Review of Management Provisions for Pacific Sardine

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Acronyms and Abbreviations

ABC	Acceptable Biological Catch
ACL	Annual Catch Limit
ACT	Annual Catch Target
BSIA	Best Scientific Information Available
BMSY	Biomass at Maximum Sustainable Yield
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CCE	California Current Ecosystem
CFR	Code of Federal Regulations
CPS	Coastal Pelagic Species
CPSAS	Coastal Pelagic Species Advisory Subpanel
CPSMT	Coastal Pelagic Species Management Team
CSNA	Central Subpopulation of Northern Anchovy
EEZ	Exclusive Economic Zone
EMSY	Exploitation Maximum Sustainable Yield
FMSY	Fishing Mortality Rate Maximum Sustainable Yield
F	Fishing Mortality Rate
FMP	Fishery Management Plan
FMSY	Fishing Mortality at Maximum Sustainable Yield
FMU	Fishery Management Unit
FPA	Final Preferred Alternative
HCR	Harvest Control Rule
HG	Harvest Guideline
MFMT	Maximum Fishing Mortality Threshold
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSE	Management Strategy Evaluation
MSST	Minimum Stock Size Threshold
MSY	Maximum Sustainable Yield
mt	Metric Ton
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NS	National Standard
NSP	Northern Subpopulation (of Pacific sardine)
OFL	Overfishing Limit
OY	Optimum Yield
PFMC	Pacific Fishery Management Council
PPA	Preliminary Preferred Alternative
SAFE	Stock Assessment and Fishery Evaluation document
SDC	Status Determination Criteria
SPR	Spawning Potential Ratio
SSB	Spawning Stock Biomass
SSC	Scientific and Statistical Committee
SSP	Southern Subpopulation (of Pacific sardine)

SST	Sea Surface Temperature
SWFSC	Southwest Fisheries Science Center
U.S.	United States

Contents

1 Introduction

Considering the newly available information on Pacific sardine population structure, the Pacific Fishery Management Council (Council) has determined it is appropriate to revise the current stock definition for Pacific sardine, as described in the fishery management unit (FMU) of the Coastal Pelagic Species Fishery Management Plan (CPS FMP; see Table 1). Newly available scientific literature on Pacific sardine, including genetic studies and a review of all preceding research on Pacific sardine population structure, reveals a lack of scientific evidence to support the long-held hypothesis that northern subpopulation (NSP) and southern subpopulation (SSP) are truly distinct subpopulations — the hypothesis that underlies current management of sardine. Instead, new information suggests Pacific sardine comprise a single, panmictic[1] population ranging from the Gulf of California to Canada (Longo et al. 2025; Craig et al. 2025; Erisman et al. 2025).

In November 2025, the Council adopted a purpose and need for this action and in April 2026, the Council indicated the preferred stock definition for Pacific sardine, an alternative that would amend the CPS FMP (Section 1.2, Table 1-1, see below) to define the stock in the FMU as the portion of the Pacific sardine population in U.S. waters, delineated as a single stock. This recommendation of a preferred stock definition for Pacific sardine allowed for development of a holistic action to amend the CPS FMP, consistent with this definition. While current management of Pacific sardine follows the best scientific information available (BSIA) to date, this action seeks to revise the sardine stock definition based on the new science available, accordingly amending the stock definition and FMP. This action is necessary to ensure Pacific sardine management is consistent with the goals and objectives of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the National Standards (NS), and the CPS FMP.

[1] A panmictic population occurs when any two individuals in a population are as likely to mate as any two others. In a population genetics context, this means there is no genetic evidence of population structure throughout its range.

Table 1. *Table 1-1 of the CPS FMP includes the FMU species which are "in the fishery" and subject to provisions of the FMP, including stocks managed under this FMP. The FMU species are specified within the Fishery Management Area, defined as the U.S. exclusive economic zone (EEZ) off the coasts of Washington, Oregon, and California between three and 200 nautical miles offshore, bounded in the north by the boundary between the United States and Canada, and in the south by the boundary between the United States and Mexico.*

Common Name	Scientific Name
Pacific sardine	*Sardinops sagax*
Northern subpopulation	
Pacific (chub) mackerel	*Scomber japonicus*
Northern anchovy	*Engraulis mordax*
Central and northern subpopulations	
Market squid	*Doryteuthis opalescens*
Jack mackerel	*Trachurus symmetricus*
Krill or Euphausiids	*All Species in West Coast EEZ*
Including these eight dominant species.	*Euphausia pacifica*
First two species are common and are	*Thysanoessa spinifera*
most likely to be targeted by fishing	*Nyctiphanes simplex*
	Nematocelis difficilis
	T. gregaria
	E. recurva
	E. gibboides
	E. eximia

1.1 Defining a Stock in an FMP

§ 302(h)(1) of the MSA requires the Council to prepare an FMP for each fishery under its authority that requires conservation and management.[2] The MSA and its National Standards also establish required provisions and guidelines for stocks in FMPs; Councils must evaluate and describe reference points[3] in their FMPs to align their management objectives to prevent overfishing of the stock and achieve optimum yield (OY). Notably, requirements include conservation and management measures and the specification of maximum sustainable yield (MSY), OY, and status determination criteria (SDC). The National Standards and other technical guidance elaborate on approaches to meeting these requirements and support the Councils' ability to meet them.

Therefore, as previously described in documentation presented to the Council (Agenda Item F.5 Attachment 1, April 2026), a revision of the stock definition for Pacific sardine includes consideration of these provisions of the MSA, the NS guidelines, technical guidance (as available), and how each applies to the conservation and management of a revised Pacific sardine stock. The framework for CPS management established in the CPS FMP also exists to meet the requirements of the MSA as well as NS guidelines and CPS-specific management objectives, and can be applied, as appropriate, to manage a revised Pacific sardine stock.

[2] Councils should consider the non-exhaustive factors (the '10 Factors') at 50 CFR 600.3005(c)(1)((i)-(x)) when deciding whether stocks require conservation and management in the EEZ.

[3] Reference points generally include the optimal yield (OY), maximum sustainable yield (MSY), status determination criteria (SDC), overfishing limit (OFL) allowable biological catch (ABC), and methods for specifying annual catch limits (ACLs)

Council and National Marine Fisheries Service (NMFS) staff have completed a review of the CPS FMP and management provisions for CPS stocks, including Pacific sardine, the requirements of an FMP per the MSA, guidance for defining reference points and SDC, and NS guidance for meeting the foundational requirements of the MSA (prevent overfishing and achieving OY). This review included a look at past work to analyze and set reference points and control rules for NSP and other stocks in the CPS FMP. Here, the results of this review are presented to provide decision points for the required components of an FMP amendment to revise the Pacific sardine stock definition, including potential options for required reference points as well as other stock-specific control rules in the CPS FMP.

In addition to a review of statutory obligations, this review also considers the unique dynamics of the target species - Pacific sardine - and the management objectives that may be considered to suit reference points and control rules to these dynamics. Pacific sardine are a short-lived, small schooling fish that, along with other CPS species, can achieve large populations in the California Current Ecosystem (CCE), as well as in other major eastern boundary currents. Pacific sardine, as well as other CPS populations, undergo boom and bust cycles, even in the absence of commercial fishing. Analyses of fish scale deposits in deep ocean sediments off southern California found layers of sardine and anchovy scales, with nine major sardine recoveries and subsequent declines over a 1,700-year period. These boom/bust cycles are heavily influenced by interannual and intraannual climate cycles. The complex mechanisms linking environmental conditions and sardine recruitment continue to be an area of scientific study, particularly under novel events such as marine heat waves in the eastern Pacific ocean. For example, Pacific sardine off the U.S. West Coast has been in low abundance for over 10 years without a strong understanding of the driver behind this. Historically, management of NSP, and CPS on the West Coast more broadly, has included consideration of these unique fishery dynamics, following scientific literature and best practices. Harvest policy has sought to reduce exploitation as stock biomass declines, protect a certain level of spawning stock biomass before reaching the overfished level, prevent pulse fishery dynamics, allow for small-scale fishing, and incorporate environmental relationships to recruitment. These management objectives may continue to be considered in specifying reference points and control rules for a U.S. Pacific sardine stock.

