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ANALYSIS OF 2004-2007 VESSEL-SPECIFIC SEABIRD BYCATCH DATA IN ALASKA DEMERSAL LONGLINE FISHERIES

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ABSTRACT

The annual incidental bycatch of seabirds by demersal groundfish longline vessels in Alaska has ranged between 4,100 and 26,300 during the period 1993 through 2006. However, average annual bycatch has declined by 73% in the last 5 years (2002-2006) compared to bycatch from the late 1990s. Despite the recent reductions resulting from mandatory mitigation requirements, seabirds continue to be caught at higher rates than would be expected given results of controlled studies that demonstrated bycatch reductions of nearly 100% with paired streamer lines. We characterize recent seabird bycatch data (2004-2007) from the Alaska demersal longline fisheries and analyze factors influencing seabird bycatch for two fisheries - Pacific cod (*Gadus macrocephalus*) and sablefish (*Anoplopoma fimbria*). Previous analyses of 1995-2000 bycatch data showed that individual vessel was the single most important source of variability in seabird bycatch rates in Alaska longline fisheries. Certain vessels consistently caught a higher proportion of birds across years and fisheries. Our results demonstrate that a few individual vessels continue to be responsible for the majority of seabird bycatch. Six vessels out of 39 contribute 38% of all birds caught in the cod demersal longline fishery when sampled rates are extrapolated to hooks deployed in observed sets. Based on this analysis, we recommend a variety of methods to further reduce seabird bycatch by longline vessels in Alaska.

CONTENTS

INTRODUCTION

Incidental catch, or bycatch, of seabirds in marine fisheries is a global conservation issue (Brothers et al. 1999, IUCN 2008). While seabird bycatch occurs in all major gear types (Brothers et al. 1999, Bull 2007, Løkkeborg 2008), longline fisheries in particular have been associated with the declines of several albatross species (Weimerskirch and Jouventin 1987, Croxall et al. 1990). Seabirds are most frequently caught during longline gear deployment while attempting to take bait from hooks although they are also caught during gear retrieval (Brothers 1991). The United States has implemented several regulatory instruments and policies to address seabird bycatch in U.S. fisheries (e.g., Migratory Bird Treaty Act, Magnuson-Stevens Fishery Conservation and Management Act, the Endangered Species Act; Moore et al. 2009). NOAA's National Marine Fisheries Service (NMFS) coordinates policies among domestic agencies affected by these regulations and participates in the regional fishery management organization (RFMO) frameworks to instigate seabird bycatch reduction in global fisheries.

Within the United States, seabird bycatch has historically been the highest in Alaska (NMFS 2001). From 1993 to 2006, the annual incidental catch of seabirds by demersal groundfish longline vessels in Alaska has ranged between 4,100 and 26,300 (NMFS 2006b, 2008). Initial mitigation requirements, strongly supported by industry, were implemented for Alaska groundfish longline vessels in 1997 and Alaska halibut vessels in 1998 (NMFS 1997, 1998); however, these measures did not appear to substantially reduce bycatch (Fig. 1). In 1999-2000, research was performed by Washington Sea Grant to test four mitigation techniques: streamer lines (single and paired), gear weighting, a setting tube, and a line shooter. All techniques tested, except the line shooter, significantly reduced bycatch rates compared to a control of no deterrent. The study concluded that paired streamers performed best, reducing bycatch rates by 88-100%, and recommended several modifications to regulations in place at the time (Melvin et al. 2001). These recommendations included deployment of paired streamers during the entire setting process, specific material and performance standards, and elimination of nighttime gear setting as an allowable deterrent. The industry voluntarily implemented these recommendations as early as 2001 although the final rule did not go into effect until 2004 (NMFS 2004). Concurrent with the initial mitigation study in 1999-2000, Dietrich et al. (2009) found that individual vessel was the single most important factor explaining the variation in seabird bycatch rates in Alaska longline fisheries during 1995-2000. Certain vessels consistently caught a higher proportion of birds across years and fisheries.

Since these studies and the last regulatory modification, average annual bycatch has declined by 73% (2002-2006; mean 5,127) compared to bycatch from the late 1990s (1995-2000; mean 18,658). Despite the recent reductions, seabirds continue to be caught at higher rates than would be expected given research results (i.e., reductions should be closer to 100% if streamers are deployed effectively; Melvin et al. 2001, Dietrich et al. 2008). Given the potential effectiveness of seabird mitigation gear, we were interested in examining whether a vessel effect still exists. The objectives of this project were to characterize recent seabird bycatch data from the Alaska demersal groundfish longline fisheries, determine if a small subset of vessels continue to be responsible for the majority of seabird bycatch, and recommend methods to further reduce seabird bycatch by longline vessels in Alaska.

METHODS

Fishery Description

Each year more than 250 million hooks are deployed by demersal groundfish longline vessels in the U. S. Exclusive Economic Zone in Alaska (EEZ; NMFS 2008). The primary groundfish target fisheries are sablefish (*Anoplopoma fimbria*), Pacific cod (*Gadus macrocephalus*), and Greenland turbot (*Reinhardtius hippoglossoides*). A vessel usually makes multiple gear deployments (sets) each day and the number of hooks deployed per set is variable between and within each target fishery (Table 1).

Both catcher (CV) and catcher-processing (CP) vessels operate in all target fisheries. In general, catcher vessels are small (20-80 feet), bait gear manually, fish during daylight hours, and deliver headed and gutted as well as whole catch to a shore-based facility for further processing. Catcher-processing vessels are larger (90-180 feet), typically use automatic baiting systems, and are likely to fish day and night and fully process fish on board. During our study interval, 41 catcher-processing vessels fished for cod and 25 for turbot under an open access management regime. Most cod sets were fished on the continental shelf at depths between 75 and 172 m (90% range) from mid-August through April, whereas most turbot were caught in June-July on the Bering Sea slope (Fig. 2). Nearly 400 vessels harvested sablefish (Hiatt 2007) under an Individual Fishing Quota (IFQ) system. The majority of sablefish was harvested by catcher vessels on the Gulf of Alaska (GOA) continental slope. The sablefish season typically starts in early March and extends to mid-November (Fig. 2).

Data

Fisheries catch and effort data were collected by NMFS-trained and certified fisheries biologists or observers. Observers are required at all times on groundfish vessels greater than or equal to 125 feet length overall (LOA; NMFS 2003). Vessels less than 125 feet and greater than or equal to 60 feet must carry an observer for 30% of the vessel's fishing days per quarter. Observers are not required on groundfish vessels less than 60 feet (e.g., most of the sablefish fleet) or halibut vessels of any size (except for a few rare circumstances).

The North Pacific Groundfish Observer Program (NPGOP; Fisheries Monitoring and Analysis Division, Alaska Fisheries Science Center, NMFS) provided fish and seabird bycatch data collected on commercial groundfish longline vessels from 2004 to 2007. For each set, observers recorded date and position of retrieval, mean depth, number of hooks deployed, and estimated weight of the total catch (NMFS 2006a). Because many longline vessels operate around the clock and there is usually only one observer, not all sets were monitored for species composition. Instead, observers randomly selected sets for species composition sampling (hereafter referred to as sampled sets; n = 45,533 sets) as well as the collection of other biological information. Within each sampled set, observers were instructed to monitor a minimum of one-third (average 35%; range 3%-100%) of the total hooks retrieved per set for species composition, recording both the number and estimated weight of target fish and all bycatch species including seabirds. In addition, seabird mitigation techniques were recorded as a 4-level categorical variable defined as follows: not verified; or when independently verified by the observer, zero;

one streamer deployed; or two streamers deployed. Seabird behavior was not monitored during gear deployment.

Data included in this analysis were restricted at two levels. For the initial examination of mean seabird bycatch rates among target fisheries, years, months, regions, and areas, 2,719 sets were excluded. These consisted of sets with all the catch discarded (10 sets); sets deployed during a seabird mitigation experiment in 2005 (613); sets that appeared to be targeting halibut, rockfish, or unknown target (1,544); and sets with < 20% of the hooks monitored (552). For the vessel-specific comparisons and modeling of factors influencing bycatch rates, we focused only on the cod and sablefish fisheries because these fisheries had the largest sample sizes and are different in terms of areas fished (both geographic and depth strata). Sets were included in this part of the analysis only if a vessel fished 3 of the 4 years and a minimum of 5 days in each year, which eliminated < 3% of the sets monitored in the cod fishery and 16% of the sets monitored in the sablefish fishery. In the cod fishery models, there was one set with a depth out of range for this fishery and 121 sets contributed by a single catcher vessel that were also excluded.

In 2006, NPGOP observers were tasked with an optional special project to describe offal discharge practices. For each vessel, observers were instructed to create a vessel diagram and flow chart of discard location and discharge type. We reviewed the submissions in order to inform the discussion regarding vessel-specific seabird bycatch reductions.

Analysis

Mean seabird bycatch rates were calculated for each target, year, month, large geographic region, NMFS management area (Fig. 3), and vessel, and for each seabird species or species group (defined in Table 2; Appendices 1-7), to qualitatively examine variation among the factors. Separate generalized additive models (GAMs) were constructed for the dominant seabird groups in the Pacific cod and sablefish target fisheries. Initial variables included categorical factors for year, month, large geographic region, NMFS management area, vessel, and deterrent, as well as continuous variables for day within year, fishing depth, total hooks deployed, and target fish CPUE (Table 3). GAMs allow for increased flexibility in assumptions compared to traditional regression techniques (i.e., normality and constant variance) as well as direct specification of error distribution (Hastie and Tibshirani 1990). GAMs also allow for the exploration of non-linear functional relationships between the dependent (i.e., seabird bycatch rates) and independent variables (Hastie and Tibshirani 1990). Models were fitted using S-Plus 2000 (Insightful Corp., Seattle, WA, USA) and were specified with either a quasi-likelihood estimate of the error distribution which included a log link and variance equal to the mean or the binary error distribution. The quasi family in S-Plus allows for parameter estimation without directly specifying the error distribution (Campos et al. 1997, Anon. 1999). The quasi-likelihood method provides a more accurate estimate of the standard errors around estimated coefficients because it accounts for the dispersion parameter (Φ) estimated from the data rather than assuming Φ equals some theoretical value (e.g., $\Phi = 1$ when Poisson or negative binomial distributions are directly specified). An offset function of sample size (number of hooks monitored) was included so that the modeling and analysis of the response variable, the number of birds caught, actually pertained to the bycatch rate (number of birds per 1,000 hooks; Clarke et al. 2003; Gardner et al. 2008). In three instances when seabird bycatch occurred in less than 1% of the sets, the binary error distribution was utilized. Variables were only loaded as main effects (including multiple smoothing options on continuous variables) with the exception of the loess smoothed surface of latitude and longitude. Interactions were excluded for several reasons: (1) interactions are computationally expensive given the magnitude of the data set (especially in the cod fishery); (2) intuitive explanations of multiple interactions are difficult, and conservation and management conclusions as to the influence of specific factors on bycatch rates are nearly impossible; and (3) some variables may be correlated non-linearly.

We used deviance as a nominal goodness-of-fit criterion. As model deviance increases (or conversely as residual deviance decreases), model fit improves. Deviance in the realm of GAMs is analogous to variance in the realm of linear regression models (Swartzman et al. 1992). Significance of each variable was tested in nested models using an approximate F-test (Hastie and Tibshirani 1990, Chambers and Hastie 1992). In general, GAM models were reduced to the best fit using a forward stepwise analysis of deviance technique with the goal of minimizing residual deviance (Chambers and Hastie 1992). Once a model was obtained that included sequentially significant variables, each variable was dropped individually to assess its unique contribution to model fit and thus its influence on seabird bycatch.

RESULTS

Mean seabird bycatch rates ranged widely for each species group and fishery as well as among years (Fig. 4), months (Figs. 5-7), areas (Figs. 8-10), and vessels (Figs. 11-13). Total bird bycatch rates were at their maximum in the turbot fishery across all 4 years (Fig. 4), although sample sizes in this fishery were much smaller than the other two fisheries examined. Fulmars were caught at the highest frequency in both the cod and sablefish fisheries (Table 4). However, in the cod fishery, the largest bycatch events were of gulls (45 and 77 birds), followed by shearwaters (33 and 20 birds) and fulmars (22 birds; Table 4). The high events in the cod fishery were caught by four unique vessels. The maximum number of birds caught in a set was much less in the sablefish fishery (maximum 14) with fulmars dominating all of the highest frequencies (greater than 6; Table 4). The highest events in the sablefish fishery were caught by two unique vessels.

In terms of temporal variables, peak bycatch rates occurred in 2007 regardless of fishery (Fig. 4). In the cod fishery, this trend was due to extraordinary shearwater and fulmar bycatch rates in August through October (Fig. 5). There was also an unusually high pulse in shearwater bycatch rates in July 2005 in all fisheries. Unlike the cod fishery where seabird bycatch rates increase in the late fall/winter season, seabird bycatch rates in the sablefish fishery were usually higher in the early season (March-May; Fig. 7). In terms of spatial variables, rates were generally highest in the Bering Sea for the cod fishery and the Gulf of Alaska for the sablefish fishery, although there were no consistent trends among areas from year to year (Figs. 8-10).

In the cod fishery, vessel, year, month, and area were all significant factors influencing bycatch rates in seabird catch models, regardless of species group (Table 5). Date and deterrent were significant in three of four groups. In the cod fishery, CPUE was significant in the gull and shearwater models where bycatch rates declined as fish catch increased, although this effect was sharper for gulls. Depth was significant only in the shearwater model, although the relationship with depth was not obvious from partial residual plots. The total number of hooks deployed was significant for shearwaters and albatross only.

In the sablefish fishery, vessel, year, and total hooks deployed were consistently significant factors influencing seabird bycatch rates across groups (Table 5). Month, date, area, and sablefish CPUE were significant for three of four groups. Sablefish CPUE was significant for all species except fulmars, and in general, bird bycatch declined as fish catch increased.

