Agenda Item C.1.a
Attachment 1
September 2014

PRELIMINARY DRAFT

ENVIRONMENTAL ASSESSMENT

INCORPORATING THE USE OF A NEW TEMPERATURE INDEX INTO THE CALCULATION OF THE PACIFIC SARDINE HARVEST GUIDELINE FORMULA

REGULATORY IDENTIFIER NUMBER _______

PREPARED BY
THE PACIFIC FISHERY MANAGEMENT COUNCIL
AND
NATIONAL MARINE FISHERIES SERVICE

AUGUST 21, 2014

1.0 INTRODUCTION

1.1 DOCUMENT ORGANIZATION

1.2 PURPOSE AND NEED

The harvest control rules for Pacific sardine include a sea surface temperature (SST) parameter measured off the Scripps Institution of Oceanography (SIO) pier. Recent research indicates that the California Cooperative Oceanic Fisheries Investigations (CalCOFI) temperature index is now a better indicator of California Bight SST and a better predictor of Pacific sardine recruitment and productivity. The purpose of this action is to change the temperature index from SIO to CalCOFI for purposes of calculating the FRACTION component of the Pacific Sardine harvest guideline (HG), while maintaining consistency with the Council's harvest policy approach. This includes the potential for revising the percent bounds currently in place for the FRACTION parameter.

The need for this action is to use the best temperature index in the temperature-productivity relationship in the HG control rule. This action considers improved temperature data and incorporates it into the Pacific sardine harvest control rule.

1.3 PLAN DEVELOPMENT SCHEDULE AND ADVISORY BODY PARTICIPATION

1.4 RELATED DOCUMENTS INCORPORATED BY REFERENCE

This section will incorporate by reference the Hurtado Fmsy analysis, Harvest Parameters Workshop report, and the Coastal Pelagic Species (CPS) Fishery Management Plan (FMP).

2.0 DESCRIPTION OF ALTERNATIVES

Harvest Control Rule Framework

To effectively evaluate the options presented below it is important to recognize the interplay between the set of Pacific sardine harvest control rules (HCRs) under current policy. Prior to Amendment 13, the Harvest Guideline (HG) was the only control rule and it described the overfishing limit, annual harvest policy, and the annual catch limit. To more explicitly define what levels would be considered overfishing, Amendment 13 adopted Overfishing Limit (OFL) and Acceptable Biological Catch (ABC) as additional harvest control rules. The formulas for the three HCRs are displayed below.

Harvest Control Rule (HCR) Formulas
OFL = BIOMASS * E_{MSY} * DISTRIBUTION
$\text{ABC}_{\text{P-star}}$ = BIOMASS * $\text{BUFFER}_{\text{P-star}}$ * E_{MSY} * DISTRIBUTION
HG = (BIOMASS - CUTOFF) * FRACTION * DISTRIBUTION

All three control rules incorporate E_{MSY}, an estimate of the exploitation rate at maximum sustainable yield. E_{MSY} is dependent upon sea surface temperature (SST) and serves as a proxy for the influence of environmental conditions on stock biomass, so that harvest levels (rates) are adjusted in relation to different conditions. For the OFL and ABC control rules, E_{MSY} is bounded from 0 to 25%. The upper bound of 25% corresponds to the upper quartile of observed temperatures.

In the HG control rule, FRACTION specifies how much of the stock is available to the fishery when biomass exceeds the CUTOFF value set at 150,000 mt. FRACTION is equal to E_{MSY} except it is bounded, currently 5-15%, as a matter of policy to limit the portion of stock available to the fishery depending on environmental conditions (Figure 1).

Analyses conducted during the Amendment 13 scoping process showed that although the HG control rule generally produced harvest levels far lower than necessary to prevent overfishing and protect the stock, there were times when the output of the ABC control rule fell below the HG at some P* (probability of overfishing) values during regimes with lower SSTs. This outcome is in part due to fixing the lower bound for FRACTION in the HG rule. Amendment 13 implemented a control rule policy that specifies the lower of the two be used for annual management. The result was that sardine management post-Amendment 13 became more precautionary, particularly in cooler and low biomass conditions.

The general implementation of this policy in setting maximum allowable catch is demonstrated in Figure 2. Under most SSTs, the HG is the lowest of the HCRs and represents the maximum allowable harvest. As SSTs become relatively cold, the HG and ABC lines converge, and the ABC HCR (illustrated here buffered at P*= 40) produces increasingly lower catch allowances and overrides the HG for annual management. In this example, when biomass (1+) is 500,000 mt, the

HG exceeds OFL and ABC (for P*40) at all temperatures below 14.8 degrees[1]. At these temperatures, the ABC (for P*40) is lowest and therefore sets the maximum harvest allowed. The results are similar for larger biomasses and other values of P*.

