JOINT MEETING TO REVIEW MANAGEMENT PROVISIONS FOR PACIFIC SARDINE

National Marine Fisheries Service (NMFS)
Southwest Fisheries Science Center (SWFSC)
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Acronyms and Abbreviations

ABC	Acceptable Biological Catch
ACL	Annual Catch Limit
ACT	Annual Catch Target
CDFW	California Department of Fish and Wildlife
BSIA	Best Scientific Information Available
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CPS	Coastal Pelagic Species
CPSAS	Coastal Pelagic Species Advisory Subpanel
CPSMT	Coastal Pelagic Species Management Team
CPS FMP	Coastal Pelagic Species Fishery Management Plan
EEZ	Exclusive Economic Zone
EMSY	Exploitation Maximum Sustainable Yield
F	Fishing mortality rate
FMP	Fishery Management Plan
FMSY	Fishing mortality at maximum sustainable yield
FMU	Fishery Management Unit
HCR	Harvest Control Rule
HG	Harvest Guideline
MAXCAT	Maximum harvest level
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
NWFSC	Northwest Fisheries Science Center
NOAA	National Oceanic and Atmospheric Administration
NS	National Standard
NSP	Northern Subpopulation (of Pacific sardine)
ODFW	Oregon Department of Fish and Wildlife
OFL	Overfishing Limit
OY	Optimum Yield
PFMC	Pacific Fishery Management Council
PPA	Preliminary Preferred Alternative
SAFE	Stock Assessment and Fishery Evaluation document
SB0	Unfished Spawning Biomass
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
WCRO	West Coast Regional Office
WDFW	Washington Department of Fish and Wildlife

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1. OVERVIEW

The meeting was convened to review key management provisions for Pacific sardine in the coastal Pelagic Species Fishery Management Plan (CPS FMP), including reference points and control rules. This joint meeting comprised the Pacific Fishery Management Council's (Council's) Scientific and Statistical Committee CPS Subcommittee (SSC-CPSSC), the CPS Management Team (CPSMT) and representatives from the CPS Advisory Subpanel (CPSAS). Staff from the National Marine Fisheries Service (NMFS) Southwest Fisheries Science Center (SWFSC) and West Coast Regional Office (WCRO) attended the meeting as technical advisors.

This represents a step within Council action to revise the Pacific sardine stock definition in the fishery management unit (FMU) of the CPS FMP based on new information on the Pacific sardine population in the U.S. exclusive economic zone (U.S. EEZ) revealing a lack of scientific evidence of truly distinct subpopulations — the hypothesis that underlies current management of sardine. Instead, new information suggests Pacific sardine comprise a single, panmictic population ranging from the Gulf of California to Canada (Longo et al. 2025; Craig et al. 2025; Erisman et al. 2025).

This action to revise the stock definition in the FMU 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. In April 2026, the Council adopted an interim Final Preferred Alternative (iFPA) stock definition as a U.S. stock, initiating the holistic action to revise the CPS FMP in accordance with this stock definition.

A revision of the stock definition for Pacific sardine includes consideration of the 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. In advance of this meeting, Council and NMFS staff completed a review of management provisions, determining that much of the framework of the CPS FMP, including reference point definitions, may be applied to a U.S. Pacific sardine stock. Therefore, the primary responsibility of meeting participants was to provide recommendations on proposed options within the framework of the CPS FMP for key management provisions for the proposed revised Pacific sardine stock definition (a U.S. stock) that would satisfy the requirements of a stock per the MSA and the NS. Within this joint meeting, the SSC-CPSSC was tasked to make recommendations on overfishing and overfished status determination criteria (SDC) and the acceptable biological catch (ABC), while the CPSMT was tasked to make recommendations on other control rules in the harvest policy, including application of the CPS harvest guideline (HG) control rule and its supporting parameters. CPSAS representatives and NMFS staff provided input throughout the meeting.

