PAPER

Long-Term Effectiveness, Failure Rates, and "Dinner Bell" Properties of Acoustic Pingers in a Gillnet Fishery

AUTHORS
James V. Carretta
Jay Barlow
Southwest Fisheries Science Center,
National Marine Fisheries Service,
National Oceanic and
Atmospheric Administration

ABSTRACT
The long-term effectiveness of acoustic pingers in reducing marine mammal bycatch was assessed for the swordfish and thresher shark drift gillnet fishery in California. Between 1990 and 2009, data on fishing gear, environmental variables, and bycatch were recorded for over 8,000 fishing sets by at-sea fishery observers, including over 4,000 sets outfitted with acoustic pingers between 1996 and 2009. Bycatch rates of cetaceans in sets with ≥30 pingers were nearly 50% lower compared to sets without pingers ($p = 1.2 \times 10^{-6}$), though this result is driven largely by common dolphin (*Delphinus delphis*) bycatch. Beaked whales have not been observed entangled in this fishery since 1995, the last full year of fishing without acoustic pingers. Pinger failure (≥1 nonfunctioning pingers in a net) was noted in 3.7% of observed sets. In sets where the number of failed pingers was recorded, approximately 18% of deployed pingers had failed. Cetacean bycatch rates were 10 times higher in sets where ≥1 pingers failed versus sets without pinger failure ($p = 0.002$), though sample sizes for sets with pinger failure were small. No evidence of habituation to pingers by cetaceans was apparent over a 14-year period of use. Bycatch rates of California sea lions in sets with ≥30 pingers were nearly double that of sets without pingers, which prompted us to examine the potential "dinner bell" effects of pingers. Depredation of swordfish catch by California sea lions was not linked to pinger use—the best predictors of depredation were total swordfish catch, month fished, area fished, and nighttime use of deck lights on vessels.
Keywords: acoustic pingers, bycatch, marine mammals, habituation, gillnets

Introduction

Acoustic pingers are effective at reducing the bycatch of a wide variety of marine mammal species (Kraus et al., 1997; Trippel et al., 1999; Gearin et al., 2000; Bordino et al., 2002; Barlow & Cameron, 2003; Palka et al., 2008). With few exceptions (Kraus, 1999; Cox et al., 2001; Palka et al., 2008), the long-term efficacy of pingers has seldom been addressed, particularly with respect to the potential for "habituation" by animals to acoustic devices. Even fewer studies have examined the potential "dinner bell" effect of pingers, whereby marine mammals are attracted by pingers to fishing nets, resulting in depredation of catch (Dawson, 1994; Kraus et al., 1997).

Barlow and Cameron (2003) reported that acoustic pingers significantly reduced cetacean and pinniped bycatch in the drift gillnet fishery for swordfish and thresher shark in California (hereafter referred to as "the fishery") during a controlled experiment in 1996 and 1997. At that time, conclusions about pinger effectiveness in reducing bycatch were limited to short-beaked common dolphins (*Delphinus delphis*) and California sea lions (*Zalophus californianus*), due to small sample sizes for other species. With nine additional years of observer data from the fishery, Carretta et al. (2008) showed that acoustic pingers apparently eliminated beaked whale bycatch. Acoustic pingers have been utilized in the fishery for 14 consecutive years (1996–2009), with 4,238 sets outfitted with pingers. This extensive dataset allowed us to assess the long-term performance of pingers beyond the experimental results reported by Barlow and Cameron (2003) and to address the following questions: Are observed data consistent with gear compliance regulations outlined in the Pacific Offshore Cetacean Take Reduction Plan (Federal Register, 1997) implemented in 1997? Have pingers remained effective at reducing bycatch over the period 1996–2009, or has "habituation" occurred? Does the failure of a few pingers in a given fishing set affect bycatch? Are pingers linked to pinniped depredation of catch in the fishery?

Methods

Fishery observers were placed onboard fishing vessels to collect data on incidental entanglement and mortality of protected species, along with data on the gear characteristics of each set fished (net length, number of pingers, extender length, pinger functionality) and on the catch of fish species. From 1990 to 2009, over 8,000 fishing sets were observed (Table 1). An attempt was made to sample at least every fifth vessel trip, with an overall goal of 20% observer coverage in the fishery (Julian & Beeson, 1998; Carretta et al. 2004). It is not practical to observe every vessel in the fishery, because some smaller vessels lack berthing space for observers. Nets in this fishery are approximately 1,800-m (1 nautical mile) long and 65-m deep, with mesh sizes ranging from 35 to 60 cm. Nets are fished for approximately 12 h from dusk until dawn and are suspended from floats so that the tops of the nets are at 11-22-m depth and the bottoms are at 75-90-m depth. Fishing regulations require that acoustic pingers be attached every 91 m along the floatline and leadline of the net and that nets be fished at a minimum depth of 10.9 m with the use of “extenders” (Federal Register, 1997). Thus, the average 1,800-m net contains approximately 40 pingers, with floatline and leadline pingers spatially “staggered” to provide acoustic coverage over the entire area of the net. Pingers emit pulsed tones with source levels of 135 dB RMS; re: 1 µPa @ 1 m, fundamental operating frequencies of 10-12 kHz (with harmonics to 80 kHz), a pulse duration of 300 ms, and a pulse interval of 4 s. Additional pinger details have previously been described by Barlow and Cameron (2003).

Pinger efficacy on bycatch reduction was evaluated by comparing proportions of fishing sets with and without bycatch for a variety of gear and set situations. The characteristics of the gear and set variables used in our analyses are summarized in Table 2, and abbreviations for all variables are used throughout this paper. Statistical comparisons of set proportions with and without bycatch in this paper are based on Fisher’s exact test, with 2 × 2 contingency tables (no bycatch versus ≥1 bycatch events per set). The proportion of sets with and without bycatch was compared for sets fished without pingers and sets with ≥30 pingers for the years 1990 through 2009. Occasionally, sets of less than 1,500 m in length were fished, with fewer than 30 pingers (referred to as “short

TABLE 1

Summary of sets observed and estimated fishing effort in the California drift gillnet fishery, 1990–2009.

Year	Observed (No Pingers)	Observed Sets (With Pingers)	Estimated Total Sets Fished (and Fraction Observer Coverage)	Fraction of Observed Sets With Pingers
1990	178	n/a	4,078 (0.043)	n/a
1991	470	n/a	4,778 (0.098)	n/a
1992	596	n/a	4,379 (0.136)	n/a
1993	728	n/a	5,442 (0.133)	n/a
1994	759	n/a	4,248 (0.178)	n/a
1995	572	n/a	3,673 (0.155)	n/a
1996	275	146	3,392 (0.124)	0.346
1997	304	388	3,039 (0.227)	0.560
1998	14	573	3,353 (0.175)	0.976
1999	2	524	2,634 (0.199)	0.996
2000	0	444	1,936 (0.229)	1.00
2001	1	338	1,665 (0.203)	0.997
2002	0	360	1,630 (0.220)	1.00
2003	0	298	1,467 (0.203)	1.00
2004	0	223	1,084 (0.205)	1.00
2005	0	225	1,075 (0.209)	1.00
2006	0	266	1,433 (0.185)	1.00
2007	1	203	1,241 (0.164)	0.995
2008	0	149	1,103 (0.135)	1.00
2009	0	101	761 (0.132)	1.00
All years	3,900	4,238	52,411 (0.155)	0.52

Pingers were first utilized in the fishery in 1996.

TABLE 2

Variables used in the prediction of depredation (damage to swordfish catch) events in the drift gillnet fishery.

Variable Name	Variable Description	Range of Values
TotCatch	Total catch of swordfish, number of individuals	1-21
Month	Month of set[a]	1-6
Lat	Latitude	≤34.5
Lon	Longitude	≤120.00
DeckLght	Were the main deck lights left on all night? 0 = No, 1 = Yes	0, 1
Soak	Number of hours that net was left to soak overnight (time fished)	2-62
DepthMesh	Number of meshes from top to bottom of net	36-160
LengthNet	Total length of net in meters	914-1,828
Genr	Was the generator engine left on all night? 0 = No, 1 = Yes	0, 1
Mesh	Mesh size in cm	40-55
Random	Random integer	1-6
Main	Was the main engine left on all night? 0 = No, 1 = Yes	0, 1
Sonr	Was the vessel's sonar left on all night? 0 = No, 1 = Yes	0, 1
Patl	Did the vessel patrol the length of net while it soaked, or did vessel remain stationary at one end of net?	0, 1
Beau.Pul	Beaufort sea state when the net was retrieved	0-6
NumPing	Number of acoustic pingers attached to the net	0 or 30-42
Extnd	Length (in m) of the line which joins the cork line and surface floats (how deep below the surface was the net fished?)	4-18
NumLght	Number of lightsticks attached to the net	0-25
DepthWater	Water depth in meters when net was retrieved	100-1,902
Set	Sequential set fished during a vessel's fishing trip	1-9

Variables are ranked in order of importance as determined by the algorithm Random Forest for the year 1997, shown in Figure 8.

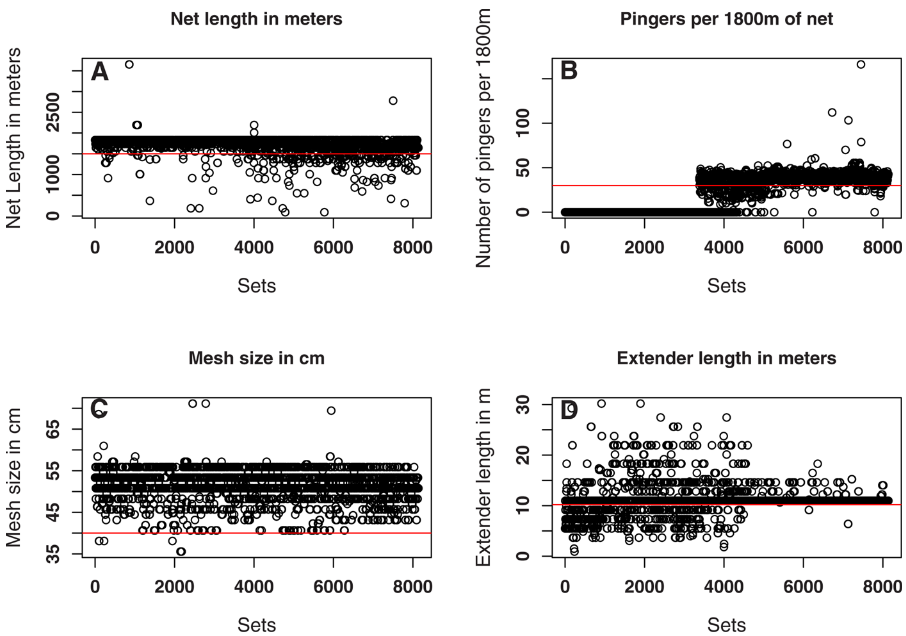
[a]The variable "*Month*" was recoded to correct for circularity of data values and represents the sequential month of fishery activity from August (=1) to January (=6) during the fishing season.

sets"). Our analyses of sets with pingers include only those that were a minimum of 1,500 m in length with ≥30 pingers. Based on the observed variability of gear variables for all sets (Figure 1), we further pared data by including only sets with the following criteria: net soak time (*Soak*) ≥8 and ≤20 h, extender lengths (*Extnd*) ≥10.9 m, and mesh size (*Mesh*) ≥40 cm. After omitting sets not meeting these criteria, 4,073 sets remained for analysis (1,281 sets without pingers and 2,792 sets with ≥30 pingers). To avoid confounding effects of spatial changes in fishing effort during the period of pinger use, we excluded sets fished inside of and north of a time/area closure implemented in 2001 to protect leatherback turtles (Figure 2). We tested the alternative hypothesis (one-tailed) that the proportion of sets with bycatch was lower in sets with ≥30 pingers. The species categories *all cetaceans*, *all pinnipeds*, and the following individual species were tested: short-beaked common dolphin (*Delphinus delphis*), northern right whale dolphin (*Lissodelphis borealis*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), California sea lion (*Zalophus californianus*), and northern elephant seal (*Mirounga angustirostris*). We excluded species with fewer than 10 total bycatch events. Beaked whale species of the genera *Berardius*, *Mesoplodon*, and *Ziphius* are included in the results for the species category *all cetaceans* but were not tested separately, as results for this group are reported in Carretta et al. (2008) with larger sample sizes. Pingers were not used in this fishery prior to the 1996–1997 experiment (Barlow & Cameron, 2003), and pingers have been used in >99% of all observed sets since 1998 (Table 1; Figure 3). For these reasons, we are unable to assess the potential *year effect* on bycatch rates and pinger effectiveness (see Discussion).

We evaluated whether habituation to pingers may have occurred using the 2,792 sets with ≥30 pingers described above. Sets were divided chronologically into two time periods representing *early* and *late* periods of pinger use, resulting in 1,396 sets from the *early* years (1996–2001) and 1,396 sets from the *late* years (2001–2009). Sets that were examined in the overlap year of 2001 were independent (early 2001 vs. late 2001). We tested the null hypothesis (two-tailed) that the proportion of sets with bycatch was equal for *early* and *late* periods for the species categories *all cetaceans* and *all pinnipeds* as well as short-beaked common dolphins and California sea lions. We also estimated the variability of bycatch rates between early and late periods for *all cetaceans* with a

FIGURE 1

(A-D) Gear characteristics for 8,138 observed drift gillnet sets fished between 1990 and 2009. Horizontal lines mark the minimum thresholds for data included in bycatch analyses (see text). Individual set data are shown in chronological order along the *x* axis, ordered by year and month.



nonparametric bootstrap. Sets from each time period were sampled with replacement (using the observed effect size of 1,396 sets from each period) and a bootstrap estimate of the bycatch rate was calculated. This was done 1,000 times to provide a distribution of "pseudo-bycatch rates" for each period. We did not determine whether or not the bootstrap bycatch rates were significantly different between the two periods, as this is addressed in the results of the Fisher's exact test and a simple visual inspection of the bootstrap estimates (Figure 4).

Pinger failure sometimes occurs in the fishery, for reasons including expired batteries, water intrusion, and physical damage from fishing operations. Beginning in 2001, fishery observers were instructed to listen to each pinger during the first set retrieval of a fishing trip. If all pingers were functioning, pinger functionality was coded as "Yes", otherwise "No" if one or more nonfunctioning pingers were found. Observers also recorded notes for sets with nonfunctioning pingers, including a count of the number of failed pingers and their relative locations on the net (e.g., floatline vs. leadline). The effect of pinger failure on bycatch was evaluated by comparing proportions of sets with bycatch for sets with all pingers functioning versus sets with ≥1 nonfunctioning pingers. Between 2001 and 2009, there were 502 observed sets with ≥30 pingers where pinger functionality was recorded. Comparisons were limited to the species category *all cetaceans* because sample sizes were too small for other species/categories.

Depredation of swordfish catch by California sea lions in the fishery has sometimes been blamed on attraction to acoustic pingers, otherwise known as the "dinner bell effect" (Dawson, 1994). Depredation of swordfish catch was infrequently observed between 1991 and 1996 (<5% of sets), but there has been a marked increase in depredation since 1997 (>15-20% of sets), coinciding with the second

FIGURE 2

Locations of observed drift gillnet fishing sets 1990–2009, used in pinger efficacy analyses. Shown are locations of 1,281 sets fished without pingers (A) and 2,792 sets fished with ≥30 pingers (B). Gray region represents leatherback turtle conservation area closed to fishing between 15 August and 15 November since 2001.

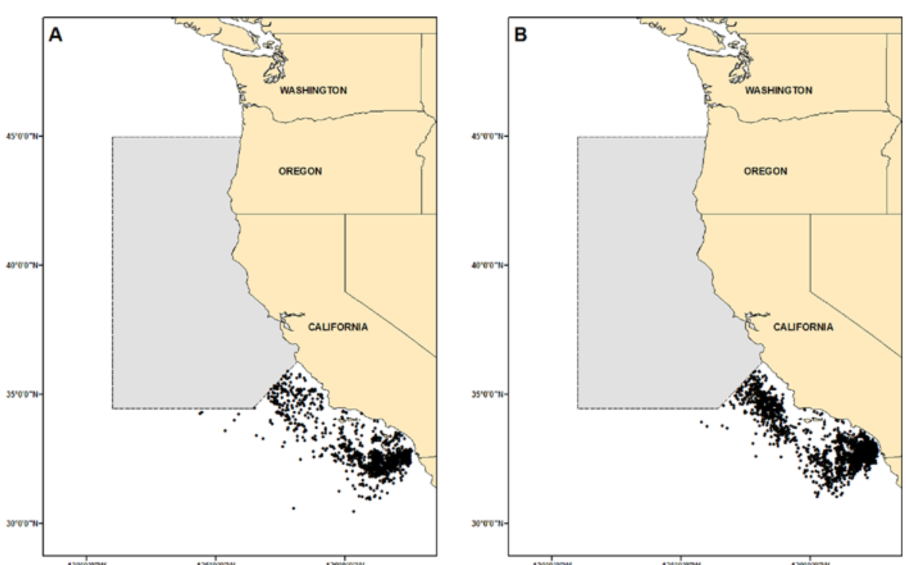
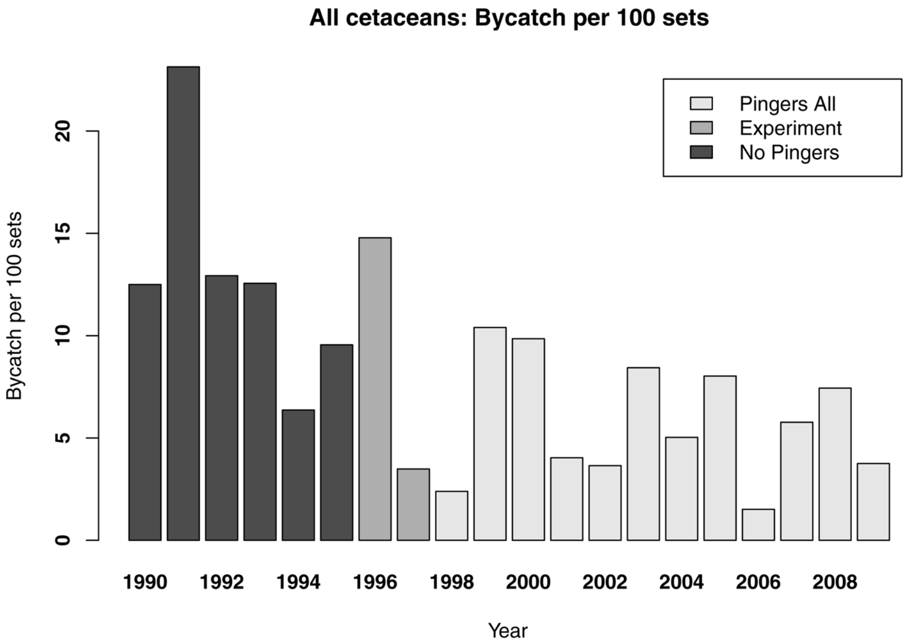


FIGURE 3

Annual rates of cetacean bycatch, 1990–2009. Three periods of pinger use in the fishery are shown: 1990–1995 (no pingers), 1996–1997 (experimental pinger use), and 1998–2009 (mandatory pinger use on all sets). Only sets fished outside of the closure area implemented in 2001 (see text) are included in this figure.



year of experimental pinger use (Figure 5). Pinger use has been mandatory in the fishery since late 1997 and has essentially been constant since that time. Thus, the effect of pingers on depredation is difficult to assess without examining sets fished both *with* and *without* pingers. For this reason, we examined sets fished in 1997 (n = 193), during the second year of the pinger experiment (Barlow & Cameron, 2003). We chose 1997 because it provided an adequate sample of sets with observed depredation, in addition to a sufficient number of sets with and without pingers. In order to be able to examine the effects of variables other than pingers on depredation, we also examined a larger sample of observed sets (n = 1,357) fished during a period of mandatory pinger use from 1998 through 2009, where all sets utilized ≥30 pingers. The depredation metric investigated was "mammal damage" (Y/N) to catch of broadbill swordfish (*Xiphias gladius*). Fishery observers distinguish between mammal and shark damage to catch based on differences in damage characteristics. Shark damage is characterized by discrete, semi-circular, clean bites out of the body of the fish, while mammal damage by pinnipeds is characterized by shredding of the body of the fish. Initial examination of the fishery observer data revealed that most cases of mammal depredation on swordfish catch occurred in the southern part of the fishery area, where California sea lions are most abundant. Due to the observed geographic bias in depredation, we selected a subset of data within the southern end of the fishery area for analysis (Figures 6 and 7).

The effect of pingers on depredation was evaluated by two methods. First, we tested the null hypothesis (two-tailed) that the proportion of sets with depredation was equal for sets without pingers and sets with ≥30 pingers during 1997, using Fisher's exact test. Sets in the 1997 depredation analysis included those without pingers (n = 69) and sets with ≥30 pingers

FIGURE 4

Bootstrap estimates of cetacean bycatch rates during early (1996–2001) and late (2001–2009) periods of pinger use in the fishery.

