Comments to the MBNMS Sanctuary Advisory Council and Research Activity Panel
Concerning the
MBNMS Forage Fish White Paper
By
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September 5, 2012

REVISED DRAFT

MBNMS Conservation Working Group White Paper

Forage Species Science and Management in the Monterey Bay National Sanctuary

Authors

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July 6, 2012

OVERVIEW

I am writing because of my concern that the fisheries of central California are being subjected to either misguided advocacy or deliberate misinformation regarding the status of forage fishes and their management.. In my opinion, the Monterey Bay National Marine Sanctuary's Conservation Workding Group (CWG) White Paper on forage species has been written by authors whom have little background on forage fishes, fisheries science or the management of forage fishes The thrust of the Paper appears to be advocacy at best and little science is evident. The principal story presented is that the Monterey Bay National Marine Sanctuary is a "Foraging Destination of the Pacific" a " Hotspot within a Hotspot". According to the author's tone local fisheries should be severely restricted to provide their idea of ideal conditions for upper-trophic level animals.

The authors go to great lengths to describe how a wide range of exotic animals come to the MBNMS to feed on forage fishes. Unfortunately they fail to recognize that the MBNMS is not a hotspot for forage fishes; in fact it is not even prime habitat for the dominant forage fishes of the California Current. They provide no information on the landings of the individual forage species, the total landings of forage fishes in the California Current or any landings in the MBNMS. The management of forage fish species is of particular concern to the authors; however, they do not present an accurate description of current management. They make little attempt to describe maximum sustainable yield estimates, other management reference points or current catch quotas. They provide no information on the population sizes of forage fishes (except for Peru). The lack of attention to descriptions of the biology, ecology and migratory behavior of the major forage fishes is simply weird for a White Paper that is supposedly to inform the public on forage species.

A quick comparison of the landings of the most important forage fishes in the MBNMS with total landings of the species (FAO 2010 data) demonstrates my concern. The management of Pacific (chub) mackerel was severely criticized in the White Paper; however the authors do not mention that landings in the MBNMS in 2010 were 4 pound vs, total world-wide landings of 4.8 billion lbs. A very similar pattern occurs with landings of the important forage fishes in the MBNMS.

	Pacific Mackerel	California Sardine	Pacific Saury	Pacific Herring	Pacific Hake	California Jack Mackerel	Northern Anchovy
MBNMS	4 lbs	4,305 mt	0 lbs	0 lbs	0 lbs	0 lbs	683 mt
Total	2.201.334 mt	696,585 mt	457,584 mt	331,094 mt	210,409 mt	705 mt	4,607 mt

Given the above information how could anyone say that the MBNMS is a hotspot for forage fishes or suggest that the tiny landings in the MNBMS could have measurable impacts on the ecology of the North Pacific.. It appears to me that the authors of the White Paper are out of touch with reality.

The absence of any material on local fishermen, local landings, or fishing methods will obviously bias the take home message to the public and in my opinion this fact alone should cause rejection of the White Paper.

SPECIFICS:

The White Paper contains profiles and pictures of photogenic predators and forage fishes. However, there are no profiles or pictures of photogenic fishermen, fishing boats and fishing gear or figures showing the landings of forage fishes in the MBNMS. Surely any White Paper on forage fishes and their management in the MBNMS should include all of the above. Even if the authors feel that descriptions of the fisheries and their landing are unimportant, one would think that a publication that is directed at the public would, at a minimum, describe the principal forage species, their biology, abundance and behavior before describing their predators, the destination of their fishery products and other perceived threats to the ecosystem. One would think that a section describing the landings and fishery for forage fishes in the MBNMS would be more important than an extensive section dealing with world production of fishmeal when there are no fish reduction plants in California.

To demonstrate what I view as the weakness of the descriptions of forage species, their landings and their management I need to show what the White Paper has failed to show. Therefore of what follows includes descriptions of what should have been presented in a White Paper on forage fishes of the MBNMS.

For example: A small number of planktivorous fishes dominate the biomass and fisheries of all of the worlds principal upwelling regions. The California, Humbolt (Peru), Canary and Benguela Currents each have one species of anchovy, sardine, jack mackerel, mackerel and hake that at times achieve very high biomass levels and these five fishes dominate the fisheries of all four ecosystems (Bakun and Parrish, 1980). All of five species are highly mobile and most of them migrate annually between lower latitude spawning/nursery grounds and higher latitude feeding grounds. These fishes are able to achieve high population levels because they are low trophic level fishes feeding primarily on zooplankton. Each species consumes a very wide range of forage allowing them to capitalize on changing environmental conditions. Sardine and anchovy consume large amounts of phytoplankton and larger jack mackerel, hake and mackerel take considerable amounts of forage fishes and small squids. All five species occur in huge aggregations. The fisheries for the species are carried out with large fishing vessels using either purse-seines (sardine, anchovy, jack mackerel and mackerel) or pelagic trawls (hake, jack mackerel and mackerel).

In the California Current adult sardine, jack mackerel and hake make extensive migrations to and from spawning grounds that are south of the MBNMS and feeding grounds that are north of the MBNMS. Pacific mackerel are most abundant in the Southern California Bight but some migrate as far north as southern Alaska for feeding during the summer. Anchovy are much more abundant in the Southern California Bight (Southern California and northern Baja California) than Central California. During the population outbreak that occurred in the 1970s the anchovy landings reached 306,028 mt in the Bight but only 8,257 mt in central northern California (Figure 1). There is a separate anchovy stock in the Pacific Northwest and the edges of the two stocks overlap in MBNMNS. A third stock occurs in southern Baja California. In addition, there are 2 non-migratory stocks of hake in protected waters of the Pacific Northwest and a ‘dwarf’ hake stock in Baja California. Separate stocks of sardine occur in southern Baja California and in the Gulf of California.

The nursery grounds of the stocks occurring in the MBNMS are primarily in southern California and Baja California. Young-of-the-year and yearling sardine, hake, jack mackerel, and Pacific mackerel are much more common in southern California than in the MBNMS. This is important in terms of the claims made in the White Paper because many of the birds that prey on the dominant forage fishes feed

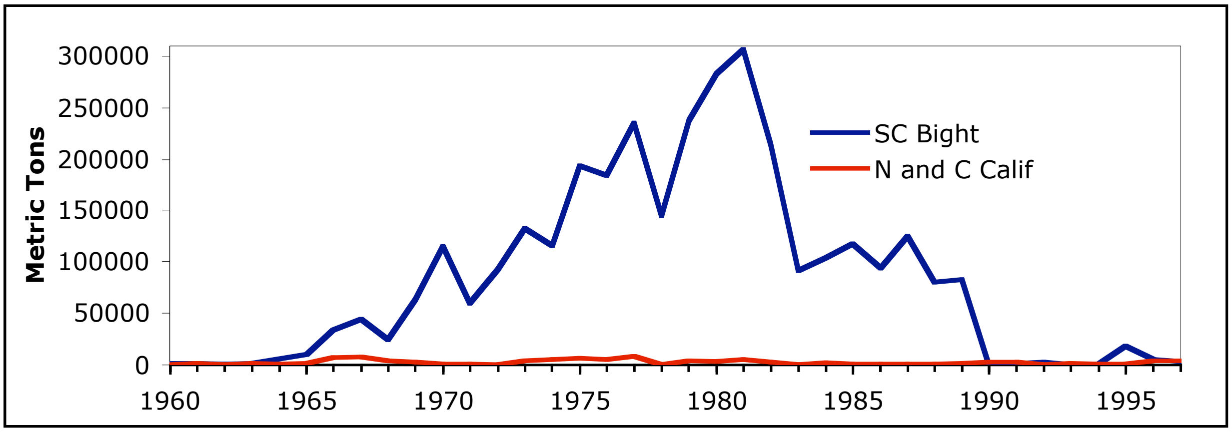


Figure 1. Anchovy landings during the peak of the fishery in the southern California Bight vs. central and northern California.

primarily on small fishes. According to Parrish et al (2000)* “adult sardines are large enough to escape seabird predation, potentially falling prey to only the largest species of gulls, cormorants, pelicans and albatross. However, these seabird species make only a minor proportion of the total seabird biomass (15%) and they are not capable of feeding on adult sardine.” Note that adult hake, jack mackerel and Pacific mackerel are much larger than adult sardine and even less likely to be consumed by most sea birds.

To visualize this take a look at the beaks of brown pelican and marbled murrelet on page 23 of the White Paper. The pelican is obviously equipped to eat 10-inch adult sardines, the marbled murrelet is not. The short description of the murrelet includes the word sardine 5 times. The unstated take-away message is that this species declined because of the collapse of the sardine fishery and it likely will not recover if we fish sardine. In contrast, an extensive review (Burkett 1995) of the food habits of marbled murrelet from Alaska to California provides a table describing the species found in the diet of marbled murrelet from 26 different food habit studies. Only one of these studies found sardine in their diet. And this is apparently the study that provided the information used in the White Paper. Burkett provides a quotation from this 1910 study:

“Field notes from work by R. H. Beck in the vicinity of Point Pinos, Monterey County, were included in Carter and Erickson’s (1988) report and are repeated here (Museum of Vertebrate Zoology; see also Beck 1910): “...the Marbled Murrelets yesterday [had in their stomachs] 2, 3, 4, or 5 small sardines [*Sardinops sagax*] about 3 inches long” (November 24, 1910); four days later, 13 murrelets were collected (November 28, 1910), and Beck noted, “Sardines 2 to 3 inches long in stomachs” (page 232)

The Burkett review also provides an excellent section on the rise and fall of the sardine and anchovy populations and the historical management their management. Below are two pieces from this section.