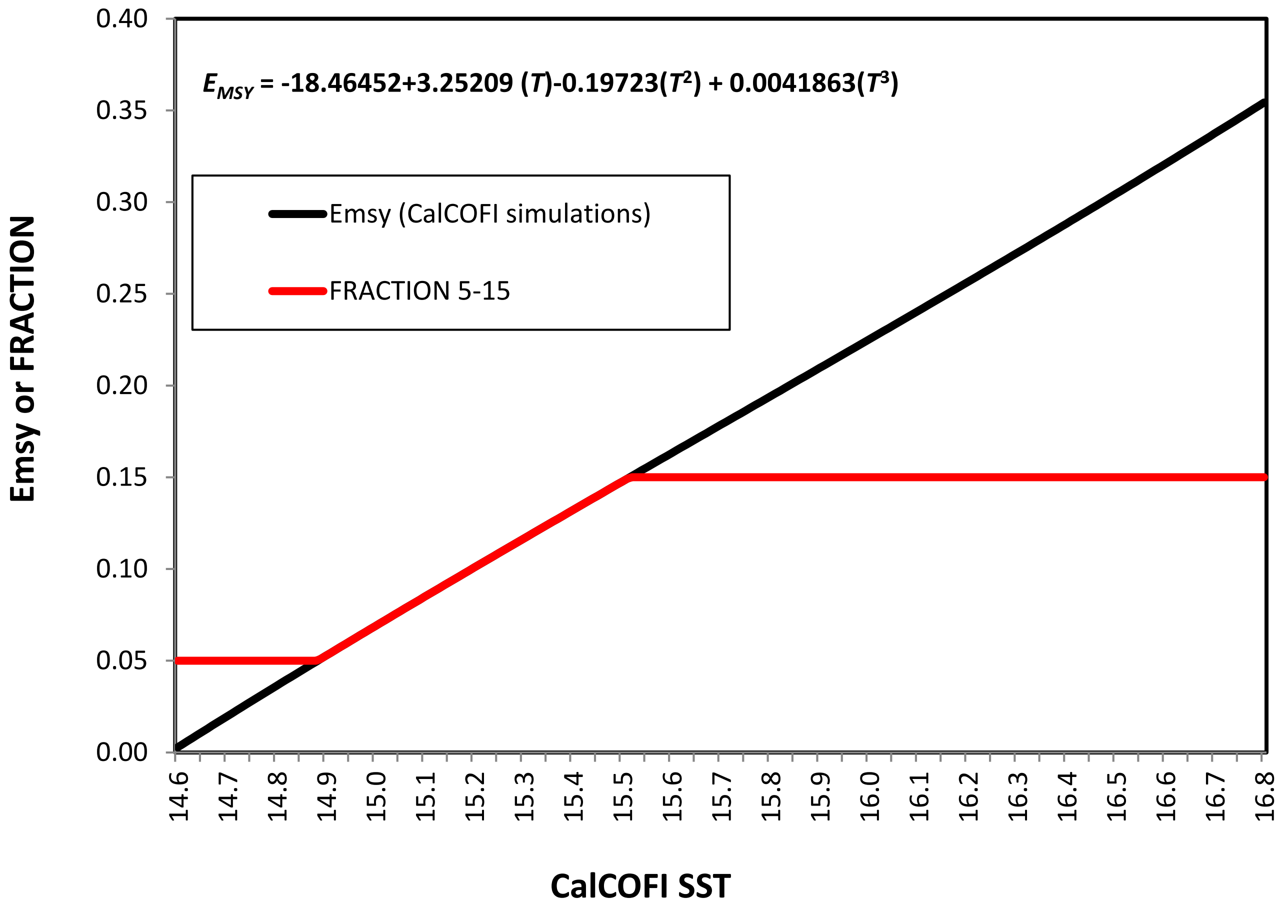

Figure 1. CalCOFI SST and Emsy, FRACTION bounded at 5-15%.

[1] Temperatures below 14.8 degrees have not been observed in the CalCOFI index since 1984 although the recent year trend has been towards cooler temperatures. The recent five year average was 15.4; the lowest recorded temperature was 14.9 in 2002.

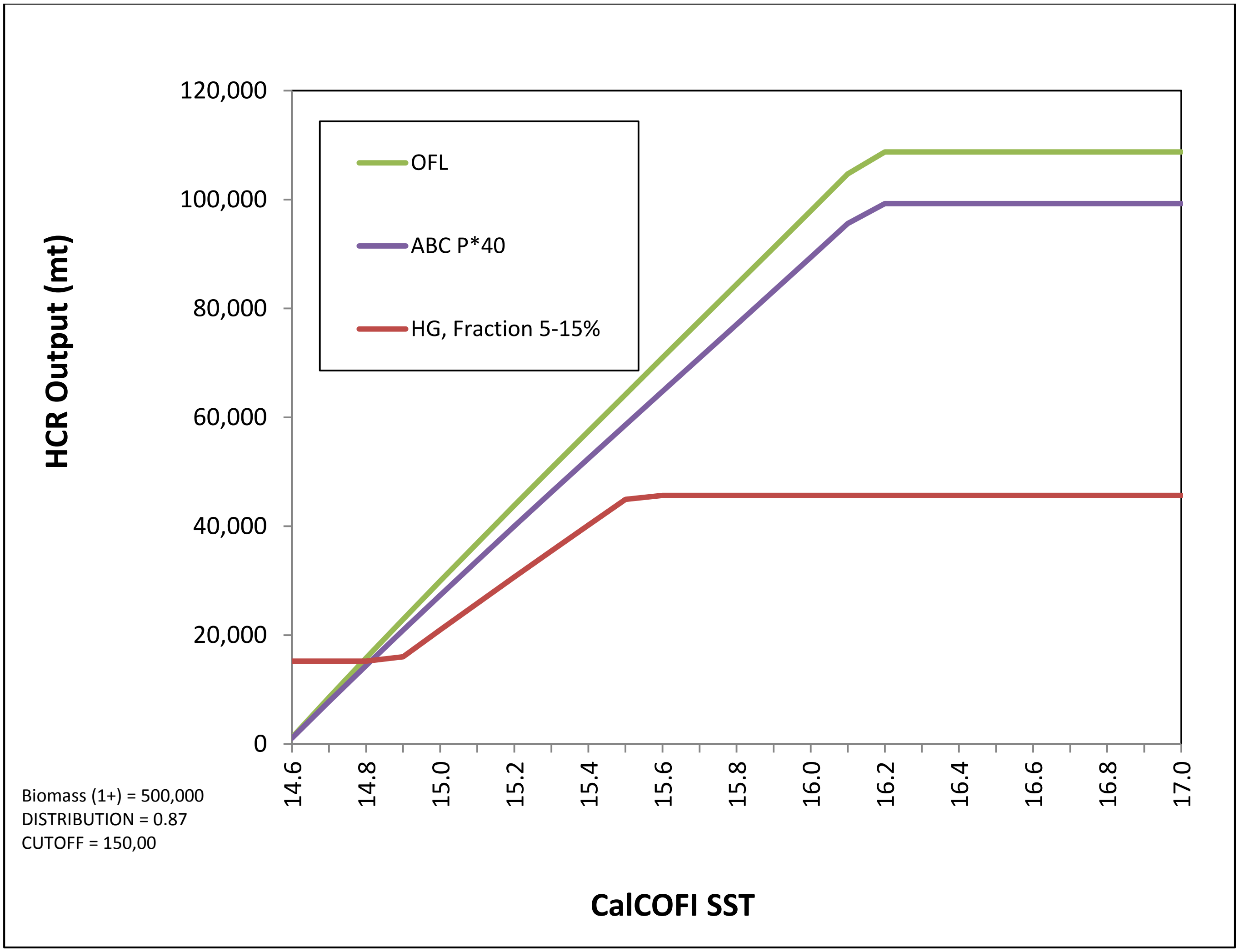

Figure 2. Illustration of the harvest control outputs: OFL, ABC P*40 with HG bounded at 5-15%. By policy annual management follows the lowest HCR.

There are several choices for incorporating an environmental co-variate into harvest policy for Pacific sardine. A hierarchy of decision points is represented in the alternatives below. The first decision point is whether to use Scripps Institution of Oceanography (SIO) (Alternative 1 or No Action) or California Cooperative Oceanic Fisheries Investigations (CalCOFI) as the temperature index (Alternatives 2 and 3). Secondarily, Alternative 2 and the sub-alternatives under Alternative 3 present a range of choices for establishing the FRACTION bounds in the HG.

At the March 2014 Council meeting the CPSMT presented information on the effects of the new index and the revised productivity relationship with environment on the performance of sardine management harvest control rules (HCR). The focus of this evaluation was on whether changing the temperature index that informs FRACTION would maintain or deviate from established policy for sardine management. Based on the information available and this evaluation, the CPSMT concluded that a HCR change to the CalCOFI index did impact current policy and that changing

FRACTION to range of 10-20 provided a better representation of the SST data and new knowledge of stock productivity. This option attempted to preserve current policy by permitting harvest rates to take more advantage of periods when biomass and productivity are higher, while still restricting harvest when biomass and productivity are depressed.

