

PACIFIC MACKEREL HARVEST GUIDELINE FOR 2006-2007 SEASON

The Council is scheduled to review the current Pacific mackerel stock assessment and adopt a harvest guideline for the 2006-2007 Pacific mackerel fishing season, which opens July 1, 2006.

The 2005/2006 Pacific mackerel harvest guideline was 17,419 metric tons (mt) with a directed fishery of 13,419 mt and a reserve of 4,000 mt. This reserve was to be used for incidental landings following a potential closure of the directed fishery. As of mid-May 2006, approximately 4,370 mt of Pacific mackerel had been landed.

On May 16-18, the Scientific and Statistical Committee (SSC) Coastal Pelagic Species (CPS) Subcommittee, the Coastal Pelagic Species Management Team (CPSMT), and the Coastal Pelagic Species Advisory Subpanel (CPSAS), held meetings to review the Pacific mackerel stock assessment as prepared by staff at the National Marine Fisheries Service, Southwest Fisheries Science Center (Agenda Item C.1.a, Attachment 1). Reference materials include CPSMT and CPSAS statements with recommendations on the harvest guideline and management measures for 2006-2007. The full SSC will prepare a supplemental statement at the June meeting.

The CPSMT has completed the seventh annual Status of the Pacific Coast CPS Fishery and Recommended Harvest Guidelines – Stock Assessment and Fishery Evaluation (SAFE) – 2006 document (Agenda Item C.1.a, Attachment 2). This document is included in an electronic format on the briefing book CD and is posted on the Council web page. Stock assessment and management recommendations can be found in Chapter 3 and Chapter 9. Once adopted, the 2006 Pacific Mackerel Stock Assessment and Stock Assessment Review Panel report will be included in the 2006 CPS SAFE as Appendix 2.

Council Action: Adopt Pacific Mackerel Harvest Guideline for the 2006/2007 Fishery.

Reference Materials:

1. Agenda Item C.1.a, Attachment 1: *Assessment of the Pacific Mackerel (Scomber japonicus) Stock for U.S. Management in the 2005-2006 Season.*
2. Agenda Item C.1.a, Attachment 2 (**electronic copy on Council Briefing Book CD**): *Status of the Pacific Coast Coastal Pelagic Species Fishery and Recommended Acceptable Biological Catches – Stock Assessment and Fishery Evaluation 2006.*
3. Agenda Item C.1.b, CPSAS Report.
4. Agenda Item C.1.b, CPSMT Report.

Agenda Order:

- a. Agenda Item Overview
- b. Reports and Comments of Advisory Bodies
- c. Public Comment
- d. **Council Action:** Adopt Harvest Guideline for 2006-2007 Season

Mike Burner

**PACIFIC MACKEREL (*Scomber japonicus*) STOCK ASSESSMENT FOR U.S.
MANAGEMENT IN THE 2006-07 FISHING YEAR**

by

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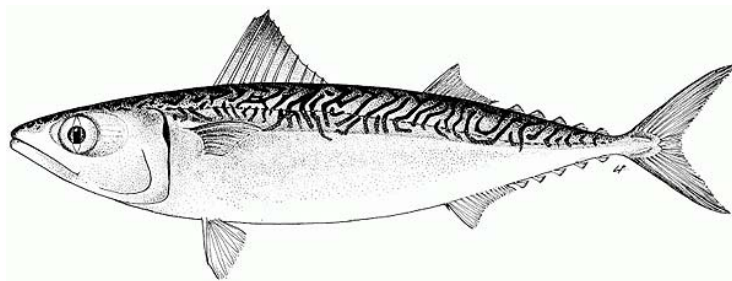


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PREFACE

A Pacific mackerel stock assessment is conducted annually in support of the Pacific Fishery Management Council (PFMC) process, which ultimately establishes a harvest guideline (HG or quota) for the fishery that operates off the U.S. Pacific coast. The HG for mackerel applies to a fishing/management season that spans from July 1st and ends on June 30th of the subsequent year (i.e., a ‘fishing year’ basis). The primary purpose of the assessment is to provide an estimate of current abundance (in biomass), which is used in a harvest control rule for calculation of annual-based quotas. For details regarding this species’ harvest control rule, see Amendment 8 of the Coastal Pelagic Species (CPS) Fishery Management Plan (FMP), section 4.0 (PFMC 1998).

The last assessment and quota-setting process was completed in June 2005—setting a 2005-06 ‘fishing year’ (July 1, 2005 – June 30, 2006) quota of 17,419 mt. The 2006-07 stock assessment presented here is an ‘update’ based on the ASAP model presented to the PFMC in 2005 (see Hill and Crone 2005). In this context, this updated assessment includes an additional year of data associated with sample information used in the overall assessment (e.g., from ongoing fishery-dependent and fishery-independent sampling programs), with similar model parameterizations as the analysis conducted in 2005. Also, sensitivity analysis related to the ASAP (2006) baseline model was conducted based on recommendations from previous reviews within the Science and Statistical Committee (SSC) and Coastal Pelagic Species Management Team (CPSMT) forums. In this context, an ‘updated’ stock assessment is presented here that follows PFMC protocols for ‘off year’ (i.e., years in which no Stock Assessment Review, STAR, takes place) population assessments of coastal pelagic species. Readers interested in further details regarding the sample data and model parameterizations used in this assessment should consult Hill and Crone (2005). The next formal STAR for Pacific mackerel is scheduled for 2007. Finally, electronic versions of model programs, input data, and displays (table and figures) can be obtained from the authors directly.

Stock distribution

There are possibly three spawning stocks of Pacific mackerel (*Scomber japonicus*) along the Pacific coasts of the U.S. and Mexico: one in the Gulf of California; one in the vicinity of Cabo San Lucas; and one extending along the Pacific coast north of Punta Abreojos, Baja California. The latter “northeastern Pacific Ocean” stock is harvested by fishers in the U.S. and Baja California, Mexico, and is considered in this assessment.

In terms of the U.S.-related management of this species through the PFMC, the northeastern Pacific Ocean population assessed here is considered an independent stock, with no area- or sector-specific allocations. The PFMC’s harvest control rule does, however, prorate the seasonal HG by a 70% portion assumed to reside in U.S. waters, see PFMC (1998) and Management below.

Data

Landings

Pacific mackerel landings from both commercial and recreational fisheries in California and commercial landings in Baja California represent the catch time series (1929-06) used in the

assessment, with estimates from all three fishing sectors pooled and treated as a single fishery within the model. Landings were aggregated on a fishing year (see Preface above) basis (Figure 1). For purposes of providing a HG for the 2006 fishing year (July 1, 2006-June 30, 2007), we assumed landings for April-June 2006 and July 2006-June 2007 would be similar to analogous periods in the previous 2005 fishing year; namely, April-June 2005 and then subsequently, July 2005-June 2006.

Additionally, biological data are collected through a California Department of Fish and Game (CDFG) port (commercial) sampling program. The CDFG has collected biological data on Pacific mackerel landed in the San Pedro (southern California) fishery since 1929. Biological data include the following specimen-based information: weight (whole in g), length (fork in mm), sex, maturity, and otoliths for age determination. Further, to some degree, port sampling data have been collected by researchers from Ensenada, Mexico (Instituto Nacional de la Pesca, INP) since 1989, but this information has not been made available to U.S.-based research teams. Thus, particular stock parameter assumptions (e.g., catch-at-age and weight-at-age distributions) used in the assessment model necessarily are based on using (assuming) sample data applicable to the California commercial fishery. We feel that a lack of Baja California port sampling data is not a serious problem for years when catches from the Mexico fleet are relatively low; however, recently, landings from both fisheries are assumed to be roughly equivalent, which potentially could introduce substantial bias inherent in unrepresentative sampling efforts (see Research and data needs below). The CDFG sample sizes relative to total landings are presented Hill and Crone (2005).