This meeting began with a welcome by Dr. Annie Yau, Fisheries Resources Division Director at the SWFSC. The SSC-CPSSC Chair of the meeting, Dr. Owen Hamel, the CPSMT Chair, Kirk Lynn, and Council Staff, Katrina Bernaus, provided opening remarks and a review of the meeting Agenda. Council Staff reviewed the purpose and scope of the meeting, including the key tasks to be accomplished by the joint meeting participants. Dr. Annie Yau then provided an update on upcoming Pacific Sardine Assessment timelines, including scientific, management, and logistical considerations impacting the timelines.

The tasks outlined for meeting participants included:

- Consider the appropriate management approach, including overfishing limit (OFL), default, and general control rules in the CPS FMP framework for application to Pacific sardine (SSC-CPSSC and CPSMT)
- Provide recommendation on appropriate option(s) (value and/or formula) for specifying minimum stock size threshold (MSST) for a U.S. Pacific sardine stock in the CPS FMP, including the appropriate definition of biomass (SSC-CPSSC)
- Recommend specification of an OFL and ABC formula type for Pacific sardine (SSC-CPSSC)
- 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)
- Early discussion on an E_{MSY} for the proposed revised Pacific sardine stock (SSC-CPSSC)

The meeting also provided opportunity for public comment, during established times on the agenda and throughout the meeting at the Chairs' discretion. Geoff Shester, Oceana, and Anna Portnoy, Wild Oceans, provided public comment.

This report is divided into individual sections developed by the SSC-CPSSC, CPSMT, and CPSAS, based on their assigned tasks. Each report section summarizes the participants' recommendations on respective management provisions. Recommendations included preferred options for management provisions within the FMP amendment to revise the Pacific sardine stock definition, as well as future research recommendations to develop and evaluate provisions when more scientific information on the U.S. stock is available. This comprehensive report will be provided to the SSC and the Council at their September 2026 meeting in Vancouver, Washington.

The meeting Chairs thanked the SWFSC for hosting the meeting and the participants for thoughtful, constructive discussions throughout the week. The recommendations from this meeting should inform the Council in the development of an FMP amendment to revise the Pacific sardine stock definition.

2. Scientific and Statistical Committee Coastal Pelagic Species Subcommittee Report on Review of Management Provisions for Pacific Sardine

The joint meeting discussed the timelines and considerations for implementation of harvest control rules, which would first be applied to the scheduled Pacific sardine update assessment in 2027, with subsequent changes to potentially be considered once results are available from more comprehensive analyses, such as simulation analyses with a suitable operating model reflecting the dynamics under the revised stock definition. In 2028, a benchmark stock assessment, reflecting the revised stock definition, is scheduled to be undertaken which could inform parameterization of simulation studies that will allow for more in depth analysis of harvest control rules. Simulations, or a management strategy evaluation, may help better evaluate proposed changes to the management system for Pacific sardine. Operating models are being developed by the SWFSC to evaluate the potential implications of uncertainty due to transboundary movement, data availability outside the U.S., alternative data sources, model structure and alternative parametrizations, as well as to quantify bias in parameterization. These analyses will help inform further discussion and could help evaluate future proposed changes to the FMP.

Council staff provided a presentation of the current management framework and basis for proposed changes to the management strategy for Pacific sardine given the status quo applied to the northern subpopulation of Pacific sardine (NSP) and proposed alternatives in order to facilitate discussion. Approaches for both less intensive management strategies and more intensive management were presented. Potential changes to reference points and harvest control rules and the level of work needed to test, develop, and refine alternatives in the future were discussed in preparation for Council advisory body and public consideration at the September 2026 Council meeting.

2.1. Sardine Status Determination Criteria - Biomass Specification

Recommendation: Age-1+ biomass remains the most practical biomass specification, while recognizing that more biologically relevant alternatives exist.

The joint meeting discussed the appropriate biomass specification for sardine status determination and concluded that age-1+ biomass should remain the current management metric. Current understanding indicates that available reproductive information is largely limited to the area encompassed by the previous Northern Subpopulation (NSP) definition. Maturity appears to be relatively stable through time, with approximately 50% of individuals reaching maturity at around 0.6 years of age. Mexico has published maturity data, which indicates maturity schedules are similar across the broader population.

