Elizabeth Reese <mszippi406@yahoo.com> Fri, Feb 3, 2012 at 9:32 AM
Reply-To: Elizabeth Reese <mszippi406@yahoo.com>
To: pfmc.comments@noaa.gov

As of 02/09/2012; 11:59 PM, the Council office has received 5,693 copies of this email.

Feb 3, 2012

Pacific Fishery Management Council

Dear Management Council,

I am writing to support the council's effort to maintain a healthy marine ecosystem and am urging it to take action to protect currently unexploited forage species.

Forage fish occupy a critical middle link in the marine food web. In light of growing global demand to turn them into feed for poultry, livestock, and aquaculture, I believe it is imperative for the council to act as soon as possible to prevent the expansion of new fisheries on forage.

The council's draft ecosystem plan notes that demand for nonmanaged forage species is likely to expand with the spectacular growth of aquaculture. The council cannot control global market trends, but it can protect marine ecosystems by holding off on opening new fisheries to catch vast quantities of baitfish for use as animal feed. Indeed, leaving enough forage fish in the water may be the single most important concrete action the council can take to maintain a balanced and resilient marine food web here on the Pacific coast.

Thank you for considering my comments and for your continued commitment to a productive marine environment.

Sincerely,

Ms. Elizabeth Reese
406 Jeff Davis Ave
Waveland, MS 39576-3226

---------- Forwarded message ----------
From: **Bill James** <Halibutbill@live.com>
Date: Thu, Feb 9, 2012 at 11:41 PM
Subject: For Briefing book Open Public Comment C.1 b
To: "pfmc." <pfmc.comments@noaa.gov>

February 9, 2012

Dan Wolford, Chairman
Pacific Fishery Management Council
Re: Open Public Comment

Mr. Chairman and Members of the Council

My name is Bill James and I am a commercial fishermen and a fishery consultant for Port San Luis Commercial Fishermen's Association. Today I am representing PSLCFA in respectfully requesting that the Pacific Fishery Management Council change Section 660.330 Open access fishery---management measures "vessel limits" to "permit holder limits" to allow for more than one California Nearshore permit holder to catch his or her bi-monthly trip limit on the same vessel. There are numerous economic and safety reasons for this request. In 2011 California Nearshore Permit holders landed only apprioximately 50 percent of their "Harvest Guideline" or ACL. Port San Luis along with Morro Bay is a top supplier to the "Live Fish Restaurants and Fish Markets in the San Francisco bay and Los Angeles areas. Advancing age, Numerous MPA's, High fuel costs, increased travel time to fishing grounds becquse of implementation to many No-Take MPA's have kept our nearshore fishermen from catching and landing the rest of their allocated fish. Our group mainly uses a low impact gear (rod and reel) to catch their fish. Please change the management measures to allow for multiple permit holders to fish opn the same vessel.

Sincerely,

Bill James for the Port San Luis Commercial Fishermen's Association

The language

Section 660.330 Open Access fishery----management measures.
(a) General. Groundfish species talen in open access fisheries will be managed with cumulative trip limits (See trip limits in Tables 3 (North)and 3

(South) of this subpart),size limits (see Section660.60(h)(5)),seasons (See seasons in Table 3 (North) and3 (South) of this subpart)., gear restrictions (see paragraph (b of this section), and closed areas (See paragraph (d) of this section and Sections660.70 through 660.79, subpart C).
(1) Unless otherwise specified,a vessel operating in the open access fishery is subject, and must not exceed any trip limit, frequency limit, and/or size limit for the open access fishery.
(2) In waters south of 42 N. Lat., individual fishermen with a state permit for the take of cabezon, greenling, or nearshore rockfish as defined in Section 660.11 are subject to, and must not exceed any trip limit, frequency limit,and/or size limit for the open access fishery.; Section 660.330(a)(1) does not apply for the take of cabezon,greenling or nearshore rockfish.

AGENDA
FISHSMART PACIFIC WORKSHOP ON IMPROVING THE SURVIVAL OF RELEASED FISH
FOCUSSING ON BAROTRAUMA

May 8-9, 2012
Portland, Oregon

Workshop Goals:

Specific to the Pacific Coast, Alaska, and Hawaii fisheries being constrained by high release mortality:

1. *Identify best practices and equipment* to employ by anglers and regulatory agencies in the Pacific region to increase the survival of angler-sought saltwater fishes constrained by high release mortality under a variety of conditions/fisheries.

2. *Develop outline for messages* directed to anglers to employ in their interaction with these saltwater species in the Pacific region.

3. *Provide guidance* to management bodies to reduce the interaction and lethality of such interactions, with these species by anglers through the consideration of management actions such as time/area closures, gear modifications, restrictions/usage and size restrictions and account for and incorporate release mortality/survivability into the regulatory process.

4. Identify gaps in the current state of knowledge in need of additional research efforts/funding in the Pacific region

Tuesday May 8: Plenary

8:00 Welcome & Logistics

8:10 Introduction – Barry Thom, the Deputy Regional Administrator, NOAA Fisheries

8:30 FishSmart Initiative – Gil Radonski/Andrew Loftus

8:50 Overview of Atlanta and St. Petersburg Workshop Results/Pacific Results of FMP Analysis -Gil Radonski/ Andrew Loftus

9:10 Framing the Issue of Release Mortality in General - ?

9:45 Questions

10:00 Break

10:15 Framing Regional Recreational Fisheries Impacted by High Release Mortality
- Pacific Coast (15 minutes) and Alaska (15 minutes)–Dan Wolford
- Hawaii (20 minutes) – Clay Tam

11:00 Overview of Issues
- ♦ Avoidance: Management techniques and Fishing Techniques designed to prevent encounters of unwanted species/sizes - Panel Discussion
  - Tom Ohaus-Alaska
  - Clay Tam-Hawaii
  - John Holloway-Oregon
  - Tom Mattusch- California (northern and southern)

Noon Lunch

1:00 Continue Overview of Issues (20 minutes each)

- ♦ Size: Effect of catching/releasing various sizes of fish on stock sustainability-Chris Lunsford

- ♦ Venting *and* Decompression/Recompression: Techniques and appropriate uses of various techniques. –Alena Pribyl

- ♦ Fish Friendly Tackle: Techniques and gear for releasing fish-Steve Theberge

2:00 Breakout groups: Loftus/Radonski group leaders

Attendees will be assigned to one of two breakout groups. The purpose of each break out group is to delve into the current state of knowledge of each of the issues, describe what is known about the issue and address each of the four workshop objectives. *One group will be asked to emphasize northern Pacific and Alaska coast issues and one will focus on southern Pacific and Hawaii issues.*

3:00 Break

3:15 Reconvene in Breakout groups

5:30 Adjourn

<u>Wednesday May 9</u>

8:00 Announcements

8:15 Breakout reports-20 minutes each-each group reports on the results of their discussions addressing the 5 issues. Commonalities and divergences between groups will be identified.

9:00 Group Discussion Develop final recommendations on best practices, angler messages, and management guidance for fisheries constrained by high release mortality in the Pacific region (3 workshop goals).

- *Best practices and gear* for anglers to increase the survival of angler-sought saltwater fishes under variety of conditions (species, temperature, depth caught, hook size, etc.
- *Develop the outline of messages* directed to anglers to employ in their interaction with these saltwater species

10:00 Break

10:15: Continue Development of Recommendations

- *Develop guidance* to regulatory bodies to reduce the interaction (avoidance) and lethality of such interactions, with those species by anglers.
- Catalogue gaps in the current state of knowledge in need of additional research efforts/funding and initial prioritization of research in the Pacific region

12:00 Lunch

Lunch Speaker: The Journey from Science to Management;" what does it take to go from developing/compiling information to changing management and regulations - Gway Kircher ODFW

Including a focus on:

- identify legal thresholds for the quality of scientific information that may be the basis for revising regulations under the MSA and ESA.

- identify regulatory avenues for collaborative research to improve scientific information (e.g., EFP process).

- identify and map State and Federal regulatory processes to implement barotraumas reduction practices.

- identify and map State and Federal regulatory processes to allow increased harvest rates by implementation of best practices.

1:00: Communications: Development and Delivery of Message Content: How Will We Use It?

Online and Social Media - RBFF? (20 minutes)
Cross Fertilization: introducing recompression gear to anglers in the Gulf and S. Atlantic – Bryan Fluech and John Stevely, Florida Sea Grant
Region Specific Communications in the Pacific – ????

2:00 Facilitated Group Collaboration : Finding a Unifying Message: Communicating Messages on Best Practices and Management Guidance (3 workshop goals). –Andrew Loftus/Gil Radonski facilitators

Using the previous day outcomes, develop messages specific to the Pacific region for:

- Best practices and gear for anglers to increase the survival of angler-sought saltwater fishes under variety of conditions (species, temperature, depth caught, hook size, etc.
  - ¨ Develop the outline of messages directed to anglers to employ in their interaction with saltwater species, and
  - Develop guidance to regulatory bodies to reduce the interaction (avoidance) and
- lethality of such interactions, with those species by anglers.
  - Catalogue` gaps in the current state of knowledge in need of additional research
  - efforts/funding

3:00 Break

3:15 Finalize Recommendations

4:00: Wrap Up- Russ Dunn, National Policy Advisor for Recreational Fisheries, NOAA Fisheries

4:30 Adjourn

Agenda Item C.1.b
Supplemental Public Comment 3
March 2012

2-9-2012

PFMC

7700 NE Ambassador Place, Suite 101
Portland, OR 97220-1384

Attention: Carolyn Porter

My name is Mike Pettis.
Could you please see to it that my letter to the Management Council is added to the council's "Briefing book" for the upcoming March meeting in Sacramento?