Biological parameters

Catch-at-age

Various sources were used to reconstruct a catch-at-age time series for Pacific mackerel (Hill and Crone 2005). For the most part, age determinations involved ageing research based on otoliths. Seven age classes represent the overall population, beginning with age-0 fish and ending with a 'plus group' for age 6 and older (Figure 2)

Weight-at-age

Year-specific weight-at-age distributions (i.e., a matrix) from fishery samples were developed for inclusion in the assessment model. This matrix was used to calculate population biomass (\geq age-1 fish, B) and spawning stock biomass (SSB) from estimated population abundance (by age in numbers of fish, N) generated from the model efforts. While it is possible that the weight estimates associated with the population-at-large differ from those derived through commercial fishery samples, no such fishery-independent data exist to further explore this uncertainty and thus, we assumed growth was similar for both the population and the fisheries that exploit it.

Maturity-at-age

Maturity schedules were not year-specific, but rather assumed consistent from year-to-year (1929-06): age 0=0%; age 1=7%; age 2=25%; age 3=47%; age 4=73%; ages \geq 5=100%.

Natural mortality-at-age

Natural mortality estimates were assumed constant across all ages (0- \geq 6) and years (1929-05), $M=0.5 \text{ yr}^{-1}$.

Survey indices of abundance

Fishery-independent survey data used in the ASAP model include (Figure 3): (1) an index ('proportion positive') of spawning abundance based on ichthyoplankton data collected through the ongoing CalCOFI survey; (2) a standardized, catch-per-unit-effort (CPUE) index from California-based commercial passenger fishing vessel (CPFV) logbooks; and (3) a standardized, index of total abundance from aerial 'spotter' plane survey data. The selectivity distributions associated with these three indices are presented in Figure 4 (bottom display). Ultimately, the three survey abundance indices for Pacific mackerel vary in quality both spatially and temporally; however, following recommendations from the previous STAR (conducted in 2004), no single index is proposed to be superior with respect to comprehensiveness or sampling design. Strengths and weaknesses of each survey program are presented in Hill and Crone (2005).

Assessment model

The stock assessment model for Pacific mackerel was developed using a forward-simulation, maximum likelihood-based Age-structured Assessment Program (ASAP). The ASAP model is based on the 'Automatic Differentiation Model Builder' (ADMB) software environment, which is essentially a C++ library of automatic differentiation code for nonlinear statistical optimization. Hill and Crone (2005) and Legault and Restrepo (1998) provide additional details concerning the ASAP modeling platform.

The final (baseline) ASAP model was based on fishery-dependent data from a single fishery, i.e., combined landings from California's commercial and recreational fisheries, and the fishery off Baja California, Mexico (see above). Fishery-independent data used in the model consisted of three relative abundance time series (survey indices) described above. In general, parameterization of the ASAP (2006) baseline model was similar to the final configuration accepted in the previous assessment conducted in 2005. That is, this year's modeling efforts included sensitivity analysis that resulted in a relatively robust baseline model that generally mimicked the model scenario developed in 2005. Sensitivity analysis addressed both time-varying effective sample sizes (1929-60 and 1961-05) and selectivity (1929-65 and 1966-05) associated with the fishery (catch-at-age) data included in the model (Table 1B). Additionally, preliminary sensitivity analysis involved further examining error assumptions associated with recruitment estimation (recruitment 'deviations' from the stock-recruitment relationship), as well as steepness associated with the stock-recruitment relationship. Finally, given the limited scope of this updated assessment, further details (diagnostics, related parameterizations, and results say) regarding the ASAP (2006) baseline model will be made available at the upcoming meeting in May 2006.

Results

Overview

As stated previously, sensitivity analysis resulted in a robust ASAP (2006) baseline model. Results are presented under several broad categories, including likelihood component estimates (Table 1A), as well as other pertinent model-related estimates (e.g., fishery selectivity, fits to survey indices, and stock-recruitment relationship for Figures 4-6, respectively) and finally, management-related estimated time series (e.g., fishing mortality, biomass, spawning stock biomass, and recruitment for Figures 7-10, respectively). Model scenarios associated with

sensitivity analysis (conducted resulted in generally similar findings as the baseline model; critical statistics from these model runs are presented in Table 1B.

Fishery selectivity

In general, an asymptotic fishery (catch-at-age distribution) selectivity ogive was estimated within the ASAP (2006) baseline model, with full selection at age 5 and slightly lower selectivity for the plus group (\geq age-6 fish), see Figure 4 (top display).

Fits to survey indices

Fits to survey indices are presented in Figure 5. For all of the indices, recent data points were fit relatively well, with some poorly fit years earlier in the time series depending on the index of interest. For example, the abbreviated (i.e., ends in 2000) spotter index of abundance was poorly fit in the middle of the time series in the baseline configuration, as well as other scenarios in the overall sensitivity analysis.

Stock-recruitment relationship

The estimated Beverton-Holt (B-H) stock-recruitment relationship for the ASAP (2006) baseline model is presented in Figure 6. As indicated in last year's assessment findings, the baseline model configuration in 2006 resulted in a relatively low estimated steepness (0.36), i.e., minor compensatory processes acting on the spawning stock at low absolute levels of abundance.

Fishing mortality-at-age

Estimated fishing mortality (F)-at-age time series for the ASAP (2006) baseline model are presented in Figure 7.

Biomass

The estimated time series of population biomass (\geq age-1 fish, B) for the ASAP (2006) baseline model is presented in Figure 8. Estimated B for the 2006 fishing year (July 2006-June 2007) was 112,700 mt. As stated previously, the overall B time series from this year's baseline model generally mimicked that estimated in 2005.

Spawning stock biomass

The estimated time series of spawning stock biomass (SSB) for the ASAP (2006) baseline model is presented in Figure 9.

Recruitment

In general, estimated recruitment (age-0 fish, R) was loosely constrained to a B-H stock-recruitment relationship (see above) in the ASAP (2006) baseline model (Figure 10). That is, given that these models are typically highly parameterized, convergence problems and/or unrealistic estimated recruitment precluded strictly unconstrained estimation of this stock parameter; however, the compensatory productivity of the population at low adult stock sizes (i.e., the 'steepness' parameter) was freely estimated.

Management

A federal FMP for CPS, including Pacific mackerel, was implemented by the PFMC in January 2000 (PFMC 1998), see Preface above. The FMP's harvest policy for Pacific mackerel,

originally implemented by the State of California, is based on MacCall et al. (1985) simulation analysis, with the addition of a proration to nominally account for the portion of the stock assumed to inhabit U.S.-based waters. In Amendment 8 to the CPS FMP (PFMC 1998), the recommended maximum sustainable yield (MSY) harvest control rule for Pacific mackerel was:

$$\text{HARVEST}_{06} = (\text{BIOMASS}_{06} - \text{CUTOFF}) \bullet \text{FRACTION} \bullet \text{DISTRIBUTION},$$

where HARVEST_{06} is the U.S. HG_{06} for the 2006 fishing year (July 2006-June 2007), CUTOFF (18,200 mt) is the lowest level of estimated biomass (B) at which harvest is allowed, FRACTION (0.3) is the fraction of B above the CUTOFF that can be harvested by fisheries, and DISTRIBUTION (0.7) is the average fraction of total B in U.S. waters. BIOMASS_{06} (112,700 mt) is the estimated B_{06} as of July 1, 2006. Based on this harvest control rule, the HG_{06} is 19,845 mt, which reflects a quota that pertains to the 2006 fishing year (July 2006-June 2007):

B_{06} (mt)	Cutoff (mt)	Fraction	Distribution	HG_{06} (mt)
112,700	18,200	0.3	0.7	19,845

Finally, it is important to note that over the last several fishing years, the U.S.-based commercial fishery has not realized the recommended HGs (Figure 11, top display). However, uncertainty (to some degree) still exists concerning the magnitude of fisheries in Mexico that harvest Pacific mackerel and thus, caution is recommended when interpreting catch vs. HG statistics (see Landings above and Research and data needs below). In this context, total landings (including U.S. commercial, U.S. recreational, and Mexico commercial fisheries) vs. ‘hypothetical,’ population-wide HGs (i.e., ignoring the ‘U.S. Distribution’ parameter in the harvest control) are presented in Figure 11 (bottom display).