A closer examination of vessel-specific seabird bycatch rates confirmed that a few individual vessels consistently had the highest bycatch rates across all years (Figs. 11-13). In addition, these same vessels tended to catch birds on a higher proportion of their sets (Tables 6-7). Furthermore, this trend was consistent across fisheries for a few catcher processors. The vessels at the lowest end of the seabird bycatch rate spectrum were also consistent across years and fisheries. The number of streamer lines deployed does not explain these vessel differences either (e.g., one vessel at the low end of bycatch rates in the cod fishery did not deploy any streamers on 18% of the sets verified by the observer).

Thirty-one of 168 observers deployed on catcher-processing vessels completed the offal discharge special project. The responses included 23 of the 40 unique CPs operating in 2006. Although the amount of information garnered from the offal discharge special project that was relevant to this analysis was sparse, it appears that the high bycatch rates of at least two vessels could be due to seabirds becoming hooked during gear retrieval rather than gear setting, as is the norm. This bycatch was likely due to birds aggregating at discharge outflows forward of the hauling station. Birds are attracted to the fishery discharge and land on the water. As the vessel moves forward, retrieving gear, the birds pass by the gear hauling station and sometimes become hooked.

DISCUSSION

As in other seabird bycatch studies in demersal (Barnes et al. 1997, Weimerskirch et al. 2000, Belda and Sanchez 2001, Reid et al. 2004) as well as pelagic longline fisheries (Murray et al. 1993, Gales et al. 1998, Klaer and Polacheck 1998), a variety of spatial and temporal variables were significant predictors of seabird bycatch events in the 2004-2007 Alaska groundfish longline fisheries. However, similar to the analysis of 1995-2000 data from the Alaska groundfish longline fisheries (Dietrich et al. 2009), individual vessel remained the single most important factor in all but one model for explaining variation of seabird bycatch rates in the more recent time period. Unfortunately, the reasons for consistently high (or low) bycatch rates by a few vessels remain elusive. Additional information must be collected regarding vessel characteristics and behavior before solutions can be adequately addressed (see Table 8 for additional data needs). If this information were collected from all vessels, the knowledge gained from the 'low' bycatch vessels could be incorporated into future outreach.

In the meantime, the fishing industry and fisheries managers could collaborate to further reduce seabird bycatch rates in two ways – providing input to modify the current fleet-initiated reporting system, and targeting outreach to the handful of vessels with a seabird bycatch problem. The CP cod fleet currently hires a consultant to analyze their seabird bycatch data (Gilman et al. 2006); however, these reports are based on quantity of birds observed caught, not on a standardized catch rate or extrapolated estimates. Therefore, some of the high bycatch rate vessels may not be aware that they rank the highest in the fleet due to differences in total number of hooks deployed. For instance, a vessel that catches 10 birds on 250,000 hooks has a rate of 0.04 birds per 1,000 hooks, whereas a vessel catching 10 birds on 500,000 hooks has a rate of 0.02; however, they appear to be the same when only quantity of birds is reported. It is important to evaluate both the rate and the total bycatch (i.e., extrapolated to total effort) when determining which vessels have the highest impact on seabirds.

Six out of 39 vessels contribute 38% of all birds caught in the cod fishery when sampled rates are extrapolated to hooks deployed in observed sets. Note that these same six vessels only constitute 15% of total effort during the same fishing operations. Further bycatch reduction work should focus on these vessels which would in turn reduce the overall seabird bycatch attributed to the cod demersal longline fishery. Targeted outreach could be accomplished by touring these vessels to gather information on current mitigation techniques, collaborating with each vessel's crew on the types of techniques they think would be most likely to reduce bycatch rates on each vessel, and developing a reduction plan. Once a plan is agreed upon, NMFS staff or a specially trained observer acting on behalf of NMFS, should be deployed to troubleshoot and assist while these vessels are actively fishing.

Finally, both the sablefish and cod fisheries are certified by the Marine Stewardship Council (MSC; Chaffee et al. 2006a, 2006b). As part of the MSC process, these fisheries are annually audited to verify they are complying with certification conditions established in the final evaluations. Although there are no specific seabird reduction criteria in either report, the cod certification does contain a condition pertaining to effects of fulmar bycatch on the North Pacific fulmar population. High seabird bycatch rates driven by a few vessels have the potential to impact the entire fleet in future assessments, and this could motivate changes in fishing practices to reduce bycatch[1].

[1] Comments by the authors regarding the Marine Stewardship Council's certification of fisheries do not reflect the official policies of the National Marine Fisheries Service.

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Table 1. -- Summary of fishery characteristics (based on observed sets). CP: catcher processor; CV: catcher vessel; CDQ: Community Development Quota.

	Year	Cod	Sable	Turbot
Fishing depth (average meters; 90% range)	All	117.5 (75-172)	568.7 (358-733)	575.6 (344-739)
Set length (average # of hooks) – CP / CV	All	14,280 / 2,777	5,417 / 3,888	8,240 / 2,268
# sets / sampled hooks (1000s)	2004	10,907 / 51,302	1,278 / 2,021	448 / 1,247
	2005	10,165 / 49,789	1,358 / 2,294	509 / 1,510
	2006	8,287 / 39,712	1,386 / 2,247	456 / 1,248
	2007	6,345 / 31,994	1,243 / 2,164	432 / 1,293
# days with sample data (including CDQ)	2004	219 (340)†	196	92
	2005	209 (314)	189	98
	2006	192 (267)	211	116
	2007	164 (256)	200	92
Number unique CP	All	41	25	25
Number unique CV	All	12	51	6

†Bering Sea catcher-processor season shown; see Figure 2 for more detail by region and vessel type.

Table 2. -- List of seabirds observed caught in Alaska demersal groundfish longline fisheries, 2004 – 2007.

Common name	Scientific name	Analysis grouping
Laysan albatross	*Phoebastria immutabilis*	Albatross
Black-footed albatross	*Phoebastria nigripes*	Albatross
Albatross, unidentified	*Phoebastria* spp.	Albatross
Northern fulmar	*Fulmarus glacialis*	Fulmar
Sooty shearwater	*Puffinus griseus*	Shearwater
Short-tailed shearwater	*Puffinus tenuirostris*	Shearwater
Dark and unidentified shearwater	*Puffinus* spp.	Shearwater
Tubenose, unidentified	Procellariiformes	Other
Herring gull	*Larus argentatus*	Gull
Glaucous-winged gull	*Larus glaucescens*	Gull
Glaucous gull	*Larus hyuperboreus*	Gull
Gull, unidentified[†]	Laridae	Gull
Red-legged kittiwake	*Rissa brevirostris*	Other
Black-legged kittiwake	*Rissa tridactyla*	Other
Cormorant, unidentified	Phalacrocoracidae	Other
Thick-billed murre	*Uria lomvia*	Other
Common murre	*Uria aalge*	Other
Murre, unidentified	*Uria* spp.	Other
Alcid, unidentified	Alcidae	Other
Seabird and bird unidentified	Aves	Other

[†]An additional gull species, slaty-backed gull *L. schistisagus*, was identified from carcasses collected during a seabird mitigation experiment in 2005 (Phillips et al. 2008).

Table 3. -- Initial variables included in seabird bycatch models.

Variable	Description
Year	2004, 2005, 2006, 2007
Month	Jan. – Dec.
Day	Julian date
Large geographic area	Bering Sea, Aleutian Islands or Gulf of Alaska
Area	Loaded as categorical NMFS management area or loess smoothed surface of latitude and longitude
Depth	Average fishing depth
Target CPUE	Cod or sablefish catch per unit effort (kg per 1,000 hooks)
Total hooks	Total hooks deployed in set
Deterrent	Not checked by observer, No deterrent, Single streamer or Paired streamer
Vessel	Unique identifier for vessel

Table 4. -- Frequencies of observed bycatch events in the subset of data used for GAM models in the cod (A) and sablefish (B) fisheries.

A

Frequency	Fulmar	Gull	Shearwater	Albatross
0	34383	34705	34865	35246
1	623	358	292	21
2	145	107	54	3
3	58	43	26	0
4	21	24	10	0
5	13	14	2	0
6	11	6	1	0
7	2	4	1	0
8	3	2	6	0
9	2	2	1	0
10	1	1	3	0
11	1	0	2	0
12	0	0	0	0
13	2	0	2	0
14	1	0	1	0
15	2	1	0	0
16	0	0	1	0
18	0	0	0	0
19	0	1	1	0
20	0	0	1	0
22	2	0	0	0
33	0	0	1	0
46	0	1	0	0
77	0	1	0	0

B

Frequency	Fulmar	Gull	Shearwater	Albatross
0	4383	4386	4432	4408
1	42	37	6	25
2	3	11	1	5
3	6	3	0	0
4	0	1	0	1
5	0	0	0	0
7	2	1	0	0
9	1	0	0	0
11	1	0	0	0
14	1	0	0	0

Table 5. -- Variable significance and percent deviance explained by seabird bycatch GAMs in the cod (A) and sablefish (B) target fisheries. NS indicates not significant. Individual variable percent deviance is not additive to total.

A *Sample size;* *%sets with bycatch*	Fulmar *35,148;* *2.5%*	%dev	Gull *35,148;* *1.6%*	%dev	Shearwater *35,148;* *1.2%*	%dev	Albatross[#] *35,148;* *0.1%*	%dev
Vessel	0.00000	**8.5%**	0.00000	**10.5%**	0.00000	**8.8%**	0.00000	**13.7%**
Year	0.00000	4.4%	0.00000	2.2%	0.00000	4.9%	0.00000	1.8%
Month	0.00000	1.0%	0.00103	1.8%	0.00066	0.6%	0.00000	3.9%
Date	0.00000º	0.6%	0.00001º	1.2%	0.00000º	1.3%	NS	
Area	0.00000	1.6%	0.00001[†]	2.1%	0.00000	2.9%	0.00000[†]	10.8%
Depth	NS		NS		0.00000[‡]	0.9%	NS	
Deterrent	0.00000	0.6%	0.00322	0.8%	NS		0.00000	1.1%
Total hooks	NS		NS		0.00057[‡]	0.4%	0.00000º	1.1%
Target CPUE	NS		0.00534[‡]	0.9%	0.00036º	0.4%	NS	
Total		22%		33%		43%		41%

B *Sample size;* *%sets with bycatch*	Fulmar *4,436;* *1.3%*	%dev	Gull *4,436;* *1.2%*	%dev	Shearwater[#] *4,436;* *0.2%*	%dev	Albatross[#] *4,436;* *0.7%*	%dev
Vessel	0.00146	8.7%	0.00000	**12.3%**	0.00000	**33.5%**	0.00000	**24.7%**
Year	0.00000	**9.7%**	0.00000	2.4%	0.00000	9.6%	0.00001	2.0%
Month	0.00000	6.6%	NS		0.00000	5.7%	0.00190	2.0%
Date	NS		0.00000º	6.0%	0.00000º	3.1%	0.00110º	1.5%
Area	NS		0.00000[†]	6.7%	0.00000	9.8%	0.00000	5.7%
Depth	0.00086º	2.4%	NS		0.00000º	7.6%	0.00173º	1.4%
Deterrent	NS		0.00330	1.1%	0.00000	7.5%	NS	
Total hooks	0.00692º	1.8%	0.01413º	1.0%	0.00000[‡]	4.7%	0.00000º	2.6%
Target CPUE	NS		0.00099º	1.5%	0.00000º	11.8%	0.00000[‡]	3.2%
Total		41%		36%		78%		44%

[#]indicates models where binary error distribution was used.
[†]loaded area as loess surface of latitude and longitude.
[‡]variable loaded with loess smoother
ºvariable loaded with spline smoother

Table 6. -- Percent of observed sets by CPs that caught at least one bird in the cod fishery by vessel (rows) and year (columns). Vessels are listed in descending order of their combined 2004-2007 mean seabird bycatch rate; annual mean is in bold. For each year, dark orange highlighted boxes indicate the top four highest bycatch rates, orange indicates the next four highest rates, tan indicates the remaining vessels above the annual mean, and green indicates the lowest seven bycatch rates. Blank cells indicate no fishing.

Percent sets with bird bycatch			
2004	**2005**	**2006**	**2007**
13%	13%	8%	28%
15%	4%	4%	12%
13%	8%	10%	13%
2%	9%	6%	21%
18%	15%	6%	20%
5%	3%	4%	15%
8%	5%	3%	4%
5%	14%	3%	5%
11%	11%	4%	10%
3%	8%	5%	17%
7%	5%	8%	11%
5%	**6%**	**4%**	**8%**
3%	5%	11%	
4%	8%	1%	20%
3%	8%	1%	5%
2%	4%	12%	5%
2%	6%	7%	4%
1%	4%	7%	9%
9%	3%	3%	9%
3%	6%	1%	9%
6%	7%	7%	11%
3%	7%	2%	2%
4%	3%	3%	
4%	3%	3%	16%
4%	10%	1%	3%
2%	2%	1%	9%
3%	7%	1%	5%
3%	3%	1%	3%
3%	3%	2%	5%
1%	1%	4%	1%
3%	2%	2%	6%
4%	3%	3%	
5%	4%	3%	3%
4%	2%	3%	3%
2%	0%	6%	18%
9%	3%	1%	0%
2%	1%	2%	2%
1%	2%	0%	0%
1%	0%	0%	0%

Table 7. -- Percent of observed sets that caught at least one bird in the sablefish fishery by vessel (rows), year (columns), and vessel type (upper and lower panels). Vessels are listed in descending order of their combined 2004-2007 mean seabird bycatch rate; annual mean is in bold. For each year, dark orange highlighted boxes indicate the top three highest bycatch rates and tan indicates the remaining vessels above the annual mean. Blank cells indicate no fishing.

