NATIONAL MARINE FISHERIES SERVICE REPORT

Mr. Mark Helvey (NMFS SWR) will provide the Council a report on the 2011 and 2012 coastal pelagic species (CPS) fisheries, and other recent activities. Dr. Russ Vetter will give a brief report on the Southwest Fisheries Science Center’s research activities.

Council Task:

Discussion.

Reference Materials:

1. Agenda Item F.1.b, NMFS Report.
2. Agenda Item F.1.c, NMFS SWFSC Report.

Agenda Order:

a. Agenda Item Overview Kerry Griffin
b. Regulatory Activities Mark Helvey
c. Fisheries Science Center Activities Russ Vetter
d. Reports and Comments of Advisory Bodies and Management Entities
e. Public Comment
f. Council Discussion

PFMC
06/04/12
**SWR Overview of Coastal Pelagic Species Workshop II: Considerations for Rights Based Management in the Pacific Sardine Fishery**

NMFS’ Southwest Regional Office and Southwest Fisheries Science Center convened a two-day workshop on April 24-25, 2012, in Monterey, California to explore rights-based management (RBM) approaches as a possible mechanism for improving management of the Pacific sardine fishery. The workshop was a follow-on to the San Francisco workshop convened in February, 2010 that looked primarily at international catch share programs. Similar to the previous workshop, the workshop was framed around information sharing about existing RBM programs operating in the Pacific, North Pacific, Gulf of Mexico, and New England Councils and how they may be useful when considering opportunities for an RBM approach in the Pacific sardine fishery. Key objectives were to: 1) review industry’s key issues and objectives related to the future of the sardine fishery, both coastwide and regionally; 2) identify how similar issues and objectives have been addressed through RBM approaches adopted elsewhere and consider lessons learned; 3) explore key elements of RBM programs and discuss industry's perspectives on existing and potential possibilities within each element; and, 4) identify follow-on steps needed to further consider rights-based management or other approaches.

Approximately forty participants including commercial fishermen, seafood processors, tribal representatives, state and federal fishery managers and scientists, membership and staff from the Pacific Council, and environmental organization representatives participated.

The workshop covered three broad themes: regional interests and flexibility, community considerations, and economic efficiencies and benefits. Presentations and panelists from industry included Bill Tucker, commercial fishermen participating in the Gulf of Mexico red snapper, grouper/tilefish IFQ program, Libby Etrie, Program Director for the Northeast Sector Service Network, Michele Longo Eder, participant in the Coast Pacific sablefish permit stacking and groundfish trawl rationalization programs, Linda Kozak, consultant for Alaska’s halibut/sablefish IFQs, crab rationalization, and Pacific cod freezer longline coop programs, and Ed Backus, manager for Ecotrust’s Community Fisheries program. In addition, NMFS personnel involved with RBM programs that also shared their experiences included Kelly Denit from the Office of Sustainable Fisheries, Mark Grant from the Northeast Region, Jessica Stephen from the Southeast Region, Jamie Goen from the Northwest Region, and Rachel Baker from the Alaska Region. Invited speaker presentations, panel discussions and small group breakouts were the methods used to provide and exchange information.
The workshop concluded with three, small-group discussions, each guided by questions that centered on the needs and interests of the sardine fishery, approaches or programs relevant to the Pacific sardine fishery, and what a RBM approach in the sardine fishery might look like. The results of those discussions provided a range of issues, considerations, and conclusions for potentially improving the fishery including:

- The fishery does not always function well in terms of operations, timing, and economics, that is, fishermen are not always able to fish for the right fish at the right time,
- Structure of state and federal permits has inconsistencies with competing incentives,
- Some components of the fishery could be better managed to anticipate future external pressures,
- Regional allocations could be a step toward improving fishery management,
- Concerns of excess processor market control need to be addressed,
- A broad cross-section of stakeholder engagement is essential,
- Develop a relatively simple program,
- Electronic data collection and recording could be helpful,
- Creating equitable initial allocations may be challenging, and
- Need flexibility; one size does not fit all fishery sectors
OVERVIEW OF COASTAL PELAGIC SPECIES
WORKSHOP II:
CONSIDERATIONS FOR RIGHTS BASED
MANAGEMENT IN THE PACIFIC SARDINE FISHERY

APRIL 24-25, 2012
MONTEREY, CA
Key Objectives:

• Review key issues and objectives related to the future of the sardine fishery,
• Identify how issues/objectives have been addressed
  • through RBM approaches adopted elsewhere
  • consider lessons learned,
• Explore key elements of RBM programs and discuss industry's perspectives on existing and potential possibilities within each element,
• Identify follow-on steps needed to further consider RBM or other approaches.
Participation

- 40 participants
- Commercial fishermen, seafood processors, tribal representatives, state/federal fishery managers and scientists,
- Members and/or staff from four Fishery Management Councils including most of the PFMC -- CPS AS
- Facilitated by CONCUR Inc.
Themes of Interest Covered

• **Regional interests and flexibility,**
  - New England Multispecies Sector Program
  - Gulf of Alaska Rockfish Program

• **Community considerations,**
  - Western Alaska Community Development Quota/ Halibut Community Quota Entities
  - Fishing Communities

• **Economic efficiencies and benefits.**
  - Gulf of Mexico Red Snapper
  - Pacific Sablefish Permit Stacking
Results of 3 Breakout Groups

Needs and Interests:
1. Fishery doesn’t function well - operations, timing, and economics
2. State and federal permits are incongruent,
3. Better management to anticipate future external pressures.

Relevant Approaches:
1. Regional allocations – possible step forward
2. Concerns of excess processor market control need to be addressed,
3. Stakeholder engagement is essential,
4. Any RBM program must be simple.

Advantages/Disadvantages of RBM system:
1. Electronic data collection and recording could be helpful,
2. Creating equitable initial allocations will be challenging,
3. Could improve management for adding value to the fishery.
Contact Information:

http://swr.nmfs.noaa.gov/sardine_wks_hp/presentations.html
Agenda Item F. Coastal Pelagic Fisheries, F.1.c. Fisheries Science Center Activities.

Topic 1. SWR Overview of Coastal Pelagic Species Workshop II: *Considerations for Rights Based Management in the Pacific Sardine Fishery.* (15 min)

Topic 2: Forage in the CCLME. (15 min)

Topic 3: Assessment and Research Schedule for CPS. (10 min)

Topic 4. Update on Results from Spring 2012 Sardine DEPM/Acoustic Trawl Survey. (5 min)

Topic 5. Report on CIE-SSC Review of Canadian Swept Area Trawl Survey. (5 min)

Topic 6. Update on Planned Summer Coastwide Tri-National Sardine Survey and combined Sardine/Hake survey of PNW and Canada. (10 min)

Topic 7. Update on new Building and Ship (2 min)
Human Consumption

HMS FMP:
- albacore
- bluefin
- swordfish
- thresher sharks
- shortfin mako shark
- blue shark
- striped marlin
- basking shark
- white shark

Groundfish FMP:
- rockfish (64 sp)
- flatfish (12 sp)
- Hake and other roundfish (6 sp)

Salmon FMP:
- chinook
- coho

MMPA:
- dolphins
- pinnipeds
- toothed whales
- baleen whales

ESA turtles:
- leatherback
- loggerhead
- green

EFMP & IEA

CPS FMP:
- Pacific sardine = 85,000 mt
- market squid = 118,000 st
- Pacific mackerel
- northern anchovy
- jack mackerel
- krill

Fish and Wildlife:
- ESA Seabirds
- Other Seabirds
Topic 2. Forage in the CCLME

Human Consumption

HMS FMP:
- albacore
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- blue shark
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Other Seabirds

CPS Fisheries

yoy forage

yoy forage

forage
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CPS FMP:
- yoy forage

Forage

yoy forage
Acoustic Trawl Survey of CPS

Multi-frequency acoustic target identification

Noise reduced'

Median filtered'
Human Consumption

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An Ecosystem Approach to Management Requires:
an Ecosystem Approach to Observations

“Investigate the sardine in relation to its physical and chemical environment, its food supply, its predators and its competitors”  California Cooperative Oceanic Fisheries Investigations, technical committee 1947
413 fish species in the CalCOFI Record

43 species of “krill”
Human Consumption

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Surveys conducted since 1983 aboard the NOAA Ship *David Starr Jordan*

Samples are sorted at sea

Trawling at night

Standardized gear
conditions in 2005-2006 were not good for groundfish reproduction
Human Consumption

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ESA turtles:
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- green

EFMP & IEA

Fish and Wildlife:
- ESA Seabirds
- Other Seabirds

CPS FMP:

yoy forage

forage
Estuary: Apr – Jun

Coastal ocean:
  Jun or Jul
  Sep or Oct
  Feb or Mar
Human Consumption

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Other Seabirds

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CPS Fisheries

yoy forage

yoy forage

yoy forage

yoy forage

yoy forage

yoy forage
Sea Lion Diet
San Nicolas Island

Anchovy

Sardine
U.S. PACIFIC MARINE MAMMAL STOCK ASSESSMENTS: 2011

James V. Carretta¹, Karin A. Forney², Erin Oleson³, Karen Martien¹, Marcia M. Muto⁴, Mark S. Lowry¹, Jay Barlow¹, Jason Baker³, Brad Hanson⁵, Deanna Lynch⁶, Lilian Carswell⁷, Robert L. Brownell Jr.⁸, Jooke Robbins⁹, David K. Mattila¹⁰, Katherine Ralls¹¹, and Marie C. Hill¹²
Figure 2. Mark-recapture estimates of humpback whale abundance in California and Oregon, 1991-2008 (Calambokidis 2009). Horizontal bars indicate ±1 standard error of each abundance estimate. Solid line shows a linear regression of the natural logarithm of abundance over time. The slope of this regression is statistically significant (p < 0.001) and approximates an annual population growth rate of between 7% and 8%.
Figure 2. Generalized logistic growth curves of Washington Coast (Jeffries et al. 2003) and Oregon (Brown et al. 2005) harbor seals.
Figure 2. Estimated number of northern elephant seal births in California 1958-2005. Multiple independent estimates are presented for the Channel Islands 1988-91. Estimates are from Stewart et al. (1994), Lowry et al. (1996), Lowry (2002) and unpublished data from Sarah Allen, Dan Crocker, Brian Hatfield, Ron Jameson, Bernie Le Boeuf, Mark Lowry, Pat Morris, Guy Oliver, Derek Lee, and William Sydeman.
Figure 2. Counts of Guadalupe fur seals at Guadalupe Island, Mexico, and the estimated population growth curve derived from counts made during the breeding season.
Figure 2. U.S. pup count index for California sea lions (1975-2005; 2008). Trends in pup counts from 1975 through 2008 are shown for four rookeries in southern California and for haulouts in central and northern California. Records of pup counts from 1975 to 2008 were compiled from Lowry and Maravilla (2005) and unpublished NMFS data.
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Assessment and Research Schedule for Coastal Pelagic Species of the Northeast Pacific Ocean: an Adaptive Approach

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center / Southwest Region

June 2012
CPS Adaptive Assessment/Research Schedule

• CPS assemblage
  o Pacific sardine (*Sardinops sagax*)
  o Pacific mackerel (*Scomber japonicus*)
  o Northern anchovy (*Engraulis mordax*, 2 sub-stocks)
  o Jack mackerel (*Trachurus symmetricus*)
  o Market squid (*Doryteuthis opalescens*)
  o Krill (Euphausiidae)

• In the past (1960s-80s) …
  o An approach that focused more broadly on several species

• In the present … (1990s-present)
  o An approach that focuses more narrowly on a couple of species

• In the future …
  o An approach more like the past is needed

• Presentation outline
  o Reasons for transitioning to a more adaptive approach
    ✓ Population biology and management
  o Pluses/Minuses
  o Implementation
  o A potential schedule
CPS Catch Time Series

Catch (mt)

Year

P. mackerel
P. sardine
N. anchovy
J. mackerel
M. squid
• Population biology-based reasons
  o Species that compose this assemblage are cyclical, productive, and exhibit highly variable abundance levels over time
  o Factors that influence abundance levels are due to both natural and human perturbations
    ✓ Prevailing oceanographic conditions and larger ecosystem dynamics
    ✓ Human impacts, both direct (fishing pressure) and indirect (pollution to habitat)

• Management-based reasons
  o Ecosystem considerations are a high priority for managing marine resources in the 21st Century
    ✓ “In an attempt to end chronic overfishing, it is imperative that ‘ecosystem’ considerations play an important role in the assessment/management of all exploited fish stocks ...” Reauthorization of MSFMC (2007)
  o Assemblage management is not a new goal, but a directive of current Fishery Management Plans
    ✓ “The CPSMT will review all CPS stocks annually and make recommendations to the Council and agencies regarding appropriate management categories for each stock (“Active” or “Monitored”), and changes to the appropriate management category for each species can be made annually by the Council based on all available data, including ABC levels and MSY control rules, and the goals and objectives of this FMP ...” Amendment 13 to CPS FMP (2010)
CPS Adaptive Assessment/Research Schedule

• Benefits
  o More species considered
  o More efficient research
  o More efficient use of staff time
  o Costs to implement are no more than presently committed
  o It’s workable and there’s precedence, with no substantive changes necessary to current management documents and related legislative actions

• Drawbacks
  o Over the long-term, it is expected that ecosystem considerations and associated research will require increased funding, to some degree
CPS Adaptive Assessment/Research Schedule

• Implementation from the Assessment Side
  o Develop a ‘prioritized’ assessment schedule
    ✤ Tier-1 assessments
      ✓ Stocks that receive high levels of fishing pressure, e.g., fishery realizes quotas over an extended timeframe (say 2-4 years), e.g., only Pacific sardine currently
      ✓ Stocks considered vulnerable to even low levels of fishing pressure, i.e., populations with low productivity and/or high susceptibility, e.g., no CPS
      ✓ Peer-review every 2 years, or more, if no meaningful data have accumulated and no substantive changes/progress in modeling efforts
    ✤ Tier-2 assessments
      ✓ Stocks that have received high levels of fishing pressure in the past, e.g., Pacific mackerel and northern anchovy
      ✓ Peer-review every 3-5 years, with the level of review based on the species, available data/time series, and assessment method
**CPS Adaptive Assessment/Research Schedule**

- Implementation from the Research Side
  - Develop a more integrated research approach

  - Improve fishery-independent surveys that address all CPS
    - Continue efforts to extend the spatial and temporal dimensions of the ongoing CPS acoustic-trawl surveys
    - Add acoustics to seasonal CalCOFI surveys

  - Improve fishery-dependent sampling programs that address all CPS
    - Strengthen arrangement between federal (SWFSC) and state (CDFG, ODFW, and WDFW)

  Continue to foster international involvement in research with both Mexico and Canada
**CPS Adaptive Assessment/Research Schedule**

<table>
<thead>
<tr>
<th>Species</th>
<th>Assessment year¹</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>2011</td>
<td>2012</td>
<td>2013</td>
<td>2014</td>
<td>2015</td>
</tr>
<tr>
<td>P. sardine</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>P. mackerel</td>
<td>A</td>
<td></td>
<td>A</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Anchovy (northern sub-stock)</td>
<td></td>
<td>A</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anchovy (central sub-stock)</td>
<td></td>
<td>A</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>J. mackerel</td>
<td></td>
<td></td>
<td>A</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Squid²</td>
<td></td>
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<td>M</td>
</tr>
<tr>
<td>Krill</td>
<td></td>
<td></td>
<td></td>
<td>E</td>
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<tr>
<td>CPS assemblage</td>
<td></td>
<td></td>
<td></td>
<td>E</td>
<td></td>
</tr>
</tbody>
</table>

¹Assessment timing/details will be species-specific and develop as does data availability, and A=actively managed, M=monitored, and E=ecosystem

²Squid assessment/managemenrt is under the purview of the state of CA
FSV Bell M. Shimada and FSV Ocean Starr
24 March to 28 April

Sardine Trawls | Sardine Eggs | Anchovy Eggs | Jack Mackerel Eggs

- **Shimada**
- **Ocean Starr**
  - **Present**
  - **Absent**

**Eggs/m³**
- 0
- 16
- 19

Legend:
- Red: Shimada
- Orange: Ocean Starr
  - **Present**
  - **Absent**

Map showing the distribution of sardine, sardine eggs, anchovy eggs, and jack mackerel eggs in the specified region.
**Analytical Methods to be Used:** swept-area of trawls and sardine biomass yield density estimates in spatial strata; sample frame includes depths to 100 m; stratified abundance estimates applied to stratum size and aggregated over strata
Topic 6: 2012 CPS Spring and Summer Coastwide Survey Plans

Workshop on Enhancing Stock Assessments of Pacific Sardine in the California Current through Coordinated Comparative Surveys

May 23-24, 2011
La Jolla, California
Topic 6. Update on Planned Summer Coastwide Tri-National Sardine Survey and combined Sardine/Hake survey of PNW and Canada

Shimada SaKe Summer Survey 2012

Leg I: Newport to San Francisco
June 24 to July 6 (13 DAS) (blue)

Leg II: San Francisco to Newport
July 9 to July 25 (17 DAS) (red)

Leg III: Newport to Port Angeles
July 30 to August 12 (14 DAS) (green)

Leg IV: Port Angeles to Newport
August 15 to August 30 (16 DAS) (orange)
Appendix 2. The vessel R/V *Ocean Starr* track lines for 1207OS Legs III and IV. Stations on leg III will be determined by the ship’s distance covered during daylight hours:
SWFSC

- New La Jolla facility (ARRA):
  - dedication Nov 2012
- RV Reuben Lasker (ARRA):
  - Launch 16 June (last Sat);
  - west coast arrival summer 2013
  - operations to begin late 2013
- Budget reductions (scaling back, prioritizing surveys, programs, backfills)
- Strategic Plan draft (Fall 2012; includes comment period)
NMFS Southwest Fisheries Science Center Activities

**Forage in the CCLME.** Several recent studies have focused on the importance of forage in maintaining healthy ecosystems. A brief review will be presented to make interested parties aware of existing and planned SWFSC and other NMFS monitoring activities that focus on three aspects of the forage question: 1. Monitoring the state of the forage base of the California Current Large Marine Ecosystem (CCLME); 2. Monitoring abundance trends and foraging needs of higher trophic level species such as the highly migratory fishes (HMS), marine mammal species and seabirds and 3. Examining the role of sentinel species in determining the forage capacity of the CCLME. Survey programs to be discussed will include:

*Forage Monitoring*
- SWFSC Fisheries Resources Division: CalCOFI Monitoring Program
- SWFSC Fisheries Resources Division: Acoustic/Trawl Coastal Pelagic Species (CPS) Ecosystem surveys.
- SWFSC Fisheries Ecology Division: Juvenile Rockfish Survey

*Fish Predator Monitoring*
- SWFSC Fisheries Ecology Division: Salmon Ocean Ecology Monitoring
- SWFSC Fisheries Resources Division: HMS Surveys
- SWR/SWFSC Fisheries Resources Division: Drift Gillnet Observer Program

*Marine Mammal Monitoring*
- AFSC, National Marine Mammal Laboratory (NMML) California Current Ecosystems Program
- SWFSC Protected Resources Division: Cetacean Ship Surveys of CCLME
- SWFSC Protected Resources Division: Pinniped Aerial Surveys
- SWFSC Protected Resources Division: Harbor Porpoise Aerial Surveys

**Assessment and Research Schedule for CPS.** At the November 2011 PFMC meeting in Costa Mesa, CA, the SWFSC introduced the idea of revisiting the CPS assessment schedule. At this meeting SWFSC will give a brief presentation (November supplementary briefing material) that asks the Council to consider tasking SSC and CPSMT to develop a more adaptive comprehensive and ecosystem based approach to the CPS assessment schedule. Given the present schedule, species such as Pacific mackerel receive a large amount of staff time even when fishing pressure is light while market squid which is fished to the harvest guideline receives less attention. A more inclusive and adaptive approach is suggested as a first step in developing a conversation among industry, NGO’s, Council staff and NMFS to provide a more adaptive allocation of scientific resources.