Several factors support retaining age-1+ biomass as the primary proxy for reproductive capacity. Historically, age-1+ biomass has functioned as a reasonable surrogate for the mature population because sardines mature relatively early in life. In addition, most maturity estimates were derived from historical spring surveys that are no longer conducted, meaning little new maturity information is expected in the near future in the same way as previously collected. As a result, current assessments will likely need to continue relying on existing maturity estimates that do not cover the spatio-temporal range of the coastwide stock. The group also noted that incorporating maturity directly into the seasonal assessment model is not straightforward. The model is

structured around January-June and July-December periods, and applying maturity schedules for fish younger than age 1 would be challenging, particularly given that 50% maturity occurs at approximately 0.6 years of age. Interpretation is further complicated by time-varying selectivity of age-0 fish within the assessment. Additionally, fecundity often increases disproportionately relative to body weight, suggesting that fish younger than age 1 may contribute even less to overall spawning output than their weight alone would indicate. Existing survey sampling programs were also not specifically designed to estimate maturity, creating additional uncertainty in any maturity-based metrics.

The SSC-CPSSC recognizes a continuum of increasing biological realism that ranges from (1) age-1+ biomass, the current approach, to (2) spawning stock biomass (SSB) based on maturity ogives, and ultimately to (3) spawning output or egg production estimates that incorporate both maturity and fecundity. While SSB would provide a more direct measure of reproductive capacity than age-1+ biomass, its implementation would require further evaluation of maturity schedules and consideration of how those schedules could be incorporated into the seasonal assessment model. Moving beyond SSB to spawning output would require substantially improved understanding of fecundity patterns, and there is currently insufficient information available to support such an approach. Consequently, additional data collection, methodological development, and research would be required before direct estimates of SSB or spawning output could be used in place of the current age-1+ biomass proxy.

Based on these considerations, the group recommends retaining the current U.S. management definition of biomass as age-1+ biomass.

2.2. Sardine Status Determination Criteria - MSST

Recommendation: A fixed-value MSST is recommended for the revised U.S. Pacific sardine stock because current uncertainties regarding stock dynamics, stock distribution, and productivity do not support immediate adoption of a fully dynamic threshold. The historical 50,000 mt value should be retained as a foundation, with consideration of a modest upward adjustment to account for inclusion of the southern stock area. A value of 65,000 mt was discussed to account for this increase given variability over recent years in the survey biomass in the area previously designated as representing southern subpopulation within U.S. waters.

At the same time, the FMP should explicitly provide for future development of a formulaic MSST, potentially based on spawning biomass depletion metrics (e.g., a fraction of dynamic SB0) and informed by the best scientific information available, while being constrained between reasonable bounds reflecting an absolute lower level requiring action and a higher level which would allow for rapid recovery during highly productive regimes. Analysis based upon the 2028 benchmark assessment should evaluate these alternatives and future simulation should provide the analyses necessary to support a potential transition to a biologically based formulaic MSST, as appropriate.

For the revised U.S. Pacific sardine stock, the SSC-CPSSC recommends retaining a fixed-value MSST, while investigating development of a formulaic MSST framework as a priority for future analyses**.** Although dynamic reference points can be advantageous and generally desirable for highly variable small pelagic species, current scientific uncertainty regarding stock structure, productivity dynamics, environmental influences, and the contribution of the southern component

of the stock suggests that a fully dynamic MSST would be difficult to justify at present. Nonetheless, continued analyses evaluating the utility of dynamic formulaic MSST should continue, based upon future benchmark stock assessments. Dynamic reference points may additionally be appropriate for overfishing or target reference point specifications.