Research and data needs

Since the late 1920s, California's Pacific mackerel fishery has been sampled by CDFG for purposes of collecting biological (size/age) data that largely serve as the foundation for catch-at-age modeling efforts. However, as previous assessments have noted, biological data from the Mexico-based fishery are generally lacking and further, coalescing catch statistics from this fishery is also somewhat problematic. Thus, NOAA Fisheries (Southwest Fisheries Science Center) continues to emphasize collaborative data exchange with Mexico (INP, Ensenada) researchers to ensure assessment-related results accurately reflect this trans-boundary fish population. Finally, although the ASAP model is a sound modeling platform for analyzing fishery-related data, it is not possible to evaluate some parameterization (including diagnostics) issues inherent in fishery assessments and thus, efforts have begun to develop a length-based, age-structured population analysis for this stock using the Stock Synthesis 2 (SS2) modeling platform (Methot 2005a, 2005b). It is expected that alternative, SS2 model configurations for Pacific mackerel will be presented at the next formal STAR scheduled in 2007.

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- Pacific Fishery Management Council (PFMC). 1998. Amendment 8: (To the northern anchovy fishery management plan) incorporating a name change to: The coastal pelagic species fishery management plan. Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 200, Portland, OR, 97220.

Table 1. Estimated likelihood components for the ASAP (2006) baseline model, display (A): n =number of observations in that component; λ =weight given that component, RSS =residual sum of squared deviations; and L =likelihood value. Sensitivity analysis associated with ASAP (2006) baseline model, display (B): scenario=parameterization revision; SSB_0 =estimated virgin SSB (mt); SSB_{06} =estimated 2006 SSB (mt); steepness=estimated steepness from stock-recruitment relationship; and L_{total} =total likelihood value.

(A)

Component	n	λ	RSS	L	% of Total
Catch (weight) - fishery	78	101	0.0196	1.98	0.2%
Catch-at-age (proportions) - fishery	546	na	na	395.92	33.8%
Fits - Survey indices					
Spotter	37	1	81.92	452.63	
CPFV	63	1	16.78	58.74	
CalCOFI	45	1	27.04	129.28	
All	145	3	125.78	640.89	54.8%
Recruitment (deviations)	78	1	20.08	20.08	1.7%
Stock-recruit fit	78	1	20.08	110.95	9.5%
F penalty	546	0.001	0.5017	0.0005	<1%
Number of estimated parameters (Total)	181	na	na	na	
Objective function (Total)	na	na	na	1,169.81	100%

(B)

Scenario ¹	SSB_0	SSB_{06}	Steepness	L_{total}
(1) Baseline model	212,783	32,171	0.36	1,169.81
(2) Time-varying selectivity - Fishery	236,515	34,873	0.35	1,076.78
(3) Time-varying effective sample sizes - Fishery	272,185	39,119	0.34	1,219.23

¹Scenario denotes: (1) final, ASAP (2006) baseline model configuration; (2) model configuration with fishery-related selectivity parameterization based on two time periods (1929-65 and 1966-05); and (3) model configuration with fishery-related effective sample sizes (catch-at-age) based on two time periods (1929-60 and 1961-05).

Landings (mt)

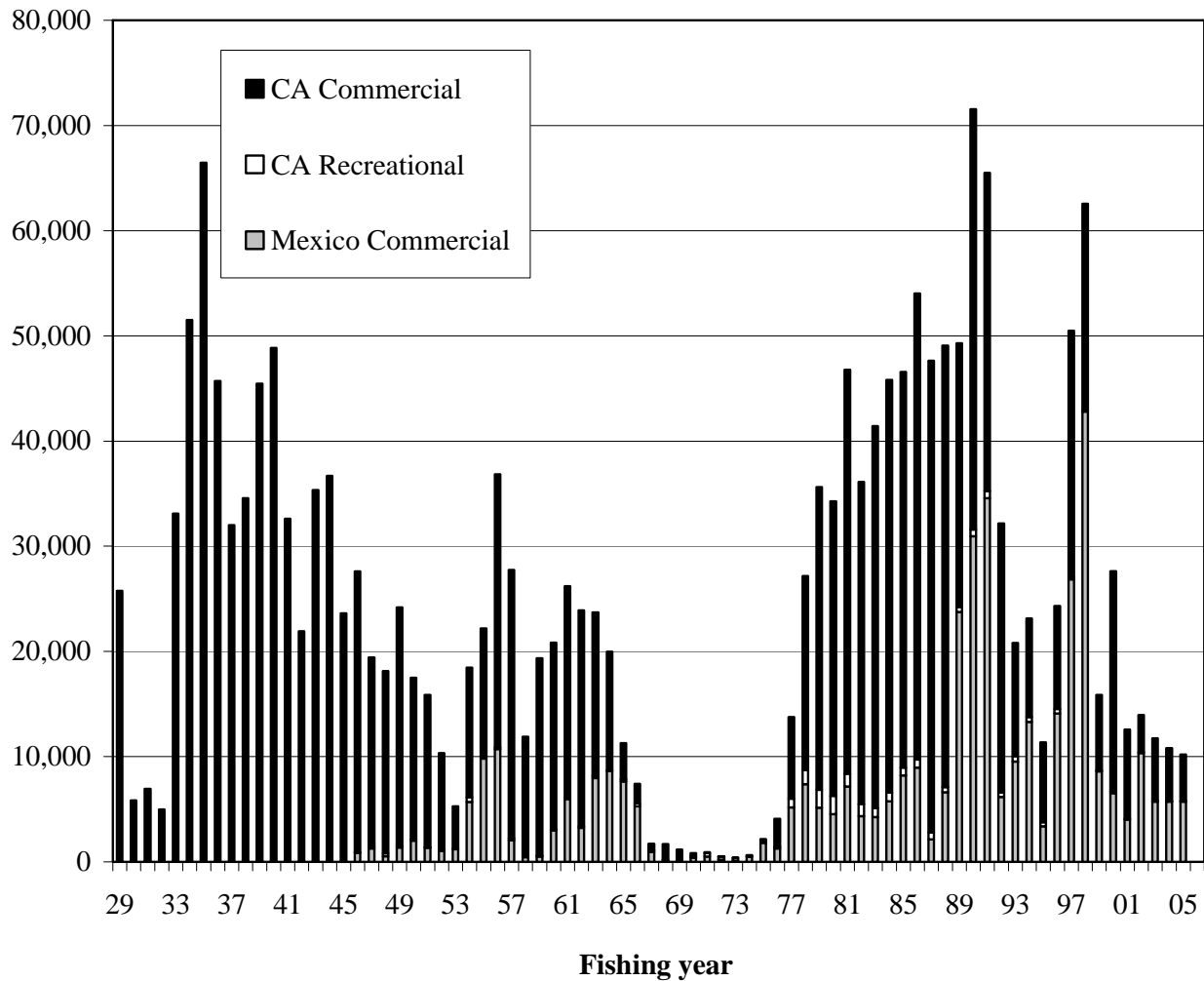


Figure 1. Commercial and recreational landings (mt) of Pacific mackerel in California (CA) and Baja California (MX), for 1929-05. Data from 1929-76 are based on a May-April 'fishing year,' and data from 1977-05 are based on a July-June 'fishing year.'