**Update on Results from Spring 2012 Sardine DEPM/Acoustic Trawl Survey.** SWFSC planned and carried out a two ship survey of spawning activity and biomass
of Pacific sardine populations and related CPS stocks. The survey was carried out aboard the FSV Shimada and the charter vessel Ocean Starr (formerly the NOAA vessel David Starr Jordan). The original plan was a coastwide survey but a combination of ship problems, harbor access and weather related delays resulted in a more typical survey of the core spawning region from the Mexican border to near the California-Oregon border. The active spawning region used in the DEPM estimate was fully sampled with acoustics, surface trawls and net tows for eggs and larvae and will form the basis of the 2012 Sardine Assessment update.

**Report on CIE-SSC Review of Canadian Swept Area Trawl Survey.** A review of the Canadian Swept Area Trawl Survey was held May 29-31, 2012 at the Torrey Pines Facility of the SWFSC. Jake Schweigert and Linnea Flostrand were the presenters from DFO, Andre Punt and Ray Conser represented the SSC. John Simmonds and Olav Rund Godø were the CIE reviewers. The two key topics were the survey design and the potential for inclusion in the Sardine Assessment.

**Update on Planned Summer Coastwide Tri-National Sardine Survey and combined Sardine/Hake survey off PNW and Canada.** SWFSC will update the Council on plans to conduct two cruises to support a coastwide survey of the distribution and abundance of Sardine and other CPS. The first is a joint SWFSC-NWFSC-industry sardine/hake survey aboard the FSV Shimada and an industry provided hake trawler the Forum Star. This survey will begin June 24 and will cover the region from south of Monterey Bay to the northern tip of Vancouver Island. The goal will be to measure the summer distributions of the northern Sardine stock at the time of maximum northward migration into Canada and during the period that the industry aerial survey is conducted off Oregon and Washington. The second cruise will be aboard the contract research vessel Ocean Starr and will survey from the Mexican border to San Francisco. This survey will measure the extent that the Central stock migrates from Mexico into Southern California.
COASTAL PELAGIC SPECIES ADVISORY SUBPANEL
REPORT ON NATIONAL MARINE FISHERIES SERVICE REPORT

Adaptive Assessment Research Schedule
The Coastal Pelagic Species Advisory Subpanel (CPSAS) heard a report on the Adaptive Assessment Research Scheduling plan, from Dr. Paul Crone. The CPSAS supports the initiative, and anticipates that it would lead to a more efficient, flexible, and effective way to approach single- and multi-species stock assessments.

Sardine Assessment
The CPSAS reviewed the National Marine Fisheries Service (NMFS) proposed activity schedule and strongly urges the Council to recommend a full stock assessment and review panel for sardine for 2013.

As noted in the NMFS Report (Agenda Item F.1.b), important new research surveys and new data are forthcoming in 2012 that will improve future stock assessments, and this information requires stock assessment review in order to be included in the model.

First is the successful methods review for the Canadian swept trawl survey, which will provide critical new information about sardines’ northern migration. In addition, the synoptic sardine–hake (SaKe) field survey is scheduled for this summer, which will extend to the northern tip of Vancouver Island, Canada. The second leg of the synoptic survey will extend to the Mexican border and Mexican researchers are also coordinating a field survey in Mexican waters. This 2012 summer survey is the outcome of the sardine workshops held in 2011 and involves uncommon cooperation among Canadian, U.S. and Mexican researchers to advance the state of knowledge about Pacific sardine.

The CPSAS would appreciate Council consideration of these new data sources and our desire to include them in future sardine management as soon as possible.

Finally, the CPSAS expresses its appreciation for the outstanding effort and cooperation leading to the greatly expanded coastwide survey. The Northwest and Southwest Fisheries Science Centers, scientists from Canada and Mexico, and the fishing industry all deserve commendation.

PFMC
06/22/12
COASTAL PELAGIC SPECIES MANAGEMENT TEAM REPORT ON NATIONAL MARINE FISHERIES SERVICE REPORT

The Coastal Pelagic Species Management Team (CPSMT) appreciates the work of the Southwest Fisheries Science Center (SWFSC) holding a workshop to review the Canada Swept Area Trawl Survey. The CPSMT was briefed on this review, and supports the inclusion of the survey data in the next full sardine stock assessment. Presently, the next full sardine stock assessment is scheduled for 2014. The CPSMT suggests that the next full sardine stock assessment be moved up to 2013. However, our support for a full 2013 assessment is contingent on the CPSMT reviewing the final report of the workshop.

PFMC
06/23/12
PACIFIC MACKEREL MANAGEMENT FOR 2012-2013

The Pacific Fishery Management Council (Council) is scheduled to adopt management measures for the 2012-2013 Pacific mackerel fishing season, which runs from July 1, 2012 through June 30, 2013.

In June 2011, the Council approved the 2011 full assessment, which estimated the age 1+ biomass to be 211,126 mt. The Council adopted an Annual Catch Target (ACT) of 30,336 mt, and an incidental set-aside of 10,128 mt. The Council also adopted a “check in” provision to consider the possibility of re-allocating the incidental set-aside to the directed fishery. However, landings have not approached the ACT, and therefore no action was subsequently warranted.

The Council also recommended foregoing an assessment in 2012. Therefore, management measures adopted for the 2012-2013 fishery will be based on the 2011 full assessment.

**Council Action:**

**Adopt Pacific Mackerel Harvest Guideline and Management Measures.**

**Reference Materials:**

None.

**Agenda Order:**

a. Agenda Item Overview
b. Reports and Comments of Advisory Bodies and Management Entities
c. Public Comment
d. **Council Action:** Adopt Harvest Guideline and Management Measures

PFMC
05/23/12
PACIFIC MACKEREL (Scomber japonicus) STOCK ASSESSMENT
FOR USA MANAGEMENT IN THE 2011-12 FISHING YEAR

by

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Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
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June 2011
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PREFACE

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 Pacific mackerel fishery that operates off the USA 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 (henceforth, presented as a ‘fishing year’). In this context, in this document, both a two-year (2010-11) and single-year (2010) reference refer to the same fishing year that spanned from July 1, 2010 to June 30, 2011. 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 HGs. 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). It is important to note that in 2010, federal mandates required regional fishery Councils to begin transitioning to a revised process for quota determination, which relies on additional statistics not previously included in stock assessment documents and thus, such information is presented here along with the typical HG-related parameters of interest, see Amendment 13 of the CPS FMP (PFMC 2010a) and Ralston et al. (2011) for details regarding these changes.

The last stock assessment and related reviews for this species were completed in 2009 (Crone et al. 2009), with a HG serving for two years (PFMC 2010b). That is, in the past, this species was assessed annually, but given both the population’s biology and limited fishing pressure the two-year span was deemed reasonable and adopted by the PFMC in 2009. The stock assessment presented here reflects a ‘full’ assessment that has undergone formal review as outlined by the PFMC and Science and Statistical Committee (SSC), see PFMC (2010c). Specifically, a stock assessment review (STAR) panel was convened from May 2-5, 2011 (NOAA Fisheries, Southwest Fisheries Science Center in La Jolla, CA) to evaluate the ongoing Pacific mackerel stock assessment. Important areas of general consensus reached by the STAR panel regarding the Pacific mackerel stock assessment conducted in 2011 follow [for further details of the week-long review see STAR (2011a)]:

- first and foremost, the stock assessment documentation/presentation followed stipulations set forth in the CPS stock assessment ‘Terms of Reference’ (PFMC 2010c) and produced a ‘base case’ model on which to provide formal management advice regarding exploitation of the Pacific mackerel population harvested off the Pacific coast of the United States (USA);
- a base case model (henceforth, Model $X\alpha$) was identified as the final model configuration (hypothesized ‘state of nature’ or model ‘scenario’), included fishery-dependent sources of data (landings, biological distributions, and catch-per-unit-effort indices of abundance), and represented a robust model that was developed via statistical (model fits and diagnostics supported ‘inside the model’) and pragmatic bases (sound assumptions/parameterizations supported ‘outside the model’);
- Model $X\alpha$ represented the culmination of substantial work over an extended timeframe, including evaluations at the data source (time series) and modeling (sensitivity analysis) levels, however, the current ‘final’ model is an ongoing effort that is improved upon as more pertinent time series become available and as such, still includes areas of uncertainty regarding the species’ biology and influential model parameterizations, which necessarily
precludes precise estimation of absolute abundance and ultimately, may warrant consideration when setting harvest levels for this species [see Assessment uncertainty and Research and Data Needs sections, and STAR (2011a)].

Given the inherent difficulties presenting the voluminous amount of results from stock assessment modeling efforts extended over a broad time period, discussion and related displays are largely presented only for the final Model XA, with summaries/comparisons/etc. to other models of interest where appropriate (e.g., estimated time series from previous assessments and/or the sensitivity analysis conducted in 2011).
EXECUTIVE SUMMARY

Stock
Pacific mackerel (Scomber japonicus) in the northeastern Pacific Ocean range from southeastern Alaska to Banderas Bay (Puerto Vallarta), Mexico, including the Gulf of California. The fish are common from Monterey Bay, California, to Cabo San Lucas, Baja California, but are most abundant south of Point Conception, California. There are possibly three spawning ‘stocks’ along the Pacific coasts of the USA and Mexico: one in the Gulf of California; one in the vicinity of Cabo San Lucas; and one along the Pacific coast north of Punta Abreojos, Baja California and extending north to waters off southern California and further, off the Pacific Northwest depending on oceanographic conditions (say regimes). This latter sub-stock, the ‘northeastern Pacific Ocean’ population, is harvested by fishers in the USA and Baja California, Mexico, and is the population considered in this assessment.

Catches
Pacific mackerel landings from both commercial and recreational fisheries in California and commercial landings in Baja California represent the catch time series used in the assessment, with landings pooled into the two broadly-defined fisheries for all modeling purposes, i.e., commercial and recreational fishing sectors, respectively. Historically, total catch time series over the last 100 years can be broadly defined by two or more ‘modes,’ e.g., late 1920s to mid 1960s and late 1970s to the present (Figure ES-1). Recent catches are presented in Table ES-1. Note that a historically complete catch time series is presented for illustrative purposes only, given the final Model XA began in 1983.

Currently, catch (including biological) data are largely collected through a California Department of Fish and Game (CDFG) port (commercial) sampling program, as well as via the Oregon Department of Fish and Wildlife (ODFW) and Washington Department of Fish and Wildlife (WDFW). That is, the CDFG has collected biological data on Pacific mackerel landed in the San Pedro (southern California) fishery since the late 1920s. Further, to some degree, port sampling data have been collected by researchers from Ensenada, Mexico (Instituto Nacional de la Pesca, INP) since 1989; however, this information is only now being distributed at a broader scale through government/academic supported programs. Recreational catches are primarily associated with southern California’s marine recreational angler community, including commercial passenger fishing vessel (CPFV), as well as other modes of fishing, such as pier and private vessel. Recreational fishery-based landings are much lower than those related to commercial fisheries (i.e., sport fisheries generate less than 5% of the total catch in any given year).
Figure ES-1. Commercial and recreational landings (mt) of Pacific mackerel in the USA (CA commercial, recreational-CPFV, and recreational-non-CPFV) and Mexico (commercial), (1929-10).

Table ES-1. Commercial and recreational landings (mt) of Pacific mackerel in the USA (CA commercial, recreational-CPFV, and recreational-non-CPFV) and Mexico (commercial), (2000-10).

<table>
<thead>
<tr>
<th>Fishing year</th>
<th>USA Commercial (mt)</th>
<th>Mexico Commercial (mt)</th>
<th>Recreational CPFV (mt)</th>
<th>Recreational non-CPFV (mt)</th>
<th>Total (mt)</th>
</tr>
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<td>00</td>
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<td>6,530</td>
<td>78</td>
<td>248</td>
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<td>10,328</td>
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<td>232</td>
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<tr>
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<td>5,972</td>
<td>2,618</td>
<td>28</td>
<td>295</td>
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<td>21</td>
<td>375</td>
<td>7,475</td>
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<td>254</td>
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<tr>
<td>10</td>
<td>2,086</td>
<td>171</td>
<td>5</td>
<td>95</td>
<td>2,357</td>
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</table>
Data and assessment
Historically, various age-structured assessment models have been used to assess the status of Pacific mackerel off the west coast of North America, which were generally based on fishery landings and length/age distributions, as well as relative indices of abundance from fisheries and/or research surveys. The last assessment of Pacific mackerel was completed in 2009 for USA management in the 2009-10 fishing year. The current assessment includes the following primary sources of data: catch time series (USA/Mexico commercial and USA recreational fisheries); length (USA recreational fishery) and age (USA commercial fishery) distribution time series; and index of abundance time series from recreational fishery surveys.

Unresolved problems and uncertainties
First and foremost, given Pacific mackerel is a ‘transboundary’ stock, the assessment would benefit greatly from additional biological and/or ‘survey’ data (e.g., index of abundance time series) from Mexico. In particular, there is currently no synoptic survey (fishery-independent) index of abundance that pertains to the entire (hypothesized) range of the modeled stock. However, it is important to note that progress continues in terms of addressing these two research efforts, which are expected to gain further support in the coming years. That is, the need for formal data exchange workshops with Mexico (as well as Canada) researchers, and commitment to synoptic surveys that provide representative sample data, particularly, programs related to the CalCOFI and acoustic-trawl survey operations based at the SWFSC. Also, see Research and data needs below.

Total stock biomass
Total biomass (age-1+ biomass, $B$) has steadily declined from the mid 1980s to the early 2000s, at which time the population began to increase moderately in size, with some signs of ‘rebuilding’ observed over the last several years (Figure ES-2 and Table ES-2). However, in historical terms, the population remains at a relatively low abundance level, due primarily to oceanographic conditions, given limited fishing pressure over the last decade has not likely compromised this species’ biology (i.e., role in the larger CPS assemblage off the Pacific coast of North America). Finally, as noted previously, recent estimates of stock size are necessarily related to assumptions regarding the dynamics of the fish (biology) and fishery (operations) over the last several years, which generally confounds long-term (abundance) forecasts for this species (also see Assessment uncertainty section).
Figure ES-2. Estimated total stock biomass (age 1+ fish in mt, \( B \)) of Pacific mackerel based on the final Model XA (1983-11). Also presented is estimated \( B \) time series from the previous assessment conducted in 2009 (Model AA, 1962-09). Note Model XA starts in 1983 (vs. 1962).

Table ES-2. Estimated recruitment (\( R \)), total biomass (\( B \)), and spawning stock biomass (SSB) of Pacific mackerel based on the final Model XA (1983-11).

<table>
<thead>
<tr>
<th>Fishing year</th>
<th>( R ) (age-0, in 1,000s)</th>
<th>( B ) (age-1+, mt)</th>
<th>SSB (mt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>98</td>
<td>91,301</td>
<td>202,367</td>
<td>116,867</td>
</tr>
<tr>
<td>99</td>
<td>158,241</td>
<td>108,333</td>
<td>73,713</td>
</tr>
<tr>
<td>00</td>
<td>206,257</td>
<td>83,644</td>
<td>56,033</td>
</tr>
<tr>
<td>01</td>
<td>197,479</td>
<td>62,130</td>
<td>32,964</td>
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<tr>
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<td>90,622</td>
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<tr>
<td>03</td>
<td>225,580</td>
<td>47,902</td>
<td>21,127</td>
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<td>04</td>
<td>435,040</td>
<td>56,302</td>
<td>20,756</td>
</tr>
<tr>
<td>05</td>
<td>625,105</td>
<td>91,182</td>
<td>25,241</td>
</tr>
<tr>
<td>06</td>
<td>585,916</td>
<td>146,630</td>
<td>37,196</td>
</tr>
<tr>
<td>07</td>
<td>589,941</td>
<td>188,743</td>
<td>55,562</td>
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<td>427,113</td>
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<td>280,972</td>
<td>228,015</td>
<td>112,880</td>
</tr>
<tr>
<td>11</td>
<td>211,126</td>
<td></td>
<td></td>
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</tbody>
</table>
Spawning stock biomass
Spawning stock biomass ($SSB$) followed the general trajectory as observed in the estimated $B$ time series, with magnitudes that are roughly one-half the size of total stock biomass (Figure ES-3 and Table ES-2).

![Figure ES-3](image)

Figure ES-3. Estimated spawning stock biomass ($SSB$) of Pacific mackerel based on the final Model $XA$ (1983-10). A confidence interval (95% CI) is also presented as dashed lines.

Recruitment
As expected, historically, estimated recruitment ($R$) has been highly variable, remaining relatively low since the population’s last period of (high) recruitment success in the mid 1980s and moderate recruitment levels in the mid 1990s (Figure ES-4 and Table ES-2).
Figure ES-4. Estimated recruitment (age-0 fish in 1,000s, \( R \)) of Pacific mackerel based on the final Model \( X4 \) (1983-10). A confidence interval (95% CI) is also presented as dashed lines.