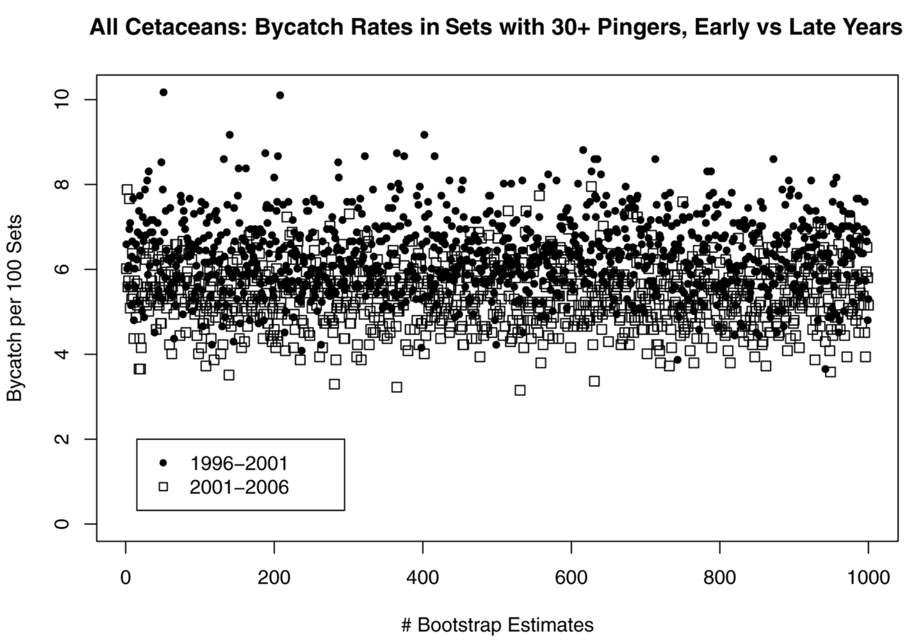
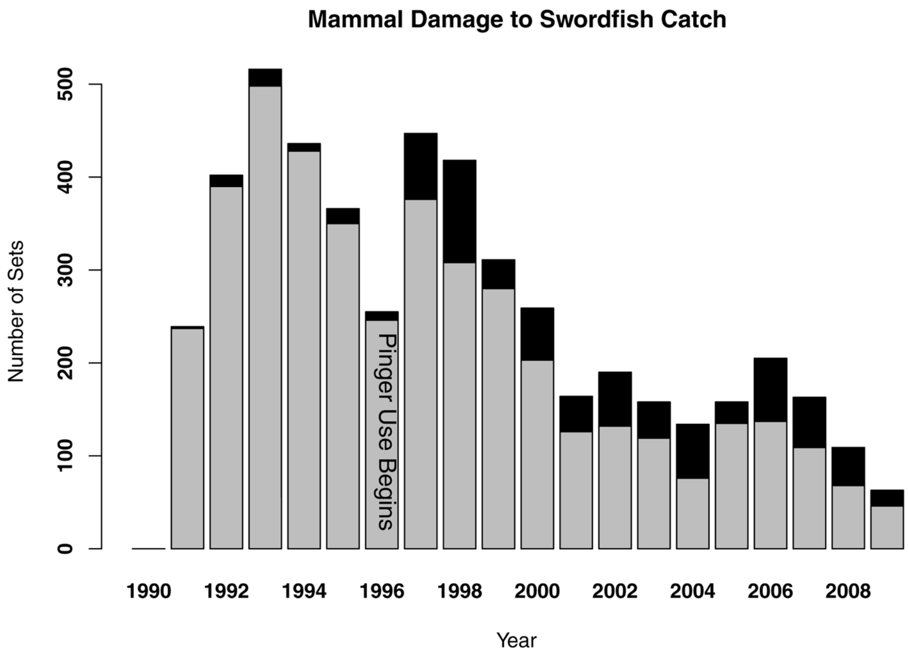


FIGURE 5

Observed occurrence of mammal damage (depredation) to swordfish catch in the drift gillnet fishery, 1990–2009. Light bars represent sets without mammal damage and dark bars represent sets with mammal damage. Damage status was not recorded in 1990.



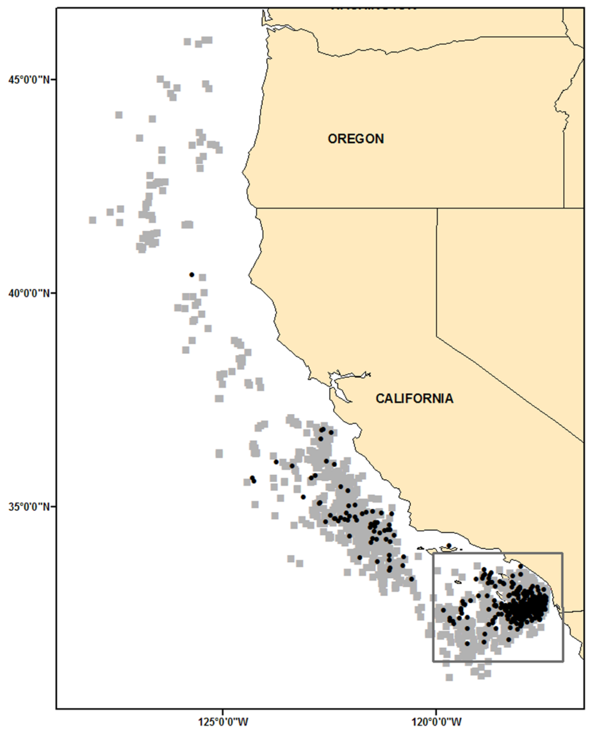
(n = 124) (Figure 6). We also investigated the effects of vessel, gear, and environmental variables on depredation for the 1997 experimental year and the period of mandatory pinger use from 1998 to 2009, using the machine-learning method *Random Forest* (Breiman, 2001). Random Forest is an extension of the classification and regression tree (CART) method of Breiman et al. (1984), which we implemented in the programming language R (Liaw & Wiener, 2002; R Development Core Team, 2006). The method creates multiple bootstrap trees (a forest) to provide consensus predictions for novel input data. Our goal was to test a suite of variables to assess if they were individually or collectively useful in predicting depredation. We examined 20 variables, including the number of acoustic pingers (*NumPing*), latitude (*Lat*), longitude (*Lon*), total swordfish catch (*TotCatch*), and a random integer (*Random*) as a calibration of variable importance (Table 2). We treated depredation as a two-class prediction problem, where the classes to be predicted were depredation = Y/N. A forest of 1,000 classification trees was built from fishing sets inside the box shown in Figures 6 and 7. Each tree was constructed using two thirds of the available sets (randomly selected, without replacement) and cross-validation of each tree was accomplished by predicting the depredation status for the one third of the sets not used in tree construction (referred to as the "out-of-bag" sample). The out-of-bag sets are introduced to each tree, predictions are made, and an overall forest error rate is calculated as the average error rate of all individual trees. Tree construction was accomplished by randomly sampling (without replacement) an equal number of sets (n = 15) with and without depredation. This effectively made the prediction task equivalent to predicting the flip of a fair coin if all variables were uninformative. Our samples (individual sets) may represent multiple sets within a single

FIGURE 6

Locations of sets fished without pingers (A) and with ≥30 pingers (B), where the status of mammal damage to swordfish catch was recorded during 1997. Gray squares represent observed sets without mammal damage to swordfish catch and dark circles represent sets with mammal damage to swordfish catch. The rectangle bounds those sets that were included in the depredation analysis.

FIGURE 7

Locations of sets fished from 1998 to 2009 where ≥30 pingers were fished and the status of mammal damage to swordfish catch was recorded. Gray squares represent observed sets without mammal damage to swordfish catch and dark circles represent sets with mammal damage to swordfish catch. The rectangle bounds those sets that were included in the depredation analysis.



fishing trip, with potential correlation between depredation events within a trip. To eliminate trip correlation, we created separate Random Forests from odd- and even-numbered fishing trips, respectively. The "odd trip" forest was used to predict "even trip" data, and vice versa. Error rates for each depredation category were calculated as the aggregate error rate of both forest predictions on novel data and summarized as a confusion matrix. Variable importance was assessed within Random Forest through a routine that randomizes (swaps) variable values between records. Variables are randomized one at a time, trees are built from the randomized data, and out-of-bag error rates are generated as described above. Variables are then "ranked" by importance, with the "most important" variables represented by the greatest decline in predictive performance under the condition of randomization.

Results

Following gear regulations in 1997 requiring pinger use and minimum extender lengths, fishermen have been largely compliant in meeting these requirements (Table 1; Figure 1). Over 99% of all observed sets since 1998 have utilized the required number of pingers per length of net and have adhered to minimum extender length requirements. Compliance is based on observed vessels only, as some smaller vessels are "unobservable" because they lack berthing space for observers (see Discussion).

Although there has been considerable interannual variability in bycatch rates in the fishery, it is apparent that bycatch rates in sets with pingers are considerably lower than in sets without (Figure 3). The proportion of sets with cetacean bycatch was significantly lower ($p = 6.7 \times 10^{-7}$) in sets with ≥30 pingers (4.4% of sets with bycatch) than in sets without pingers (8.4% of sets) (Table 3). Among the individual cetacean species tested, only short-beaked common dolphin ($n = 164$ sets with bycatch) had significantly lower bycatch ($p = 2.0 \times 10^{-4}$) in sets with ≥30 pingers (3.2% of sets) than in sets without pingers (5.7% of sets). Consistent with the findings of Barlow and Cameron (2003), bycatch rates of northern right whale dolphin ($n = 19$ bycatch events, $p = 0.893$) and Pacific white-sided dolphin ($n = 14$, $p = 0.115$) were not significantly different between sets without pingers and sets with ≥30 pingers, possibly due to small sample sizes. Beaked whale bycatch has not been observed in this fishery since 1995, the last full year of fishing without acoustic pingers. Over 4,000 fishing sets with pingers have been observed since 1996 without beaked whale bycatch, compared with 33 beaked whale entanglements in 3,300 fishing sets without pingers between 1990 and 1995 (Carretta et al., 2008). Pinniped bycatch was not significantly different ($p = 0.141$) between sets with ≥30 pingers (3.1% of sets) and sets without pingers (3.8% of sets). However, opposite patterns were observed for California sea lions and northern elephant seals. Sea lions were entangled more frequently in sets with ≥30 pingers (2.6% of sets), compared to sets without pingers (1.6% of sets, $p = 0.988$).

TABLE 3

Number of sets with and without bycatch for selected species/species groups.

Species	No Pingers			≥30 Pingers			
	No Bycatch	Bycatch ≥ 1	Individuals per 100 Sets	No Bycatch	Bycatch ≥ 1	Individuals per 100 Sets	Fisher's Exact Test *p* Value
California sea lion *Zalophus californianus*	1,261	20	1.5	2,719	73	2.9	0.988
Northern elephant seal *Mirounga angustirostris*	1,250	31	2.4	2,779	13	0.46	1.1×10^{-7}
Common dolphin, short-beaked *Delphinus delphis*	1,208	73	7.6	2,701	91	4.0	2.0×10^{-4}
Pacific white-sided dolphin *Lagenorhynchus obliquidens*	1,274	7	0.62	2,785	7	0.35	0.115
Northern right whale dolphin *Lissodelphis borealis*	1,277	4	0.31	2,777	15	0.75	0.893
All cetaceans	1,173	108	11.4	2,667	125	5.9	6.7×10^{-7}
All pinnipeds	1,232	49	4.0	2,705	87	3.5	0.141

Sets are divided among those without pingers and those where ≥30 pingers were used. The Fisher's exact test significance level for the one-tailed alternative hypothesis (sets with ≥30 pingers have lower proportions of bycatch) is given in the last column. The species categories "all cetaceans" and "all pinnipeds" include bycaught animals identified to species or genera in this table, and other species for which fewer than 10 total bycatch events were recorded (e.g., unidentified cetacean, Risso's dolphin, unidentified pinniped).

Northern elephant seals were entangled far less frequently in sets with ≥30 pingers (0.5% of sets) than in sets without pingers (2.4% of sets, $p = 1.1 \times 10^{-7}$).

Habituation to pingers is not apparent in this fishery: the proportion of sets with bycatch was not significantly different between *early* and *late* periods of pinger use for *all cetaceans* ($p = 0.583$), *all pinnipeds* ($p = 0.827$), short-beaked common dolphin ($p = 0.522$), and California sea lions ($p = 0.235$) (Table 4; Figure 4). Bycatch rates of cetaceans and pinnipeds were lower in the *late* period of pinger use (Table 4; Figure 4), although bycatch rates of California sea lions were 18% higher during the *late* period.

Pinger failure was recorded in 19 of the 502 sets (3.7%) examined from

TABLE 4

Number of sets with and without bycatch for *early* (1996–2001) and *late* (2001–2009) pinger periods.

Species	1996–2001 (n = 1,396)			2001–2009 (n = 1,396)			
	Early Sets No Bycatch	*Early* Sets Bycatch ≥ 1	Individuals per 100 Sets	*Late* Sets No Bycatch	*Late* Sets Bycatch ≥ 1	Individuals per 100 Sets	Fisher's Exact Test *p Value*
Common dolphin, short-beaked *Delphinus delphis*	1,347	49	4.5	1,354	42	3.5	0.522
California sea lion *Zalophus californianus*	1,365	31	2.7	1,354	42	3.2	0.235
All cetaceans	1,330	66	6.5	1,337	59	5.3	0.583
All pinnipeds	1,354	42	3.5	1,351	45	3.4	0.827

The Fisher's exact test significance level for the two-tailed null hypothesis (proportions of sets with bycatch are equal for early and late periods of pinger use) is given in the last column. The species categories "all cetaceans" and "all pinnipeds" include bycaught animals identified to species below, all beaked whales, and other species for which fewer than 10 total bycatch events were recorded (e.g., unidentified cetacean, Risso's dolphin, unidentified pinniped).

TABLE 5

Summary of sets with and without cetacean bycatch for 502 sets where pinger functionality was recorded.

	Pinger Failure Occurred			Pingers Functional			
	No Bycatch	Bycatch ≥ 1	Bycatch per 100 Sets (Individuals)	No Bycatch	Bycatch ≥ 1	Bycatch per 100 Sets (Individuals)	Fisher's Exact Test *p Value*
All cetaceans	12	4	50.0	471	15	4.7	0.002

The Fisher's exact test significance level for the one-tailed alternative hypothesis (sets with pinger failure have a higher proportion of cetacean bycatch) is given in the last column.

2001 to 2009 (Table 5). In sets with ≥1 nonfunctioning pingers, the proportion of sets with cetacean bycatch (4/16, 25% of sets) was significantly higher (p = 0.002, one-tailed Fisher's exact test) than in sets where all pingers were functioning (15/486, 3.0% of sets). Observer notes on pinger failure were not systematically recorded, but for 12 sets with sufficient documentation, observers indicated a range of 3-26 pingers as nonfunctioning (median failure rate = 4, mean failure rate = 6.8, mean number of pingers deployed = 37). There was no apparent pattern of failure on the floatline or on the leadline in these sets. Among sets with pinger failure where the number of failed pingers was recorded, approximately 18% of deployed pingers failed. There were 32 bycatch events for which the functional status of the pinger nearest to the entangled cetacean was recorded. In these sets, the adjacent pinger was fully functional in 27 of 32 cases (84%) and nonfunctioning in 5 cases (18%).

Sea lion depredation of swordfish catch increased in 1997, coincident with the second year of the pinger experiment, when the number of nets outfitted with pingers more than doubled (Table 1; Figure 5). However, there was no difference in the proportion of sets depredated between sets without pingers and sets with ≥30 pingers (two-tailed Fisher's exact test, p = 0.742; Table 6). Random Forest correctly predicted the depredation status for 63.7% (123/193) of sets observed in 1997 (Table 7) and 66.3% (899/1,357) of sets observed during 1998–2009 (Table 8). Variable importance rankings (in order of importance) returned by Random Forest indicate that in 1997, the variables *TotCatch*, *Month*, *Lat*, *Lon*, and *DeckLght* provided the most predictive power (Figure 8). The variable *NumPing* ranked 16th in importance out of 20 variables, less important than the variable *Random* and outperforming only the variables *Extnd, NumLght, DepthWater,* and *Set*. Among the sets with positive depredation in 1997, the vessel's deck lights remained on all night in 45 of 57 sets (79%), while sets without depredation had all-night deck light use in 86 of 136 (63%) of sets. In the larger 1998–2009 data set where *all sets* were outfitted with ≥30 pingers, the variables *Lat*, *Lon*, *TotCatch*, *Month*, and *DepthWater* provided the most predictive power (Figure 9). During 1998–2009, the variable *DeckLght* "lost importance" relative to 1997 and the rate of all-night deck light use during 1998–2009 was nearly equal among sets without depredation (83%) and sets with positive depredation (85%). Although the variable *NumPing* ranked sixth in importance in the

TABLE 6

Summary of depredation status on swordfish catch in 1997 for sets without pingers and sets with ≥30 pingers.

	Pingers = 0			Pingers ≥30			
	Depredation (Y)	Depredation (N)	Fraction Sets Depredated	Depredation (Y)	Depredation (N)	Fraction Sets Depredated	Fisher's Exact Test *p Value*
Sets	19	50	0.275	38	86	0.306	0.742

Sets where ≥30 pingers were fished are divided among those sets where fishery observers noted any pinger failure and those where all pingers tested were functional. The Fisher's exact test significance level for the two-tailed alternative hypothesis (sets with ≥30 pingers and sets without pingers have different proportions of depredation) is given in the last column.

TABLE 7

Prediction of depredation status from Random Forest analysis for 1997, where sets were fished either without pingers (n = 69) or with ≥30 pingers (n = 124).

	Predicted Yes	Predicted No	% Correct Classified
Observed Yes	**38**	19	66.7%
Observed No	51	**85**	62.5%
All observations			**63.7%**

Correct predictions are shown in bold font. Table values represent correct classification percentages for novel data, based on Random Forest algorithms described in the text.

TABLE 8

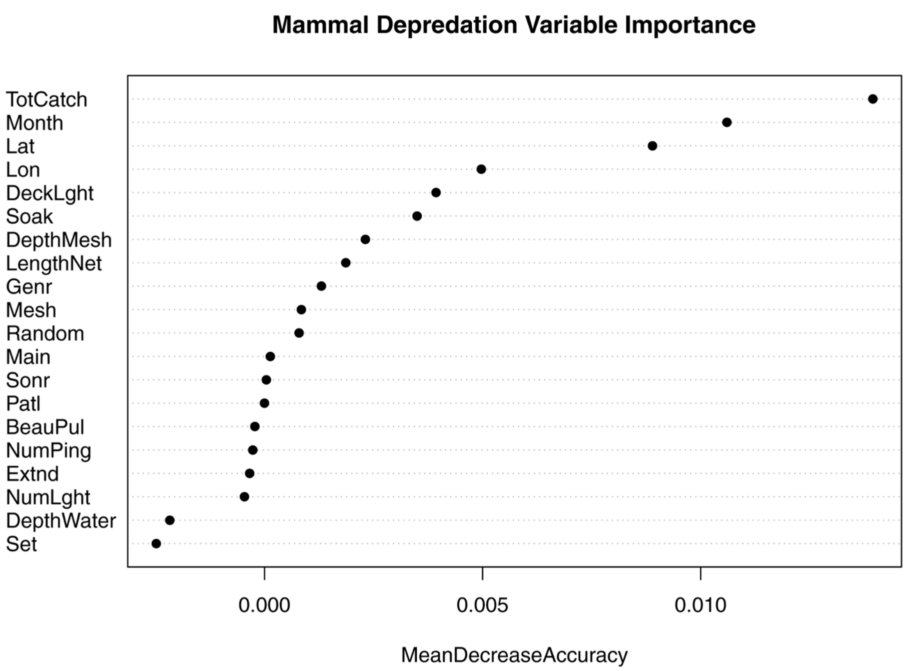
Prediction of depredation status from Random Forest analysis for 1998 to 2009, where all sets were fished with ≥30 pingers (n = 1,357).

	Predicted Yes	Predicted No	% Correct Classified
Observed Yes	**317**	147	68.4%
Observed No	311	**582**	65.2%
All observations			**66.3%**

Correct predictions are shown in bold font. Table values represent correct classification percentages for novel data, based on Random Forest algorithms described in the text.

FIGURE 8

Variable importance measures from a Random Forest classification tree algorithm used to predict the status (Yes/No) of mammal damage to swordfish catch in 1997. Variable descriptions are provided in Table 2.



1998 to 2009 set data, only a negligible decrease in predictive accuracy was observed (<0.1%) when this variable was randomized. Overall correct classification rates were also negligibly changed when *NumPing* was omitted from analyses of both the 1997 and 1998–2009 set data.

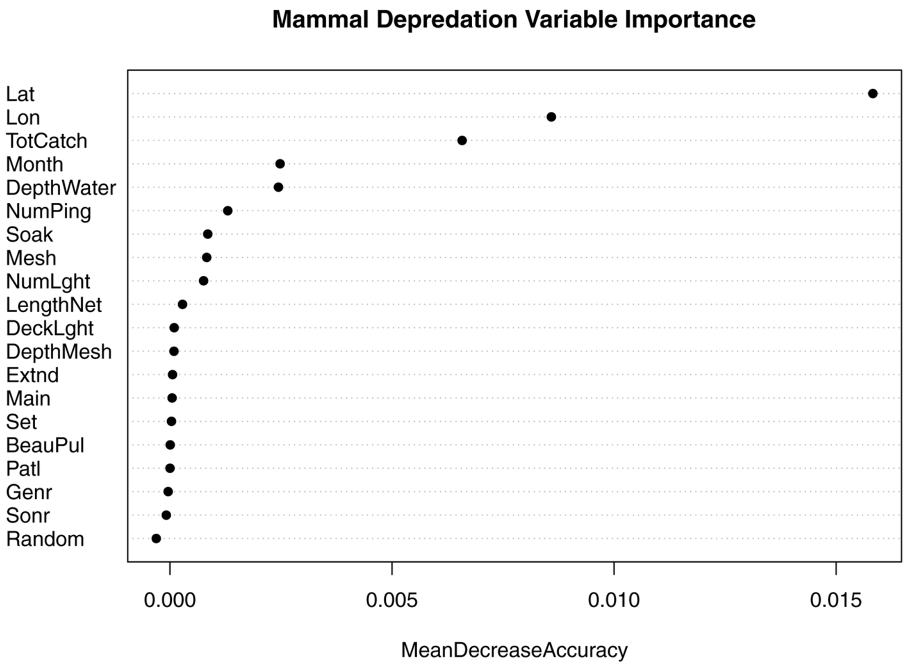
Discussion

While pinger and extender length gear compliance for *observed* vessels is high, an increasing fraction of fishing effort in this fishery is conducted by vessels too small to accommodate observers. In 2009, 34 vessels participated in the fishery, 11 of which were unobservable. Total estimated fishing effort for the unobservable vessels in 2009 was 368 sets, or 48% of all estimated fishing effort (Carretta & Enriquez, 2010). While unobservable vessels are occasionally boarded by Coast Guard personnel to check for gear compliance, the frequency is too rare to draw conclusions from. Therefore, we cannot evaluate pinger and other gear compliance for the unobserved portion of this fishery.