	Percent sets with bird bycatch			
	2004	**2005**	**2006**	**2007**
Catcher-Processor				
	2%	10%	19%	7%
		11%	4%	24%
	0%	2%	4%	9%
	2%	9%	14%	9%
	1%	**6%**	**5%**	**6%**
	0%	5%	3%	
	3%	10%	0%	0%
	0%	5%	2%	0%
	3%	3%		0%
	0%	0%	1%	0%
	0%	2%	2%	0%
	0%	1%	0%	0%
Catcher Vessels				
	25%	7%	13%	6%
	0%	5%	0%	24%
	13%	0%	0%	12%
	0%	4%	0%	0%
	0%	0%	13%	0%
	0%	5%	3%	3%
		0%	0%	13%
	1%	**1%**	**1%**	**4%**
	0%	0%	8%	
	4%	5%	2%	0%
	5%	0%	0%	
	0%	6%	0%	0%
	0%	0%	0%	8%
	0%	0%	0%	6%
	0%	0%	0%	4%
	0%	0%	0%	0%
	0%	0%	0%	0%
	0%	0%	0%	0%
	0%	0%	0%	0%
	0%	0%	0%	0%
	0%	0%	0%	0%
	0%	0%	0%	0%
	0%	0%	0%	0%
	0%	0%	0%	0%
		0%	0%	0%
		0%	0%	0%
	0%		0%	0%
	0%	0%		0%

Table 8. -- Information needs to address vessel-specific differences in seabird bycatch rates.

Vessel attractiveness to seabirds

1. Auto- or hand-bait?
   a. If auto-bait, does excess bait just fall continuously from stern during gear deployment or is it collected and discarded after gear deployment?
   b. If auto-bait, how effective is baiter? Are there a lot of flying pieces of bait or does it typically stay on the hooks? Is there a scupper under the auto-baiter that is discharging small bait pieces into the gear deployment path?
   c. If hand-bait, is bait fresh? What is typical lag time between baiting the gear and deployment?
2. Offal or other discharge during gear deployment?
   a. If offal, is it macerated? What size? Where does discharge occur?
   b. Does discharge typically float into gear deployment path?
   c. Which birds are present during discharge? Use protocol similar to Zador and Fitzgerald (2008).

Effect on gear sink rate (i.e., distance astern gear available near surface)

3. Gear deployment speed
4. Location of gear deployment (stern versus side)
5. Deployment into propeller up- or down-wash
6. Height of gear deployment
7. Does the vessel use integrated weight gear?
8. Does vessel add weight to gear (e.g., cannonballs, rocks)? If yes, how much weight is added and at what intervals? Is weight added all the time or just under certain circumstances (e.g., high current fishing areas)?
9. Does vessel add floats to gear? Are floats added all the time or just under certain circumstances (e.g., high snail, crab or starfish areas)?
10. Does vessel utilize a line setting tube or line shooter? If yes, how often does gear jump out of the tube and deploy normally?

Streamer line effectiveness

11. How many streamer lines are deployed? Height of steamer line(s) at stern. How are streamers attached?
12. What is used to create drag (terminal end)?
13. Aerial extent of streamers
14. Are streamers frequently tangled or do they always hang down to the water (if there were no wind)?
15. When only a single streamer deployed, is it always on the windward side?
16. Are streamers maintained? Are there streamers frequently missing or broken?
17. Reason for lack of streamer deployment. Are all instances without streamers due to the weather exclusion?

Crew attitude toward using mitigation

18. How often does streamer become entangled in longline gear?
19. Captain/mate attitude regarding deployment of streamer lines
20. Crew attitude regarding deployment of streamer lines
21. Consistency of crew that deploy streamer lines within and among trips

Mitigation techniques utilizted for birds caught during deployment are different than during retrieval.

22. Differentiate data collected between birds caught during gear deployment and retrieval. If birds frequently caught during retrieval, is there any discard forward of the hauling station?

Misc.

23. Bird presence (abundance) and interaction rate during gear deployment?
24. Does vessel employ any other seabird mitigation techniques? Explain in detail.

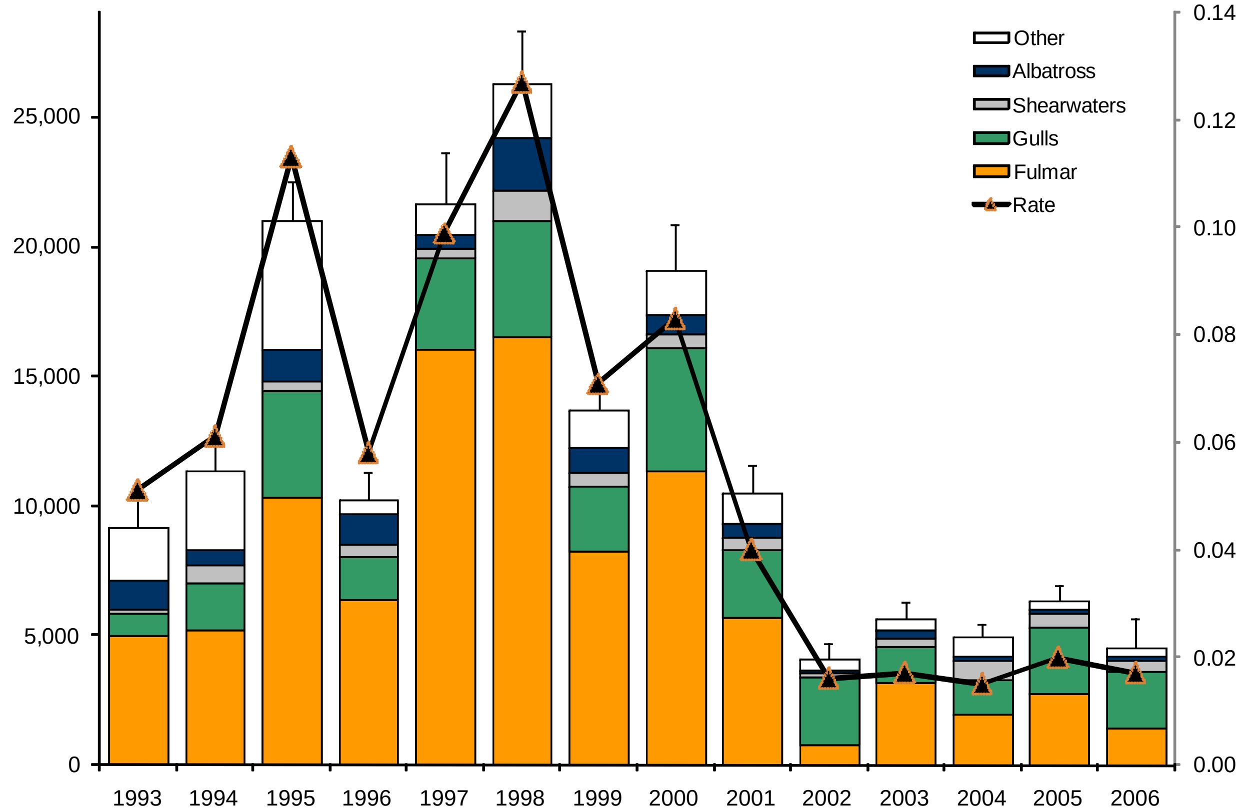


Figure 1. -- Estimated annual seabird bycatch (primary axis) and rates (birds/1,000 hooks, secondary axis) in Alaska demersal groundfish longline fisheries (NMFS 2008). Error bars are the upper 95% confidence interval on total seabird bycatch estimate.

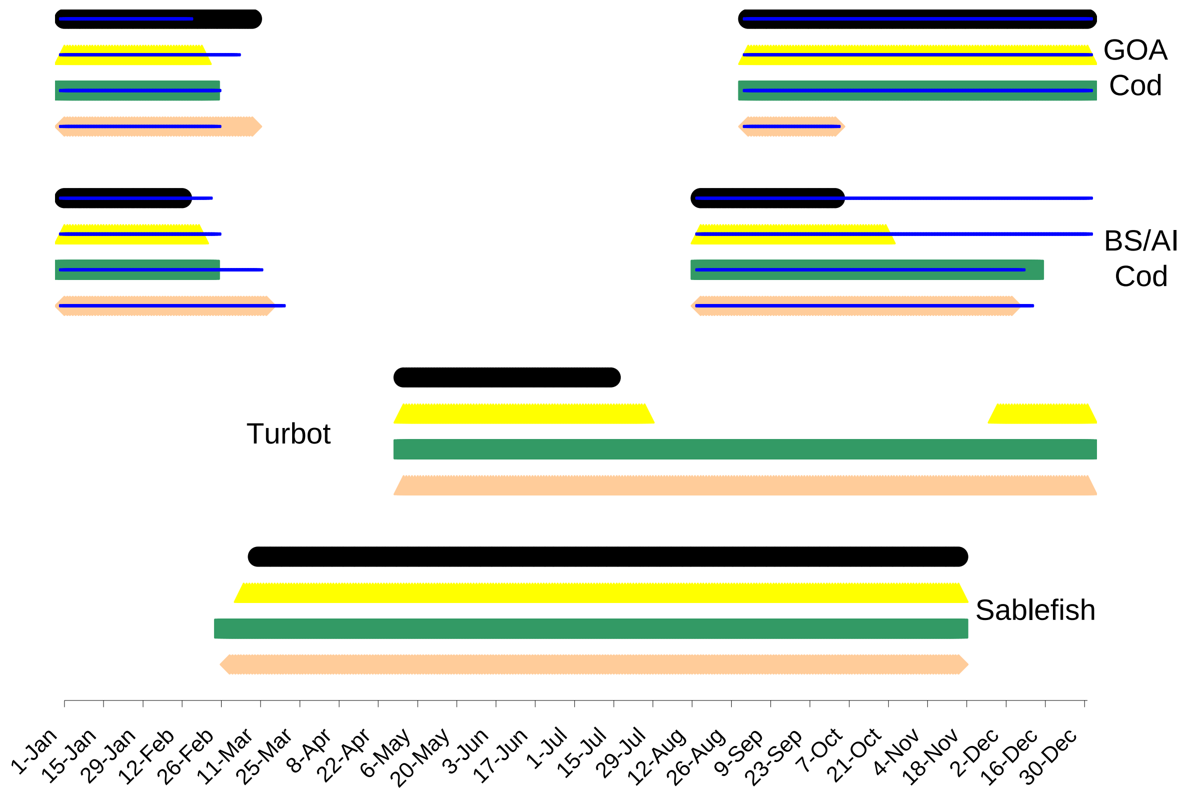


Figure 2. -- Opening and closure (no symbol) dates by fishery and year (2004 to 2007 ordered from bottom, tan, to top, black). Blue lines for cod fisheries indicate catcher vessels, which differed from catcher-processing vessels. GOA: Gulf of Alaska; BS/AI: Bering Sea and Aleutian Islands.

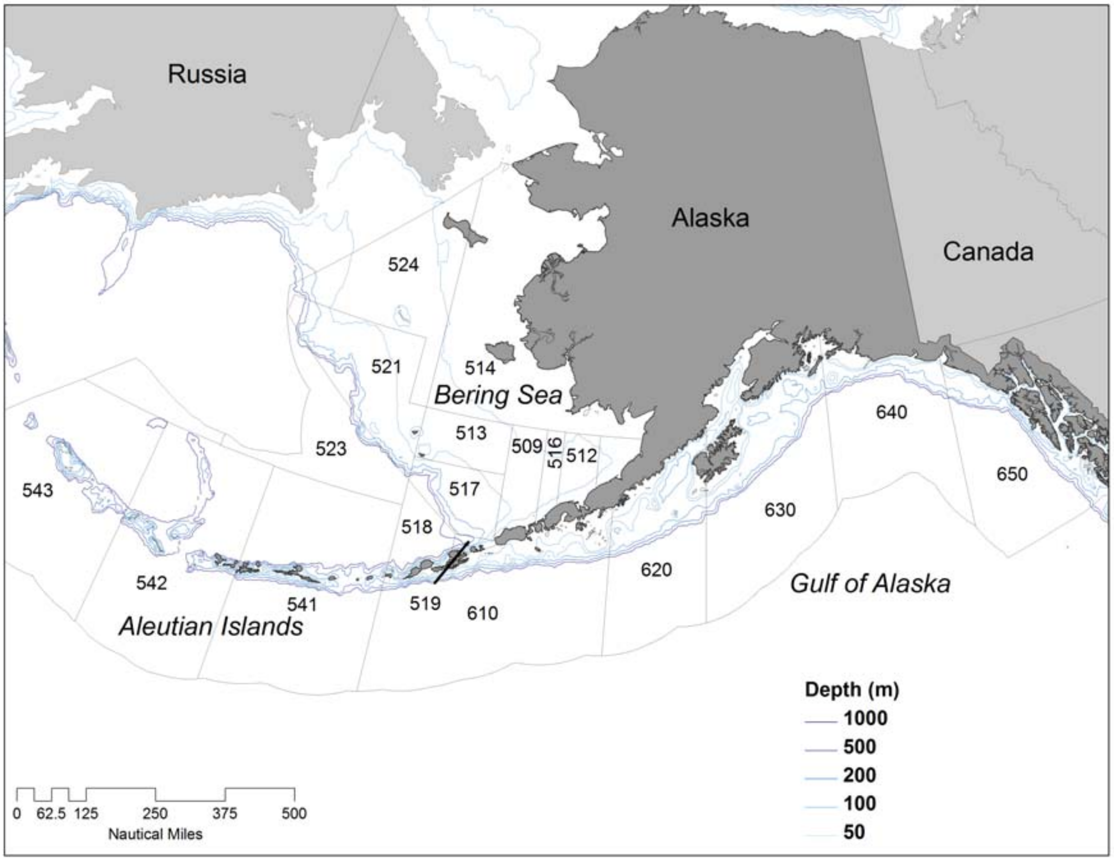
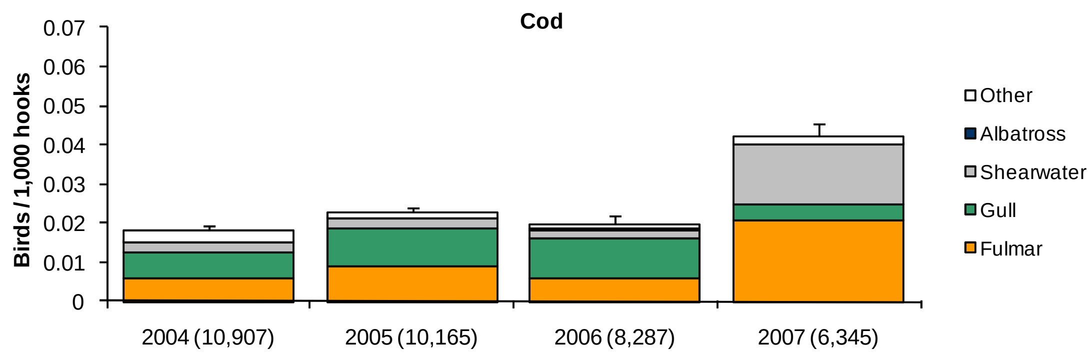
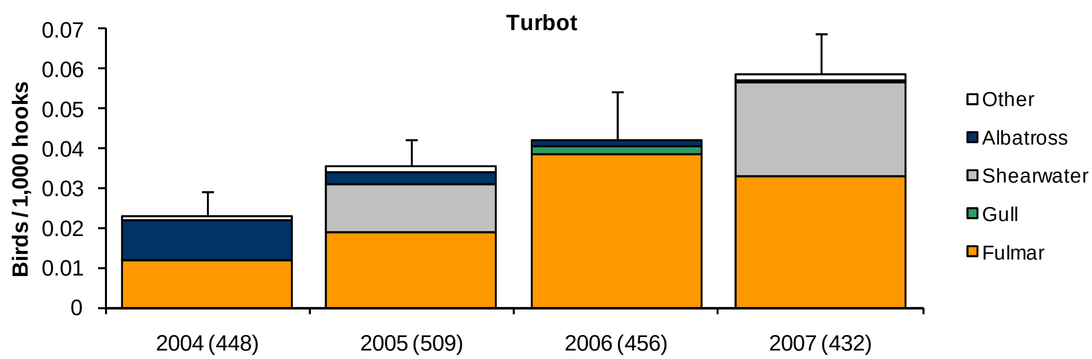


Figure 3. -- Location of NMFS regulatory management areas for the Bering Sea, Aleutian Islands, and Gulf of Alaska.