**Management performance**

Since 2000, Pacific mackerel has been managed under a Federal Management Plan (FMP) harvest policy, stipulating that a maximum sustainable yield (MSY) for this species should be set according to the following harvest control rule:

\[
\text{Harvest} = (\text{Biomass-Cutoff}) \cdot \text{Fraction} \cdot \text{Distribution},
\]

where Harvest is the harvest guideline (HG), Cutoff (18,200 mt) is the lowest level of estimated biomass at which harvest is allowed, Fraction (30%) is the proportion of biomass above the Cutoff that can be harvested by fisheries, and Distribution (70%) is the average fraction of total Biomass (ages 1+) assumed in USA waters (PFMC 1998). The HGs under the federal FMP are applied to a July-June fishing ‘year.’ Landings and associated HGs since 1992 are presented in Figure ES-5. The HG for the 2011-12 fishing year based on Model \( X4 \) is 40,514 mt (Table ES-3). Also see Harvest Control Rule for USA Management in 2011-12 section for alternative methods for quota determination that are used in concert with the current HG.

From 1985 to 1991, the biomass exceeded 136,000 mt and no state quota restrictions were in effect. State quotas for 1992-00 fishing years averaged roughly 24,000 mt. The HGs averaged
roughly 15,000 mt from 2001-06. In 2007, the HG was increased substantially to over 70,000 mt based largely on assumptions regarding variability surrounding estimated recruitment and remained at an elevated level until 2009, when the calculated HG (55,408 mt) was reduced by management (PFMC) to 10,000 mt to address uncertainty related to two alternative models (see Preface and PFMC 2010b); the 10,000 mt HG was adopted in 2010 as well. Finally, note that the HG in 2011 (40,514 mt) is strictly preliminary, given formal adoption of the HG will be addressed at the next Council meeting in June 2011. It is important to note that over the last decade, from a management context, the fishery has not fully utilized HGs, with average yields since this time of roughly 5,000 mt (Figure ES-5).

**Figure ES-5.** Commercial landings (USA directed fishery in mt) and quotas (HGs, mt) for Pacific mackerel (1992-11).

<table>
<thead>
<tr>
<th>B (Age 1+, mt)</th>
<th>Cutoff (mt)</th>
<th>Fraction</th>
<th>Distribution</th>
<th>HG (mt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>211,126</td>
<td>18,200</td>
<td>30%</td>
<td>70%</td>
<td>40,514</td>
</tr>
</tbody>
</table>
**Research and data needs**

First and foremost, given the transboundary status of this fish population, it is imperative that efforts continue in terms of encouraging collaborative research and data exchange between NOAA Fisheries (Southwest Fisheries Science Center) and researchers from both Canada’s and in particular, Mexico’s academic and federal fishery bodies, i.e., such cooperation is critical to providing a synoptic assessment that considers available sample data across the entire range of this species in any given year.

Second, fishery-independent survey data for measuring (relative) changes in mackerel spawning (or total) biomass are currently lacking. Further, at this time, two indices of relative abundance are used in the assessment, which are developed from a marine recreational fishery (CPFV fleet and related fishing modes) that typically do not (directly) target the species. That is, the recently implemented CRFS provides useful information regarding this species' dynamics and further, represents a valuable survey for obtaining abundance trends for finfish generally targeted by marine recreational fishers in coastal waters off California. In this context, it is imperative that future research funds be focused on improvement (e.g., broadening the scope and increasing the frequency) of the current fishery-independent surveys operating out of the NOAA's SWFSC (e.g., CalCOFI and acoustic-trawl surveys), with emphasis on a long-term horizon, which will necessarily rely on cooperative efforts between the industry, research, and management, as well as cooperation from international fishery agencies.

Third, given the importance of age (and length) distribution time series to developing a sound understanding of this species’ population dynamics, it is critical that data collection programs at the federal and particularly, the state level continue to be supported adequately. In particular, CDFG/NOAA funding should be bolstered to ensure ongoing ageing-related laboratory work is not interrupted, as well as providing necessary funds for related biological research that is long overdue. For example, maturity-related time series currently relied upon in the assessment model are based on data collected over twenty years ago during a period of high spawning biomass that does not reflect current levels, i.e., the SWFSC and CDFG have begun field/laboratory efforts collecting, processing, and analyzing reproductive samples from Pacific mackerel harvested in both the recreational and commercial fisheries. Also, further work is needed to obtain more timely error estimates from production ageing efforts in the laboratory, i.e., accurate interpretation of age-distribution data used in the ongoing assessment necessarily requires a reliable ageing error time series.

Finally, the MSY control rule utilized in the Pacific mackerel federal CPS-FMP was developed in the mid-1980s based on estimated abundance and stock-recruitment data at that time and thus, the control rule should be re-examined using new data and simulation methods. Given substantial amounts of additional sample data have accumulated since the initial research that was undertaken to formally establish this harvest strategy, it would be prudent to conduct further simulation modeling work to address particular parameters included in the overall control rule (including ‘cutoff,’ ‘fraction,’ and ‘distribution’ values).
INTRODUCTION

Distribution
Pacific mackerel (Scomber japonicus; a.k.a. ‘chub mackerel’ or ‘blue mackerel’) in the northeastern Pacific range from southeastern Alaska to Banderas Bay (Puerto Vallarta), Mexico, including the Gulf of California (Hart 1973). They are common from Monterey Bay, California, to Cabo San Lucas, Baja California, but are most abundant south of Point Conception, California. Pacific mackerel usually occur within 30 km of shore, but have been captured as far as 400 km offshore (Fitch 1969; Frey 1971; Allen et al. 1990; MBC 1987).

Migration
Pacific mackerel adults are found in water ranging from 10 to 22.2°C (MBC 1987) and larvae may be found in water around 14°C (Allen et al. 1990). As adults, Pacific mackerel move north in summer and south in winter between Washington and Baja California (Fry and Roedel 1949; Roedel 1949), with northerly movement in the summer accentuated during El Niño events (MBC 1987). There is an ‘inshore-offshore’ migration off California, with increased inshore abundance from July to November and increased offshore abundance from March to May (Cannon 1967; MBC 1987). Adult Pacific mackerel are commonly found near shallow banks. Juveniles are found off sandy beaches, around kelp beds, and in open bays. Adults are found from the surface to 300 m depth (Allen et al. 1990). Pacific mackerel often school with other coastal pelagic species (CPS), particularly jack mackerel and Pacific sardine, and likely based on age-dependent attributes as well (Parrish and MacCall 1978).

Over the last two decades, the stock has likely more fully occupied the northernmost portions of its range in response to a warm oceanographic regime in the northeastern Pacific Ocean, with further evidence, given Pacific mackerel have been found as far north as British Columbia, Canada (Ware and Hargreaves 1993; Hargreaves and Hungar 1995). During the summer months, Pacific mackerel are commonly caught incidentally in commercial whiting and salmon fisheries off the Pacific Northwest, but historically, these catches have been limited. Pacific mackerel sampled from Pacific Northwest incidental fisheries are generally older and larger than those captured in the southern California fishery (Hill 1999). In addition, this species is harvested by recreational anglers on CPFVs and private vessels, but is typically not highly prized in the fishery, with catches relatively low when compared with commercial landings.

Life history
Pacific mackerel found off the Pacific coast of North America are the same species found elsewhere in the Pacific, Atlantic, and Indian Oceans (Collette and Nauen 1983). Synopses regarding the biology of Pacific mackerel are presented in Kramer (1969) and Schaefer (1980).

Currently, the general consensus within the coastal pelagic species research forum is that there are likely three spawning stocks in the northeastern Pacific Ocean: one in the Gulf of California, one near Cabo San Lucas, and one along the Pacific coast north of Punta Abreojos, Baja California to British Columbia, Canada. Spawning occurs from Point Conception, California to Cabo San Lucas from 3 to 320 km offshore (Moser et al. 1993). Off California, spawning occurs from late April to September at depths to 100 meters. Off central Baja California, spawning occurs year round, peaking from June through October. Around Cabo San Lucas, spawning
occurs primarily from late fall to early spring. Pacific mackerel seldom spawn north of Point Conception (Fritzsche 1978; MBC 1987), although young-of-year (age-0) fish have been recently reported as far north as Oregon and Washington.

Like many coastal pelagic species with similar life history strategies, Pacific mackerel have indeterminate fecundity and appear to spawn whenever sufficient food is available and appropriate oceanographic conditions prevail. Individual fish may spawn eight times or more per year and release batches of 68,000 eggs per spawning. Actively spawning fish appear capable of spawning daily or every other day (Dickerson et al. 1992).

Pacific mackerel larvae eat copepods and other zooplankton, including fish larvae (Collette and Nauen 1983; MBC 1987). Juvenile and adult mackerel feed on small fish, fish larvae, squid, and pelagic crustaceans, such as euphausids (Clemmens and Wilby 1961; Turner and Sexsmith 1967; Fitch 1969; Fitch and Lavenberg 1971; Frey 1971; Hart 1973; Collette and Nauen 1983). Pacific mackerel larvae are subject to predation from a number of invertebrate and vertebrate planktivores. Juvenile and adults are eaten by larger fishes, marine mammals, and seabirds. Principal predators include porpoises, California sea lions, pelicans, and large piscivorous fishes, such as sharks and tunas. Pacific mackerel school as a defense against predation, often with other pelagic species, including jack mackerel and Pacific sardine.

Population dynamics of the Pacific mackerel stock off southern California have been extensively studied in the past and of particular importance was pioneering research conducted during the 1970s and 1980s, e.g., Parrish (1974), Parrish and MacCall (1978), Mallicoate and Parrish 1981, and Macall et al. (1985). More recently, USA-based research efforts associated with pelagic species that inhabit coastal areas of the Pacific coast of North America have focused on the Pacific sardine population. Pacific mackerel experience cyclical periods of abundance (‘boom-bust’), which is typical of other small pelagic species that are characterized by relatively short life spans and high intrinsic rates of increase. Analysis of mackerel scale-deposition data (Soutar and Issacs 1974) indicated that periods of high biomass levels, such as during the 1930s and 1980s, are relatively rare events that might be expected to occur, on average, about once every 60 years (MacCall et al. 1985). It is important to note that assessment model structure and results generally support MacCall’s research, with periods of strong recruitment estimates occurring no more frequently than at least 30 years or so. Recruitment is highly variable over space and time and not likely related to spawning biomass stock size (Parrish 1974), or at least not tightly linked to parent abundance levels within the historical range of estimated spawning stock biomass levels (Parrish and MacCall 1978).

**Stock structure and management units**

The full range of Pacific mackerel in the northeastern Pacific Ocean is from southeastern Alaska to Banderas Bay (Puerto Vallarta), Mexico, including the Gulf of California. The majority of the fish are typically distributed from Monterey Bay, California, to Cabo San Lucas, Baja California, being most abundant south of Point Conception, California. It is likely that multiple ‘spawning’ stocks exist along the Pacific coasts of the USA and Mexico, although at this time, stock structure exhibited by this species is not known definitively: one in the Gulf of California; one in the vicinity of Cabo San Lucas; and one along the Pacific coast north of Punta Abreojos, Baja California and extending north to waters off southern California and further, off the Pacific
Northwest depending on oceanographic conditions (say regimes). This latter sub-stock, the ‘northeastern Pacific Ocean’ population, is harvested by fishers in the USA and Baja California, Mexico, and is the population considered in this assessment.

The Pacific Fishery Management Council (PFMC) manages the northeastern Pacific stock as a single unit, with no area- or sector-specific allocations. However, the formal Fishery Management Plan (FMP) harvest control rule does include a stock distribution adjustment, based on a long-term assumption that roughly 70% of this transboundary population resides in USA waters in any given year (PFMC 1998).

**Fishery descriptions**

Pacific mackerel are currently harvested by three ‘fisheries’: the USA commercial fishery that primarily operates out of southern California; a sport fishery based largely in southern California; and the Mexico commercial fishery that is based in Ensenada and Magdalena Bay, Baja California. In the commercial fisheries, Pacific mackerel are landed by the same boats that catch Pacific sardine, anchovy, jack mackerel, and market squid (generally, referred to as the west coast ‘wetfish’ fleet). There is no directed fishery for mackerel in Oregon or Washington; however, small amounts (100-300 mt annually) are taken (incidentally) by whiting trawlers and salmon trollers. Catches in the Pacific Northwest peaked at 1,800 mt following the major El Niño event of 1997-98.

The history of California’s Pacific mackerel fishery has been reviewed by Croker (1933; 1938), Roedel (1952), and Klingbeil (1983). Pacific mackerel supported one of California’s major fisheries during the 1930s and 1940s and more recently, particular years in the 1980s and 1990s. During the early years of the fishery, Pacific mackerel were taken by lampara and pole-and-line boats, which were replaced in the 1930s by the same purse seine fleet that fished for sardine. Before 1929, Pacific mackerel were taken incidentally, in relatively small volumes, with sardine and sold as fresh fish (Frey 1971). Canning of Pacific mackerel began in the late 1920s and increased as greater processing capacities and more marketable ‘packs’ were developed. Landings decreased in the early 1930s due to the economic depression and subsequent decline in demand, but increased significantly by the mid-1930s (66,400 mt in 1935-36). During this period, Pacific mackerel were second only to Pacific sardine in total (annual) landings. Harvests subsequently underwent a long-term decline and for many years, demand for canned mackerel remained steady and exceeded supply. Supply reached record low levels in the early 1970s, at which time the State of California implemented a ‘moratorium’ on the directed fishery.

Following a period of ‘recovery’ that spanned from the mid to late 1970s, the moratorium was lifted and subsequently, through the 1990s, the fishery ranked third in volume for finfish landed in California. During this time, the market for canned mackerel fluctuated due to availability and economic conditions. Domestic demand for canned Pacific mackerel eventually waned and the last mackerel cannery in California closed in 1992. At present, most Pacific mackerel is used for human consumption or pet food, with a small, but increasing amount sold as fresh fish.

Pacific mackerel are caught by recreational anglers in southern California, but seldom as a target species (Young 1969). During the 1980s, California’s recreational catch averaged 1,500 mt per year, with Pacific mackerel being one of the most important species harvested by the California-
based CPFV fleet. Pacific mackerel are also harvested in California's recreational fishery as bait for directed fishing on larger pelagic species. Additionally, Pacific mackerel are caught by anglers in central California, but typically, only in small amounts. The state-wide sport harvest constitutes a small fraction (less than 5% in weight) of the total landings.

The Mexico fishery for Pacific mackerel is primarily based in Ensenada and Magdalena Bay, Baja California. The Mexico purse seine fleet has slightly larger vessels, but is similar to southern California’s fleet with respect to gear (mesh size) and fishing practices. The fleet operates in the vicinity of ports and also targets other small pelagic species. Demand for Pacific mackerel in Baja California increased after World War II. Mexico landings remained stable for several years, rose to 10,725 mt in 1956-57, then declined to a low of 100 tons in 1973-74. Catches in Mexico remained relatively low through the late 1980s. Landings of Pacific mackerel in Ensenada peaked twice, first in 1991-92 at 34,557 mt, and again in 1998-99, at 42,815 mt. The Ensenada fishery has been comparable in volume to the southern California fishery since 1990. In Baja California, Pacific mackerel are either canned for human consumption or reduced to fish meal.

Management history
The state of California first applied management measures to Pacific mackerel in 1970, after the stock had collapsed in the mid 1960s. A moratorium was placed on the fishery at this time, with a small allowance for incidental catch in mixed-fish landings. In 1972, legislation was enacted that imposed a landing quota based on the estimate of age-1+ (≥1-yr old fish) biomass generated from formal assessments. A couple of very strong year classes in the late 1970s triggered a stock recovery (increase in total abundance), which was followed by the fishery being reopened under a quota system in 1977. During the span of the recovery period from 1977 to 1985, various adjustments were made to quotas for directed take of Pacific mackerel and to incidental catch limits, i.e., even during the ‘moratorium’ substantial allowances were made for incidental catches associated with this species (Parrish and MacCall 1978).

State regulations enacted in 1985 imposed a moratorium on directed fishing when the total biomass was less than 18,200 mt, and limited the incidental catch of Pacific mackerel to 18% during such moratoriums. The fishing year was set to extend from July 1st to June 30th of the following year. Seasonal quotas, equal to 30% of the total biomass in excess of 18,200 mt, had been allowed when the biomass was between 18,200 and 136,000 mt, and there was no quota limitation when the total biomass was 136,000 mt or greater.

A federal fishery management plan (FMP) for coastal pelagic species, including Pacific mackerel, was implemented by the PFMC in January 2000 (PFMC 1998). The FMP’s harvest policy for Pacific mackerel, originally implemented by the State of California, is based on simulation analysis conducted during the mid 1980s, with the addition of a proration to account nominally for the portion of the ‘stock’ assumed to inhabit USA waters, see MacCall et al. (1985) and PFMC (1998). The current maximum sustainable yield (MSY) control rule for Pacific mackerel is:

\[
\text{Harvest} = (\text{Biomass-Cutoff}) \cdot \text{Fraction} \cdot \text{Distribution}
\]
where Harvest is the harvest guideline (HG), Cutoff (18,200 mt) is the lowest level of estimated biomass at which harvest is allowed, Fraction (30%) is the proportion of biomass above the Cutoff that can be harvested by fisheries, and Distribution (70%) is the average fraction of total Biomass (ages 1+) assumed in USA waters. The HGs under the federal FMP are applied to a July-June 'fishing year.'

California’s recreational catch of Pacific mackerel is included within the USA HG, but there are no other restrictions (e.g., size or bag limits) on this fishery. Total annual harvest of Pacific mackerel by the Mexico fishery is not regulated by quotas, but there is a minimum legal size limit of 255 mm. International management agreements between the USA and Mexico regarding transboundary stocks, such as Pacific mackerel, have not been developed to date (see Preface and Research and data needs).

Management performance
From 1985 to 1991, the biomass exceeded 136,000 mt and no state quota restrictions were in effect. State quotas for 1992-00 fishing years averaged roughly 24,000 mt. The HGs averaged roughly 15,000 mt from 2001-06. In 2007, the HG was increased substantially to over 70,000 mt based largely on assumptions regarding variability surrounding estimated recruitment and remained at an elevated level until 2009, when the calculated HG (55,408 mt) was reduced by management (PFMC) to 10,000 mt to address uncertainty related to two alternative models (see Preface and PFMC 2010b); the 10,000 mt HG was adopted in 2010 as well. It is important to note that over the last decade, from a management context, the fishery has not fully utilized HGs, with average yields since this time of roughly 5,000 mt. Finally, recent legislation concerning management of exploited fisheries in the USA now require alternative methods for quota determination that are used in concert with the HG method above [see PFMC (2010a), SSC (2010), and Ralston et al. (2011) for methods used to derive OFL, ABC, ACL, and associated buffer values]. Also, see Harvest Control Rule for USA Management in 2011-12 section below.