“Because of the natural fluctuations in anchovies and sardines as shown from the scale-deposition studies, murrelets probably evolved to use this resource in proportion to availability. Thus, the periodic lows in anchovy and sardine populations would probably not adversely affect

the murrelet as long as alternative forage fish remained available. Development of new fisheries (sand lance or euphausiids) and escalation of harvests for rockfish and herring would be expected to affect murrelets, especially in conjunction with a low period of anchovies and sardines, and El Niño events." (page 238).
"The low occurrence of sardines in the diet of murrelets is interesting given the wide geographic distribution of this fish" (Page 238)

The low occurrence of sardines in the diet of murrelets is due to the fact that 2-3 inch sardines are not commonly found in central California or further north, as will be described later.

It is difficult for me understand why the White Paper's authors presented such a biased and misleading profile on marbled murrelet. Whatever the reason, the profile for marbled murrelet reflects very poorly on the science standards of the MBNMS's CWG and any experts on birds who reviewed the original version of the White Paper.

The White Paper correctly points out that many predatory species come to MBNMS to feed on forage fishes. I note that many of the predatory species that they highlight are warm water species that usually occur in the MBNMS during the late spring to early fall when surface temperatures are the highest. It would seem that if this were true it would be a very good idea for the forage fishes to get out of the MBNMS during this period. And, that is exactly what hake, sardine, and jack mackerel do; they go north to their feeding grounds off of the Pacific Northwest during the summer and fall. The reason that planktivors migrate to the north is not to avoid the tourists but because that is where the primary production 'hot spot' is. Primary production is at a maximum during the spring to fall off the area between the Columbia River and Vancouver Island; levels are much lower off of northern and central California and even lower off of southern California and Baja California (Figure 2).

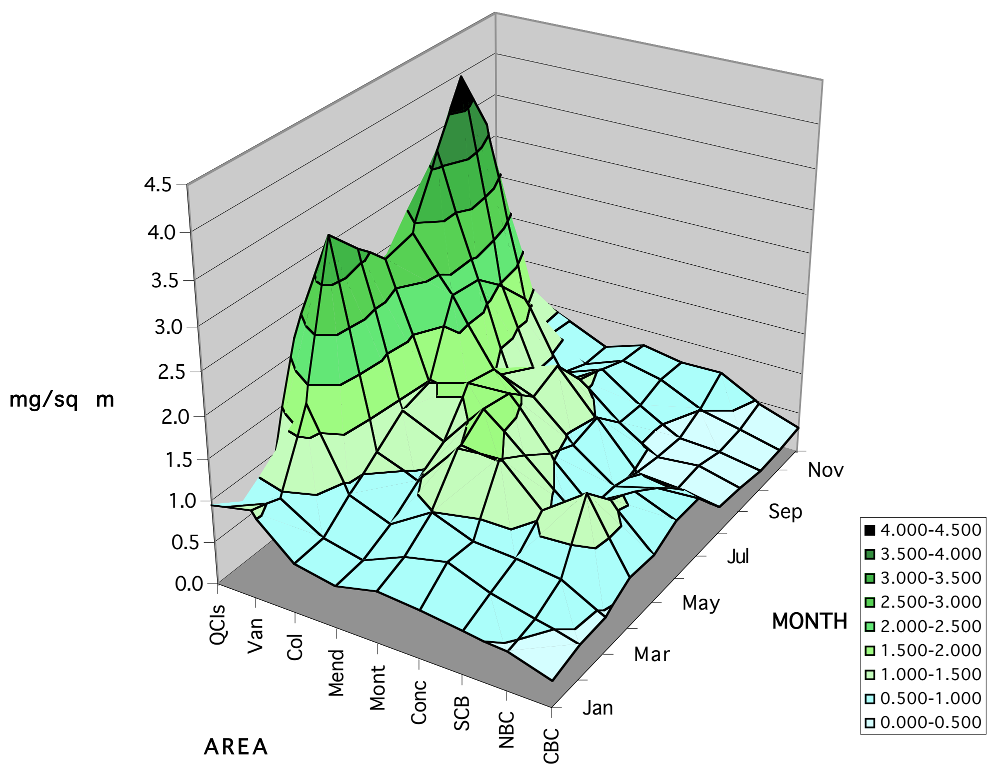


Figure 2. Satellite chlorophyll in the California Current. Queen Charlotte Islands (QCIs) to Central Baja California (CBC). Data provided by Cara Wilson NMFS Pacific Grove.

Clearly the 'forage destination' for forage fish is the OCNMS not the MBNMS.

MIGRATORY BEHAVIOR

The White Paper shows several figures showing the movements of their highlighted predators; they fail to provide similar information for the forage species that the Paper is supposed to be about.

It was pointed out decades ago that the upwelling maxima of the California Current (i.e. Point Conception to Cape Blanco) has very unfavorable oceanographic conditions for the successful reproduction of fish species with pelagic eggs (Parrish et al 1981). Offshore transport and turbulent mixing are apparently too intense for early life history stages to survive and drift to favorable nearshore nursery grounds. This original study was followed by a comparative analysis of the breeding and nursery grounds of the anchovy and sardine stocks of the world's four major eastern boundary currents (Parrish et al 1983). This analysis showed that in each current system, spawning grounds were located in regions with low upwelling and low turbulent mixing and areas of high upwelling and turbulent mixing were avoided. Spawning areas are also located in areas where larval transport would place juveniles in favorable low wind stress nursery grounds. Anchovy are quite small and unable to make the extensive migrations commonly observed in sardines. Therefore when population sizes are large the centers of biomass occurs within and near the favorable spawning and nursery grounds. When sardine populations are small their center of biomass is also in these same favorable areas. However when sardine population outbreaks occur their center of biomass occurs in areas of higher food production this is pole-ward in the Japan, California, Peru/Chile and Canary Current populations, and into the upwelling maximum region from both directions in the south Africa populations (Parrish et al 1989).

Wind speeds have a major affect on the distribution of young-of-the-year and yearling forage fishes that have pelagic eggs. Low wind speeds (i.e. low offshore transport and low turbulent mixing) are associated with abundant populations of juvenile and small fishes in the low latitude nursery grounds and they are uncommon in regions with high wind speeds and intense upwelling. This has a generally unappreciated affect on the birds that breed in the upwelling centers such as the MBNMS as this region has very low concentrations of juvenile forage fishes in comparison with southern California and Baja California It may also be a major factor in the breeding grounds of the California sea lion which are also south of Point Conception.

The seasonal migration pattern between lower latitude spawning grounds and higher latitude feeding grounds for Pacific hake (Figure 3) is the same pattern found in sardine and to a lesser extent jack mackerel. Some Pacific mackerel also migrate into the Pacific Northwest during the summer; however, both Pacific mackerel and anchovy tend to be more common in southern California and Baja California than north of Point Conception. In southern California small anchovies are most common in shallow near-shore waters and larger anchovies move offshore into deep-water areas (Parrish et al 1985).

The spawning grounds for hake, sardine and jack mackerel are heavily dependent upon sea surface temperature with spawning concentrations occurring off Baja California during cold years (Figure 4a) and further north during warm years (Figure 4b). In warm years the northern edge of the spawning grounds extends into central California; however, eggs are primarily excluded from the nearshore area and the principal concentrations of eggs is from 40-200 km offshore (Figure 4b). The prevailing larval drift patterns from the southern spawning grounds are southeastwards and the California nursery grounds for all five species are in the Southern California Bight. It is not until the fish are two and three years old that they occur north of Point Conception in large concentrations.

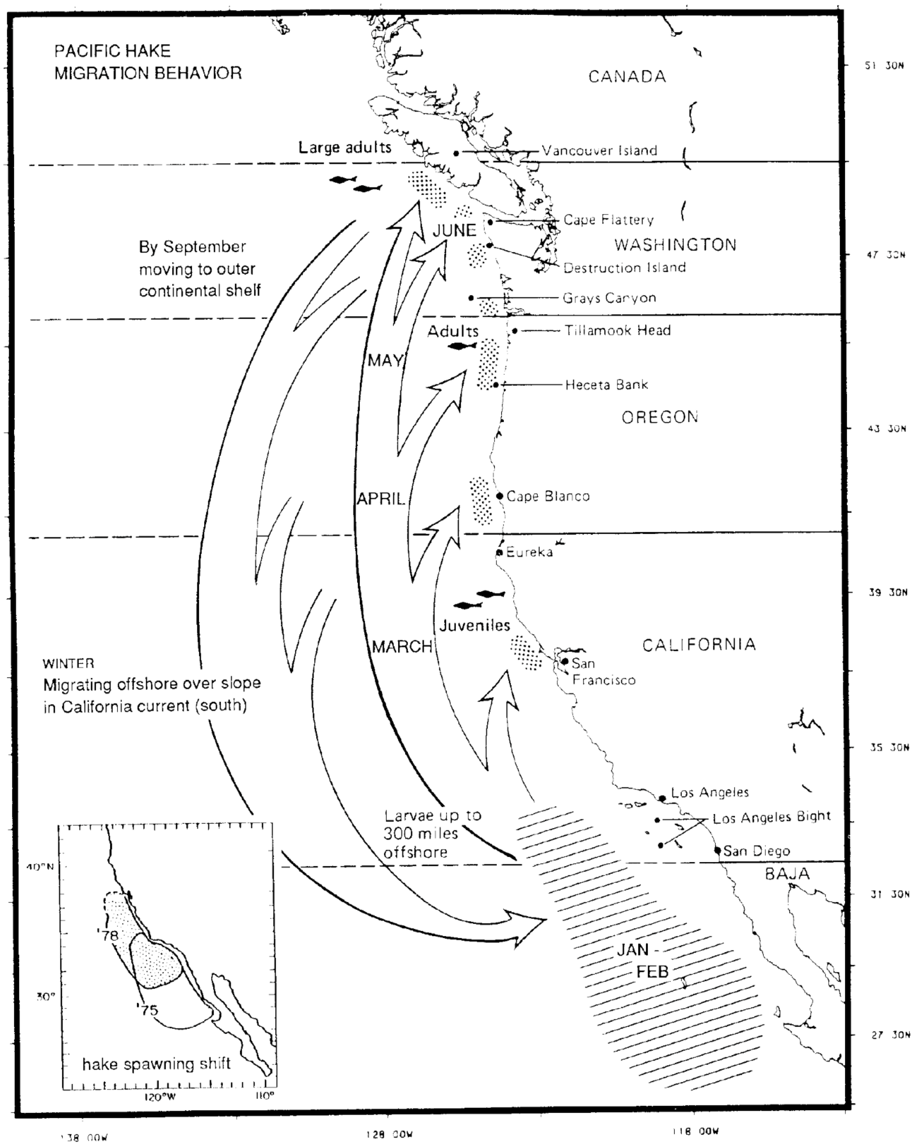


Figure 3. Migration of the Pacific hake. From Bailey et al (1982)

The central stock of anchovy is most abundant in the southern California Bight and the northern stock is more abundant in the Pacific Northwest. As a result anchovy abundance is at a minimum in northern and central California. Anchovy, due to their small size do not have the swimming capacity of the other 4 species; however, tagging studies show some larger anchovy tagged in southern California moved as far as central California.