A



B



C

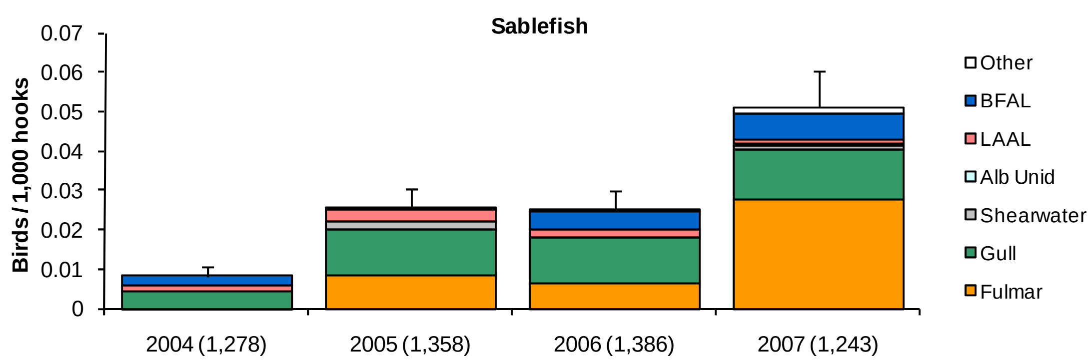


Figure 4. -- Mean bird bycatch rates by year in the cod (a), turbot (b), and sablefish (c) fisheries. Error bars are standard errors on total. Sample size (sets) in parentheses on x-axis.

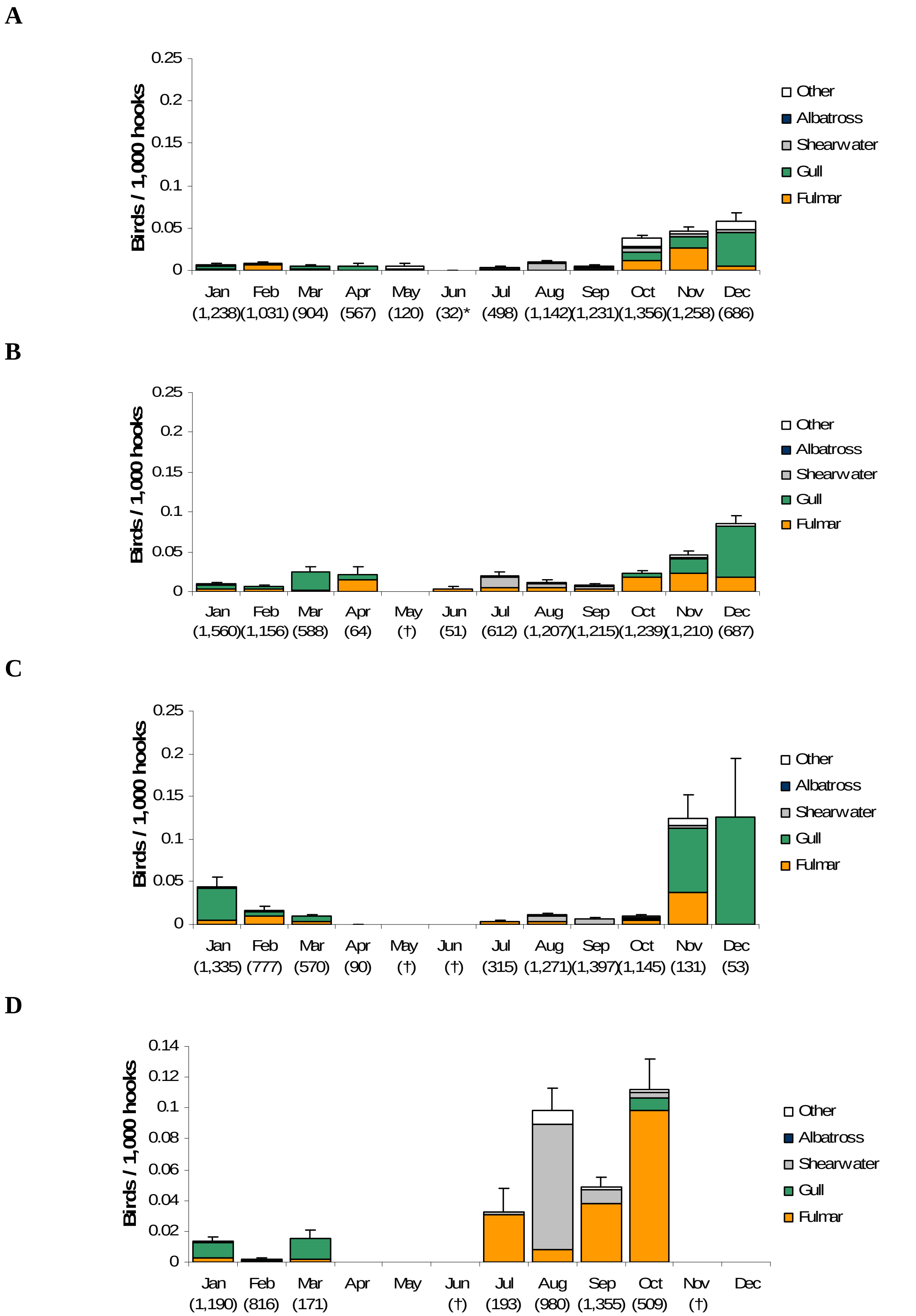


Figure 5. -- Mean bird bycatch rates by month in the Bering Sea cod fishery in 2004 (a), 2005 (b), 2006 (c) and 2007 (d). Error bars are standard errors on total. Aleutian Islands and Gulf of Alaska not included due to low sample sizes. Sample size (sets) in parentheses on x-axis; no effort indicated by no parentheses. †Effort occurred but fewer than three vessels and rates are not shown; *small sample size.

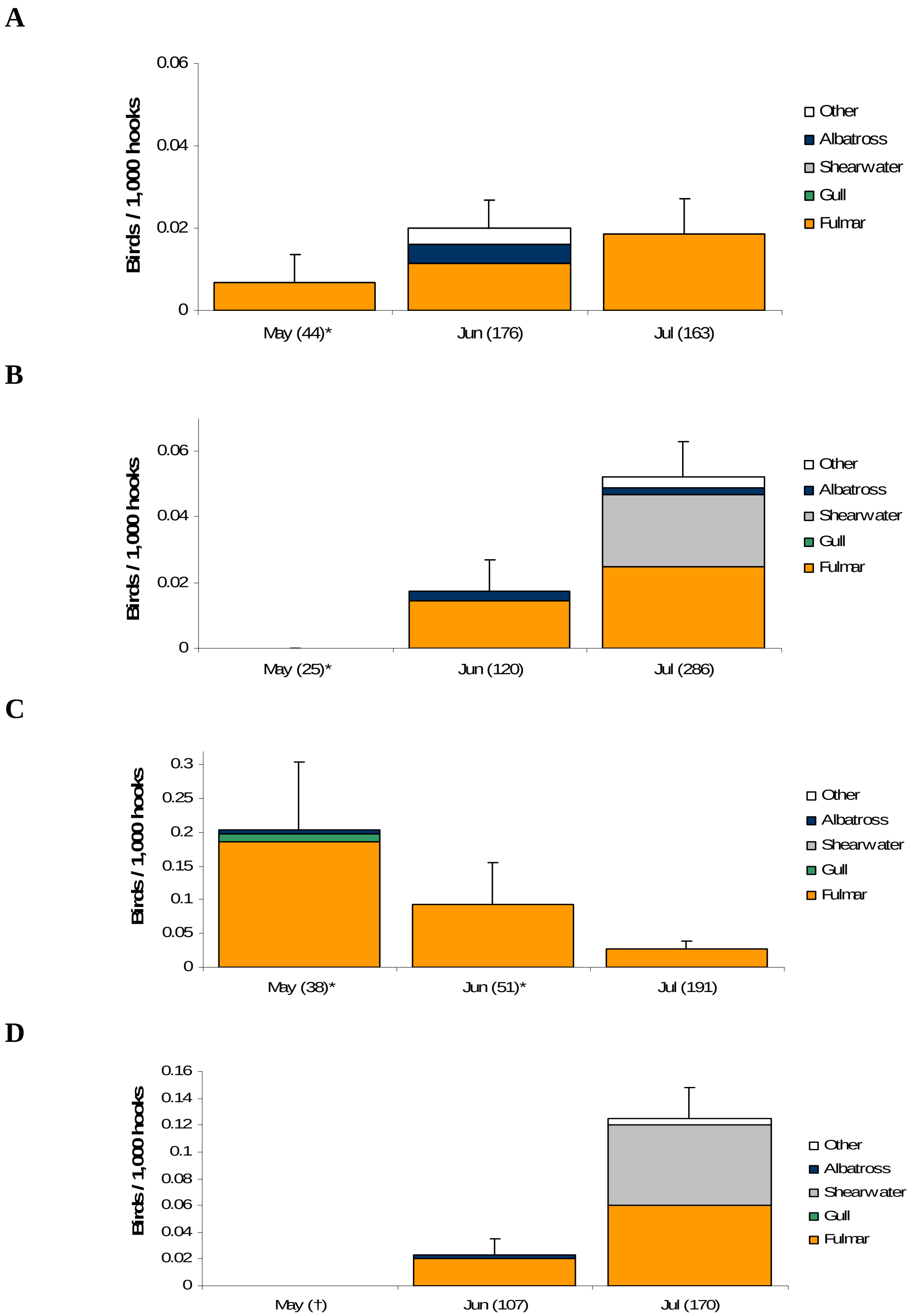


Figure 6. -- Mean bird bycatch rates by month in the Bering Sea turbot fishery in 2004 (a), 2005 (b), 2006 (c) and 2007 (d). Error bars are standard errors on total. Sample size (sets) in parentheses on x-axis; no effort indicated by no parentheses. †Effort occurred but fewer than three vessels and rates are not shown; *small sample size. Note different scale in (c) and (d).

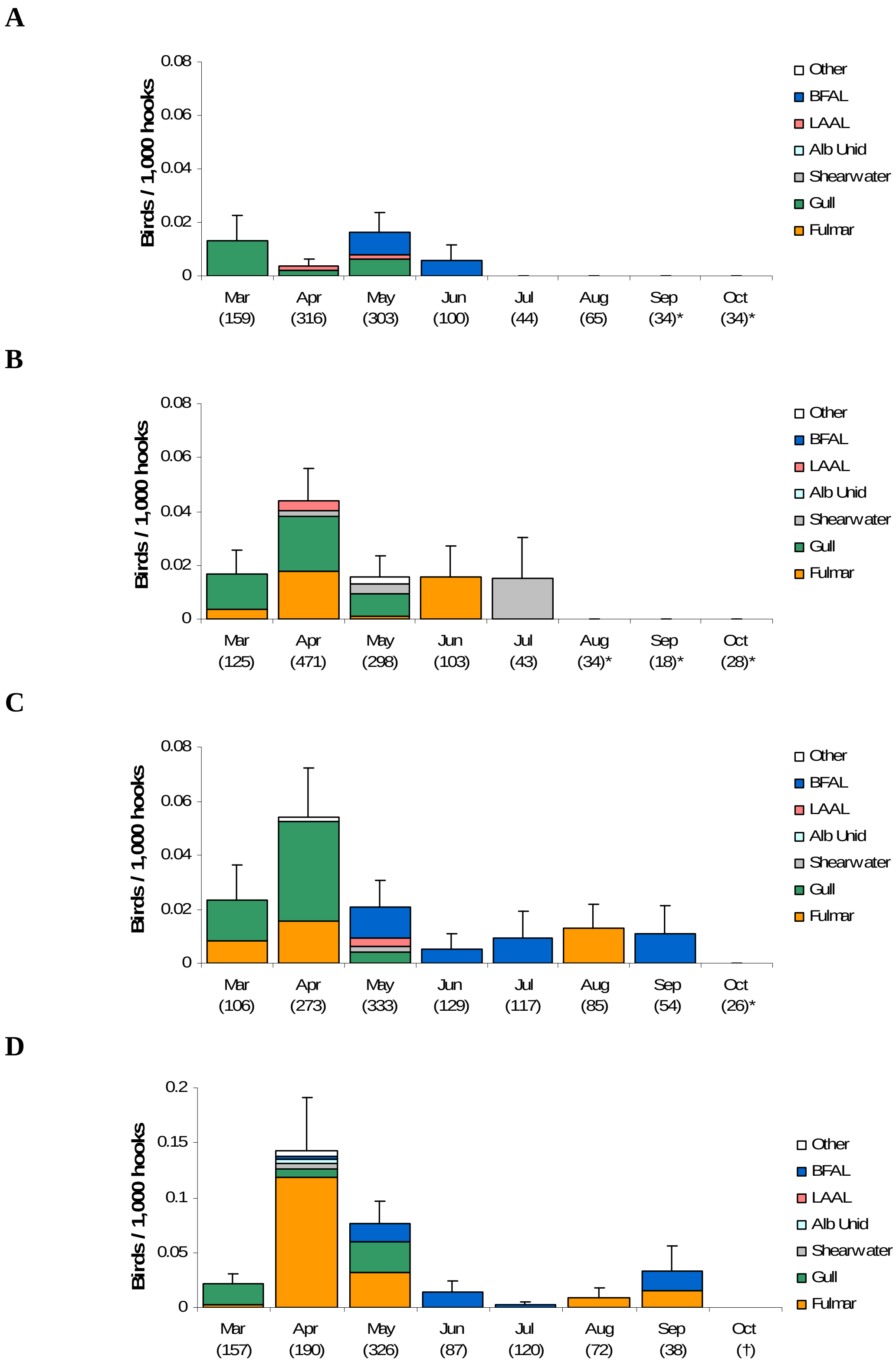


Figure 7. -- Mean bird bycatch rates by month in the Gulf of Alaska sablefish fishery in 2004 (a), 2005 (b), 2006 (c) and 2007 (d). Error bars are standard errors on total. Sample size (sets) in parentheses on x-axis; no effort indicated by no parentheses. †Effort occurred but fewer than three vessels and rates are not shown; *small sample size. Note different scale in (d).