To ensure the analysis of transitioning to CalCOFI and the new Emsy relationship were fully captured, in particular when compared to what was previously in place as well as variations on the lower bound of FRACTION, the Council requested the Coastal Pelagic Species Management Team (CPSMT) also examine FRACTION bounds of 0-20 and 5-20. Those alternatives, along with the general decision points of transitioning from SIO to CalCOFI are presented below.

Alternative 1 – SIO Temp Index; HG FRACTION 5-15 (NO ACTION)
This alternative retains the Scripps Institution of Oceanography (SIO) pier temperature index to describe the relationship between ocean conditions and sardine stock productivity and the bounds around the FRACTION harvest control rule parameter as adopted in Amendment 8 of the CPS FMP. It maintains the OFL and ABC control rules adopted in Amendment 13 of the CPS FMP.

Alternative 2 – New Temp Index (CalCOFI); Maintain existing bounds on FRACTION
This alternative retains the existing HG FRACTION bounds of 5-15% adopted originally in Amendment 8 to implement a temperature-based harvest control rule, but adopts the CalCOFI temperature index.

Alternative 3 – New Temperature Index (CalCOFI); Revise bounds on FRACTION

3a. FRACTION 10-20%

This alternative adjusts the HG FRACTION range in the harvest guideline control rule to 10-20%.

3b. FRACTION 5-20%

Alternative 3b maintains a lower bound of FRACTION at 5% and increases the upper bound to 20%.

3c. FRACTION 0- 20%

Under this alternative the bounds for Fraction in the HG control rule are the broadest of all the options, set at 0-20%.

3.0 AFFECTED ENVIRONMENT

For the purposes of this action, the general action area is the West Coast Exclusive Economic Zone (EEZ) (which is directly affected by the Federal action) and the marine waters, other than internal, of the states of Washington, Oregon, and California (which may be indirectly affected by the federal action).

3.1 SARDINE RESOURCE

Pacific sardine (*Sardinops sagax*) are small schooling fish. When the population of Pacific sardine is large, it is abundant from the tip of Baja California to southeastern Alaska and throughout the Gulf of California. In the north, sardines tend to appear seasonally. Sardines also form three (and possibly four) subpopulations. The northern subpopulation of sardines is most important to U.S. commercial fisheries. Sardines are taken by a wide variety of predators. More information on current Pacific sardine abundance and population trends is contained in the current CPS SAFE Report (DRAFT) (PFMC 2014) and the *Assessment of the Pacific Sardine Resource in 2014 for U.S. Management in 2014-2015* (Hill et al 2014). The Pacific sardine resource is assessed each spring in support of the Council process that recommends an annual OFL, ABC, Annual Catch Limits (ACL) and HG for the U.S. commercial fishery. The primary purpose of the assessment is to provide an estimate of current biomass which is used to calculate HGs for the July 1 to June 30 management cycle.

Sardine, along with other species such as anchovy, hake, jack mackerel, and Pacific mackerel can achieve large populations in the California Current region as well as in other major eastern boundary currents. These populations are important to the trophic dynamics of the entire California Current ecosystem. Anchovy and sardines are key consumers of large quantities of primary production (phytoplankton) in the ecosystem and all five species are significant consumers of zooplankton. Additionally, all five species, and particularly the mackerels, hake, and also squid, are important predators of the early stages of fish. The juvenile stages, and in many cases the adults, of squid and all five species of finfish are important as forage for seabirds, pinnipeds, cetaceans, and other fish.

Trophic interactions between CPS and higher-trophic-level fish are complex, and it is unknown if populations of individual predaceous fish are enhanced or hindered by large populations of CPS. The value of CPS as forage to adult predators versus the negative effects of CPS predation (on larvae and juveniles of predator fish species) and competition (removal of phytoplankton, zooplankton, and other fish) is unknown.

Modeling efforts are underway that may enhance our understanding of these linkages and improve our ecosystem-based management approaches for these species. However, implementing ecosystem-based management requires an understanding of the complex dynamics of marine ecosystems as well as an understanding of how humans fit into the system. A key step toward ecosystem-based management is to better understand how interactions within food webs affect species of commercial and conservation importance. Efforts are underway to provide comprehensive diet information and food web analysis for major taxa within the California Current ecosystem, including fish, marine mammals, birds, and invertebrates (Dufault et al 2009). Furthermore, robust simulations of the California Current ecosystem that will allow the exploration of potential effects of natural and human-induced perturbations over a range of spatial and temporal scales have been undertaken (Horne et al 2010). Future management tools based on this ongoing work by NOAA will provide a platform for addressing important hypotheses relating to the effects of perturbations (e.g., harvest), characterizing the potential trade-offs of alternate management actions, and testing the utility of ecosystem indicators for long-term monitoring programs (Kaplan et al. 2013). Additionally, these tools will allow consideration of the entire ecosystem such that ecosystem management can maintain multiple ecosystem services as well as system resilience rather than focusing on a single species.

Environmental changes affect all species; however, small coastal pelagic species off the Pacific coast, like those managed by the CPS FMP, show responses that offer dramatic examples of environmental effects. In 1983, the biomass (age 1 +) of Pacific sardine was estimated to be 5,145 mt. By 1999, the biomass was estimated to be around 1 million mt (Conser et al.2001). Pacific mackerel biomass (age 1 +) estimates were atypically high in the early 1980s but began declining steadily from the mid-1980s to the early 2000s. Population estimates increased moderately, with some signs of 'rebuilding' observed in the years 2009-2011 (Crone et al. 2011). More recently, and in historical terms, the population remains at a relatively low abundance level, due primarily to oceanographic conditions. In *El Nino* years, the availability of squid in its typical spawning areas where it is harvested is low, but squid make a dramatic reappearance when the effects of *El Nino* abate.

These types of fluctuations in abundance are common in R-selected species (e.g., pollock, herring, sardine, and mackerel), which generally have higher reproductive rates, are shorter-lived, attain sexual maturity at younger ages, and have faster individual growth rates than K-selected species (e.g., rockfish, many flatfish). As such, predators that utilize R-selected fish species as prey (marine mammals, birds, and other fish) have evolved in an ecosystem in which fluctuations and changes in relative abundances of these species have occurred. Consequently, most of them are generalists who are not dependent on the availability of a single species but rather on a suite of species, any one (or more) of which is likely to be abundant each year.