ASSESSMENT

Ultimately, the Pacific mackerel stock assessment final Model \( X_A \) presented here reflects two primary changes from recently conducted assessments, including: (1) an additional index of abundance derived from recreational fishery data collected through the newly implemented California Recreational Fishery Survey (CRFS, 2004-10); and (2) additional (historical) length distribution data collected from an observer (CPFV) sampling program conducted by CDFG from 1985-89. Other changes associated with estimation methods for influential areas of parameterization were also necessary, particularly, those related to selectivity/catchability associated with biological distributions and indices of abundance. Parameterization details associated with Model \( X_A \) are presented below (see Model description sections) and in Table 5.

A full suite of assessment-related displays for the final Model \( X_A \) are presented in the body of this document. Additionally, SS program files associated with Model \( X_A \) are presented in Appendix 1. Finally, Table 5 presents a broad range of important parameter-related statistics associated with Model \( X_A \), as well as for the final model adopted in the previous formal assessment conducted in 2009 (aka Model \( A_A \)).
History of modeling approaches

Parrish and MacCall (1978) were the first to provide stock status determinations for Pacific mackerel using an age-structured population model (i.e., traditional virtual population analysis, VPA). The ADEPT model (the ‘ADAPT’ VPA modified for Pacific mackerel; Jacobson 1993 and Jacobson et al. 1994) was used to evaluate stock status and establish management quotas for approximately 10 years. The assessment conducted in 2004 (for 2004-05 management) represented the final ADEPT-based analysis for this stock (see Hill and Crone 2004a). That is, the forward-simulation model ASAP (Legault and Restrepo 1998) was reviewed and adopted for Pacific mackerel at the 2004 STAR Panel (Hill and Crone 2004b). The ASAP model was used for assessments and management advice from 2005 through 2008. The STAR conducted in 2009 determined that the SS model provided the best (most flexible) platform for assessing the status of Pacific mackerel currently (i.e., the 2009-10 fishing year) and in the future, see STAR (2009).

Sources of data

Fishery-dependent data

Overview

Fishery-related data for assessing Pacific mackerel included: landings (California commercial, California recreational, and Mexico commercial); port sample (biological) data from California’s commercial (purse seine) and recreational (CPFV) fisheries; biological (length) data from an observer (CPFV) sampling program coordinated through the CDFG; and logbook (CPFV) and survey (CRFS) data from marine recreational fisheries for purposes of developing catch-per-unit-effort (CPUE) indices. Since 1992, the CDFG has collected biological data on Pacific mackerel landed in the southern California fishery (primarily, San Pedro). Samples have also been collected from the Monterey fishery when available. For this assessment, raw sample data were available from 1962 through 2010. Biological samples include whole body weight, fork length, sex, maturity, and otoliths for age determination. Currently, CDFG collects 12 ‘random’ (port) samples per month (25 fish per sample) to determine length/age distributions, catch-at-age, weight-at-age, etc. for the directed fishery. Mexico port sampling data have been collected by INP-Ensenada since 1989, but have not been available for purposes of inclusion in this ongoing assessment effort and thus, California commercial data were assumed to be representative of the combined commercial fisheries. Lack of Baja California port sampling data is not a serious problem for some years when Mexico catches were low. However, in recent years, Baja California and California catches have been roughly equal in volume, which necessarily increases the likelihood that potential biases associated with the omission of (and subsequent assumptions concerning) sample data from the Mexico fishery. Sample sizes associated with this data collection program are presented in Table 1.

Pacific mackerel were aged by CDFG biologists, based on identification of annuli in whole sagittae. Historically, a birth date of May 1st was used to assign year class (Fitch 1951). In 1976, ageing protocols changed to a July 1st birth date, which coincided with a rebounding resource, resumed fishery sampling, and a change in the management season from a May 1st opening to a July 1st start date.

Fishery inputs were compiled by ‘biological year,’ based on the birth dates used to assign age. Therefore, data prior to 1976-77 were aggregated in the biological year of May 1st (year_x) through April 30th (year_x+1), and data from 1976-77 forward were aggregated July 1st (year_x)
through June 30th (year, +1). The biological year used in this assessment is synonymous with the ‘fishing year’ defined previously, as well as with ‘fishing season’ as reported in the historical literature. That is, the change in birth date assignment from May 1st to July 1st coincided with a change in the management season in the mid-1970s, with historical sources of landings and biological data reflecting this change.

**Catches**

The assessment includes commercial and recreational landings in California and commercial landings in Baja California (Mexico) from 1983 to 2010. Annual (fishing year) landing estimates of Pacific mackerel are presented in Table 2 and Figure 1.

The following discussion regarding harvest prior to 1983 is provided for general information only, given the current assessment model (Model XA) begins in 1983. California commercial landings of Pacific mackerel were obtained from a variety of sources based on dealer landing receipts (CDFG) and in some cases, augmented with port sampling for mixed load portions. Data from 1929-61 were obtained from Parrish and MacCall (1978). Monthly landings for the period May 1962 to September 1976 were obtained from CDFG fish bulletins recovered to an electronic data base format (PFEL 2005). Raw landing receipt data for Pacific mackerel from 1976 to 1991 were of marginal quality, owing to the large quantities of Pacific mackerel landed as mixed loads with jack mackerel. During this period, many processors reported either species as ‘unspecified’ mackerel on landing receipts. For these years, mackerel landings receipts were augmented with shoreside ‘bucket’ sampling of mixed loads to estimate species compositions. The CDFG reported these data in two forms: (1) annual stock status reports to the California legislature; and (2) single page ‘CDFG Wetfish Tables.’ Both sources are considered more accurate than PacFIN or other landing receipt-based statistics for this period. Data sources from late 1976 to the present are as follows: October-December 1976 are from Klingbeil and Wolf (1986); January-December 1977 are from Wolf and Worcester (1988); January 1978-December 1981 are from Jacobson et al. (1994a); January 1982-December 2010 are from CDFG Wetfish Tables, as well as PacFIN (for the limited landings from Oregon and Washington); and finally, landing estimates for January-June 2011 and July 2011-June 2012 were assumed to be similar to the analogous time blocks of the previous year, namely, January-June 2010 and July 2010-June 2011, respectively.

California recreational landings (mt) from 1980 to the present (2-month ‘wave’ resolution) were obtained directly from Pacific RecFIN data base estimates. Historical estimates (pre-1980) of total recreational catch were derived from CPFV logbook data collected since 1936 (Hill and Schneider 1999). The CPFV catch (number) was converted to metric tons using an assumed average weight of 0.453 kg (1 lb) per individual, based on RecFIN samples and consistent with Parrish and MacCall (1978). The CPFV harvest was expanded to total recreational tonnage using wave-specific ratios from RecFIN.

Baja California data include landings from commercial purse seine fisheries in Ensenada, Cedros Island, and Magdalena Bay. Ensenada landings were compiled as follows: 1946-47 through 1969-70 (May-April) data are from Parrish and MacCall (1978); 1970-71 through 1975-76 (May-April) data are from Schaefer (1980); quarterly data from July 1976 through December 1986 are from Jacobson et al. (1994b); monthly data from January 1987 through November 2003
were provided by INP-Ensenada (García and Sánchez, 2003; Celia Eva-Cotero, INP-Ensenada, personal communication, INP-Ensenada staff); monthly landings from December 2003 through December 2004 were not available and thus, were substituted with corresponding months from the previous year. Ensenada landings in 2005, available from Cota et al. (2006), were apportioned into monthly catch using ratios from the previous few years. Ensenada landings for January to June 2006 were taken from Cota et al. (2006). Monthly landing data for the Cedros Island (January 1981-December 1994) and Magdalena Bay (January 1981 – May 2003) fisheries were provided by R. Felix-Uraga (CICIMAR-IPN, La Paz, personal communication). The fishery off Cedros Island ceased in 1994. For 2003 to 2009, commercial landings for the Ensenada and Magdalena Bay fisheries were taken from CONAPESCA’s web archive of Mexican fishery yearbook statistics (CONAPESCA 2010).

Finally, small volumes (100 to 300 mt per year) of Pacific mackerel are taken incidentally in other fisheries (e.g., whiting, salmon troll, and Pacific sardine) off Oregon and Washington. Biological samples collected from these fisheries (Hill 1999) indicated fish from these waters are typically larger and older than the directed fishery off California and thus, these limited samples have not been included in the current assessment model presented here.

Length distributions
All model scenarios included length distributions for the USA recreational fisheries, including CPFV (1985-89, 1992-10) and non-CPFV (2004-10) time series, i.e., utilizing age-based selectivity. Age-based selectivity was used in all model scenarios, including: age distribution time series from the fishery, as well as mean length-at-age time series (see Age distributions and Mean length-at-age distributions below); and length distribution time series (no age data available) from the recreational fisheries. Length distributions for the recreational fisheries were partitioned into CPFV (Figure 2A) and non-CPFV time series (Figure 2B): CPFV time series is developed from both a CDFG observer sampling program (1985-89) and the Marine Recreational Fishing Statistical Survey (MRFSS and related Pacific RecFIN data base) using sample examined catch data (1992-10); and non-CPFV time series developed from the California Recreational Fishery Survey (2004-10).

The CDFG conducted a CPFV onboard observer sampling program in southern California from 1975-78 and from 1985-89, and in central and northern California from 1987-98. That is, the earlier time series (1975-78) was omitted, given the model started in 1983, and the latter time series (1987-98) was omitted, given limited sample data over this time period, as well as having a representative time series for these data already in the model (i.e., 1992-10). Ultimately, selectivity parameterization for both the recreational fishery and CPFV index of abundance (i.e., mirrored the recreational fishery) was based on the length distribution developed from only the CPFV fishery. Finally, see Reilly et al. (1998) for further details of this sampling program and overall data collected.

The length distribution from CRFS represented fish caught via all recreational fishing modes, but the CPFV fleet, which allowed for the most reasonable selectivity parameterization for the CRFS index of abundance, see CRFS abundance index section below.
Length distributions were developed using 1-cm length (fork) bins, with the smallest bin equal to 1 cm and the largest equal to 60 cm. The 60-cm bin includes fish that were greater than or equal to 60 cm. The total number of lengths (say specimens measured for length) observed in each distribution (of each time step) was divided by 25 (the average number of fish collected per sample) and subsequently, used as the effective sample size in baseline model configurations. Ultimately, length distributions (in numbers of fish) were converted to proportion estimates for all modeling efforts.

**Age distributions**
Age distribution time series were developed from the same (CDFG) port sample data base described previously, i.e., the sampling program entails recording length, sex, age (via otolith collections), etc. from each fish in the 25-fish sample taken from a completed fishing trip. It is important to note that age (and length) distributions developed from this sampling program are considered to be representative of the landings associated with the (commercial) fishery and thus, serve as the foundation for evaluating cohort dynamics in the fully-integrated models. Ultimately, age distributions (in proportion-at-age) were based on 9 age bins that represented age-0 to age-8+, i.e., a ‘plus group’ that includes ≥8-yr old fish. The total number of ages (say specimens measured for age) observed in each distribution was divided by 25 (the average number of fish collected per sample) and subsequently, used as the effective sample size in baseline model configurations. Ultimately, age distributions (in numbers of fish) were converted to proportion estimates for all modeling efforts. Annual age distributions (1983-10) associated with all models are presented in Figure 3.

**Mean length-at-age distributions**
For the primary purpose of evaluating growth dynamics associated with this species, mean length-at-age time series (1983-10) were developed from the same (CDFG) port sample data base described above and used in conjunction with age distributions in SS model scenarios (Figure 4). Effective sample size estimates were obtained using the same 25-fish adjustment employed for the other biological distributions, based on typically sample sizes from a completed fishing trip.

**Ageing error distribution**
In efforts to provide the most realistic measure of uncertainty associated with estimated age distribution time series, an ageing error vector, based on standard ‘double-read’ methods, was also included in all model scenarios, i.e., a SD vector by age was used in all SS model scenarios (Figure 5). It is important to note that further ageing error analysis pertaining to this species is warranted, given the current vector is considered preliminary at this time.

**Commercial passenger fishing vessel (CPFV) index of abundance**
California Fish and Game legislation has required CPFV captains to provide records of catch and effort data to CDFG since 1936. In the past, Pacific mackerel have been among the top five species reported on CPFV logs, both in southern California and state-wide; however, the species is not typically targeted per say by the fishery. This information resides in a logbook data base (Hill and Barnes 1998; Hill and Schneider 1999) that summarizes CPFV catch and effort by month and Fish and Game statistical blocks (10 nm²). A single state-wide index of relative abundance was developed, based on a delta-Generalized Linear Model (delta-GLM) approach for
estimating year effects (Dick 2010), i.e., a CPUE time series of relative abundance (Figure 6A). The index is based on a fishing year basis, as is the case with other time series used in the models. Selectivity parameterization associated with this index mirrored the recreational fishery (i.e., age-based selectivity based on length distribution time series).

To account for potential changes in catchability associated with the CPFV fleet over time, a delta-GLM model was used to 'standardize' the data and separate effects from critical factors (e.g., spatial-temporal). That is, by incorporating year as a factor, the delta-GLM generates estimates of annual standardized catch rate and its variance that can be generally interpreted as a relative index of abundance of the population. Ultimately, the index of abundance is based on two GLMs: the first GLM estimates the probability of a positive observation, based on a binomial likelihood and logit link function; and the second GLM estimates the mean response for the positive observations, assuming a gamma error distribution. The final index is the product of the back-transformed year effects from the two GLMs. Technical details concerning the delta-GLM analysis follow:

1. data were combined within year/quarter/fleet strata (i.e., the overall, statewide fishery was partitioned into a northern and southern ‘fleet’ based on latitude/longitude spatial fishing ‘blocks’);
2. CPUE was calculated (number of fish/1,000 angler-hours fishing) for each spatial/temporal stratum;
3. fishing years 1983 to 2010 were used in the analysis;
4. latitude/longitude blocks were combined into broader spatial areas based on the fishing practices of the northern and southern CPFV fleets, i.e., historically, the southern fleet has exerted the vast amount of fishing pressure associated with this overall fishery (Pt. Conception was used as the ‘north/south’ delimiter to partition the two regional fleets);
5. the delta-GLM method models the probability of obtaining a zero catch and the catch rate separately, given the catch rate is non-zero (Stefansson 1996; Maunder and Punt 2004). In this assessment, we estimate the probability of a positive observation using a binomial distribution and a logit link function. Then, the mean response for positive observations was estimated assuming a gamma distribution for the error term. The basic model for positive observations included the log of mean catch rate (μ) as a function of three main effects (fishing year \( i \), quarter \( j \), and fleet \( k \)),

\[
\log_e(\mu_{ijk}) = U_R + Y_i + Q_j + F_k + \epsilon_{ijk},
\]

where \( \mu_{ijk} \) is the mean catch rate (number of fish/1,000 angler-hours) in year \( i \), quarter \( j \), and fleet \( k \). The fishing year effect is denoted by \( Y_i (i=1, 2, ..., I; I=49 \text{ fishing years}) \). The quarter of the year effect is denoted by \( Q_j (j=1, 2, ..., J; J=4 \text{ quarters}) \). The fleet effect is denoted as \( F_k (k=1, ..., K; K=3 \text{ fleets}) \). The error term is denoted \( \epsilon_{ijk} \), where for each combination of indices, \( \epsilon_{ijk} \) is iid and gamma distributed. Finally, the reference cell is denoted as \( UR (R=1 \text{ reference cell, i.e., year=2004, quarter=4, and fleet=south}) \);
6. no temporal/spatial interactions (e.g., year and fleet or quarter and fleet) were included in the final delta-GLM model, given such interactions had little effect on increasing the amount of variability in mean catch rate as a function of the suite of explanatory variables (i.e., minor improvement of \( R^2 \) statistic, see Hill and Crone 2005, Crone et al. 2006); and
(7) a delta-GLM function written in the statistical programming language R (Dick 2010) was used to estimate a mean catch rate from the CPFV data set. A major feature of this function is that it estimates coefficients of variation (CV) for the relative index of abundance using a jackknife (leave-one-out) method. However, because the CPFV data were very extensive (nearly 90,000 observations), estimation of both year effects for the survey simultaneously with measures of dispersion (i.e., CVs) was problematic and ultimately, unsuccessful, i.e., an average CV (0.30) was used for each annual estimate of the time series.

Finally, note that all other estimation techniques used to evaluate these data, including GLMs, GAMs, and even nominal mean time series resulted in very similar results, i.e., ultimately, trajectories used in the model to model relative population size over time.

California Recreational Fisheries Survey (CRFS) index of abundance

The California Recreational Fisheries Survey (CRFS) began in 2004 to provide catch and effort estimates for California marine recreational finfish fisheries in six coastal districts and four fishing modes. It represents a collaborative effort between the CDFG and the Pacific States Marine Fisheries Commission (PSMFC) and provides higher spatial and temporal resolution than the previous federal-based survey (MRFSS, 1980-03). See PSMFC (2010) for details regarding survey goals, methods, data availability/accessibility, etc.

The CRFS index of abundance was evaluated at the fishing mode level (Figure 6B), and developed in a similar manner as that above for the CPFV logbook-related index, with the final time series used in modeling efforts having the following differences:

(1) all fishing modes, with the exception of the CPFV fleet (Figure 6A-B);
(2) CPUE was calculated as the number of fish per fishing party/day, i.e., data base structure and limited (examined) sample information precluded calculations at a finer scale (e.g., angler/hour), however, the units of CPUE are likely inconsequential to the overall analysis, given 'positive catch' records composed roughly 1-4% (depending on fishing mode) of the total records (see Table 3 for summary CRFS statistics and Figure 6A-B applicable to Pacific mackerel and the overall survey); and
(3) fishing years 2004 to 2010 were used in the analysis.

Finally, this time series represents an additional index of abundance that has not been included in past assessments and was considered an alternative index in sensitivity analysis conducted in 2011, which in effect, complements the CPFV index above, given it includes data from leisure fishing modes not included in the CPFV analysis.

Biological data

Weight-length

A weight-length (W-L) relationship for Pacific mackerel was modeled using port sample data collected by CDFG from 1962 to 2010 (see Fishery-dependent data above). A straightforward power function was used to determine the relationship between weight (kg) and fork length (cm) for both sexes combined:
where $W_L$ is weight-at-length $L$, and $a$ and $b$ are the estimated regression coefficients. Weight-length parameters based on data from 1962-10 ($a = 3.1E-06$ and $b = 3.4$) were used (fixed) in all model scenarios (Figure 7).