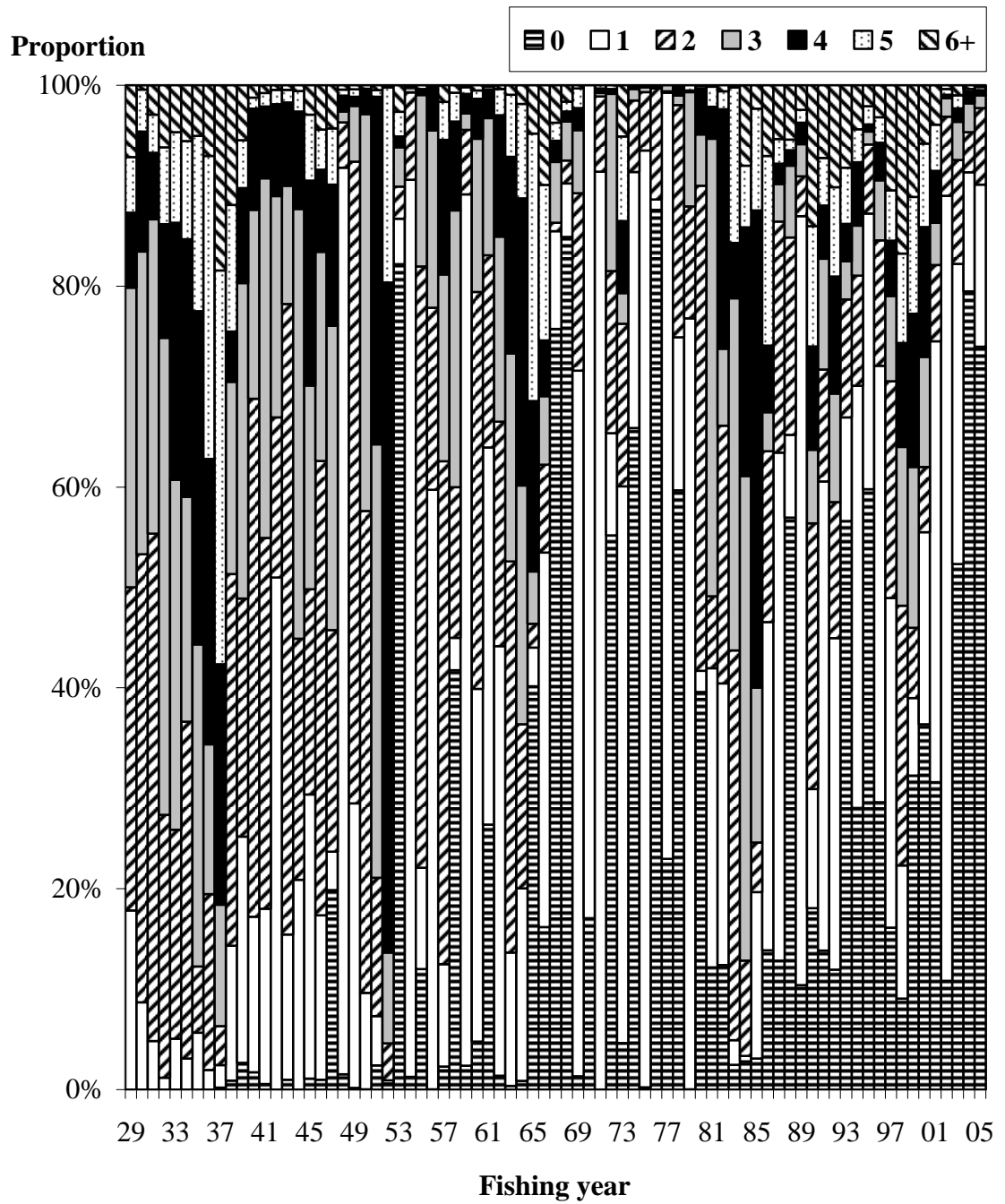


Figure 2. Pacific mackerel catch-at-age (in proportion) estimates used in the ASAP (2006) baseline model (1929-05).