Thank you Carolyn, I appreciate your help with this.

Michael D. Pettis

Mike Pettis

2-9-2012

PFMC
7700 NE Ambassador Place, Suite 101
Portland, Or 97220-1384

Attention: Don McIsaac & Council Members

My name is Mike Pettis, I am a longline fisherman and I have been participating in the fixed gear sablefish fishery for the past 27 years.

Approximately 10 years ago the Council implemented a fixed gear stacking provision. Enough time has passed now that the fleet has a good idea of how well the stacking provision is working and where there might be room for improvements. For the past several years there has been little opportunity for fixed gear fishermen to get their issues onto the council agenda since the Council has been very busy with trawl rationalization.

I think it is high time that the fixed gear sector of the groundfish industry gets some attention. Could the Council, as they are considering adjustments to the trawl rationalization, also consider adjustments to the fixed gear stacking provision? Could committees of fixed gear fishers recommend changes that could improve our situation? If the fixed gear fleet is forced to wait until all the trawl issues are perfected before our issues are addressed it will be a long time coming.

Please make some provision for fixed gear fishers to express their ideas and get some Council action toward making our fishery better. Our situation isn't perfect either.

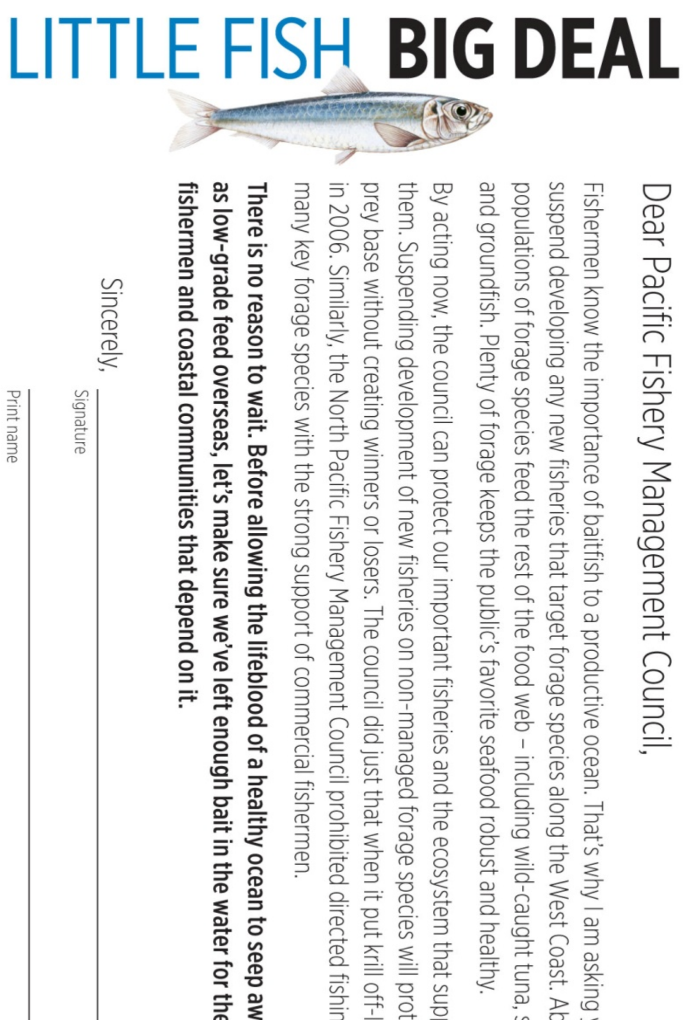
Thank you for considering this request.

Michael D. Pettis

Mike Pettis
310 SE Yaquina View Dr.
Newport, OR 97365

Agenda Item C.1.b
Supplemental Public Comment 4
March 2012

Example of the 38 postcards received as supplemental public comment:



LITTLE FISH BIG DEAL

Dear Pacific Fishery Management Council,

Fishermen know the importance of baitfish to a productive ocean. That's why I am asking you to suspend developing any new fisheries that target forage species along the West Coast. Abundant populations of forage species feed the rest of the food web – including wild-caught tuna, salmon, and groundfish. Plenty of forage keeps the public's favorite seafood robust and healthy.

By acting now, the council can protect our important fisheries and the ecosystem that supports them. Suspending development of new fisheries on non-managed forage species will protect the prey base without creating winners or losers. The council did just that when it put krill off-limits in 2006. Similarly, the North Pacific Fishery Management Council prohibited directed fishing for many key forage species with the strong support of commercial fishermen.

There is no reason to wait. Before allowing the lifeblood of a healthy ocean to seep away as low-grade feed overseas, let's make sure we've left enough bait in the water for the fishermen and coastal communities that depend on it.

Sincerely,

Signature

Print name

COASTAL CONSERVATION ASSOCIATION
WASHINGTON

Pacific Fishery Management Council
Dan Wolford, Chairman
7700 N.E. Ambassador Place, Suite 101
Portland, Oregon 97220-1384

Dear Chairman Wolford and Council Members,

The Coastal Conservation Association Washington (CCA Washington) is a nonprofit organization dedicated to the conservation of marine resources representing more than 6,000 Washingtonians who have a stake in protecting a well-functioning marine food web. Our members have donated thousands of hours working to restore salmon and steelhead to Northwest rivers and streams, all in the hope that we may pass along this natural heritage to our children and grandchildren. We urge the council to do its part to support a healthy ecosystem by protecting forage species in the ocean that aren't currently being managed and to analyze the effects of PFMC managed fisheries on these important prey species in relation to the impacts on salmon populations.

The history of large-scale commercial fishing reveals numerous examples of the overharvest of important targeted and non-targeted stocks, which has negative impacts throughout the marine food web. For example, commercial fisheries extracting massive numbers of forage fish directly impact the health of depleted and ESA-listed stocks dependent on such forage fish. The availability of forage fish to provide a source of food for salmon, other fish, marine birds and marine mammals should take precedence over harvest. CCA Washington supports systematic and vigilant programs of professional catch monitoring and evaluation to identify and correct problems related to bycatch and over harvest of forage fish at an early stage.

Small prey fish are an important food source for salmon and other marine life higher on the food chain. An abundance of forage fish, such as whitebait smelt, also help out-migrating juvenile salmon and steelhead by serving as alternative prey for predatory seabirds, marine mammals and larger fish in estuaries such as the mouth of the Columbia River.

We are concerned about growing worldwide demand to convert vast quantities of forage fish for secondary purposes, such as feed for poultry, livestock and farmed fish. The council noted in its own draft ecosystem plan in November that the incentive for targeting new species of lower-trophic-level fish is likely to grow more attractive due to the spectacular growth of the global aquaculture industry. CCA Washington believes that harvest management should err in favor of conservation and recovery, which is why we urge the Council to not only hold off authorizing any new fisheries targeting forage species but to also refrain from expanding any existing forage fish fisheries such as the proposed quota increase for sardines on the west coast until the science is in place to manage both the prey fish and the predator fish that depend on them. As Washington residents, we also note that our state Fish and Wildlife Commission's Forage Fish Management Plan rightly prioritizes the role forage fish play in the ecosystem ahead of its value in the net.

Thank you,

Bryan Irwin
Executive Director
CCA Washington

30 Years of Conservation
Dedicated to the Conservation and Protection of Marine Life
1006 West 11th Street • Vancouver, WA 98660 • Tel (877) 255-8772 • Fax (877) 255-8774
www.ccapnw.org

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Monterey Bay National Marine Sanctuary
299 Foam Street
Monterey, California 93940

February 23, 2012

Dear Sanctuary Advisory Council Members,

As part of our Ecosystem-based Management Initiative, the Monterey Bay National Marine Sanctuary is collecting and synthesizing information it will provide to the Pacific Fishery Management Council (PFMC) for consideration in their Essential Fish Habitat (EFH) Review process. Information from federal, state, and academic datasets (e.g., groundfish habitat suitability models, groundfish trawl effort data, coral by-catch data) has already been collected. However, additional local and expert knowledge would enhance understanding of the sustainable uses and resource conditions of the sanctuary. Your information will be relied upon to identify specific needs and goals of sanctuary stakeholders as we engage the PFMC in their EFH review process. MBNMS views the EFH review process as an opportunity to collaborate with our partners and stakeholders to enhance protection and support sustainable uses of sanctuary resources.

We are currently seeking information relevant to the EFH review process, with a focus on the following topics:

- locations of benthic habitat essential to groundfish species
- locations of benthic habitat that are unique, rare, remarkable
- locations of areas that are currently or historically of interest to bottom contact gear fisheries, and their relative value
- any constraints to specific fisheries (e.g., ITQ, fuel costs) as they relate to EFH, and opportunities for promoting additional sustainable fisheries (e.g., market availability)
- locations necessary for research that may be affected by EFH regulations

If you or your constituents have expert and/or local knowledge on these topics, we encourage you to share that information with us so it can be considered in our analyses and communications with the PFMC. There are two immediate stages for stakeholder input:

Stage 1: Information gathering between now and March 22nd.
During this first stage, MBNMS would like all interested parties to provide information on the topics listed above. MBNMS staff will incorporate as much of the available information as possible into our analyses, and the results will be presented for discussion at the April 19th Advisory Council meeting.