Length-at-age

The von Bertalanffy growth equation was used to model the relationship between fork length (cm) and age for Pacific mackerel (1962-10):

$$L_A = L_\infty \left(1 - e^{-k(A-t_0)}\right),$$

where $L_A$ is the length-at-age $A$, $L_\infty$ (‘L-infinity’) is the theoretical maximum length of the fish, $k$ is the growth coefficient, and $t_0$ (‘t-zero’) is the theoretical age at which a fish would have been zero length. Length-at-age was estimated internally in all SS model scenarios, generally based on the following baseline growth equation for this population calculated from the CDFG data base (1962-10): $L_\infty = 39.3$ mm, $k = 0.342$, and $t_0 = -1.752$ (Figure 7). Of particular note is the rapid growth exhibited by this species, i.e., past research (Parrish and MacCall 1978; Mallicoate and Parrish 1981), as well as analysis conducted here on recent biological sample data, indicates fish, on average, realize over 50% of their total growth (in length) in the first year of life and subsequently, grow a few cm per year until death at roughly 40 cm (approximately, age 7-8). Sensitivity analysis resulted in relatively robust estimates of $k \approx 0.30$.

Maximum size and age

The largest recorded Pacific mackerel was 63.0 cm in length (FL) and weighed 2.9 kg (Roedel 1938; Hart 1973), but the largest Pacific mackerel taken by commercial fishing (CA) was 47.8 cm FL and 1.72 kg. The oldest recorded age for a Pacific mackerel was 14 years, but most commercially caught Pacific mackerel are less than 4 years old, with few living beyond age 8 and larger than 45 cm.

Maturity-at-age

The estimated maturity schedule (ogive) used in the past for this stock was assumed in all model scenarios here (Table 4 and Figure 7). That is, normalized net fecundity-at-age (the product of fraction mature, spawning frequency, and batch fecundity) was used to interpret CalCOFI ichthyoplankton data and ultimately, generate estimates of $SSB$. Fraction mature was estimated by fitting a logistic regression model to age and fraction mature data from Dickerson et al. (1992). Spawning frequency was estimated by fitting a straight line to age and spawning frequency data from the same study. Following Dickerson et al. (1992), batch fecundity per gram of female body weight was assumed constant.

Natural mortality

Natural mortality rate ($M$) was assumed to be 0.5 yr$^{-1}$ for all ages and both sexes, and used in all modeling efforts presented here (Figure 7). Parrish and MacCall (1978) estimated natural mortality for Pacific mackerel using early catch curves ($M = 0.3-0.5$), regression of $Z$ on $f$ ($M = 0.5$), and comparative studies of maximum age ($M = 0.3-0.7$; Beverton 1963) and growth rate ($M = 0.4-0.6$; Beverton and Holt 1959). The above authors considered the regression of $Z$ on $f$ to be
the most reliable method, with the estimate $M = 0.5$ falling within the range of the plausible estimates, i.e., an instantaneous $M = 0.5$ can be practically interpreted as an annual rate of roughly 40% of the stock dying each year due to ‘natural causes.’

Stock-recruitment
A Beverton-Holt (B-H) stock-recruitment ($S/R$) relationship was assumed for this population for all models scenarios, i.e., as observed in the historical literature, as well as from modeling efforts here, recruitment is highly variable and not likely related closely to absolute levels of $SSB$ biomass ($SSB$). However, it is important to note that steepness ($h$) ranged from roughly 0.35 to 0.75, depending on the model scenario, indicating that at low $SSB$ levels, recruitment is estimated to decrease slightly to moderately (Figure 8). Parrish (1974) and Parrish and MacCall (1978) discussed general life history strategies for this population that are tightly linked to oceanographic conditions and further, that periods of strong year classes (cohorts) are likely produced only when $SSB$ is high (or moderately so) and more importantly, not likely to occur more than once or twice every 60 years.

Responses to past STAR/SSC recommendations
The three overriding recommendations from past reviews focused on data availability from Mexico, omission/inclusion/parameterization of available indices of relative abundance used in the ongoing assessment, and updating biological parameters considered influential in the overall modeling effort. See STAR (2009) for further discussion regarding these issues.

Regarding relations with Mexico and issues surrounding future data exchange and professional collaboration on research projects … SWFSC staff continue to engage in such discussions, meetings, conferences, etc. with academic colleagues and federal researchers from Mexico, e.g., updated landing information and additional, albeit preliminary, larval survey data have been made available recently.

Regarding indices of relative abundance used in the current assessment … substantial progress was made with developing an alternative index of abundance (see CRFS index of abundance above), sensitivity analysis that addressed inclusion/omission of the suite of alternative indices, and further examinations of time-varying catchability/selectivity within an index (see Model description sections, Assessment model results, and Assessment uncertainty below).

Regarding updating biological parameters used in the ongoing assessment … SWFSC and CDFG have jointly begun field/laboratory efforts collecting, processing, and analyzing reproductive samples from Pacific mackerel harvested in both the recreational and commercial fisheries. It is important to note that an ‘aggressive’ sampling plan over a 2 to 4 year time horizon will be required to accumulate enough samples to develop an updated maturity schedule for use in stock assessments due to limited landings of this species, coupled with few field-based surveys.

Model description
Overview
The Stock Synthesis (SS, Methot 2005, 2011) model is founded on the AD Model Builder software environment, which essentially is a C++ library of automatic differentiation code for nonlinear statistical optimization (Otter Research 2001). The model framework allows full
integration of both population size and age structure, with explicit parameterization both spatially and temporally. The model incorporates all relevant sources of variability and estimates goodness of fit in terms of the original data, allowing for final estimates of precision that accurately reflect uncertainty associated with the sources of data used as input in the overall modeling effort.

The SS model comprises three sub-models: (1) a population dynamics sub-model, where abundance, mortality, and growth patterns are incorporated to create a synthetic representation of the true population; (2) an observation sub-model that defines various processes and filters to derive expected values for different types of data; and (3) a statistical sub-model that quantifies the difference between observed data and their expected values and implements algorithms to search for the set of parameters that maximizes goodness of fit. This modeling platform is also very flexible in terms of estimation of management quantities typically involved in forecast analysis. Finally, from an international context, the SS model is rapidly gaining popularity, with SS-based stock assessments being conducted on numerous marine species throughout the world. The SS model used in this assessment was the most recently distributed version, namely, version 3.20b (January 2011).

Likelihood components and model parameters
Likelihood components and estimates for important SS model scenarios are presented in Table 5, including, fits to catch, age/length distributions, and indices, as well as parameter estimates for initial conditions (age distribution, recruitment, and fishing mortality), growth, recruitment, stock-recruitment relationship, etc.

Convergence criteria
The convergence criterion for maximum gradient determination was set to 0.0001 in the SS model. Fidelity of model convergence was explored by changing particular ‘starting’ values for multiple parameters and evaluating the converged ‘minimum’ values, i.e., evaluating ‘global’ vs. ‘local’ convergence properties of the overall, multi-dimensional numerical estimation.

Model selection and evaluation
We strongly adhered to model development (say parameterization involved in the various scenarios constructed in sensitivity analysis) that was based on the following: supports general consensus regarding this species’ life history; results in no noticeable inconsistencies (across likelihood components) within the fully-integrated model scenario; addresses uncertainty in a sound, robust, and parsimonious manner; and finally, produces realistic (meaningful) results that can be directly assimilated into ongoing management efforts.

Sensitivity analysis
Sensitivity analysis resulted in a suite of models for review at the onset of the STAR meeting in May 2011, as well as numerous model scenarios developed during the interactive meeting itself. In keeping with final assessment documentation protocols, model presentation is largely devoted to the final base case model selected by the STAR panel and STAT (i.e., Model XA). Pertinent summary statistics for both Model XA and for comparative purposes, the previous assessment final model (Model AA) adopted in 2009 are presented in Table 5A-D. Additionally, final sensitivity analysis for Model XA is presented in Table 5D, i.e., influential parameterizations
were evaluated via 16 model scenarios to ensure the final model was both robust and generally consistent across data sources. Readers interested in details regarding the plethora of model scenarios evaluated in the review meeting via sensitivity analysis should consult STAR (2011). Finally, note that other model scenarios involved in the overall sensitivity analysis were generally similar to Model XA, i.e., parameterization differences largely reflected a step-wise approach, whereby a single change in a parameter of interest (e.g., selectivity for a fishery, omission/addition of time series, etc.). A complete suite of displays is presented for Model XA within the body of the document. Key features of the final Model XA follow:

Model XA:
- **Time period**: 1983-10 (new parameterization, i.e., previously, 1962);
- **Fishery structure**: two (USA/Mexico commercial and USA recreational);
- **Surveys**: two indices of relative abundance (CPFV index and the new CRFS index);
- **Time-step**: annual;
- **Gender structure**: combined sexes;
- **Longevity**: 12 years (new parameterization, i.e., previously, 15 years);
- **Natural mortality**: 0.5 for all ages. Also, see Natural mortality above.
- **Growth**: estimated and constant over time;
- **Selectivity (biological distributions)**: age-based, a single time block, and asymptotic for the commercial fishery and dome-shaped for the recreational fishery. Selectivity issues regarding age- or size-based approaches were given much attention, based on relations to the actual operation of the fisheries and dynamics of the stock. That is, we feel that the distribution exhibited by this species on any given year and subsequently, its probability of capture (selectivity) is more influenced by ‘time’ (say age) than by size (say length), i.e., this is true for all age groups, from the high variability observed in the presence/absence of 0-1 yr-old fish to the adults in the estimated age distributions modeled here. Recognizing that in reality, both attributes are likely influential to some degree, it is more likely that movement (and capture) are driven by age, i.e., versus gear (mesh) constraints that also generally influence vulnerability. Given the biological sampling design in place provides ‘random’ samples of fish (for purposes of length, age, etc.) from completed boat trips, selectivity parameterization based on representative age distributions of the catch becomes the logical approach. Although the biological distributions from the recreational fishery were in terms of size (length, given no age data available), age-based selectivity was estimated from CPFV length distribution for this fishery as well. Finally, preliminary
modeling efforts indicated age- or size-based selectivity resulted in similar conclusions of
stock status;
• Selectivity (indices): age-based, a single time block, and dome-shaped (i.e., mirrors
recreational fishery) for the CPFV index of abundance and age-based, a single time block,
and dome-shaped (estimated from non-CPFV length distribution);
• Catchability: constant over time, with CVs = 0.30 for year effects;
• Stock-recruitment: Beverton-Holt stock-recruitment model. An asymptotic relationship
between parents and offspring was assumed in all model scenarios. Also, see Stock-
recruitment above. Variance associated with log recruitment estimation was fixed, i.e., \( \sigma_r = 1.0 \) (in most model scenarios, generated root MSEs were roughly = 1.0 (0.8-1.25); and
• Variance adjustments to time series: None. Note that in the final model in 2009, a variance
adjustment was implemented for the recreational fishery length distribution
parameterization, i.e., this re-weighting was not deemed necessary for the final model in
2011.

Assessment model results (Model XA)
Results are summarized below, with discussion regarding important topics related to the overall
population analysis presented in the Assessment uncertainty section below. Trends of estimated
trajectories of management-related time series (e.g., biomass, spawning stock biomass, and
recruitment) from updated model scenarios in 2011 were very similar to those generated from the
previous assessment in 2009, with strictly magnitude differences observed for the most dynamic
period of the historical time series, i.e., higher estimates of stock size and recruitment in the late
1970s to late 1980s in the updated 2011 models, which were expected, given: (1) the additional
length time series included in the updated models, i.e., 1975-78 and 1985-89 distributions, which
were composed of large and old fish (also, see Length distributions section above); (2) related
changes to estimated selectivity and time blocks associated with this roughly 10-yr period; (3)
the inclusion of the mean length-at-age time series, coupled with a maturity schedule that is
based on larger/older individuals being more fecund than smaller/younger fish; (4) catches and
catch rates increasing markedly; which ultimately, (5) represented the high recruitment success
for that narrow timeframe. It is important to note that the points above are essentially moot,
given the final Model XA has a start year of 1983, which essentially resulted in a period of
consistent growth over the modeled timeframe (1983-10).

Model fits to biological distributions are presented in the following displays: Figure 9A is
observed vs. predicted estimates for the age distribution time series for the commercial fishery;
Figure 9B is the associated Pearson residual plot for the age distribution fits; Figure 9C is the
associated input vs. effective sample size plot for the age distribution fits; Figures 10A and 10D
are observed vs. predicted estimates for the length distribution time series from the recreational
fishery, CPFV and CRFS (non-CPFV fishing modes), respectively; Figures 10B and 10E are the
associated Pearson residual plot for the length distribution fits, CPFV and CRFS (non-CPFV
fishing modes), respectively; Figures 10C and 10F are the associated input vs. effective sample
size plots for the length distribution fits, CPFV and CRFS (non-CPFV fishing modes),
respectively; Figure 4 is the observed vs. predicted estimates for the mean length-at-age
distribution time series for the commercial fishery; and Figure 11 is the associated Pearson
residual plot for the mean length-at-age distribution fits. Estimated selectivity for the fishery
catches is presented in Figure 12A (commercial fishery) and Figure 12B [recreational fishery,
CPFV and CRFS (non-CPFV fishing modes)]. In general, fits to biological distributions were relatively good; however, in some years, large ‘pulses’ of younger fish were not fit with high precision, e.g., 0-1 yr-old fish in the commercial fishery age distributions.

Fits (normal and log space) to the indices of abundance are presented in Figures 13 and 14, for CPFV and CRFS, respectively. In general, model fits to the indices were relatively good; however, as previously noted above, no iterative reweighting of variance was conducted and thus, fits could be improved for the indices, noting that fits to the biological distributions would be compromised to some degree.

Estimated Beverton-Holt stock-recruitment relationship is presented in Figure 8 (see Stock-recruitment section above). Estimates of recruitment deviations and associated asymptotic standard errors are presented in Figure 15.

The estimated $F$-based spawning potential ratio (SPR) time series is presented in Figure 16. As expected, SPR estimates have varied over time, with exploitation declining markedly since roughly 2000 to historically low levels (see Assessment uncertainty below).

Estimated time series for management-related derived quantities of interest for Model $XA$ are presented in the following displays: Figure 17 is total stock biomass (age 1+ fish in mt, $B$); Figure 18 is spawning stock biomass ($SSB$ in mt); and Figure 19 is recruitment (age-0 fish in numbers). Both $B$ and $SSB$ as steadily declined from the mid 1980s to the early 2000s, at which time the population began to increase moderately in size, with some signs of ‘rebuilding’ observed over the last several years. However, as noted previously, recent estimates of stock size are necessarily related to assumptions regarding the dynamics of the fish (biology) and fishery (operations) over the last few, which generally confounds long-term (abundance) forecasts for this species. Again, estimated $B$ time series from the overall sensitivity analysis were very similar in trend and as noted above, differed in magnitude only for a short period of time historically, when additional length data/selectivity from particularly the 1970s are included in the model scenario. Results from retrospective and prospective analyses for Model $XA$ are presented in Figure 20A-B, i.e., for the retrospective analysis, data associated with terminal years 2010 to 2005 were omitted (sequentially) from the model and for the prospective analysis, the model was begun one year later than 1983 in a sequential manner. As observed in all past assessments, a retrospective pattern was evident in the current assessment as well, i.e., a tendency to overestimate stock abundance ($B$) in any current year, with future assessments based on additional data producing estimates lower in magnitude. The prospective analysis indicated moderate variability in model results based on later start years, but the pattern was not consistent from a chronological context as was the case with the retrospective. For comparative purposes, final estimated $B$ time series for the historical assessment period (2004-11) are presented in Figure 21. It is important to note that in 2007, estimated $B$ scaled upwards substantially, based largely on assumptions regarding variability surrounding estimated recruitment, i.e., since 2005, $\sigma_R$ has increased from 0.25 to 0.7 to the current level of assumed variability of 1.0, which is more in line with internal estimation of recruitment uncertainty associated with assessment models developed recently for this (and other) species.
Assessment uncertainty
Assessment uncertainty can be partitioned into essentially two inter-related areas.

First and foremost, the collective information, i.e., all sample data (time series used in the stock assessment presented here) and modeling results (via sensitivity analysis), as well as time series from available survey data, laboratory research, and related stock status studies conducted in the past, indicate the following:

- in terms of life history strategy, the Pacific mackerel population off the Pacific coast of North America is in many (most really …) ways a typical coastal pelagic species, but in a (key) few, unique as well, including:
  - exhibiting high recruitment success not on a decadal basis, say like many small, large-schooling pelagic species, but rather, on a multi-decadal cycle spanning 30 to 50 or more years;
  - growing rapidly from a prey existence to a predator role, with nearly 70% of growth in size (length) realized by age 1;
  - upon reaching adult status, it maintains a relatively low profile at the CPS assemblage level for extended periods of time, until oceanographic conditions are favorable and SSB is at least average in size, which produces a brief period of population expansion;
- it is important to note that although the stock is currently at a low level (i.e., not experiencing the 50-yr or so boom in recruitment), it is not very likely due to fishing pressure, but rather a less than ideal oceanographic regime (say for this species);
  - harvest rates have been very low over the last decade (see Harvest Control Rule for USA Management in 2011-12 below), e.g., recent $F_{SPR}$ estimates are 90%-95%, which is a very small removal of reproductive potential for such a species with a moderately high intrinsic rate of increase ($r$);
  - further, the species’ has a relatively short life span, with longevity of roughly 8-10 years likely, which provides additional resiliency to ongoing artificial perturbations, such as fishing operations managed under conservative exploitation schemes; and
  - the bottom-line is this is a classical recruitment fishery situation, whereby the stock provides relatively little benefit to fishing interests (commercial or leisure) for protracted periods, with narrow windows of opportunity (very high abundance) every 30-60 years.

In terms of this stock assessment modeling effort, the following areas contribute the most variation in the overall model and in this context, would benefit from further evaluation, i.e., model robustness could be improved by further addressing the following:

- which data source(s) are emphasized in the model scenario, e.g., decisions regarding ‘weighting’ biological distributions vs. indices of abundance, the inclusion/omission of length and/or mean length-at-age distributions, etc.;
- selectivity and catchability parameterization;
  - selectivity estimation associated with age (commercial fishery) and length (recreational fisheries) distributions were sensitive in particular model scenarios of interest and related to other influential parameterizations, such as growth;
catchability estimation associated with the CPFV and CRFS indices of abundance is
necessarily an ongoing parameterization effort, given re-weighting and model emphasis
considerations regarding the sources of data included in the model scenario of interest;
• the need for two fisheries, given both the commercial and recreational fisheries harvest
very similar fish and at low levels, particularly, the leisure fishery;
• a model with fisheries combined was evaluated, but differences in some years
concerning the size (and age) of fish harvested in each of the fisheries precluded further
development of this model scenario at this time, i.e., further examinations of
differences/similarities between the two fisheries is warranted, given such a
parameterization would substantially simplify the current assessment; and finally,
• stock-recruitment parameterization related to sensitivity analysis should include
evaluating the influence of steepness ($h$) set at different (hypothetical) values,
particularly, $h = 1.0$, given suppositions regarding this species’ reproductive
compensation at low SSB levels.