1.2 Purpose of this Meeting

The objective of this joint meeting, which includes the CPS subcommittee of the Council's Scientific and Statistical Committee (CPSSC of the SSC), the CPS Management Team (CPSMT), and representatives of the CPS Advisory Subpanel (CPSAS), is to develop a recommendation for key management provisions (reference points and control rules) for the proposed revised Pacific sardine stock definition (U.S. stock), identified by the Council in April 2026, and the related amendment to the CPS FMP. Council and NMFS staff have also completed a review of management provisions in advance of this meeting, determining that much of the framework of the CPS FMP, including reference point definitions (essential frameworks outlined in Section 4.1 - 4.5 of the CPS FMP), may be applied to a U.S. Pacific sardine stock.

The primary responsibility for meeting participants is to review the information provided herein and provide recommendations on proposed options within the framework of the CPS FMP which would satisfy the requirements of a stock, per the MSA and the NS. These decision points are outlined in Section 2 of this document. Further, meeting participants may provide

recommendations for parameters to apply within the control rules, details of which are outlined in Section 3 of this document. As time allows, there will also be opportunity at this meeting to discuss preferred approaches to calculate certain values (i.e. E_{MSY}) within the control rules. The priority for these discussion points are parameter values to be defined within the harvest guideline (HG), as well as approaches to calculate E_{MSY} to be applied within the upcoming 2027-2028 harvest specifications cycle, though long term approaches may also be discussed.

The decision and discussion points are summarized as follows:

1. Status determination criteria (SDC) and supporting parameters
    a. Specification of overfished status (minimum stock size threshold [MSST]) and biomass defined as input
    b. Specification of overfishing status (overfishing limit [OFL]) and the ABC control rule
    c. As time allows, discuss approaches, calculations, or values for E_{MSY}
2. Harvest Guideline (HG) control rule and supporting parameters
    a. Application of management approach in CPS FMP
    b. Discuss and recommend values or approaches for specifying parameters of control rules: CUTOFF, FRACTION, and MAXCAT[4]

Within this meeting, the CPSSC will focus on (1) SDC and ABC, while the CPSMT will focus on (2) HG control rule and supporting parameters. The two groups will coordinate via joint sessions to discuss any overlap between these decision points. Meeting participants are expected to prepare and deliver a final report including all recommendations from their review. This report will include sections from the CPSSC, CPSMT, and relevant advisors (CPSAS, NMFS). This report will be submitted for consideration by the Council and its SSC at its September 2026 meeting in Vancouver, Washington.

1.3 Information for Meeting Participants' Consideration in Meeting Tasks

This document includes information that Council and NMFS staff have determined is beneficial for participants to consider in evaluating and recommending options for reference points and management provisions. Meeting participants may also draw on their expertise and knowledge as scientists, managers, and industry members to bring forth additional information in discussing and recommending management options. At this point in time, a stock assessment for the U.S.-only stock is not yet available. However, that does not preclude the definition of reference points and control rules for the stock in the FMP.

This document is organized into sections by individual decision points for reference points, control rules, and individual parameters (see list of items included in review and evaluation, above), with each section including specific information, objectives, criteria, analyses, and references relevant to evaluating that particular decision point. A more detailed summary of the MSA, NS, and CPS

[4] DISTRIBUTION is not within this discussion, as further detailed in Section 3.3

FMP considerations relevant to this action is also described in Agenda Item F.5 Attachment 1 from the April 2026 Council meeting.

In sum, the information presented in this document is intended to inform a discussion of management options, including reference points and control rules, for a U.S. Pacific sardine stock and related amendment to the CPS FMP. The documentation includes:

1. Summary of the CPS management framework, including which provisions will apply to revised stock criteria and objectives of reference points and control rules, as applicable
    a. Criteria of the MSA and application of NS guidance, particularly NS1 (OY) and NS 2 (BSIA)
    b. Goals and objectives for CPS management defined in the CPS FMP (Section 1.6 of the FMP). While many potential reference points and control rules, in combination, may meet the requirements of the MSA, specific consideration for the needs and unique dynamics of the CPS fishery should be discussed by meeting participants.
2. Potential options for defining reference points, applying control rules, and defining or calculating parameters, proposed by NMFS and Council staff as a result of their review of management provisions, including examples of those historically applied to NSP.
3. Other relevant references within or outside the Council process that may be helpful in reviewing and evaluating specific management options
4. Tasks for meeting participants related to each decision point (reference point, control rule, parameter, discussion point etc.)

2 Management Framework of the CPS FMP

The CPS FMP is designed to meet the requirements of the MSA and guidance of the NS as well as CPS-specific management objectives via framework management. This section will describe the framework of the CPS FMP providing options for how it may be applied to a U.S. Pacific sardine stock.

2.1 Flexibility and Adaptive Management

The framework approach described in the FMP is intended to allow modifications to management procedures to be made in a timely and efficient manner (Section 2.1). Further, Section 2.2.3 – *Procedures for Specifying OFL, MSY, ABC, and Optimum Yield* – reads that, as data become available, improve, or are updated, control rules and OY specifications or procedures may be modified. Changes and additions to these formulas are authorized by the FMP and in certain scenarios it is not necessary to amend the CPS FMP in order to develop or modify harvest control rules or definitions of overfishing. This ability to apply adaptive management practices is evident throughout the FMP. For instance, use of particular formulas or values defined within the FMP is often not precluded by other reasonable methods or proxy values deemed appropriate by BSIA.

Flexibility and adaptive management also applies to specification of SDC. SDCs may be specified in the FMP as adaptable in order to accommodate changes in BSIA without amending the FMP (NOAA Fisheries 2024). For instance, stock status determinations may be based on any reasonable proxy accepted through the BSIA process. Additionally, when a more data-rich approach is expected in the future, a contingency method may be specified until an improved method is developed (see examples from the Mid-Atlantic and Western Pacific Councils, NOAA Fisheries 2024).

The objectives of the FMP, including adaptive management and flexibility for managing dynamic CPS stocks, will be further discussed within individual sections, below. Meeting participants should consider this foundation in the CPS FMP and guidance for SDC in their discussion of management options for Pacific sardine. Adaptive management is particularly of interest for a stock subject to change under varying environmental conditions, and at the current moment when data on the revised stock are limited.

2.2 Goals and Objectives

Section 1.6 of the CPS FMP specifies its Goals and Objectives (not listed in order of priority):

- Promote efficiency and profitability in the fishery, including stability of catch.
- Achieve OY.
- Encourage cooperative international and interstate management of CPS.
- Accommodate existing fishery segments.
- Avoid discard.
- Provide adequate forage for dependent species.
- Prevent overfishing.
- Acquire biological information and develop long-term research program.
- Foster effective monitoring and enforcement.
- Use resources spent on management of CPS efficiently.
- Minimize gear conflicts.

2.3 Management Approaches

Section 4 of the CPS FMP specifically defines the OY, MSY, and acceptable biological catch (ABC) control rules, the overfishing and overfished definitions, and the overfishing limit (OFL) for CPS stocks. For example, OY for a CPS stock is defined to be *"the level of harvest which is less than or equal to ABC estimated using an ABC control rule, consistent with the goals and objectives of the FMP, and used by the Council to manage the stock."*

The CPS FMP utilizes two primary management approaches for stocks subject to harvest; stocks may require one management approach or the other depending on harvest levels, biological or socio-economic factors, or other stock-specific concerns. These approaches were initially developed and defined in the FMP under Amendment 8. Amendment 13, which directly addressed NS 1 through the revised guidelines at 50 CFR 600.310, retained these general frameworks while making the FMP consistent with those guidelines through the inclusion of a buffer between the ABC and OFL, as well as specification of annual catch limits and accountability measures. The

FMP also does not preclude the use of other general types of control rules that may be useful for CPS, as long as they are compatible with the MSA and NS. Meeting participants may consider which management approach is most appropriate for the U.S. stock of Pacific sardine.

1. **Management approach for less-intensive management of a stock (i.e. 'Default' control rule)**

The 'Default' CPS Harvest Control Rule (HCR) is defined at Section 4.6.1 and 4.6.2 of the CPS FMP. The Council may use the default harvest control rule for species where it has been determined that little need for intensive management exists unless a better species-specific rule is available. The default rule sets a precautionary ABC equal to 25 percent of the best estimate of the MSY catch level which is also the OFL. Currently, this approach is utilized for both northern anchovy and jack mackerel. The default HCR is specifically defined as:

"The default harvest control rule sets ABC equal to 25 percent of the best estimate of the MSY catch level. Overfishing occurs whenever catch exceeds the OFL or whenever fishing occurs at a rate that is high enough to jeopardize the capacity of the stock to produce MSY. Overfishing of a CPS stock managed using the default control rule is 'approached' whenever projections or estimates indicate that the overfishing will occur within two years….