2.2.1. MSST options considered

The historical MSST of 50,000 mt has the advantage of continuity. However, that value was developed for the area of spawning in the United States in the Spring and was based on assumptions and operating-model analyses conducted during development of Amendment 8, in the late 1990s (PFMC 1998). While it has served as the overfished threshold for many years, it is not necessarily a biologically-derived estimate for the revised stock definition and can be viewed as somewhat outdated in the current context. Because the revised stock includes the southern portion of the population, maintaining the exact 50,000 mt threshold may not appropriately reflect the expanded stock area. In particular, while the 50,000 was meant to cover the whole U.S. stock, at the time, it was based on information available in the spring and so it likely does not fully represent fish that move from Mexico into U.S. water post-Spring. However, the delineation of the previously defined NSP and southern subpopulation (SSP) areas does not perfectly separate those sardines that entered U.S. waters between the spring and the summer, which, coupled with the high variability in observed "SSP" biomass in the survey in recent years leads us to minimize the addition to the previous 50,000 MSST.

A reasonable approach given current information would be to retain the historical framework but increase the fixed MSST to reflect inclusion of the southern stock area, using the relative contribution of previously defined NSP and SSP survey biomass estimates as the basis for scaling. Based on preliminary survey-biomass comparisons (Table 1), the northern and southern areas appear to have contributed similar amounts of biomass on average over the recent 10 year period, although the southern area shows much higher interannual variability. This would support consideration of an MSST larger than 50,000 mt, for example in the range of approximately 65,000 mt. The latter value represents adding the smallest estimated amount of the southern portion of the population seen in recent surveys from 2018 through 2025. This would be in order to account for the addition of this biomass, but not allow a periodic low level of this highly variable portion of the stock to drive an overfished declaration.

Table 1. *Pacific sardine biomass values from the Integrated Survey/ CPS survey. Biomass estimates are in metric tons and for U.S. waters. Table produced during the meeting by SWFSC staff.*

		Northern					Southern					Total
survey	year	biomass	biomass_sd	biomass_ci_lower	biomass_ci_upper	biomass_cv	biomass	biomass_sd	biomass_ci_lower	biomass_ci_upper	biomass_cv	
1507SH	2015	14,795	12,390	254	43,883	84						
1606RL	2016	33,731	23,196	2,325	95,306	69	323	166	0	672	51	
1706RL	2017	14,155	4,082	6,261	25,710	29						
1807RL	2018	25,148	16,782	3,617	62,439	67	33,093	14,516	8,957	65,417	44	58,242
1907RL	2019	33,632	6,333	20,613	48,339	19	14,890	4,935	3,346	30,260	33	48,521
2107RL	2021	47,721	19,811	12,719	92,322	42	76,823	21,371	18,243	137,177	28	124,544
2207RL	2022	69,506	14,430	24,321	106,749	21	107,092	24,738	35,550	195,577	23	176,598
2307RL	2023	77,252	36,044	14,344	182,477	47	82,132	19,278	17,881	182,702	23	159,385
2407RL	2024	77,703	34,734	10,434	176,226	45	32,927	8,869	24,909	75,419	27	110,630
2506SH	2025	66,640	37,436	3,434	185,846	56	20,049	5,939	2,267	42,663	30	86,689
Total from 2018		397,602					367,006					

In general, the group identified four primary alternatives for candidate fixed values for MSST.

1. 50,000 mt. This value is the status quo, maintains continuity, and was derived to represent sardine in the United States in Spring.
2. ~65,000 mt. This is adjusted upwards to account for addition of fish from southern areas that arrive after Spring and is based on relative NSP and SSP acoustic survey biomass contributions as estimated during the Summer.
3. ~84,000 mt. This is approximately equivalent to 0.2SB0 from the 2016 NMFS SWFSC report and analysis and is based on a formulaic approach that is directly tied to biomass-based stock dynamics. However, this was derived from an assessment under previous stock assumptions and should be interpreted cautiously.
4. ~22,000-25,000 mt. This is the range of 0.2SB0 estimates from the most recent (2024 and 2025) NSP assessments, but may be difficult to justify as a management threshold because it was also derived from an assessment under previous stock assumptions. These also represent values for when the stock is in a low-productivity state, and when the proportional approach may not be appropriate for timely recovery given a change in productivity.