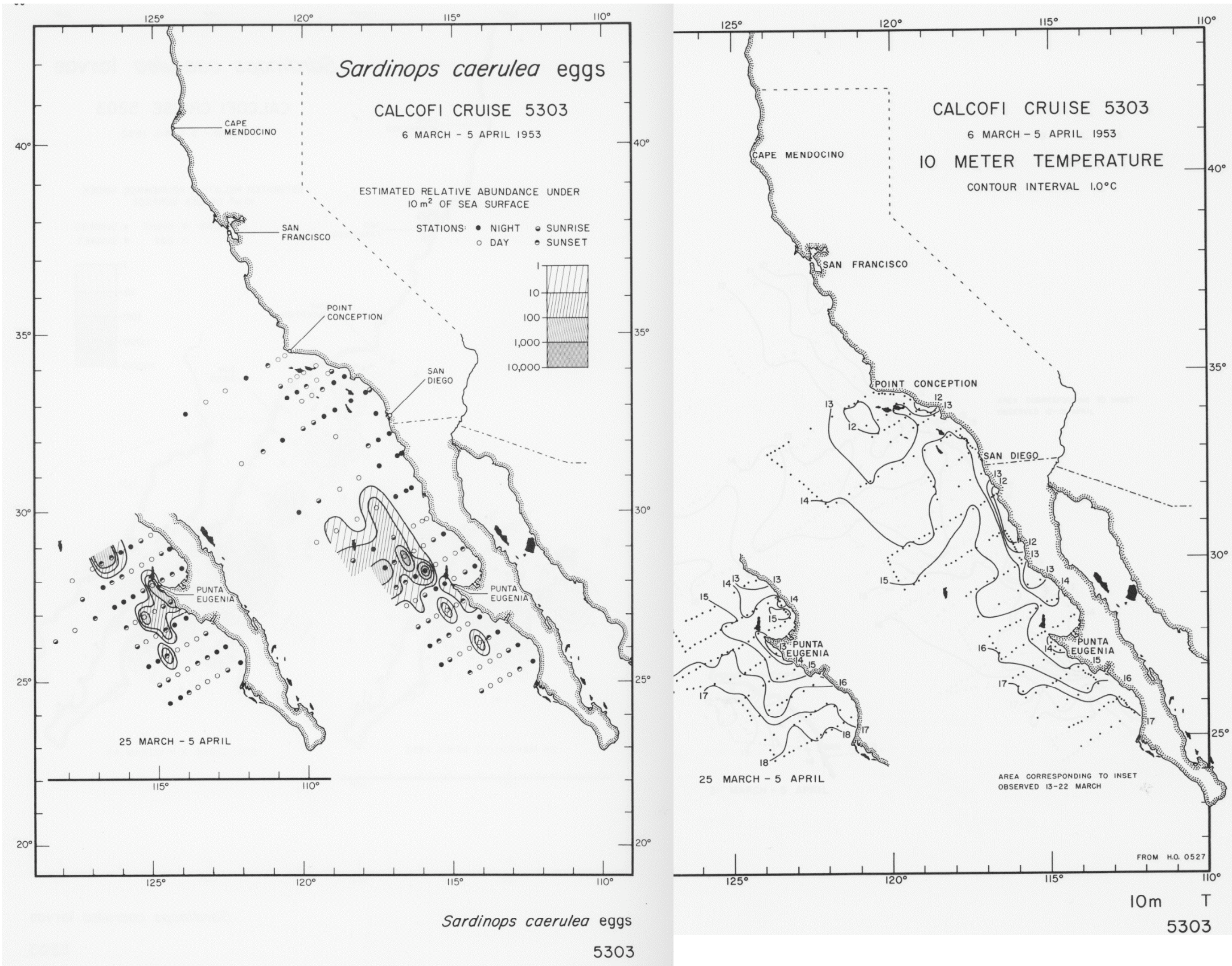


Figure 4a. Sardine egg survey and sea surface temperature charts (1953) during a cold regime.

The five species that dominate the fisheries and forage fish pools of the world's major upwelling ecosystems are generalists and generalists do not follow set rules. The material described above is the general pattern in the northern part of the California Current and environmental conditions often change the rules. During warm years some sardine have the audacity to spawn in their northern feeding grounds. Plastic life history patterns are common in these fishes, it allows them to cope and capitalize on the extreme variability in environmental conditions that occurs upwelling ecosystems. For example, anchovy have much faster growth rates in the inshore areas of southern California than in the offshore areas and rates are very low in Baja and very high in central California (Parrish et al 1985). Condition factors (relative fatness) in jack and Pacific mackerel are correlated with large-scale variations in circulation patterns (Parrish and Mallicoate 1995). All five species have very high fecundity and produce multiple batches of eggs at very short time intervals. For example, Macewicz and Hunter (1993) found that the average mature female jack mackerel spawned every 5 days and 8% spawned at 1-3 day intervals.

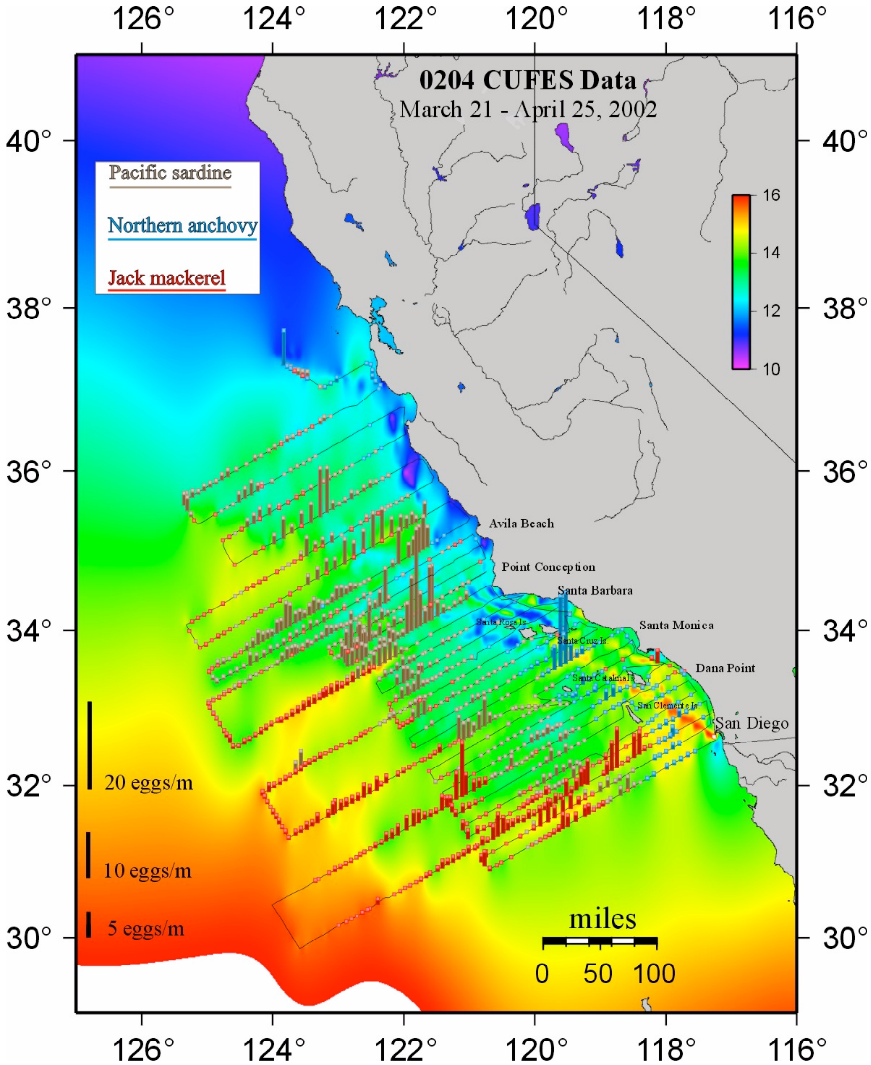


Figure 4b. Sardine egg survey (2003) during a warm regime.

The MBNMS is not prime breeding or nursery ground for forage fishes.

FISHERIES FOR FORAGE SPECIES

The dominant forage fishes of the California Current have their feeding grounds well north of the MBNMS and their principal spawning and nursery grounds south of the MBNMS; this significantly affects the fisheries for these species. The fishery for forage species in MBNMS is primarily carried out by purse-seiners that traditionally harvested sardines as they migrated from the northern feeding grounds to the southern spawning grounds. Sardines have very low availability to capture in the MBNMS during the late winter to early spring spawning season (Figure 4b) or during the northward spring migration to the feeding grounds off of Oregon, Washington and Canada because during this period the bulk of the fish are well offshore and wind speeds are often too high for successful seining.