…Stock specific MSY proxies, ABC, and ACLs can be revised based on the best available science as recommended by the SSC and as adopted through the annual harvest specification process, and will be reported in the CPS SAFE...

…In general, the default ABC control rule consists of a 75 percent reduction from OFL to ABC until such time as the SSC recommends an alternate value based on the best available science. ACLs would be specified for multiple years until such time as the species becomes managed using the general harvest control rule or a new species-specific control rule, or new scientific information becomes available. ACLs may also be sector-specific. "

Simply written, the default approach is as follows:

OFL= Stock Specific MSY Proxy
ABC= OFL*0.25
ACL= Equal to ABC or reduced by OY considerations.

2. **Management Approach for intensive management of a stock (i.e. 'General' or 'HG' control rule)**

This management approach utilizes the General Harvest Control Rule (also known as the Harvest Guideline or HG control rule) as defined at Section 4.6.3 of the CPS FMP and is intended for more intensive, stock-specific management. It utilizes estimates of annual biomass and is designed to continuously reduce the exploitation rate as biomass declines. This management approach also

includes OFLs and ABCs based on MSY or MSY proxy harvest rates applied to the best available estimate of biomass. The general control rule is meant to be flexible and able to be modified to suit the conditions in any particular fishery and has been historically utilized for NSP. the general HCR is used to set a HG for the entire stock based off the following formula:

H = (BIOMASS - CUTOFF) * FRACTION * DISTRIBUTION

Where: *"H is the harvest target level, CUTOFF is the lowest level of estimated biomass at which directed harvest is allowed and FRACTION is the fraction of the biomass above CUTOFF that can be taken by the fishery. BIOMASS is generally the estimated biomass of fish age 1+ at the beginning of the season. DISTRIBUTION is the average portion of biomass assumed in U.S. waters.*

The general harvest control rule (depending on parameter values) is compatible with the MSA and useful for CPS that are important as forage. If the CUTOFF is greater than zero, then the harvest rate (H/BIOMASS) declines as biomass declines. By the time BIOMASS falls as low as CUTOFF, the harvest rate is reduced to zero. The CUTOFF provides a buffer of spawning stock that is protected from fishing and available for use in rebuilding if a stock becomes overfished. The combination of a spawning biomass buffer equal to CUTOFF and reduced harvest rates at low biomass levels means that a rebuilding program for overfished stocks may be defined implicitly. Moreover, the harvest rate never increases above FRACTION. If FRACTION is approximately equal to F_{MSY}, then the harvest control rule harvest rate will not exceed FMSY.

It may be advisable to define a maximum harvest level parameter (MAXCAT) so that total harvest specified by the harvest formula never exceeds MAXCAT…

Harvest control rules and other OY considerations will be used to set an HG. The HG cannot exceed the ACL or ABC. In cases where the HG exceeds the ABC, the Council will set a lower ACL, HG, or ACT[5] in response. An HG or ACT may be utilized below an ACL or sector-specific ACL to account for management uncertainty, discard or bycatch mortality, and research take. These provisions will be considered on an annual basis in response to changing"

The FMP also defines the OFL, ABC, and ACL used under the general framework:

OFL = BIOMASS * F_{MSY} * DISTRIBUTION[6]
ABC = BIOMASS * BUFFER[7] * F_{MSY} * DISTRIBUTION
ACL = LESS THAN OR EQUAL TO THE ABC

[5] Annual Catch Target

[6] Further discussed in Section 3.3

[7] Comprised of the uncertainty buffers within the Council's risk policy - P* and sigma

The general control rule approach is one example of how the CPS FMP includes mechanisms for amending harvest management measures in response to conservation or socioeconomic concerns. As described above, inherent in the CPS FMP is the presumption of adaptation to a changing management and science landscape. When developed as a part of Amendment 8 to the CPS FMP, it was noted that the general control rule is intended to be simple and flexible, able to be modified to suit the conditions in any particular fishery.

2.3.1 Options for Management Framework Applied to Pacific Sardine

1. Application of the less-intensive approach including the 'Default' control rule

The less-intensive management approach, including the associated OFL (see section 2.4.2, below) and default control rule may be applied to a U.S. stock of Pacific sardine, with no HG developed. This framework is currently utilized for northern anchovy and jack mackerel. However, these species are not as intensively harvested as Pacific sardine and therefore may not be appropriate.

2. Application of the intensive management approach, including the 'General' control rule (HG)

The intensive management approach, including the associated OFL (see section 2.4.2, below) and the HG may be applied to a U.S. stock of Pacific sardine. As described above, this framework has historically been utilized for NSP.

For NSP, the parameters comprising the general control rule were also specified to create a stock-specific rule within the CPS FMP (Section 4.6.4 of the CPS FMP). Section 3 of this document further details objectives and options for discussing the specification of these parameters (i.e., FRACTION, CUTOFF) for the U.S. stock of Pacific sardine. If it is determined appropriate to apply the general harvest control rule, meeting participants may also provide recommendations on specification of those parameters.

References from work to analyze the HG as applied to NSP may be helpful in these considerations (Amendment 8; Hurtado-Ferro and Punt 2014, Wildermuth et al. 2024). The general control rule has previously been analyzed for NSP via fishery simulations and MSE, including within the Amendment 8 analysis. A similar modelling exercise is not currently available for the revised Pacific sardine stock, but results of previous analyses may provide insights for a U.S. stock. Overall, it should be noted that the selected control rule for NSP met relevant goals and objectives in the CPS FMP, including, promoting efficiency and profitability in the fishery, including stability of catch, achieving optimum yield, providing adequate forage for dependent species, and preventing overfishing.

Tasks

- Consider the appropriate management approach, including OFL (discussed further in Section 2.4.2, below), default, and general control rules in the CPS FMP framework for application to Pacific sardine

- Stock-specific specifications of parameters within the OFL and HG rule to be discussed in later sections

2.4 Status Determination Criteria

This section provides summary information on SDC relevant for Pacific sardine in response to the Council recommending management of a U.S. Pacific sardine stock. It lists the current SDCs utilized for NSP and provides summary information on SDC options by drawing from NS 1 technical guidance and best practices from across fishery management organizations (see Restrepo et al. 1998, Methot et al. 2025).

SDC include both overfished and overfishing determinations. NS 1 and its guidelines specifically address the MSA requirement to prevent overfishing and achieve OY. Per 50 CFR 600.310(e)(2)(ii), each FMP must describe "objective and measurable SDC to determine overfishing and overfished statuses of stocks and stock complexes." By applying an SDC defined in an FMP, the Council monitors the stock status and determines whether overfishing is occurring and whether the stock or stock complex is overfished. SDCs are often based on fishing rates or biomass levels associated with MSY or MSY-based proxies.

The reference points[8] related to determining if overfishing is occurring are either a maximum fishing mortality threshold (MFMT) or an OFL, or reasonable proxy. The reference point related to determining whether a stock is overfished is the minimum stock size threshold (MSST) or reasonable proxy. These reference points and the criteria for specifying and calculating them will be described in further detail in the following sections (Section 2.4.1 and Section 2.4.2).

While SDCs must be objective, measurable, and enable monitoring of stock status, and are typically based on biomass levels or fishing rates associated with MSY or MSY-based proxies, the regulations explicitly allow alternative types of SDCs when data are not available to specify SDCs based on MSY or MSY proxies, provided they promote long-term sustainability of the stock (50 CFR 600.310(e)(2)(ii)). Examples of flexible and adaptable SDC are detailed in a NMFS white paper on Flexible Status Determination Criteria Examples and their Application (NOAA Fisheries 2024). Several Councils have adopted flexible SDC in their FMPs to enable more timely and efficient stock status determinations when the process might otherwise be delayed by the timeline required to amend an FMP (NOAA Fisheries 2024). This strategy is useful during the process of revising SDC when new BSIA is brought to bear from stock assessments or other processes, as echoed by the regulations: "A Council should consider a process that allows SDCs to be quickly updated to reflect the best scientific information available" (50 CFR 600.310(e)(2)(ii)). Because a new scientific understanding of the sardine population is driving this action, and because CPS, including Pacific sardine, undergo extreme, productivity regime shifts likely driven by environmental factors, exploring adaptable frameworks for Pacific sardine could provide the operational agility needed to manage the stock dynamically without triggering perpetual FMP amendments. Examples of adaptable frameworks include defining multiple alternatives to

[8] In the NS1 guidelines the "reference points" are defined as SDC, MSY, OY, ABC, and annual catch limit (ACL) (50 CFR 600.310(b)(2)(iv))

calculate SDC based on BSIA, relating SDC to data availability and/or shifting environmental baselines, and/or allowing the use of reasonable proxies.