3.2 Habitat

In 2011 a five-year review of CPS essential fish habitat (EFH) was completed and can be found in the 2011 Stock Assessment and Fishery Evaluation (SAFE) document (PFMC 2011). Although some new information was gathered during this process, no changes were made to the actual description of CPS EFH. A complete description of EFH for CPS may be found in Appendix D of the CPS FMP (PFMC 1998). In determining EFH for CPS, the estuarine and marine habitat necessary to provide sufficient production to support maximum sustainable yield and a healthy ecosystem were considered. Using presence/absence data, EFH is based on a thermal range bordered within the geographic area where a managed species occurs at any life stage, where the species has occurred historically during periods of similar environmental conditions, or where environmental conditions do not preclude colonization by the species.

The specific description and identification of EFH for CPS finfish accommodates the fact that the geographic range of all species varies widely over time in response to the temperature of the upper mixed layer of the ocean, particularly in the area north of 39° N latitude. For example, an increase in sea surface temperature since the 1970s has led to a northerly expansion of the Pacific sardine resource. CPS EFH is linked to ocean temperatures, which shift temporally and spatially, providing a dynamic definition of EFH. This definition is as follows:

> *The east-west geographic boundary of EFH for each individual CPS finfish and market squid is defined to be all marine and estuarine waters from the shoreline along the coasts of California, Oregon, and Washington offshore to the limits of the exclusive economic zone (EEZ) and above the thermocline where sea surface temperatures range between 10^0C to 26^0C. The southern boundary of the geographic range of all CPS finfish is consistently south of the US-Mexico border, indicating a consistency in SSTs below 26^0C, the upper thermal tolerance of CPS finfish. Therefore, the southern extent of EFH for CPS finfish is the US-Mexico maritime boundary. The northern boundary of the range of CPS finfish is more dynamic and variable due to the seasonal cooling of the SST. The northern EFH boundary is, therefore, the position of the 10^0C isotherm which varies both seasonally and annually.*

3.3 PROTECTED SPECIES

A more thorough description of the affected environment for protected species can be found in the Biological Opinion completed in December 2010 for the Pacific sardine fishery as well as in the Environmental Impact Statement (EIS) prepared for Amendment 8 to the Northern Anchovy FMP, now the CPS FMP (PFMC 1998). While the analysis provided in the EIS focused primarily on the fishery in southern California, most of the species that were identified occur along the entire U.S. West Coast and, thus, the analysis is applicable to fisheries currently managed under the CPS FMP.

The harvesting of Pacific sardines may affect species in two ways, direct take of the animals during the prosecution of the fishery (incidental catch) or indirectly due to reductions in prey base (sardine) that serve as forage. Protected species include species protected by three federal laws, the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), and the Migratory Bird Treaty Act (MBTA).

The following list of endangered or threatened species that may be present in the action area:

Species	**Status**
Marine Mammals	
Blue whale *(Baleaenoptera musculus)*	Endangered
Fin whale *(Baleranoptera physalus)*	Endangered
Humpback whale (*Megaptera novaeangliae*)	Endangered
Sei whale (*Balaenoptera borealis*)	Endangered
Sperm whale (*Physeter macrocephalus*)	Endangered
Killer whales, southern resident DPS (*Orcinus orca*)	Endangered

Northern Right whale (*Eubalaena glacialis*)	Endangered
Steller sea lion, eastern distinct population segment (DPS) (*Eumetopias jubatus*)	Threatened
Southern sea otter (*Enhydra lutris nereis*)	Threatened
Guadalupe fur seal (*Arctocephalus townsendi*)	Threatened
Birds	
Short-tailed albatross (*Phoebastria albatrus*)	Endangered
Marbled murrelet *(Brachyramphus marmoratus marmoratus)*	Threatened
Bald eagle *(Haliaeetus leucocephalus)*	Threatened
California least-tern *(Sternum antillarum browni)*	Endangered
Xantus's murrelet *(Synthliboramphus hypoleucus)*	Candidate
Sea turtles	
Leatherback turtle (*Dermochelys coriacea*)	Endangered
North Pacific Loggerhead turtle (*Caretta caretta*)	Endangered
Olive Ridley (*Lepidochelys olivacea*)	Endangered/Threatened
Green Sea Turtle (*Chelonia mydas*)	Endangered/Threatened
Marine invertebrates	
White abalone (*Haliotis sorenseni*)	Endangered
Black abalone (*Haliotis crachereodii*)	Endangered
Fish	
Green Sturgeon, southern DPS (*Acipenser medirostris*)	Threatened
Pacific eulachon, southern DPS (*Thaleichthys pacificus*)	Threatened
Yelloweye Rockfish (*Sebastes ruberrimus*)	Threatened

Salmonids		
ESU[a/]	**ESA Status Month and Year of Initial Listing**	**Stock Representation in Pacific Salmon FMP**
- - - CHINOOK - - -		
Central Valley Fall and Late Fall-run	Candidate Species Sept. 1999	Sacramento River Fall
Central Valley Spring-run	Listed Threatened Sept. 1999	Sacramento River Spring
Sacramento River Winter-run	Listed Endangered Aug. 1989	Sacramento River Winter
California Coast	Listed Threatened Sept. 1999	Eel, Mattole, and Mad Rivers
Southern Oregon/Northern California Coast	Not Warranted Sept. 1999	Southern Oregon Smith River Klamath River Fall
Upper Klamath and Trinity Rivers	Not Warranted	Klamath River Fall Klamath River Spring

Oregon Coast	Not Warranted	Central and Northern Oregon
Washington Coast	Not Warranted	Willapa Bay Fall Grays Harbor Fall Grays Harbor Spring Queets Fall Queets Spring/Summer Hoh Fall Hoh Spring/Summer Quillayute Fall Quillayute Spring/Summer Hoko Summer/Fall (Western Strait of Juan de Fuca)
Puget Sound	Listed Threatened May 1999	Elwha Summer/Fall (Eastern Strait of Juan de Fuca) Skokomish Summer/Fall (Hood Canal) Nooksack Spring (early) Skagit Summer/Fall Skagit Spring Stillaguamish Summer/Fall Snohomish Summer/Fall Cedar River Summer/Fall (Lake Washington) White River Spring Green River Summer/Fall Nisqually River Summer/Fall (South Puget Sound)
Lower Columbia River	Listed Threatened May 1999	Sandy, Kalama, and Cowlitz (fall and spring) North Lewis River Fall
Upper Willamette River	Listed Threatened May 1999	Upper Willamette River
Upper-Columbia River Summer/Fall	Not Warranted	Upper River Bright Upper River Summer
Upper Columbia River Spring	Listed Endangered May 1999	Upper River Spring
Snake River Fall	Listed Threatened May 1992	Snake River Fall
Snake River Spring/Summer	Listed Threatened May 1992	Snake River Spring/Summer
- - - COHO - - -		

Central California Coast	Listed Threatened Dec. 1996	By proxy - Rogue/Klamath hatchery coho
Southern Oregon/Northern California Coasts	Listed Threatened May 1997	Southern Oregon Coastal Natural Northern California
Oregon Coast	Listed Threatened Oct. 1998	South Central Oregon Coast North Central Oregon Coast Northern Oregon Coastal
Lower Columbia River	Listed Threatened June 2005	Columbia River Natural
Southwest Washington Coast	Candidate Species July 1995	Grays Harbor
Olympic Peninsula	Not Warranted	Queets Hoh Quillayute Fall Strait of Juan de Fuca (Western)
Puget Sound/Strait of Georgia	Candidate Species	Strait of Juan de Fuca (Eastern) Hood Canal Skagit Stillaguamish Snohomish
- - - PINK - - -		
Puget Sound, Odd Numbered Years	Not Warranted	Puget Sound

a/ A description of the ESU boundaries may be found at 63 FR 11486 (March 9, 1998) for Chinook and 60 FR 38016 (July 25, 1995) for coho.