Pacific mackerel, jack mackerel and anchovy have been important in the MBNMS in some years. However the fisheries for these species are much larger in southern California and Baja California than in central California. Anchovy was a major fishery in the MBNMS during the anchovy outbreak in the

1970s and early 1980s; but this fishery was quite minor in comparison to the fishery south of Point Conception (Figure 1).

Market squid are one of the most important fisheries in the MBNMS in terms of volume and as the market price for squid is higher than that for the other forage species it is even more important in terms of value. The average life span of market squid is only 6 months and they die after spawning. Individual squid can lay up to several thousand eggs. Squid landings and presumably populations are extremely sensitive to environmental factor. Landings typically fall to extremely low levels during major El Ninos. The squid fishery in the MBNMS is based on harvesting squid after they have concentrated on near-shore spawning grounds and the squid taken in the fishery would be dead a week or two later if they were not harvested. This causes fishery management for squid to be completely different than that for forage fishes. Population assessments are not likely to useful because they would have to be made every couple of months and unless the assessments could be made very quickly the squid would be gone before the results could be used for management. Annual catch quotas are enacted, but quota management is not a particularly good management strategy with market squid because if the population is high large numbers of eggs will be deposited; however, if the population is small any reasonably large quota will not be caught and therefore the quota provided no protection. In essence a quota on market squid stops fishing when it does not need to be stopped and it does not stop fishing when it should be stopped. Therefore, management and recent research has concentrated on egg escapement with time and area closures (weekend closures and State MPAs in the MBNMS) designed to allow more than 30% of the eggs to be deposited on the bottom. The fishery also has fishing effort limitations on the number of boats that can fish that add additional protection.

Hake presently produce the largest fishery in the California Current; they are primarily captured with trawl nets in the Pacific Northwest. There has not been a significant hake fishery in the MBNMS since the departure of the USSR fleet in the 1970s.

LANDINGS

The White Paper provides no information on:

1. The landings of forage fishes in the MBNMS.
2. The total landings of forage fishes in the California Current.
3. The landings of individual forage fishes.
4. Comparisons of the MBNMS landings of forage fishes to other areas.

The only landings information given in the White Paper is the following figure (Figure 5). The authors use this figure to suggest that landings of forage species has been increasing sharply and that this increase is a serious cause of concern to the ecosystem of the MBNMS. However, they are apparently so unfamiliar with the fisheries of California that they did not remove the large volume of tropical tuna landings that produces the visual effect of increasing fisheries for the CPS species (i.e. Highly Migratory in their figure). The bulk of the highly migratory species landed in California in the 1980s were tropical tuna caught outside of the California Current Ecosystem, in the Eastern Tropical Pacific, the Western Tropical Pacific and even in the Atlantic. To include skipjack and yellowfin tuna landings of fish caught in tropical ecosystems, then present landings as percentages completely bias the pattern of landings of coastal pelagics in author's figure.

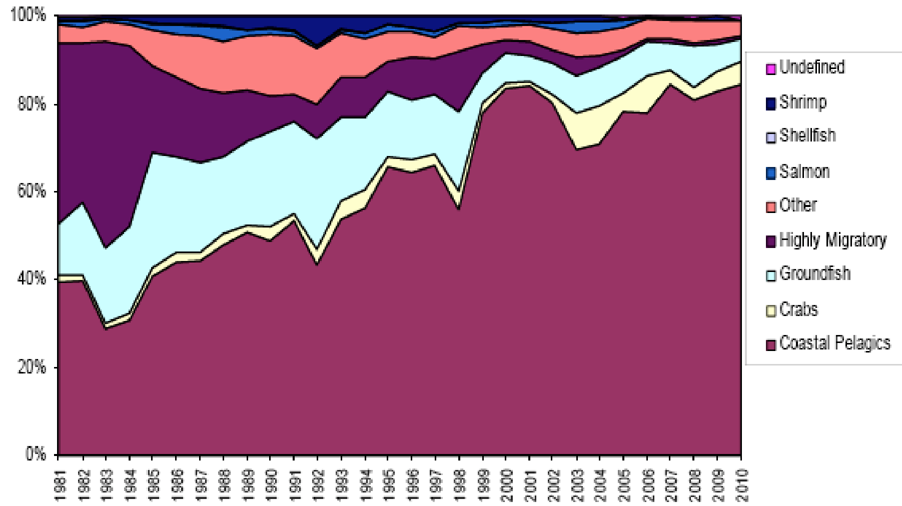


Figure 5: Relative contribution of species groups to total California landings by weight. Data source: Pacific Fisheries Information Network (PacFIN).

If the authors wanted to show that landings of forage species is increasing at a dramatic rate in the MBNMS they should have presented a time series of the landings of forage species in the MBNMS.

Of course any real analysis of the landings of forage fishes should include both the landings in the MBNMS and the landings in the California Current Ecosystem. Landings from any single region are likely to have both spatial and temporal bias.

What would the author's have found if they had looked at the landings of forage fishes in the MBNMS?

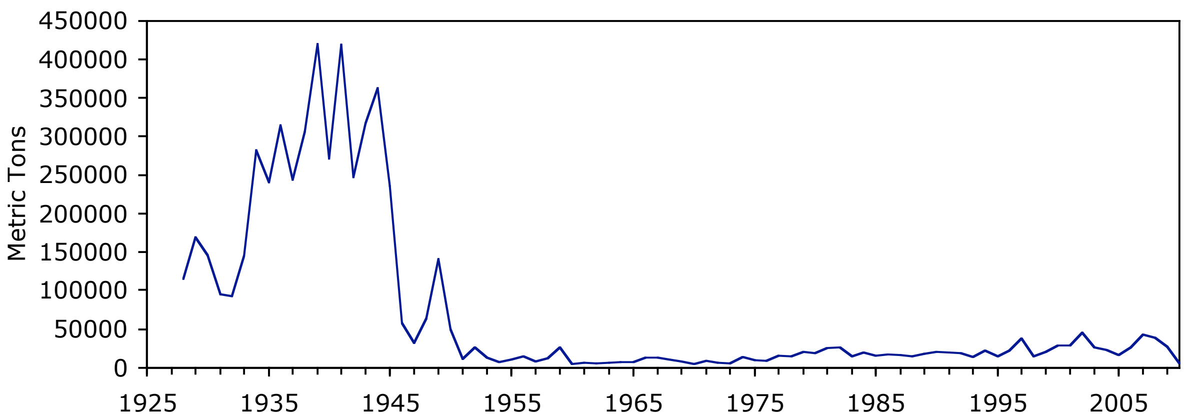


Figure 6. Total landings of sardine, anchovy, herring, squid, Pacific mackerel, jack mackerel, and hake in the Monterey and San Francisco Port Areas*.
* Data from live access server at NMFS Pacific Grove and California catch statistics.

A plot of the landings of forage fishes in the MBNMS shows that landings averaged over 300,000 MT during the peak of the sardine fishery in the 1930s and 1940s; then with the collapse of the sardine population landings declined to a level of less than 20,000 MT for several decades and then rose slightly after about 1995 (Figure 6). The massive reduction in landings associated with the collapse of the sardine population would be expected to have caused very serious ecosystem alteration if the White Paper's thesis is correct. Presentation of the evidence of significant ecosystem impacts would certainly strengthen the Paper's thesis. Why did they not provide this evidence?

Given that there appears to be a modest increase in the landings of forage fishes in the MBNMS it seems pertinent to see which species are responsible for the increase; and, surprise, surprise the species that has had the increase is the sardine (Figure 7). So the author's concerns that increasing landings may cause negative effects on ecosystem predators are completely false. The increased landings were caused by a more than 100-fold increase in the population size of sardines. The population size of age 2+ sardine was 6,000 metric tons in 1983 and 988,385 in 2011 (Hill et al 2012). What the White Paper presents as a negative is most certainly a positive for both the fishermen and the ecosystem. Perhaps if the authors had presented the stock assessment of California sardine instead of Peruvian sardine they would not have made this error.

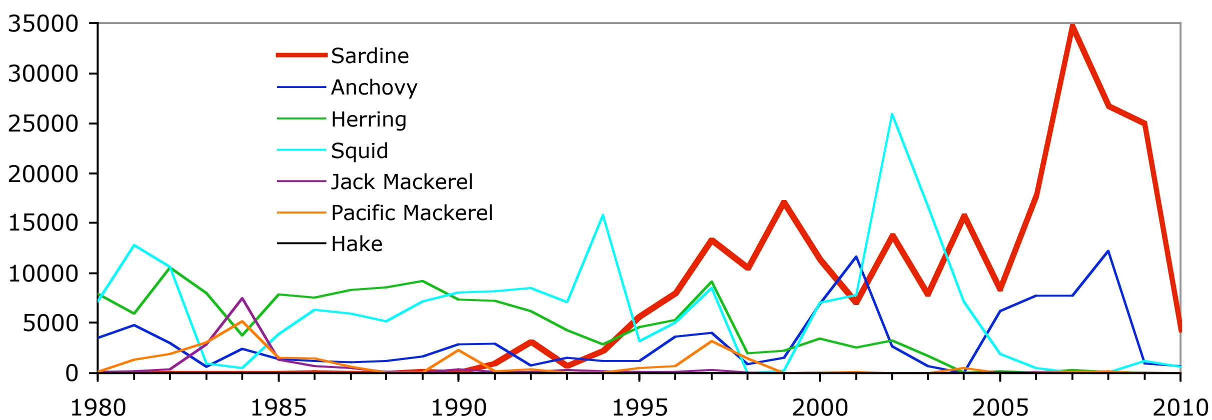


Figure 7. Landings of sardine, anchovy, herring, squid, Pacific mackerel, jack mackerel, and hake in the Monterey and San Francisco Port Areas.