2.4.1 Overfished Status Determination Criteria

Any fishery management plan which is prepared by any Council, or by the Secretary [of Commerce], with respect to any fishery, shall— . . . specify objective and measurable criteria for identifying when the fishery to which the plan applies is overfished (with an analysis of how the criteria were determined and the relationship of the criteria to the reproductive potential of stocks of fish in that fishery) (MSA sec 303(a)(10)). If the Secretary determines at any time that a fishery is overfished, the Secretary shall immediately notify the appropriate Council and request that action be taken to end overfishing in the fishery and to implement conservation and management measures to rebuild affected stocks of fish (MSA sec 302(e)(2)).

The most commonly used SDC for making an overfished determination is a biomass-based MSST. NS1 states the following regarding MSSTs (50 CFR 600.310(e)(2)(i)(E-F)):

> "(E) *Overfished.* A stock or stock complex is considered ''overfished'' when its biomass has declined below MSST.
>
> (F) *Minimum stock size threshold (MSST)* means the level of biomass below which the capacity of the stock or stock complex to produce MSY on a continuing basis has been jeopardized.*"*

Biomass

In the CPS FMP, biomass is defined as (50 CFR 660.502 "Biomass"):

"Biomass means the estimated amount, by weight, of a CPS population. The term biomass means total biomass (age one and above) unless stated otherwise."

Overfished determinations for NSP have been based on an MSST defined as 50,000 mt of age 1+ biomass on the first day of the fishing year (July 1). However, providing language in the FMP to allow for more flexibility in defining MSST and biomass would allow for MSST to be set based on best scientific information available. Noting that the biomass definition does state, "...unless stated otherwise," guidance on how and where to best define biomass if using something other than age 1+ could be part of this discussion.

Defining biomass very specifically may preclude the ability to use a different type of biomass value in a timely manner in cases where the exact one is not available or a change is warranted. For example, as previously suggested by the SSC, the spawning stock biomass (SSB) is more consistent with NS1 guidance when available because they directly relate to reproductive potential and that the SSB is more appropriate for estimating MSST for an actively managed CPS stock (Agenda Item E.1.a Supplemental SSC Report 1, September 2016). However, in the case of Pacific sardine, age 1+ biomass is likely going to be very similar to SSB given that age 1 sardines are known to spawn and a portion are considered part of the SSB. Thus, consideration about defining

biomass using a framework, based on the available data, versus a fixed biomass definition, could bring more flexibility to the FMP.

2.4.1.1 Guidance for Overfished Status Determination and MSST

Overfished status determination criteria, including MSST, are described in the MSA and the NS1 guidelines, as well as technical guidance for NS1. Additionally, several goals and objectives of the CPS FMP are relevant to the overfished status determination criteria.

MSST is defined in terms of reproductive potential and linked to the ability to produce MSY on a continuing basis, and thus MSY-based reference points (Restrepo et al. 1998) are often used as both a default and a standard to strive for. MSY cannot always be reliably calculated for a stock, and/or is not constant for stocks that exhibit life history characteristics of large recruitment fluctuations that are likely environmentally-driven. In such cases, alternatives exist such as depletion based estimates (e.g., a proportion of spawning stock biomass in the absence of fishing, SSB_0). It is possible to include alternative MSST options in an FMP for various reasons, including in case information later becomes available such that MSST should be updated accordingly (Restrepo et al. 1998, NOAA Fisheries 2024).

From a biological standpoint, life history characteristics are a primary consideration when selecting an appropriate MSST. A stock's ability to increase back to the biomass that produces MSY is dependent on the underlying stock-recruitment relationship, S-R, our knowledge of the S-R, and ability to model it, as well as potential environmental covariates that may influence recruitment success. Occurrence of regime shifts or periods of higher versus lower productivity can also be taken into account, for example by selecting a more recent or otherwise representative time period upon which to base MSST (Methot et al. 2025, Karp et al. 2019).

In recognition that calculating MSY for Pacific sardine is not applicable given their life history, the Council does not use an MSY-based SDC, instead, the CPS FMP (PFMC 1998) defines an overfished sardine population (NSP) as a fixed value.

Additionally, it is important to note that no assessments of a U.S. Pacific sardine exist as of this writing, so the information provided here is in the absence of specific analyses or results for this stock. Options for moving forward with setting SDCs exist and are described below.

2.4.1.2 Options for MSST

Overfished status pertains to a biomass of a stock and is usually determined by comparing biomass to the MSST or reasonable proxy, where the stock is overfished if it is below the MSST (50 CFR 600.310(e)(2)(i)(E)). Among the numerous possibilities for specifying an MSST, the options presented here are essentially a fixed-value MSST or formulaic MSST (or a combination thereof, and including allowance for a reasonable proxy). Within the formulaic approach, there are also multiple types to consider, including MSY-based and depletion-based approaches. Further within these categories, are multiple formulas that could be specified to calculate an MSY-based or depletion-based MSST. Discussion of these options should take into account NS guidance for SDC, regulations and guidance on alternative and flexible approaches (50 CFR 600.310(e)(2)(ii), NOAA Fisheries 2024), as well as the life history characteristics of sardine.

Some possible discussion points relevant for consideration in making a recommendation are:

1. Utilization of a fixed value versus a formulaic MSST? (see previous SSC input on use of a formulaic MSST; Agenda Item E.1.a Supplemental SSC Report 1, September 2016, for recommendation that formulaic MSST be used)
2. If a fixed value is to be used, what should that value be?
3. If a formulaic MSST is to be used, should MSST be MSY-based, or depletion-based? What formula should be specified?
4. How should biomass be defined for the MSST?
5. Should the FMP include the ability to use a proxy, or two or more of the above options for flexibility in calculating the MSST?

The options below may also not be mutually exclusive. It is possible to include alternative MSST options in an FMP for various reasons, including in case information later becomes available such that MSST should be updated accordingly (Restrepo et al. 1998, NOAA Fisheries 2024). In order to create an adaptive approach, consideration should be given to whether multiple options to calculate MSST could be defined within the FMP, and used based on BSIA. For instance, a definition could include MSST = Option 1 or Option 3, as determined by BSIA. The CPSSC could consider what the best approach is for the new U.S. Pacific sardine stock at this time and take into account the guidance available on flexible SDCs and the process by which they would recommend secondary/alternative methods, as determined by BSIA.

1. MSST = 50,000 mt or Reasonable Proxy and/or Alternative consistent with the BSIA and regulatory process

50,000 mt was the MSST established for the NSP in CPS FMP Amendment 8 (1998). A simple analysis determined that 50,000 mt was the minimum stock size required to rebuild to 1.5 million metric tons (Mmt) in less than 10 years, assuming a population growth rate of 40% per year, reflecting a population under highly productive conditions.

2. Other Static Value or Reasonable Proxy and/or Alternative consistent with the BSIA and regulatory process

The MSST may also be defined as a static value other than the 50,000 mt defined for NSP, or reasonable proxy.

3. Formulaic MSST or Reasonable Proxy/Alternative consistent with the BSIA and regulatory process

Instead of defining MSST as a static value hardwired into the FMP, MSST could be written as a formula relating it to an estimate of B_{MSY} or SSB_{MSY} or proxies such as percent depletion. For example, MSST = ½ B_{MSY}. Formulaic approaches have been used in other FMPs and accommodate a variable reference level responsive to stock assessments, and was discussed specifically for sardine in the past (NMFS 2024, Agenda Item E.1.a, Supplemental NMFS Report 1, September 2016).

MSST is defined in terms of reproductive potential and linked to the ability to produce MSY on a continuing basis, and thus MSY-based reference points (Restrepo et al. 1998) are often used as

both a default and a standard to strive for. The central difficulty of an MSY-based formulaic approach for CPS is that long-term equilibrium metrics (such as SSB_{MSY}) are often unrealistic (i.e., not constant) for species such as small pelagics, and therefore relies on defining appropriate windows of time to capture stock dynamics. MSY cannot always be reliably calculated for a stock, and/or is not constant for stocks that exhibit life history characteristics of large recruitment fluctuations that are likely environmentally-driven. In such cases, alternatives exist such as depletion based estimates (e.g., a proportion of spawning stock biomass in the absence of fishing, SSB_0). The most appropriate method for defining MSST depends in part on life history characteristics, underlying stock-recruitment relationship, and assumptions regarding environmental covariates. While the MSST definition for NSP was not necessarily based on fractions of SSB_0 or SSB_{MSY}, these alternatives could be explored for the revised Pacific sardine stock. This revision would require a broader definition of the biomass estimate utilized for SDC (rather than age 1+, see discussion).