Stage 2: Additional information gathering after preliminary analysis.
After the April 19th presentation to the Advisory Council, MBNMS would like to receive information to refine the analysis. The types of information gathered in this stage will be affected by April PFMC decisions about whether and how to move forward with EFH Review.

For Stage 1, there are three different ways you can share your knowledge with Sanctuary staff. Please engage in any or all of the following information gathering opportunities:

1) Open house March 20th from 3:00 – 8:00 p.m.
Sanctuary staff will be available to meet with stakeholders to discuss their interests and knowledge related to the EFH review process. Staff will be happy to discuss the information already available or answer questions stakeholders may have about the EFH review process.

2) Several small group meetings. Please schedule these meetings with Dr. Rikki Dunsmore ASAP.

3) Written comments. Please submit comments to Dr. Rikki Dunsmore by March 22nd. Due to the limited staff time, we will not be able to respond to individual submittals. Receipt of information will be acknowledged.

Contact information:

Dr. Rikki Dunsmore
Monterey Bay National Marine Sanctuary
299 Foam Street
Monterey CA 93940
rikki.dunsmore@noaa.gov Phone (831) 331 6113

For Stage 2, we will follow up with specific guidelines for input based on the EFH Review process and timeline adopted by the PFMC.

We appreciate the meetings we have held with you to date and look forward to continuing these discussions. We encourage all members of the Advisory Council to get the word out to any constituents who might have information to contribute or who wish to be made aware of this process.

Sincerely,

John Hunt, Ph.D.
Deputy Superintendent

Monterey Bay National Marine Sanctuary
Sanctuary Advisory Council Materials
Revised February 23, 2012

Sanctuary Engagement in Essential Fish Habitat Review

Background

The Monterey Bay National Marine Sanctuary (MBNMS) Ecosystem-based Management (EBM) Initiative is designed to advance management goals with the understanding that (1) sanctuary resources are special by their very designation and are expected to be managed accordingly; (2) sanctuary resources are inter-related and best managed holistically; and (3) well-coordinated management across many local, state, and federal agencies is needed not only to provide for a higher level of resource protection, but also to ensure viability of uses and activities that are compatible and sustainable.

Fishing in the sanctuary is managed by multiple agencies and is best understood in an ecosystem context. The 2008 Management Plan for the MBNMS speaks to the importance of understanding the effects of fishing, particularly bottom trawling impacts on benthic habitats, and contains other benthic habitat-related Action Plans addressing the Davidson Seamount, marine protected areas, sea floor characterization, associated education, collaborative research, and conservation planning.

MBNMS relies on the National Marine Fisheries Service (NMFS) and the California Department of Fish and Game (CDFG) for fishery management in the sanctuary. Over the past decade, NMFS, the Pacific Fishery Management Council (PFMC), and the State of California have applied various fisheries management tools in MBNMS waters. These were created largely because of historical overfishing and the need to rebuild certain fish stocks, ensure productivity of fish habitat, and protect federally-listed endangered species. Many areas within the sanctuary are managed with specific restrictions on the use of bottom trawls and other bottom contact gear in State waters and PFMC-designated Essential Fish Habitat (EFH) and Rockfish Conservation Areas (RCAs). (Please see the attached map.)

Existing fisheries management agencies, such as NMFS and CDFG, are primarily concerned with the regulation and management of fish stocks for healthy fisheries. In contrast, the sanctuary has a different and broader mandate under the National Marine Sanctuaries Act (NMSA) to protect all sanctuary resources on an ecosystem-wide basis. MBNMS's mandate is to be complementary to, and not redundant with, existing fisheries management authorities. NOAA policy is clear regarding sanctuary actions that may affect fishing. Since its designation, whenever any proposed action to protect the health of the ecosystem directly or indirectly affects fishing, MBNMS has followed a prescribed process for coordination with fishery management agencies. MBNMS first consults with the State, PFMC, and NMFS, as well as the industry to determine an appropriate course of action. The NMSA requires that the PFMC be provided with the opportunity to draft regulations. In addition, the NOAA Interagency

Memorandum of Understanding ensures that NMFS has a major role in the development of any fishing regulations in the sanctuary.

Essential Fish Habitat (EFH) on the West Coast

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." In January 2002, NMFS issued a final rule that established guidelines to assist the Regional Fishery Management Councils and the Secretary of Commerce in the description and identification of EFH in fishery management plans, the identification of adverse effects to EFH, and the identification of actions required to conserve and enhance EFH.

In November of 2005, the PFMC amended its groundfish fishery management plan (FMP) to designate EFH for groundfish on the west coast, including areas within MBNMS. The groundfish FMP includes over 90 different species that, with a few exceptions, live on or near the bottom of the ocean. These are made up of rockfish, flatfish, roundfish (such as lingcod), sharks, skates and other species. The PFMC is currently considering whether there is sufficient new information to request proposals leading to possible changes in the EFH designations (see below).

Along the West Coast, NMFS and the PFMC considered fishing gear restrictions and area closures as the primary tools for minimizing adverse effects to EFH. These measures directly control both the type of impact, based on allowed gear type, and where impacts may occur, based on area restrictions. Gear types were ranked for their potential to have adverse effects in the following order: (1) bottom-tending mobile gear types (e.g., bottom trawl in which the otter boards or the footrope of the net are in contact with the seabed) and (2) other gears that contact the bottom. Gear types that do not contact the bottom were not prioritized for EFH.

Pristine benthic habitat was identified in the EFH designations, with an emphasis on biogenic habitat (e.g., deep sea corals). Deep sea corals and sponges are considered important because of their role in creating habitat for various fish life stages, and because they are extremely slow growing and thus very slow to recover from disturbance. Hard bottom habitat was also prioritized due to its potential ecological complexity and sensitivity to impact.

In addition to describing EFH and designating EFH Conservation Areas and Habitat Areas of Particular Concern, the Council also adopted measures to mitigate the adverse impacts of fishing on groundfish EFH. Principal among these are implementation of management areas to protect sensitive habitats. Within areas designated as EFH, there are three types of areas that are closed to certain types of fishing gear:

- There are bottom trawl closed areas, such as the deeper portions of Monterey Canyon, which are closed to all types of bottom trawl fishing gear except demersal seine.

- There are bottom contact closed areas that are closed to all types of gear intended to make contact with bottom during fishing operations, as well as gear deployed deeper than 500 fathoms. The Davidson Seamount is the only EFH bottom contact closed area designated within MBNMS.
- The bottom trawl footprint closure areas prohibit trawling in the Exclusive Economic Zone (EEZ) between depths of 1,280 and 3,500 meters, which is the outer extent of groundfish EFH. This covers a considerable portion of the deeper waters of the sanctuary.

Please see the attached map for details.

Essential Fish Habitat Review

The PFMC is currently considering whether there is sufficient new information to request proposals leading to possible changes in the groundfish EFH designations. The PFMC's EFH Review Committee has been meeting over the past two years to discuss the scope of data available to the EFH review process and ways to address data gaps. West coast sanctuary staff participate on the review committee. In 2011 the PFMC requested that any new data be submitted for consideration. The PFMC will soon release a report of those new data that better indicates where trawling is occurring and identifies areas with sensitive habitat that were not protected in the 2005 EFH designations. In April, 2012, the PFMC will meet to decide whether to entertain proposals that could result in amendments modifying the EFH designations in the groundfish Fishery Management Plan (FMP). If proposals are requested, they would likely be due in June, 2012. The PFMC would then consider any proposals or other correspondence to determine whether EFH changes might be warranted. If so, it is likely the PFMC would begin a process of up to two years considering the merits of proposals and how they might result in amendments to the groundfish FMP.

MBNMS Interest in the EFH Review Process

A number of Action Plans in the MBNMS Management Plan identify sanctuary priorities that can be at least partially addressed by working with NMFS and the PFMC through the EFH review process. Primary among these are the Action Plans for Bottom Trawling Effects on Benthic Habitats and Marine Protected Areas. These Action Plans are the result of many years of consultation with the Sanctuary Advisory Council and stakeholders, and have benefited from a large volume of public comment.

The Ecosystem-based Management Initiative promotes a collaborative approach to working with agencies on processes such as EFH review. A fundamental principle of ecosystem-based management is coordination among agencies to achieve multiple objectives in protecting complex ecosystems. The EFH review process provides an opportunity to achieve success with respect to each of the four goals of the EBM Initiative:

1. Maintain and/or restore marine ecosystem health, services and function;
2. Ensure protection of unique and rare features;
3. Facilitate research to differentiate between natural variation and human impacts;
4. Facilitate ecologically and economically sustainable uses, including fisheries.

(1) The goal of maintaining ecosystem health is in alignment with PFMC mandate under the Sustainable Fisheries Act, which requires fishery management plans to “describe and identify essential fish habitat…, minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat” (MSA §303(a)(7)).

(2) The NMFS and PFMC prioritization of hard bottom and biogenic habitat, including that formed by deep sea corals and sponges, is an opportunity to provide protection for unique and rare benthic features in the sanctuary. A major theme arising from the MBNMS Unique and Rare Features Workshop (May, 2011) was to identify features that contribute disproportionately to ecosystem health, biodiversity and productivity, a goal echoed by PFMC concern for the role of these habitats in fish production.

(3) MBNMS has asked for advice from its Research Activities Panel about whether and how the EFH process can contribute to the establishment or accommodation of areas needed for research. It is not known whether the PFMC would consider the needs of specific studies, but preservation of undisturbed reference areas is a sanctuary interest that may be advanced through the EFH review.