Pingers continue to be effective at reducing cetacean bycatch in this fishery, though this conclusion is largely driven by short-beaked common dolphin results. Pinger effects on the bycatch of Pacific white-sided dolphin and northern right whale dolphin are unclear, as these species are infrequently entangled in the fishery. The magnitude of common dolphin bycatch reduction we report is approximately 50% for sets with pingers, which is less dramatic than the 80% reduction reported by Barlow and Cameron (2003) in the 1996–1997 experiment. The level of bycatch reduction we report is still highly significant and we do not know the reasons for the apparent dif-

FIGURE 9

Variable importance measures from a Random Forest classification tree algorithm used to predict the status (Yes/No) of mammal damage to swordfish catch from 1998 to 2009. Variable descriptions are provided in Table 2.



ference in pinger effectiveness between the 1996–1997 experimental years and the 1998–2009 mandatory pinger years. There are sample size differences to consider, with many more sets being evaluated in the nonexperimental years (Table 1). Observed differences in pinger effectiveness between experimental and operational fishery periods was also reported by Palka et al. (2008), who attributed those differences to differences in mesh size fished. We attempted to standardize the sets used in our analysis by setting *a priori* boundaries for variables such as mesh size, extender length, net length, and soak time. Observed differences in bycatch rates between experimental and operational fishery periods in sets with pingers for our fishery could be due to variability in pinger functionality, as observers only began systematic testing of pinger functionality in 2001, several years after the pinger experiment began. In retrospect, there is no way to test this, other than noting that 2 years with full pinger use (1999 and 2000) had the highest cetacean bycatch rates during the era of mandatory pinger use and occurred prior to systematic pinger checks by observers (Figure 3). It is also worth noting that cetacean bycatch rates were lower (but not significantly so) during the late period of pinger use (2001–2009) when compared with the early period of pinger use (1996–2001) (Table 4, Figure 4).

Bycatch rates of California sea lion were higher with pinger use, but pingers do not appear to be responsible for this increase. A more likely explanation is continuing increases in California sea lion numbers (Carretta et al., 2009) coincident with a decline in fishing effort. Northern elephant seal bycatch significantly declined with pinger use, which is interesting because so little is known about the hearing capabilities of these animals. One confounding factor in assessing long-term pinger effectiveness is that the year effect on entanglement rates is unknown, because only 2 years (1996 and 1997) are characterized by a sufficient number of sets with and without pingers. This potential effect could be better addressed if the experimental design of Barlow and Cameron (2003) were applied every year, but the desire to reduce absolute bycatch levels necessitates using pingers on all sets.

Habituation to pingers by cetaceans or pinnipeds is not apparent in this fishery, based on comparisons of set proportions with bycatch for early and late periods of pinger use. For cetaceans, this conclusion is largely driven by the relatively large numbers of short-beaked common dolphin entanglements. Increases in California sea lion bycatch rates in recent years are not likely due to pinger habituation or the dinner bell effect (see below).

Failure of ≥1 pingers in 19 of 502 observed sets (3.7%) provides one measure of the minimum fraction of sets where some pinger failure may be expected in this fishery. The true rate of pinger failure is probably higher because observers may sometimes fail to detect nonfunctioning pingers. Mean pinger failure in the 19 sets where it was observed was 6.8 per set, or approximately 15–20% of the usual number (35–40) fished per set. This failure rate appears to have a significant impact on the probability of cetacean bycatch and is probably related to resulting gaps in acoustic coverage of the net. Pinger failure rates have not been published for most fisheries, but Palka et al. (2008) reported that 13% of tested pingers were nonfunctional in an Atlantic gillnet fishery during years of high pinger use.

Our assumption is that depredation of swordfish catch is caused by California sea lions, which are the most abundant pinniped in California waters (Carretta et al., 2009) and are known to depredate swordfish catch in this fishery (Miller et al., 1983). It is unlikely that cetaceans depredate catch in this fishery, as most cetaceans entangled in the fishery feed on small schooling fishes or squid too small to be entangled in drift gillnets. Increases in depredation rates in 1997 coincide with the second year of the pinger experiment and the onset of a major El Niño event (Enfield, 2001). Reduced prey availability for California sea lions associated with El Niño events (DeLong et al., 1991) may increase the likelihood of depredation on gillnets and perhaps contributed to the relatively high depredation rates seen in 1997. Depredation rates have remained high since 1997 (Figure 5), which may reflect learned behavior by sea lions and increases in their population size since that time (Carretta et al., 2009). However, pingers do not appear to be linked to depredation, based on nearly equal depredation rates in sets with and without pingers and variable importance measures from Random Forest analysis. The most important variables, in order of importance, were *TotCatch*, *Month*, *Lat*, *Lon*, and *DeckLght*, with three of five related to the timing and location of fishing activity. The importance of *TotCatch* may reflect that sea lions are attracted to nets with greater numbers of entangled swordfish, while *DeckLght* importance suggests sea lions use vessel lights as visual cues to locate nighttime fishing activity. For the larger data set of 1998–2009, the variable *DeckLght* "loses importance." For unknown reasons, fishermen began using deck lights at much higher rates beginning in 1999 (in this case *DeckLght* behaves more like a constant than a variable). The year 1997 was characterized by low rates of deck light use compared to subsequent years and use of deck lights was not recorded prior to 1996 when the pinger experiment began. Thus, outside of 1997, it is difficult to assess the importance of deck lights on depredation. Although Random Forest provides measures of variable importance, no single variable may be "statistically significant" in the traditional sense. More often, there are ensembles of "weak predictors" with *collective* predictive power, as is the current case. The variable importance score for *TotCatch* reflects a ~1% decline in predictive accuracy after randomization (Figure 8), which would not be *statistically significant* in most types of analyses. However, in the framework of prediction, "significance" is based on the *aggregate predictability of an event*, with respect to the prior probability of success if none of the variables are informative. Recall that our Random Forest was constructed with equal numbers of Y/N depredation events, reducing the problem to a binomial one, with a 0.5 probability of success if all of the variables were uninformative. In that context, the probability of correctly predicting the depredation status of at least 64% of sets is <0.005.

Acknowledgments

We would like to thank Lyle Enriquez for managing the drift gillnet observer program. This work would not have been possible without the support of the National Marine Fisheries Service Southwest Regional Office and the cooperation of the California drift gill net vessel operators. The manuscript was improved by the reviews of Susan Chivers, Jeff Moore, and two anonymous reviewers.

Authors:

James V. Carretta and Jay Barlow
U.S. National Marine Fisheries Service
Southwest Fisheries Science
Center, National Marine Fisheries
Service, National Oceanic and
Atmospheric Administration,
3333 North Torrey Pines Court,
La Jolla, CA 92037
Email: Jim.Carretta@noaa.gov;
Jay.Barlow@noaa.gov

References

Barlow, J., & Cameron, G.A. 2003. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Mar Mammal Sci. 19:265-83. http://dx.doi.org/10.1111/j.1748-7692.2003.tb01108.x.

Bordino, P., Kraus, S., Albareda, D., Fazio, A., Palmerio, A., Mendez, M., & Botta, S. 2002. Reducing incidental mortality of franciscana dolphin *Pontoporia blainvillei* with acoustic warning devices attached to fishing nets. Mar Mammal Sci. 18(4):833-42. http://dx.doi.org/10.1111/j.1748-7692.2002.tb01076.x.

Breiman, L. 2001. Random Forests. Mach Learn. 45:5-32. http://dx.doi.org/10.1023/A:1010933404324.

Breiman, L., Friedman, J., Olshen, R., & Stone, C. 1984. Classification and Regression Trees. Pacific Grove, CA: Wadsworth Publishing Co., 358 p.

Carretta, J.V., Barlow, J., & Enriquez, L. 2008. Acoustic pingers eliminate beaked whale bycatch in a gill net fishery. Mar Mammal Sci. 24(4):956-61.

Carretta, J.V., & Enriquez, L. 2010. Marine mammal and sea turtle bycatch in the California/Oregon swordfish and thresher shark drift gillnet fishery in 2009. Southwest Fisheries Science Center Administrative Report LJ-10-03. 11 p.

Carretta, J.V., Forney, K.A., Lowry, M.S., Barlow, J., Baker, J., Johnston, D., … Carswell, L. 2009. U.S. Pacific Marine Mammal Stock Assessments: 2009. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFSC-453. 326 p.

Carretta, J.V., Price, T., Petersen, D., & Read, R. 2004. Estimates of marine mammal, sea turtle, and seabird mortality in the California drift gillnet fishery for swordfish and thresher shark, 1996–2002. Mar Fish Rev. 66(2):21-25.

Cox, T.M., Read, A.J., Solow, A., & Tregenza, N. 2001. Will harbour porpoises (*Phocoena phocoena*) habituate to pingers? J Cetacean Res Manage. 3(1):81-6.

Dawson, S.M. 1994. The potential for reducing entanglement of dolphins and porpoises with acoustic modifications to gillnets. Rep Int Whal Commn Special Issue. 15:573-8.

DeLong, R.L., Antonelis, G.A., Oliver, C.W., Stewart, B.S., Lowry, M.S., & Yochem, P.K. 1991. Effects of the 1982–1983 El Niño on several population parameters and diet of California sea lions on the California Channel Islands. In: Pinnipeds and El Niño: Responses to environmental stress, eds. Trillmich, F., & Ono, K.A., pp. 166-72. Berlin: Springer-Verlag.

Enfield, D.B. 2001. Evolution and historical perspective of the 1997–1998 El Niño–Southern Oscillation Event. Bull Mar Sci. 69(1):7-25.

Federal Register. 1997. Taking of marine mammals incidental to commercial fishing operations; Pacific offshore cetacean take reduction plan regulations. Final Rule. 62(192):51805-14.

Gearin, P.J., Gosho, M.E., Leake, J.L., Cooke, L., DeLong, R.L., & Hughes, K.M. 2000. Experimental testing of acoustic alarms (pingers) to reduce bycatch of harbour porpoise, *Phocoena phocoena*, in the state of Washington. J Cetacean Res Manage. 2(1):1-9.

Julian, F., & Beeson, M. 1998. Estimates of marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990–95. Fishery Bulletin, U.S. 96:271-84.

Kraus, S. 1999. The once and future ping: Challenges for the use of acoustic deterrents in fisheries. Mar Technol Soc J. 33(2):90-3.

Kraus, S.D., Read, A., Anderson, E., Baldwin, K., Solow, A., Spradlin, T., & Williamson, J. 1997. Acoustic alarms reduce porpoise mortality. Nature. 388:525. http://dx.doi.org/10.1038/41451.

Liaw, A., & Wiener, M. 2002. Classification and regression by randomForest. R News. 2(3):18-22.

Miller, D.J., Herder, M.J., & Scholl, J.P. 1983. California marine mammal fishery interaction study, 1979–81. NMFS Southwest Fish. Cent., Administrative Report LJ-83-13C. 233 p.

Palka, D.L., Rossman, M.C., VanAtten, A.S., & Orphanides, C.D. 2008. Effect of pingers on harbour porpoise (*Phocoena phocoena*) bycatch in the U.S. Northeast gillnet fishery. J Cetacean Res Manage. 10(3):217-26.

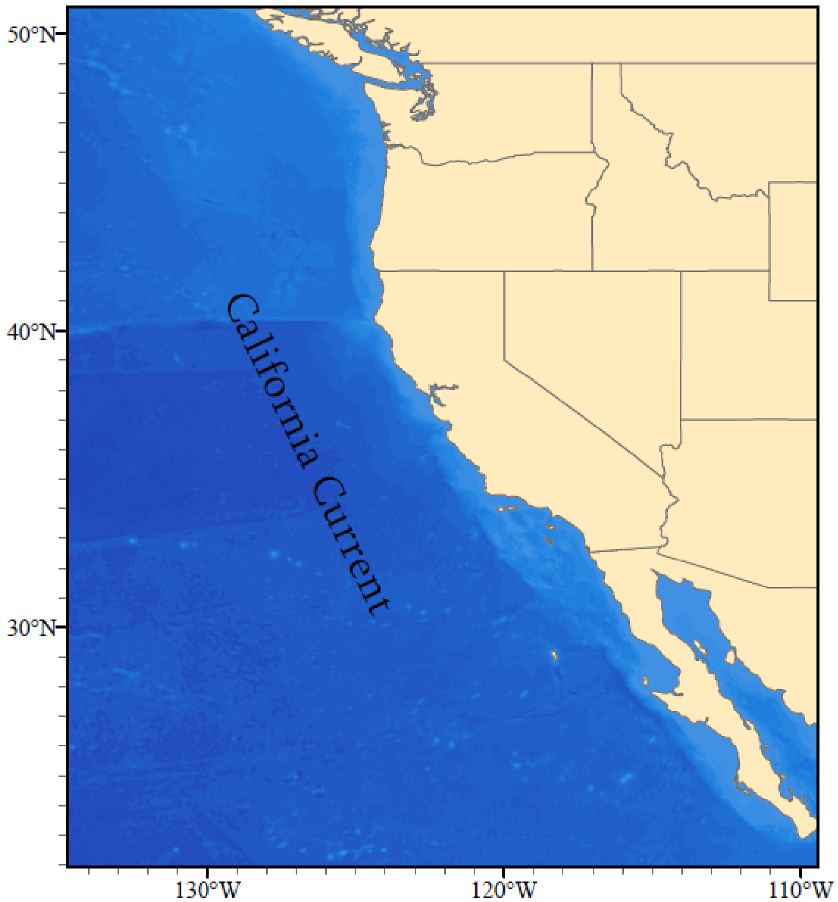
R Development Core Team. 2006. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org.

Trippel, E.A., Strong, M.B., Terhune, J.M., & Conway, J.D. 1999. Mitigation of harbour porpoise (*Phocoena phocoena*) by-catch in the gillnet fishery in the lower Bay of Fundy. Can J Fish Aquat Sci. 56:113-23. http://dx.doi.org/10.1139/cjfas-56-1-113.

2011 Annual Report
Volume 4, Annual 3

Summary of 2011 Climatic and Ecological Conditions In the California Current LME

This report is a 2011 summary of climate and ecosystem conditions for 2011, for public distribution, compiled by PaCOOS coordinator Rosa Runcie (email: Rosa.Runcie@noaa.gov).
Full content can be found after the Executive Summary. Previous summaries of climate and ecosystem conditions in the California Current can be found at http://pacoos.org/



CLIMATE CONDITIONS IN BRIEF

- **El Niño Southern Oscillation (ENSO):** La Niña to ENSO-neutral conditions occurred during May 2011 and continued through July 2011. La Niña conditions returned in August 2011 and strengthened during September and October. November and December 2011, La Niña conditions continued across the eastern and central equatorial Pacific Ocean. La Niña conditions are expected to gradually strengthen and continue into the Northern Hemisphere winter 2011-2012.
- **Pacific Decadal Oscillation (PDO):** The PDO has been mostly negative since September 2007 however the 2009-2010 El Niño event disrupted this pattern for 10 months. The PDO is now once again negative and values have been strongly negative (> - 1.3) since July 2011.
- **Upwelling Index (UI):** The Upwelling Indices show that upwelling during 2011 was about average overall. However, there was considerable monthly variability relative to the 20-year (1948-67) upwelling index (UI) mean. During 2011 cool salty waters, characteristic of upwelling, were found from Baja California to Vancouver Island. The cessation of upwelling in mid-September resulted in one of the shortest annual upwelling periods since the 1997 El Niño.

- **Madden Julian Oscillation (MJO):** The MJO index did not indicate significant MJO activity from January to March. The MJO strengthened early April but began to weaken mid-April as it propagated eastward. The MJO index increased in amplitude early May. The MJO index did not indicate significant MJO activity from June through early August, and increased in amplitude late-August. The MJO strengthened the third week of September and indicated some irregular eastward propagation followed by an increase in amplitude the last week of September. The MJO continued an eastward propagation the first three weeks of October and increased in strength mid-October. The amplitude decreased early November followed by an increase mid-to-late November with continued eastward propagation. Mid-to-late December, the MJO continued eastward propagation, and was not as strong in activity during December 2011 as the activity during autumn 2011.
- **Water Temperature and Salinity at Newport Hydrographic Line, Oregon:** Analysis of water mass properties in terms of average temperature and salinity at a depth of 50 m at station NH 05 shows that interannual variations in water mass properties are in general related to the PDO: during positive PDO years, relative fresh and warm water is found at depth and vice versa. Upwelling in 2011 did not bring cold salty waters to the continental shelf. Rather, intermediate values of both temperature and salinity were seen in both the 2nd and 3rd quarters as well as in the May-September composite.
- **Observations along the Trinidad Head Line, California:** Unlike the pervious two years, in which substantial downwelling and freshening of the entire water column was observed at the midshelf station (TH02) towards the end of the year, late 2011 was marked by periods of sustained northerly winds. Freshening of the surface waters occurred, possibly as a consequence of seasonal riverine discharge, but the physical effects of upwelling on water column characteristics are clearly evident into mid December. No substantial phytoplankton bloom has been observed in response to this late-year upwelling.

ECOSYSTEM CONDITIONS IN BRIEF

- **California Current Ecosystem Indicators:**
    1. **Oregon Copepods:** Two copepod indices continue to track closely the PDO and ONI. These indices are (1) the copepod species richness monthly anomaly and (2) the copepod community index monthly anomaly. The result can be interpreted as follows: when the PDO is in a negative phase, boreal, lipid-rich cold water copepod species are transported southward out of the Gulf of Alaska and become the dominant components of the lower trophic levels. When the PDO is in positive phase, warm water, and lipid-poor copepod species typical of subtropical waters that lie offshore and south of Oregon become important in the Northern California Current and in some years dominate.
    2. **Southern California Krill:** The abundance of euphausiids was assessed off Southern California (SC) and off Central California (CC) from springtime CalCOFI cruises. In Spring 2011, the abundance of the cool-temperate *Euphausia pacifica* and *Thysanoessa spinifera* was slightly-to-moderately higher than the long-term mean in both SC and CC, while the coastal subtropical species *Nyctiphanes simplex* was undetectable in both regions.
    3. **Central-Northern California Juvenile Rockfish:** The annual midwater trawl survey for juvenile rockfish and other pelagic nekton along the Central California coast in May-June showed trends in 2010 and 2011 were of increasing abundance for the species and assemblages that tend to do better with cool and productive conditions, including juvenile rockfish, juvenile Pacific hake, market squid and krill. In 2011, juvenile rockfish, market squid, and other groundfish (such as Pacific hake, shown, and Pacific sanddabs, not shown) were at their highest levels since the early 2000s. By contrast, the coastal pelagic forage species (adult northern anchovy and Pacific sardine) were at low levels in 2009 and 2010. As with the 2010 results, the 2011 survey continued to indicate a return to conditions similar to those seen in the early 1990s and early 2000s.

4. **Coastwide Coastal Pelagics:**
   Pacific Sardine:
   Canadian Program on High Seas Salmon: integrated epipelagic ecosystem survey off the west coast of British Columbia to Southeast Alaska: Sardine catches were lower off British Columbia in 2011 compared to 2010, and may be attributed to generally lower sea surface temperatures in 2011.
   Summer trawl sardine survey off the West Coast of Vancouver Island (WCVI), 2011 update: Regional estimates of sardine catch density and seasonal biomass in the WCVI core survey region from night sampling in 2006 and 2008 to 2010 (no survey was conducted in 2007) show a declining trend, whereas the 2011 estimates are approximately double the 2010 estimates.
5. **Salmon:** Pelagic fishes have been sampled in June and September off the coast of Washington and Oregon since 1998. Catches of juvenile salmonids in the June survey were about average for juvenile coho and spring Chinook but well below average in September. Although it is difficult to assign a direct cause for what appears to be poor survival during the summer 2011, conditions indicate that the poor survival was due to generally weak upwelling conditions during the summer as a short upwelling season.

- **Marine Birds and Mammals:**
  Marine Birds: The relative abundance of Cassin's auklets on CalCOFI surveys declined from the late 1980s to late 1990s before rebounding in the early-mid 2000s. The long-term trend showed no trend in auklet density over the past 15 years. The latter years (2010 and 2011) showed low relative abundance. The relative abundance of shearwaters showed a consistent decline over the 25-year time series (1987-present), though the rate of change has decreased recently. From low-points in the mid-1990s, shearwater relative abundance increased in the mid-late 1990s, before declining steadily thereafter. The latter years (2010 and 2011) showed a disparate pattern with higher abundance of shearwaters in 2010 and lower abundance in 2011.
- **Harmful Algal Blooms:**
  Washington: No annual summary was available at the time of this report.
  Oregon: *Alexandrium* persisted along much of the coast during the spring and summer while *Pseudo-nitzschia* was infrequently reported until August. Increases in phycotoxins in bivalve tissue resulted in one shellfish closures during the year. Other harmful algae encountered during 2011 include *Chochlodinium sp.*, *Akashiwo sanguinea* and *Dinophysis spp.*.
  California: *Pseudo-nitzschia* was observed at a number of sites along the entire southern California coast from January to May. During January to March, low numbers of *Alexandrium* were detected at sampling sites throughout southern California. *Alexandrium* was not observed at any northern California sampling sites in January and was observed at only two sampling sites in February. Domoic acid was not detected in any shellfish samples analyzed in northern California in September.