From a biological standpoint, life history characteristics are a primary consideration when selecting an appropriate MSST. A stock's ability to increase back to the biomass that produces MSY is dependent on the underlying stock-recruitment relationship (S-R), our knowledge of the S-R, and ability to model it, as well as potential environmental covariates that may influence recruitment success. Occurrence of regime shifts or periods of higher versus lower productivity can also be taken into account, for example by selecting a more recent or otherwise representative time period upon which to base MSST (Methot et al. 2025, Karp et al. 2019).

Although a formulaic approach was ultimately not pursued for NSP, here, we offer a few summary points from the work resulting from the 2016 workshop evaluating MSST approaches for CPS (PFMC/NOAA Fisheries 2016 Review and Re-evaluation of MSSTs for finfish in CPS FMP):

- The workshop explored several methods for calculating MSST based on estimates of SSB_{MSY} and SSB_0 under longer-term 'equilibrium' conditions as well as dynamic SSB0
- There was concurrence in the workshop report and SSC response (Agenda Item E.1.a Supplemental SSC Report 1, September 2016) that, due to the dynamic nature of CPS populations and assessments, a framework (formulaic) approach would be more appropriate than fixed-value MSSTs for coastal pelagic species. This would assure that management decisions were made based on current knowledge, rather than outdated historical estimates.
- The SSC concluded that MSSTs based on SSB are more consistent with National Standard guidance when such estimates are available, because they directly relate to reproductive potential.
- The Council (Decision Summary Document) ultimately did not revise the MSST for NSP at this time. However, these methods for calculating MSST for CPS stocks may be useful in the present situation where an MSST is not yet defined and in order to define MSST to be adaptable within the FMP.

Tasks

- Provide recommendation on appropriate option(s) (value and/or formula) for specifying MSST for a U.S. Pacific sardine stock in the CPS FMP, including the appropriate definition of biomass

2.4.2 Overfishing Status Determination Criteria and ABC control rules

Overfishing occurs whenever a stock or stock complex is subjected to a level of fishing mortality or total catch that jeopardizes the capacity of a stock or stock complex to produce MSY on a continuing basis. (50 CFR 600.310(e)(2)(i)(B))

2.4.2.1 Guidance for the OFL

There are two options for setting overfishing status determination criteria. MFMT is a fishing mortality-based SDC, and the OFL is the corresponding catch-based SDC. The NMFS guidelines for National Standard 1 (NS1) of the MSA states the following regarding MFMT and OFL (50 CFR 600.310(e)(2)(i)(B-D)):

> (C) *Maximum fishing mortality threshold (MFMT)* means the level of fishing mortality (i.e F), on an annual basis, above which overfishing is occurring. The MFMT or reasonable proxy may be expressed either as a single number (a fishing mortality rate or F value), or as a function of spawning biomass or other measure of reproductive potential.
>
> (D) *Overfishing limit (OFL)* means the annual amount of catch that corresponds to the estimate of MFMT applied to a stock or stock complex's abundance and is expressed in terms of numbers or weight of fish."

Each FMP must specify a method used to determine the overfishing status for each stock or stock complex. For domestically-managed stocks or stock complexes, one of the following methods (described in [(*1*) and (*2*) below]) should be specified. If the necessary data to use one of the methods described [below] is not available, a Council may use an alternate type of overfishing SDC as described in paragraph (e)(2)(ii).

(*1*) ***Fishing Mortality Rate Exceeds MFMT.*** Exceeding the MFMT for a period of 1 year constitutes overfishing. [*Maximum fishing mortality threshold (MFMT)* means the level of fishing mortality (i.e. F), on an annual basis, above which overfishing is occurring. The MFMT or reasonable proxy may be expressed either as a single number (a fishing mortality rate or F value), or as a function of spawning biomass or other measure of reproductive potential.]

(*2*) ***Catch Exceeds the OFL.*** Exceeding the annual OFL for 1 year constitutes overfishing.

ABC

Acceptable biological catch (ABC) is a level of a stock or stock complex's annual catch, which is based on an ABC control rule that accounts for the scientific uncertainty in the estimate of OFL, any other scientific uncertainty, and the Council's risk policy.

For stocks and stock complexes required to have an ABC, each Council must establish an ABC control rule that accounts for scientific uncertainty in the OFL and for the Council's risk policy, and that is based on a comprehensive analysis that shows how the control rule prevents overfishing.

2.4.2.2 Options for Overfishing SDC and ABC Control Rules

The CPS FMP defines overfishing as catch exceeding an OFL.

Based on its two primary management approaches (intensive and less intensive), described in Section 2.3, the CPS FMP provides two options to calculate the OFL through both the intensive and less-intensive management approaches. These rule types for the OFL correspond to respective ABC and harvest policy control rules. As mentioned in Section 2.3, other general types of control rules may be useful for CPS and the CPS FMP does not preclude their use as long as they are compatible with National Standards and the MSA.The intensive approach has historically been utilized for NSP, thus the OFL within the default approach has not been applied for Pacific sardine.

1. **OFL and ABC for less-intensive management of a stock**

The CPS FMP states that the Council may use the default harvest control rule for species where it has been determined that there is little need for intensive management, unless a better species-specific rule is available.

The default for the OFL in the CPS FMP is OFL = Stock Specific MSY Proxy

For example, the OFL for jack mackerel is set equal to its estimate of MSY of 126,000 mt.

The default ABC control rule consists of a 75 percent reduction from OFL to ABC until such time as the SSC recommends an alternate value based on the best available science. The default harvest control rule sets the ABC equal to 25 percent of the best estimate of the MSY catch level (ABC = OFL×0.25), and may be prorated by an estimate of the fraction of the stock in U.S. waters (DISTRIBUTION), in cases where a biomass estimate includes the portions of the population in foreign waters. If the stock is delineated as U.S.-only and the stock biomass is estimated only for the portion of the population in the U.S. EEZ, this term is not required (see further discussion in Section 3.3).

2. **OFL and ABC for intensive management of a stock**

The OFL within the approach for more intensive management in the CPS FMP has historically been utilized for NSP. If a more intensive approach is taken up for Pacific sardine, the OFL would be defined as follows:

OFL = BIOMASS*E_{MSY}*DISTRIBUTION

The general control rule, which has been utilized for NSP, defines overfishing using an equation for OFL:

OFL = BIOMASS * E_{MSY} * DISTRIBUTION

Where:

BIOMASS is generally the estimated age 1+ biomass at the beginning of the season (see above),

E_{MSY} is the exploitation rate for deterministic equilibrium MSY (discussed further in Section 3.1),

DISTRIBUTION is the estimated long-term average portion of the biomass in the U.S. (Discussed further in Section 3.3)

For the NSP, E_{MSY} has historically been a form of an F_{MSY} proxy. To date, the E_{MSY} has been temperature-dependent, calculated based on the relationship between Pacific sardine recruitment and sea surface temperature. This essentially establishes an environmentally-dependent control rule that varies the harvest rate with sea surface temperature. Again, DISTRIBUTION represents the estimate of the portion of the stock in U.S. waters and in cases where it is delineated as U.S.-only and the stock biomass is estimated only for the portion of the population in the U.S. EEZ, this term is not applicable.

Under this control rule, the ABC is a reference point that incorporates a scientific uncertainty buffer against overfishing; a percentage reduction of the OFL as determined by the SSC and the Council's risk policy (ABC = BIOMASS×BUFFER×F_{MSY}×DISTRIBUTION).

Tasks

- Recommend specification of an OFL and ABC formula type for Pacific sardine
- Discuss application of parameters within the formula

3 Discussion of Control Rule Parameters

Section 2, above, covers the key provisions that NMFS and Council Staff have determined are necessary to outline within the CPS FMP to manage a U.S. Pacific sardine stock. The options described in Section 2 are complete in and of themselves to amend the FMP and meet statutory requirements, but within future harvest specifications processes, individual values, specifically E_{MSY}, will need to be applied within these frameworks. Additionally, the parameters specific to the HG control rule (ie. FRACTION and CUTOFF) should be specified to be stock-specific for Pacific sardine, as was done previously for NSP. This proceeding section is intended to discuss specification and/or calculation of individual, stock-specific parameter values within the control rules. Exact values or formulas may be an output for some parameters (FRACTION, CUTOFF, MAXCAT), while for others, the output may not be an exact formula or value, but an early discussion and recommendations on approaches to take (E_{MSY}). Meeting participants should discuss values and/or calculations for the short and long term, as time permits.