Relative abundance

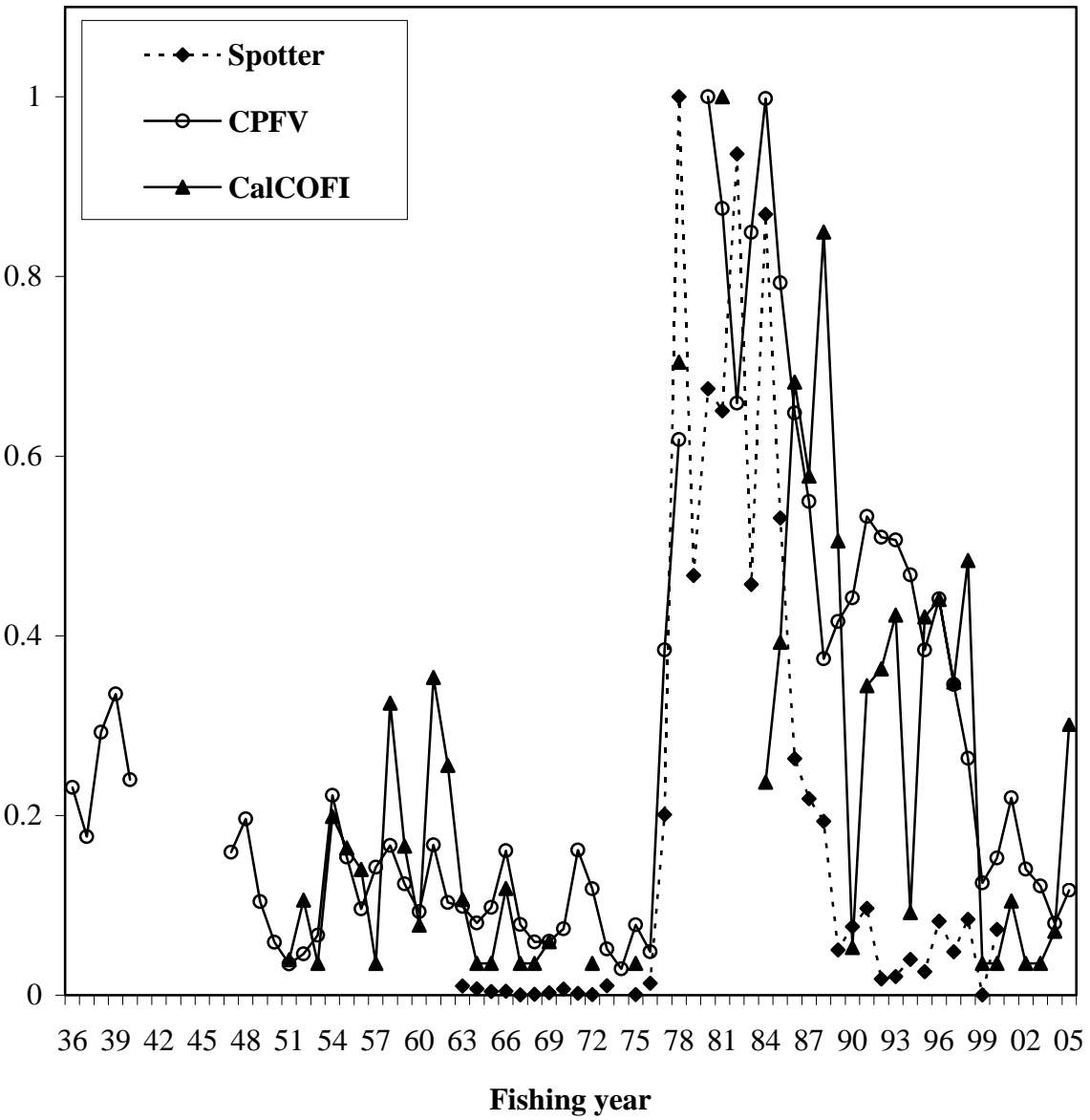


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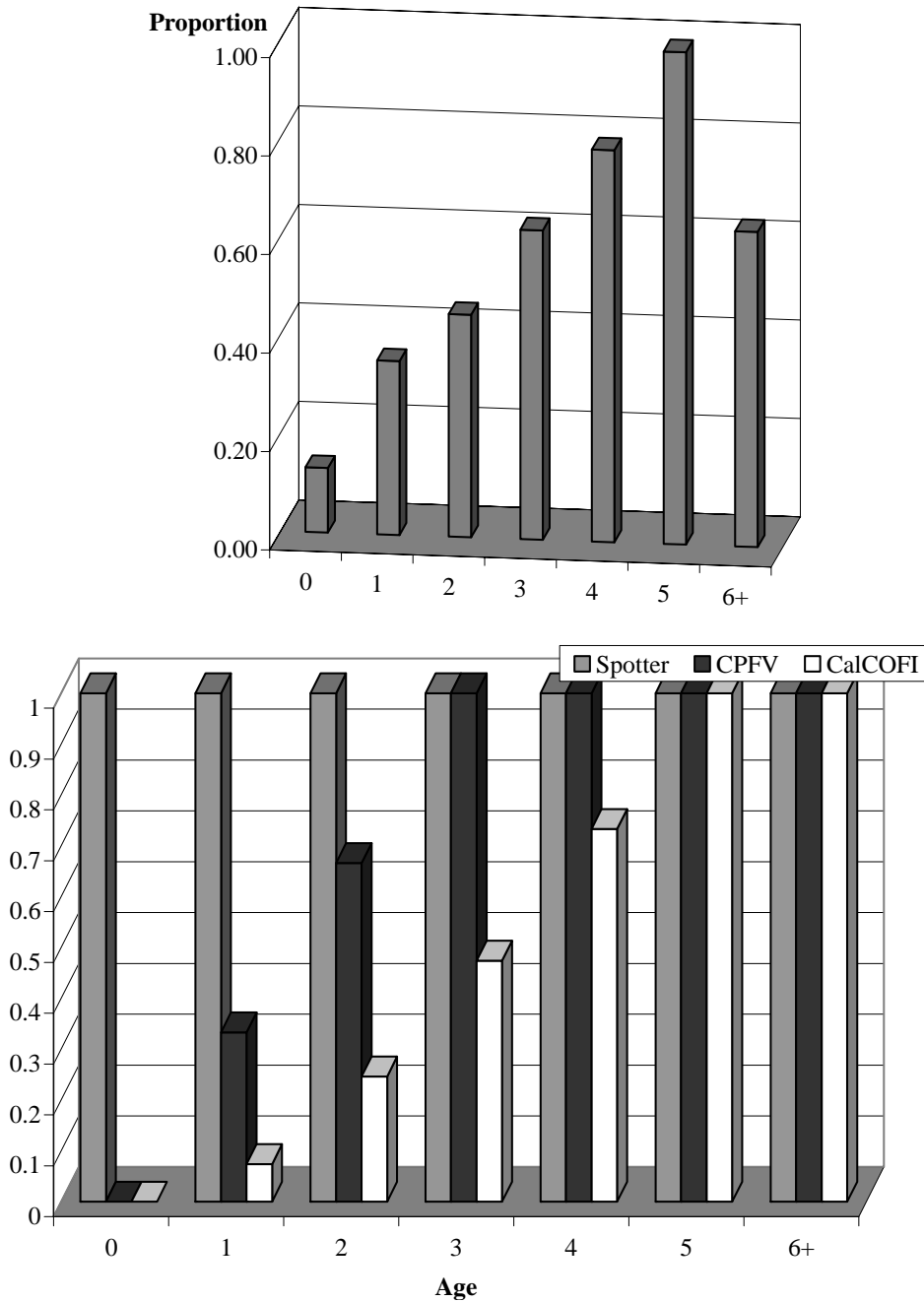


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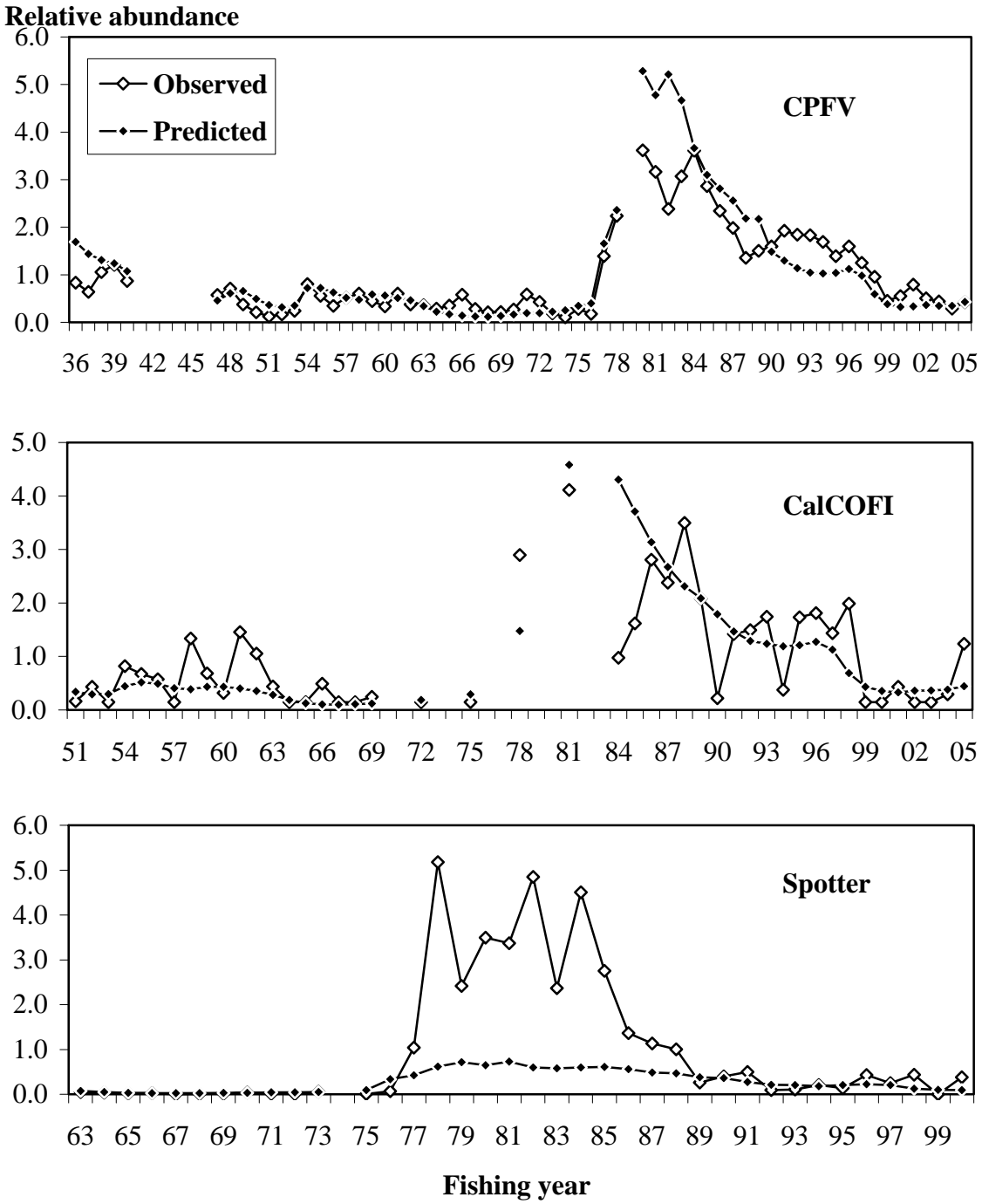