- **Dissolved Oxygen Concentration**

PACIFIC COAST FISHERIES MANAGEMENT SUMMARIES AND RECOMMENDATIONS IN BRIEF

- **Highly Migratory Species (tuna, sharks, billfishes):** Bigeye overfishing is still occurring, so members need to agree on a replacement measure at the February 2012 meeting.

- **Pacific Sardine:** Summary of the Oregon fishery for pacific sardine (*Sardinops sagax*): Lower estimates of biomass and the resultant lower Harvest Guidelines since 2008 have led to a derby style fishery and changed the timing of the fishery off Oregon and Washington with peak catch occurring in July during recent years for Oregon vessels.

Summary of the Washington purse seine fishery for pacific sardine (*Sardinops sagax*): A review of landings data from the top five vessels from 2000-2011 shows that a single vessel total annual landing average about 1,400 metric tons.

NEW RESEARCH ACTIVITIES IN THE CALIFORNIA CURRENT SYSTEM IN BRIEF

- **Marine Mammals:** "SOCAL-BRS" (Behavioral Response Study) is a multi-year effort (2010-2014) designed to better understand marine mammal behavior and reactions to sound. Altogether, 38 tags were deployed on 25 blue whales, 7 Risso's dolphins, 2 bottlenose dolphins, and one Cuvier's beaked whale. A summary of this study will be included in the SOCAL-11 project report that will be issued sometime in early 2012.

CLIMATE CONDITIONS

El Niño Southern Oscillation (ENSO):

Source : http://www.cdc.noaa.gov/people/klaus.wolter/MEI/mei.html, http://www.cpc.noaa.gov/products/analysis_monitoring/enso_advisory/

The Multivariate ENSO Index (MEI) turned strongly negative in April 2010, to large negative values not seen since 1955 and the mid-1970s (Figure 1). A transition from La Niña to ENSO-neutral conditions occurred during May 2011. During June and July 2011, ENSO-neutral conditions continued and were reflected in the overall pattern of small sea surface temperature (SST) anomalies across the equatorial Pacific Ocean. La Niña conditions returned in August 2011 due to the strengthening of negative SST anomalies across the eastern half of the equatorial Pacific Ocean. During September and October 2011, La Niña conditions strengthened as indicated by increasingly negative SST anomalies across the eastern half of the equatorial Pacific Ocean. November and December 2011, La Niña conditions continued across the eastern and central equatorial Pacific Ocean. MEI values from 2005 to 2011 are shown in Figure 2. While it is not yet clear what the ultimate strength of this La Niña will be, La Niña conditions are expected to gradually strengthen and continue into the Northern Hemisphere winter 2011-2012.

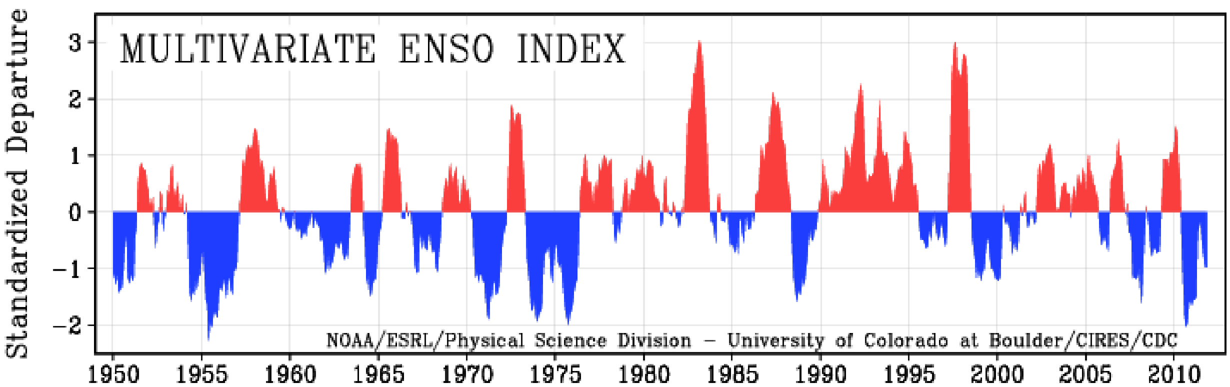


Figure 1. NOAA Physical Sciences Division attempts to monitor ENSO by basing the Multivariate ENSO Index (MEI) on the six main observed variables over the Pacific. These six variables are: sea-level pressure, zonal and meridional components of the surface wind, sea surface temperature, surface air temperature, and total cloudiness fraction of the sky.

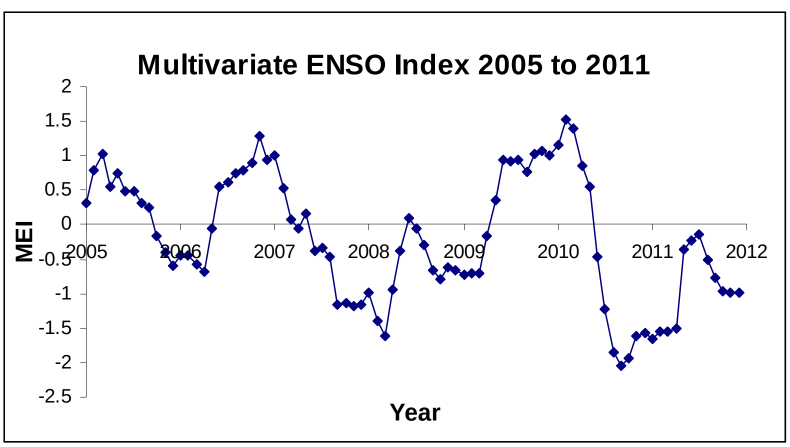


Figure 2. Multivariate ENSO Index 2005 to 2011. Mean used from bimonthly MEI values from the entire MEI Index time series, starting with Dec1949/Jan1950 thru Nov/Dec2011 (http://www.esrl.noaa.gov/psd/enso/mei/table.html).

Northern California Current ENSO Conditions:
Source: Bill Peterson, NOAA, NMFS
The transition to cold ocean conditions established in the northern California Current (NCC) in September 2007 was interrupted by a moderately strong El Niño event that warmed coastal waters of the NCC from August 2009 through May 2010. However, the NCC since has returned to cool phase conditions as a result of La Niña initiated in June 2010. This is indicated by a negative Oceanic Niño Index (ONI) and negative PDO value. Their values continue to be negative through November 2011. Should the La Niña conditions persist into spring 2012, the result will be perhaps the best ocean conditions (from the viewpoint of coastal pelagic fishes) observed in the past few decades. Juvenile salmon which enter the sea in spring 2012 (spring Chinook, coho and steelhead) might have very high survival. There is some uncertainty in this prognosis because some NOAA forecast models predict a weakening of La Niña conditions whereas others predict a strengthening. Regardless, cold ocean conditions will likely prevail through the spring of 2012.

Pacific Decadal Oscillation (PDO):
Source: Jerrold Norton, NOAA (Jerrold.G.Norton@noaa.gov),
http://jisao.washington.edu/pdo/, http://www.pfeg.noaa.gov/products/PFEL/modeled/indices/upwelling/NA/data_download.html
http://coastwatch.pfel.noaa.gov/cgi-bin/elnino.cgi NMFS/SWFSC/ERD monthly coastal upwelling index, http://jisao.washington.edu/pdo/
http://jisao.washington.edu/pdo/PDO.latest, http://www.osdpd.noaa.gov/ml/ocean/sst/anomaly.html,
http://www.cpc.ncep.noaa.gov/products/GODAS/
The Pacific Decadal Oscillation: The Pacific Decadal Oscillation index (PDO) is positive when there are positive sea surface temperature (SST) anomalies along the coast and extending 1500 km off of western North America and negative SST anomalies farther offshore and in the central and western North Pacific. Negative PDO index values indicate the reverse pattern where the positive anomalies are offshore and negative SST anomalies are characteristic of coastal regions. Negative SST anomalies have persisted in the northeastern Pacific Ocean over the last 16 months. The November PDO value is strongly negative (-2.33) and the lowest since December 1961, but statistically comparable negative values occurred in the last quarters of 1990 and 1999. These strongly negative values occur during runs of negative monthly PDO indices. Only about 25% of the last 60 monthly PDO have been positive. Negative PDO conditions are expected to persist into spring. More robust California salmon populations are associated with the negative PDO. The environmental conditions associated with the current persisting negative PDO pattern are probably partially responsible for the success of recent salmon stock rebuilding efforts in California. It is also likely that the current persisting PDO pattern is partially responsible for the return of robust market squid fisheries to the Monterey Bay area.

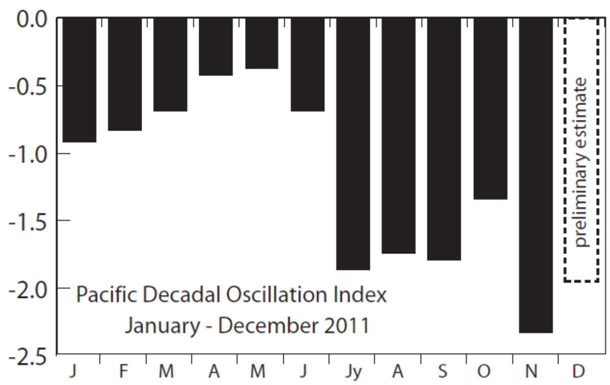


Figure 3. The graph shows monthly values for the Pacific Decadal Oscillation (PDO) Index for January 2011 through December 2011. The PDO is considered a long-lived El Niño like pattern of Pacific climate variability based on sea surface temperature measurements north of 10°N. Monthly PDO index values are found at http://jisao.washington.edu/pdo/PDO.latest .

Pacific Decadal Oscillation (PDO), the Oceanic Niño Index (ONI), and Sea Surface Temperature at Newport, Oregon:
Source: Bill Peterson, NOAA, NMFS
The PDO has been mostly negative since September 2007 however the 2009-2010 El Niño event disrupted this pattern for 10 months. The PDO is now once again negative and values have been negative (< - 1.3) since July 2011 Logerwell et al. (2003) showed that one prerequisite for good coho salmon survival is a cold winter preceding the spring when they enter the sea as juveniles. Assuming that the same is true for yearling Chinook salmon, the strongly negative values of the PDO observed in autumn 2011, if they persist through

the winter and early spring of 2011-2012, could result in the best ocean conditions for salmon in decades. This is an early indication that 2012 could result in some of the highest catches and returns of salmon to the Columbia River and coastal streams of Washington and Oregon in 2013 (for coho) and 2014 (spring Chinook). Values of the PDO averaged over the summer months of May-September are shown in Figure 4.

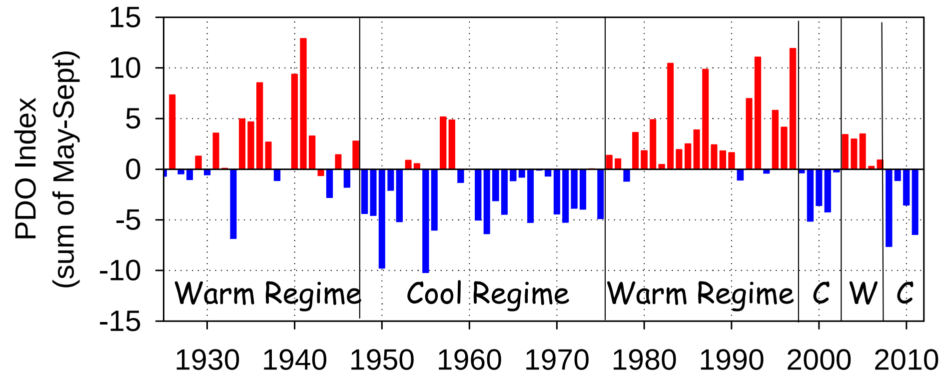


Figure 4. Time series of the PDO showing values summed from May through September of each year. Note that the "decadal" pattern has now shifted to a semi-decadal pattern, with shifts more frequently.

The Oceanic Niño Index (ONI): The PDO and ONI are often highly correlated (Figure 5). The ONI is a three month running mean of SST anomalies in the Nino 3.4 region (5°N-5°S; 120°-170°W). The change in sign of the PDO to negative in June 2010 was accompanied by a change in sign of the ONI in the same month. The ONI presently (November 2011) has a value of – 0.7, and although this is not a strongly negative value, it is noteworthy that it has been becoming more negative each month since July 2010 (Figure 5). Negative ONI values are expected to continue (as indicated by the forecast of for continued La Niña conditions at the equator) which suggests that the northern North Pacific will also remain cold into the spring 2012.

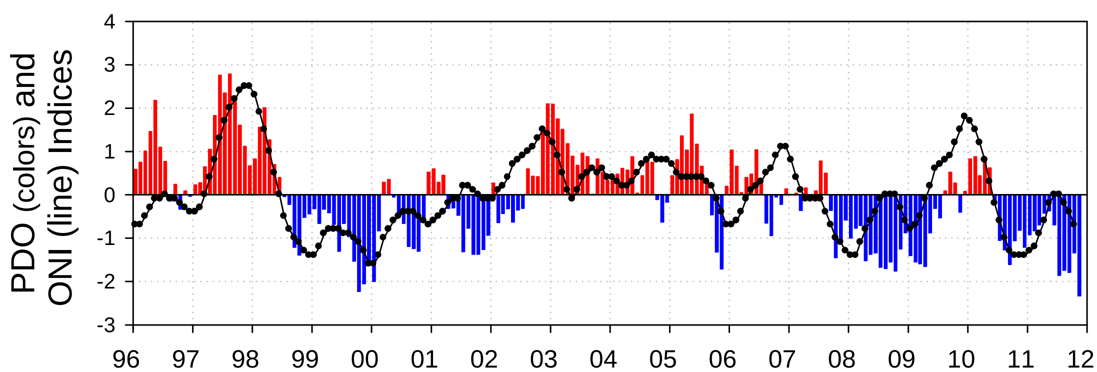


Figure 5. Time series of monthly values of the Oceanic Niño Index (ONI) and Pacific Decadal Oscillation (PDO), from 1996 to present. Note that the two indices are often correlated with the ONI often leading the PDO. Both changed sign at the same time in 2010 (in July). It is also noteworthy that the PDO has been in negative phase for most months from August 2007 until present.

Sea surface temperatures measured at Newport, Oregon: In past reports SST from the NOAA Buoy 46050 located 20 miles off Newport have been reported. The NOAA buoy was damaged by a storm in February 2011 and not repaired until July 2011. Instead for 2011, SST measured at station NH-05 (five miles from shore along the Newport Hydrographic Line) are reported, and upwelling season temperature anomaly (averaged over the months of May-September are shown (Figure 6). SSTs during the summer of 2011 were cooler than normal as expected during the negative phase of the PDO.

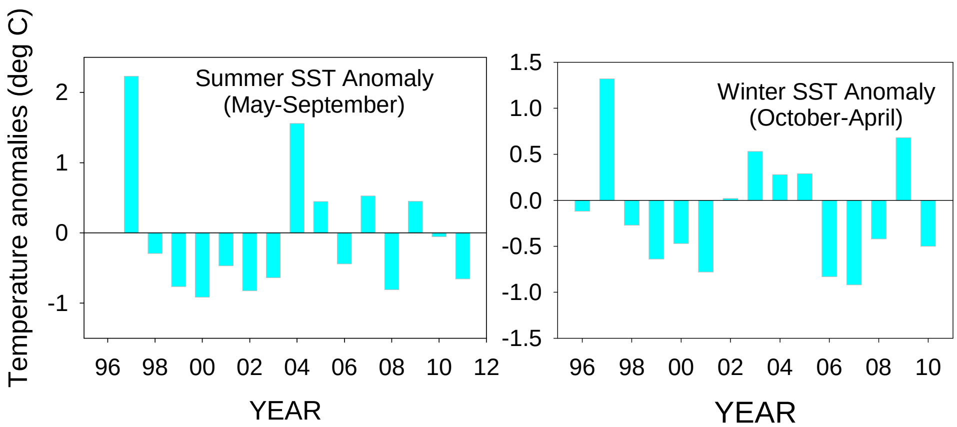


Figure 6. SST anomalies at station NH 05 during summer (left) and winter (right). Note that during the winter of 2010-11 and during summer 2011, waters were colder than normal in accord with the negative values of the PDO observed during the same time period.

Upwelling Index:

Source: Jerrold Norton, NOAA (Jerrold.G.Norton@noaa.gov)

The Upwelling Indices (Figure 7) show that upwelling during 2011 was about average overall. However, there was considerable monthly variability relative to the 20-year (1948-67) upwelling index (UI) mean. The season of consistent upwelling favorable winds is variable with latitude and from year-to-year. Equator ward, upwelling favorable, winds are associated with the eastern Pacific subtropical high atmospheric pressure system that is persistent throughout the year off southern Baja California. As this high pressure builds northward in the spring upwelling becomes more intense progressively farther north. Upwelling is less intense and has a shorter season at northern locations (Figure 7, top panel). During 2011 cool salty waters, characteristic of upwelling, were found from Baja California to Vancouver Island. Some observers found pulsed, rather than more continuous presence of upwelled water. Variation in the monthly upwelling pattern is shown by the upwelling index anomalies (Figure 7, bottom panel).

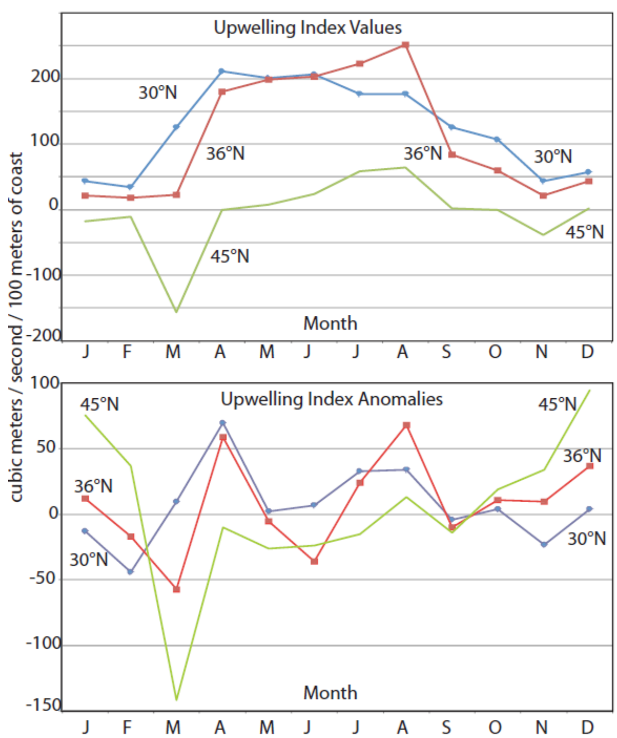


Figure 7: Monthly Upwelling Indices and anomalies at 30°,36° and 45°N (http://www.pfeg.noaa.gov/products/pfel/modeled/indices/upwelling/NA/upwell_menu_NA.html).

Source: Bill Peterson, NOAA, NMFS and El Niño Watch, Advisory http://coastwatch.pfel.noaa.gov/cgi-bin/elnino.cgi
Upwelling was initiated on day 105 (15 April) in 2011 (Figure 8). However, the winds were relatively weak during the beginning of the season, and significant upwelling did not start until day 155 (June 4). There was an early end to the 'season', with a reversal to primarily downwelling conditions on day 259 (16 September). The cessation of upwelling in mid-September resulted in one of the shortest annual upwelling periods since the 1997 El Niño. The total amount of upwelling for 2011 was 4,555 m^3/s per 100 m of coastline, which is 26% lower than the 40–year average of 6,163 m^3/s per 100 m.

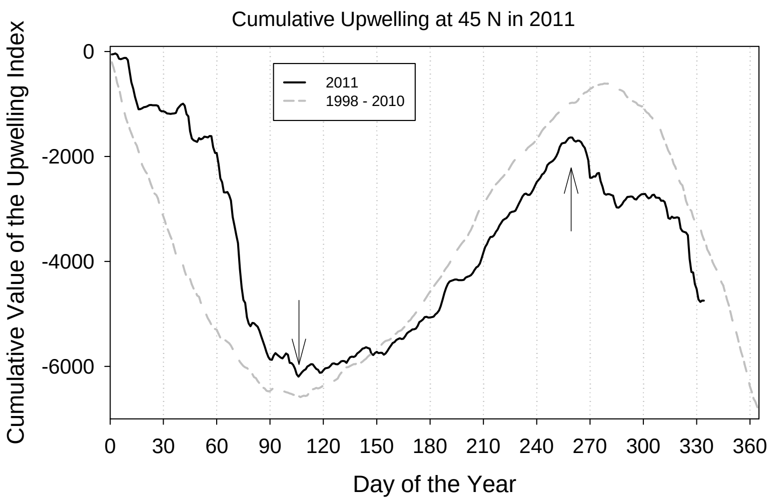


Figure 8. Cumulative values of the PFEL coastal upwelling index compared to climatology of 1998-2010. Upwelling in 2011 began at about the same time as the "average" year, but ended significantly earlier than climatology. The vertical arrows indicate the date of spring and fall transitions points (spring transition on day 105 (15 April); fall transition on day 259 (16 September).