3.1 E_{MSY} (OFL and HG)

3.1.1 Definition for E_{MSY}

E_{MSY} is the exploitation rate for deterministic equilibrium MSY and is used as an F_{MSY} proxy.

As with MSST, MFMTs and OFLs are linked to MSY on a continuing basis, and thus MSY-based reference points (Restrepo et al. 1998) are often used as both a default and a standard to strive for. In cases where F_{MSY} cannot be calculated, spawning potential ratio (% spawning potential ratio [SPR]) is a life-history based common proxy. Again life history characteristics should be considered when selecting a %SPR level as an F_{MSY} proxy. Less desirable and less commonly used proxies are yield-per-recruit (F_{max} and $F_{0.1}$).

For NSP, the OFL formula has utilized a temperature-dependent E_{MSY} as an MSY proxy harvest rate, most recently based on a temperature-recruitment relationship using a running 3-year average of the California Cooperative Oceanic Fisheries Investigations (CalCOFI) temperature index with an upper bound of 25%. However, the use of this relationship is not specified in the CPS FMP, allowing flexibility to react to the best scientific information available for calculating EMSY during the annual specification process.

Since 2014, the E_{MSY} for Pacific sardine has been determined through annual recommendations by the Council's SSC[9], calculated via a temperature-recruitment relationship based on a running 3-year average of the California Cooperative Oceanic Fisheries Investigations (CalCOFI) temperature index.

The relationship between CalCOFI temperature and NSP recruitment-per-spawner that forms the basis for temperature-dependent EMSY was recently updated and still found to be statistically significant (Allen-Akselrud et al. 2025, Agenda Item G.2 Attachment 2, April 2025). This relationship has not been analyzed for the new stock as of this writing..

Other methods have been used in the past, including the use of temperature data from Scripps Pier and the estimation of a static F_{MSY} value, independent of environmental data. Life history is again important to consider in determining how best to calculate and select E_{MSY} for a U.S. Pacific sardine stock. Another important consideration is what are the "prevailing ecological, environmental conditions and fishery technological characteristics" (see MSY definition in NS1 50 CFR 600.310(e)(1)(i)(A)).

Operationally, E_{MSY} is used in Pacific sardine HCRs as follows:

1. OFL = BIOMASS * E_{MSY} * DISTRIBUTION
2. ABC = BIOMASS * BUFFER[10] * E_{MSY} * DISTRIBUTION
3. HG = (BIOMASS - CUTOFF) * FRACTION * DISTRIBUTION
   Where the FRACTION parameter is set equal to the percent-bounded, time-varying E_{MSY}

[9] Under the MSA, the SSC provides scientific advice for NMFS' consideration in fishery management decisions, including ABC and preventing overfishing. Per National Standard 2 at 50 CFR 600.315(a)(2), scientific information that is used to inform decision-making should include an evaluation of its uncertainty and management decisions should recognize the risks, such as those to overfishing, associated with the sources of uncertainty.

[10] Comprised of the uncertainty buffers within the Council's risk policy - P* and sigma

If the general control rule OFL formula is retained for management of a U.S. Pacific sardine stock, the E_{MSY} may continue to be used in this formula. As stated above, the value of E_{MSY} and the methods to calculate it are not defined within the FMP (except under the specification of the 'FRACTION' term in the general control rule, as a percent-bounded, time-varying fishing rate based on a temperature-dependent exploitation fraction (E_{MSY}), discussed further in Section 3.2). Therefore, specifying the value of E_{MSY} is not being tasked at this meeting and is not required for an FMP Amendment which revises the Pacific sardine stock definition.

Similar to how there are numerous options to set MSST, there are numerous options to set and calculate E_{MSY}. At its most complicated, E_{MSY} could be re-calculated through development of a model and evaluated in an MSE to either calculate a single fixed E_{MSY} value that does not account for environmental variation, or an equation relating E_{MSY} to temperature or another environmental variable. Use of an MSE would likely incorporate longer-term fluctuations in population dynamics. At the other extreme of assessment modeling-calculated values, another option is calculating an E_{MSY} (F_{MSY}) with each assessment using terminal year(s) of catch divided by biomass (age 1+) as was done with the northern anchovy benchmark (Kuriyama et al 2022). In the latter case, only recent years of data and not the history of fluctuations are used. Several approaches to an assessment-derived F_{MSY} were explored for the central subpopulation of northern anchovy (CSNA) when discussing potential approaches for calculating a new OFL for CSNA (Agenda Item G.2.a Joint SSC/CPSMT Report 1, April 2017) [11] The findings of this report and the SSC/CPSMT response may be useful to revisit in considering an assessment-derived E_{MSY} for Pacific sardine. Finally, life-history based, productivity based analyses such as an SPR-based metric can be calculated. Literature outside the Council process has also reviewed the CPS FMP's use of a temperature-dependent E_{MSY} term for Pacific sardine. Some references that may be useful are Zwolinski and Demer (2019), Free et al. (2022), Punt et al. (2014), Wildermuth et al. (2024) & Hurtado-Ferro and Punt (2014).

Reasonable proxies for E_{MSY} and how they may be calculated may also be considered and discussed. For instance, in the interim period between use of the Scripps Pier SST-based and the CalCOFI SST-based E_{MSY} calculations for the NSP, a static value was calculated before the development and review of a new environmentally-linked index (what was eventually CalCOFI SST). There was a need to estimate a static F_{MSY} value for the NSP independent of environmental data in order to specify the OFL and ABC in the harvest specifications process. To calculate this interim value, Hill et al. (2011, appendix to the stock assessment) utilized the fishery simulation model from the Amendment 8 analyses to estimate an F_{MSY} for NSP independent of SST and other control rule parameters. This analysis estimated the F_{MSY} for NSP at 0.18. Although this value was generated utilizing a stock assessment model for NSP, other life history approaches could be taken to set a different static value, including the exploration of other F_{MSY} proxies used in CPS management.

[11] The most appropriate way to calculate an F_{MSY} and OFL for CSNA was discussed over several meetings, including by a STAR panel and the Council's SSC

Task

- Early discussion on an E_{MSY} for the proposed revised Pacific sardine stock

Although separate and distinct from the FMP amendment process for the revised stock, this workshop also provides an opportunity for the CPSSC to hold an early discussion of how E_{MSY} might be specified for a U.S. Pacific sardine stock that may be used in both the near (for instance, in the upcoming 2027-28 harvest specifications cycle) and long-term, though the specification of this parameter is not part of the essential task list at hand for this meeting.

For example, the CPSSC might discuss what is technically feasible, or worthwhile to explore based on current scientific literature and best practices for specifying E_{MSY} for a U.S. stock of Pacific sardine, as well as the merits and tradeoffs of various approaches that may be further explored in future analyses. The CPSSC may also consider the importance of life history in determining how best to calculate and select E_{MSY} for a U.S. Pacific sardine stock. Input on approaches that do not warrant pursuing further can also be discussed.

Possible considerations to frame this discussion on how to best calculate E_{MSY} include:

1) Fixed value vs fixed equation, or a framework /formulaic E_{MSY} ?
2) If a fixed value or fixed equation is to be used, how should these be calculated?
3) If a framework/ formulaic E_{MSY} should be used, should it be MSY-based, productivity based, or other? Should an exact formula(s) be specified? How should these be calculated?

3.2 FRACTION (HG)

Within the general harvest control rule, FRACTION is equal to the F_{MSY} used in the OFL and ABC control rules. For the northern subpopulation of Pacific sardine, FRACTION has been a percent-bounded, time-varying fishing rate based on a temperature-dependent exploitation fraction (E_{MSY}). As established in Amendment 8, the environmentally dependent FRACTION was determined for NSP on the basis of a 3-year running average of the Scripps Pier sea surface temperature, bounded between 5 and 15 percent. In 2014, the Council adopted a revised temperature-recruitment relationship, based on the 3-year running average of the CalCOFI temperature index. FRACTION is the result of that formula but bounded between 5 and 20 percent.