2.2.2. Future Direction: Formulaic MSST

The SSC-CPSSC supported continuing evaluation of a formulaic approach for future implementation. A future formulaic MSST could be based on x%SSB_0 given that productivity and some life history parameters are not well known. The best x% value for Pacific Sardine would need to be established, and could include a fixed or dynamic approach to specifying SSB_0.

A bounded dynamic approach may be particularly attractive because it balances adaptability with stability and limits the risk of large swings in overfished determinations resulting from assessment changes alone and would also provide for an absolute level requiring action.

2.3. Overfishing Level (OFL) and Acceptable Biological Catch (ABC)

Current overfishing status determination criteria for NSP is biomass based. Overfishing occurs when catch exceeds the Overfishing Limit (OFL).

- OFL = BIOMASS * E_{MSY} * DISTRIBUTION.
- E_{MSY}: The exploitation rate for maximum sustainable yield, often calculated using a temperature-dependent recruitment relationship.
- DISTRIBUTION: Historically set at 0.87 for NSP, representing the estimated portion of the stock in U.S. waters.

2.3.1. Distribution Parameter

- For the revised stock definition, being U.S,-only, the DISTRIBUTION parameter can be set to 1 or removed.
- Note that removing the DISTRIBUTION would mean excluding Mexico and Canada. When sardines return to Canada and are moving across the northern border, that issue could also be addressed in the assessment.

2.3.2. E_{MSY} (Exploitation Rate at MSY) Options

- The current approach uses E_{MSY} (rather than an F_{MSY} coupled with an estimated selectivity), based on environmental variables (e.g., ocean temperature).

- E_{MSY} for Pacific sardine ranges from bounds of 0.05 to 0.25, determined by a multi-year average temperature metric.

Six approaches were evaluated to revise the current E_{MSY} for the US-only sardine stock: simulation-derived Management Strategy Evaluation (MSE), raw assessment-derived value, productivity-based, fixed/constant value, environmental linkage, and a hybrid approach.

An MSE is considered the most theoretically robust and scientifically defensible framework to derive an E_{MSY} value because the evaluation can successfully incorporate long-term environmental fluctuations, climate regimes, and recruitment variability. However, an MSE is highly resource-intensive to develop and slow to update, making it poorly suited for immediate operational needs.

An assessment-derived value taken directly from each stock assessment can capture contemporary observations. While highly responsive to current stock status, it is exceptionally sensitive to assessment assumptions and errors. This makes it extremely noisy and prone to year-to-year volatility, which may be effectively "chasing noise". It is also currently unfeasible because a new benchmark assessment for the new U.S.-only sardine stock won't be available until 2028.

A productivity-based calculation executed outside the assessment would utilize traits such as growth, maturity, and reproduction. By utilizing fixed biological proxies like 30% or 50% of the spawning potential ratio rather than raw model numbers, this method eliminates reliance on unstable climate metrics, bypassing a decaying temperature index that is unrepresentative of the expanded stock, and smooths out disruptive volatility. Nonetheless, it demands strong parameter estimates that can themselves be dynamic, and it risks oversimplifying shifts in dynamic environments.

The historical environmental variable linkage to E_{MSY} is tied to a running multi-year average of ocean temperature via the CalCOFI sea surface temperature (SST) index, which traditionally produces E_{MSY} values bounded between 0.05 and 0.25 (calculated values have averaged 0.17, never below 0.15). While intuitive for environmentally driven stocks like Pacific sardine, the existing temperature control rule may not apply because it was fitted exclusively using northern sardines and completely ignores highly productive southern sardines spawning in warmer Mexican waters. Furthermore, recent refitting reveals a unimodal response curve where extreme heat waves actually reduce production and weaken the statistical correlation over time.

A fixed-value approach institutes a constant E_{MSY}, such as the value of 0.18 that has historical precedent in Pacific sardine management (Hill et al. 2011, appendix to the stock assessment). This option is highly stable, predictable, and simple to execute within harvest control rules, yet it completely ignores environmental variance and carries the distinct risk of over-harvesting during low-productivity regimes or under-harvesting during boom phases.