Madden Julian Oscillation (MJO):

Source: **http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml** ***(Expert Discussions)***
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/ARCHIVE/ ***(summaries)***
The MJO is an intraseasonal fluctuation or "wave" occurring in the global tropics with a cycle on the order of 30-60 days. The MJO has wide ranging impacts on the patterns of tropical and extratropical precipitation, atmospheric circulation, and surface temperature around the global tropics and subtropics. The MJO does not cause El Niño or La Niña, but can contribute to the speed of development and intensity of El Niño and La Niña episodes. The MJO index did not indicate significant MJO activity during the first week of January. During mid-January the MJO strengthened and by late January the 850-hPa easterly zonal winds weakened and westerly anomalies developed near the Date Line due to increased MJO activity. The MJO weakened the first two weeks in February. Westerly 200-hPa vector wind anomalies weakened during the first week across the equatorial Pacific Ocean. The MJO remained week throughout February and March, although the MJO index indicated an increase in amplitude with eastward propagation of 200-hPa velocity potential anomalies during the first half of March. The MJO strengthened early April and began to weaken mid-April as it propagated eastward. Late April, the MJO index indicated a slight strengthening of the signal with eastward propagation and faster speeds than typically associated with the MJO. The MJO index increased in amplitude early May, with the enhanced convective phase of the MJO located over the western Pacific. The MJO index did not indicate significant MJO activity all of June and through early August 2011. Westerly 850-hPa vector wind anomalies persisted across the eastern Pacific Ocean early-to-mid June with a slight increase in intensity late June. Westerly anomalies persisted across the eastern Pacific Ocean early July. Mid-July, the MJO index indicated fast eastward propagation associated with other subseasonal coherent tropical variability. Late July, westerly anomalies shifted northward and weakened. Early to mid-August, westerly anomalies continued and strengthened across the Pacific. Late August, the MJO index increased in amplitude with eastward propagation. The MJO index indicated weak activity during the first two weeks of September. The MJO strengthened the third week of September and indicated some irregular eastward propagation followed by an increase in amplitude the last week of September. The MJO continued an eastward propagation the first three weeks of October and increased in strength mid-October. Late October, the MJO index indicated a decrease

in amplitude with reduced eastward propagation. The MJO amplitude decreased early November followed by an increase mid-to-late November with continued eastward propagation. Early-to-mid December the MJO index began to weaken with little eastward propagation. Mid-to-late December, the MJO increased in amplitude with continued eastward propagation. The MJO was not as strong in activity during December 2011 as the activity during autumn 2011.

Deep Water Temperature and Salinity at Newport Hydrographic Line, OR:
Source: Bill Peterson, NOAA, NMFS
Analysis of seasonally averaged temperature and salinity at a depth of 50 m at station NH 05 (water depth 62 m), shows that interannual variations in water mass properties are in general related to the PDO; during positive PDO years, relatively fresh and warm water is found at depth and vice versa. Figure 8 shows these relationships for the upwelling season (May-September) and subdivides this into quarterly values (2nd quarter, April-June which is early in the upwelling season), and 3rd quarter (July-September, when upwelling is strongest). Upwelling in 2011 did not bring cold salty waters to the continental shelf (a result that could be deduced from the upwelling index data in Figure 9). Rather, intermediate values of both T and S are shown in Figure 9.

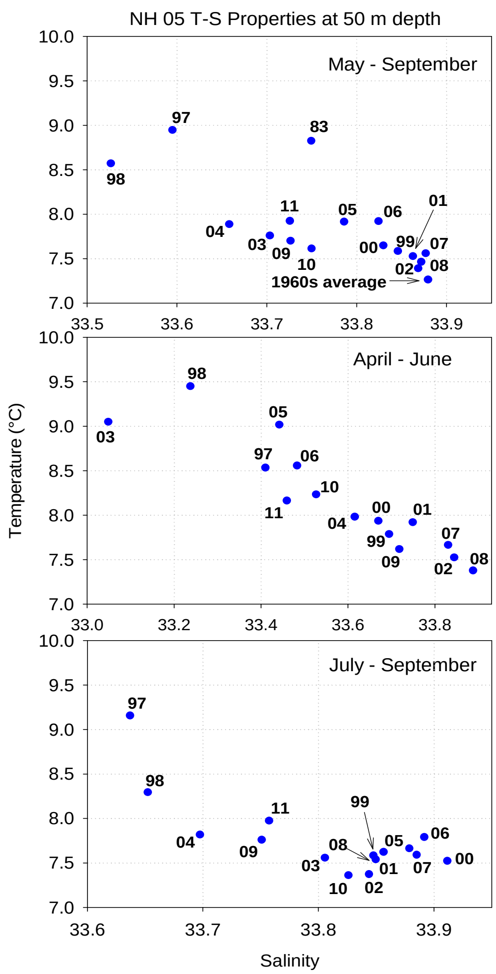


Figure 9. Temperature-Salinity at a depth of 50 m at station NH 05 (water depth 62 m), showing the interannual variations in water mass properties.

Quarterly update and annual summary of observations along the Trinidad Head Line (41° 03.5' N)
Source: Eric Bjorkstedt (NMFS/HSU), and Jeff Abell (HSU)

Observations along the Trinidad Head Line[1] during 2011 captured the response of the coastal ocean to the strong upwelling and downwelling events that occurred during the early part of the year, and the subsequent transition to summer conditions intermediate to those observed in 2009 and 2010, with a shallow, warmer layer lying over cooler waters on the shelf. Unlike the previous two years, in which substantial downwelling and freshening of the entire water column was observed at the midshelf station (TH02) towards the end of the year, late 2011 experienced periods of sustained northerly winds. There is some freshening of the surface waters, possibly as a consequence of seasonal riverine discharge, but the physical effects of upwelling on water column characteristics are clearly evident into mid December. No substantial phytoplankton bloom has been observed in response to this late-year upwelling.

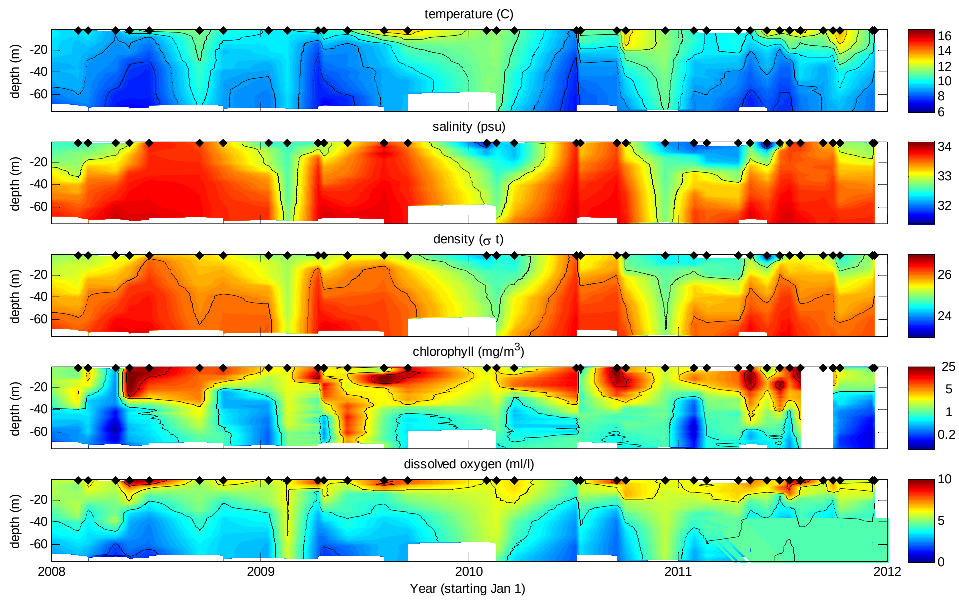


Figure 10. Preliminary observations of the evolution of water column characteristics at station TH02 (41° 03.5' N, 124° 16' W, approximately 7 nm offshore, 75m depth at mid-shelf) along the Trinidad Head Line. Top to bottom: Hovmoller plots (time by depth) from 2008 through 2011 of temperature, salinity, density, fluorescence, and dissolved oxygen. Blank areas indicate missing data. Small symbols along top of each plot indicate time of each cruise. Interpolations between widely spaced points should be interpreted with greater caution.

[1]Cruises along the Trinidad Head Line were supported by NOAA Fisheries SWFSC and by the Ocean Protection Council under a grant to Jeff Abell at Humboldt State University. We gratefully acknowledge the support and skill of Captain Scott Martin and crew of the R/V Coral Sea, and the assistance of Kathryn Crane, Jose Montoya, Caymin Ackerman, Ted Cummiskey, Greg O'Connell and the several other students, technicians, and volunteers who have helped to collect these data.

ECOSYSTEMS

California Current Ecosystem Indicators:
Oregon Copepods:
Source: Bill Peterson, NOAA, NMFS

Two copepod indices continue to track closely the PDO and ONI (Figure 11). These indices are (1) the copepod species richness monthly anomaly (based on the number of species in a given sample) and (2) the copepod community index monthly anomaly (based on an ordination of species abundance data from the same station NH05). When the PDO is in a negative (or "cold") phase, boreal, lipid-rich cold water copepod species are transported southward out of the Gulf of Alaska (GOA) and become the dominant components of the lower trophic levels. These species are also dominant zooplankton of the coastal ecosystem of the Bering Sea and coastal GOA. When the PDO is in positive (or warm) phase, warm water, and lipid-poor copepod species typical of subtropical waters that lie offshore and south of Oregon become important in the NCC and in some years dominate. "Species richness" tracks the PDO closely as well. It is low -PDO and high during +PDO, because subarctic water has lower copepod biodiversity than does the sub-tropics. Also, during warm phase of the PDO, upwelling tends to develop later in the year and subtropical copepod species that have been transported northwards with the Davidson current in winter will linger longer in shelf waters, into the spring/summer months, leading to a "subtropical copepod community" on the shelf in spring. These shifts at the base of the food chain between lipid-poor and lipid-rich plankton communities may significantly impact the feeding conditions for salmon and forage fishes.

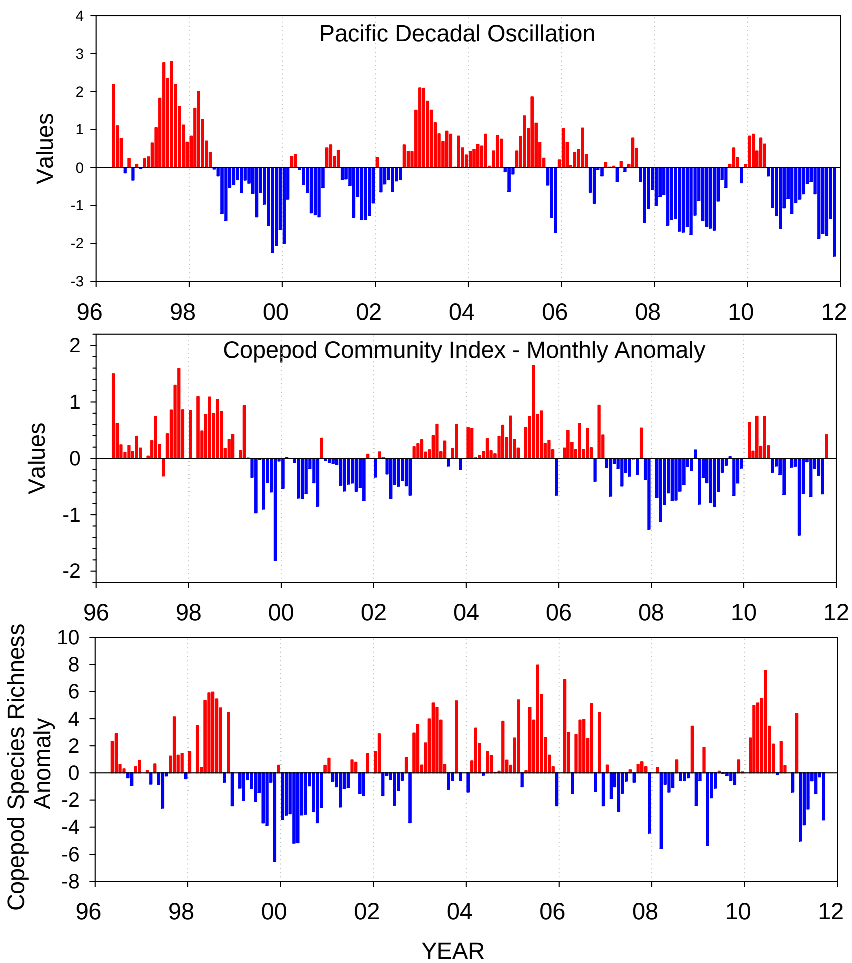


Figure 11. Monthly time series of the PDO compared to the monthly anomalies of the Copepod Community Index (derived from the x-axis scores of an ordination) and the monthly anomaly of the Copepod Species Richness (species richness is the number of species in a sample).

<u>Southern California Krill</u>:

Source: Mark D. Ohman, Scripps Institution of Oceanography (mohman@ucsd.edu)

<u>Euphausiids</u>: The abundance of euphausiids was assessed off Southern California (SC) and off Central California (CC) from springtime CalCOFI cruises. In Spring 2011, the abundance of the cool-temperate *Euphausia pacifica* and *Thysanoessa spinifera* was slightly-to-moderately higher than the long-term mean in both SC and CC, while the coastal subtropical species *Nyctiphanes simplex* was undetectable in both regions.

Ecosystem indicators for the Central California Coast, May 2011:

Source: John Field and Keith Sakuma, Fisheries Ecology Division, SWFSC

The Fisheries Ecology Division of the SWFSC has conducted an annual midwater trawl survey for juvenile rockfish and other pelagic nekton along the Central California coast in late spring (May-June) since 1983. The survey targets pelagic juvenile rockfish for fisheries oceanography studies and for developing indices of year class strength for stock assessments, although many other commercially and ecologically important species are captured and enumerated as well. The results here summarize trends in the core area since 1990, as not all species were consistently identified in earlier years. From 1983 through 2008 cruises took place on the NOAA ship David Starr Jordan, but since 2009 a series of different ships has been utilized; in 2011 the cruise took place onboard the F/V Excalibur and had limited temporal and spatial coverage relative to the post-2003 period. The data for the 2011 survey presented here are preliminary, and the analysis does not account for potential differences in catchability among vessels (although see Sakuma et al. 2006). Although this survey has sampled a greater spatial area (roughly Cape Mendocino to the U.S./Mexico border) from 2004 onward, the results presented here focus on the core survey area (corresponding to the region just south of Monterey Bay to just north of Point Reyes, CA) as the length of the time series leads to more informative insights.

The standardized anomalies from the log of mean catch rates are shown by year for six key forage species and assemblages that are sampled in this survey (Figure 12). Most are considered to be well sampled, although the survey was not designed to accurately sample either krill or coastal pelagic species which have variable depth distributions, and those numbers should be considered with caution. Trends in 2010 and 2011 were of increasing abundance for the species and assemblages that tend to do better with cool and productive conditions, including juvenile rockfish, juvenile Pacific hake and market squid. In 2011, juvenile rockfish, market squid, and other groundfish (such as Pacific hake, shown, and Pacific sanddabs, not shown) were at their highest levels since the early 2000s. By contrast, the coastal pelagic forage species (adult northern anchovy and Pacific sardine) were at low levels in 2009 and 2010, although this is likely a greater reflection of their local availability and ocean conditions rather than their coast wide or regional abundance. As with past reports (e.g., Bjorkstedt et al. 2010), the trends observed in these six indicators are consistent with trends across a broader suite of taxa within this region, with the first and second components (of a principle components analysis) explaining 39% and 14% of the variance in the data respectively (representing strong covariance among young-of-the-year groundfish, cephalopods and euphausiids, which in turn tend to be negatively correlated with coastal pelagic and mesopelagic fishes). As with the 2010 results, the 2011 survey continued to indicate a return to conditions similar to those seen in the early 1990s and early 2000s.

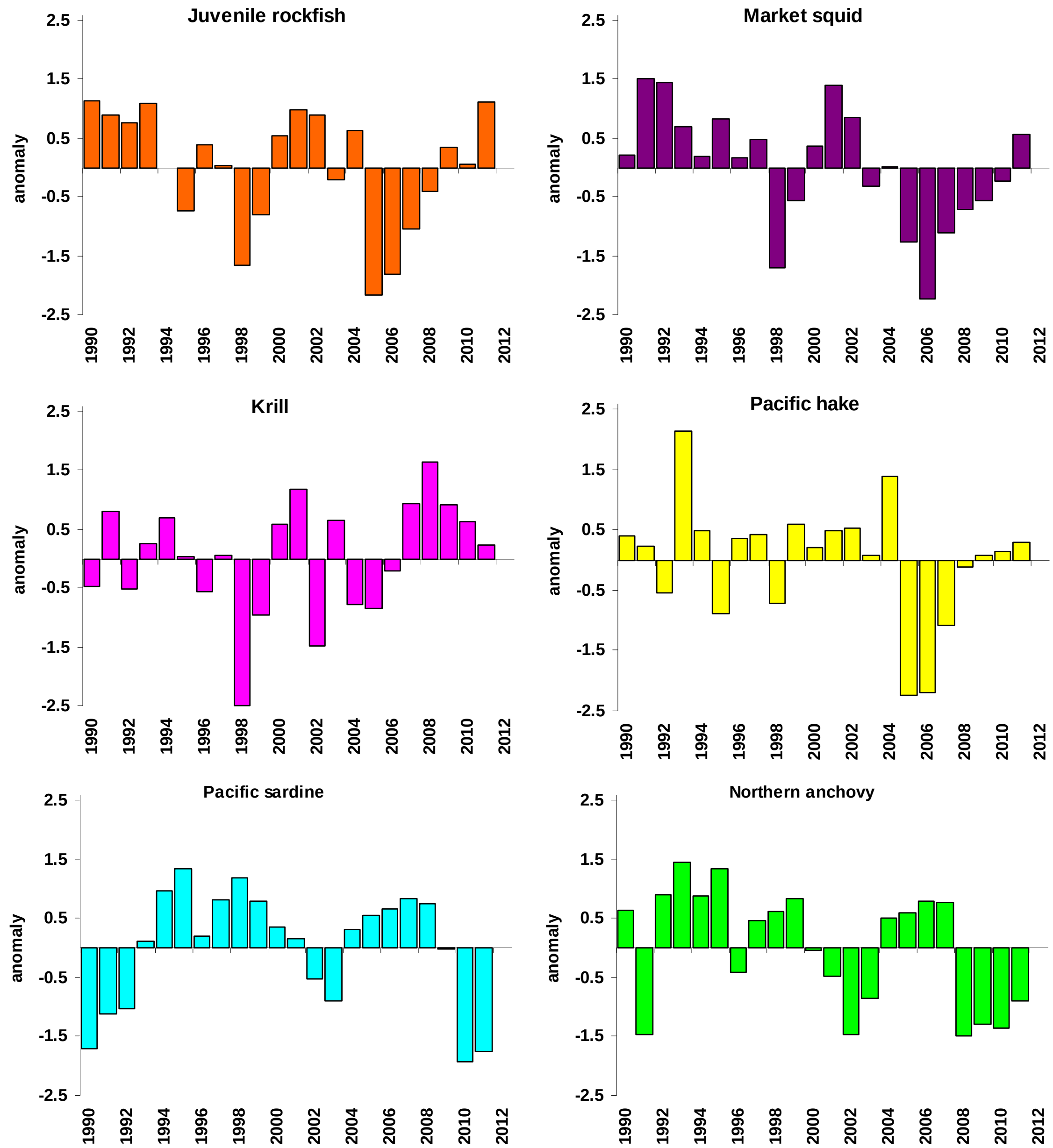


Figure 12. Long-term standardized anomalies of several of the most frequently encountered pelagic forage species from the central California rockfish recruitment survey in the core region (1990-2011 period only, not all taxa were recorded from 1983-1989).

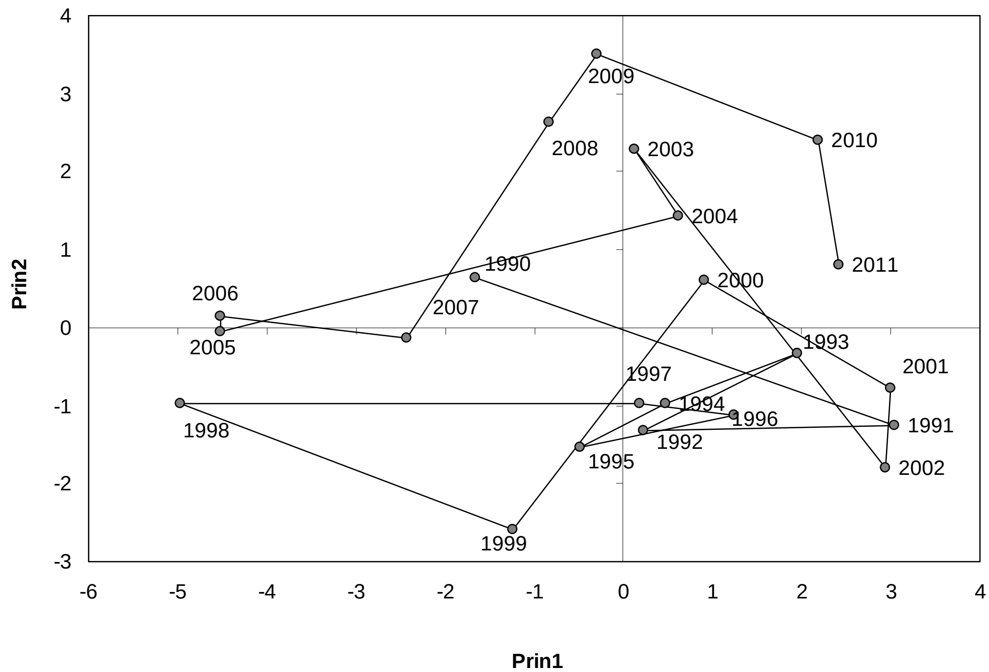


Figure 13. Principal component scores plotted in a phase graph for the fourteen most frequently encountered species groups sampled in the central California core area in during 1990-2011.