(4) The fourth EBM Initiative goal of facilitating sustainable uses is clearly affected by PFMC decisions on EFH. The sanctuary’s interest is to make progress on its research and resource protection goals without negatively affecting fishing industry revenue. Data sets on benthic habitat are available from a number of sources, and MBNMS has gathered this information for many years. Information on fishing industry values related to EFH is only partially available in public data sets. MBNMS and ultimately the PFMC will need additional information about areas and techniques that must remain open to the trawl fleet for the continued viability of the industry.

MBNMS Approach to EFH Review

Since the inception of the EBM Initiative more than two years ago, MBNMS has shared its intention to engage in the EFH review process. MBNMS will communicate its priorities and local knowledge to NMFS and the PFMC. MBNMS will submit written comments, maps, and other information to make the most of this opportunity, based on its overall approach of protecting benthic habitat and remarkable features without reducing revenues for the affected fishing industry. MBNMS staff continues to gather information from the PFMC, the scientific community, the Sanctuary Advisory Council and stakeholders (see below). While a substantial amount of this information has been gathered, there are gaps, particularly with respect to fishing fleet valuation of areas that are or may be affected by EFH. MBNMS will consider the effects of fishery quotas, advances in fishing gear, and the locations of benthic features and fishing effort. A major part of the evaluation will be geographic information system (GIS) analyses to identify areas according to their conservation and fishing values.

Input from the Sanctuary Advisory Council and Constituents

MBNMS would like to gather input from sanctuary constituents to include in its analyses and communications with the PFMC. MBNMS requests that Advisory Council members and the communities they represent provide input for this process so that their interests are well represented. Specifically, staff would like additional information on:

- locations of benthic habitat essential to groundfish species
- locations of benthic habitat that are unique, rare, remarkable
- locations of areas that are currently or historically of interest to bottom contact gear fisheries, and their relative value
- any constraints to specific fisheries (e.g., ITQ, fuel costs) as they relate to EFH, and opportunities for promoting additional sustainable fisheries (e.g., market availability)
- locations necessary for research that may be affected by EFH regulations

As stated earlier, MBNMS staff have already been gathering and analyzing this information as part of related efforts guided by the sanctuary Management Plan and through the EBM Initiative process. There may, however, be additional information not yet captured. To gather this information, MBNMS will conduct additional outreach in at least two stages.

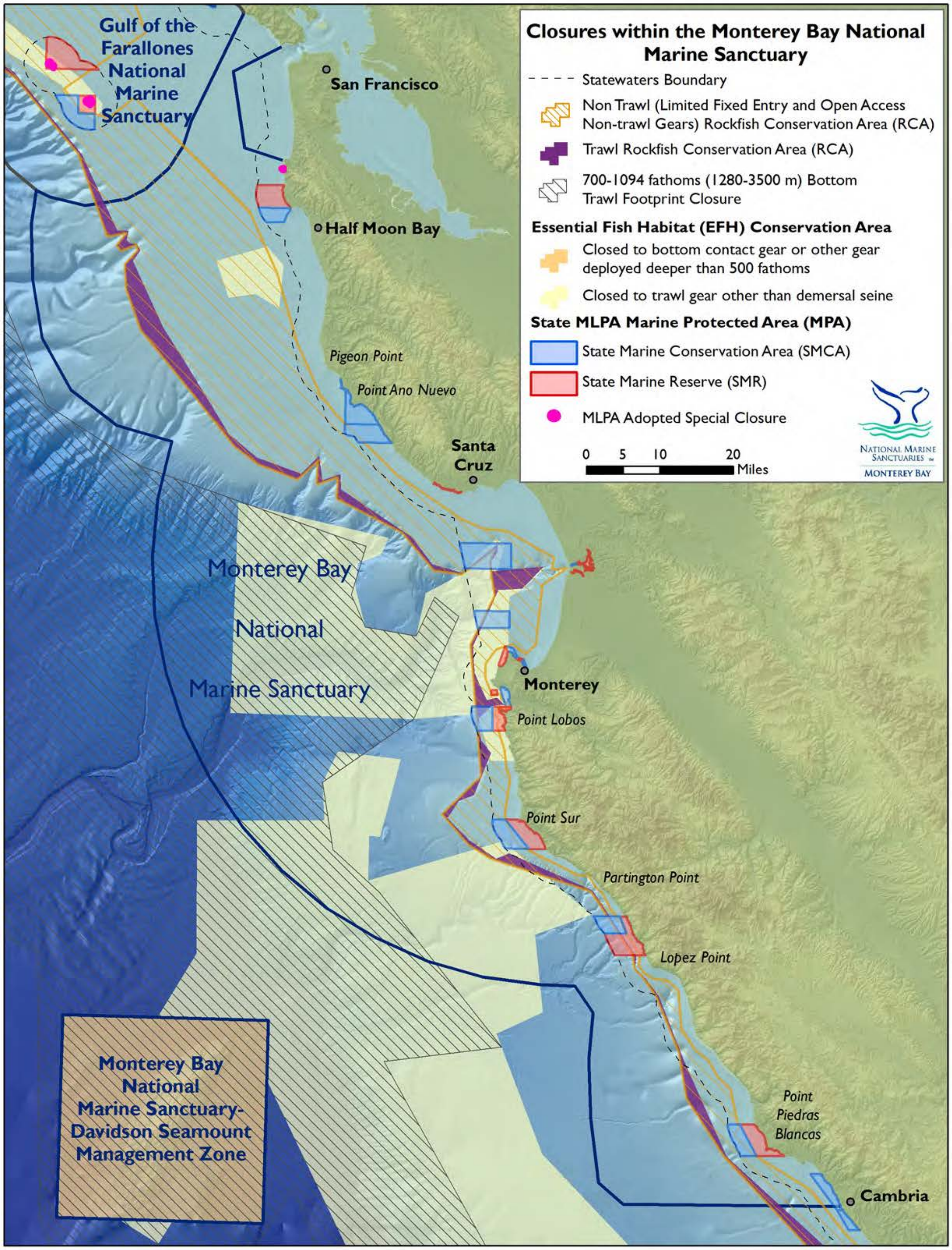
In the first stage, staff will receive information and participate in meetings with stakeholders through March 22, 2012. Staff asks that Advisory Council members distribute this briefing document and the attached information request to interested constituents. Advisory Council members or constituents may send written materials to MBNMS (rikki.dunsmore@noaa.gov). MBNMS staff can also schedule small group meetings to receive information and to present the information we have and the approach we are pursuing. MBNMS appreciates the meetings held to date, and looks forward to continuing these discussions. MBNMS will also host an open house March 20th from 3:00 – 8:00 p.m. At this event sanctuary staff will be available to meet with stakeholders to discuss their interests and knowledge related to the EFH review process. Staff will be happy to discuss the information already available or answer questions stakeholders may have about the EFH review process.

After the first stage of stakeholder input closes on March 22, staff will incorporate new information into analyses to be presented at the April 19th Sanctuary Advisory Council meeting. The second stage for related input will be discussed at that Advisory Council meeting and will be designed to get Advisory Council and stakeholder input on the results of the analyses. Details on stakeholder input beyond that point will depend on how PFMC moves forward with EFH review, but will most likely include another opportunity for comment on MBNMS input to the review process.

The SAC Conservation Working Group has identified benthic habitat protection as one of its three focal areas, and has discussed engagement with the EFH process. MBNMS staff will seek the assistance of the CWG to alert its constituents and others in the conservation community to the availability of MBNMS briefing materials and opportunities to meet. Staff will also continue to solicit input from the Research Activities Panel and the scientific community.

We encourage all members of the Sanctuary Advisory Council to get the word out to any constituents who might have information to share or wish to be made aware of this process. Information can be submitted in writing to Rikki Dunsmore (rikki.dunsmore@noaa.gov) by March 22.

As staff continues this important phase of information gathering for this element of the EBM Initiative, we appreciate your assistance in making the most of this opportunity to meet our responsibilities for the Monterey Bay National Marine Sanctuary.


Closures within the Monterey Bay National Marine Sanctuary
Statewaters Boundary
Non Trawl (Limited Fixed Entry and Open Access Non-trawl Gears) Rockfish Conservation Area (RCA)
Trawl Rockfish Conservation Area (RCA)
700-1094 fathoms (1280-3500 m) Bottom Trawl Footprint Closure
Essential Fish Habitat (EFH) Conservation Area
Closed to bottom contact gear or other gear deployed deeper than 500 fathoms
Closed to trawl gear other than demersal seine
State MLPA Marine Protected Area (MPA)
State Marine Conservation Area (SMCA)
State Marine Reserve (SMR)
MLPA Adopted Special Closure
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National Marine Sanctuaries
Monterey Bay
Gulf of the Farallones National Marine Sanctuary
San Francisco
Half Moon Bay
Pigeon Point
Point Ano Nuevo
Santa Cruz
Monterey Bay National Marine Sanctuary
Monterey
Point Lobos
Point Sur
Partington Point
Lopez Point
Point Piedras Blancas
Cambria
Monterey Bay National Marine Sanctuary-Davidson Seamount Management Zone

Agenda Item C.1.b
Supplemental Public Comment 8 (Geoff Shester)
March 2012

A cold oceanographic regime with high exploitation rates in the Northeast Pacific forecasts a collapse of the sardine stock

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Edited by Paul G. Falkowski, Rutgers, The State University of New Jersey, New Brunswick, Brunswick, NJ, and approved February 1, 2012 (received for review August 22, 2011)

The oceanographic conditions in the north Pacific have shifted to a colder period, Pacific sardine (*Sardinops sagax*) biomass has declined precipitously in the California Current, the international sardine fishery is collapsing, and mackerel (*Trachurus symmetricus* and *Scomber japonicus*) are thriving. This situation occurred in the mid-1900s, but indices of current oceanographic conditions and the results of our acoustic-trawl surveys indicate it likely is recurring now, perhaps with similar socioeconomic and ecological consequences. Also alarming is the repetition of the fishery's response to a declining sardine stock—progressively higher exploitation rates targeting the oldest, largest, and most fecund fish. Furthermore, our data indicate the recent reproductive condition of sardine is poor, and their productivity is below modeled estimates used to derive the current fishery-exploitation rates. Consequently, the sardine population has been reduced to two cohorts that are unlikely to produce an appreciable new cohort. Thus, a near-term recovery of this important stock is unlikely, depending on the return of warmer oceanographic conditions, reduced pressure from mackerel species, and perhaps the adoption of a more precautionary strategy for managing the residual sardine population.