Concern over the percentage of forage fish landed in the California Current does merit discussion. Unfortunately the White Paper provides no analyses that would assist in the determination of what percentage of the California Current landings should be forage fishes. The White Paper also completely ignores the basic fact that the annual production of biomass decreases by about a factor of 10 with each upward step in trophic level. In this regard the authors should have informed their readers that the annual production of forage species is about 10 times the annual production of their predators and that the sustainable yield of forage species is about 10 times the sustainable yield of their predators.

This is why both the fisheries in the world's major upwelling ecosystems and the World's landings are dominated by planktivors instead of high-trophic level fishes.

This is why terrestrial ecologists are encouraging people to eat lower on the food chain! The White Paper appears to suggest the opposite.

THE AUTHOR'S CLAIM THAT THE MBNMS IS A 'HOT SPOT' FOR FORAGE SPECIES:

To back up this claim the authors should have made some comparison to the amounts of forage species in other areas. Landings are a quick way to do this. The 2010 landings of major forage fishes in the MBNMS could be used to give the readers some perspective on the validity of the MBNMS "hot spot" concept from a global perspective. Based on the most recent FAO landing statistics Pacific mackerel had the 4th highest landings, California sardine was the 15th., Pacific saury was 21st, Pacific herring was 38th, and Pacific hake was the 49th. . The California jack mackerel and northern anchovy did not make the FAOs 2010 list of the most important species; however, for comparison the closely related Chilean jack mackerel was the 14th most important (728,301 mt) and although their 2010 landings are much reduced from previous years the Peruvian anchovy was still the most important (4,205,976 mt). Total international landings (2010) and the landings in MBNMS of 7 important forage fish species occurring in the MBNMS are given in Table 1.

	Pacific Mackerel	California Sardine	Pacific Saury	Pacific Herring	Pacific Hake	California Jack Mackerel	Northern Anchovy
MBNMS	4 lbs	4,305 mt	0 lbs	0 lbs	0 lbs	0 lbs	683 mt
Total	2.201.334 mt	696,585 mt	457,584 mt	331,094 mt	210,409 mt	705 mt	4,607 mt

Table 1. Total and MBNMS landings (2010) of the most important forage fish species in the California Current. (Total landings are from the FAO 2010 Fishery Statistics. MBNMS landings include San Francisco and Monterey Port Areas from the California catch statistics).

Had the authors of the White Paper bothered to look at the readily available FAO and California landings statistics before writing their advocacy claims they would have found that landings of the above 7 fish species in the MBNMS in 2010 was only 0.13 % of their total landings (4,988 vs. 3,902,318) almost all of the forage fish landed in MBNMS ports was California sardine (4,305 mt). Did they noticed that Mexico caught 630,221 mt of California sardines?

How can the MBNMS be a 'hot spot' for forage species when the fishery for them is tiny?

How can this tiny fishery be a threat to the ecosystem when it only takes 0.13% of the annual landings of the 7 most important species?

Of course, landings can be misleading and this is exactly what occurs in the above data. The absence of landings for many of the species cannot be considered evidence that there are no forage fishes in the MBNMS. A real analysis of the forage fishes should include time series data from stock assessments of the most important forage fishes. Time series are available for sardine, hake, anchovy, shortbelly rockfish and herring. Unfortunately the author's neglected to do this.

FISHERY MANAGEMENT

Stock assessments and fishery management: The White Paper's treatment of fishery management is simply inadequate. There is no discussion or presentation of readily available estimates of maximum sustainable yield for the 5 major Coastal Pelagic Species (CPS). There is no coherent description of the way the Federal management manages fisheries including Overfishing Limits (OFLs), Acceptable Biological Catches (ABCs), Annual Catch Limits (ACLs) or Harvest Guidelines (HGs). There is no mention of the differences between actively managed and monitored species. There are only two comments on stock assessments for California Current forage fishes (both very negative in tone). No information is presented for the species that have current stock assessments and there is no description of the very extensive fishery analyses that forms the basis for management of forage species by the PFMC. There is no mention of effort restrictions.

The authors have chosen to include an extensive treatment of the use of forage fishes for reduction into fishmeal and oil and the author's opinions on the detrimental affects of this practice; however, they do not mention that there are no reduction plants in California. They also do not explain how demand for fish meal and oil will increase the fisheries for forage fishes in California. Do they want to imply that annual quotas are based on demand rather than stock assessments and harvest control rules that are based on the 'best available science' and heavily peer reviewed both by STAR panels and the Science and Statistics Committee of the Pacific Fisheries Management Council?

Of course, this is essentially what they do imply. The bias in the White Paper is clearly evident in the following extract from the profile for the mackerels.

"The status of the jack mackerel population off the U.S. Coast is unknown, and the Pacific mackerel assessment is highly uncertain. Despite this uncertainty, federal managers allow commercial and recreational fisheries, mostly off of central and southern California to take 31,000 metric tons of jack mackerel per year and 11,000 metric tons of Pacific mackerel."

The authors suggest that much of the 11,000 mt of Pacific mackerel and 31,000 mt of jack mackerel that the Council allows the fishermen to take are from central California. If they had looked at recent landing statistics they would have found that in 2010 only four pounds of Pacific mackerel and zero pounds of jack mackerel were landed in central California (Table 1). Of course, based on the information they presented in the White Paper it is possible that the authors did not know what the recent landings have been.

Rather than focusing on the bias evident in the above statement on the mackerels I will instead attempt to do what the White Paper does not do. Put the management of the mackerels into context.

What should have been presented regarding stock assessments, management reference points and forage species? .

There should have been a discussion of the differences in management of actively managed species and monitored species and an explanation for the reason for the differences.

There should have been brief descriptions of the most important management reference points that form the basis of federal fishery management,

For example:

OFL The overfishing limit is equal to the maximum long-term yield (MSY) from a stock.
ABC The acceptable biological yield is the OFL reduced to account for scientific uncertainty.
ACL The annual catch limit is the ABC reduced to account for ecological, economic and social optimum yield considerations. PFMC (Supplemental CPSMT Report 2, November 2010)

For example:

PFMC Control rules for monitored CPS species

OFL	Stock-specific MSY proxy
ABC	OFL * 0.25
ACL	Equal to ABC or reduced by OY considerations.

Current control rule values and most recent catches in metric tons.

	Jack Mackerel	Anchovy Northern Stock	Anchovy Central Stock
Biomass	1,000,000		
OFL	126,000	39,000	100,000
ABC	31,000	9,750	25,000
ACL	31,000	1,500	25.000
U.S. Catch (2010)	310	242	1,847

If the authors had shown scientific rigor they might have altered their negative comment about the 31,000 mt ABC for jack mackerel. As seen in the information above the estimated biomass for jack mackerel is 1,000,000 metric tons, the MSY (OFL) is 126,000 mt and the SSC and PFMC set the ABC at 25% of the MSY estimate specifically to account for the lack of a current stock assessment. If the authors did not know that the current ABC was set at 25% of the MSY (OFL) estimate and that the most recent total catch was only 1% of the ACL and 0.2% of the OFL they were lazy. If they did know this they were actively misleading the public.

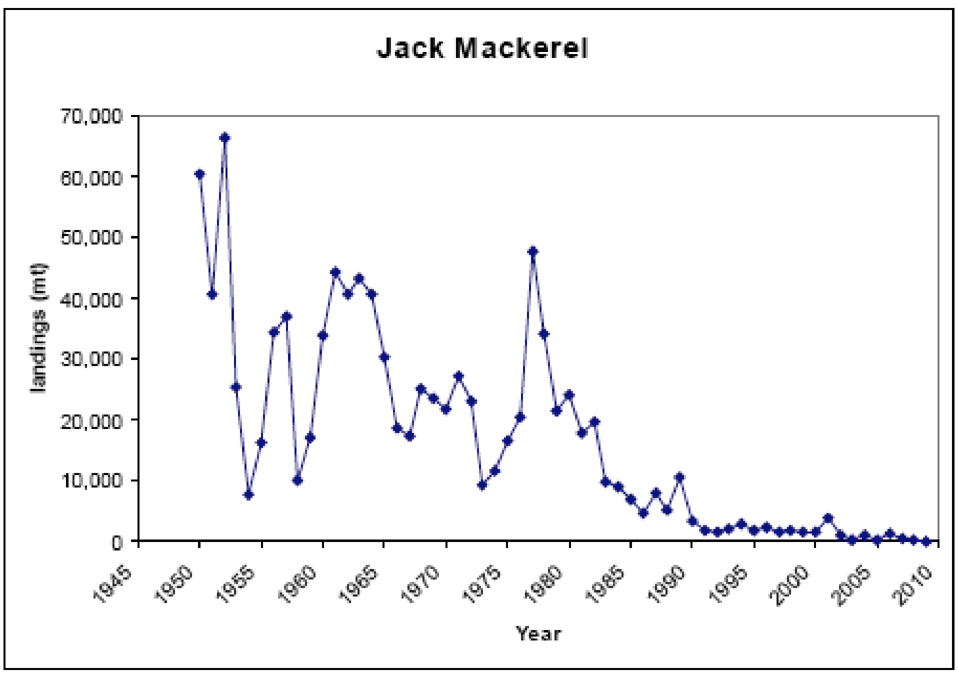


Figure jm US landings of jack mackerel

If the authors had shown the US landings of jack mackerel it would have been obvious why jack mackerel is a 'monitored' species. The landings are so low, and also so geographically restricted that they cannot be used to make a valid stock assessment. A quick look at Figure 4b will show that jack mackerel eggs are very abundant and spread over thousands of square miles of ocean 80 to 200 miles off of Southern California.