Pacific Sardine:
Canadian Program on High Seas Salmon: integrated epipelagic ecosystem survey off the west coast of British Columbia to Southeast Alaska.

Source: Marc Trudel, Fisheries and Oceans Canada, Nanaimo, BC

The Canadian Program on High Seas Salmon has been conducting integrated epipelagic ecosystem surveys from the west coast of British Columbia to Southeast Alaska since 1998 to assess the effects of ocean conditions and climate change on the distribution, migration, growth and survival of Pacific salmon, and to forecast salmon returns to British Columbia. These surveys are usually conducted in late spring-early summer (June-July) and in the fall (October-November). In addition, these surveys have been conducted during winter (February-March) since 2001 to assess the effects of winter conditions on the ecology, bioenergetics, and survival of juvenile salmon.   Results are shown for 2005-2011 (Figures 14-16).

Overall, sardine catches were lower off British Columbia in 2011 compared to 2010 (Figure 15), and may be attributed to generally lower sea surface temperatures in 2011. No sardines were caught in February-March 2011, whereas a few sardines were caught off the west coast of Vancouver Island during this time of year from 2005-2007 and in 2010 (Figures 14 and 15). Catch-per-unit effort and prevalence was also lower in June-July 2011—in fact, both measures were the lowest observed since our reporting started in 2005 (Figure 16). By October-November 2011, nearly all sardines had left the west coast of British Columbia—a pattern not observed since 2008. In contrast, sardines were still relatively abundant off the west coast of Vancouver Island during previous autumn surveys (other than 2008), and even as far north as the central coast of British Columbia (in 2005), presumably due to warmer waters in those years.

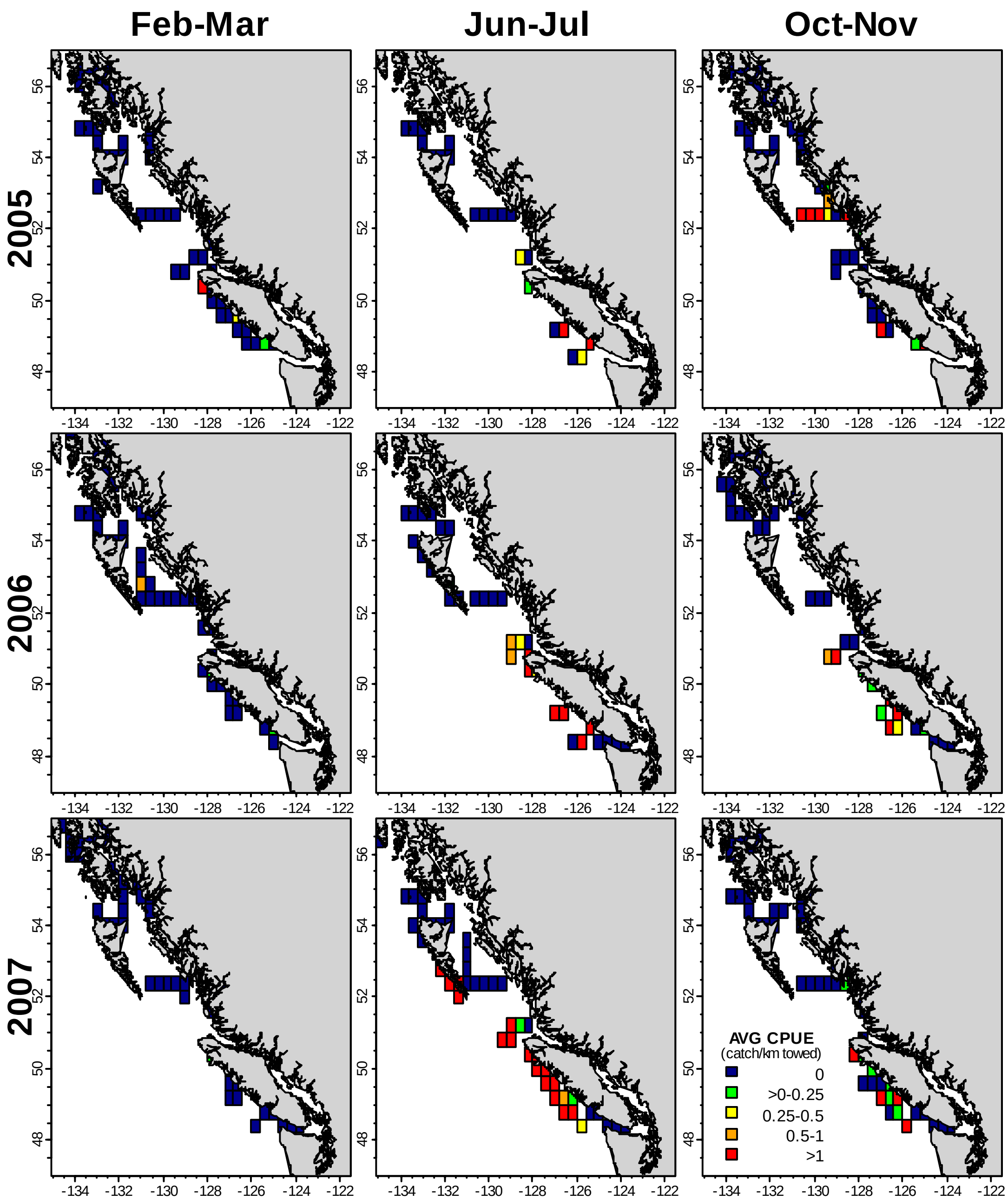


Figure 14. Average sardine CPUE by season and year, 2005-2007. Each cell represents a 0.4° latitude by 0.4° longitude area, and is colored based on the average CPUE of stations found in the cell.

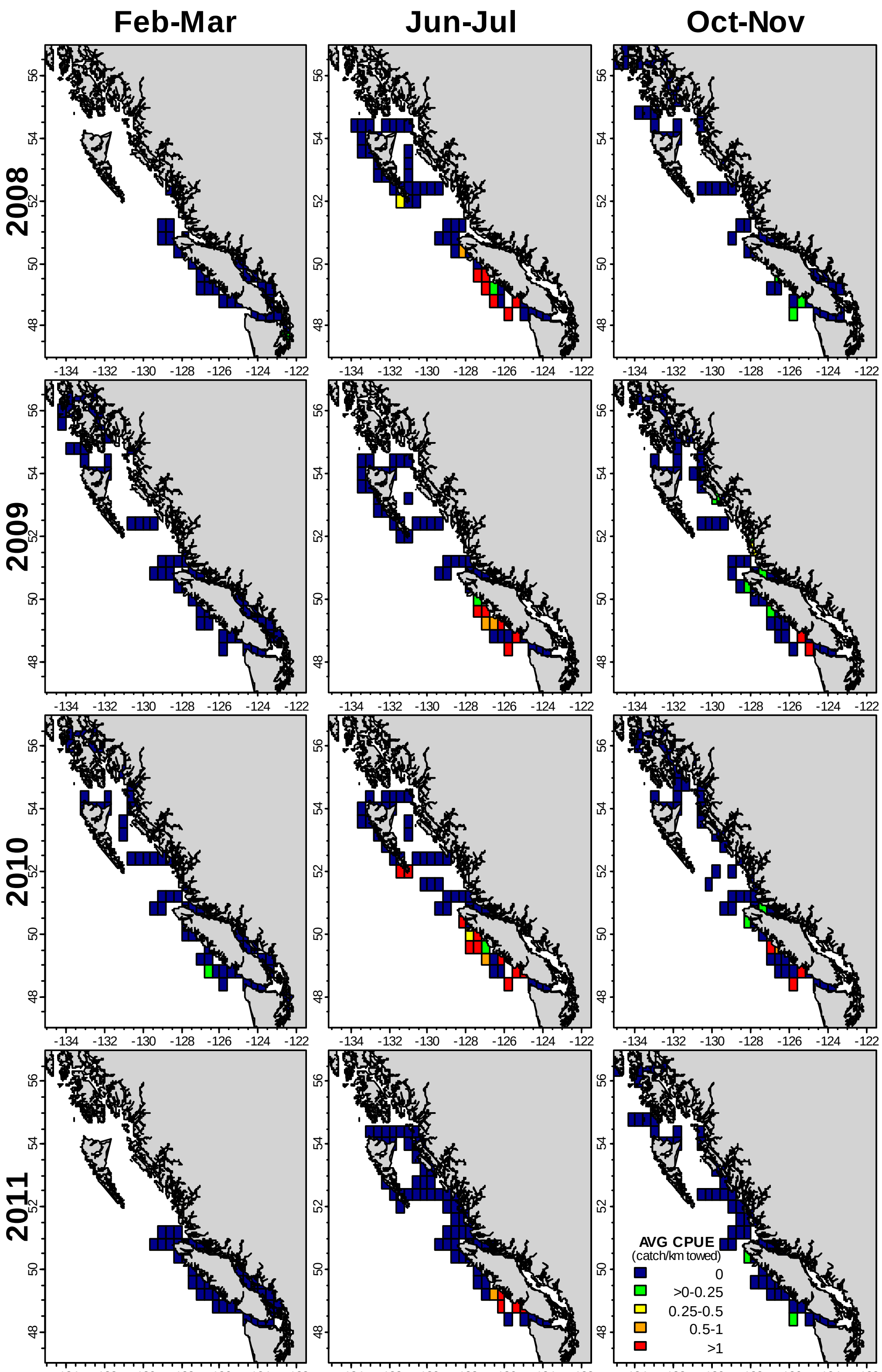
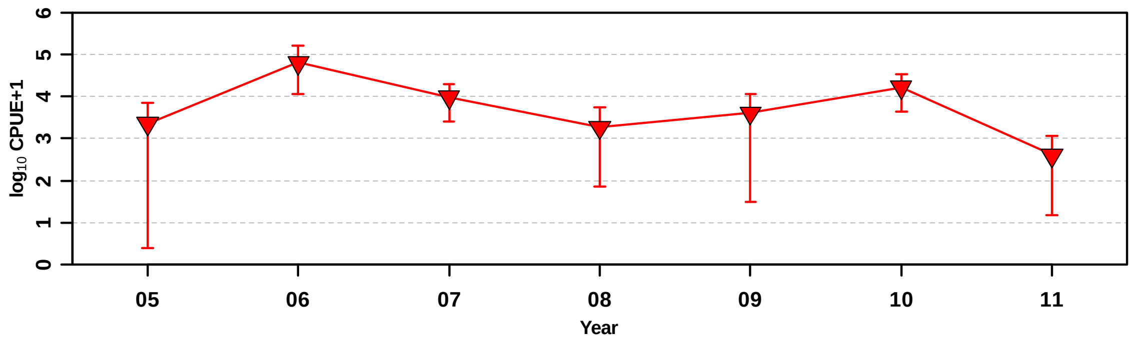


Figure 15. Average sardine CPUE by season and year, 2008-2011. Each cell represents a 0.4° latitude by 0.4° longitude area, and is colored based on the average CPUE of stations found in the cell.



Prevalence:	0.278	0.480	0.554	0.313	0.333	0.327	0.170

Figure 16. Annual variation in CPUE of sardines (all size classes combined) caught in High Seas Salmon trawl surveys off the west coast of Vancouver Island in summer (June-July). Prevalence indicates the percentage of stations from the survey that contained sardines.

Summer trawl sardine survey off the west coast of Vancouver Island, 2011 update.

Source: Jake Schweigert, Fisheries and Oceans Canada, Nanaimo, BC

<u>Survey background</u>

Summer surveys directed at collecting information on sardines off the West coast of Vancouver island (WCVI) started in 1992 (McFarlane and MacDougall, 2001). Fishing is conducted using a mid water trawl towed near the surface (e.g. <30 m) using floats on the headlines at average speeds approximating 4.0 to 5.5 knots. Since 2006, sampling has been conducted at night (Schweigert et al., 2009). Surveys are conducted to observe biological trends of sardine related to regional distribution, abundance, morphometrics and ecological conditions.

The 2011 survey was conducted between July 19 and August 1 and sampling sites were based on intersections of a regional 10x10km grid extending approximately 2 to 52 km from shore with a range in latitude of 50.7-48.5° extending southward to 10 km from the U.S. border. The region was further subdivided into 8 zones to aid in the planning of sampling coverage across the region and for future exploration of possible stratification schemes. Assignment of sampling stations was done by applying proportional probabilities to possible stations so that each sub-region would receive approximately equal sampling intensity. This was planned by assuming that 70 coastal stations would be sampled over the region. In 2011, 68 coastal stations were sampled and 41 of the tows had sardines. Relatively high catch densities occurred off Brooks Peninsula and southward throughout the region at varying distances from shore, whereas sampling sites further offshore and in the southeast corner of the region had many of the tows lacking sardines (Figure 17).

<u>WCVI survey catch densities and biomass estimates</u>

Biomass estimates for the region (and by sub-region in past reports) have been calculated using sardine catch densities (metric ton /km^3) and average sardine catch density extrapolated over the represented area's size and surface volume (Schweigert and McFarlane 2001; Schweigert et al., 2009; DFO, 2011). Sardine catch weights have been recorded for all tows and estimates of the volume of water swept during a tow have been determined by multiplying the length and width dimensions of the trawl net mouth by the effective fishing distance covered during the tow (time between end of net deployment and beginning of net retrieval). The core area of the survey region is approximately 16,740 km^2 and catch densities are assumed to represent sardine distributions in the top 30m of the region, therefore the region's surface volume is estimated at ~ 502.2 km^3 (Figure 1, DFO 2011). Recent regional estimates of sardine catch density and seasonal biomass in the WCVI core survey region from night sampling in 2006 and 2008 to 2010 (no survey was conducted in 2007) show a declining trend, whereas the 2011 estimates are approximately double the 2010 estimates (Figures 17 and 18).

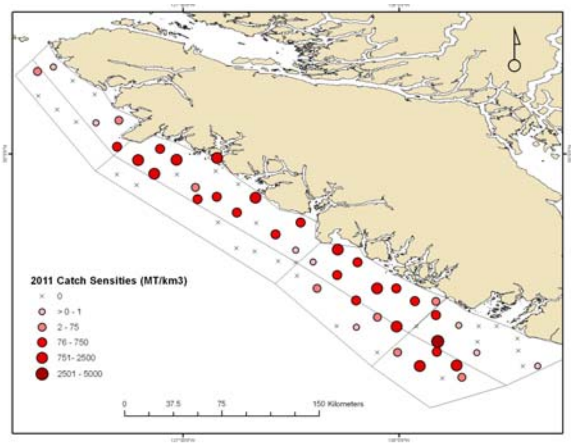


Figure 17. West coast of Vancouver Island 2011 night surface trawl locations and approximate Pacific sardine catch densities for night sampling, occurring between July 19- August 1.

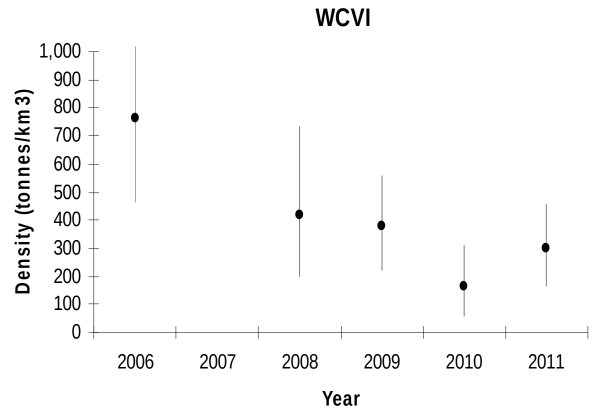


Figure 18: West coast of Vancouver Island 2006-2011 night surface trawl survey average sardine catch density estimates (in metric tons per km^3) and no survey conducted in 2007. Vertical bars represent 95% Confidence Intervals derived from bootstrapping observed densities for each year's set of samples.

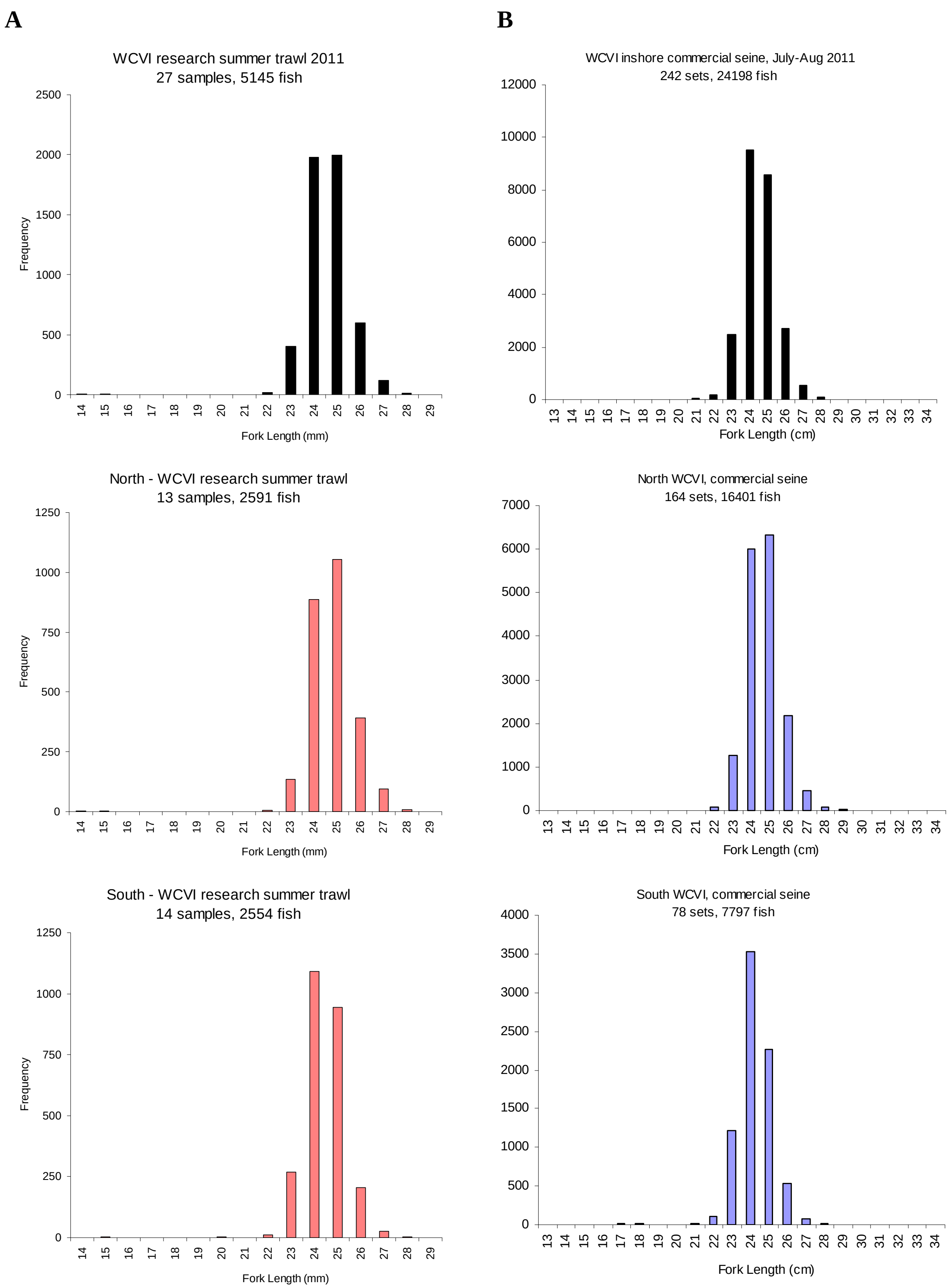


Figure 19. Fork length distributions representing sardines collected in 2011 from the WCVI summer surface trawl survey between July 19 and August 1 (A) and from commercial purse seine catches between July 5 and August 26. A perpendicular line seaward off Esperanza Peninsula delineates northern and southern groupings.