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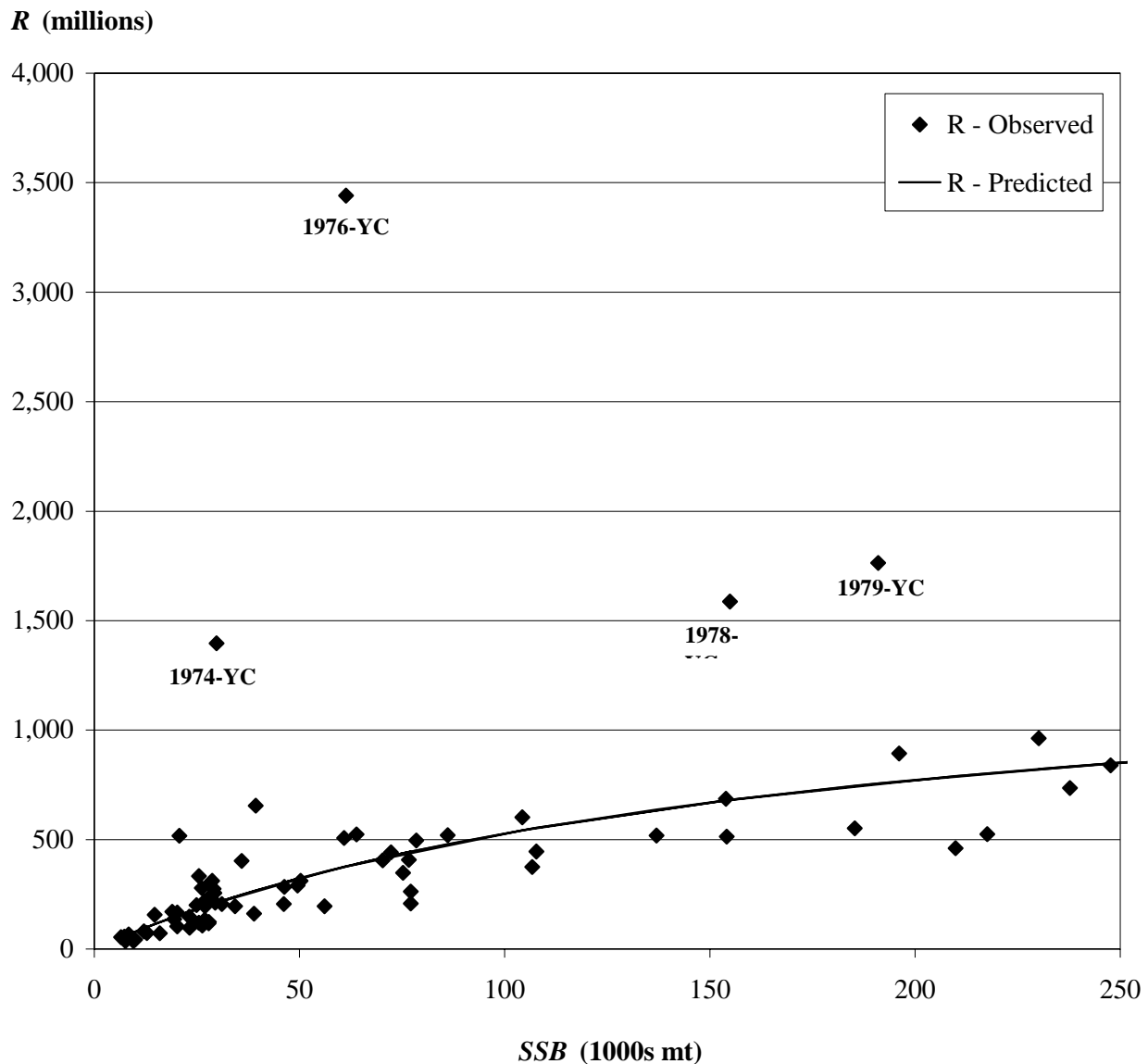


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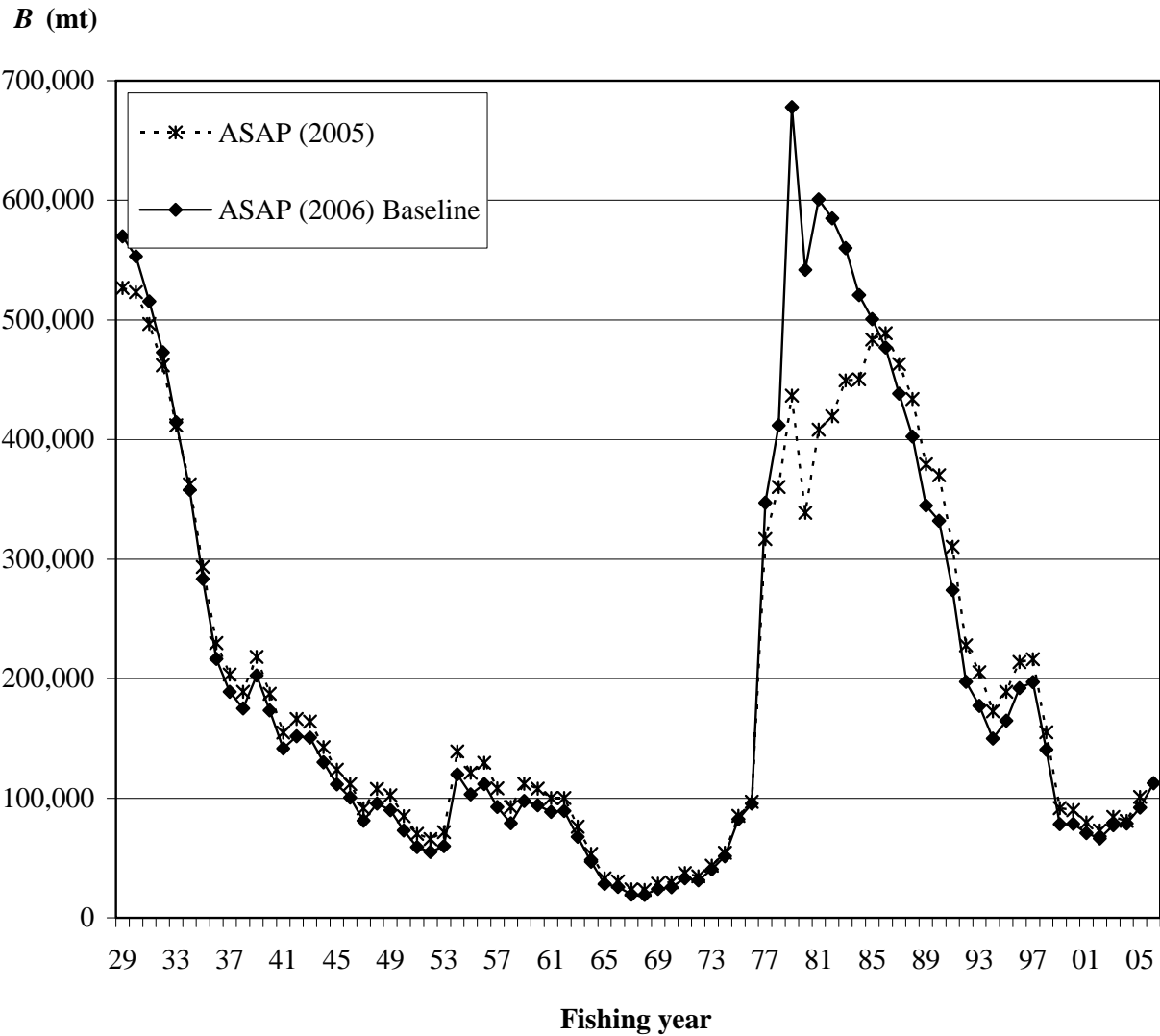


Figure 8. Estimated biomass (>age-1 fish, B in mt) of Pacific mackerel generated from the ASAP (2006) baseline model (1929-06). Estimated B for ASAP (2005) baseline model is also presented.