Pacific Decadal Oscillation | upwelling system | pelagic community | management

It is widely recognized that many fish stocks worldwide have collapsed because of overexploitation (1), but other stocks wax and wane, perhaps because of cyclical environmental factors (2), anthropogenic factors, or both (3). A paradigmatic example of periodic fish abundance and exploitation is the Pacific sardine (*Sardinops sagax*) fishery in the northeast Pacific (Fig. 1). Fossil evidence from the last 1,700 y indicates that the stock abundance is cyclical with a period of ~60 y, independent of fishing (4).

Because sardine and other small pelagic fishes comprise the majority of landings worldwide, and these stocks exhibit large interannual and interdecadal variations of abundance and collapse (5), long-term ecological studies are conducted to understand better the relationships of pelagic fishes, their environment, and the fisheries. Notably, the California Cooperative Oceanic Fisheries Investigations (CalCOFI) began multidisciplinary time series in 1949 to study the ecological aspects of the sardine population growth and collapse off the west coast of the United States in the early to mid-1900s (6). During this period, the "northern" sardine stock (7) and the international sardine fishery burgeoned, spanning from Mexico to Canada; then, because of overfishing during periods of low productivity (8), it contracted abruptly and ultimately halted, with significant socioeconomic effects, for nearly 20 y (6).

Here, we examine the many parallels between the growth and collapse of the northern sardine stock in the early to mid-1900s and the current situation. We begin with a review of the scientific literature to glean a number of characteristics of this historical stock and its environment. Then, using a combination of references and our own data and analyses (9–11), we systematically show that all these characteristics are present again.

Results

A Fish Story (1930s–1950s). This first account is a synthesis of the literature aimed at identifying characteristics of the collapse of the sardine stock and fishery in the last century. In the 1930s and 1940s, sardine dominated the fish landings in North America (6) and comprised the largest single-species fishery in the Western hemisphere (12). The stock migrated seasonally, spawned principally in the spring offshore southern and central California, and foraged in the summer in the coastal upwelling regions off northern California, Oregon, Washington, and Vancouver Island (Fig. 1) (9, 13). The mostly unregulated fishery intensely targeted the larger migrating sardine in the northern upwelling regions (6, 8). Only 5 y after the landings peaked there during the 1943–1944 season (6), the population did not appear off Vancouver Island. The following season, no sardine were found north of California. By 1952, the sardine fishery north of Monterey Bay had ended (6).

A few years earlier, apparently forecasting the collapse of the sardine fishery off the west coast of the United States, nearly identical events occurred in a sardine fishery on the western side of the Pacific basin. Landings off Japan peaked in 1938, 2 y after the landings peaked off the United States and Canada, and dropped to a historical low in 1945, approximately 10 y before the United States sardine fishery collapsed (Fig. 2*A*) (12). This coincidence prompted theories of basin-scale oceanographic forcing (14).

During the period of declining and then low sardine biomass in the northeast Pacific, jack mackerel (*Trachurus symmetricus*) thrived and dominated the biomass of pelagic fishes, followed by northern anchovy (*Engraulis mordax*) and then Pacific mackerel (*Scomber japonicus*) (15) (Fig. 2*B*). This succession led to a pivotal hypothesis that warm periods (e.g., 1927–1947) favor sardine in this region, and cold periods (e.g., 1948–1977) favor anchovy (16, 17). It also appears that the periods of gradual transition favor mackerel (15). In 1978, the Pacific Decadal Oscillation index (PDO) (18) described another cold-to-warm transition (16), and the northern sardine stock began to increase again off the west coast of the United States (Fig. 2 *B* and *C*) (19).

Summarizing more than 60 y of retrospective analyses of these and other data, the collapse of the sardine fishery in northeast Pacific was characterized by

1. Negative phase of the PDO and decline in the Japanese sardine stock (basin-scale concordance);

Author contributions: J.P.Z. and D.A.D. designed research, performed research, analyzed data, and wrote the paper.

The authors declare no conflict of interest.

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[2]This article does not necessarily reflect the official views or policies of the National Marine Fisheries Service.

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ECOLOGY

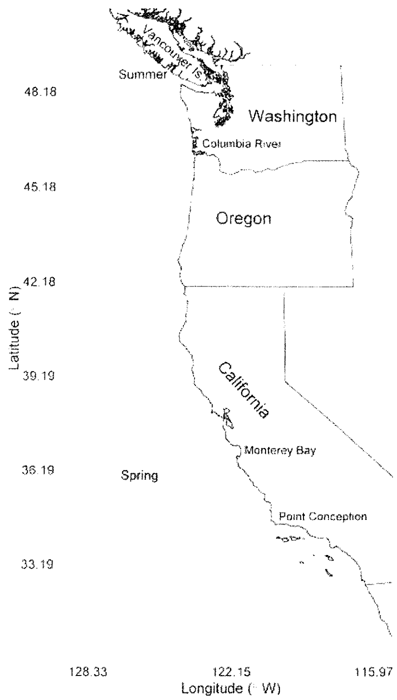

Fig. 1. Potential sardine habitat during spring (April) and summer (July) predicted using satellite-sensed oceanographic conditions during 1998–2009 (9). In agreement with our model predictions (9, 10), Pacific sardine (*Sardinops sagax*) spawn offshore of California during spring and then migrate north to feed in the coastal upwelling regions in summer (10, 13). The oldest, largest, fattest, most fecund sardine migrate farthest north (41).

2. Focus of the fishery on the oldest, largest, most fecund fish (fishery focus);
3. Decline in the sardine biomass below a critical level (critical biomass);
4. Shift in the dominant species and their schooling behavior (species alternation); and
5. Halt in the seasonal sardine migration (seasonal migration).

Each of these signs is elaborated in the next five sections.

Basin-scale concordance. There is compelling evidence that low-frequency oceanographic fluctuations triggered collapses of the sardine populations in both margins of the north Pacific in the mid-1900s (Fig. 2*A*) (12, 15). The PDO identifies "cold" and "warm" periods in the north Pacific, alternating every 20–30 y (18). A 21-y warm period from 1925–1946 favoring sardine transitioned to a 29-y cold period from 1947–1976. Then, in the 1980s and 1990s, another warm period appears to have promoted increases in the sardine biomasses off Japan and Chile (12) and off the United States and Canada (Fig. 2*A*) (12, 16). In addition to the effects of the changing environment, the collapse of the northern sardine stock in the California Current ecosystem (CCE) was attributed in part to the international fishery (6, 8).

Fishery focus. The oldest, largest, and most fecund sardine in this stock complete a seasonal migration from their spawning area offshore of southern California in the spring to their coastal feeding grounds off Oregon, Washington, and Vancouver Island in the summer (Fig. 1) (13). Before the collapse of this sardine population, these old fish, selected for their large size and high fat content, were intensely and increasingly targeted in the northern fisheries (Fig. 2*C*), stripping the population of its ability to reproduce and recruit successfully (6, 8). The sardine fishery was not managed, except for a limit on the fraction of the catch used for "reduction" (fish meal and oil products), and landings were governed solely by socioeconomic considerations. Population exploitation rates, exceeding 20% per year when the ocean temperatures