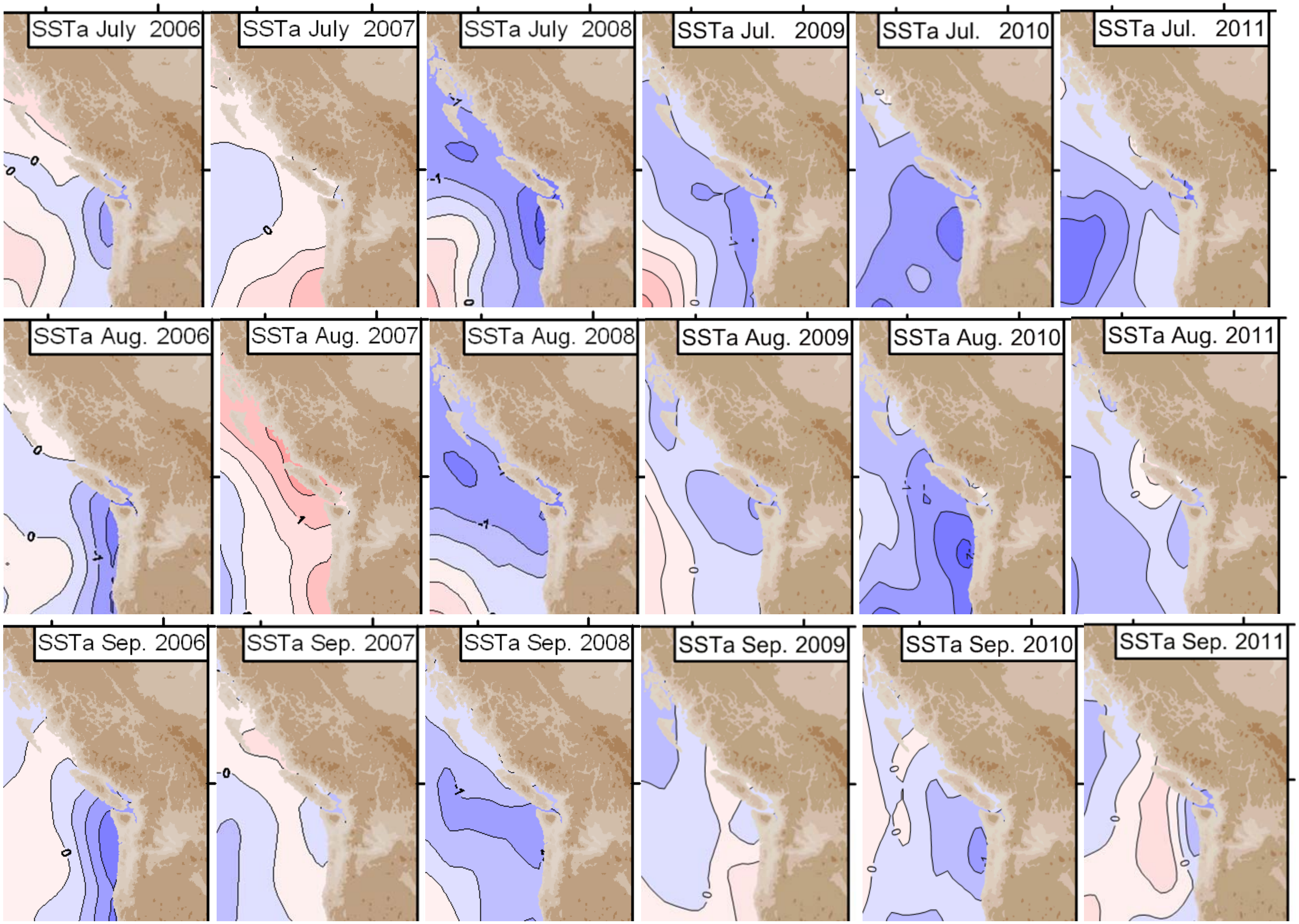


Figure 20. Mean sea surface temperature anomalies for waters surrounding British Columbia in June, August and September. Information from: http://www.pac.dfo-mpo.gc.ca/science/oceans/data-donnees/sst-tsm/index-eng.htm

The summaries provided and the appearance of external links do not constitute an endorsement by the Department of Commerce/National Oceanic Atmospheric Administration of the information, products or services.

Salmon:

Source: Bill Peterson, NOAA, NMFS

Pelagic fishes have been sampled in June and September off the coast of Washington and Oregon since 1998, using a Nordic 264 rope trawl. Catches of juvenile salmonids in 2011 were about average for juvenile coho and spring Chinook in June but below average in September (Figure 21). Although it is difficult to assign a direct cause for what appears to be poor survival during the summer 2011, conditions indicate that the poor survival was due to generally weak upwelling conditions during the summer as a short upwelling season.

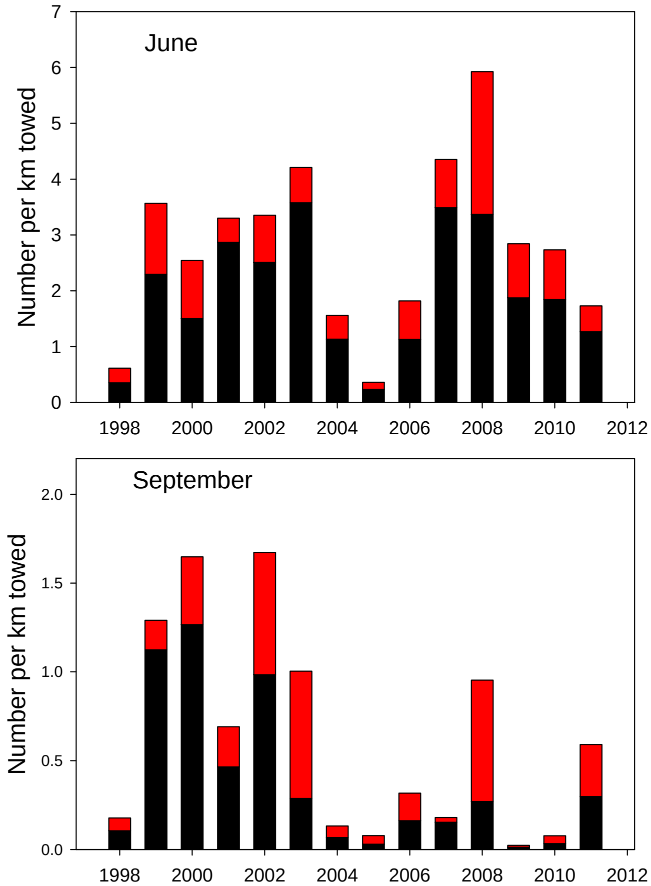


Figure 21. Catches of juvenile salmonids in pelagic trawl surveys carried in June and September in coastal waters off Washington and Oregon. Black indicates juvenile coho; red juvenile Chinook salmon. Catches in both months were below average.

Marine Birds and Mammals:

Marine Birds:

Auklets and shearwaters as indicators of ecosystem change off southern California

Source: William J. Sydeman and Sarah Ann Thompson (Farallon Institute for Advanced Ecosystem Research)

Seabirds are the most conspicuous marine organisms living at the interface of the atmosphere and the ocean. As such, they may provide useful information on spatial and temporal variability of marine ecosystem productivity and 'health'. Climate change and fishing may be decreasing ecosystem productivity and the ocean's carrying capacity, with effects on seabirds and other species at the upper trophic levels.

The Cassin's Auklet (*Ptychoramphus aleuticus*) and Sooty Shearwater (*Puffinus griseus*) are abundant seabirds of the North Pacific Ocean. Auklets are resident to the California Current, and forage mainly on euphausiids and larval fish (Ainley et al., 1996, Abraham and Sydeman, 2004). Shearwaters are seasonal migrants and feed on zooplankton and forage fish (Briggs and Chu, 1987). Surveys of marine birds have been conducted in conjunction with seasonal California Cooperative Oceanic Fisheries Investigation (CalCOFI) and California Current Ecosystem-Long-Term Ecological Research (CCE-LTER) cruises since May 1987 (Veit et al., 1996). The resulting database now contains 87 surveys over 25 years, including information through July 2011. While the ship is underway at speeds >5 k, seabirds are identified and counted by an experienced observer using a 300-m strip-width transect (see Yen et al., 2006 for details). We tested the hypothesis that auklet and shearwater densities have decreased through time in accordance with hypothesized decreases in ecosystem productivity (Veit et al., 1997, McGowan et al., 1998, Hyrenbach and Veit, 2003). The shearwater and auklet indicators are important because they may reflect complex biological processes occurring in the marine environment that are difficult to measure directly.

As an ecosystem indicator, auklets are most abundant off southern California in the fall and winter. The shearwater is a trans-hemispheric migrant (Shaffer et al., 2006); shearwaters may be found in the California Current year-round, but their relative abundance is greatest during the spring and summer. In winter, and to a lesser extent, fall, the at-sea density of auklets declined, but the decline was most pronounced in the early portion of this time series (Figure 22). The relative abundance of auklets declined from the late 1980s to late 1990s before rebounding in the early-mid 2000s. The data show no linear trend in auklet density over the past 15 years. There was, however, clear autocorrelation in these data, with increasing and then decreasing abundance in the early-mid 2000s. The latter years (2010 and 2011) showed low relative abundance. The relative abundance of shearwaters showed a consistent decline over the 25-year period, though the rate of change has decreased recently (Figure 22). From low-points in the mid-1990s, shearwater relative abundance increased in the mid-late 1990s, before declining steadily thereafter. The latter years (2010 and 2011) showed disparate patterns with higher abundance in 2010 and lower abundance in 2011.

Overall, these observations support previous assessments and calculations of seabird population change in the Southern California Bight (Veit et al., 1996, 1997, Hyrenbach and Veit 2003, Sydeman et al., 2009). These patterns of population variability in shearwaters and auklets at sea support the hypothesis that environmental change is affecting the marine ecosystem off southern California. Auklets and shearwaters are high-energy diving species with cold-water affinities (Hyrenbach and Veit, 2003). While we found secular trends in abundance for these species, we also demonstrated interannual variability and some strongly contrasting patterns of variability between these species. Thus, there are some similarities (both species have declined), but also some major differences in the population variability of these species. We hypothesize this variation is related to the fact that shearwaters are wintering migrants while the auklets are resident and local breeders.

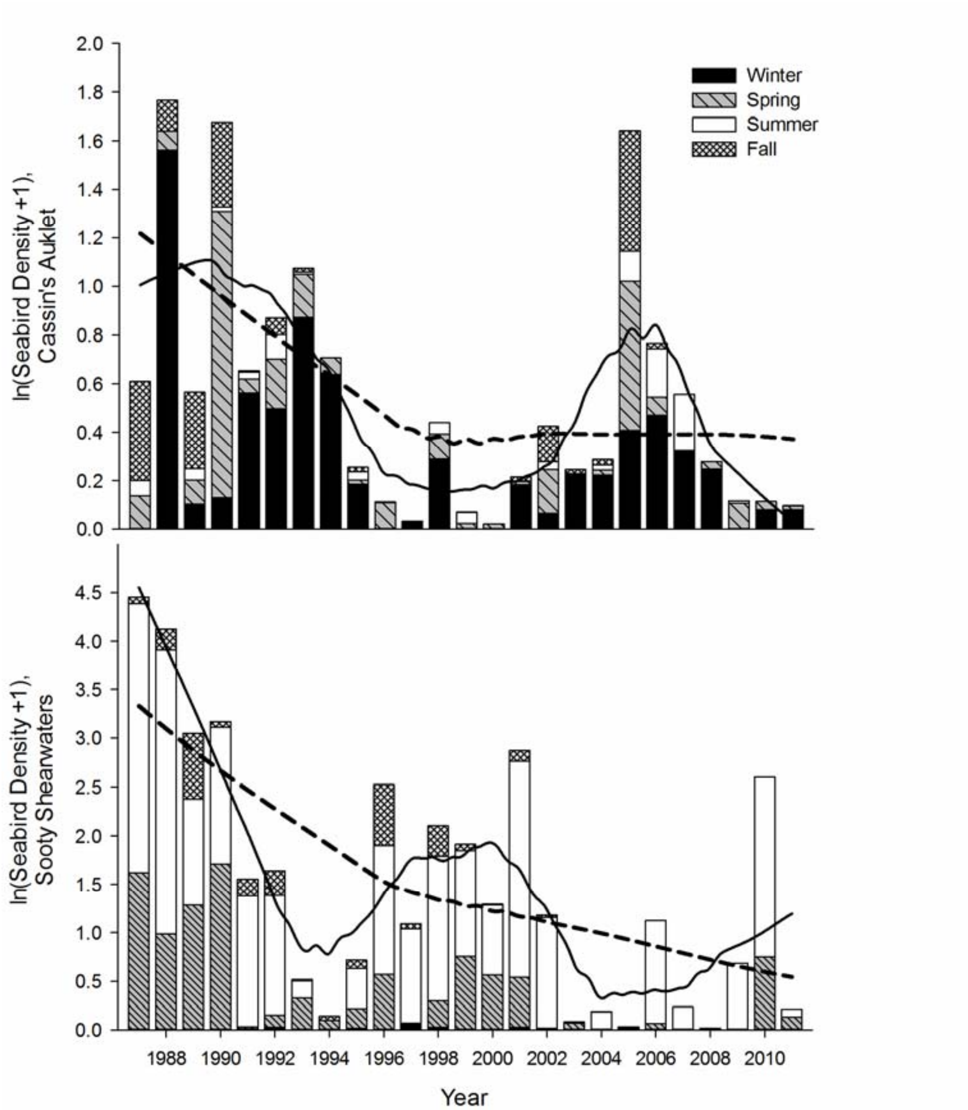


Figure 22. Changes in Sooty Shearwater and Cassin's Auklet relative abundance (birds km^{-2}) on 87 CalCOFI surveys, May 1987 - July 2011. Stacked bars denote seasonal density estimates, with a dashed Lowess smoothing line (bandwidth=0.8) shown for each species based on the averaged annual value, and a solid Lowess smoothing line (bandwidth=0.3) to illustrate interannual autocorrelation.

Harmful Algal Blooms:

This section provides a summary of two toxin-producing phytoplankton species *Pseudo-nitzschia* and *Alexandrium* activity. *Alexandrium* is the dinoflagellate that produces a toxin called paralytic shellfish poisoning (PSP), and *Pseudo-nitzschia* is the diatom that produces domoic acid.

Washington HAB Summary

Source: http://ww4.doh.wa.gov/gis/mogifs/biotoxin.htm

Washington's Olympic Region Harmful Algal Bloom (ORHAB) partnership monitors nine regular sites along Washington's outer coast for the presence of harmful phytoplankton species weekly. No annual summary was available at the time of this report. Please view the http://ww4.doh.wa.gov/gis/mogifs/biotoxin.htm site for the most current status.

Oregon HAB Summary

Source: Oregon Department of Fish and Wildlife http://www.dfw.state.or.us/MRP/shellfish/razorclams/plankton.asp
Source: Zach Forster, Oregon Department of Fish and Wildlife

The Monitoring Oregon's Coastal Harmful Algae (MOCHA) project monitors ten sites along the coast of Oregon for the presence of harmful algae. These sites include three along Clatsop Beach, one on Cannon Beach, two on the central coast and four sites on the south coast. *Alexandrium* persisted along much of the coast during the spring and summer while *Pseudo-nitzschia* was infrequently reported until August. Increases in phycotoxins in bivalve tissue resulted in one shellfish closure during the year. Other harmful algae encountered during 2011 include *Chochlodinium sp.*, *Akashiwo sanguinea* and *Dinophysis spp.*.

Alexandrium was first detected in the nearshore waters of the Oregon coast in May. By June, *Alexandrium* was encountered regularly during weekly sampling along the northern and central Oregon coast. *Alexandrium* abundance and diversity continued to increase on the north coast through the later part of August with cell counts reaching as high as 5,000 cells/L at multiple sample sites. Subsequent increases in paralytic shellfish toxins resulted in a month long closure of all mussel harvesting from the Columbia River south to Cascade Head.

Three distinct blooms of *Pseudo-nitzschia (P-n)* were captured along the Oregon coast beginning in late July (Fig. 23). On the north coast, an accumulation of larger type *P-n* cells persisted for six weeks. A small increase of domoic acid in razor clam tissue, well below the regulatory closure limits, occurred during this time. On the south coast, sample sites from Gold Beach to Coos Bay experienced a bloom of the smallest type *P-n* which lasted from July through August. Finally, in September, a third bloom of larger type *P-n* cells was recorded at Gold Beach with cell counts exceeding a million cells per liter. Mussels collected from an adjacent sample site in Gold Beach during this time increased from 0 to 7.3 ppm domoic acid. However, no shellfish harvest closures due to domoic acid occurred in 2011.

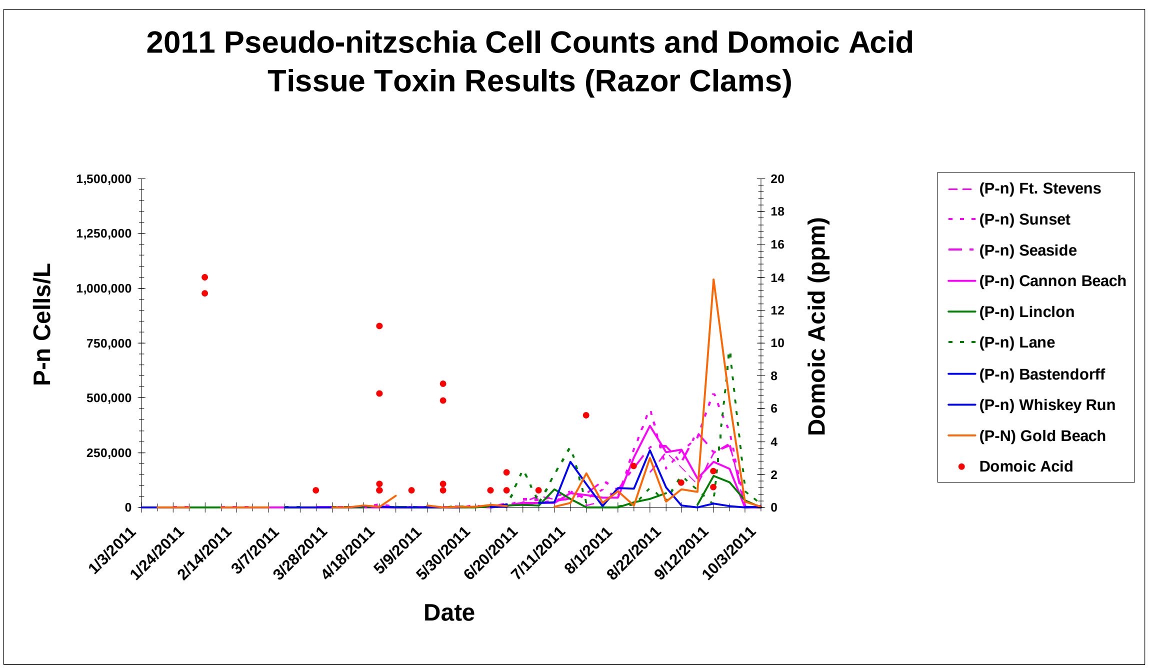


Figure 23. Cells per liter of *Pseudo-nitzschia* and *Alexandrium* during 2011 along the Oregon Coast.

California HAB Summary

Source: Gregg W. Langlois, CA Department of Public Health

http://www.cdph.ca.gov/healthinfo/environhealth/water/Pages/Shellfish.aspx

Shellfish samples are collected at different sites along the coast of California. Some stations are sampled on at least a weekly basis. Cell concentrations of *Pseudo-nitzschia* and *Alexandrium* were very variable spatially and from week-to-week during 2011. Often domoic acid (DA) levels were fine during one week only during a month at a single location.

Pseudo-nitzschia was observed at a number of sites along the entire southern California coast from January to May. January to March, low numbers of *Alexandrium* were detected at sampling sites throughout southern California. *Alexandrium* was not observed at any northern California sampling sites in January and was observed at only two sampling sites in February. In February, the concentration of domoic acid remained high in samples of lobster viscera from offshore near Anacapa and Santa Cruz islands. *Alexandrium* was observed at sites in most northern California counties in March. In March, domoic acid was detected at numerous sites between San Luis Obispo and Ventura counties, and toxin levels exceeded the alert level throughout this range. In April and May, *Alexandrium* was mostly absent from samples along the entire California coast. PSP toxins were absent from all shellfish samples from January to March, and in May. During the third week in April mussels from offshore of Santa Barbara contained a low concentration of PSP. Throughout April, domoic acid was also detected at numerous sites between San Luis Obispo and Ventura counties. Domoic acid concentrations dropped below the detection limit by the beginning of May at sites in Santa Barbara and Ventura counties. During the second week of June, offshore of Santa Barbara the toxin concentration in shellfish exceeded the federal alert level and continued to increase throughout the month. The levels of domoic acid decreased below the detection limit by the first week of July, but the decline was temporary, as the toxin level increased during the second week and exceeded the alert level the last two weeks of July. Domoic acid was not detected in any samples analyzed in northern California during June or July. In July, a low level of the PSP toxins was detected in mussels collected from Portuguese Bend in the Palos Verdes region. During the first week of September, a low level of domoic acid persisted in shellfish from the aquaculture lease offshore of Santa Barbara, then declined below the detection limit for the remainder of the month. By the end of the month a low concentration of this toxin was detected in sentinel mussels in outer Morrow Bay. By August domoic acid concentrations exceeded alert levels throughout California. Domoic acid was not detected in any shellfish samples analyzed in northern California in September.

In September, paralytic shellfish poisoning (PSP) toxins were not detected in any shellfish samples in southern California. In northern California, low levels of PSP toxins were detected in sentinel mussels from outer Humboldt Bay during the first week of the month and farther inside the bay by the second week. Low concentrations of these toxins were also detected in shellfish from sites in San Mateo and Santa Cruz counties. Sentinel mussels at the Santa Cruz Pier contained low levels of the PSP toxins throughout the month.

PACIFIC COAST FISHERIES MANAGEMENT SUMMARIES AND RECOMMENDATIONS

Summary of the Oregon Fishery for Pacific Sardine (*Sardinops sagax*)

Source: Oregon Department of Fish and Wildlife, Marine Resources Program (November, 2011).

Oregon Fishery Summary: The sardine fishery is prosecuted with purse seine vessels. Off the Pacific Northwest, weather events such as storms, heavy fog, or high seas are major factors in the success rate of catching sardines. These types of events make it difficult to predict how many pounds of sardines will be delivered during any given day. Another variable that can affect Oregon based fishermen is the quality of the sardines. Belly thickness, quantity of food in the stomach tissues, average size of the fish, and oil content can all influence the quality of the fish. All of these factors can affect the ex-vessel price paid to the fishermen. Sardines caught in the summer months in the area of Oregon and Washington are feeding in productive nutrient rich waters. During this time, the fish are increasing their oil content or “fat”. High oil content is important in the palatability for human consumption. The peak oil content for sardine off Oregon and Washington generally occurs in August and September, which coincided with the peak months of sardine landings in Oregon from 2005 – 2007. The federal coastwide harvest guideline was not a limiting factor for the fishery until 2008, when all three sardine catch allocation periods were closed early because the allocation was reached. Lower estimates of biomass and the lower Harvest Guidelines since 2008 have led to a derby style fishery and changed the timing of the fishery off Oregon and Washington with peak catch occurring in July during recent years for Oregon vessels (Figure 24).