Critical Habitat		
Steller sea lion (*Eumetopias jubatus*)	Rogue Reef: Pyramid Rock Oxnard Reef: Long Brown Rock and Seal Rock Ano Nuevo I. Southeast Farrallon I. Sugarloaf I.	Associated aquatic zones 3,000 feet seaward in State and Federally managed waters from the baseline of each rookery
Green Sturgeon, southern DPS (*Acipenser medirostris*)	US coastal marine waters within 60 fathoms from Monterey Bay, CA, to Cape Flattery, WA, the Sacramento River and other select waters within the Sacramento-San Joaquin River-Delta system, and other select coastal bays and estuaries waters within California, Oregon, and Washington.	

Leatherback sea turtle (*Dermochelys coriacea*)	Includes approximately 16,910 square miles (43,798 square km) stretching along the California coast from Point Arena to Point Arguello east of the 3,000 meter depth contour; and 25,004 square miles (64,760 square km) stretching from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 meter depth contour. The designated areas comprise approximately 41,914 square miles (108,558 square km) of marine habitat	Critical habitat extends to a water depth of 80 meters from the ocean surface and is delineated along the shoreline at the line of extreme low water, except in the case of estuaries and bays where COLREGS lines (defined at 33 CFR part 80) shall be used as the shoreward boundary of critical habitat.

A number of non-ESA listed marine mammals may also occur in the affected area, these include the northern fur seal, California sea lion, harbor seal, northern elephant seal, bottlenose dolphin, Pacific white-sided dolphin, common dolphin, harbor porpoise, Dall's porpoise, and minke whale. These species, like all marine mammals, are protected under the MMPA. Section 118 of the MMPA requires NMFS to place all U.S. commercial fisheries into one of three categories (I, II, III) based on the level of incidental serious injury and mortality of marine mammals occurring in each fishery (16 U.S.C. 1387(c)(1)), with Category I being the highest level of interactions and III being the lowest level. The California, Oregon and Washington sardine fisheries are listed as Category III fisheries, meaning that these fisheries have a remote likelihood of/no known incidental mortality or serious injury of marine mammal.

In addition, a number of non-ESA listed sea birds have been identified that forage on sardine and therefore may be affected directly or indirectly by the sardine fishery. These birds include grebes and loons, petrels and albatrosses, pelicans and cormorants, gulls, terns, auks, and some raptors (PFMC 1998).

At-sea observers have witnessed interactions with California sea lions, Pacific white-sided dolphins, and gulls within the California portion of the fishery. Observer records indicate that marine mammals, marine turtles, and steelhead are not encountered in the Pacific sardine purse seine fishery in Oregon and Washington. Fishermen in the southern subarea have not recorded incidental catch of marine turtles, southern green sturgeon, or steelhead in the sardine purse seine fishery. This is supported by preliminary observer information from vessels operating from San Pedro, Moss Landing, Dana Point, and San Diego, California.

Critical habitat for ESA listed cetaceans and most sea turtles has not been designated or proposed within the action area. Critical habitat for listed salmonids does not include marine waters and therefore it is not within the action area. Critical habitat for Steller sea lions in California are the rookeries at Ano Nuevo Island, Sugarloaf Island, and the southeast Farrallon Islands (50 CFR

226.202). Sardine fishermen in California do not fish near these islands therefore, critical habitat for Steller sea lions in California is not part of the affected environment.

3.4 FISHING INDUSTRY

During the 1940s and 1950s, approximately 200 vessels participated in the Pacific sardine fishery. In California, some present day CPS vessels are remnants of that fleet.

In recent history, a fishery for Pacific sardine has operated off Oregon and Washington since 1999. This fishery targets larger sardine, which have typically sold as bait for Asian longline tuna fisheries. Beginning in 2006, this fishery has been expanding into human consumption markets.

Along the West Coast, other vessels target CPS finfish in small quantities, typically selling their catch to specialty markets for relatively high prices. In recent years, these have included:

- Approximately 18 live bait vessels in southern California and two vessels in Oregon and Washington that landed about 4,000 mt per year of CPS finfish (mostly northern anchovy and Pacific sardine) for sale to recreational anglers.
- Roundhaul vessels that take a maximum of 1,000 mt to 3,000 mt per year of northern anchovy that are sold as dead bait to recreational anglers.
- Roundhaul and other mostly small vessels that target CPS finfish (particularly Pacific mackerel and Pacific sardine) for sale in local fresh fish markets or canneries.
- In Washington, albacore tuna vessels using lampara gear that target northern anchovy for use as live bait in the tuna fishery.

The CPS fishery is administratively divided into a federally managed “limited entry” fishery (requiring Federal permits in order to participate in the fishery), south of 39 degrees North latitude (Southern subarea), and an “open access fishery” (not requiring Federal permits to participate in the fishery), north of 39 degrees North latitude (northern subarea). Vessels landing less than five metric tons of CPS per trip in the Southern subarea are exempt from limited entry requirements. However, the states of Oregon and Washington both have specific state restrictions that limit the number of vessels in their respective fisheries. The CPS LE fleet currently consists of 65 permits and 56 vessels. The LE vessels range in age from 4 to 70 years, with an average age of 34 years. The capacity goal and transferability provisions established under Amendment 10 are based on calculated gross tonnage (GT) of individual vessels. Calculated GT serves as a proxy for each vessel’s physical capacity and is used to track total fleet capacity. The fleet capacity goal established through Amendment 10 is 5,650.9 GT, and the trigger for restricting transferability is 5,933.5 GT (Goal + 5 percent). The current LE fleet is 4,753 GT, well within the bounds of the capacity goal and not likely substantially different from current capacity. In the northern subarea, fishermen must have individual state harvest permits to fish for Pacific sardine.

The northern subarea fishery operates in an area approximately 45 nm north and 30 nm south of the Columbia River, and extends approximately 35 nm offshore. Fishing depths range from 7 fathoms to over 400 fathoms. There are less specific data available to characterize the geographic range of the southern subarea fishery except that the majority of Pacific sardine are landed in the central California ports of Monterey and Moss Landing and the Southern California port in San

Pedro. The gear type traditionally used in the CPS fishery is a purse seine. Typical purse seine nets measure 185 fathoms long, 22 fathoms wide and 1,600 meshes deep with 1 ¼ inch mesh (Lutz and Pendleton, 2000).