3.2.1 Objectives for FRACTION

Within the general harvest control rule, FRACTION is the fraction of the biomass above CUTOFF that can be taken by the fishery. The purpose of FRACTION is to specify how much of the stock is available to the fishery when BIOMASS exceeds CUTOFF. The harvest rate never increases above FRACTION. If FRACTION is set approximately equal to the true F_{MSY} for the stock (i.e. fishing mortality rate for deterministic equilibrium MSY), then the harvest control rate will not exceed F_{MSY}, therefore bringing in considerations to achieve OY to avoid overfishing.

3.2.2 Options for FRACTION

1. Specify FRACTION as E_{MSY}

For Pacific sardine, FRACTION may be specified according to the general harvest control rule, in which FRACTION is equal to E_{MSY} used in the OFL and ABC control rules. For NSP (as well as other stocks in the CPS FMP, such as Pacific mackerel), this has been the foundational basis for setting FRACTION.

For clarity and conciseness in the FMP text, specificity of a temperature-derived formula upon which to base FRACTION may be removed from the FMP text. As noted in Section 3.1describing options for calculating E_{MSY}, there are several potential methods for calculating E_{MSY} that may be applied for Pacific sardine in the future. Further, relationships between FRACTION, F_{MSY}, and environmental conditions are technical in nature and may be revised to accommodate new ideas and data, as needed. Historically, Specification of FRACTION in the FMP should allow for such adaptability, as methods for calculating E_{MSY} could change over time as new BSIA has become available (i.e., historical change from Scripp's Pier to CalCOFI-based SST in E_{MSY}). Therefore, it would be prudent to maintain and specify E_{MSY} as the basis for calculating FRACTION. The choice to specify bounds for FRACTION, as was done for NSP, is a policy decision and not required to set FRACTION equal to E_{MSY}.

Tasks

- Consider CPSSC discussion on calculation of E_{MSY}
- Recommend appropriate specification of FRACTION for Pacific sardine
- Discuss any additional considerations for specifying FRACTION

3.3 DISTRIBUTION (OFL and HG)

DISTRIBUTION, defined as a parameter within the OFL and HG for stocks in the CPS FMP, represents the average portion of population biomass estimated in U.S. waters. It recognizes that a stock may range beyond U.S. waters and, therefore, the total biomass may not be in U.S. waters.

DISTRIBUTION is incorporated into the formulas for OFL and the general harvest control rule in the CPS FMP as follows:

OFL = BIOMASS*EMSY*DISTRIBUTION

H = (BIOMASS - CUTOFF)*FRACTION*DISTRIBUTION

3.3.1 Objectives for DISTRIBUTION

NS 3

National Standard 3 guidelines provide the basis for designating management units for species in need of conservation and management in the EEZ. FMPs should include conservation and management measures for that part of the management unit within U.S. waters, although the Secretary can ordinarily implement them only within the EEZ (50 CFR 600.320(d)(2))

National Standard 3 guidelines also outline several ways international boundaries may be dealt with to account for the potential impacts of management activities of other countries on the fishery (50 CFR 600.320(e)(4)). These include:

(i) By limiting the management unit's scope to that portion of the stock found in U.S. waters;

(ii) By estimating MSY for the entire stock and then basing the determination of OY for the U.S. fishery on the portion of the stock within U.S. waters; or

(iii) By referring to treaties or cooperative agreements.

CPS FMP

The CPS FMP recognizes that management of transboundary stocks is one of the most difficult problems in the management of CPS. Ideally, transboundary stocks would be managed cooperatively with other countries but, at this time, no agreements exist between the U.S., Canada, or Mexico for CPS. In the absence of a cooperative agreement, the default approach in the CPS FMP is to prorate the OFL and the target harvest level (H) by the estimated portion of the stock resident in U.S. waters or by estimating only the portion in U.S. waters (setting a 'DISTRIBUTION' parameter). Other approaches that may be developed in the future are not precluded by the default in the CPS FMP.

Under Amendment 8, DISTRIBUTION terms were defined for each species in the CPS FMP based on estimates of the portion of the stocks biomass in U.S. waters. Since Amendment 8, the estimate for the NSP has been set to a fixed value of 0.87 based on fish spotter data (detailed in Amendment 8 Appendix B).

3.3.2 Application of DISTRIBUTION to Revised Stock

Recent literature indicates that Pacific sardine comprises a cohesive population ranging from the Gulf of California, Mexico, to British Columbia, Canada (Longo et al. 2025; Craig et al. 2025; Erisman et al. 2025). Further, the Council has indicated preference to revise the stock to be delineated as the portion of Pacific sardine in the U.S. EEZ. Because the revised stock definition does not include biomass outside U.S. waters, the original objective of the DISTRIBUTION term no longer applies for Pacific sardine. Therefore, in a stock-specific control rule, DISTRIBUTION may either be removed from the control rule or set equal to one, with either producing the same outcome for the stock. As the SSC reported in April 2026, "Restricting the assessed BIOMASS to U.S. waters might eliminate the need for a DISTRIBUTION term in the HG HCR, but biological

connectivity with Mexico would need to be accounted for when evaluating the HCRs," (Agenda Item F.5.a Supplemental SSC Report 1, April 2026). Therefore, there is not a specific task related to DISTRIBUTION required of meeting participants at this time.

3.4 CUTOFF (HG)

CUTOFF is the lowest level of estimated biomass at which the primary directed fishery is allowed; below CUTOFF, the Council may close the directed fishery, only allowing for small-scale harvest. CUTOFF has been defined as 50,000 mt for NSP.

3.4.1 Objectives for CUTOFF

CUTOFF is a component of the general control rule intended to protect the stock when biomass is low by continuously reducing the exploitation rate as biomass declines, providing for an implicit rebuilding program. Paired with other aspects of the general harvest control rule, such as E_{MSY}, CUTOFF helps ensure that the stock is protected in years with low stock biomass or unproductive recruitment conditions. CUTOFF also aligns with the FMP objectives to provide adequate forage for dependent species, ensuring that the stock is not overexploited in years with low stock biomass and safeguarding a 'seed stock' to prevent overfished conditions and support rebuilding. The CUTOFF is meant to serve somewhat as an "implicit" rebuilding program, but is not a requirement for rebuilding per the MSA, and if the stock became overfished, it would still be possible for Council to develop an explicit rebuilding program that would meet all legal requirements, separate from the CUTOFF. A CUTOFF value also helps prevent unstable pulse fishery conditions, in which temporary high exploitation leads to prolonged and frequent fishery closures. References that include an analysis of CUTOFF, as applied to NSP, include Wildermuth et al. (2024) and Pikitch et al. (2012).

3.4.2 Options for CUTOFF

If applying the HG control rule, a stock-specific CUTOFF may be specified for the U.S. stock of Pacific sardine. However, CUTOFF is not a requirement per the MSA or NS and is not used for all CPS stocks (those managed under the default control rule)

1. CUTOFF = 150,000 mt

For NSP, CUTOFF has been defined as 150,000 mt, which is three times the MSST defined for NSP. This value, or its relative fraction compared to MSST, may also be applied to a U.S. Pacific sardine stock. 150,000 mt was selected as the value to be defined in the FMP under the Amendment 8 analysis, in which values including 50,000 mt, 100,000 mt and 150,000 mt were included in the fishery simulation model. Analysts recommended this entire range as acceptable for the NSP HG, though specifically recommended 100,000 mt or 150,000 mt as the options that would achieve the desired objectives of safeguarding a seed stock and reducing exploitation rate before reaching the overfished status, due to the relative buffer between the CUTOFF and the MSST. These values also prevented a 'pulse' fishery and supported both relatively high, stable catch and biomass. The 150,000 mt value maybe the most reasonable option to apply for a U.S. stock, given the information available on its performance within the HG set for NSP.

2. CUTOFF = other value or relative proportion of MSST

Depending on management objectives, a value other than 150,000 mt, or a different relative proportion to MSST, could be applied for a U.S. Pacific sardine stock. However, there is no current analysis on the U.S. stock to compare any alternative value to the 150,000 mt that has been used for NSP. As noted above, values ranging from 50,000 mt to 150,000 mt were analyzed for NSP via Amendment 8.

Tasks

- Recommend a stock-specific CUTOFF for Pacific sardine

3.5 MAXCAT (HG)

Per the CPS FMP, defining a MAXCAT, the maximum allowable level of catch, may be advisable to complement the general harvest control rule to guard against extremely high catch levels. MAXCAT has been defined as 200,000 mt for NSP.

3.5.1 Objectives for MAXCAT

There is no requirement to set a MAXCAT value for the Pacific sardine stock. However, the MAXCAT may be paired with the general HG control rule as described under Section 2.3 so that the total harvest allowed does not exceed a specified upper bound.