Generally speaking, uncertainty in the overall assessment was evaluated using some combination
of the following: the confidence intervals associated with estimated parameters of interest (e.g.,
time series of $SSB$ and recruitment); sensitivity analysis (i.e., developing alternative model
scenarios); and examinations (qualitative and quantitative) of important residual plots from
critical model fits (e.g., fits to biological distributions and indices of abundance). All of the
above were addressed in the assessment conducted here. Finally, it is important to note that
model estimates of absolute stock size are likely more uncertain than presented here, given the
final estimates are necessarily based on the following: strict probability samples in the field
cannot be obtained; subjective assumptions used to develop model scenarios; potential weighting
issues with particular data sources; and unaccounted for variability associated with related
sources of data and parameters within the fully-integrated, multiple likelihood modeling
platform.

**HARVEST CONTROL RULE FOR USA MANAGEMENT IN 2011-12**

As stipulated in Amendment 8 to the CPS FMP (PFMC 1998), the recommended maximum
sustainable yield (MSY) control rule for Pacific mackerel is (Table 6A):

\[
\text{Harvest} = (\text{Biomass-Cutoff}) \cdot \text{Fraction} \cdot \text{Distribution},
\]

where Harvest is the harvest guideline (HG), Cutoff (18,200 mt) is the lowest level of estimated
biomass at which harvest is allowed, Fraction (30%) is the proportion of biomass above the
Cutoff that can be harvested by fisheries, and Distribution (70%) is the average fraction of total
Biomass (ages 1+) assumed in USA waters (PFMC 1998). The HGs under the federal FMP are
applied to a July-June fishing year. Landings and associated HGs since 1992 are presented in
Figure 22A.

From 1985 to 1991, the biomass exceeded 136,000 mt and no state quota restrictions were in
effect. State quotas for 1992-00 fishing years averaged roughly 24,000 mt. The HGs averaged
roughly 15,000 mt from 2001-06. In 2007, the HG was increased substantially to over 70,000 mt
based largely on assumptions regarding variability surrounding estimated recruitment and
remained at an elevated level until 2009, when the calculated HG (55,408 mt) was reduced by management (PFMC) to 10,000 mt to address uncertainty related to two alternative models (see Preface and PFMC 2010b); the 10,000 mt HG was adopted in 2010 as well. Note that the HG in 2011 (40,514 mt) is strictly preliminary, given formal adoption of the HG will be addressed at the next Council meeting in June 2011. It is important to note that over the last decade, from a management context, the fishery has not fully utilized HGs, with average yields since this time of roughly 5,000 mt (Figure 22A). ‘Hypothetical’ quotas and total landings, based on omission of the USA ‘Distribution’ parameter in the harvest control rule are presented in Figure 22B.

Finally, recent legislation concerning management of exploited fisheries in the USA now require alternative methods for quota determination that are used in concert with the HG method above, see PFMC (2010a) and SSC (2010), and Ralston et al. (2011) for methods used to derive OFL, ABC, ACL, and associated buffer values (Table 6B).

RESEARCH AND DATA NEEDS

First and foremost, given the transboundary status of this fish population, it is imperative that efforts continue in terms of encouraging collaborative research and data exchange between NOAA Fisheries (Southwest Fisheries Science Center) and researchers from both Canada’s and in particular, Mexico’s academic and federal fishery bodies, i.e., such cooperation is critical to providing a synoptic assessment that considers available sample data across the entire range of this species in any given year.

Second, fishery-independent survey data for measuring (relative) changes in mackerel spawning (or total) biomass are currently lacking. Further, at this time, two indices of relative abundance are used in the assessment, which are developed from a marine recreational fishery (CPFV fleet and related fishing modes) that typically do not (directly) target the species. That is, the recently implemented CRFS provides useful information regarding this species' dynamics and further, represents a valuable survey for obtaining abundance trends for finfish generally targeted by marine recreational fishers in coastal waters off California. In this context, it is imperative that future research funds be focused on improvement (e.g., broadening the scope and increasing the frequency) of the current fishery-independent surveys operating out of the NOAA's SWFSC (e.g., CalCOFI and acoustic-trawl surveys), with emphasis on a long-term horizon, which will necessarily rely on cooperative efforts between the industry, research, and management, as well as cooperation from international fishery agencies.

Third, given the importance of age (and length) distribution time series to developing a sound understanding of this species’ population dynamics, it is critical that data collection programs at the federal and particularly, the state level continue to be supported adequately. In particular, CDFG/NOAA funding should be bolstered to ensure ongoing ageing-related laboratory work is not interrupted, as well as providing necessary funds for related biological research that is long overdue. For example, maturity-related time series currently relied upon in the assessment model are based on data collected over twenty years ago during a period of high spawning biomass that does not reflect current levels, i.e., the SWFSC and CDFG have begun field/laboratory efforts collecting, processing, and analyzing reproductive samples from Pacific mackerel harvested in both the recreational and commercial fisheries. Also, further work is needed to obtain more timely error estimates from production ageing efforts in the laboratory,
i.e., accurate interpretation of age-distribution data used in the ongoing assessment necessarily requires a reliable ageing error time series.

Finally, the MSY control rule utilized in the Pacific mackerel federal CPS-FMP was developed in the mid-1980s based on estimated abundance and stock-recruitment data at that time and thus, the control rule should be re-examined using new data and simulation methods. Given substantial amounts of additional sample data have accumulated since the initial research that was undertaken to formally establish this harvest strategy, it would be prudent to conduct further simulation modeling work to address particular parameters included in the overall control rule (including ‘cutoff,’ ‘fraction,’ and ‘distribution’ values).

ACKNOWLEDGEMENTS

Thanks to all individuals involved in the data collection- and laboratory-related programs surrounding this species, inclusive … in particular, those individuals from the California Department of Fish and Game and the Southwest Fisheries Science Center (NOAA). Regarding the overall analysis, thanks are extended to Alex Aires-da-Silva, Kevin Piner, Vardis Tsontos, HuiHua Lee, Rick Methot, Ian Taylor, Ian Stewart, the STAR panel, and in particular, Mark Maunder, who provided invaluable insight in terms of both theoretical concepts underlying animal population dynamics in general, as well as explicit model-related advice regarding a parameterization or two … all of the support is appreciated.

REFERENCES


Table 1. Sample sizes associated with CDFG data collection program for Pacific mackerel (1983-10).

<table>
<thead>
<tr>
<th>Fishing Year</th>
<th>Commercial</th>
<th>Recreational</th>
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</thead>
<tbody>
<tr>
<td>83</td>
<td>2,668</td>
<td></td>
</tr>
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Table 3. California Recreational Fisheries Survey (CRFS) summary statistics relevant to the CRFS index of abundance derived for Pacific mackerel (2004-10): Region is number of samples (i.e., interviewed party=sample) and NC=northern CA and SC=southern CA; Modes are number of samples, with All=zero catch and positive catch samples and Positive Creel=positive catch samples; Party Size is number of samples; Catch Size is number of samples (by number of fish in creel); Avg. No. Anglers in Party is average number of anglers; and Avg. Trip Length is average trip length in hours.

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Table 4. Normalized net fecundity calculations for Pacific mackerel, which in effect, represented the maturity schedule (ogive) used in all model scenarios.

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<thead>
<tr>
<th>Age (yrs)</th>
<th>Observed Fraction Mature</th>
<th>Predicted Fraction Mature</th>
<th>Observed Spawning Frequency (% spawning day⁻¹)</th>
<th>Predicted Spawning Frequency (% spawning day⁻¹)</th>
<th>Net Fecundity (eggs g⁻¹)</th>
<th>Normalized Net Fecundity (eggs g⁻¹)</th>
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<tbody>
<tr>
<td>0</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
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<tr>
<td>1</td>
<td>0.214</td>
<td>0.487</td>
<td>0.000</td>
<td>1.380</td>
<td>0.672</td>
<td>0.074</td>
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<tr>
<td>2</td>
<td>0.867</td>
<td>0.636</td>
<td>3.900</td>
<td>3.520</td>
<td>2.240</td>
<td>0.246</td>
</tr>
<tr>
<td>3</td>
<td>0.815</td>
<td>0.763</td>
<td>6.800</td>
<td>5.660</td>
<td>4.320</td>
<td>0.474</td>
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<tr>
<td>4</td>
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<td>0.855</td>
<td>9.900</td>
<td>7.800</td>
<td>6.670</td>
<td>0.733</td>
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<tr>
<td>5</td>
<td>0.882</td>
<td>0.916</td>
<td>7.700</td>
<td>9.940</td>
<td>9.110</td>
<td>1.000</td>
</tr>
<tr>
<td>6+</td>
<td>0.882</td>
<td>0.916</td>
<td>7.700</td>
<td>9.940</td>
<td>9.110</td>
<td>1.000</td>
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a Observed fraction mature and observed spawning frequency from Dickerson et al. (1992). Predicted fraction mature from logistic regression. Predicted spawning frequency from linear regression. Net fecundity is adjusted (normalized) to a maximum value of 1.0. Batch fecundity is assumed constant.
Table 5. Model scenario summaries for the final model (Model XA) selected for management purposes of the Pacific mackerel stock in the current year 2011 and for the previous assessment conducted in 2009 (Model AA), including: (A) new data sources and critical parameterizations; (B) likelihood component estimates and derived quantities of importance; (C) model parameters included in Model XA; and D) final sensitivity analysis for Model XA.

### (A) Time series

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<tr>
<td>Landings - Recreational (USA fishery)</td>
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<tr>
<td>Age distributions - Commercial fishery</td>
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<tr>
<td>Length distributions - Recreational fishery (1992-10) - All fishing modes</td>
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<tr>
<td>Length distributions - Recreational fishery (1985-89) - CPFV (new time series 2011)</td>
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<td>Length distributions - Recreational fishery (1992-10) - CPFV</td>
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<tr>
<td>Length distributions - Recreational fishery (2004-10) - non-CPFV</td>
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<tr>
<td>Mean length-at-age distributions - Commercial fishery</td>
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<tr>
<td>CPFV index</td>
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<tr>
<td>CRFS index (2004-10) - new time series (2011)</td>
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### (B) Parameterization

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<td>Fixed</td>
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<td>Estimated</td>
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<td>Fixed - all ages (M=0.5)</td>
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<td>Commercial fishery=asymptotic / Recreational fishery=dome-shaped</td>
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<td>CPFV=mirrors recreational fishery / CRFS=dome-shaped</td>
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<tr>
<td>Shape</td>
<td>Dome-shaped</td>
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Table 5. Continued.

(B)  

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**Key estimated parameters and derived quantities**

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<td>Fishing mortality ($F$) - Commercial fishery</td>
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**Population time series**

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<td>$B$ (peak year)</td>
<td>1,321,550 (1982)</td>
<td>1,065,990 (1983)</td>
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<tr>
<td>$B$ (end year)</td>
<td>282,849 (2009)</td>
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<td>$HG$ (current year)</td>
<td>55,408</td>
<td>40,514</td>
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*Estimated initial fishing mortality was not fit to 'equilibrium' catch, but rather, implemented for purposes of providing a more robust initial non-equilibrium age composition.
Table 5. Continued.
(C)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min_Value</th>
<th>Max_Value</th>
<th>Init_Value</th>
<th>Fin_Value</th>
<th>SD</th>
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Table 5. Continued.

(D)

<table>
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<tr>
<th>Sensitivity run</th>
<th>Model</th>
<th>B (2011)</th>
<th>B (2011) - Peak</th>
<th>-ln L (Total)</th>
<th>-ln L (CPFV)</th>
<th>-ln L (CRFS)</th>
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</thead>
<tbody>
<tr>
<td>Base case</td>
<td>XA</td>
<td>211,126</td>
<td>1,065,990</td>
<td>842.5</td>
<td>-6.4</td>
<td>-5.3</td>
</tr>
<tr>
<td>2x λ (CPFV index)</td>
<td>XA1</td>
<td>219,896</td>
<td>1,123,910</td>
<td>830.4</td>
<td>-16.3</td>
<td>-6.2</td>
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<tr>
<td>2x λ (CRFS index)</td>
<td>XA2</td>
<td>200,383</td>
<td>1,073,720</td>
<td>836.4</td>
<td>-7.6</td>
<td>-6.6</td>
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<tr>
<td>2x λ (Recreational length distribution)</td>
<td>XA3</td>
<td>287,442</td>
<td>1,025,710</td>
<td>1,029.7</td>
<td>-5.8</td>
<td>-3.9</td>
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<tr>
<td>2x λ (Commercial age distribution)</td>
<td>XA4</td>
<td>178,682</td>
<td>981,870</td>
<td>1,188.6</td>
<td>10.8</td>
<td>-1.5</td>
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<tr>
<td>2x λ (Length-at-age distribution)</td>
<td>XA5</td>
<td>210,748</td>
<td>1,103,060</td>
<td>864.1</td>
<td>-5.9</td>
<td>-5.6</td>
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<tr>
<td>Omit CRFS data (inclusive)</td>
<td>XA6</td>
<td>251,550</td>
<td>1,047,730</td>
<td>785.2</td>
<td>-0.5</td>
<td>na</td>
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<tr>
<td>M = 0.3 yr⁻¹</td>
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<td>323,656</td>
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<td>XA8</td>
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<td>444,452</td>
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<td>-3.4</td>
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<tr>
<td>M = 0.6 yr⁻¹</td>
<td>XA9</td>
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<td>840.3</td>
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<td>XA10</td>
<td>**</td>
<td>**</td>
<td>839.3</td>
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<tr>
<td>Start in 1978</td>
<td>XA11</td>
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<td>1,080,300</td>
<td>1,231.6</td>
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<td>Start in 1981</td>
<td>XA12</td>
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<td>1,096,960</td>
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<td>556,043</td>
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<td>Length-at-age max - estimate CV</td>
<td>XA14</td>
<td>226,929</td>
<td>1,082,290</td>
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<td>Sigma r = 0.8</td>
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<td>1,071,720</td>
<td>845.0</td>
<td>-6.2</td>
<td>-5.3</td>
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</table>

**Biomass estimate from sensitivity run was essentially infinite and hessian may not be positive definite.
Table 6. Harvest control rule information for the Pacific mackerel fishery (2011-12) based on Model $\mathcal{X}A$, including: (A) 'harvest guideline' statistics (see Harvest Control Rule and USA Management in 2011-12); and (B) harvest formulas associated with recent regulations associated with reauthorization of National Standards 1 of the MSFCMA, see PFMC (2010a) for parameter definitions ($\sigma=0.36$).

(A)

<table>
<thead>
<tr>
<th>$B$ (Age 1+, mt)</th>
<th>Cutoff (mt)</th>
<th>Fraction</th>
<th>Distribution</th>
<th>HG (mt)</th>
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<tr>
<td>211,126</td>
<td>18,200</td>
<td>30%</td>
<td>70%</td>
<td>40,514</td>
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(B)

<table>
<thead>
<tr>
<th>Harvest Formula Parameters</th>
<th>Value</th>
</tr>
</thead>
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<tr>
<td>BIOMASS (ages 1+, mt)</td>
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</tr>
<tr>
<td>$P^{\text{star}}$ (probability of overfishing)</td>
<td>0.45 0.4 0.3 0.2</td>
</tr>
<tr>
<td>BUFFER$_{P^{\text{star}}}$</td>
<td>0.95577 0.91283 0.82797 0.73861</td>
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<tr>
<td>$F_{MSY}$</td>
<td>0.3</td>
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<tr>
<td>FRACTION</td>
<td>0.3</td>
</tr>
<tr>
<td>CUTOFF (mt)</td>
<td>18,200</td>
</tr>
<tr>
<td>DISTRIBUTION (U.S.)</td>
<td>0.7</td>
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</table>

Amendment 13 Harvest Formulas

| MT |
|------------------|------------------|
| OFL = BIOMASS * $F_{MSY}$ * DISTRIBUTION | 44,336 |
| ABC$_{0.45}$ = BIOMASS * BUFFER$_{0.45}$ * $F_{MSY}$ * DISTRIBUTION | 42,375 |
| ABC$_{0.40}$ = BIOMASS * BUFFER$_{0.40}$ * $F_{MSY}$ * DISTRIBUTION | 40,472 |
| ABC$_{0.30}$ = BIOMASS * BUFFER$_{0.30}$ * $F_{MSY}$ * DISTRIBUTION | 36,709 |
| ABC$_{0.20}$ = BIOMASS * BUFFER$_{0.20}$ * $F_{MSY}$ * DISTRIBUTION | 32,747 |
| ACL = LESS THAN OR EQUAL TO ABC | TBD |
| HG = (BIOMASS - CUTOFF) * FRACTION * DISTRIBUTION | 40,514 |
| ACT = EQUAL TO HG OR ACL, WHICHERVER VALUE IS LESS | TBD |
Figure 1. Commercial and recreational landings (mt) of Pacific mackerel in the USA (CA commercial, recreational-CPFV, and recreational-non-CPFV) and Mexico (commercial), (1983-10).
Figure 2. Length distributions of Pacific mackerel from: (A) the CDFG observer sampling program (1985-89) and RecFIN (CPFV) data base (1992-10) associated with the CPFV fishery; and (B) the CRFS sampling program (2004-10) associated with the non-CPFV fisheries.
Figure 3. Age distributions of Pacific mackerel from the CDFG (commercial fishery) port sampling program (1983-10).
Figure 4. Estimated mean length-at-age (cm/yr, open circles) time series of Pacific mackerel from CDFG (commercial fishery) port sampling program (1983-10). Also, model fits to this time series are presented (curved line in each display).
Figure 5. Pacific mackerel ageing error vector (SD by age) from CDFG age production laboratory based on double-read analysis.
Figure 6. Indices of abundance: (A) CPFV (CPFV logbook sampling program) and CRFS (non-CPFV fisheries); and (B) the CRFS survey time series evaluated at the fishing mode level (CPFV Logbook=abbreviated CPFV in 6A, CRFS_1 = man-made, CRFS_2=beach/bank, CRFS_3=charter/party, CRFS_4=private/rental, CRFS_124=omits charter/party, and CRFS_1234=all modes). Note that only the CPFV and CRFS_124 indices were used in Model X4. Also, missing lines between data points reflects years with no sampling.
Figure 7. Biological parameters for Pacific mackerel either assumed or estimated in the assessment models: (A) weight-length relationship; (B) length (cm)-at-age (yr); and (C) maturity (also, see Table 4) and natural mortality ($M$).
Figure 8. Beverton-Holt stock ($SSB$ in 1000s mt)-recruitment ($R$ in millions of fish) relationship for Pacific mackerel estimated in the final Model $XA$. Recruitment estimates are presented as (year+1) values. Strong year classes are highlighted and steepness ($h$) = 0.70.
Figure 9. Model X4 fit diagnostics associated with the commercial fishery age distribution time series (1983-10): (A) observed (open circles) vs. predicted (line) estimates; (B) Pearson standardized residuals (observed – predicted; maximum bubble size = 8.43; dark circles represent positive values); and (C) effective vs. observed (input) sample sizes for the commercial fishery age distribution time series (solid line represents a 1:1 relationship and the dashed line reflects a loess smoother).
Figure 9. Continued.
Figure 10. Model $X_A$ fit diagnostics associated with the recreational fisheries length distribution time series (displays A-C=CPFV fishery via CPFV logbook sampling program and displays D-F=non-CPFV fisheries via CRFS): (A and D) observed (open circles) vs. predicted (line) estimates; (B and E) Pearson standardized residuals (observed – predicted; maximum bubble size = 4.04 and 3.88, dark circles represent positive values); and (C and F) effective vs. observed (input) sample sizes for the commercial fishery age distribution time series (solid line represents a 1:1 relationship and the dashed line reflects a loess smoother).
Figure 10. Continued.
length comp, sexes combined, whole catch, CRFS