The Pacific sardine fishery in Oregon operates as a day fishery with vessels based primarily in Astoria where processing plants for sardine operate. Many vessels utilize aircraft to assist in locating schools of sardine and setting their nets when weather permits. Weather and tides are major factors in fishing operations and timing of vessels transiting in and out of the Columbia River. The Pacific sardine fishery off Oregon started in 1935, but there are recorded landings of sardine in Oregon dating back to 1928. The catch dropped off in the 1940s with 1948 being the last year of directed fishery landings until 1999 when the fishery was revived. Pacific sardine was managed as a developmental fishery from 1999 to 2005. In 2004, the sardine industry asked ODFW to remove Pacific sardines from the developmental species list and create a LE system for the fishery. ODFW began work with the Developmental Fisheries Board and the industry to develop alternatives for the fishery. In December 2005, the Oregon Fish and Wildlife Commission (OFWC) moved the Pacific sardine fishery from a developing fishery into a state-run LE fishery system. Twenty Oregon permits were initially established and made available to qualifying participants for the 2006 fishery. The OFWC amended an LE permit eligibility rule in August 2006, which resulted in an immediate addition of six permits for a total of 26 LE sardine fishery permits.

In April 2009 the OFWC enacted a number of rule changes for the Pacific sardine fishery. First, the OFWC modified the requirement for minimum landings of sardines into Oregon to qualify for permit renewal (initially enacted in 2006). The minimum landing requirements for permit renewal are now effective only when the federal coastwide maximum HG for the fishing year exceeds 100,000 mt. The minimum landing requirements, either a minimum of ten landings of at least five mt each or landings totaling at least $40,000 ex-vessel price, were not changed. Next, the OFWC eliminated a rule that became effective in 2008, which specified that permit holders must either own or operate a vessel that is permitted. The OFWC also established a lottery system for sardine permits. If the number of permits issued falls below 24 a lottery may be held the following year, but the total number issued shall not exceed 26 LE permits. Finally, a new rule defined catching vessels and limited catch sharing to catching vessels with state LE sardine permits. Of the 25 permits available in 2013, 14 vessels actively fished in the 2013 fishery.

Pacific sardines are the primary coastal pelagic species harvested off the state of Washington. From 2000 through 2009, participation in the sardine fishery was managed under Washington's Emerging Commercial Fishery Act (ECFA), which provides for the harvest of a newly classified species or harvest of a classified species in a new area or by new means. In 2003, to address management needs of the fishery, a formal Sardine Advisory Board (Board) was created, and the WDFW Director, in collaboration with the Board, advanced the sardine fishery designation from trial to experimental as provided for under the ECFA. The number of experimental fishery permits was capped at 25. The experimental fishery program continued through June 2009. Besides limiting participation, WDFW also restricted the amount of sardines sold for reduction to a 15 percent season cumulative total by weight by individual vessel.

Pacific sardines are the targeted catch in the Washington fishery, but anchovy, mackerel, and squid can also be retained and landed. In 2011, 2012, and 2013 mackerel was the only other coastal pelagic species landed, fluctuating from 0.42 mt in 2011 to 636 mt in 2012 to 196 mt in 2013.

During the 2009 Washington State legislative session, WDFW proposed legislation to establish a commercial license limitation program specifically for the harvest and delivery of Pacific sardines into the state. The legislation was passed into rule in July 2009. The new rules established 16 licenses to be issued to holders of a 2008 sardine experimental fishery permit only, with an exception for past participants of the experimental fishery that became ineligible because of loss of their vessel at sea. These newly created sardine licenses can be sold. In addition, the new rule provides criteria for the issuance of temporary annual permits at the discretion of the WDFW Director. In combination, the number of permanent and temporary annual licenses cannot exceed 25. Of the 16 licenses issued in 2011 seven were actively fished in the 2011 fishery. In 2012, 9 of the 16 Washington limited entry licenses were actively fished, as was one temporary annual permit issued for 2012. In 2013, 15 Washington limited entry licenses were issued.

A description of the affected socioeconomic environment and further economic analysis of this action can be found in Section 7.

3.5 TRIBAL FISHERIES

Treaties between the United States and Pacific Northwest Indian Tribes reserve the rights of the Tribes to take fish at usual and accustomed fishing grounds. The Pacific Fishery Management Council's Coastal Pelagic Species Fishery Management Plan (CPS FMP), as amended by Amendment 9 and codified in National Marine Fisheries Service (NMFS) regulations (50 CFR 660.518), outline a process for the Council and NMFS to consider and implement tribal allocation requests for CPS.

The Quinault Indian Nation requested that for the 2014-2015 fishing season NMFS provide the Quinault Indian Nation with the exclusive right to harvest 4,000 mt (2,000 mt less than in 2013) of Pacific sardine in their Usual and Accustomed Fishing Area off the coast of Washington State, pursuant to the 1856 Treaty of Olympia (Treaty with the Quinault). In 2013, through consultation, 6,000 mt of Pacific sardine were set-aside for the Quinault Indian Nation with the expectation that two Quinault fishing vessels would participate in the fishery. In 2013, in part because only one Quinault vessel fished, out of the expected two, the Tribe harvested only 586 mt. For 2013, the Tribe expects that two Quinault vessels will fish actively for sardine. The Quinault usual and accustomed fishing area (U & A) is defined in § 660.50(c)(4) as "That portion of the Fishery Management Area between 47°40.10' N. lat. (Destruction Island) and 46°53.30' N. lat. (Point Chehalis) and east of 125°44' W. long." This represents an area directly off Westport/Gray's Harbor, Washington, and waters to the north of this area. This area is also regularly fished by the non-tribal commercial fishery.

While a large proportion of the sardine stock off the West Coast may pass through the Usual and Accustomed Fishing Area (U&A) of the Quinault in some years, the requested amount for 2014-2015, as in 2013, was not based on a scientific determination of their precise treaty share under current conditions. In future years, the precise amount provided under the treaty will have to be more fully examined.

4.0 ANALYSIS OF ALTERNATIVES

This chapter describes anticipated impacts of the alternatives on fish resources, habitat, protected resources, and the socio-economic environment. Table 1 below depicts fishery performance measures of the action alternatives.

Table 1. Fishery performance measures of action alternatives.