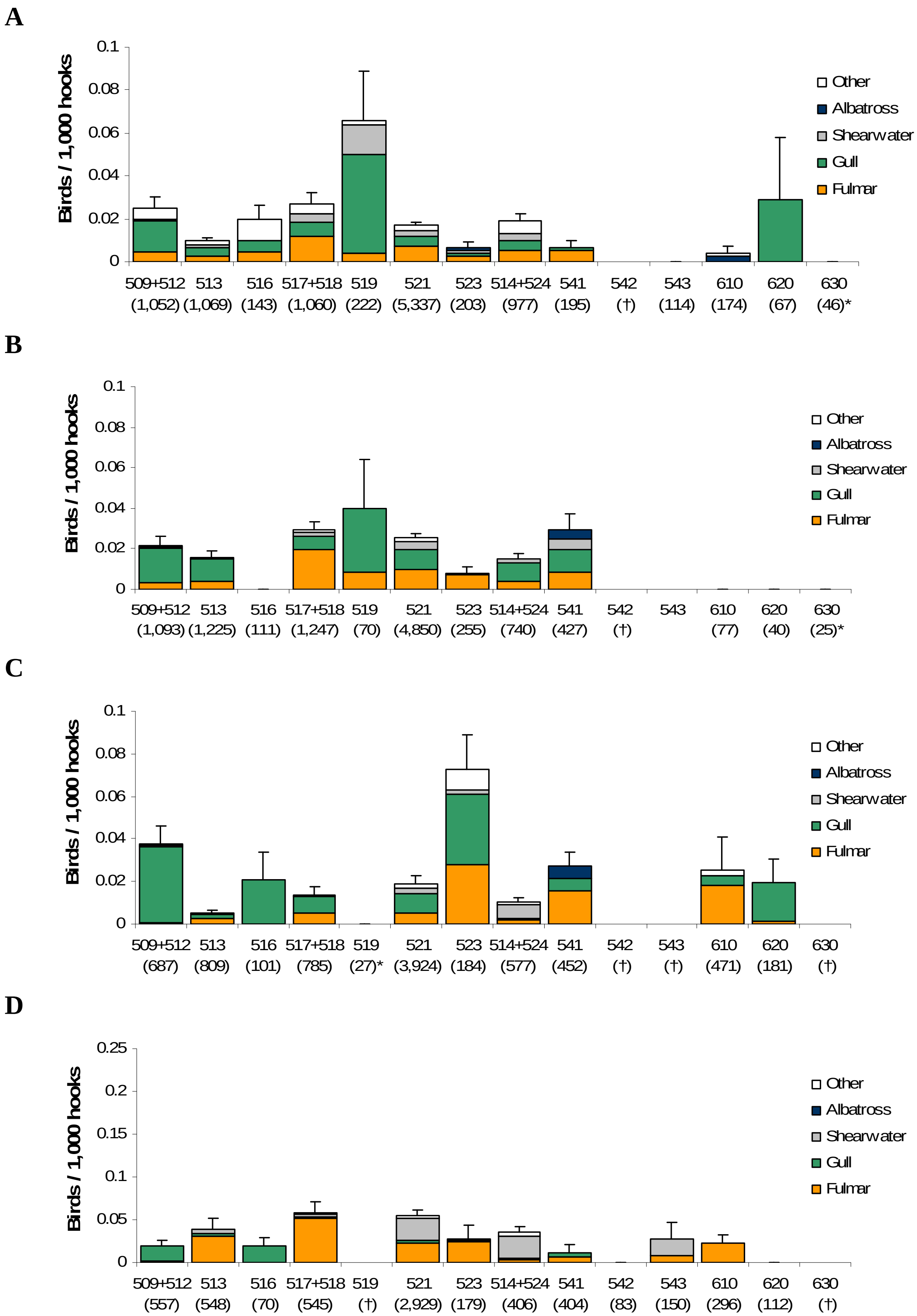


Figure 8. -- Mean bird bycatch rates by area in the cod fishery for 2004 (a), 2005 (b), 2006 (c) and 2007 (d). Error bars are standard errors on total. Sample size (sets) in parentheses on x-axis; no effort indicated by no parentheses. †Effort occurred but fewer than three vessels and rates are not shown; *small sample size. Note different scale in (d).

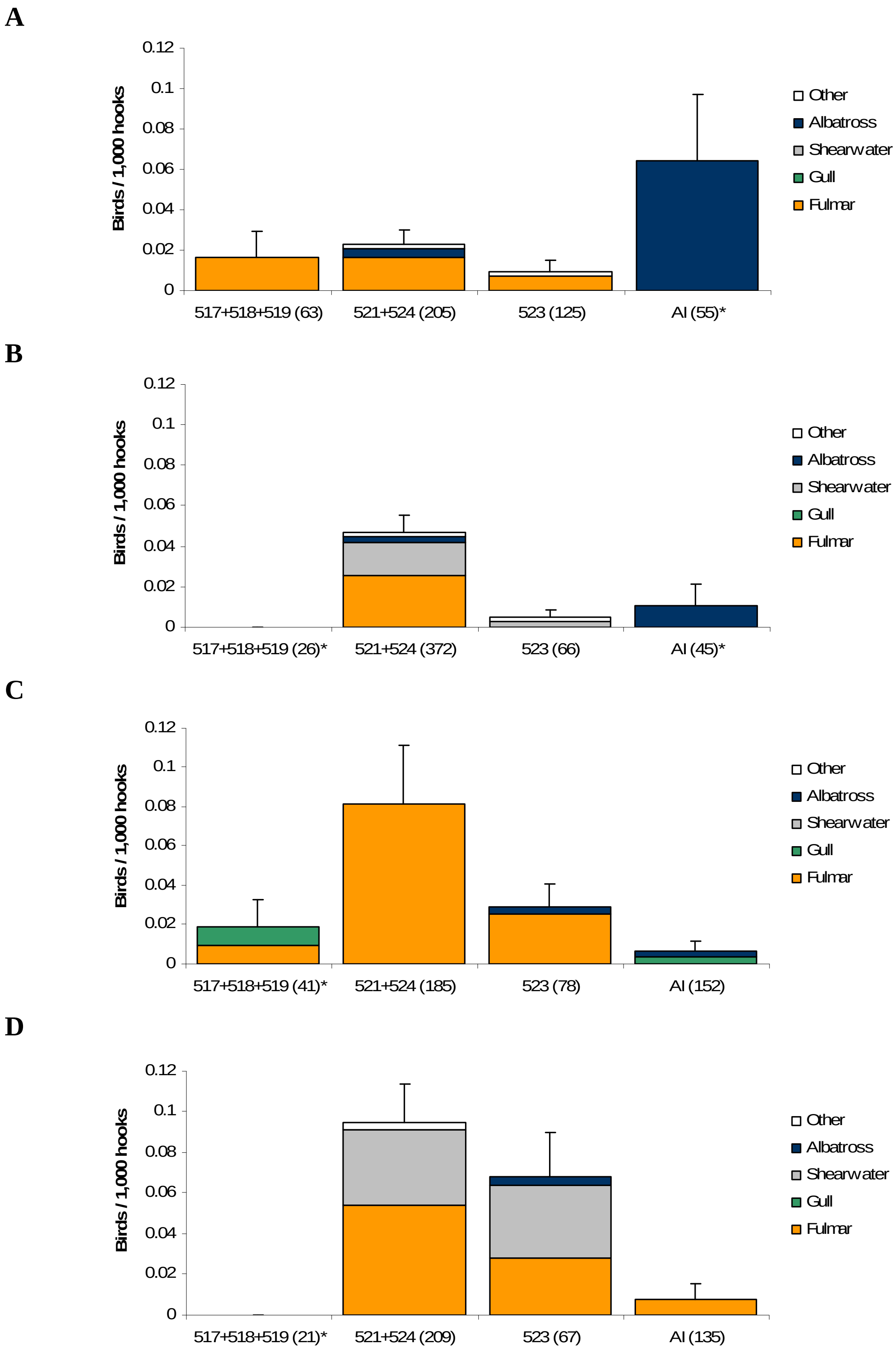
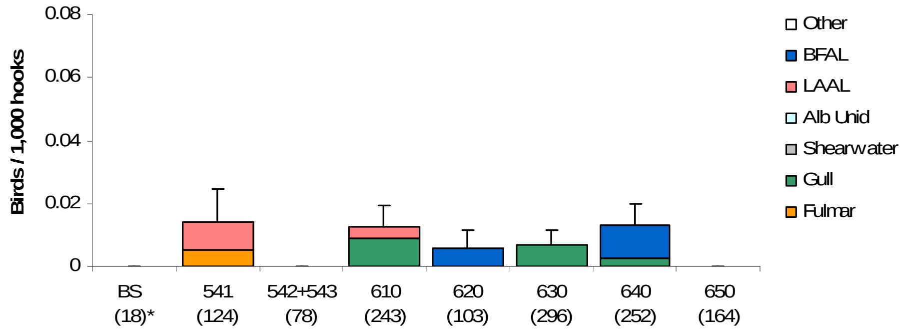
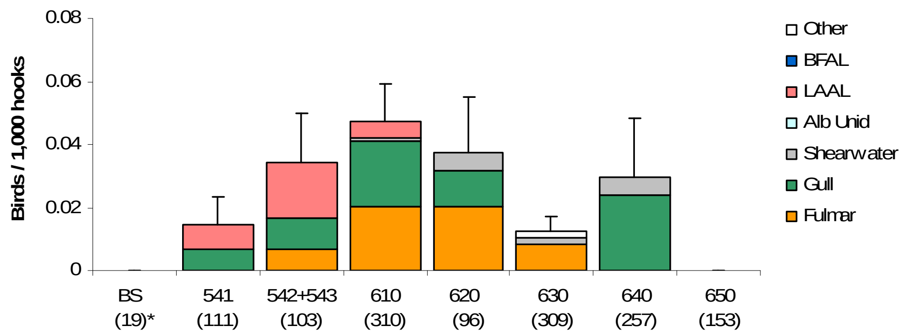


Figure 9. -- Mean bird bycatch rates by area in the turbot fishery for 2004 (a), 2005 (b), 2006 (c) and 2007 (d). Error bars are standard errors on total. Sample size (sets) in parentheses on x-axis; no effort indicated by no parentheses. †Effort occurred but fewer than three vessels and rates are not shown; *small sample size.

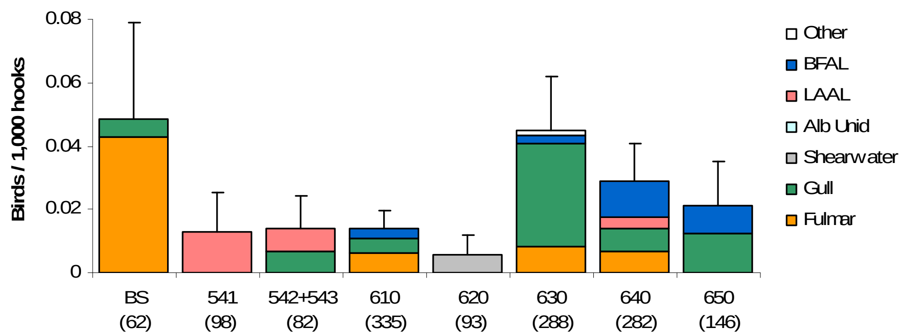
A



B



C



D

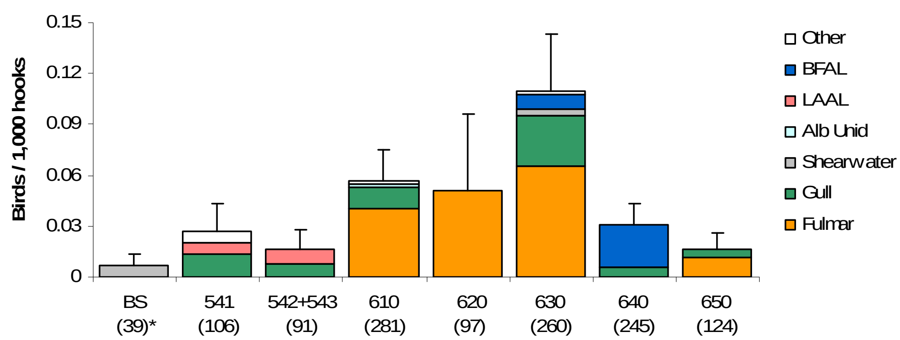


Figure 10. -- Mean bird bycatch rates by area in the sablefish fishery for 2004 (a), 2005 (b), 2006 (c) and 2007 (d). Error bars are standard errors on total. Sample size (sets) in parentheses on x-axis; no effort indicated by no parentheses. *Small sample size. Note different scale in (d).