Figure 10. Continued.
Figure 10. Continued.
Figure 11. Model $X_A$ fit diagnostics associated with the commercial fishery mean length-at-age time series (1983-10), i.e., the associated Pearson standardized residuals plot (observed – predicted; maximum bubble size = 3.46; dark circles represent positive values). Also, see Figure 4 related diagnostics.
Figure 12. Estimated time-varying age-based selectivity distributions associated with model \( X A \): (A) commercial fishery (1983-10); and (B) recreational fishery (1985-10 CPFV) and (2004-10 CRFS).
Figure 13. Model \( X_A \) fits to the CPFV index of relative abundance (one time block, 1983-10): (A) normal space; and (B) log space.
Figure 14. Model $X_4$ fits to the CRFS index of relative abundance (one time block, 2004-10): (A) normal space; and (B) log space.
Figure 15. Recruitment-related estimates from model $X_4$: (A) recruitment deviations; and (B) SEs associated with the deviations (horizontal line indicates the estimate of the standard deviation of log recruitment deviations, i.e., fixed $\sigma_R = 1.0$).
Figure 16. Estimated $F$-based spawning potential ratio time series for model $XA$ (1983-10).
Figure 17. Estimated total stock biomass (age 1+ fish in mt, $B$) of Pacific mackerel based on Model $XA$ (1983-11).
Figure 18. Estimated spawning stock biomass (SSB) of Pacific mackerel based on Model XA (1983-10). A confidence interval (95% CI) is also presented as dashed lines.
Figure 19. Estimated recruitment (age-0 fish in 1,000s, R) of Pacific mackerel based on Model XA (1983-10). A confidence interval (95% CI) is also presented as dashed lines.
Figure 20. Estimated total stock biomass (age 1+ fish in mt, $B$) of Pacific mackerel based on a: (A) retrospective analysis that omitted one year of data in chronological order (2006-10), i.e., Model $XA=2010$; and (B) prospective analysis that started the model one year later in chronological order, i.e., Model $XA=1983$. 
Figure 22. Harvest guideline statistics for Pacific mackerel: (A) commercial landings (USA directed fishery in mt) and quotas (HGs in mt), (1992-11); and (B) total landings (mt) and hypothetical quotas based on no USA ‘Distribution’ parameter in the harvest control rule. Incidental landings from Pacific Northwest fisheries are not included, but typically are limited, ranging 100 to 300 mt per year. Also, see Harvest Control Rule for USA Management in 2011-12 section.
Appendix 1

SS Model XA (2011) files

# P. mackerel stock assessment (1983-10)
# P. R. Crone (June 2011)
# Stock Synthesis 3 (v. 3.20b) - R. Methot
# Model XA: number of fisheries = 2 / surveys = 2 / time-step = annual /
# biological distributions = age, length, and mean length-at-age /
# selectivity = age-based
#
# NOTES: ** ... ** = Pending questions and/or comments
#
# STARTER FILE
#
XA.dat # Data file
XA.ctl # Control file
0 # Read initial values from 'par' file: 0 = no, 1 = yes
1 # DOS display detail: 0, 1, 2
1 # Report file detail: 0, 1, 2
0 # Detailed checkup.sso file: 0 = no, 1 = yes
0 # Write parameter iteration trace file during minimization
1 # Write cumulative report: 0 = skip, 1 = short, 2 = full
0 # Include prior likelihood for non-estimated parameters
1 # Use soft boundaries to aid convergence: 0 = no, 1 = yes (recommended)
1 # Number of bootstrap data files to produce ** New parameterization **
20 # Last phase for estimation
10 # MCMC burn-in interval
2 # MCMC thinning interval
0 # Jitter initial parameter values by this fraction
-1 # Minimum year for SSB sd_report: (-1 = styr-2, i.e., virgin population)
-2 # Maximum year for SSB sd_report: (-1 = endyr, -2 = endyr+N_forecastyrs
0 # N individual SD years
0.0001 # final convergence criteria (e.g., 1.0e-04)
0 # Retrospective year relative to end year (e.g., -4)
1 # Minimum age for 'summary' biomass
1 # Depletion basis (denominator is: 0 = skip, 1 = relative X*B0, 2 =
# relative X*Bmsy, 3 = relative X*B_styr
0.6 # Fraction for depletion denominator (e.g., 0.4)
1 # (1-SPR) report basis: 0 = skip, 1 = (1-SPR)/(1-SPR_tgt), 2 = (1-
# SPR)/(1-SPR_MSY), 3 = (1-SPR)/(1-SPR_Btarget), 4 = raw_SPR ** If no
Forecast, then option = 4 **
1 # F SD report basis: 0 = skip, 1 = exploitation(Bio), 2 =
# exploitation(Num), 3 = sum(F_rates) ** If no Forecast, then option = 0
**
1 # F report basis: 0 = raw, 1 = F/Fspr, 2 = F/Fmsy, 3 = F/Fbtgt ** New
parameterization **
999 # End of file
# FORECAST FILE

1 # Benchmarks: 0 = skip, 1 = calculate (F_SPR, F btgt, F MSY) ** Related to Benchmark relative_F basis, Forecast, and F and SPR report basis (in ctl file) options **
2 # MSY: 0 = none, 1 = set to F SPR, 2 = calculate F MSY, 3 = set to F Btgt, 4 = set to F( endyr )
0.3 # SPR target - relative to B0 (e.g., 0.3)
0.5 # Biomass target - relative to B0 (e.g., 0.5)
# Benchmark years: begin_bio, end_bio, begin_selex, end_selex, begin_relative_F, end_relative_F (enter actual year, -999 = start_yr, 0 = end_yr, <0 = relative end_yr)
0 0 0 0 0 0
1 # Benchmark relative_F basis: 1 = use year range, 2 = set relative_F same as Forecast below
# 1 # Forecast: 0 = none, 1 = F SPR, 2 = F MSY, 3 = F Btgt, 4 = Avg_F (uses first-last relative_F years), 5 = input annual F scalar
1 # Number of forecast years
1.0 # F scalar (only used for Forecast = 5)
# Forecast years: begin_selex, end_selex, begin_relative_F, end_relative_F (enter actual year, -999 = start_yr, 0 = end_yr, <0 = relative end_yr)
0 0 0 0
# 1 # Control rule method: 1 = catch = f(SSB) West Coast, 2 = F = f(SSB)
0.5 # Control rule Biomass level (as fraction of B0, e.g. 0.40) above which F is constant
0.1 # Control rule Biomass level (as fraction of B0, e.g. 0.10) below which F is set to 0
0.75# Control rule target as fraction of F_limit (e.g., 0.75)
3 # Number of forecast loops (1-3: fixed at 3 for now)
3 # First forecast loop with stochastic recruitment
0 # Forecast loop control #3 (reserved for future bells&whistles)
0 # Forecast loop control #4 (reserved for future bells&whistles)
0 # Forecast loop control #5 (reserved for future bells&whistles)
2015 # First year for caps and allocations (should be after years with fixed inputs)
0 # SD of log(realized F/target F) in forecast (set value >0.0 to cause active implementation error)
0 # Do West Coast groundfish rebuilder output (0 = no, 1 = 0)
2007 #Rebuilder: first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
2010 #Rebuilder: year for current age structure (Yinit) (-1 to set to endyear+1)
fleet relative F: 1 = use first-last allocation year, 2 = read season(row) x fleet(column) below
Note: that fleet allocation is used directly as average F if Forecast = 4
Basis for forecast catch tuning and for forecast catch caps and allocation: 2 = dead bio, 3 = retain bio, 5 = dead num, 6 = retain num
Conditional input if relative F = 2 (total of 4 lines)
Fishery relative F: rows = seasons and columns = Fishery
Fishery: F1 F2 F3
0.1 0.1
Maximum total catch by fishery (-1 to have no max)
-1 -1
Maximum total catch by area (-1 to have no max)
-1
Fleet assignment to allocation group (enter group ID# for each Fishery, 0 for not included in an allocation group)
0 0
Conditional on >1 allocation groups (total of 3 lines)
Allocation fraction for each of: 0 allocation groups
No allocation groups
Number of forecast catch levels to input (otherwise calculate catch from forecast F)
Basis for input forecast catch: 2 = dead catch, 3 = retained catch, 99 = input Hrate(F) with units that are from fishery units (note new codes in SSv3.20b)
Input fixed catch values: year, season, Fishery, catch (or F)
2011 1 1 2257
2011 1 2 100
999 # End of file
# Pacific mackerel stock assessment (1983-10)
# P. R. Crone (June 2011)
# Stock Synthesis 3 (v. 3.20b) - R. Methot
# Model XA: number of fisheries = 2 / surveys = 2 / time-step = annual / biological distributions = age, length, and mean length-at-age / selectivity = age-based
#
# # CONTROL FILE
#
# MODEL DIMENSION PARAMETERS
#*******************************************************************************
#  Morph parameterization
#
# 1 # Number of growth patterns (morphs)
# 1 # Number of sub-morphs within morphs
#  # Note: 'conditional' (8) lines follow, based on above morph/season/area parameterization
#
# Time block parameterization (time-varying parameterization)
# 1 # Number of block designs: Selectivity/Catchability
# 2 # Blocks in design 1
#
# 1983 1989 1990 2011 # Blocks - design 1
#
# BIOLOGICAL PARAMETERS
#*******************************************************************************
# 0.5 # Fraction = female (at birth)
# 0 # Natural mortality (M)
# 0 # Natural mortality type: 0 = 1 parameter, 1 = N_breakpoints, 2 = Lorenzen, 3 = age-specific, 4 = age-specific with season interpolation
#  # Placeholder for number of M breakpoints (if M type option >0)
#  # Placeholder for Age (real) at M breakpoints
#  # Growth
# 1 # Growth model: 1 = VB with L1 and L2, 2 = VB with A0 and Linf, 3 = Richards, 4 = readvector
# 0.5 # Growth_age at L1 (L_min): Age_min for growth
# 12 # Growth_age at L2 (L_max) - (to use L_inf = 999): Age_max for growth
# 0 # SD constant added to length-at-age (LAA)
# 0 # Variability of growth: 0 = CV_f(LAA), 1 = CV_f(A), 2 = SD_f(LAA), 3 = SD_f(A)
# 3 # Maturity option: 1 = logistic (length), 2 = logistic (age), 3 = fixed (vector of proportion-at-age), 4 = read age fecundity
#  # Maturity-at-age (if maturity option = 3)
# 0 0.07 0.25 0.47 0.73 1 1 1 1 1 1 1 1 1 # Maturity-at-age (proportion) for option = 3, i.e., 'Accumulator age' + 1 **;
# 1 # First mature age (no read if maturity option = 3)
# 1 # Fecundity option: 1 is eggs=Wt*(a+b*Wt), 2 is eggs=(a*L^b), 3 is eggs=(a*Wt^b)
# 0 # Hermaphroditism option: 0 = none, 1 = invoke female to male transition
# 1 # MG parameter offset option: 1 = none, 2 = M,G,CV_G as offset from GP1, 3 = like SS2
# MG parameter adjust method: 1 = do SS2 approach, 2 = use logistic
transformation to keep between bounds of base parameter approach
#
# M, maturity, and growth parameterization
# Low High Initial Prior_mean Prior_type SD Phase
Dev_minyr Dev_maxyr Dev_stddev Block_def Block_type
# M parameterization
0.3 0.7 0.5 0 -1 0 -3 0 0 0 0 0 0 # M_p1 (M = 0.5, all ages)
# Growth parameterization
# Length-at-age
4 35 15 0 -1 0 3 0 0 0 0 0 0 # VB_L_Amin (Length-at-age = 0.5)
30 70 45 0 -1 0 3 0 0 0 0 0 0 # VB_L_Amax (Length-at-age = 12)
0.1 0.7 0.35 0 -1 0 3 0 0 0 0 0 0 # VB_K
0.01 0.5 0.1 0 -1 0 3 0 0 0 0 0 0 # CV_young
0.0001 0.5 0.01 0 -1 0 -3 0 0 0 0 0 0 # CV_old
# Weight-length
-1.5 3.12e-006 0 -1 0 -3 0 0 0 0 0 0 0 # W-L_a
1.5 3.40352 0 -1 0 -3 0 0 0 0 0 0 0 # W-L_b
# Maturity parameterization ** fixed vector for maturity-at-age **
-3 3 3 0 -1 0 -3 0 0 0 0 0 0 # Maturity (inflection)
-3 3 3 0 -1 0 -3 0 0 0 0 0 0 # Maturity (slope)
-3 3 1 0 -1 0 -3 0 0 0 0 0 0 # Eggs/gm (intercept)
-3 3 0 0 -1 0 -3 0 0 0 0 0 0 # Eggs/gm (slope)
# Population recruitment apportionment (distribution) ** Placeholders **
-4 4 0 0 -1 0 -4 0 0 0 0 0 0 # Recruitment distribution (growth pattern)
-4 4 1 0 -1 0 -4 0 0 0 0 0 0 # Recruitment distribution (area)
-4 4 0 0 -1 0 -4 0 0 0 0 0 0 # Recruitment distribution (season)
# Cohort growth deviation
1 5 1 0 -1 0 -4 0 0 0 0 0 0 0 # Cohort growth deviation
#
# 1 # Custom environment (MG) parameterization
#
# 1 # Custom block (MG) parameterization ** No time block for growth
# parameterization **
# Low High Initial Prior_mean Prior_type SD Phase
# -5 5 0 0 -1 0 3 # VB_L_Amin: (1962-89)
# -5 5 0 0 -1 0 3 # VB_L_Amin: (1990-10)
# -5 5 0 0 -1 0 3 # VB_L_Amax: (1962-89)
# -5 5 0 0 -1 0 3 # VB_L_Amax: (1990-10)
# -5 5 0 0 -1 0 3 # VB_K: (1962-89)
# -5 5 0 0 -1 0 3 # VB_K: (1990-10)
#
# Seasonal effects on biology parameters
0 0 0 0 0 0 0 0 0 0 # ** Placeholder **
#
# Stock-recruit (S-R)
3 # S-R function: 1 = B-H w/flat top, 2 = Ricker, 3 = standard B-H, 4 = no
steepness or bias adjustment
# Low High Initial Prior_mean Prior_type SD Phase
1 30 10 0 -1 0 1 # ln(R0)
0.1 1 0.9 0 1 0 5 # Steepness
0 2 1 0 0 -1 0 -3 # Sigma_R
-5 5 0 0 -1 0 -3 # Env lnk coefficient
-15 15 0 0 -1 0 1 # Initial eqilibrium recruitment offset
0 2 0 0 -1 0 -3 # Autocorrelation in recruitment devs
0 # Index for environment variable to be used
0 # Environment target
Recruitment residual (recruitment devs) parameterization
1 # Recruitment dev type: 0 = none, 1 = dev_vector, 2 = simple
1978 # Start year for recruitment devs
2009 # Last year for recruitment devs
1 # Phase for recruitment devs
0 # Read 11 advanced recruitment options: 0 = off, 1 = on - ** Placeholders **

# Start year for (early) recruitment devs
# Phase for (early) recruitment devs
# Phase for forecast recruitment devs
# Lambda for forecast recruitment devs (before endyr+1)
# Last recruitment dev with no bias adjustment
# First year of full bias correction adjustment
# Last year for full bias correction adjustment in MPD
# First recent year no bias adjustment in MPD
# Lower bound for recruitment devs
# Upper bound for recruitment devs
# Read initial values for recruitment devs

# FISHING MORTALITY PARAMETERS
=============================================================================

# Fishing mortality (F) parameterization
0.1 # F ballpark for tuning early phases
-2000 # F ballpark year (negative value = off)
1 # F method: 1 = Pope, 2 = instantaneous F, 3 = hybrid
0.9 # F or Harvest rate (depends on F method)

# No additional F input needed for F method = 1 - ** Placeholders **
# Read overall start F value, overall phase, N detailed inputs to read
# for F method = 2
# Read N iterations for tuning for F method = 3 (recommend 3 to 7)

# Initial F parameters ** non-equilibrium initial age distribution implemented **
# Low High Initial Prior_mean Prior_type SD Phase
0.0001 5 0.1 0 -1 0 1 # Initial F (F1)
0.00001 5 0.001 0 -1 0 -1 # Initial F (F2)