Alternative	**2**	**3a**	**3b**	**3c**
HG FRACTION (%)	5-15	10-20	5-20	0-20
OFL E_{MSY} (%)	0-25	0-25	0-25	0-25
CUTOFF	150	150	150	150
MAXCAT	200	200	200	200
Performance Measures				
Biological				
Mean B1+ (SD)	1220 (888)	1182 (883)	1186 (882)	1187 (881)
Mean SSB (SD)	945 (757)	911 (753)	915 (752)	916 (751)
%B1+>400	92	91	92	92
Depletion (B1+ % of Unfished B1+)	78	75	75	76
Economic				
%No catch	4.7	4.7	4.8	5.1
%Catch<50	31	31	31	31
Median catch	97	107	107	107
Mean catch all (SD)	106 (73)	112 (75)	111 (75)	111 (76)

4.1 EFFECT ON PACIFIC SARDINE FISH RESOURCES

4.1.1 ALTERNATIVE 1 – NO ACTION

This Alternative is based on the Scripps Institution of Oceanography (SIO) Temperature Index and an HG FRACTION range of 5-15%. Amendment 8 of the CPS FMP adopted a harvest policy for Pacific sardine that included a SST temperature-dependent exploitation factor as a biological indicator of stock status/productivity. The SIO temperature time series has provided SST for use in the HCRs. In 2013 an evaluation of SST indexes found that the 1984-2008 CalCOFI SST time series provides the best fit for the sardine recruitment – environment relationship (PFMC 2013). This temperature index was found to track more closely with other SST time series and is more geographically representative of the sardine recruitment environment than the current SIO pier index. This finding was subsequently endorsed by the PFMC SSC.

Under the No Action alternative, FRACTION in the HG would continue to rely on SIO which has been deemed less representative of current ocean conditions. The effect on fish resources is difficult to calculate because impacts to the resource will vary with biomass and temperature. In general, the effect of the No Action alternative, by relying on a weaker indicator of stock productivity, may be to increase management uncertainty.

4.1.2 Alternative 2 – New temperature index and maintain existing bounds on FRACTION (5-15%)

This alternative replaces the temperature index from SIO with CalCOFI but maintains the existing bounds on FRACTION. Noteworthy is the high depletion value of 78% (Table 1). [2] By comparison, depletion under Amendment 8 was 64%. Unlike the FRACTION bounds adopted under Amendment 8, FRACTION bounded at 5-15% based on CalCOFI does not bracket the mid-range of temperatures vs E_{MSY}. Nor does it encompass stochastic E_{MSY} which was 0.12 under Amendment 8 analyses compared to the more-recently computed stochastic E_{MSY} 0.18 (Hurtado-Ferro and A. E. Punt. 2014). As a consequence, Alternative 2 is a very conservative harvest policy under all conditions. For example, with biomass (1+) at 370,000 mt and CalCOFI SST at 15.3 (2014-2015 estimates, rounded) the effective harvest rate is approximately 6%. In comparison, with a biomass of 700,000 and the same CalCOFI temperature, the harvest rate increases to 8%. The harvest rate with this latter biomass and SST of 16.7 degrees (representing warmer conditions) is 10%.

4.1.3 Alternative 3 – New temperature index and revise bounds on FRACTION

This alternative describes the effect of changing the bounds on FRACTION. Like Alternative 2, this alternative also is based on the recommended CalCOFI temperature index. Overall, the effects of the various FRACTION bounds on fish resources are not markedly different because at a given biomass and E_{MSY} between 10 and 20 percent, each alternative will produce the same result. The biological performance measures presented in Table 1 illustrates the similarity among and between the different bounds for FRACTION.

Alternative 3a - FRACTION 10-20%

Adjusting the HG FRACTION from 5-15% to 10-20% mirrors the increase from stochastic Emsy of 0.12 in Amendment 8 to 0.18 based on the updated analysis and new operating model (Hurtado-Ferro and A. E. Punt. 2014). This increase in E_{MSY} reflects a statistically identified increased productivity and therefore the ability of the stock to withstand a higher average fishing rate. Additionally, a FRACTION that ranges from 10-20% also better reflects the mid-range of actual measured temperatures and aligns with CalCOFI temperatures and the temperature vs E_{MSY} relationship in a manner similar to the where the 5-15% range fell relative to SIO temperatures. Bounding Fraction at 10-20% permits higher harvest rates to take advantage of periods when

[2] Depletion refers to the portion of the population remaining after harvest (i.e., the percentage of fish left in the ocean after harvest). Thus, higher depletion values are considered desirable from a fishery resource perspective.

biomass and productivity are high and restricts harvest when biomass and productivity are low, in a manner similar to the No Action Alternative, thereby preserving current harvest policy. Additionally, although the lower bound in this scenario would increase from 5% to 10% compared to alternative 2, during low biomass and presumably less productive conditions, this lower bound still limits fishing to only a 5% effective harvest rate (Figure 3).

Alternative 3b - FRACTION 5-20%

This alternative blends Alternative 2 and Alternative 3a by maintaining a lower bound of FRACTION at 5% and increasing the upper bound from 15% to 20%. By increasing the FRACTION term up to 20%, this alternative also accommodates the increase in stochastic E_{MSY} from 0.12 to 0.18. By extending the range of FRACTION to 20%, this alternative is similar in effect to the No Action Alternative but increases harvest opportunity compared to Alternative 2 when environmental conditions are favorable. In maintaining the lower FRACTION bound at 5% the effect of this alternative under cooler regimes is more similar to Alternative 2 than the No Action Alternative.

Alternative 3c - FRACTION 0-20%

Under Alternative 3c, the bounds for Fraction in the HG control rule are the broadest of all the options, 0-20%. The upper bound of 20% captures the adjustment for the change from the SIO to the CalCOFI temperature index described previously, so like alternatives 3a and 3b, it allows increased harvest rates to take advantage of years when environmental conditions are favorable and biomasses are high. However, the lower bound of 0% is more conservative and restricts harvests to a greater degree under unfavorable environmental conditions and low biomasses above CUTOFF than any of the other alternatives. A FRACTION of 0-20% means the HG will always be lower than the OFL and ABC control rules at all P* values (Figure 4). The HG, therefore, represents the maximum allowable harvest at all stock sizes and temperature conditions.