The objective of defining a MAXCAT value for a stock is to guard against extremely high catch levels for several reasons:

- Due to errors in estimating biomass
- To reduce year-to-year variation in catch levels
- To avoid overcapitalization during short periods of high biomass and high harvest
- Prevent catch from exceeding MSY at high stock levels
- Spread catch from stock year classes over a wider range of fishing seasons.

Per the analysis under Amendment 8 to the CPS FMP, MAXCAT helps prevent pulse fisheries, in which short periods of high exploitation lead to frequent and prolonged fishery closures. While pulse fisheries may generate the highest average catch over a long time period, they also result in high variation in catch and more years with zero catch, due to fishery closures.

3.5.2 Options for MAXCAT

1. **MAXCAT = infinite (set no MAXCAT)**

MAXCAT may not need to be specified to meet the goals and objectives of the CPS FMP and Pacific sardine fishery.

2. **MAXCAT = 200,000 mt**

For NSP, MAXCAT was set to 200,000 mt. This value was modeled in the Amendment 8 fishery simulation model and was the lowest value modelled. Relatively speaking, a high MAXCAT, particularly when paired with a high CUTOFF (currently set at 150,000 mt for NSP), produced pulse fishery dynamics when compared to a lower MAXCAT. In this scenario, the fishery is over-exploited while open and frequently closed to protect from high exploitation at lower biomass. This extreme variability in catch was not supported by managers and industry members under Amendment 8. MAXCAT should be specified at 200,000 mt to meet the goals and objectives of the CPS FMP and sardine fishery. Similar to CUTOFF above, the 200,000 mt value may be the most reasonable value that could be applied to the U.S. stock, given the information available on its application to NSP.

3. **MAXCAT = 300,000 - 400,000 mt**

Values ranging from 300,000 - 400,000 mt were also modelled for NSP under the Amendment 8 analysis. MAXCAT could be specified at another value to meet the goals and objectives of the CPS FMP and sardine fishery. It should be noted that the Amendment 8 analysis demonstrated that a high MAXCAT value, particularly when combined with a high CUTOFF, led to pulse fishery dynamics, wherein temporary periods of high exploitation led to more variation in catch and more frequent directed fishery closures. Therefore, the lower 200,000 mt MAXCAT was originally supported by both managers and industry members. As with CUTOFF, there is no current analysis on the U.S. stock to compare any alternative value to the 200,000 mt that has been used for NSP.

Tasks

- Consider whether a stock-specific MAXCAT value should be specified for Pacific sardine and recommend a value, if appropriate

4 Conclusion

Overall, the information provided in this document is intended to support the primary responsibility for meeting participants, to provide recommendations on proposed options within the framework of the CPS FMP which would satisfy the requirements of a stock, per the MSA and the NS. The materials are also intended to support the secondary priority of initial discussions on specific values, calculations, and approaches within this framework. Therefore, the key tasks, described throughout this document, are described below, and organized by priority. To reiterate, the CPSSC will focus on tasks related to the SDC, while the CPSMT will focus on tasks related to other control rules within the management approaches.

Summary of Tasks

Meeting Participants will prepare and deliver a final report, organized by CPSSC, CPSMT, and advisor tasks, including all recommendations from this meeting.

The decision and discussion points are summarized as follows:

1. Status determination criteria (SDC) and supporting parameters
    a. Specification of overfished status (minimum stock size threshold [MSST]) and biomass defined as input
    b. Specification of overfishing status (overfishing limit [OFL]) and the ABC control rule
    c. As time allows, discuss approaches, calculations, or values for E_{MSY}

2. Harvest Guideline (HG) control rule and supporting parameters
    a. Application of management approach in CPS FMP
    b. Discuss and recommend values or approaches for specifying parameters of control rules: CUTOFF, FRACTION, and MAXCAT

Highest Priority Tasks

- Consider the appropriate management approach, including OFL, default, and general control rules in the CPS FMP framework for application to Pacific sardine *(CPSSC and CPSMT)*
- Provide recommendation on appropriate option(s) (value and/or formula) for specifying MSST for a U.S. Pacific sardine stock in the CPS FMP, including the appropriate definition of biomass *(CPSSC)*
- Recommend specification of an OFL and ABC formula type for Pacific sardine *(CPSSC)*

Other Priority Tasks

- Recommend appropriate specification of FRACTION for Pacific sardine *(CPSMT)*
- Recommend a stock-specific CUTOFF for Pacific sardine *(CPSMT)*
- Consider whether a stock-specific MAXCAT value should be specified for Pacific sardine and recommend a value, if appropriate *(CPSMT)*

Lowest Priority Tasks

- Early discussion on an E_{MSY} for the proposed revised Pacific sardine stock *(CPSSC)*

Timeline

This report will be submitted for consideration by the Council and its SSC at their September 2026 meetings. Recommendations from this group will inform development of an FMP amendment package, to be presented to the Council at their September 2026 meeting in Vancouver, Washington. No management decisions will be made at this meeting.

Per the next steps for the sardine stock definitions action outlined in April 2026 (Figure 1), this meeting and its outputs may facilitate Council decision making on this action on the intended timeline.

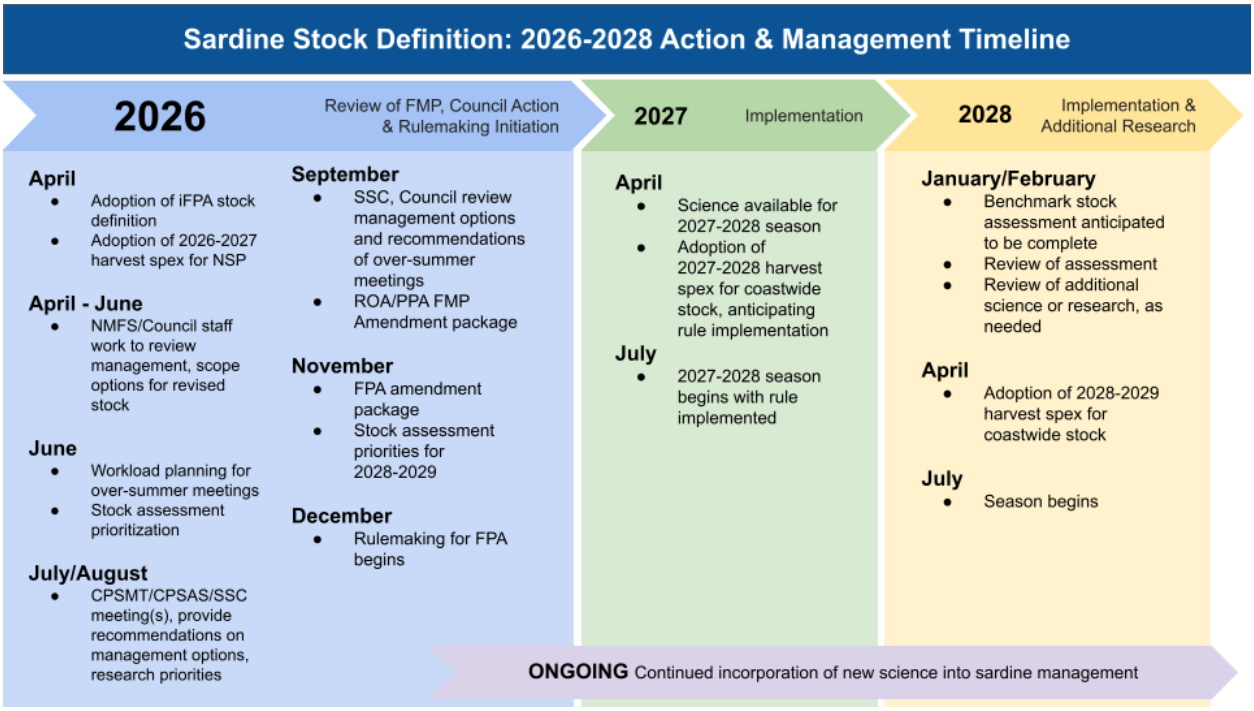

Figure 1. *Proposed timeline for implementation of stock definition revision and management. In April 2026, the Council selected a interim final preferred alternative (iFPA) stock definition. In September 2026, the Council is anticipated to adopt a range of alternatives (ROA) and preliminary preferred alternative (PPA) for the holistic amendment package. In November 2026, the Council is anticipated to adopt a final preferred alternative (FPA) for the holistic amendment package.*

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