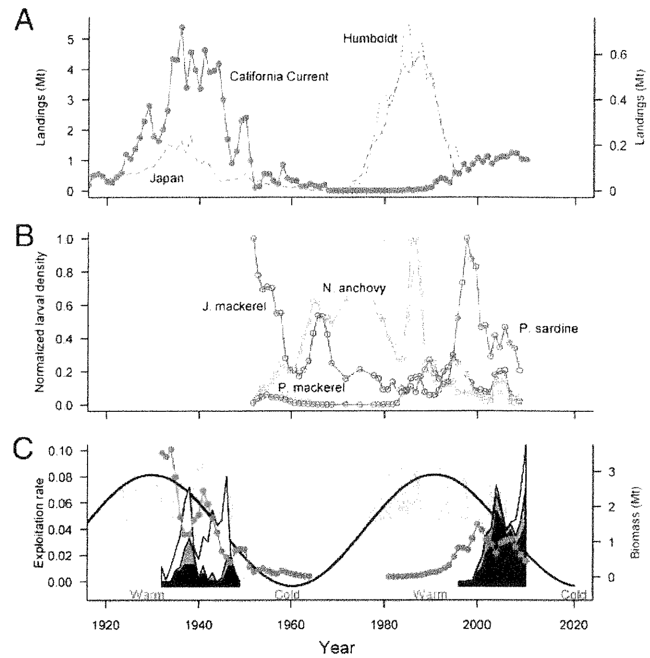

Fig. 2. (*A*) Landings in Mt of the sardine fisheries off the west coasts of North America (solid line, right *y*-axis), Chile (dotted line, left *y*-axis), and Japan (dashed line, left *y*-axis) (12). (*B*) Normalized 3-y-running mean larval densities of northern anchovies (green line), Pacific sardine (red line), Pacific mackerel (aqua line), and jack mackerel (blue line) off southern California indicate changes in the dominant pelagic fish species in the CCE: sardine in 1990–2010, jack mackerel in the 1950s, anchovy in the 1960s–1980s, and Pacific mackerel in the 1980s. (*C*) Biomass of the northern sardine stock age 2 y+ in the CCE (25) (red); cumulative exploitation rates (catch divided by estimated abundance) from the fisheries off Oregon (black), Washington (dark gray), and Vancouver Island (light gray); and monthly PDO indices (vertical blue and pink bars) oscillating with a 60-y period; Our fit of a 60-y cycle to the monthly PDO index (black line) predicts the indices will be maximally negative in 2020 and suggests another warm period conducive to sardine in 2035. The dramatic drop in the exploitation rate of the northern fisheries in the 1940s is the result of the decline and interruption of the feeding migration that occurred 5 y after the landings peaked in the northern fisheries. In 2010, the exploitation rate in the northern fisheries peaked at a new maximum. The time series of sardine landings used to construct *A* were obtained from refs. 12 and 25. The time series of larval densities of northern anchovies, Pacific sardine, Pacific mackerel, and jack mackerel in *B* are from the 1951–2010 CalCOFI surveys (http://calcofi.org).

were below average and sardine production was low, resulted in a decline in the sardine biomass (19). The northern fisheries increasingly exploited the large migrating fish until they were depleted locally (Fig. 2*C*), and the fate of this sardine population was determined after just two seasons with unsuccessful spawning (8). Exploitation of the declining stock continued off California until a moratorium on their landings was imposed in 1967. By then, however, the sardine stock had virtually disappeared (6).

Critical biomass. When the total biomass of age 2-y-plus individuals, comprising most of the spawning stock biomass, decreased below 0.74 million tons (Mt) in 1948 (Fig. 2*C*) (20), and most of the largest individuals had been removed by the fishery, sardine progressively disappeared from the fisheries off Canada and then off the northwest United States (6). Thus, a sardine population below this critical biomass, in combination with unfavorable environmental conditions indicated by negative and declining PDO values (Fig. 2*C*), precipitated the collapse by preventing the remaining sardine from reproducing successfully (8). Through intense, localized harvesting, the fishery reduced the number of age classes and consequently the behavioral diversity of the stock, reducing its ability to adapt readily to unstable environmental conditions (8).

Species alternation. In addition to identifying oceanographic and meteorological conditions favoring sardine, the PDO also may explain the sequential dominance of multiple species of small pelagic fishes in upwelling ecosystems throughout the Pacific (Fig. 2*B*) (16). The warm and cold periods, each lasting approximately 3 decades (Fig. 2*C*), alternately favor sardine and anchovies, respectively (Fig. 2*B*) (15, 16). During the shorter periods of gradual transition, e.g., in the 1950s and the 1980s, jack and Pacific mackerel populations grow rapidly and thrive (Fig. 2*B*) (15). During the last cold period, 1947–1976 (29 y), when sardine abundances were low, few sardine were found in single-species schools; rather, they schooled within the more abundant Pacific and jack mackerel schools (19). This "school trap" behavior may have a negative dampening effect on sardine recruitment and growth if it reduces their ability to search for optimal feeding and reproductive conditions (21), and their eggs and larvae may become forage for the other coaggregating fish species (22).

Seasonal migration. In the mid-1900s, a conspicuous indicator of the collapse of the northern sardine stock in the CCE was the interruption of the seasonal feeding migration led by older, larger individuals. Sardine migrate seasonally when their energetic gains exceed the costs of swimming to and foraging in upwelling areas with higher primary productivity (Fig. 1) (23). Thus, sardine typically do not begin to migrate from the area in which they were spawned and recruited until they are more than 1 y old and longer than about 20 cm. When most of the larger fish were depleted by the fishery, the Canadian fishery abruptly declined in the mid-1940s, and the migration soon stopped (6). By 1949, the sardine stock did not migrate to Vancouver Island, and during 1950 the stock did not migrate north of California (6). During the late 1940s and early 1950s, the sardine fishery continued off California. During this time, the remaining sardine presumably experienced decreased foraging opportunities, their physiological condition deteriorated, and the population failed to produce substantive recruitments (8). Consequently, the sardine population plummeted in the early 1950s.

A Fish Story (1980s–Present). This second account is both a synthesis of the literature and our analysis of results from our acoustic-trawl surveys (surveys that combine echosounder and net sampling) of multiple coastal pelagic fish species off the West coast of the United States during spring 2006, spring and summer 2008, spring 2010, and spring 2011 (10, 11). We systematically evaluate the characteristics of the last collapse to foresee if the sardine population and fishery off the west coast of North America is likely to collapse again.

Basin-scale concordance. The Chilean sardine stock peaked in 1985 and then declined steeply (12), and Japanese sardine catches peaked in 1988 and then also dropped sharply (Fig. 2*A*) (12). These collapses were coincident with a declining period of the PDO in the 1990s (Fig. 2*C*). Meanwhile, off the west coast of the United States, Pacific mackerel were abundant between 1980 and 1998 (18 y) (Fig. 2*B*) (24). Because of competition from Pacific mackerel and the potential dampening effect on recruitment related to mixed-species aggregations (17, 21), the peak in the population size of the northern sardine stock in the CCE lagged the peaks in the northwest and southeast Pacific by approximately a decade (Fig. 2*A*) (15).

Based on a retrospective analysis of CalCOFI and other data, the sardine abundance in the CCE was predicted to peak around 1998 (15). It peaked in 2001 (Fig. 2*C* and see Fig. 4). Because of a strong 2003 cohort (Fig. 2*C*) (25), the northern sardine stock in the CCE increased again, peaked in 2006, and since then has been declining precipitously (Fig. 2*C* and see Fig. 4). Catches of pink, chum, and sockeye salmon, which historically track the rise and fall of the sardine populations in the Pacific basin (26), peaked with the PDO, around 1990 (27).

Fishery focus. During the recent exploitation period, sardine landings by the United States and Canadian fisheries commonly are perceived as being low relative to those during the mid-1900s (Fig. 2*A*), partly because of the existence of harvesting control regulations (25). Although the United States and Canada have used separate management policies, they are linked by the proportions of the sardine stock available for fishing in each season and region, set in the annual harvest guidelines, derived from the United States assessment model (28). Until recently, Canadian managers assumed that 10% of the northern sardine stock estimated by the United States assessment migrated into Canadian waters during summer (29). Since 2009, however, based on the results of Canadian trawl surveys and despite the steady decline of all fishery-independent estimates of sardine abundance (Fig. 3), the Canadian management increased its estimate of the migrating proportion from 10 to 18%, effectively increasing allowable catches there by ~80% (29).

Under the environmental conditions and management constraints on the fishery, the northern sardine stock recovered in the 1990s to less than one-third of the biomass of the 1930s. It started to decline in 2001 and in 2010 reached the lowest spawning stock biomass values since the beginning of Federal management (Fig. 3) (25). The exploitation rates of migrating sardine in the northern fisheries off Oregon, Washington, and Vancouver Island started to rise in the late 1990s and then temporarily decreased because of a strong recruitment from the 2003 cohort (Fig. 2*C*). However, in the absence of another substantial recruitment, the exploitation rates of the aging sardine stock have increased dramatically since 2006 (Fig. 2*C*) (25). Thus, the northern fisheries again are increasingly targeting the migrating sardine, which are the largest, oldest, and most fecund animals. In 2010, the total population exploitation rate peaked at ~23% (25), exceeding the high rates conducive to the recession of the sardine stock in the 1940s, when sardine productivity was declining (8).

Critical biomass. The latest extended warm period of the PDO, initiated in 1977 (18, 30), created conditions considered beneficial for sardine, such as improved inshore retention of early life stages, increased stability of the water column, and adequate plankton communities for forage (31). Nevertheless, the northern sardine stock did not recover in the CCE until *circa* 1990, perhaps when the hypothesized dampening effect of Pacific mackerel subsided (Fig. 2*C*). In subsequent years, boosted by warm, episodic El Niño events, sardine biomass increased, exceeding the spawning stock biomass of 0.76 Mt in 1997 (Fig. 3), when sardine again were found extensively off Vancouver Island (32). This event marked the expansion of their seasonal migration to the historical northern limit. Throughout their geographical range, sardine growth was rapid, recruits per unit spawning stock biomass were high (25), and there were multiple successful recruitment events (32). The fishery was fully reestablished, but, because of the lower population size, management constraints, and no reduction fishery, it yielded maximum catches that were only about one-quarter of the historical values (Fig. 2*A*) (6, 25). Nevertheless, since 2006 (2007 in the assessment time series), the spawning stock biomass indices have declined steadily (Fig. 3).