A hybrid approach blends the static constant value with an environmental formulaic term. By applying an equal weighting, the extremes are narrowed down to a compressed variability range of 0.115 to 0.215, offering a practical compromise that remains partially responsive to ocean conditions while heavily mitigating annual noise and mitigating uncertainty of correlation between new stock and environmental variables.

Future directions

An exploration of MSE-based E_{MSY} or adaptive productivity-based E_{MSY} is recommended as environmental relationships may change and require a durable framework, while avoiding heavily assessment-derived E_{MSY} unless annual assessments improve.

2.3.3. Acceptable Biological Catch

The Acceptable Biological Catch (ABC) level is currently derived from the OFL, multiplied by a buffer of uncertainty. That buffer fraction is derived from a combination of the P* risk tolerance determined by the Council and a σ value which is based on the category designation of the stock assessment and a time-varying component related to the natural mortality rate *M*. In particular, σ in year n of application of an assessment (n=1 in the first year of application, etc.) is found via:

$\sigma = \sigma_{base}*(1+0.52*M*n)$

We recommend that this approach be maintained.

Notes:

Distribution should be removed (==1) throughout control rules.

Simplifying E_{MSY} would go a long way toward satisfying the CPSAS objection (see CPSAS advisor report in later section) that the ABC calculation is overly complicated. If there is a desire in addition to have set buffers by year from assessment and assessment category, those could be developed and reviewed, and would stand as long as our understanding of natural mortality and assessment uncertainty did not change in a substantial manner.

3. COASTAL PELAGIC SPECIES MANAGEMENT TEAM REPORT ON REVIEW OF MANAGEMENT PROVISIONS FOR PACIFIC SARDINE

3.1. Management Approach in Coastal Pelagic Species Fisheries Management Plan (CPS FMP)

Recommendation: The CPSMT recommends an intensive management approach (i.e., "General" or "Harvest Guideline" control rule) for the newly defined stock ("U.S. stock") of Pacific sardine.

The intensive management approach was used for the northern subpopulation of Pacific sardine (NSP) as it utilizes annual estimates of biomass and is designed to reduce exploitation rates as biomass declines. This approach would best meet relevant goals and objectives in the CPS FMP, including promoting efficiency and profitability in the fishery, stability of catch, achieving optimum yield, providing adequate forage for dependent species, and preventing overfishing.

In addition to the harvest control rule parameters, annual catch limits (ACLs) were discussed during this meeting. ACLs are set annually to avoid exceeding acceptable biological catch (ABC) and can be set equal to or less than the ABC. An annual catch target (ACT) can be put in place so as to not exceed the ACL. This policy has been in place and implemented by the Council for Pacific sardine in past harvest specification cycles and will continue.

The CPSMT will continue to recommend appropriate ABC, ACL, ACT, and accountability measures during upcoming Pacific sardine harvest specifications processes.

3.2. Harvest Guideline Control Rule Parameters

3.2.1. DISTRIBUTION

Recommendation: The CPSMT recommends that the DISTRIBUTION parameter be set to a value of one (1) in the Harvest Guideline (HG) control rule for the U.S. stock, to account for all Pacific sardine in U.S. waters. This is consistent with the Scientific and Statistical Committee Coastal Pelagic Species Subcommittee's (SSC-CPSSC) recommendation for DISTRIBUTION for OFL and ABC, and would be applied to all control rules for Pacific sardine.

3.2.2. FRACTION

Recommendation: The CPSMT recommends that FRACTION remains specified as E_{MSY}.

Language in the CPS FMP on FRACTION could be modified to remove descriptions of a temperature-based E_{MSY} (this is reported in the annual Stock Assessment and Fishery Evaluation (SAFE) report, and state "FRACTION = E_{MSY}." Setting FRACTION equal to E_{MSY} allows FRACTION to change over time with E_{MSY} as new scientific information becomes available. Upper and lower bounds, as described for FRACTION in the FMP, could be applied to E_{MSY}, if determined appropriate by the SSC.