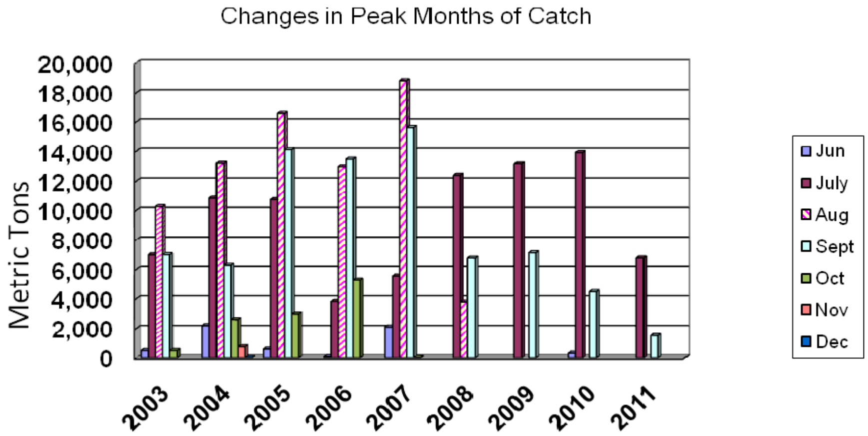


Figure 24. Oregon landings for the months of June through December from 2003 to 2011.

Summary of the Washington Purse Seine Fishery for Pacific Sardine (*Sardinops sagax*)
Source: Washington Department of Fish and Wildlife (October, 2011).
Pacific sardines are the primary coastal pelagic species harvested in Washington waters. Washington annual and monthly information is presented in Tables 1 - 2.

Table 1. Comparison of Landings (metric tons), Number of Landings and Number of Vessels in the Washington sardine purse seine fishery 2004-2011.

	2011*	2010	2009	2008	2007	2006	2005	2004
No. of Vessels	7	8	8	5	6	7	11	14
Total Landings (mt)	7,918	12,379	8,009	6,432	4,663	4,362	6,714	8,911
No. of Landings	126	232	173	150	106	108	207	236
Average Landing (mt)	63	53	46	43	44	39	32	37

* Preliminary

A review of landings data from the top five vessels from 2000-2011 shows that single vessel total annual landings average about 1,400 metric tons (Table 2). Factors such as season length, weather and ocean conditions, sardine abundance relative to proximity to port, processing capacity and skipper experience. Prior to 2008 the fishery did not attain the periodic allocation quotas or the annual harvest guideline. Due to reduced harvest guidelines, the fishery has experienced closures. In Washington, weather and ocean conditions are typically most favorable from May through October. Processor capacity does limit the number and size of deliveries; however, upgrades have increased facility capabilities compared to earlier years of the fishery.

Table 2. Total annual landings (mt) for top five vessels, 2000-2011, ranked from highest to lowest. *Preliminary

Vessel	2011*	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
1	1,655	3,036	2,192	1,762	1,152	1,953	1,901	2,689	3,307	4,056	2,702	1,920
2	1,276	1,913	1,519	1,636	952	668	1,745	2,504	2,393	2,164	1,902	1,800
3	1,267	1,707	1,296	1,291	797	664	1,480	986	2,258	1,735	1,218	542
4	1,218	1,510	1,141	1,249	734	534	927	775	1,167	1,338	925	264
5	992	1,372	1,005	494	610	452	248	580	1,080	1,331	887	133

Highly Migratory Species:
Source: El Niño Watch, Advisory http://coastwatch.pfel.noaa.gov/cgi-bin/elnino.cgi
Source: Pacific Fisheries Management Council (http://www.pcouncil.org/)
Eighth Meeting of the Western and Central Pacific Fisheries Commission: The Council made recommendations to the U.S. delegation to the WCPFC8 meeting, which has been rescheduled to a future date in February 2012. The recommendations focused on conservation of bigeye tuna in the Western Pacific, encouraging better cooperation between the WCPFC and the Inter-American Tropical Tuna Commission, and supporting a variety of management, control and surveillance measures under consideration by the WCPFC.

The WCPFC's conservation measure for tropical tunas, which aims to end overfishing on bigeye tuna in the Western and Central Pacific Ocean expired at the end of 2011. Bigeye overfishing is still occurring, so members need to agree on a replacement measure at the February 2012 meeting.

NEW RESEARCH ACTIVITIES IN THE CALIFORNIA CURRENT SYSTEM

Marine Mammals:
SOCAL-BRS (Behavioral Response Study)
Source: Jay Barlow, NOAA, NMFS http://sea-inc.net/socal-brs/socal-11/ and http://sea-inc.net/2011/10/06/end-socal-11/
"SOCAL-BRS" (Behavioral Response Study) is a multi-year effort (2010-2014) designed to better understand marine mammal behavior and reactions to sound. It is an interdisciplinary research collaboration, building on previous efforts in the Bahamas and Mediterranean Sea. The overall objective is to provide a better scientific basis for estimating risk and minimizing effects of active sonar for the U.S. Navy and regulatory agencies. SOCAL-BRS is also part of a larger international collaboration to measure the impacts of noise marine mammals using opportunistic and experimental approaches (including controlled exposure experiments, or "CEEs"). SOCAL-11 extends existing collaborations among scientists from private sector and academic scientists, the U.S. National Oceanic and Atmospheric Administration (NOAA), and U.S. Navy researchers and operational personnel. It is jointly funded by the U. S. Navy, Chief of Naval Operations, Environmental Readiness Division (OPNAV N45) and the Office of Naval Research (ONR).

In summary, 38 tags were deployed (including v2 and v3 Dtags (Woods Hole Oceanographic Institution), and Wildlife Computer MK-10 TDRs and TDR-satellite tags) on 25 blue whales, 7 Risso's dolphins, 2 bottlenose dolphins, and one Cuvier's beaked whale. CEEs were conducted on 18 individuals (13 total sequences) including 13 blue whales, 4 Rissos, and one Cuvier's beaked whale. All of these were completed within all specified protocols, animals were observed following CEEs, and several were cut short because marine mammals ignored the sound source and came within the specified safety zone during transmissions. Three focal follow sequences were completed in testing tagless group follow protocols, including two with common dolphins and one with bottlenose dolphins.

A summary of this study will be included in the SOCAL-11 project report that will be issued sometime in early 2012. A blog post and other messages will announce the availability of this report, and it will be posted on www.socal-brs.org.

Literature Cited:

Abraham, C. L., and W. J. Sydeman. 2004. Ocean climate, euphausiids and auklet nesting: inter-annual trends and variation in phenology, diet and growth of a planktivorous seabird, *Ptychoramphus aleuticus*. Marine Ecology Progress Series 274:235-250.

Ainley, D. G., L. B. Spear, and S. G. Allen. 1996. Variation in the diet of Cassin's auklet reveals spatial, seasonal, and decadal occurrence patterns of euphausiids off California, USA. Marine Ecology Progress Series 137:1-10.

Bjorkstedt, E., R. Goericke, S. McClatchie, E. Weber, W. Watson, N. Lo, B. Peterson, B. Emmett, R. Brodeur, J. Peterson, M. Litz, J. Gomez-Valdes, G. Gaxiola-Castro, B. Lavaniegos, F. Chavez, C. A. Collins, J. Field, K. Sakuma, S. J. Bograd, F. B. Schwing, P. Warzybok, R. Bradley, J. Jahncke, G. S. Campbell, J. A. Hildebrand, W. J. Sydeman, S. A. Thompson, J. L. Largier, C. Halle, S. Y. Kim, J. Abell. 2011. State of the California Current 2010-2011: Regionally variable responses to a strong (but fleeting?) La Niña. California Cooperative Oceanic Fisheries Investigations (CalCOFI) Report Vol. 52.

Briggs, K. T., and E. W. Chu. 1987. Trophic relationships and food requirements of California seabirds: updating models of trophic impact. Pages 279-301 *in* J. P. Croxall, editor. Trophic relationships and food of California seabirds. Cambridge University Press.

DFO. 2011. Evaluation of Pacific sardine (*Sardinops sagax*) stock assessment and harvest guidelines in British Columbia. DFO Can. Sci. Advis. Sec. Science Advisory Report. 16.

Hyrenbach, D. K., and R. R. Veit. 2003. Ocean warming and seabird communities of the Southern California Current System (1987-98): response at multiple temporal scales. Deep-Sea Research Part II - Topical Studies in Oceanography 50:2519-2536.

Logerwell, E. A., N. J. Mantua, P. W. Lawson, R. C. Francis, and V. N. Agostini. 2003. Tracking environmental processes in the coastal zone for understanding and predicting Oregon coho (Oncorhynchus kisutch) marine survival. Fisheries Oceanography 12(6): 554-568.

McFarlane, G. A., and L. A. MacDougall. 2001. Biological information for Pacific sardine captured during research cruises, 1992-2000. Can. Tech. Rep. Fish. Aquat. Scie. 2372:149.

McGowan, J. A., D. R. Cayan, and L. M. Dorman. 1998. Climate-ocean variability and ecosystem response in the Northeast Pacific. Science 281:210-217.

Schweigert, J., and G. A. McFarlane. 2001. Stock assessment and recommended harvest for Pacific sardine in 2002. DFO Can. Sci. Advis. Sec. Res. Doc. 126:12.

Schweigert, J., G. A. McFarlane, and V. Hodes. 2009. Pacific sardine (*Sardinops sagax*) biomass and migration rates in British Columbia. DFO Can. Sci. Advis. Sec. Res. Doc. 088:14.

Shaffer, S. A., Y. Tremblay, H. Weimerskirch, D. Scott, D. R. Thompson, P. M. Sagar, H. Moller, G. A. Taylor, D. G. Foley, B. A. Block, and D. P. Costa. 2006. Migratory shearwaters integrate oceanic resources across the Pacific Ocean in an endless summer. Proceedings of the National Academy of Sciences of the United States of America 103:12799-12802.

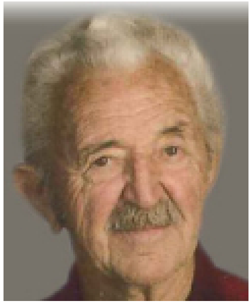
Sydeman, W. J., K. L. Mills, J. A. Santora, S. A. Thompson, D. F. Bertram, K. H. Morgan, B. K. Wells, J. M. Hipfner, and S. G. Wolf. 2009. Seabirds and climate in the California Current--A synthesis of change. California Cooperative Oceanic Fisheries Investigations Reports 50:82-104.

Veit, R. R., P. Pyle, and J. A. McGowan. 1996. Ocean warming and long-term change in pelagic bird abundance within the California current system. Marine Ecology Progress Series 139:11-18.

Veit, R. R., J. A. McGowan, D. G. Ainley, T. R. Wahls, and P. Pyle. 1997. Apex marine predator declines ninety percent in association with changing oceanic climate. Global Change Biology 3:23-28.

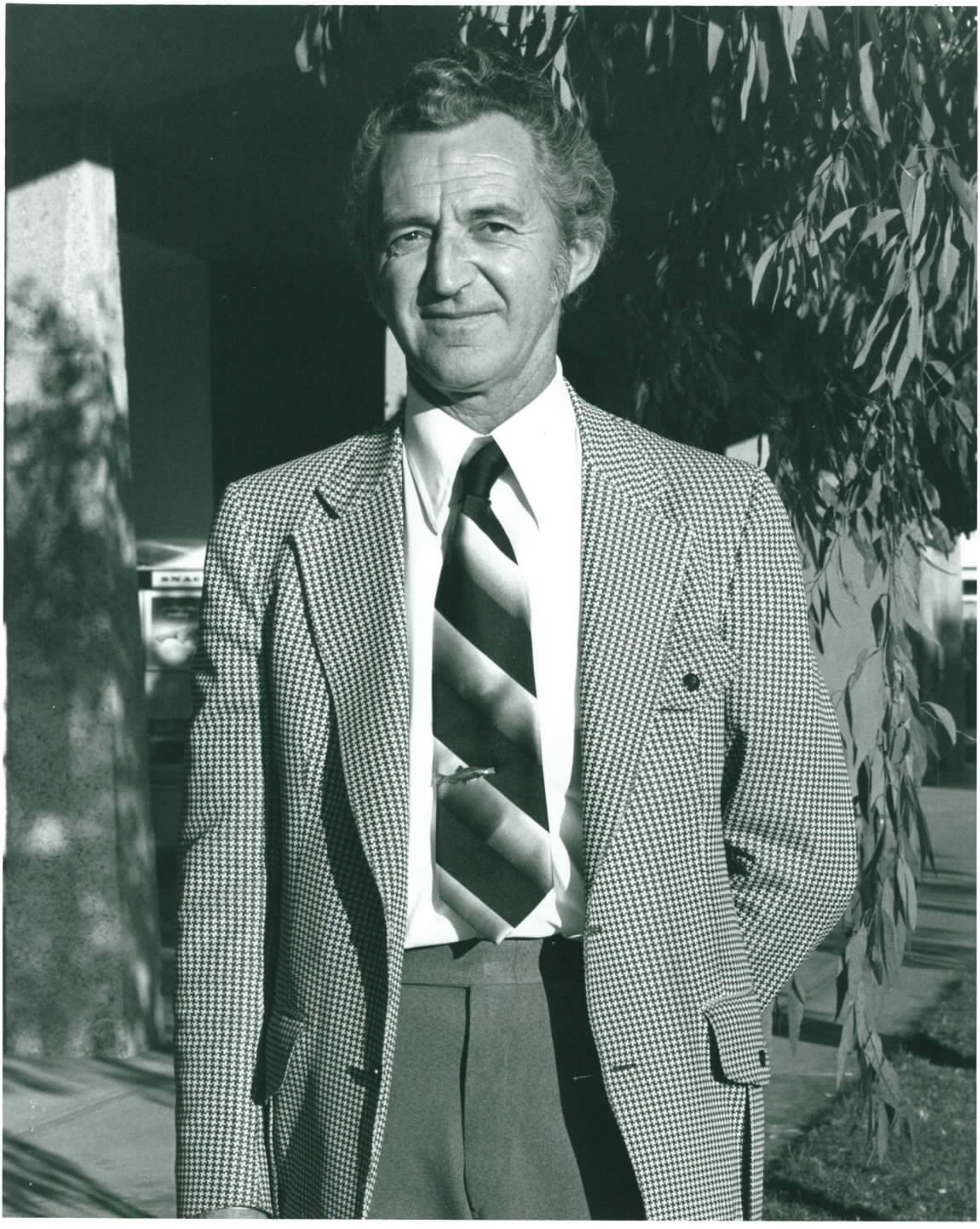
Yen, P. P. Y., W. J. Sydeman, S. J. Bograd, and K. D. Hyrenbach. 2006. Spring-time distributions of migratory marine birds in the southern California Current: Oceanic eddy associations and coastal habitat hotspots over 17 years. Deep-Sea Research Part II - Topical Studies in Oceanography 53:399-418.

John J. Ro. al



John, .he son of Achilles and Albina Royal was born June 24, 1922 in Wolf Creek, Colorado and passed away peacefully in his home on February 18, 2012 in San Pedro, California. He was preceded in death by his son, John Joseph Royal, Jr. John is survived by the love of his live and wife of 64 years, Rosie; his daughter, Linda Smith (Brent); his grandson, Ian (fianc#233; Jillian); his granddaughter, Kimberly Smith; and three sisters, Virginia Mulligan, Marion Patricio and Betty Peterson. John's family came from Colorado in 1928 at which time he attended Barton Hill, Dana and San Pedro High School. At a young age, he began working as a milk boy and carrier for the News Pilot to support his family. After graduating high school, he attended the United States Maritime Officers School and served in the Merchant Marine during World War II. In 1946, John began commercial fishing and became a member of Fisherman's Union Local 33, I.L.W.U. In 1957, he was elected executive secretary-treasurer of the Fisherman's Union, Local 33, I.L.W.U. and held that position until August 1, 1995. During these years, John was appointed to several state and national committees including president of the LA Harbor Commission and advisor to Pacific Fishery Management Council. Aside from work, he enjoyed his years in the Mazzini Club, B.P.O.E., Italian-American Club, Boy's Club and D.B.'s. His true passions in life were being with his family, spending time in Colorado, fishing and working in his garden, helping others and fighting vigorously for the rights of the fishing industry. This is a small glimpse of the amazing life John lead, but is short of highlighting all his accomplishments and contributions to his family and community. John was loved dearly and will be deeply missed. The Memorial Service for Mr. Royal will be Monday, February 27 at 11:00 a.m. in the Green Hills Memorial Chapel in Rancho Palos Verdes. Visitation is Sunday from 1:00 - 5:00 at the Green Hills Mortuary. In lieu of flowers, donations can be made to St. Jude Children's Research at 1-800-873-6983 tribute #30353542. Please sign the guestbook at www.dailybreeze.com/obits.

Published in Daily Breeze from February 23 to February 25, 2012



Calif. Mar. Res. Comm., CalCOFI Rept., 13: 108–109, 1969

VIEWPOINT OF THE INDUSTRY: FISHERMEN AND ALLIED WORKERS

JOHN J. ROYAL
Executive Secretary-Treasurer
Fishermen & Allied Workers' Union, Local 33, I.L.W.U.
San Pedro, California

I feel that because of the lack of proper interest on the part of top-level people in the State of California and the Federal Government, our fisheries have disintegrated and fishermen have abandoned the trade at an alarming rate since the end of World War II.

Tremendous amounts of money are being appropriated for the exploration of outer space, defense build-ups, experimental uses of atomic power, etc., but appropriations for oceanography and fisheries research and development are notably lacking. Programs that have been scheduled and monies that have been allocated to fisheries are all well and good as far as they go, but they neither *go far enough, nor soon enough.* There is little value in developing a great wealth of knowledge and know-how in fisheries as to the conditions and abundance of the resources and stocks; the spawning and migratory habits; the best methods of catching, preserving, freezing and processing these fish; blueprinting better, faster, newer and more efficient vessels and gear, if no one remains to benefit from it all.

Today, now, immediately is the time for action, *not tomorrow.* A crash program to assist the fishermen is needed if we intend to maintain California's fisheries and industry. A fire must be started among the top people at both State and Federal levels to awaken them to the fact that up until now fishermen have only touched the outer fringes of the tremendous resources that abound off of our shores. They must be made to realize that unless we range out, explore, find and develop these resources, they will eventually be wiped out by foreign fishing fleets without regard to conservation. The economic loss from such action would be felt by our fishermen, community and State, for decades to come.

It would be shameful indeed if we as fishermen and Californians stand idly by and watch the remnants of what was once a very great California industry die, as our State and Federal government seems prone to do. I believe that at one time fisheries ranked third or fourth in value in our great State and there is no reason why this industry cannot once again regain that important position, thereby benefiting the citizens and State.

I submit ten cardinal points for your consideration as to some steps that should be taken to keep this industry alive while we are awaiting the development of long-range plans and programs.

It would be greatly appreciated if strong thought and study be given to them.

1) Continuation and expansion of work being done by the Marine Research Committee and CalCOFI scientists
2) Ways and means to raise additionally needed monies to expand programs of scientific research, experimentation and development
3) Scientifically-managed fisheries to:
   a) Afford maximum protection and conservation of all the resources in coastal waters.
   b) Equal utilization of the resources to all Californians, whether for recreational, sportfishing or commercial fishing purposes.
   c) Protection of these resources from inroads by foreign fishing fleets to prevent abuses of our conservation programs and depletion of the stocks.
4) Continued and expanded scientific research on the following species:
   a) Anchovies
   b) Jack and Pacific mackerel
   c) Pacific hake
   d) Pacific saury
   e) Squid
   f) All other species which might be suitable for canning, reduction or fish protein concentrate purposes.
5) Exploration research to establish the following:
   a) Geographical areas of the stocks and locations as per species.
   b) Abundance and size of the stocks.
   c) Spawning areas and months.
   d) Pattern of migration as per months or season, inshore, offshore, north, south, etc.
   e) Depths of the stocks.
   f) Feed and environmental habits.
   g) Effects of shoreside pollution on the stocks, feed, plankton, etc.
6) Research and development of new and appropriate fishing gear and techniques
   a) Bottom trawl.
   b) Mid-water trawl.
   c) Seine or round haul nets.
   d) Electrofishing.
   e) Winches and retrieving gear.
   f) Depth sounders, fish finders, scanners, etc.
   g) Installation of water temperature and weather equipment.
7) Removal of present State restrictions which presently prevent the following:
   a) Utilization of certain types of fishing nets and gear.

b) Taking or landing of certain species.
c) Fishing in closed areas, for military or sport reasons, which could be fished at nights or at certain times or months.

8) Establish schools in sea ports to train new, young fishermen in the following:
   a) Engineering and diesel engines.
   b) Refrigeration systems and methods.
      1) Brine
      2) Spray
      3) Sharp freeze
   c) Navigational equipment and aids.
      1) Geographical
      2) Celestial
   d) General over-all rigging.
      1) Wire splicing
      2) Rope splicing
      3) Winch handling
      4) Cables, blocks and retrieving gear
      5) Proper method of hanging and/or constructing various types of nets, and repairs thereto
      6) General over-all knowledge of ship nomenclature and ship handling
      7) Safety, aboard ship and at sea
      8) Ability to read and understand weather charts, temperature charts, currents, thermocline and their effects on the fish. Signs of pending storms, etc.

9) Creation of a separate marine commission for ocean resources
   a) Present Fish & Game Commission too overburdened to carry out proper and just responsibilities of ocean resources.

10) Financial assistance from state and federal government to boatowners, fishermen and processors to/or for:
   a) Designing, developing and constructing newer, faster and more efficient vessels with better holding and freezing facilities, fish finding equipment, etc.
   b) Construction of new types of fishing nets, gear and equipment based on new highly sophisticated methods, backed by research and proven experimentation.
   c) Monetary subsidy to pay for fish being utilized in new infant fisheries caught by boatowner and fishermen beyond what price processors can pay during early development of proper processing methods, such as in hake fisheries.
   d) Assist canners and processors in proper and new methods, including pollution controls, as an incentive to keep them from going out of business or relocating outside of California.