The current decreasing trend of biomass of the northern sardine stock in the CCE is witnessed by all fisheries-independent

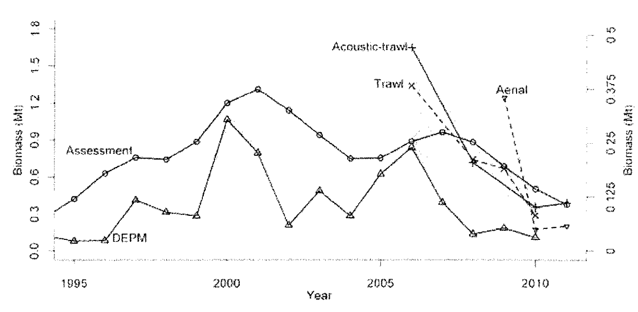

Fig. 3. Estimates of spawning stock biomass with 95% confidence intervals (shaded areas) for the northern sardine stock off North America from assessment (open circles; ref. 25), daily egg production method (DEPM) (open triangles; ref. 39), and our acoustic-trawl methods (x symbols and solid line, ref. 11), and estimates of abundance (95% confidence intervals were omitted for clarity) off southern Vancouver Island from trawl surveys (x symbols and dashed line; ref. 28) and off Oregon and Washington from aerial surveys (small triangles and dashed line; ref. 25). The *y* axis on the right refers to the trawl-survey estimates. Some estimates are of the entire stock (continuous lines), and some are of unknown proportions of the stock (dashed lines).

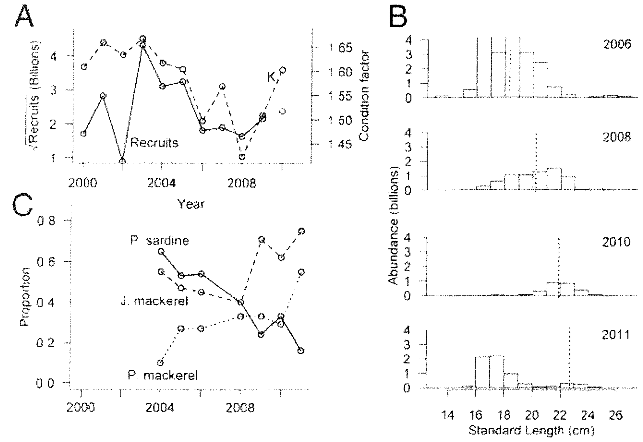

Fig. 4. (*A*) Estimates of sardine recruits (28) and associated condition factors (*K*) (34) from our analysis of sardine landings off Oregon and Washington. Since 2003, the decrease in *K* correlates with the decline in sardine production. (*B*) Biomass-weighted length distributions of the northern sardine stock from our spring acoustic-trawl surveys (11). The mean lengths (dashed line) of the 2003 cohort (perhaps including 2003- and 2004-y classes) indicate that its biomass has diminished greatly between 2006 and 2011. The mean length of the most recent cohort (perhaps including 2009- and 2010-y classes) is small, ~17 cm. The number of recruits (in billions; solid line) is measured on the left y-axis. (*C*) Proportions of trawl catches in our surveys (11, 12) that included sardine and mackerel. The trends indicate that catches of only sardine (indicating monospecific schools) are decreasing, and catches of jack and Pacific mackerel are increasing during spring surveys off California. These trends indicate that sardine are schooling increasingly with mackerels. Note: in *A*, the 2010 recruitment was estimated as the abundance of the smaller modal class of sardine, in the 2011 acoustic-trawl survey (shown in *B*). Recruitment indices used in *A* are from ref. 25. Condition factor used in *A*: data courtesy of the Oregon and Washington Departments of Fish and Wildlife.

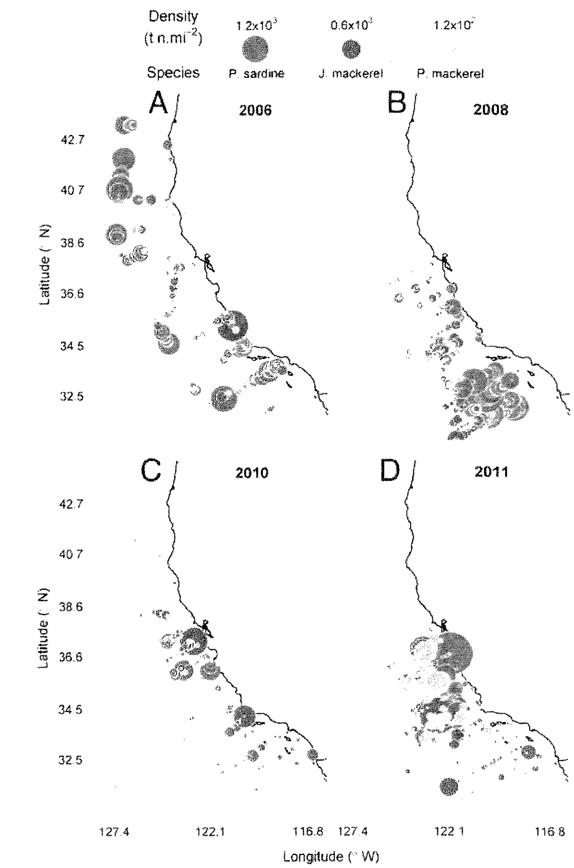

Fig. 5. Distribution and abundance of sardine and mackerel off the west coast of the United States during springs of 2006, 2008, 2010, and 2011, estimated from our acoustic-trawl surveys (11). Our survey results show that in 2011 sardine were surpassed by jack and Pacific mackerel as the dominant epipelagic fish species.

estimates of abundance (Fig. 3) (11, 25) and can be related to the beginning of an unstable period of the PDO and the fishery focus (Fig. 2*C*). In 2010, all spawning stock biomass estimates were lower than the 0.74 Mt estimated for sardine in 1948 (20) when the stock failed to migrate to Vancouver Island after being severely depleted of the older age classes (6). If sardine migrate in summer to the highly productive upwelling regions off Oregon, Washington, and Vancouver Island, they will be targeted increasingly by the United States and Canadian fisheries. If sardine do not migrate to their summer feeding grounds, they may not gain sufficient weight for extensive spawning during the following spring (33).

Based on market-sampling data, a notable trend associated with the current decline in sardine biomass is the gradual loss of fitness of the adult population, evidenced by a general decrease of their condition factor (*K*) (34) before the spawning season (Table S1). A progressive decrease in their condition, suppressing their reproductive potential, explains their low recruitments from 2004–2008 (Fig. 4 *A* and *B*). Improved sardine condition during 2009–2010 corresponded to a slight increase in recruitment. A modest recruitment in 2011 (Fig. 4*B*), perhaps comprising both the 2009- and 2010-y classes, was observed in the results of the latest acoustic-trawl survey conducted in April 2011 (Fig. 5*D*). However, because these new recruits may not find it energetically feasible to migrate to the feeding grounds until their second year of their life (23), they may not gather and store enough energy to reproduce extensively, curtailing future recruitment.

Species alternation. In addition to the effects of the environment and fisheries, the growth and reproduction of the 2011 recruitment may be affected by both competition and predation. Our survey data show that jack mackerel has been abundant in the sardine habitat in the CCE since at least 2006 (Fig. 4*C*), and the Pacific mackerel biomass increased dramatically in 2011 (Fig. 5*D*). Our analysis also shows that these recent increases in the abundance of mackerel are coupled with a significant reduction of monospecific sardine schools in the CCE since 2004 (Fig. 4*C*). Schooling with mackerel could affect sardine condition, because mackerel tend not to migrate as far north or as near shore as sardine, presumably preferring different environments (24) and prey. Mackerel may forage on small sardine and sardine eggs and larvae if the species coaggregate during sardine spawning (22).

Seasonal migration. Currently the likelihood for a renewed cessation of the seasonal sardine migration is high. Our survey results show clearly that the last significant year-class was spawned by the northern stock in the CCE in 2003 (Fig. 4*A*); this year-class peaked in biomass in 2006 (Fig. 3) and since then has been depleted severely by natural and fishery-related mortality (Figs. 2*C* and 4*B*). The April 2011 survey results (Fig. 5*D*) indicate that the large 2003 cohort, which peaked in abundance in 2006, has been greatly surpassed in numbers by the modest number of recruits observed in 2011 (Fig. 4*B*). The biomass of the potentially migrating fish [i.e., the largest individuals with lengths in excess of 20 cm (13)] is well below the past critical value of 0.74 Mt of age 2-y-plus sardine, and the residual large fish are increasingly mixed with mackerel. These signs and the associated potential negative-feedback mechanisms (17, 21) indicate the sardine stock is collapsing and that there will be long-lasting ecological and socioeconomic effects if history is repeating.

Discussion

The recent reduction in sardine biomass has been accompanied by a decrease in per-capita reproductive output. This recruitment depensation (35) appears to occur when individuals of the decreasing population are unable to exploit their environment for optimal foraging and reproduction. Theoretically, when minority species school with other species of fish, their adult populations are fragmented, migration routes are disrupted, and foraging and therefore reproductive potentials are reduced (33). However, the effects of depensation are difficult to identify and quantify (36), and population models frequently assume, on the contrary, that fish increase their reproduction in response to a decrease in population size (37). Therefore, assessment models likely overestimate reproductive success at low population sizes (37). Consequently, management inadvertently can allow overharvesting, which may cause subsequent stock recovery to be slow and incomplete (33, 35, 36, 38).