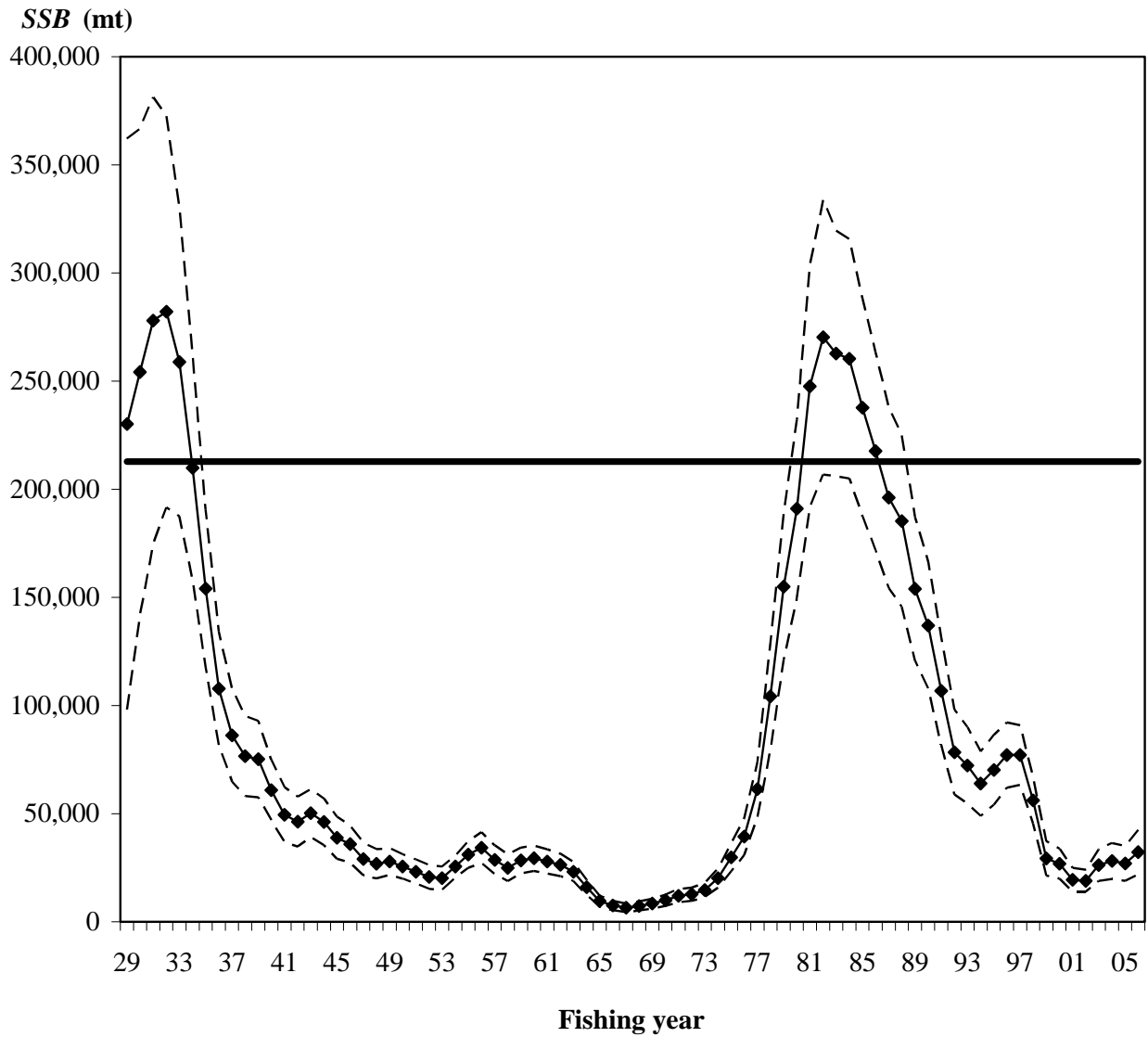


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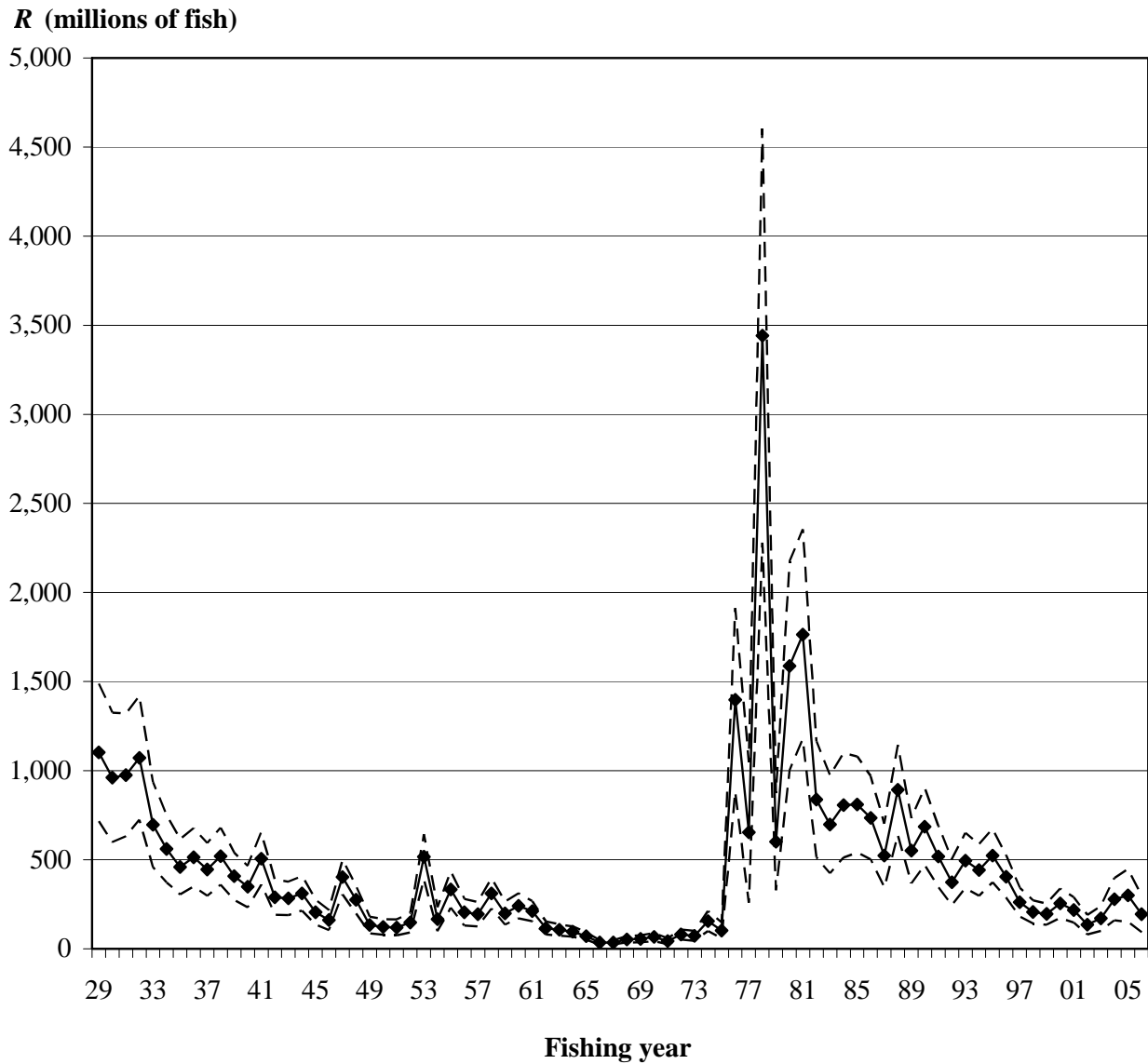


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Landings (mt)