# CATCHABILITY (q) PARAMETERS
=============================================================================

# Catchability (q) parameterization
# Columns: Do den_dep power (0 = off and survey is proportional to abundance, 1 = add parameter for non-linearity); Do env_link (0 = off, 1 = add parameter for env effect on q);
# Do extra SD (0 = off, 1 = add parameter for additive constant to input SE in ln space); q_type (<0 = mirror other fishery/survey, 0 = no parameter q - median unbiased, 1 = no parameter q - mean unbiased, 2 = estimate parameter for ln(q), 3 = ln(q)+set of devs about ln(q) for all years - parm_rand_dev, 4 = ln(q)+set of devs about q for index_yr-1 - parm_rand_walk)
0 0 0 0 # F1 = COM (USA commercial and Mexico commercial)
0 0 0 0 # F2 = REC (USA recreational)
0 0 0 0 # S1 = CPFV
0 0 0 0 # S2 = CRFS
# q parameters (if any)
# Low High Initial Prior_mean Prior_type SD Phase
# -1 1 0.0001 0 -1 99 3 # ln(q) - S1
#
# SELECTIVITY (S) PARAMETERS
=============================================================================#
# Selectivity/retention parameterization  
# Size (length) parameterization  
# A = selectivity option: 1 - 24  
# B = do retention: 0 = no, 1 = yes  
# C = male offset to female: 0 = no, 1 = yes  
# D = mirror selectivity (fishery/survey)  
# A B C D  
# Size selectivity (S) - ** No size-based S **
0 0 0 0 # F1  
0 0 0 0 # F2  
0 0 0 0 # S1  
0 0 0 0 # S2  
# Age selectivity (S) - ** Age-based S is implemented **
20 0 0 # F1 (double-normal distribution)  
20 0 0 # F2 (double-normal distribution)  
15 0 2 # S1 (mirror F2)  
20 0 0 # S2 (double-normal distribution)  
# S (age) parameters  
# Low High Initial Prior_mean Prior_type SD Phase Env_var Use_dev  
# Dev_minyr Dev_maxyr Dev_stddev Block_def Block_type  
# F1 (double-normal)
-20 15 1 0 -1 0 4 0 0 0 0 0 0 0 0 # P_1 (1983-10, peak size)  
-20 15 -5 0 -1 0 -4 0 0 0 0 0 0 0 0 # P_2 (1983-10, top logistic)  
-20 15 1.5 0 -1 0 -4 0 0 0 0 0 0 0 0 # P_3 (1983-10, ascending limb width - exp)  
-20 20 -1 0 -1 0 4 0 0 0 0 0 0 0 0 # P_5 (1983-10, initial S - at first age bin)  
-20 20 15 0 -1 0 -4 0 0 0 0 0 0 0 0 # P_6 (1983-10, final S - at last age bin)  
# F2 (double-normal)
-10 15 2 0 -1 0 4 0 0 0 0 0 0 0 0 # P_1 (1983-10, peak size)  
-10 15 -4 0 -1 0 4 0 0 0 0 0 0 0 0 # P_2 (1983-10, top logistic)  
-15 15 -1 0 -1 0 4 0 0 0 0 0 0 0 0 # P_3 (1983-10, ascending limb width - exp)  
-20 15 -4 0 -1 0 4 0 0 0 0 0 0 0 0 # P_4 (1983-10, descending limb width - exp)  
-25 15 -5 0 -1 0 4 0 0 0 0 0 0 0 0 # P_5 (1983-10, initial S - at first age bin)  
-20 15 -2 0 -1 0 4 0 0 0 0 0 0 0 0 # P_6 (1983-10, final S - at last age bin)  
# S1 (mirror F2) ** no additional parameter lines needed **
# S2 (double-normal)
-10 15 2 0 -1 0 4 0 0 0 0 0 0 0 0 # P_1 (1983-10, peak size)  
-10 15 -4 0 -1 0 4 0 0 0 0 0 0 0 0 # P_2 (1983-10, top logistic)  
-15 15 -1 0 -1 0 4 0 0 0 0 0 0 0 0 # P_3 (1983-10, ascending limb width - exp)  
-20 15 -4 0 -1 0 4 0 0 0 0 0 0 0 0 # P_4 (1983-10, descending limb width - exp)  
-25 15 -5 0 -1 0 4 0 0 0 0 0 0 0 0 # P_5 (1983-10, initial S - at first age bin)  
-20 15 -2 0 -1 0 4 0 0 0 0 0 0 0 0 # P_6 (1983-10, final S - at last age bin)
# Conditional: custom Sel_env parameterization ** No time block for selectivity parameterization **
# Low High Initial Prior_mean Prior_type SD Phase
# -2 2 0 0 -1 99 -2

# Conditional: custom Sel-block parameterization
# F1 S time blocks (block design 1) ** For age-based S **
# Low High Initial Prior_mean Prior_type SD Phase

# Conditional: selparm trends
# Conditional: for selparm_dev_Phase
# Conditional: env/block/dev adjust method (1 = standard, 2 = logistic transition to keep in base parm bounds, 3 = standard with no bound check)

# Tag loss and reporting parameterization
0 # TG_custom: 0 = no read, 1 = read if tags exist
# Conditional if no tag parameters
# Low High Initial Prior_mean Prior_type SD Phase Env_var Use_dev Dev_minyr Dev_maxyr Dev_stddev Block_def Block_type
# -6 6 1 1 2 0.01 -4 0 0 0 0 0 0

# LIKELIHOOD COMPONENT PARAMETERS
=============================================================================

# Variance and sample size/effective sample size adjustments (by fleet/survey): (0/1)
# F1 F2 S1 S2
0 0 0 0 # constant (added) to survey CV
0 0 0 0 # constant (added) to discard CV
0 0 0 0 # constant (added) to body weight CV
1 1 1 1 # scalar (multiplied) to length distribution sample size (effective ss)
1 1 1 1 # scalar (multiplied) to age distribution sample size (effective ss)
1 1 1 1 # scalar (multiplied) to size-at-age distribution sample size (effective ss)

# Maximum lambda phase: 1 = none
1 # SD offset: 1 = include

# Likelihood component (lambda) parameterization
# Likelihood component codes:
# 1 = survey, 2 = discard, 3 = mean body weight, 4 = length distribution, 5 = age distribution, 6 = weight distribution, 7 = size-at-age distribution,
# 8 = catch, 9 = initial equilibrium catch, 10 = recruitment devs, 11 = parameter priors, 12 = parameter devs, 13 = crash penalty, 14 = morph composition
# 15 = tag composition, 16 = tag neg_bin

4 # Number of changes to likelihood components
# Columns: Likelihood_comp Fishery/Survey Phase Lambda_value Size_distribution_method
# Surveys
# 1 3 1 0 1 # Survey off = S1
# 1 4 1 0 1 # Survey off = S2
#
#  Length distributions
4 1 1 0 1 # Length distribution off = F1
#
#  Age distributions
5 1 1 0 1 # Length distribution off = F1
#
#  Mean size-at-age distributions
7 1 1 0 1 # Size-at-age distribution off = F1
#
#  Equilibrium catch
9 1 1 0 1 # Equilibrium catch off = F1
9 2 1 0 1 # Equilibrium catch off = F2
#
#  Priors
11 1 1 0 1 # Priors = off
#
0 #  SD reporting option: (0/1)
999 # End of file
# Pacific mackerel stock assessment (1983-10)
# P. R. Crone (June 2011)
# Stock Synthesis 3 (v. 3.20b) - R. Methot
# Model XA: number of fisheries = 2 / surveys = 2 / time-step = annual /
# biological distributions = age, length, and mean length-at-age /
# selectivity = age-based
#
# INPUT DATA FILE
#
# 1983 # Start year
# 2010 # End year
# 1 # Number of 'seasons' (quarters)
# 12 # Number of months per season
# 1 # Spawning season
# 2 # Number of fishing 'fleets' (fisheries)
#   F1 = COM (USA commercial and Mexico commercial)
#   F2 = REC (USA recreational)
# 2 # Number of 'surveys' (CPUE Indices: annual-based)
#   S1 = CPFV
#   S2 = CRFS
# 1 # Number of areas (populations)
#   COM%REC%CPFV%CRFS
# 0.5 0.5 0.5 0.5 # Fishery/survey timing within time block
# 1 1 1 1 # Area assignment for each fishery/survey
# 1 # Catch units: 1=biomass, 2=numbers
# 0.01 0.01 # SE of ln(catch), i.e., equals CV in ln space
# 1 # Number of genders
# 12 # Number of ages (accumulator age)
# Catch: initial (annual) 'equilibrium' catch (mt)
# 100 100
# Number of catch records (lines)
# 28
# Catch time series (biomass in mt): Columns=fisheries, year, season
# 40573.39 1544.12 1983 1
# 45001.01 1467.32 1984 1
# 45811.90 1015.90 1985 1
# 53263.39 859.20 1986 1
# 46958.31 1264.46 1987 1
# 48576.06 688.56 1988 1
# 48787.53 618.27 1989 1
# 70934.59 616.06 1990 1
# 64824.75 680.14 1991 1
# 31753.59 463.87 1992 1
# 20311.09 608.80 1993 1
# 22674.40 1062.65 1994 1
# 10982.43 1013.40 1995 1
# 23877.14 685.54 1996 1
# 50272.33 803.99 1997 1
# 62393.05 429.61 1998 1
# 15757.21 152.65 1999 1
# 27466.58 325.32 2000 1
# 12439.36 571.05 2001 1
# Number of observations (lines) for all surveys (indices)
35
# Columns: Fishery/Survey, Units (0=numbers, 1=biomass, 2=F), Error type
# (-1=normal, 0=lognormal), >0=t-dist. (df = input value)
1 1 0 # F1 = COM (USA commercial and Mexico commercial)
2 1 0 # F2 = REC (USA recreational)
3 0 0 # S1 = CPFV
4 0 0 # S2 = CRFS
#
# Columns: Year, Season, Survey, Observation, Error
1983 1 3 91.82 0.30
1984 1 3 101.23 0.30
1985 1 3 77.63 0.30
1986 1 3 60.91 0.30
1987 1 3 41.32 0.00
1988 1 3 29.28 0.30
1989 1 3 40.64 0.30
1990 1 3 45.04 0.30
1991 1 3 49.95 0.30
1992 1 3 37.06 0.30
1993 1 3 44.49 0.30
1994 1 3 42.05 0.30
1995 1 3 37.36 0.30
1996 1 3 40.95 0.30
1997 1 3 24.98 0.30
1998 1 3 12.89 0.30
1999 1 3 7.34 0.30
2000 1 3 14.03 0.30
2001 1 3 11.19 0.30
2002 1 3 8.88 0.30
2003 1 3 5.56 0.30
2004 1 3 9.75 0.30
2005 1 3 16.70 0.30
2006 1 3 15.95 0.30
2007 1 3 22.64 0.30
2008 1 3 31.73 0.30
2009 1 3 24.45 0.30
2010 1 3 12.00 0.30
2004 1 4 0.0419 0.30
2005 1 4 0.0576 0.30
2006 1 4 0.0551 0.30
2007 1 4 0.0640 0.30
2008 1 4 0.0567 0.30
2009 1 4 0.0532 0.30
2010 1 4 0.0324 0.30
#
# Discard parameterization
0 # Number of Fisheries with discard
# Placeholder for discard units (1 = same as catch units, 2 = fraction, 3 = number)
# Placeholder for Fishery discard error type (>0 = df of t-dist - read CV below, 0 = normal with CV, -1 = normal with se, -2 = lognormal)
# Columns: Fishery, Units, Error type
0 # Number of discard observations (lines)
# Placeholder for discard lines
# Columns: Year, Season, Fishery, Observation, Error
# Mean body weight parameterization
0 # Number of mean body weight observations (lines)
100 # df for t-dist - not conditional, i.e., needs number even if no mean body weight observations
# Population size distributions
1 # Length bin method: 1 = use fishery length bins below, 2 = generate from min/max/width below, 3 = read count and vector below
# Placeholder for number of population length bins
# Placeholder for vector of population length bins
0 # Compression of length/age distribution 'tails'
0.0001 # Constant added to length/age data (constant added to expected frequencies)
# Combine males and females at or below this bin number
# Fishery/Survey size distributions
60 # Number of length bins
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55
56 57 58 59 60
59 # Number of fishery length distribution observations (lines) ** Length distributions for Fishery 1 are not used (included for provisional/comparative purposes only)**
# Length distributions (1983-10) - annual (percent)
# Length distributions: Columns=year, season, fishery/survey, gender, partition, sample size, length bin observations (in numbers)
1983 1 1 0 0 106.7 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
1984 1 1 0 0 91.6 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
0.00000 0.00000 0.00000 0.00000 0.00044 0.00306 0.00480 0.01135 0.00436 0.00567 0.00262 0.00262 0.00000 0.01528 0.04845 0.10170 0.16194 0.16019 0.12353
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# Fishery age distributions

9 # Number of age_bins
0 1 2 3 4 5 6 7 8

1 # Number of ageing error matrices ('Accumulator age' (12) + 1 vectors)
0.5 1.5 2.5 3.5 4.5 5.5 6.5 7.5 8.5 9.5 10.5 11.5 12.5 # Age bin mid-points
0.406 0.642 0.712 0.784 0.992 1.304 1.345 1.5 1.637 1.809 1.964 2.119 2.273 # Age bin SD

28 # Number of age distributions observations (lines)
2 # Length bin method for Lbin_lo and Lbin_hi: 1 = use population length bin index, 2 = use length data bin index, 3 = actual lengths (must use population length index option)
-1 # Combine males and females at or below this bin number

# Fishery age distributions (1983-10) - annual (percent)

# Age distributions: Columns=year, season, fishery/survey, gender, partition, ageing error (age bin SD), Lbin_lo, Lbin_hi, sample size, age bin observations (in percent)

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Fishery mean length-at-age distributions

Number of mean length-at-age observations (lines)

Mean length-at-age distributions (1983-10) - annual (cm)

Mean length-at-age distributions: Columns=year, season, fishery/survey, gender, partition, ageing error, sample size (nominal only), mean length-at-age observations (in cm), mean length-at-age sample sizes

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# Environmental variables

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# Tag data

# Morph data

999 # End of file
In June 2011, the Council approved a full assessment for Pacific mackerel that estimated the age 1+ biomass to be 211,126 mt. The Council adopted an Annual Catch Target (ACT) of 30,386 mt and an incidental set-aside of 10,128 mt. The Council further adopted a “check in” provision to consider the possibility of reallocating the incidental set aside to the directed fishery. The Council also recommended foregoing an assessment in 2012, and basing 2012-2013 management measures on the 2011 full assessment.

In the 2011-2012 Pacific mackerel fishery catches again were light, although evidence of mackerel again appeared in research cruises and on the grounds, but largely offshore, according to spotter pilot reports. Although mackerel catches have been limited during recent years, the industry would like to reserve the right to access fish should they become available.

Pacific mackerel are subject to periodic explosions in biomass and landings, as occurred unexpectedly in the 2000-2001 season, and which led to the premature closure of the directed mackerel fishery.

In light of that fact, the CPSAS recommends that the Council re-adopt the 2011-2012 management measures for the 2012-2013 fishery, including a P* choice of 0.45:

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Setting the ACT at 30,386 mt produces an incidental set aside of 10,128 mt.

In adopting management measures for 2012-2013 the Council should consider the following:
- Recent observations indicate an increase in Pacific mackerel.
- A rapid increase in Pacific mackerel biomass without adequate quota for incidental catches, as occurred in 2000-2001, could create negative impacts to the directed fishery and other fisheries.
- Fishermen and processors can only build viable business plans when there is a sufficient harvest guideline to justify the associated expenses.

Re-adopting the ACT for Pacific mackerel that the Council approved in 2011 will provide flexibility for the fleet to target mackerel when they become available to the fishery. This will help mitigate severe economic impacts if and when sardine and other CPS fisheries are at low harvest thresholds.

The Coastal Pelagic Species Advisory Subpanel (CPSAS) further recommends that in the event the directed fishery closes, any remaining incidental may be used as follows:
• A 45 percent incidental catch is allowed when Pacific mackerel are landed with other coastal pelagic species; and
• Up to 1 mt of Pacific mackerel could be landed without landing any other CPS.

The CPSAS recommends an in-season review of the 2012-2013 Pacific mackerel fishery at the April 2013 Council meeting, if needed, to consider releasing a portion of the incidental set-aside to the directed fishery.

PFMC
06/23/12
The Coastal Pelagic Species Management Team (CPSMT) met June 21-22, 2012 to review management and research recommendations for Pacific mackerel for the 2012-13 fishing year, and to discuss these topics with the Coastal Pelagic Species Advisory Subpanel (CPSAS). In May 2011, a full stock assessment for Pacific mackerel was reviewed by a Stock Assessment Review (STAR) Panel in La Jolla, California and subsequently by the Pacific Fishery Management Council (Council) in June 2011 in Spokane, Washington. For use in the 2012-13 fishing year, the CPSMT supports all measures adopted by the Council in 2011. These were as follows:

1. establish an overfishing limit (OFL) of 44,336 mt, acceptable biological catch (ABC) of 42,375 mt (based on the Council’s P* choice of 0.45), annual catch limit (ACL) and harvest guideline (HG) equal to 40,514 mt, annual catch target (ACT) of 30,386 mt. This includes an incidental set-aside of 10,128 mt for catch in non-directed fisheries;
2. should the directed fishery realize the ACT (30,386 mt), the Council recommends that National Marine Fisheries Service (NMFS) close the directed fishery and shift to an incidental catch-only fishery, with a 45 percent incidental landing allowance when Pacific mackerel are landed with other coastal pelagic species (CPS), with the exception that up to 1 mt of Pacific mackerel could be landed without landing any other CPS;
3. to provide time to address research and data needs associated with this species, as well as the broader CPS assemblage assessment efforts, the Council decided that no assessment be conducted in 2012, with all management decisions applicable for at least two consecutive management cycles, i.e., the 2011-12 and 2012-13 fishing years; and,
4. in concert with the Southwest Fisheries Science Center, review and provide guidance regarding a more adaptive assessment and research schedule that addresses the longer-term dynamics of the CPS assemblage.

PFMC
06/23/12
Dr. Paul Crone from the National Marine Fisheries Service (NMFS) Southwest Fisheries Science Center (SWFSC) provided the Scientific and Statistical Committee (SSC) with a review of the 2011 Pacific mackerel assessment results and an overview of the assessment schedule for Pacific mackerel and other coastal pelagic species (CPS). The SSC endorses a 2012-2013 overfishing level (OFL) of 44,336 mt and $\sigma = 0.36$, and harvest management measures as recommended by the Coastal Pelagic Species Management Team. The SSC further noted that if the same assessment for Pacific mackerel is to be used for 2013-2014, it would be preferable to consider a population abundance projection before adopting an OFL.

Dr. Crone discussed the need for continuing survey work even when the landings are low, emphasized the need to adjust the assessment schedule to better conform to the landings and indicated that the SWFSC is developing a new adaptive management framework for CPS assessment. Dr. Crone also emphasized that that fishery biological sample sizes for some CPS are not sufficient for ongoing monitoring and evaluation needs. The SSC supports the idea of an adaptive management approach to determining appropriate species for assessment and notes the importance of adequate biological sample sizes to support these future assessments.

PFMC
06/23/12