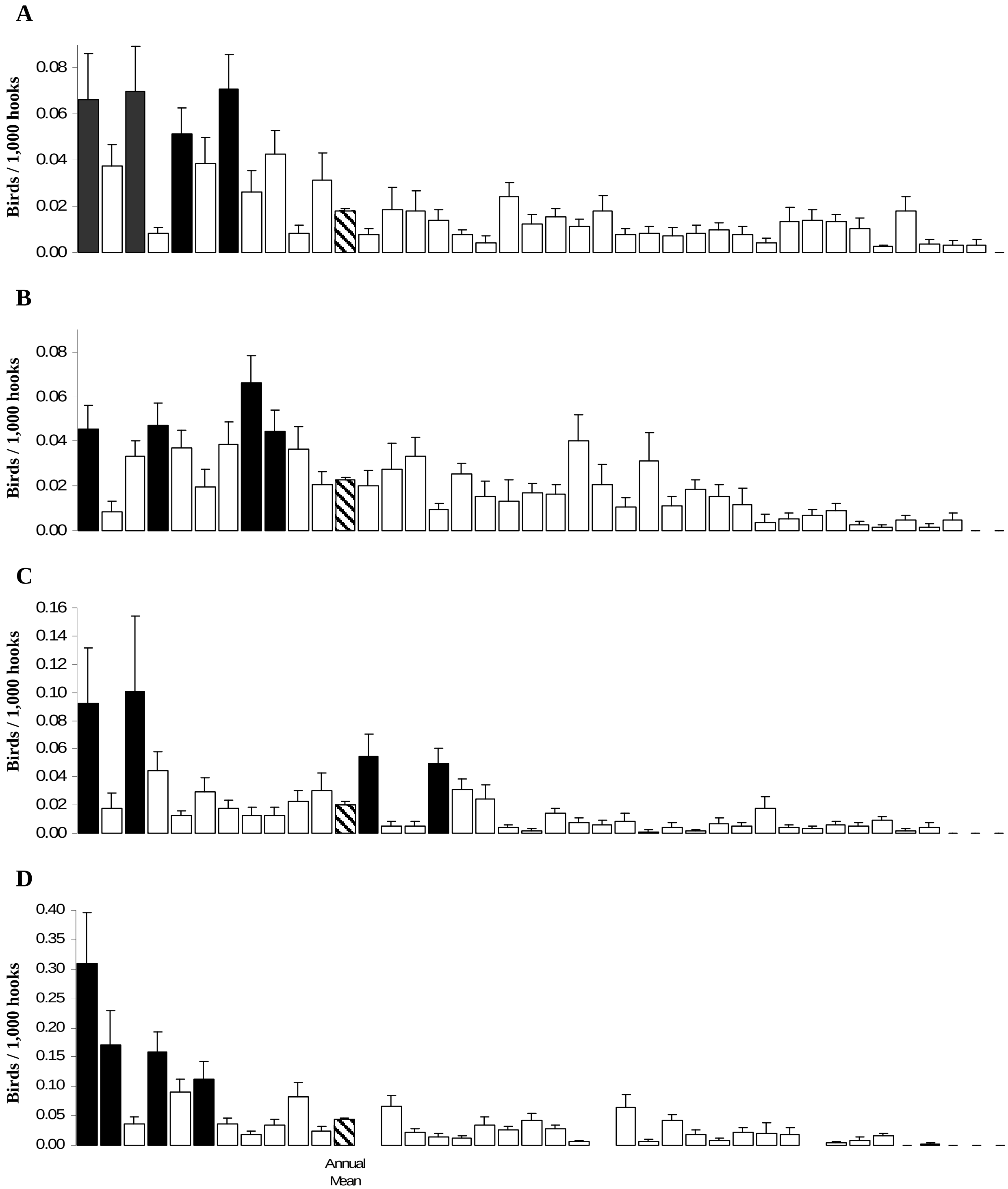


Figure 11.-- Vessel-specific bycatch rates in the cod fishery for 2004 (a), 2005 (b), 2006 (c) and 2007 (d). Annual mean indicated with stripes and top 10% of vessels highlighted with black bars. Each column represents a unique vessel; " _ " = zero bycatch and blank columns indicate a vessel didn't fish in that year. Error bars are standard errors. Note difference of scale in (c) and (d).

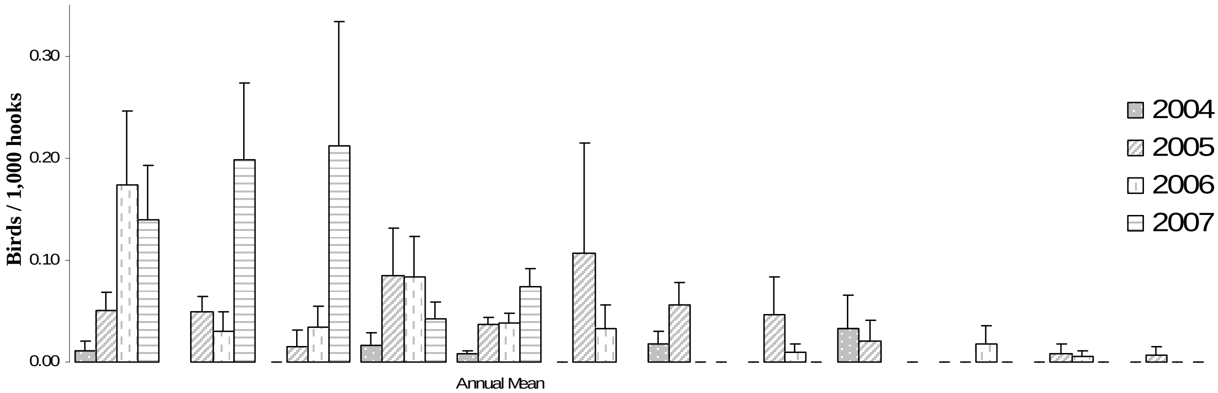


Figure 12.--Vessel-specific bycatch rates in the sablefish fishery for catcher-processors by year. Each column represents a unique vessel-year; "_" = zero bycatch and blank columns indicate a vessel didn't fish in that year. Error bars are standard errors.

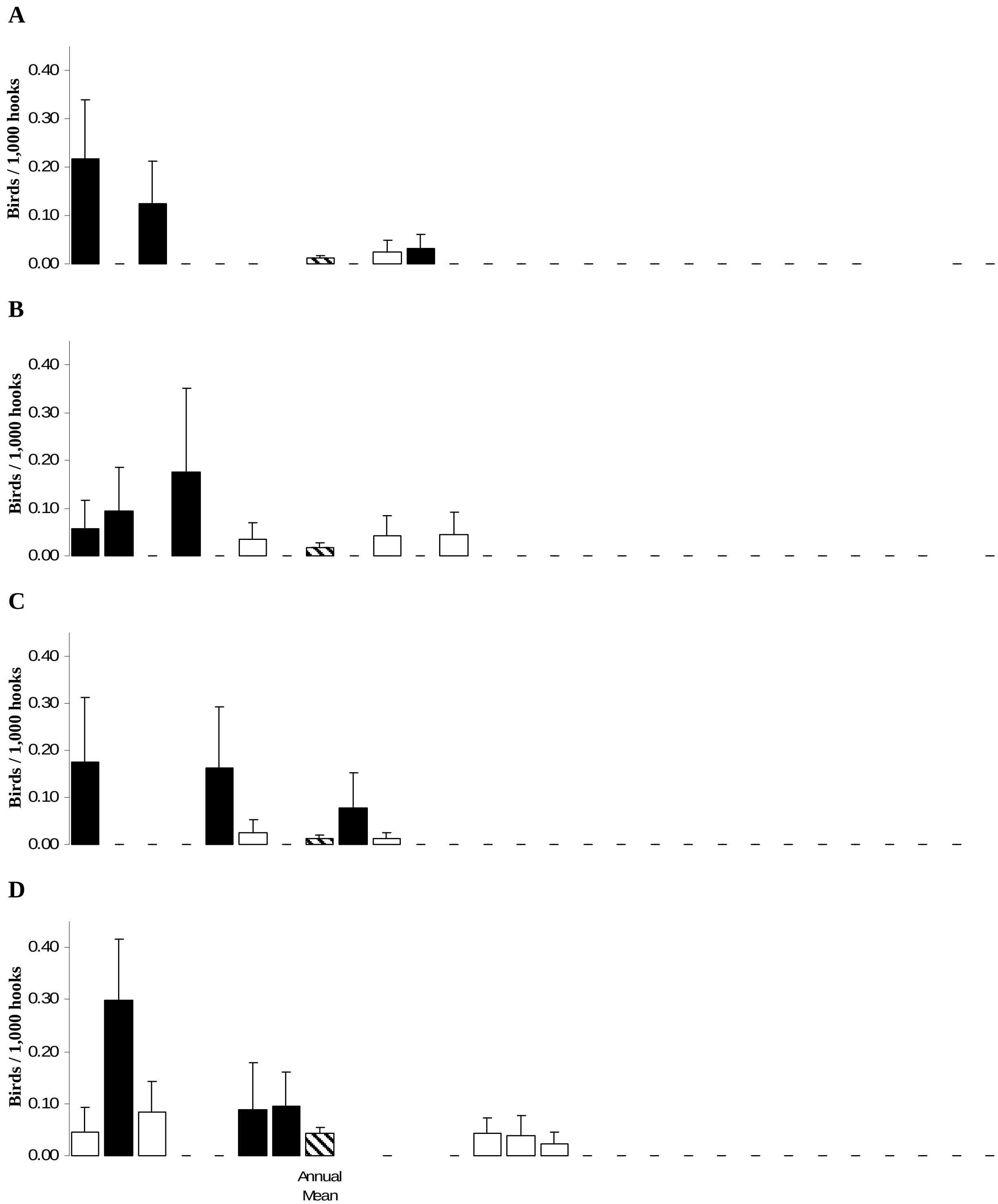


Figure 13.-- Vessel-specific bycatch rates in the sablefish fishery for catcher vessels in 2004 (a), 2005 (b), 2006 (c) and 2007 (d). Each column represents a unique vessel; "_" = zero bycatch and blank columns indicate a vessel didn't fish in that year. Annual mean indicated with stripes and top three vessels highlighted with black bars. Error bars are standard errors.

APPENDICES

Appendix 1. -- Mean seabird bycatch rates (Catch-per-unit-effort (CPUE) or number caught per 1,000 hooks) by year and target fishery.

					Mean						Standard Error of Mean						
Target	Year	N sets	Sampled hooks	Total hooks	Total bird CPUE	Fulmar CPUE	Gull CPUE	Shear-water CPUE	Albatross CPUE	Other CPUE	Total bird CPUE	Fulmar CPUE	Gull CPUE	Shear-water CPUE	Albatross CPUE	Other CPUE	# vessels
Cod	2004	10,907	51,302,422	150,885,602	0.018	0.006	0.006	0.002	0.000	0.003	0.001	0.001	0.001	0.000	0.000	0.000	47
Cod	2005	10,165	49,788,842	145,869,397	0.023	0.009	0.010	0.002	0.000	0.001	0.001	0.001	0.001	0.000	0.000	0.000	43
Cod	2006	8,287	39,712,357	116,987,588	0.020	0.006	0.010	0.002	0.000	0.001	0.002	0.001	0.002	0.000	0.000	0.000	45
Cod	2007	6,345	31,993,708	93,274,021	0.042	0.021	0.004	0.015	0.000	0.002	0.003	0.002	0.001	0.002	0.000	0.000	40
Sable	2004	1,278	2,020,923	5,693,947	0.008	0.000	0.004	0.000	0.004	0.000	0.002	0.000	0.002	0.000	0.002	0.000	57
Sable	2005	1,358	2,294,031	6,436,414	0.026	0.008	0.011	0.002	0.003	0.001	0.005	0.002	0.004	0.001	0.001	0.001	58
Sable	2006	1,386	2,247,120	6,414,147	0.025	0.006	0.011	0.000	0.007	0.000	0.005	0.002	0.004	0.000	0.002	0.000	63
Sable	2007	1,243	2,164,333	6,076,291	0.051	0.028	0.012	0.001	0.008	0.001	0.010	0.008	0.003	0.001	0.003	0.001	56
Turbot	2004	448	1,246,999	3,505,990	0.023	0.012	0.000	0.000	0.010	0.001	0.006	0.004	0.000	0.000	0.004	0.001	20
Turbot	2005	509	1,509,579	4,266,631	0.036	0.019	0.000	0.012	0.003	0.002	0.007	0.005	0.000	0.004	0.002	0.001	15
Turbot	2006	456	1,248,320	3,702,452	0.042	0.038	0.002	0.000	0.002	0.000	0.012	0.012	0.001	0.000	0.001	0.000	21
Turbot	2007	432	1,293,294	3,578,725	0.059	0.033	0.000	0.024	0.001	0.002	0.010	0.007	0.000	0.008	0.001	0.001	14

Appendix 2.-- Mean seabird bycatch rates (Catch-per-unit-effort (CPUE) or number caught per 1,000 hooks) by year, month and large geographic region for the cod fishery. †Effort present but fewer than three vessels.