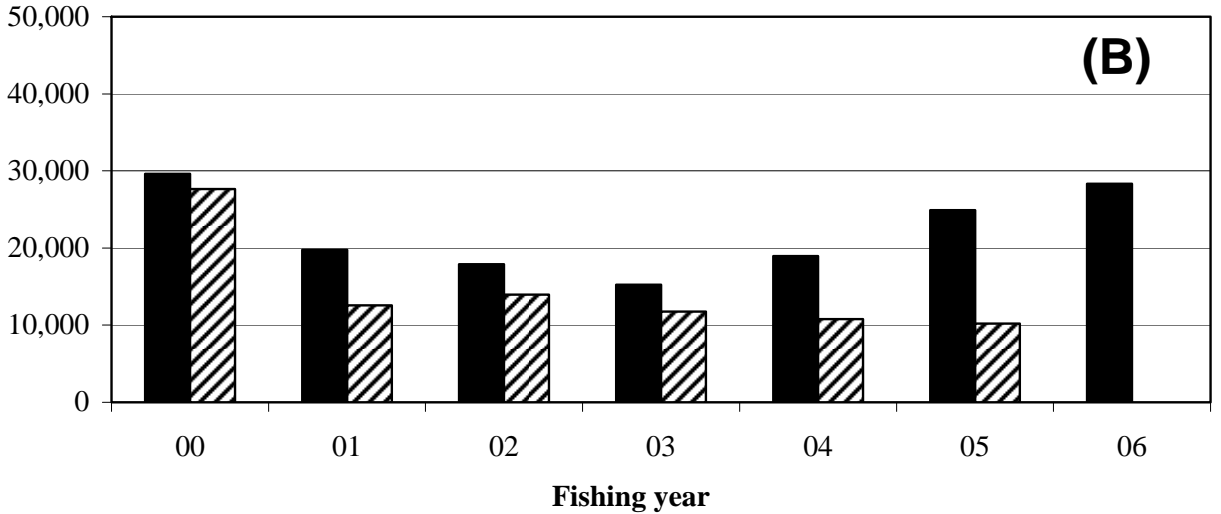
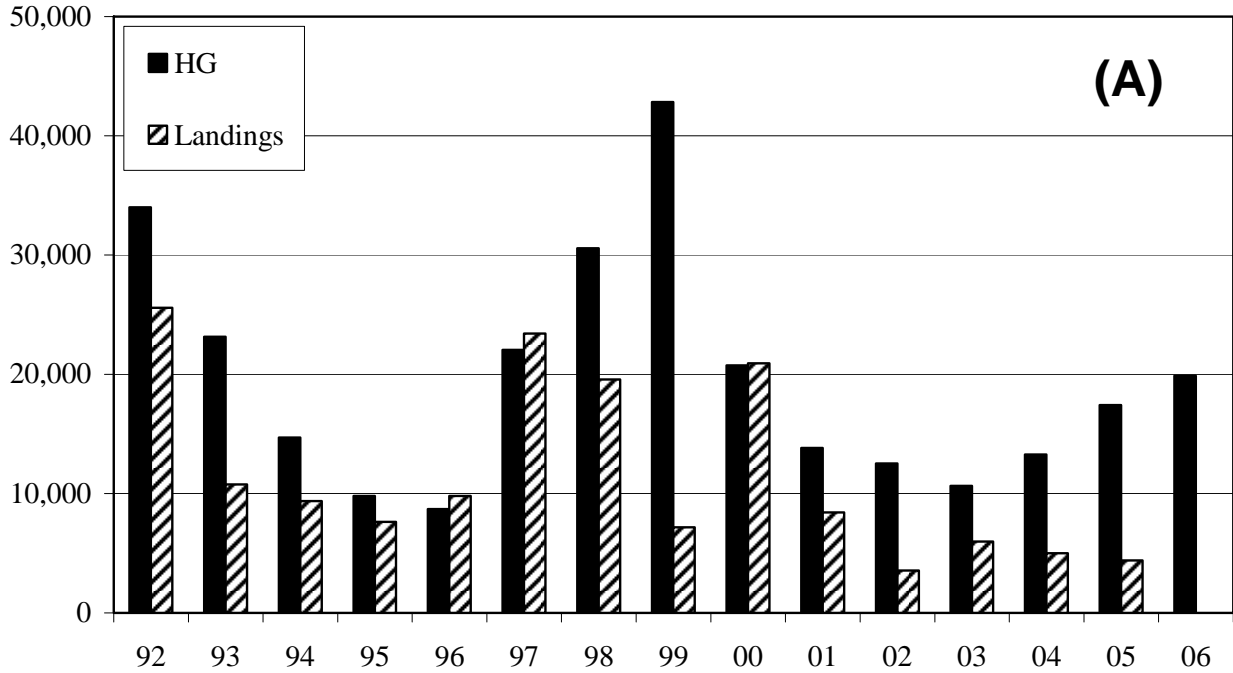


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COASTAL PELAGIC SPECIES ADVISORY SUBPANEL STATEMENT ON PACIFIC
MACKEREL HARVEST GUIDELINE FOR THE 2006/2007 SEASON

The Coastal Pelagic Species Advisory Subpanel (CPSAS) heard a report from Dr. Paul Crone of the Coastal Pelagic Species Management Team (CPSMT) regarding the Pacific mackerel stock assessment and proposed harvest guideline for the 2006-2007 season. Dr. Crone reported that the 2006-07 assessment, developed using the ASAP model, resulted in a biomass estimate of 112,700 mt, higher than the previous year.

Based on the most recent information, the CPSMT is recommending a harvest guideline of 19,845 mt for the 2006-2007 season, an increase of 2,426 mt from 2005-06 (17,419 mt).

Based on this harvest guideline, the CPSAS is recommending a directed fishery for 13,845 mt to begin on July 1, 2006. There will be 6,000 mt as a set aside for the incidental fishery. After the directed fishery quota is reached, the fishery would revert to an incidental-catch-only fishery. Under this incidental-catch-only fishery, the CPSAS recommends a 40% incidental catch rate when Pacific mackerel are landed with other coastal pelagic species (CPS), except that up to 1 mt of Pacific mackerel could be landed without landing any other CPS.

The CPSAS recommends an in-season review of the mackerel season for the March 2007 Council meeting, if needed, with the possibility of re-opening the directed fishery as an automatic action if a sufficient amount of the harvest guideline remains.

The CPSAS is concerned about the accuracy of Pacific mackerel landings data from Mexico and notes that the magnitude of Pacific mackerel landings in Mexico may be underestimated. The CPSAS recommends the Council send letter to the organizers of the Trinational Sardine Forum, including National Marine Fisheries Service - Southwest Fishery Science Center, requesting that Pacific mackerel issues be included in the forum's proceedings.

PFMC
05/24/06

COASTAL PELAGIC SPECIES MANAGEMENT TEAM STATEMENT ON
PACIFIC MACKEREL HARVEST GUIDELINE FOR THE 2005/2006 FISHERY

The Coastal Pelagic Species Management Team (CPSMT) met in a joint session with a subcommittee of the Scientific and Statistical Committee to review the current stock assessment update for Pacific mackerel. The CPSMT supported conclusions from the most recent Pacific mackerel stock assessment presented at the Southwest Fisheries Science Center in La Jolla, California in May 2006 and further recommends the Pacific Fishery Management Council (Council) implement the resulting harvest guideline (HG) associated with the harvest control rule stipulated in this species' fishery management plan (FMP) for the 2006/2007 management season (i.e., July 1, 2006 through June 30, 2007). Based on a total stock biomass estimate (July 1, 2005) of 112,700 mt, the HG for U.S. fisheries is 19,845 mt. This HG recommendation is roughly 14% greater than the HG adopted by the Council for the 2005/2006 fishing year (17,419 mt).

Stock assessment modeling of Pacific mackerel was conducted using a forward-simulation, maximum likelihood-based Age-structured Assessment Program (referred to as ASAP). The final ASAP model was based on fishery-dependent data from a single fishery (i.e., combined landings from California's commercial and recreational fisheries, and the fishery off Baja California, Mexico). Fishery-independent data used in the model consisted of relative abundance time series (indices) developed from three research surveys: an index ('proportion positive') of spawning abundance based on ichthyoplankton data collected through the ongoing California Cooperative Oceanic Fisheries Investigations (CalCOFI) survey; a standardized, catch per unit effort (CPUE) index from California-based commercial passenger fishing vessel (CPFV) logbooks; and an index of total abundance from aerial spotter plane survey data. Parameterization of the ASAP (2006) baseline model was identical to the 2005 stock assessment.

Finally, 'overfishing' for Pacific mackerel is defined in the CPS FMP as harvest exceeding acceptable biological catch (ABC) for two concurrent years. Recent U.S. annual landings have been well below ABCs or the harvest guideline. The 'cutoff' value (18,200 mt) in the harvest control rule essentially serves as a proxy for a minimum stock size threshold. The current total stock biomass estimate (112,700 mt) is well above this threshold level. It is important to note that over the last several fishing years, the U.S.-based commercial fishery has not realized the recommended HGs. However, uncertainty still exists concerning the magnitude of fisheries in Mexico that harvest Pacific mackerel and thus, caution is recommended when evaluating fishery impacts on transboundary Pacific mackerel stocks.