It is certainly valid to point out that there are no current stock assessments, that population sizes are not well known and that management reference points for jack mackerel are therefore suspect. When this is combined with the failure to show a time series of the US landings, a lack of knowledge or interest in the reasons that the landings are so low I can see more bias than validity.

MONITORED AND ACTIVELY MANAGED SPECIES

The original authors of the Coastal Pelagic Species Management Plan, realized that landings of jack mackerel, central stock anchovy and northern stock anchovy were so low that the cost of producing stock assessments would be larger than the landed value of the catch. They realized that stock assessments of squid were not technically feasible. They convinced the Council that the most practical policy was to monitor the landings of jack mackerel and anchovy and if landings showed an increase the stock would be moved to active status, like sardine and Pacific mackerel and stock assessments would then be made. Sardine and Pacific mackerel are relatively short-lived species, their populations are heavily altered by 2-3 year periods of favorable or unfavorable environmental conditions and they have significant fisheries. Therefore stock assessments are made each year for these fisheries. Many of the groundfish species are very long-lived, their population levels change much more slowly and stock assessments are not carried out on an annual basis for their fisheries. Hake is the largest US fishery in the California Current and stock assessments are made annually.

The White Paper has critical comments on the Pacific mackerel stock assessment but they apparently did not think that the stock assessments that have been made for hake, sardine, central stock anchovy, shortbelly rockfish and herring were important enough to mention.

DISCUSSION OF CURRENT FISHERY MANAGEMENT.

The White Paper provides no favorable discussion of the current fishery management of forage fishes with the exception of species for which the PFMC has prevented any directed fishery (krill) or stocks that have greatly reduced quotas (shortbelly rockfish). They have avoided including a number of peer reviewed studies on fishery management in the California Current ecosystem that demonstrate the conservative management in this ecosystem. They do not mention several recent ecosystem analyses that have shown that ecosystem function is not highly affected by fisheries on forage fishes in the California Current. They not mention recent studies that state that forage fishes have moderate susceptibility to overfishing. They do not show the available stock assessment for shortbelly rockfish that shows this population collapsed during a period of unfavorable environmental conditions when there was no fishery on the species. They do not tell their readers that this is one of the reasons that the abundance of larval rockfishes is reduced in central California.

If the authors had presented the reasons for the separation of actively managed and monitored species it would have been clear to the reader why the PFMC has set a low priority on the development of expensive stock assessments for the monitored stocks. If they do not know the reasons they might have asked someone with a fisheries background. It should have been clear that to compensate for the lack of annual stock assessments the PFMC set ABC at 25% of the best available OFL/MSY estimate (126,000 mt). Compare the above information for jack mackerel with the highly biased statement quoted above from the White Paper. Why didn't the authors tell the reader that the ABC was set at

25% of the OFL because current biomass assessments are not available? Why didn't they inform the reader that there is an older stock assessment, partially based on egg abundance, that estimated the unfished biomass of jack mackerel at 14.8 to 18.1 million metric tons.

The White Paper approves of the allowed harvest rates for krill and shortbelly rockfish and is critical of the allowed harvest rates of the other CPS species. As seen in Table 1 the estimates of the MSY harvest rates is 12.9% for jack mackerel, 18% for sardine and 30% for anchovy and Pacific mackerel. The Federal catch limit for the northern stock of anchovy allows fishermen to take 1.5% of the population per year and the rate for jack mackerel is 3.1% per year. Although these rates are a small fraction of the estimated harvest rates at maximum sustained yield they are apparently not small enough for the authors of the White Paper.

Sardine is the only species that had 2010 US landings larger than 1% of the estimated 2011 biomass. The White Paper takes exception to the management of jack mackerel yet the present harvest rate of jack mackerel is only slightly higher than that for shortbelly rockfish (i.e. 0.003%)..

SPECIES	MSY Harvest Rate	US ACL Harvest Rate	US 2010 Harvest Rate	Total 2010 Harvest Rate
Krill	NA	0%	0.000%	
Shortbelly Rockfish	NA	< 0.3%	0.001%	
Anchovy Northern Stock	30.0%	1.50%	0.186%	NA
Jack Mackerel	12.6%	3.10%	0.003%	NA
Anchovy Southern Stock	30.0%	7,50%	0.550%	NA
Sardine	18.0%	11.1%	6.760%	14.76%
Pacific Mackerel	30.0%	14.4%	0.997%	NA

TABLE 1. 2011 MSY, ACL ACT, HG AND 2010 harvest rates for California Current forage species. (Biomass estimates for the anchovy stocks are not available so ACL and 2010 harvest rates are based on multiplying OFL by 3.33 based on PFMC comments that the maximum yield of anchovy was the same as Pacific mackerel. Probably this is not a good idea but it does allow rough estimates of the assumed rates for comparative purposes.

The White Paper approves of harvest rates that are as close to zero as possible (i.e. 0.000% for krill and 0.001% for shortbelly rockfish) and disapproves of actual 2010 harvest rates that were as low as 0.003% (jack mackerel). It shows biased landings data that imply that landings of CPS species are increasing rapidly in the MBNMS, suggests that this will have huge implications on endangered species and photogenic animals, but fails to tell it's readers that the combined jack and Pacific mackerel landings in MBNMS ports in 2010 was 4 pounds. Sardine is the only species with a 2010 harvest rate that exceeded 1% of its 2011 population level with a MSY rate of 18% the US 2010 harvest rate was 6.76% and when the foreign catch is included it was 14.76%.

STOCK ASSESSMENTS

Stock assessments are only mentioned in a negative sense. The comment that the Pacific mackerel assessment is highly uncertain is apparently the unsupported opinion of the authors as there is no supporting reference. In fact, high quality stock assessments are available for 3 of the largest biomass forage species in the California Current (hake, sardine and Pacific mackerel). All three of these stock assessments were judged data rich by a recent review of scientific uncertainty of stock assessments in the California Current Ecosystem (Ralston et al 2011) and the PFMC is using the same coefficient of variation (CV=0.37) and uncertainty buffer P*=0.45 for Pacific mackerel as that used for the data-rich groundfish stock assessments. I do not suggest that the stock assessments are highly accurate; rather I suggest that they are no more imprecise than the large number of groundfish assessments currently available. Assessing how many fish are in the sea is not a precise exercise. As a friend of mine once said; counting fish is just like counting trees, except you cannot see them and they move.

The only stock assessments shown in the White Paper are stock assessments for anchovy and sardine in Peru. The authors need to explain why stock assessments in Peru are important enough to present; but stock assessments in the California Current are ignored. Perhaps the reason is that they used the figure is that it shows a sharp decline in Peruvian marine birds associated with the 4-12 million ton fishery in Peru.

I note that no time series of marine bird or marine mammal population levels are presented for the California Current. If evidence existed for a negative correlation between forage fish abundance or landings for the California Current why was this information not presented? If there is evidence to show that marine birds or mammals are having extended declines in their population size (as apposed to experiencing unfavorable years due to short-term environmental condition) why is there no data showing these declines. Not showing time series that have increasing trends in California and instead showing data with declining trends for Peru leads readers to invalid conclusions. Why didn't the White Paper include time series of the populations sizes of Stellar and California sea lions that show very large population increases over the past 3 decades? Why didn't they show time series of the most common marine birds?

POPULATION COLLAPLSES OF FORAGE FISH POPULAITONS

The White Paper states that scientists have recently concluded that forage species are likely to collapse.

"Conversely, scientists have recently concluded that forage species are just as likely, if not more likely, to experience fishery collapses than larger fish, often because managers tend to set more aggressive harvest rates for these species.24 "

This statement should have been reworded by replacing the word ' scientists' with "academic scientists from universities that do not offer courses in ichthyology or fishery management". In fact the frequent collapses of fisheries for forage species was so well known that in 1994 the Scientific Committee on Oceanic Research (SCOR) established a working group to look at the problem (SCOR WG-98 Worldwide large-scale fluctuations of sardine and anchovy populations). This group included fisheries biologists and oceanographers working on sardine and anchovy in Japan, California, Mexico, Ecuador, Peru, Chile, Australia, South Africa, Namibia and the Canary Islands and it produced three papers describing the problem of fishery collapses of forage fishes associated with regime-scale environmental variations (Lluch-Belda et al 1989, Lluch-Belda et al 1994, and Schwartzlose et al 1999), Again, the authors exhibit their limited backgrounds in fisheries.

SPECIES PROFILES

In my opinion, a White Paper on forage species should actually provide some information on the forage species and the information should have been presented before other subjects are discussed. The authors apparently do not think that information on the forage species life history, behavior, distribution and migrations are important enough to be included. Rather than point out an exhaustive list of what is not in the White Paper I will limit my comments to a single profile; mackerels.

Instead of providing information on the biology, migratory behavior, and population information on the mackerels the authors show the same bias shown throughout the White Paper. They use the mackerels to provide information on their predators and to point out the author's opinions on the Federal management of the species. The author's bias is clearly seen in a comparison of the profiles for the mackerels and the leatherback sea turtle. No biological, behavioral or distributional information is given for the mackerels; but a full-page map of the distribution of the leatherback is presented and their migration and food habits are described. While an interesting animal I see no reason that leatherbacks are even included in the Paper; the principal species in their died is not even mentioned in the White Paper's list forage species.

What should the authors have included in a profile of the mackerels?