The CPSMT supports the SSC-CPSSC evaluations of the six methods/approaches discussed during the workshop to specify E_{MSY} for the U.S. Pacific sardine stock. The process for determining E_{MSY} established by the SSC should continue to be documented in the SAFE report. When information is insufficient to determine E_{MSY}, the CPSMT supports the use of a default static value or a formulaic hybrid E_{MSY} set by the SSC.

3.2.3. CUTOFF

Recommendation: The CPSMT recommends that CUTOFF be kept in the HG calculation and to apply the value utilized for NSP at 150,000 metric tons (mt).

Pacific sardine has historically experienced large fluctuations in abundance on decadal scales, even in the absence of fishing. Although it is not a requirement of the Magnuson-Stevens Act or National Standards, the CPSMT supports the use of CUTOFF as a precautionary value to protect this stock from exploitation pressures during times of low abundance.

For the NSP, CUTOFF was defined as 150,000 mt. This value was selected from a fisheries simulation analysis of 50,000 mt, 100,000 mt, and 150,000 mt in Amendment 8 (PFMC, 1998). Analysts specifically recommended 100,000 mt or 150,000 mt to safeguard a seed stock and significantly reduce exploitation before reaching MSST. These values were also determined to help prevent a "pulse" fishery and support both relatively high, stable catch and biomass. The CPSMT views a 150,000 mt CUTOFF as the most reasonable option for management of a U.S. Pacific sardine stock, given the performance of this value in simulations for the NSP in Amendment 8 (PFMC, 1998) and in 2014. The CPSMT finds these analyses applicable to the management of a U.S. Pacific sardine stock. The CPSMT discussed the possibility of adjusting CUTOFF as it relates to one of the SSC-CPSSC's recommendations to adjust the minimum stock size threshold (MSST), and found that 150,000 mt would provide an adequate safeguard regardless of the recommended adjustment.

3.2.4. MAXCAT

Recommendation: The CPSMT recommends applying the value utilized for NSP and setting MAXCAT at 200,000 mt for the fishing year.

Maximum catch (MAXCAT) at 200,000 mt was previously analyzed and found to stabilize the fishery and allow high levels of harvest over time when the population is large. Higher levels of MAXCAT were found to result in higher chances of pulse fisheries. Since Amendment 8 of the CPS FMP was adopted (PFMC, 1998), the Pacific sardine HG has not exceeded 186,791 mt (2000) and U.S. landings have not exceeded 127,695 mt (2007).

3.3. Additional Recommendations

The CPSMT recommends further evaluation under different productivity regimes of higher and lower values than those recommended here for FRACTION, CUTOFF, and MAXCAT in the harvest control rules for the U.S. Pacific sardine stock when a benchmark assessment is expected in 2028.

4. Coastal Pelagic Species Advisory Subpanel Report on Review of Management Provisions for Pacific Sardine

The CPSAS supports the reports and recommendations of the management team and the SSC CPS subcommittee and believes the discussions over the joint meeting reflect a thoughtful consideration of the issues that arise in development of management of a single U.S. Pacific sardine stock.

The CPSAS, in particular, is concerned that the development of a management framework for a single stock should fully consider the implications of and the interactions between the different management specifications included within that framework, as well as the impacts on whether the amount of the biomass available to the fishery could be managed as a directed fishery (i.e., whether NMFS could open a directed fishery). In addition, the current formulations of the OFL and HG apply E_{MSY} differently and may impede understanding of these parameters for some stakeholders by giving the impression that total exploitation is substantially higher than permitted.

This occurs because the total exploitation rate of the HG, since it subtracts the CUTOFF from total biomass, does not simply equal the E_{MSY} exploitation rate applied in the OFL and ABC. The OFL applies E_{MSY} (E_{MSY} is proxy for F_{MSY} for Pacific sardine) to the BIOMASS (age+1) as a whole; the HG applies FRACTION (which is equal to E_{MSY}, within certain bounds) to the BIOMASS minus CUTOFF (currently 150,000 mt):