Year	Region	Month	N sets	Sampled hooks	Total hooks	Mean: Total bird CPUE	Mean: Fulmar CPUE	Mean: Gull CPUE	Mean: Shear-water CPUE	Mean: Albatross CPUE	Mean: Other CPUE	SE: Total bird CPUE	SE: Fulmar CPUE	SE: Gull CPUE	SE: Shear-water CPUE	SE: Albatross CPUE	SE: Other CPUE	# vessels
2004	AI	Jan																
		Feb	111	328,952	928,941	0.009	0.009	0.000	0.000	0.000	0.000	0.005	0.005	0.000	0.000	0.000	0.000	4
		Mar	†															
		Apr	†															
		May	†															
		Jun	†															
		Jul	†															
		Aug	†															
		Sep	†															
		Oct	†															
		Nov	†															
		Dec																
	BS	Jan	1,238	6,234,949	18,597,393	0.006	0.001	0.003	0.000	0.000	0.001	0.001	0.000	0.001	0.000	0.000	0.001	30
		Feb	1,031	5,378,057	15,686,294	0.009	0.007	0.001	0.000	0.000	0.001	0.002	0.002	0.001	0.000	0.000	0.000	30
		Mar	904	4,571,887	13,074,537	0.005	0.002	0.003	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.000	29
		Apr	567	2,450,361	6,694,115	0.006	0.000	0.005	0.000	0.000	0.001	0.002	0.000	0.002	0.000	0.000	0.001	9
		May	120	698,938	1,943,112	0.004	0.001	0.000	0.000	0.000	0.003	0.003	0.001	0.000	0.000	0.000	0.003	6
		Jun	32	156,662	413,379	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4
		Jul	498	1,913,569	5,420,194	0.004	0.002	0.000	0.001	0.000	0.000	0.002	0.002	0.000	0.001	0.000	0.000	11
		Aug	1,142	5,712,725	17,185,020	0.010	0.001	0.000	0.007	0.000	0.002	0.002	0.000	0.000	0.001	0.000	0.001	32
		Sep	1,231	6,269,524	19,081,048	0.006	0.001	0.000	0.003	0.000	0.001	0.001	0.000	0.000	0.001	0.000	0.001	34
		Oct	1,356	6,584,551	19,608,523	0.037	0.011	0.010	0.005	0.000	0.010	0.004	0.002	0.002	0.001	0.000	0.002	35
		Nov	1,258	6,318,720	18,600,529	0.046	0.026	0.013	0.003	0.000	0.004	0.005	0.004	0.003	0.001	0.000	0.001	35
		Dec	686	2,824,363	8,102,692	0.057	0.005	0.039	0.004	0.000	0.009	0.011	0.001	0.008	0.002	0.000	0.005	32
	GOA	Jan	167	512,851	1,450,229	0.002	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.000	0.002	7
		Feb																
		Mar	†															
		Apr	7	11,621	34,968	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
		May	†															
		Jun	†															
		Jul																
		Aug	†															
		Sep	89	344,508	1,025,184	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4
		Oct	†															
		Nov	†															
		Dec																

Appendix 2. -- Continued.

Year	Region	Month	N sets	Sampled hooks	Total hooks	Mean Total bird CPUE	Mean Fulmar CPUE	Mean Gull CPUE	Mean Shear-water CPUE	Mean Albatross CPUE	Mean Other CPUE	SE Total bird CPUE	SE Fulmar CPUE	SE Gull CPUE	SE Shear-water CPUE	SE Albatross CPUE	SE Other CPUE	# vessels
	AI	Jan																
		Feb	†															
		Mar	112	258,000	761,217	0.031	0.010	0.011	0.000	0.010	0.000	0.013	0.006	0.007	0.000	0.006	0.000	3
		Apr	†															
		May	†															
		Jun																
		Jul																
		Aug	†															
		Sep	†															
		Oct	†															
		Nov	†															
		Dec	†															
2005	BS	Jan	1,560	8,132,349	23,899,484	0.010	0.003	0.006	0.000	0.000	0.001	0.002	0.001	0.002	0.000	0.000	0.000	37
		Feb	1,156	5,686,899	16,749,248	0.007	0.004	0.002	0.000	0.000	0.000	0.002	0.002	0.001	0.000	0.000	0.000	34
		Mar	588	2,712,931	7,818,323	0.025	0.002	0.022	0.000	0.001	0.000	0.006	0.001	0.006	0.000	0.001	0.000	10
		Apr	64	227,364	658,660	0.021	0.015	0.006	0.000	0.000	0.000	0.011	0.010	0.006	0.000	0.000	0.000	4
		May	†															
		Jun	51	223,449	637,660	0.003	0.003	0.000	0.000	0.000	0.000	0.003	0.003	0.000	0.000	0.000	0.000	3
		Jul	612	2,971,582	8,459,817	0.020	0.005	0.000	0.014	0.000	0.001	0.004	0.002	0.000	0.003	0.000	0.001	13
		Aug	1,207	6,158,566	18,176,673	0.012	0.004	0.000	0.006	0.000	0.002	0.002	0.001	0.000	0.001	0.000	0.001	36
		Sep	1,215	6,359,788	18,895,232	0.008	0.003	0.000	0.003	0.000	0.001	0.001	0.001	0.000	0.001	0.000	0.000	35
		Oct	1,239	6,579,468	19,164,823	0.023	0.018	0.005	0.000	0.000	0.000	0.003	0.003	0.001	0.000	0.000	0.000	34
		Nov	1,210	6,247,928	18,149,382	0.046	0.023	0.019	0.001	0.000	0.004	0.005	0.003	0.003	0.000	0.000	0.002	34
		Dec	687	3,401,297	10,125,179	0.085	0.019	0.063	0.000	0.000	0.002	0.011	0.003	0.010	0.000	0.000	0.001	35
	GOA	Jan	53	58,701	168,852	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
		Feb	†															
		Mar	6	10,791	26,159	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
		Apr	14	23,051	59,196	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
		May	†															
		Jun	†															
		Jul																
		Aug																
		Sep	62	145,169	422,367	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5
		Oct																
		Nov																
		Dec																

Appendix 2. -- Continued.

Year	Region	Month	N sets	Sampled hooks	Total hooks	Mean Total bird CPUE	Mean Fulmar CPUE	Mean Gull CPUE	Mean Shear-water CPUE	Mean Albatross CPUE	Mean Other CPUE	SE Total bird CPUE	SE Fulmar CPUE	SE Gull CPUE	SE Shear-water CPUE	SE Albatross CPUE	SE Other CPUE	# vessels
		Jan	†															
		Feb	127	329,417	916,141	0.054	0.044	0.010	0.000	0.000	0.000	0.017	0.016	0.006	0.000	0.000	0.000	4
		Mar	203	450,713	1,319,781	0.020	0.001	0.005	0.000	0.013	0.000	0.009	0.001	0.004	0.000	0.007	0.000	6
		Apr																
		May																
	AI	Jun	†															
		Jul	†															
		Aug	64	139,983	380,765	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
		Sep	†															
		Oct	†															
		Nov																
		Dec																
		Jan	1,335	6,926,904	20,751,785	0.044	0.005	0.038	0.000	0.000	0.001	0.012	0.002	0.011	0.000	0.000	0.000	36
		Feb	777	3,771,288	11,002,500	0.017	0.010	0.004	0.000	0.000	0.003	0.005	0.004	0.001	0.000	0.000	0.001	35
		Mar	570	2,372,118	6,713,424	0.010	0.004	0.005	0.000	0.000	0.000	0.002	0.002	0.002	0.000	0.000	0.000	12
		Apr	90	239,721	696,040	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4
		May	†															
		Jun	†															
2006	BS	Jul	315	1,576,351	4,672,355	0.004	0.004	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.000	11
		Aug	1,271	6,724,248	20,053,818	0.011	0.003	0.000	0.007	0.000	0.002	0.002	0.001	0.000	0.002	0.000	0.001	36
		Sep	1,397	8,105,800	24,029,980	0.006	0.001	0.000	0.005	0.000	0.000	0.002	0.000	0.000	0.001	0.000	0.000	36
		Oct	1,145	6,627,050	19,587,139	0.010	0.005	0.001	0.001	0.000	0.003	0.002	0.001	0.001	0.000	0.000	0.001	39
		Nov	131	576,714	1,616,775	0.125	0.038	0.075	0.003	0.000	0.010	0.027	0.010	0.021	0.002	0.000	0.004	3
		Dec	53	203,011	585,344	0.125	0.000	0.125	0.000	0.000	0.000	0.069	0.000	0.069	0.000	0.000	0.000	12
		Jan	68	74,023	218,485	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4
		Feb	67	177,962	506,138	0.014	0.000	0.000	0.000	0.000	0.014	0.014	0.000	0.000	0.000	0.000	0.014	5
		Mar	15	44,873	124,282	0.021	0.000	0.000	0.000	0.000	0.021	0.021	0.000	0.000	0.000	0.000	0.021	4
		Apr	†															
		May	6	9,654	26,210	0.040	0.000	0.040	0.000	0.000	0.000	0.040	0.000	0.040	0.000	0.000	0.000	3
	GOA	Jun																
		Jul																
		Aug																
		Sep																
		Oct	247	522,453	1,427,351	0.014	0.001	0.013	0.000	0.000	0.000	0.008	0.001	0.008	0.000	0.000	0.000	12
		Nov	248	538,677	1,464,164	0.043	0.035	0.008	0.000	0.000	0.000	0.028	0.024	0.005	0.000	0.000	0.000	9
		Dec																

Appendix 2. -- Continued.

Year	Region	Month	N sets	Sampled hooks	Total hooks	Mean Total bird CPUE	Mean Fulmar CPUE	Mean Gull CPUE	Mean Shear-water CPUE	Mean Albatross CPUE	Mean Other CPUE	SE Total bird CPUE	SE Fulmar CPUE	SE Gull CPUE	SE Shear-water CPUE	SE Albatross CPUE	SE Other CPUE	# vessels
2007	AI	Jan	†															
		Feb	†															
		Mar	200	501,354	1,381,466	0.005	0.002	0.002	0.000	0.001	0.000	0.003	0.002	0.002	0.000	0.001	0.000	3
		Apr	114	238,342	706,406	0.004	0.000	0.004	0.000	0.000	0.000	0.004	0.000	0.004	0.000	0.000	0.000	3
		May																
		Jun	†															
		Jul	†															
		Aug	†															
		Sep	154	426,959	1,120,907	0.003	0.003	0.000	0.000	0.000	0.000	0.003	0.003	0.000	0.000	0.000	0.000	4
		Oct	†															
		Nov																
		Dec																
	BS	Jan	1,190	6,722,187	20,024,749	0.013	0.002	0.010	0.000	0.000	0.001	0.003	0.001	0.003	0.000	0.000	0.001	33
		Feb	816	4,383,441	12,752,288	0.002	0.001	0.001	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.000	31
		Mar	171	887,628	2,509,951	0.015	0.002	0.013	0.000	0.000	0.000	0.006	0.001	0.005	0.000	0.000	0.000	7
		Apr																
		May																
		Jun	†															
		Jul	193	899,589	2,523,668	0.032	0.031	0.000	0.001	0.000	0.000	0.015	0.015	0.000	0.001	0.000	0.000	6
		Aug	980	5,871,202	17,163,477	0.099	0.008	0.000	0.081	0.000	0.010	0.014	0.001	0.000	0.014	0.000	0.002	30
		Sep	1,355	7,776,660	22,834,879	0.048	0.038	0.001	0.009	0.000	0.001	0.006	0.006	0.001	0.002	0.000	0.001	33
		Oct	509	2,373,198	6,957,004	0.112	0.098	0.008	0.004	0.000	0.002	0.020	0.019	0.003	0.002	0.000	0.001	31
		Nov	†															
		Dec																
	GOA	Jan																
		Feb	95	268,729	764,571	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5
		Mar	40	127,546	345,182	0.007	0.000	0.007	0.000	0.000	0.000	0.007	0.000	0.007	0.000	0.000	0.000	5
		Apr	3	4,011	7,671	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
		May																
		Jun																
		Jul	†															
		Aug																
		Sep	†															
		Oct	275	746,768	2,149,164	0.024	0.024	0.000	0.000	0.000	0.000	0.009	0.009	0.000	0.000	0.000	0.000	6
		Nov	†															
		Dec																

Appendix 3.-- Mean seabird bycatch rates (Catch-per-unit-effort (CPUE) or number caught per 1,000 hooks) by year, month and large geographic region for the turbot fishery. †Effort present but fewer than three vessels.

						Mean						Standard Error of Mean						
Year	Region	Month	N sets	Sampled hooks	Total hooks	Total bird CPUE	Fulmar CPUE	Gull CPUE	Shear-water CPUE	Albatross CPUE	Other CPUE	Total bird CPUE	Fulmar CPUE	Gull CPUE	Shear-water CPUE	Albatross CPUE	Other CPUE	# vessels
2004	AI	Apr	†															
		May	†															
		Jun	†															
	BS	Apr	†															
		May	44	98,917	271,480	0.007	0.007	0.000	0.000	0.000	0.000	0.007	0.007	0.000	0.000	0.000	0.000	5
		Jun	176	562,823	1,505,027	0.020	0.011	0.000	0.000	0.005	0.004	0.007	0.006	0.000	0.000	0.003	0.003	7
		Jul	163	502,107	1,487,740	0.019	0.019	0.000	0.000	0.000	0.000	0.009	0.009	0.000	0.000	0.000	0.000	8
		Oct	†															
		Dec	†															
2005	AI	Feb	†															
		Mar	13	22,939	65,322	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
		May	27	64,336	193,976	0.018	0.000	0.000	0.000	0.018	0.000	0.018	0.000	0.000	0.000	0.018	0.000	3
		Jun	†															
		Aug	†															
	BS	Mar	†															
		Apr	†															
		May	25	79,366	224,723	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
		Jun	120	340,899	953,082	0.017	0.014	0.000	0.000	0.003	0.000	0.009	0.008	0.000	0.000	0.003	0.000	6
		Jul	286	902,035	2,545,921	0.052	0.025	0.000	0.022	0.002	0.003	0.011	0.008	0.000	0.006	0.002	0.002	9
		Aug	28	90,886	258,095	0.024	0.024	0.000	0.000	0.000	0.000	0.024	0.024	0.000	0.000	0.000	0.000	6
2006	AI	Mar	11	19,138	53,490	0.094	0.000	0.048	0.000	0.046	0.000	0.063	0.000	0.048	0.000	0.046	0.000	3
		Apr	†															
		May	†															
		Jun	†															
		Jul	55	125,202	351,307	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4
		Aug	†															
		Oct	†															
		Nov	†															
	BS	Mar	†															
		Apr	†															
		May	38	101,503	291,895	0.204	0.187	0.010	0.000	0.007	0.000	0.101	0.101	0.010	0.000	0.007	0.000	4
		Jun	51	161,980	466,408	0.092	0.092	0.000	0.000	0.000	0.000	0.064	0.064	0.000	0.000	0.000	0.000	5
		Jul	191	591,054	1,801,140	0.028	0.028	0.000	0.000	0.000	0.000	0.012	0.012	0.000	0.000	0.000	0.000	10
		Aug	12	25,505	80,794	0.033	0.033	0.000	0.000	0.000	0.000	0.033	0.033	0.000	0.000	0.000	0.000	5
		Oct	7	10,910	30,958	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
		Nov	†															
2007	AI	Mar	†															
		Apr	†															
		May	38	67,479	201,637	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
		Jun	77	142,903	421,099	0.013	0.013	0.000	0.000	0.000	0.000	0.013	0.013	0.000	0.000	0.000	0.000	3
		Jul	†															
		Sep	†															
		Oct	†															
	BS	May	†															
		Jun	107	401,216	1,094,106	0.023	0.021	0.000	0.000	0.003	0.000	0.012	0.011	0.000	0.000	0.003	0.000	5
		Jul	170	589,640	1,600,813	0.125	0.060	0.000	0.060	0.000	0.004	0.023	0.014	0.000	0.019	0.000	0.002	8
		Aug	†															
		Oct	†															
		Nov	†															

Appendix 4.-- Mean seabird bycatch rates (Catch-per-unit-effort (CPUE) or number caught per 1,000 hooks) by year, month and large geographic region for the sablefish fishery. †Effort present but fewer than three vessels.