For example:
Pacific mackerel are closely related to the tunas. They are short-lived (very few live more than 8 years); they are most abundant in Southern California and Baja California, although in warm years some adults migrate as far north as Alaska during the summer, Younger mackerel are primarily planktivors but adult mackerel consume considerable quantities of fishes and squids. Food habit studies in southern California showed that nearly half of the adult diet is anchovy, Emmett et al, (2001) cite a study in Canada that found that Pacific mackerel consumed nearly all of the salmon smolts released from a hatchery resulting in few returns from that brood year; however, Emmett's own study off of the Columbia River found that Pacific mackerel feed exclusively on invertebrates. Food habit studies in the Gulf of California found that more than 98% of the volume of food was fish larvae (primarily anchovy). Clearly Pacific mackerel are opportunistic predators that defy any attempt to describe their preferred diet. Pacific mackerel have extremely variable population levels with breakout type population expansions that persist for periods of up to a decade several times a century. The most recent stock assessment of Pacific mackerel, along with those of sardine and hake should have been included in a single figure; instead of the stock assessment figure for Peru.

For example:
Jack mackerel are members of the Jack family and not closely related to true mackerels; however, they are very similar in appearance and often school with Pacific mackerel. They are long-lived and have migratory behavior similar to that of sardine and hake. Their major spawning grounds are in southern California and they extend 100s of kilometers offshore (Figure 4b). Young jack mackerel (ages 1-4) are common in surface waters of their nursery grounds in southern California where they are taken in purse-seine fisheries. However, when the young adults enter the migratory phase they move offshore into deeper water where they are unavailable to the fishery older jack mackerel (ages 12-30) are common in the Pacific Northwest. No significant fishery for the offshore or northern segment of the population has ever occurred. It is estimated that the population size of jack mackerel is not less than 1,000,000 mt. however, an early assessment estimated that the unfished biomass was between 14-18 million mt.

ECOSYSTEM CONSIDERATIONS

The White Paper begins with a statement that will certainly mislead readers.

"The health and biodiversity of fish species, marine mammals, sea turtles, and seabirds of the California marine sanctuaries are dependent on the base of the food web. Small schooling fish and invertebrates like sardines, herring, squid, anchovy, smelts and krill are vital prey or "forage" for many larger species of fish and wildlife."

In fact, small schooling fishes are not the base of the food web. They are trophic level 3 or higher species that primarily feed on second trophic level zooplankton that feed on primary production.

The authors point out that the Lenfest report recommends that thresholds be used for the management of forages fishes (Pikitch et al 2012). It appears that the authors think that thresholds are a new and desirable fishery management strategy. The authors apparently do not know that thresholds were originally developed and used to manage California forage fishes in the early 1970s (Parrish and MacCall 1979). During the 1990s the use of thresholds in fishery management spread to the groundfish fisheries in the California Current and they are now mandated in the management of federally managed fisheries. The present harvest guideline for sardine was developed with a model that evaluated 20 different thresholds from 50,000 mt to 1,000,000 mt. The model clearly showed that low thresholds were a very desirable factor for sardine and that moderate and high thresholds resulted in a pulse fishery that closed the fishery for periods as long as 4 decades.

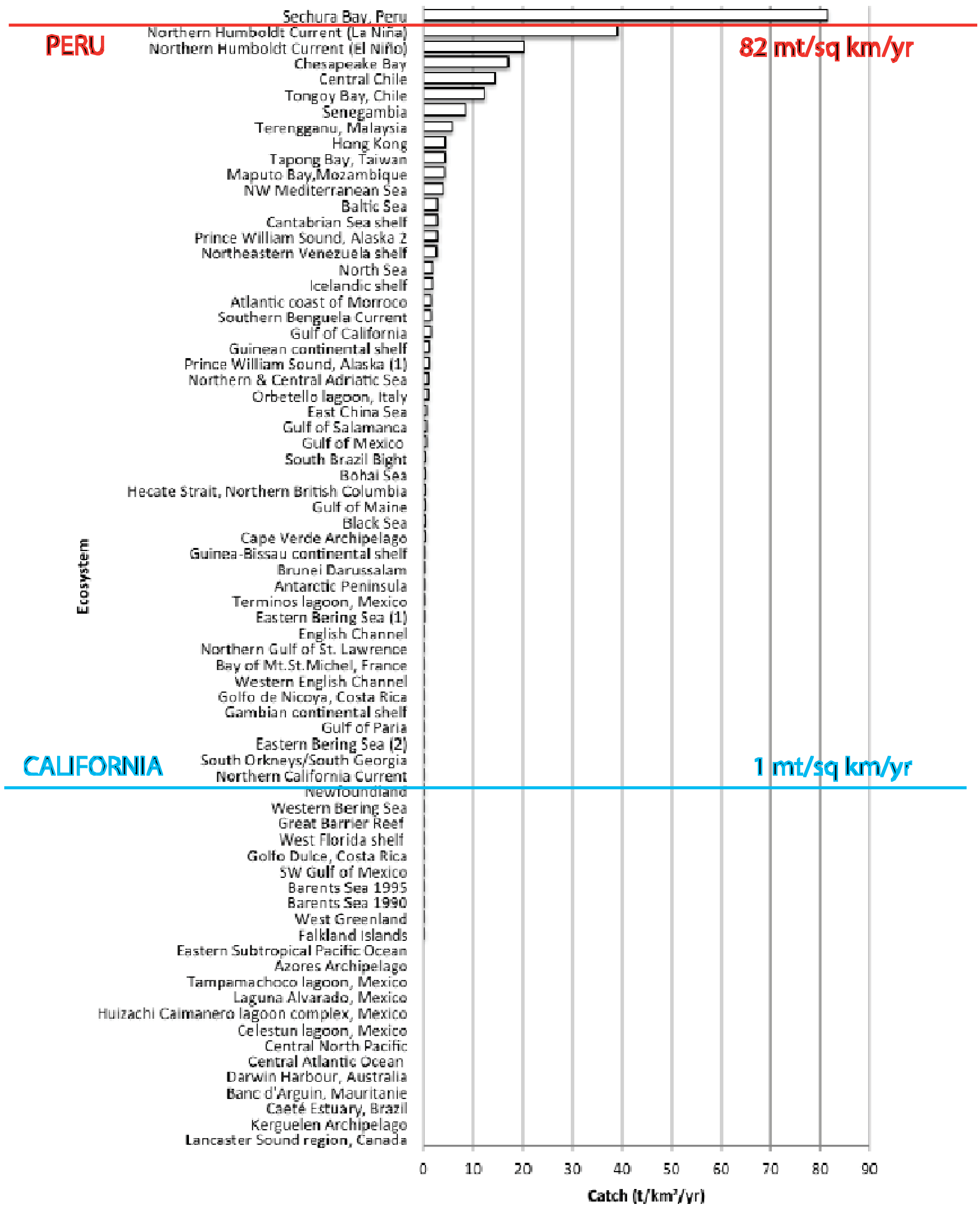
Although the authors used the Lenfest report they ignored information in the report that would have allowed a comparison of the fishery management of forage fishes in the California Current with those in 71 other marine ecosystems. One would think that this was exactly what the MBNMS would be interested in seeing. How are we doing compared with the rest of the world?

The Lenfest information, (Figures E5.1 and E5.5 reproduced below) shows that the Peru Current is the most productive for forage fishes and that the California Current is the second most productive of the ecosystems examined. The figures show that fisheries in the Peru ecosystem have been taking a huge percentage (77-96%) of the annual production of forage fishes (i.e. the Sechura Bay, and northern Humbolt ecosystems in figures E5.1 and E5.5). In California Current predators consume 98% of the annual production, only 2% percent is caught in the fishery. According to the Lenfest report California Current predators consumed 3 to 20 times as much forage fish per unit area as the predators of the other 71 ecosystems examined (Figure E5.5).

I note that according to the information in the White Paper the consumption of forage by the common murre (225,000 mt) is twice the size of the average landings of sardine during the last decade and there was no evidence presented showing that the population size of the common murre has declined. This appears to be the reason that the authors use a time series of marine bird and forage fish populations for the Peru Current rather than time series from the California Current. The fishery in the Peru Current has had huge impacts on marine birds; where are the time series comparing bird and forage fish populations in the California Current?