OFL = BIOMASS*E_{MSY}*DISTRIBUTION
ABC = BIOMASS*E_{MSY}*BUFFER*DISTRIBUTION
H = (BIOMASS - CUTOFF)*FRACTION

The subtraction of CUTOFF prior to applying FRACTION in the HG has the effect of reducing the portion of the biomass available to a directed fishery substantially and reducing the effective exploitation rate at biomass levels above but relatively close to CUTOFF. This construct, together with the impracticality of managing a relatively small tonnage fishery, may result in no directed fishery for biomass levels as high as 300,000 mt to 400,000 mt, despite a directed fishery technically being permitted above 150,000 mt. A fishery of the amount generated by these biomass levels (i.e., 25,000 mt to 50,000 mt) may be unmanageable. This outcome is troubling for two reasons. First, descriptions of the fishery's management suggest that a directed fishery is permissible for biomass levels above 150,000 mt. While technically true, such a statement is very misleading to stakeholders, as a substantially higher biomass may be needed to actually open a fishery. Second, the understanding of the management's effect on both the fishery and the sardine biomass may be incomplete. To the extent possible, any future analyses on the U.S. stock (i.e., models and interpretations of models) should consider the potential absence of a directed fishery at levels of biomass relatively close to CUTOFF.

In addition, we ask that both management provisions, and any future modeling to analyze these provisions, consider potential for increasing fish available to the directed fishery at biomass levels relatively close to CUTOFF to ensure that reasonable fishing opportunities are available. For example, a harvest guideline could apply a higher FRACTION to the amount of biomass above CUTOFF when biomass is relatively close to CUTOFF. The result would be an increase in the HG when close to the CUTOFF, but would not change the HG at higher biomass levels. To maintain an upper bound on the total exploitation rate, the total exploitation rate could be capped at E_{MSY} (and subject to the limitation of the ABC).

For example, the HG could be 2 times FRACTION at all levels of biomass where the resulting overall exploitation rate is below E_{MSY} times BUFFER. The following tables show the calculations

for where the resulting HG is less than E_{MSY} times biomass and biomass times E_{MSY} for all higher biomass levels. Note, for simplicity, the tables do not consider the application of BUFFER and do not calculate the ABC, which may be lower than the directed limit calculated in this example. The ACL would always be equal to or lower than the ABC.

HG = (BIOMASS - CUTOFF)*2*FRACTION

where (BIOMASS- CUTOFF)*2*FRACTION<Biomass*E_{MSY}*BUFFER

and
BIOMASS*Emsy*BUFFER for all other Biomass levels.

In this instance, the biomass amount above CUTOFF (i.e., total biomass – CUTOFF, for instance 50,000 mt if BIOMASS is 200,000 mt) would be multiplied by two times the FRACTION, while the total exploitation rate of H would be less than E_{MSY}. Under this example, a manageable fishery may be attainable at biomass levels between 200,000 mt and 300,000 mt. While under the existing structure a biomass level of between 300,000 and 400,000 may be necessary for the directed fishery to open.

The Council could also set a lower ACL for OY considerations as necessary through the harvest specifications process.

Table 2. Exploitation rates at increasing biomass levels under proposed example

Fraction	**0.18**		
(Biomass - Cutoff)*Fraction			
Biomass	**Excess Biomass**	**Directed Limit**	**Overall Exploitation Rate**
150,000	-	-	0
200,000	50,000	9,000	0.05
250,000	100,000	18,000	0.07
300,000	150,000	27,000	0.09
400,000	250,000	45,000	0.11
500,000	350,000	63,000	0.13
(Biomass - Cutoff)*Fraction*2			
Biomass	**Excess Biomass**	**Directed Limit**	**Overall Exploitation Rate**
150,000	-	-	-
200,000	50,000	18,000	0.09
250,000	100,000	36,000	0.14
300,000	150,000	54,000	0.18
400,000	250,000	72,000	0.18
500,000	350,000	90,000	0.18

Other means of calculating increasing availability of a reasonable portion of the biomass to the directed fishery could also be explored. In any case, analysis and consideration of any future management should reflect the true potential for a directed fishery at levels of biomass relatively close to CUTOFF.

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