In the 1940s, the larger, migrating sardine were targeted aggressively, the number of cohorts declined (8), and their seasonal migration stopped (6). These factors likely reduced the duration of spawning events and the stock's ability to thrive in an unstable environment (8). The harvesting pressure on the residual sardine stock continued off southern California until the early 1960s (6). Consequently, when the CCE experienced another warm period in the 1980s, the recovery of the northern sardine stock in the CCE apparently was delayed by a decade (15) (Fig. 2*A*). By that time, the warm period had begun to wane, and the stock grew to only about one-third of its historical size and remained large for only half as long before declining again in association with the onset of another cold period (Fig. 2*C*).

Currently, the sardine population appears to be comprised almost entirely of two cohorts. Our survey results show that the older cohort now is almost negligible, and the recent cohort is small. Nearly gone are the largest fish with high reproductive potential, which spawn more frequently, during longer periods, and with the largest egg batches (39). Our analysis of landings data shows that the residual large fish are exploited increasingly (Fig. 2*C*). Consequently, the reproductive potential of the population is greatly diminished. This effect likely will increase recovery times relative to a population with similar biomass but with more cohorts and diverse behaviors (8, 33).

In 2011, based on the results of our acoustic-trawl survey, the sardine biomass of the northern stock in the CCE no longer dominated that of other epipelagic fish species, and sardine were found increasingly in mixed-species schools (Figs. 4*C* and 5). This behavior limits their ability to locate optimal sardine habitat (21), enhances predation of the sardine eggs and larvae (22), and potentially may halt their seasonal feeding migration, again with deleterious effects on their condition. We hypothesize that the low sardine biomass and their increased propensity to mix with other species creates a negative-feedback mechanism that serves to accelerate the decline of the population and greatly limits the possibilities for a near-term recovery.

Currently, the exploitation of sardine off the west coast of North America is at the highest possible rate within the management framework (25), and the largest, most fecund fish have been targeted increasingly despite clear indications of their depletion (Figs. 2*C* and 3). The harvest guidelines are based on a positive relationship between sea-surface temperature and sardine productivity observed in data from the previous warm cycle (25). That relationship, however, does not hold in the current state of the ecosystem (40), and our analysis of the stock recruitment indicates that sardine recruitment is currently density dependent and is affected positively by the condition of the parental population before the spawning season (Table S1). Succinctly, the current decline in the northern sardine stock in the CCE is the result of the high exploitation rates of a stock with limited productivity since 2003, coincident with a transition into a cold period.

In contrast to the fishery-independent biomass indices, which show precipitous declines, total sardine landings indicate only slight signs of stock biomass recession (Fig. 2*A*). Perhaps, irrespective of the fishery, the effects of changes in the environment are inescapable, and the sardine stock is fated to collapse again (15). Perhaps, as in the past, the residual sardine stock should be fished until continued fishing is not economically viable (6). Although economically attractive in the short term, this strategy may have long-term deleterious effects on the numerous natural predators of sardine and on the speed of the sardine-stock recovery during the next warm period (33). In addition to being prey for mackerel, sardine are prey for Pacific hake (*Merluccius productus*), multiple depleted species of shark, tuna, salmon, marlin, and barracuda, and many species of seabirds and marine mammals (41). Also, if the residual seed stock of sardine is too small, the fish may not form single-species aggregations and find optimal foraging and reproductive habitat, and their behavioral and phenotypic diversity may be insufficient for resilience during unstable environmental conditions (8). For example, the onset, size, and duration of the recent sardine fishery all were apparently affected adversely by persistent fishing of the declining stock in the mid-1900s (Fig. 2 *A* and *C*).

As an alternative to the above strategy, considering the current stock size, distribution, demographics, and condition estimated directly from acoustic-trawl surveys (10, 11) and the cyclical environmental periods witnessed by the PDO and other indicators, the exploitation rates could be set conservatively. Jacobson and MacCall (42) indicated that during persistent periods of adverse environmental conditions (e.g., cold seawater temperatures), little or no sardine harvest may be sustainable. Such a precautionary approach might allow a seed stock to persist until, and recruit quickly in, another warm period and thereby reduce uncertainty in social and business decisions in both the short and long term.

In the short term, the success of the northern sardine stock in the CCE appears to depend on the strength and management of the modest number of sardine recruits detected in the 2011 acoustic-trawl survey. In the medium term, sardine will have to struggle with more unstable and colder oceanographic conditions and the increasing predation and competition of resurging epipelagic species. In the long term, the condition and size of the northern sardine stock in the CCE may well depend on the management actions taken now.

The management strategies for Pacific sardine must be in accordance with the 1976 Magnuson Fishery Conservation and Management Act and subsequent reauthorizations and amendments (43). In particular, current management actions must consider "the rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce the maximum sustainable yield on a continuing basis." To do so, assessments rely on long-term averages of estimated fishing and natural mortality and recruitment success (44). However, such long-term stability is not exhibited naturally by populations of Pacific sardine (8, 42) and other small pelagic fishes (5, 45). Consequently, management strategies that maximize yield during periodic population increases may accelerate the periodic population declines. Therefore, different management objectives and procedures may be required to avoid overfishing of short-lived, environmentally dependent pelagic fish species. We advocate that stock assessment and management of sardine and other small pelagic fishes consider the short term sustainability of the stock based on direct measurements of mortality (natural and fishing) and recruitment strength evaluated through the results of frequent acoustic-trawl surveys (10, 11), together with an evaluation of the cyclical environmental conditions [e.g., as indicated by the PDO (14, 16)].

Conclusion

The exact cause of the collapse of the northern sardine stock in the CCE in the mid-1900s remains elusive (17). However, our analysis of the literature and the results of our 2006–2011 acoustic-trawl surveys (10, 11) indicate that many environmental and anthropogenic characteristics of the collapse appear to be recurring. All indicators show that the northern sardine stock off the west coast of North America is declining steeply again and that imminent collapse is likely.

Our acoustic-trawl surveys (10, 11) have provided unique foresight of this ecological and socioeconomic juncture. Based on the results of our spring 2011 survey of multiple pelagic fish species, the dominant species of small pelagic fishes in the CCE has changed, for the near future, to Pacific mackerel. In the past, the importance of such indicators was recognized only after striking repercussions in the fishery had occurred (6, 8). By then, the path of the northern Pacific sardine stock was irreversible, and the recovery was protracted (6).

Materials and Methods

Monthly values of the PDO (http://jisao.washington.edu/pdo/PDO.latest) (Fig. 2*C*) (18), starting in 1900, were averaged by year, and a sinusoidal oscillation with a 60-y period, identified by spectral analysis, was fitted to the time series by least-squares minimization. Then the trend of the PDO from 2011–2020 was forecast.

Indices of the sardine spawning stock biomass (Fig. 3) were obtained from the 2010 stock assessment (25), from the daily egg production method (DEPM) annual survey reports (ref. 39 and references therein), and from our acoustic-trawl surveys (10, 11). Also using data from our surveys, Fig. 4C was constructed by calculating the proportions of sardine and jack and Pacific mackerel in trawl catches containing one or more fish species, and the proportion of trawls in which sardine dominated (where sardine catch by weight was greater than 90% of all of the epipelagic fish catch) in the survey trawls from 2004–2011 (ref. 39 and references therein). Recruitment indices used in Fig. 4A and Table S1 are in ref. 25. Mean condition factors were calculated by averaging the individual condition factors ($K = 10^5$ *weight *length^{-3}; where weight is in grams and length is in millimeters) (34) of sardine larger than 19 cm (standard length) obtained from the Oregon and Washington fisheries during the feeding season before the recruit's year-class (data courtesy of the Oregon and Washington Departments of Fish and Wildlife).

Sardine biomass densities were estimated from our surveys of the CCE conducted using the acoustic-trawl method (10, 11) in spring 2006, 2008, 2010, and 2011 (Fig. 5) and were analyzed in the context of our verified modeled of sardine habitat (Fig. 1) and migration (9, 10). Acoustic densities from echoes of schooling epipelagic species were apportioned to the species present in the trawls, considering their abundances and length compositions. Sardine length distributions, weighted by their relative abundance in the survey area, were derived from the trawl catches.

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C.1
Agenda Item C.1.b
Supplemental P.C. 9
March 2012

February 28, 2012

Dan Wolford, Chairman

Pacific Fishery Management Council

Re. Open Public Comment

Mr. Chairman Members of the Council

My name is Bill James and I am a Commercial Nearshore Fishermen representing Port San Luis Commercial Fishermen's Association. The following comments are in addition to comments sent February 9, 2012 requesting the Council to change § 660.330 to allow for "vessel limits" to be changed to allow multiple persons that hold Nearshore Permits to be able to fish together on one vessel and catch their Bi-monthly limit.

The change requested in my opinion meets the three management goals (Conservation, Economics, and Utilization) from the Pacific Coast Groundfish Fishery Management Plan) and is also consistent with all 17 Objectives in the Groundfish Management Plan especially Objective 6 "Economics" …Attempt to achieve the greatest possible net benefits to the fishing community. This change is also consistent and enhances the 10 National Standards in the Magnuson-Stevens Fishery Conservation and Management Act of 2006, especially National Standard 7,8,9,10. National standard #7 "Minimize costs and avoid duplication". National standard #8 "provide for sustained participation and minimize adverse impacts to fishers and fishing communities. National standard #9 Minimize bi-catch or mortality of bi-catch. National standard #10 Promote safety at sea.
Please consider these changes, Sincerely, Bill James for PSLCFA