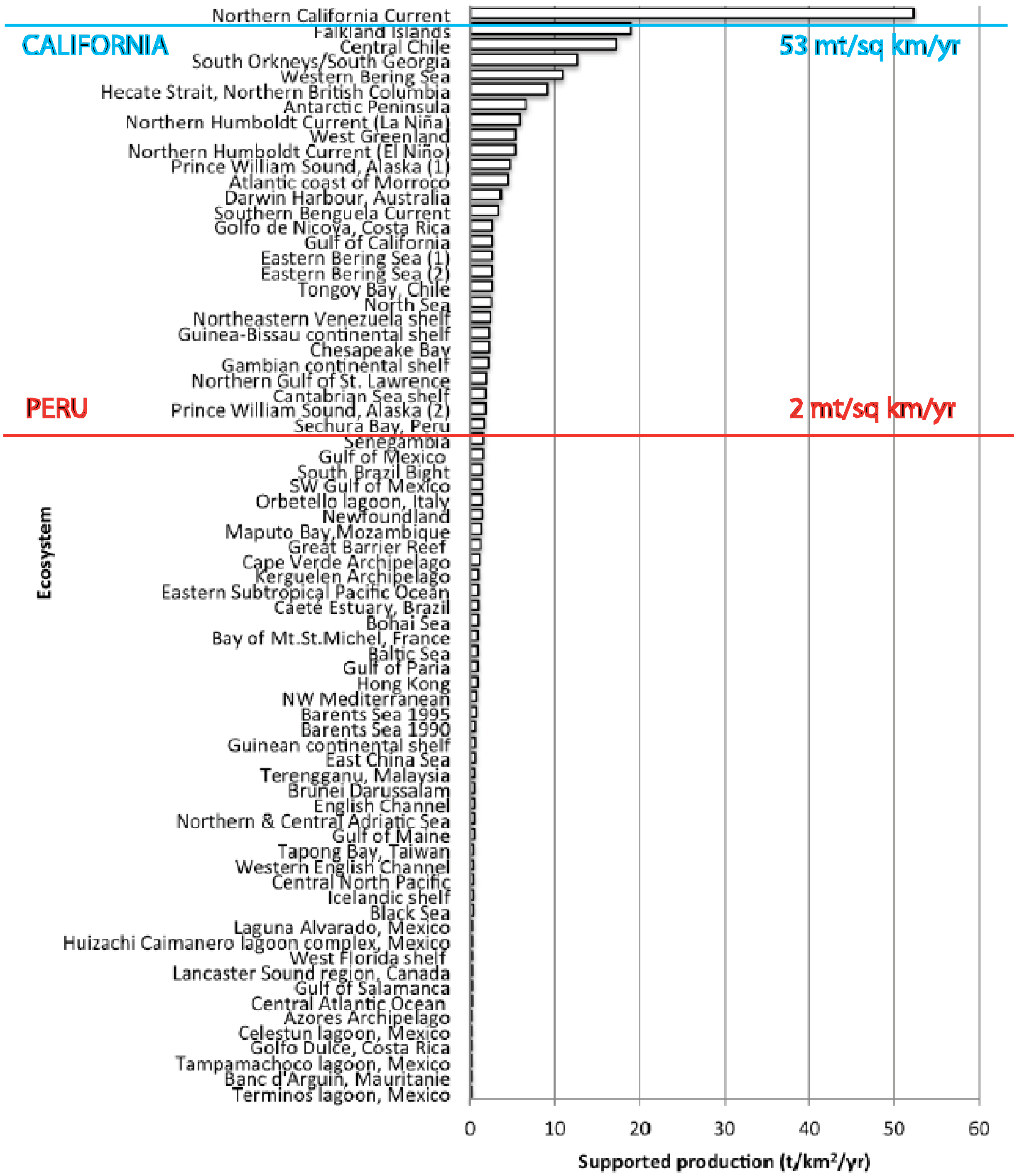
The fact that the White Paper references the Lenfest report but fails to include the ecosystem comparisons from the White Paper is, in my opinion, just another example of the unacceptable bias that runs thru the entire paper.

Figure E5.1
Forage Fish Catch Across all Ecopath Models by Volume.



The Secura Bay, Peru fishery harvests 82 mt of forage fishes per sq. km per year
The California fishery harvests 1 mt of forage fishes per sq km per year

Figure E5.5
Supportive Contribution of Forage Fish to Ecosystem Predator Production Across all Ecopath Models.



Predators in Sechura Bay, Peru consume 2 mt of forage fishes per sq km per year
Predators in California consume 53 mt of forage fishes per sq km per year.

ENERGETICS

The White Paper presents the following table showing the energy density of the species consumed by juvenile albacore and food quality is obviously very important,

Table 1: Energy density of common prey of juvenile albacore tuna in the California Current System (from Glaser 2010).

Prey category	Energy Density (kJ/g) ± SD
Cololabis saira (Pacific saury)	7.5 ± 1.0
Sardinops sagax (Pacific sardine)	7.3 ± 0.6
Myctophidae (Lanternfish)	7.1 ± 0.6
Paralepididae (Barracudinas)	7.1 ± 0.6
Engraulis mordax (Northern anchovy)	6.6 ± 0.5
Fishes (other)	6.6 ± 0.6
Trachurus symmetricus (Jack mackerel)	6.4 ± 0.5
Merluccius productus (Pacific whiting)	5.9 ± 1.3
Vinciguerria lucetia (lightfish)	5.2 ± 0.4
Cephalopods (squid)	4.4 ± 0.5
Sebastes spp. (rockfish)	4.2 ± 0.3
Crustaceans (other)	3.2 ± 1.1
Euphausiids (krill)	3.1 ± 1.1
Pleuroncodes planipes (pelagic red crab)	3.0 ± 1.3
Amphipods	2.5 ± 0.9

The other term in the energy equation is how much food does an animal require. On this part of the equation nothing is presented even though this material is in references used in the Paper.

The amount of food that animals require is an important concept in discussion of the competition of birds vs. salmon vs. humans for forage species. The authors of the White Paper should have informed their readers that cold blooded animals (sardine) have much lower food requirements than warm blooded animals (harbor seals) and that large animals (Grey whales) have lower requirements than small animals (krill).. Data extracted from Field et al (2006) on the consumption of forage per unit body weight per year by different animals is presented below.

Species Group	Consumption/ unit biomass	Species Group	Consumption/ unit biomass
Common murres	129.0	Shearwaters	138.0
Copepods	70.0	Micro-zooplankton	300.0
Small jellies	30.0	Krill	40.0
Baleen whales	7.6	Fur seals	39.0
Pacific sardine	5.0	Albacore	7.3
Longspine Thornyhead	0.4	Dover sole	1.1

Field's data shows that marine birds and small zooplankton consume about 100 times more forage per unit body weight than sedentary fishes. Rates of larger zooplankton are also very high, 30-40 times

their body weight. Marine mammals consume 8-40 times their own weight per year, active fishes consume 5-7 times their body weight and sedentary fishes have very low rates (0.4-1.1).
This very large difference in trophic efficiency has significant ecosystem consequences; but again only one side of the issue has been presented in the White Paper.

Another very important factor is not discussed. The high oil content of forage fishes is quite well known. However, it is not well known that oil content is highly variable seasonally and highly dependent upon the size of the fish. In September large sardines on the feeding grounds off of the Pacific Northwest have 20-28% of their body weight in oil. In April the same fish are finishing spawning off of Point Conception and their oil content is only 4-6% of their body weight. The long swim from Vancouver Island to Point Conception and several months of spawning is what that oil reserve is for. In June-July the 2-4 inch offspring from those large sardines are in the inshore waters of the Southern California Bight and their oil content is less than the spawned out adults. The small 2-3 inch sardines that were eaten by marbled murrelets in 1910 off of Point Pinos did not have the high oil content found in adult sardines.

Nitpicking:

I am sure that several reviewers have pointed out that figure 5 contains erroneous information. Blue rockfish are not fish eaters, their food habits are entirely different that those of albacore. In fact their food habits have more in common with those of the leatherback turtle than the other species in the figure.

I note that one of the White Paper's authors recently made a public comment at the August SAC meeting in Santa Cruz. She pleaded with the SAC to do something about the squid fishery because of the marbled murrelet. However, squid are not even mentioned in the marbled murrelet section of the White Paper and marbled murrelets are not mentioned in the squid section.

Contrary evidence.

Although it is too new to expect it to be included in the present draft of the White Paper the material in a recent paper is too important to be ignored.

Hannesson, R., In Press. Strictly for the birds? On ecosystem services of forage fish. Marine Policy

Hannesson examines the conclusions of the Lenfest report by examining four well-known crashes of forage fish stocks: the Pacific sardine, the Norwegian spring-spawning herring, the South African pilchard and the Peruvian anchovy. He concludes "We have seen that the effect of four spectacular crashes of forage fish stocks on other commercial fisheries was limited to nonexistent. Hence, these stocks appear to play a much smaller role for fish higher up in the food chain than one might think."

Hannesson's figure 1 shows that the landings of sardine predators are completely out of phase with the landings of sardines in California. Hannesson's data showing that predator population sustained high landings during the 40 years that sardine were virtually absent from the California Current ecosystem contradicts the story that the productivity of the ecosystem was harmed.

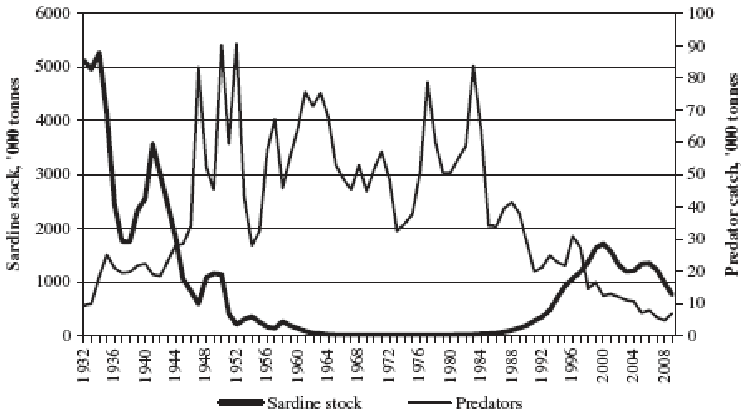


Fig. 1. Landings of sardine predators in California and the sardine stock biomass 1932–2009.
Sources: California fish landings data base (landings) and Kevin Hill (personal communication), Southwest Fisheries Science Center, La Jolla, California (sardine stock biomass). Sardine stock includes 0-age group.

While the authors of the White Paper will probably not agree with Hannesson on the important point that there is little evidence that the 4 decade long collapse of the California sardine had demonstrable affect on the California Current ecosystem they present no evidence in the White Paper that seriously contradicts Hannesson's analysis.

Hannesson's agrees with the Lenfest report in that "certain sea bird populations have been severely impacted by exploitation of small pelagics": however, he notes that a trade off between food for birds and food for humans is necessary.

CONCLUSION: The most informative evidence that the White Paper could have presented is the Lenfest figures E5.1 and E5.5 showing the biomass of forage fish taken by fisheries and that consumed by ecosystem predators. This would have allowed a comparison of the merits of fishery management in the California Current to management elsewhere in the World. This is really the information that it is important for the public to acquire. I note that the Lenfest information for the California Current completely contradicts the tone and substance presented in the White Paper.

The very harsh words in the introduction and elsewhere in this review are due to the fact that in my opinion the authors have either undertaken a study that they are ill prepared for, or they have knowingly refused to present data and describe management regulations that accurately describes the present state of forage fish populations, prey populations and the management of forage fishes in the US portion of the California Current. I suspect that that both are true.

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