemented state permits for sardine. In Oregon and Washington, the fishery did not develop until the 2000s. In 1999, a fishery for the Pacific sardine started to operate in both states targeting larger sardines to be sold as bait to Asian longline tuna fisheries [@SAFE2020]. Then, in 2006 the fishery expanded in both states to supply the market for human consumption. In Oregon, the Pacific sardine fishery was categorized as a “developmental fishery” until 2005, and the first LE permits were issued in this state in 2006, capped at 26 (currently, there are 24 LE permits for this fishery in Oregon). In Washington, the Pacific sardine fishery was a “trial fishery” from 2000-2002 with a state HG of 15,000 metric tons (i.e., no limits on the number of participants). Later, from 2003 to 2009, the fishery was under an “experimental fishery” category, with experimental permits capped at 25. Finally, in 2009, Washington’s Pacific sardine fishery was designated as a “commercial fishery” with a LE program that allocated 16 permanent permits and ten temporary ones. In Washington, fishing for sardine is prohibited from January 1st to March 31st, and directed commercial harvest is prohibited within state waters (0 to 3 miles).

The market squid fishery was unregulated and open access until permits became required in California in 1998. However, there were no limits to the number of permits issued by the authorities. In 2001, a HG was implemented at 125,000 U.S. tons for this fishery. Later, in 2005, the California Fish and Game Commission (CFGC) implemented the Market Squid Fisheries Management Plan, which reduced the fleet to a maximum of 73 vessels, limits the number of light boats to 34, reduced the HG to 118,000 U.S. tons and incorporated a weekend closure to allow for a period of uninterrupted spawning [@SAFE2020].[[1]](#footnote-20) Oregon’s market squid fishery started in 2014 with few vessels targeting squid (15 in 2016 and 11 in 2018), while in Washington, there are no directed landings of market squid. In 2019 two permits were issued to allow market squid catch from Oregon to be delivered to Washington ports.

Pacific sardine fishing season in California has a peak in landings during the early summer to fall in the Monterrey area, specifically in Moss Landing, while in Southern California, specifically in San Pedro and Terminal Island, peak landings occur during the winter. Fishing seasons for Pacific sardine are shown in Panel (a) of Figure . In Oregon and Washington state, specifically at Astoria and Ilwaco/Chinook ports, the fishing season is primarily during summer and early fall. Panel (b) shows that market squid fishing season in Southern California, specifically in San Pedro, Terminal Island, and Ventura, goes from fall to winter, while in Northern California, specifically in Moss Landing and Monterrey, the season goes from late spring to summer.

1. Vessel permits allow vessels to attract squid with light and use purse seine for harvest, Brail permits allow vessels to attract squid with light and use brail gear, and light boat permits only allows to attract squid with lights [↑](#footnote-ref-20)