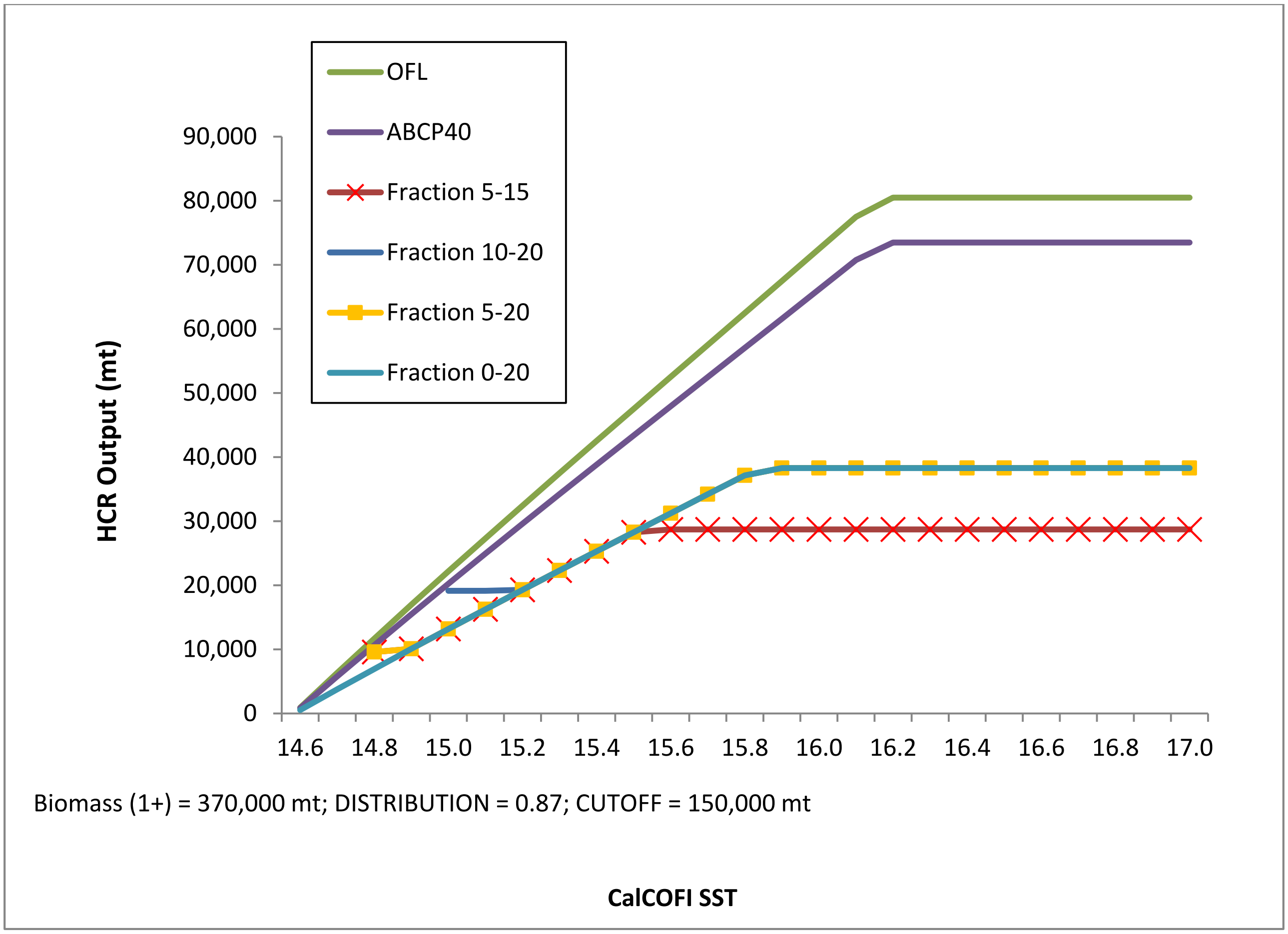

Figure 3. An illustration of harvest control outputs: OFL, ABC P*40 and HG with varying FRACTION bounds.

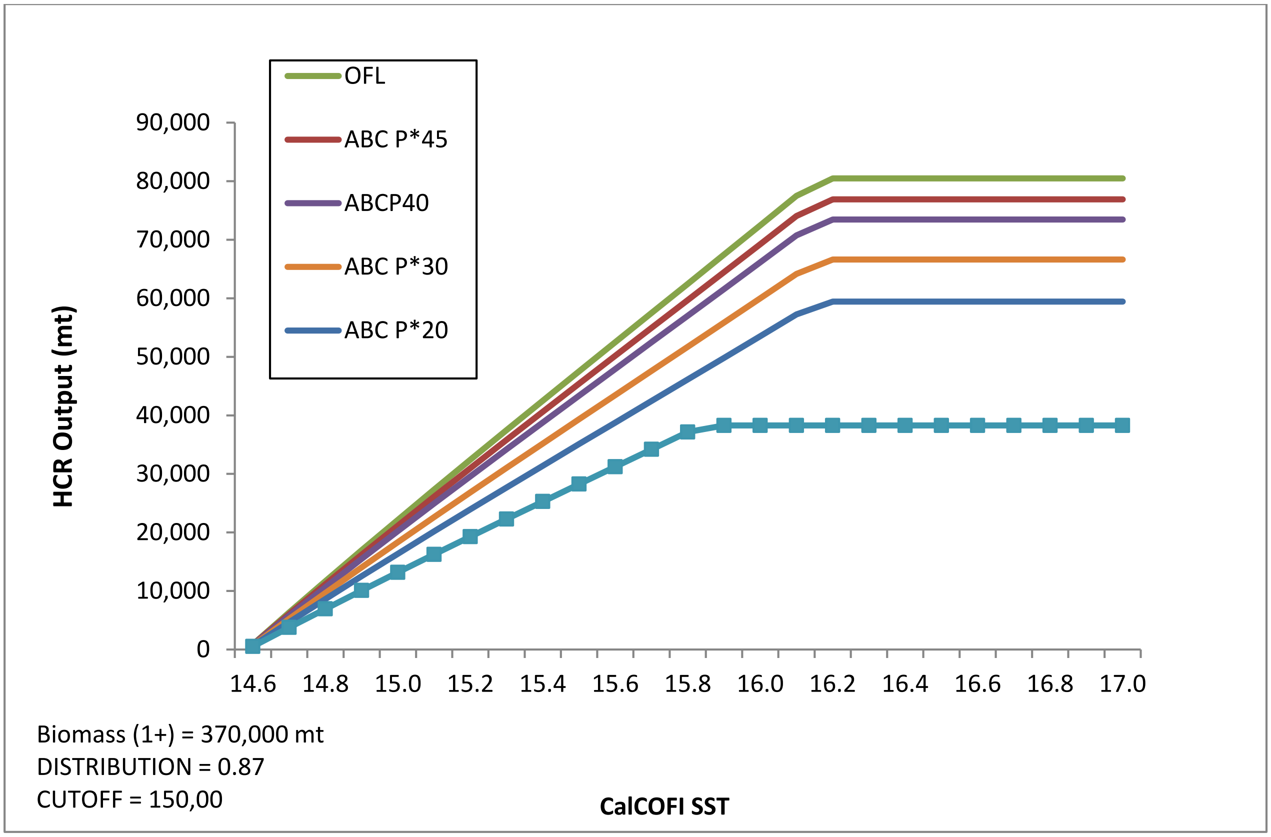

Figure 4. An illustration of harvest control rule outputs: OFL, ABC at various P* values and the HG when FRACTION is bounded 0-20%.

**Note: Sections 4.2 (Effects on Habitat and Ecosystem Resources), 4.3 (Effects on Protected Species), 4.4 (Effects on Socio-economics), 4.5 (Cumulative Effects), and other relevant information to be added later.*

6.0 LITERATURE CITED

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