						Mean						Standard Error of Mean						
Year	Region	Month	N sets	Sampled hooks	Total hooks	Total bird CPUE	Fulmar CPUE	Gull CPUE	Shear-water CPUE	Albatross CPUE	Other CPUE	Total bird CPUE	Fulmar CPUE	Gull CPUE	Shear-water CPUE	Albatross CPUE	Other CPUE	# vessels
		Mar	48	88,638	251,940	0.013	0.013	0.000	0.000	0.000	0.000	0.013	0.013	0.000	0.000	0.000	0.000	3
		Apr	33	54,732	155,123	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
		May	†															
		Jun	51	72,513	204,510	0.022	0.000	0.000	0.000	0.022	0.000	0.022	0.000	0.000	0.000	0.022	0.000	4
	AI	Jul																
		Aug	†															
		Sep	†															
		Oct																
		Nov																
		Mar	†															
2004	BS	May	†															
		Jun	†															
		Mar	159	255,644	744,107	0.013	0.000	0.013	0.000	0.000	0.000	0.010	0.000	0.010	0.000	0.000	0.000	11
		Apr	316	505,693	1,431,582	0.004	0.000	0.002	0.000	0.002	0.000	0.003	0.000	0.002	0.000	0.002	0.000	22
		May	303	510,243	1,376,719	0.017	0.000	0.007	0.000	0.010	0.000	0.007	0.000	0.005	0.000	0.005	0.000	26
		Jun	100	169,577	523,589	0.006	0.000	0.000	0.000	0.006	0.000	0.006	0.000	0.000	0.000	0.006	0.000	11
	GOA	Jul	44	59,786	176,439	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5
		Aug	65	74,891	210,817	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8
		Sep	34	47,153	130,413	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7
		Oct	34	34,805	95,109	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
		Nov	†															
		Feb	†															
		Mar	133	250,638	689,189	0.033	0.000	0.013	0.000	0.020	0.000	0.013	0.000	0.008	0.000	0.011	0.000	5
		Apr	†															
		May	30	78,068	234,209	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
	AI	Jun																
		Jul																
		Aug	†															
		Sep																
		Oct	†															
		Nov																
		Mar	†															
		Apr	†															
2005	BS	May	†															
		Jul	8	21,672	60,423	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5
		Aug	†															
		Mar	125	239,310	654,574	0.017	0.004	0.013	0.000	0.000	0.000	0.009	0.004	0.008	0.000	0.000	0.000	15
		Apr	471	825,413	2,274,919	0.044	0.018	0.020	0.002	0.003	0.000	0.012	0.006	0.010	0.002	0.002	0.000	28
		May	298	452,412	1,284,611	0.016	0.001	0.008	0.004	0.000	0.002	0.008	0.001	0.007	0.003	0.000	0.002	23
		Jun	103	180,855	530,888	0.016	0.016	0.000	0.000	0.000	0.000	0.011	0.011	0.000	0.000	0.000	0.000	11
	GOA	Jul	43	68,246	196,880	0.015	0.000	0.000	0.015	0.000	0.000	0.015	0.000	0.000	0.015	0.000	0.000	4
		Aug	34	47,642	136,010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7
		Sep	18	17,512	48,197	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4
		Oct	28	25,917	75,584	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4
		Nov	†															

Appendix 4. -- Continued.

						Mean						Standard Error of Mean						
Year	Region	Month	N sets	Sampled hooks	Total hooks	Total bird CPUE	Fulmar CPUE	Gull CPUE	Shear-water CPUE	Albatross CPUE	Other CPUE	Total bird CPUE	Fulmar CPUE	Gull CPUE	Shear-water CPUE	Albatross CPUE	Other CPUE	# vessels
		Mar	69	113,357	325,291	0.035	0.000	0.008	0.000	0.027	0.000	0.021	0.000	0.008	0.000	0.020	0.000	4
		Apr	†															
		May	†															
		Jun	†															
	AI	Jul	†															
		Aug	†															
		Sep																
		Oct	†															
		Nov	†															
		Mar	†															
		May	†															
		Jul	21	43,527	119,165	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6
2006	BS	Aug	†															
		Sep	†															
		Oct	13	28,956	78,689	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
		Nov	12	31,295	84,581	0.138	0.109	0.029	0.000	0.000	0.000	0.110	0.109	0.029	0.000	0.000	0.000	3
		Mar	106	177,232	486,776	0.023	0.009	0.015	0.000	0.000	0.000	0.013	0.006	0.011	0.000	0.000	0.000	7
		Apr	273	488,387	1,387,501	0.054	0.015	0.037	0.000	0.000	0.002	0.018	0.006	0.017	0.000	0.000	0.002	23
		May	333	534,041	1,541,056	0.021	0.000	0.004	0.002	0.015	0.000	0.010	0.000	0.003	0.002	0.008	0.000	28
		Jun	129	166,746	482,347	0.005	0.000	0.000	0.000	0.005	0.000	0.005	0.000	0.000	0.000	0.005	0.000	14
	GOA	Jul	117	178,318	507,485	0.009	0.000	0.000	0.000	0.009	0.000	0.009	0.000	0.000	0.000	0.009	0.000	10
		Aug	85	114,205	338,328	0.013	0.013	0.000	0.000	0.000	0.000	0.009	0.009	0.000	0.000	0.000	0.000	10
		Sep	54	81,668	235,039	0.011	0.000	0.000	0.000	0.011	0.000	0.011	0.000	0.000	0.000	0.011	0.000	9
		Oct	26	35,570	103,935	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5
		Nov	†															
		Mar	†															
		Apr	†															
		May	†															
		Jun	43	67,438	186,783	0.018	0.000	0.000	0.000	0.018	0.000	0.018	0.000	0.000	0.000	0.018	0.000	4
	AI	Jul	42	57,245	167,423	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
		Aug	†															
		Sep	†															
		Oct	†															
		Nov																
		Mar	†															
		Jun	†															
2007	BS	Jul	19	59,209	147,274	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5
		Aug	†															
		Sep	11	37,818	99,431	0.023	0.000	0.000	0.023	0.000	0.000	0.023	0.000	0.000	0.023	0.000	0.000	3
		Nov	†															
		Mar	157	306,275	827,206	0.022	0.002	0.020	0.000	0.000	0.000	0.009	0.002	0.008	0.000	0.000	0.000	10
		Apr	190	350,299	1,001,482	0.143	0.118	0.008	0.006	0.006	0.006	0.048	0.045	0.004	0.006	0.004	0.004	19
		May	326	526,327	1,462,433	0.076	0.032	0.027	0.000	0.017	0.000	0.021	0.014	0.011	0.000	0.009	0.000	24
		Jun	87	116,585	345,267	0.014	0.000	0.000	0.000	0.014	0.000	0.010	0.000	0.000	0.000	0.010	0.000	13
	GOA	Jul	120	230,263	674,486	0.003	0.000	0.000	0.000	0.003	0.000	0.003	0.000	0.000	0.000	0.003	0.000	12
		Aug	72	135,343	359,024	0.009	0.009	0.000	0.000	0.000	0.000	0.009	0.009	0.000	0.000	0.000	0.000	8
		Sep	38	51,702	154,444	0.033	0.016	0.000	0.000	0.017	0.000	0.023	0.016	0.000	0.000	0.017	0.000	5
		Oct	†															
		Nov	†															

Appendix 5.-- Mean seabird bycatch rates (Catch-per-unit-effort (CPUE) or number caught per 1,000 hooks) by year and NMFS management area for the cod fishery. †Effort present but fewer than three vessels.

					Mean						Standard Error of Mean						
Year	Region	N sets	Sampled hooks	Total hooks	Total bird CPUE	Fulmar CPUE	Gull CPUE	Shear-water CPUE	Albatross CPUE	Other CPUE	Total bird CPUE	Fulmar CPUE	Gull CPUE	Shear-water CPUE	Albatross CPUE	Other CPUE	# vessels
	509+512	1,052	4,377,935	12,651,871	0.025	0.005	0.014	0.001	0.000	0.005	0.005	0.002	0.003	0.000	0.000	0.003	24
	513	1,069	5,458,170	16,161,398	0.010	0.002	0.004	0.001	0.000	0.002	0.002	0.001	0.001	0.001	0.000	0.001	31
	516	143	648,438	1,928,441	0.019	0.005	0.005	0.000	0.000	0.009	0.007	0.003	0.003	0.000	0.000	0.005	8
	517+518	1,060	4,529,566	13,243,877	0.027	0.012	0.007	0.004	0.000	0.005	0.005	0.003	0.003	0.001	0.000	0.001	36
	519	222	468,693	1,360,615	0.066	0.004	0.046	0.014	0.000	0.002	0.023	0.003	0.018	0.006	0.000	0.002	14
	521	5,337	27,880,950	82,216,808	0.017	0.007	0.005	0.003	0.000	0.002	0.001	0.001	0.001	0.000	0.000	0.000	37
	523	203	952,954	2,765,036	0.006	0.003	0.001	0.002	0.001	0.000	0.003	0.002	0.001	0.001	0.001	0.000	17
2004	514+524	977	4,797,600	14,078,790	0.019	0.005	0.005	0.003	0.000	0.006	0.003	0.001	0.001	0.001	0.000	0.002	26
	541	195	561,498	1,653,221	0.007	0.005	0.001	0.000	0.000	0.000	0.003	0.003	0.001	0.000	0.000	0.000	8
	542	†															
	543	114	271,680	820,128	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
	610	174	585,524	1,693,661	0.004	0.000	0.000	0.000	0.003	0.002	0.003	0.000	0.000	0.000	0.003	0.002	12
	620	67	275,587	803,773	0.029	0.000	0.029	0.000	0.000	0.000	0.029	0.000	0.029	0.000	0.000	0.000	3
	630	46	52,159	137,249	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6
	Total	10,907	51,302,422	150,885,602	0.018	0.006	0.006	0.002	0.000	0.003	0.001	0.001	0.001	0.000	0.000	0.000	
	509+512	1,093	4,907,038	14,171,433	0.021	0.003	0.017	0.000	0.000	0.001	0.004	0.001	0.004	0.000	0.000	0.000	24
	513	1,225	6,965,647	20,038,906	0.016	0.004	0.011	0.000	0.000	0.001	0.003	0.001	0.003	0.000	0.000	0.000	26
	516	111	541,249	1,576,126	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6
	517+518	1,247	5,525,947	16,060,759	0.029	0.019	0.007	0.002	0.000	0.001	0.004	0.003	0.002	0.001	0.000	0.001	29
	519	70	170,646	516,496	0.040	0.008	0.032	0.000	0.000	0.000	0.024	0.006	0.022	0.000	0.000	0.000	7
	521	4,850	24,956,799	73,963,051	0.025	0.010	0.010	0.003	0.000	0.002	0.002	0.001	0.001	0.001	0.000	0.000	33
	523	255	1,195,410	3,439,470	0.008	0.007	0.000	0.001	0.000	0.000	0.003	0.003	0.000	0.001	0.000	0.000	16
2005	514+524	740	4,443,554	12,980,234	0.015	0.004	0.009	0.002	0.000	0.000	0.003	0.001	0.002	0.001	0.000	0.000	24
	541	427	825,741	2,395,496	0.030	0.009	0.011	0.005	0.005	0.000	0.008	0.005	0.004	0.003	0.002	0.000	7
	542	†															
	543																
	610	77	171,683	489,636	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8
	620	40	54,348	156,655	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5
	630	25	20,581	52,085	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4
	Total	10,165	49,788,842	145,869,397	0.023	0.009	0.010	0.002	0.000	0.001	0.001	0.001	0.001	0.000	0.000	0.000	

Appendix 5. -- Continued.

Year	Region	N sets	Sampled hooks	Total hooks	Mean: Total bird CPUE	Mean: Fulmar CPUE	Mean: Gull CPUE	Mean: Shear-water CPUE	Mean: Albatross CPUE	Mean: Other CPUE	SE of Mean: Total bird CPUE	SE of Mean: Fulmar CPUE	SE of Mean: Gull CPUE	SE of Mean: Shear-water CPUE	SE of Mean: Albatross CPUE	SE of Mean: Other CPUE	# vessels
	509+512	687	3,275,215	9,446,440	0.038	0.001	0.036	0.000	0.000	0.001	0.008	0.000	0.008	0.000	0.000	0.001	18
	513	809	4,174,221	12,484,374	0.005	0.002	0.002	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.000	24
	516	101	422,629	1,205,830	0.020	0.000	0.020	0.000	0.000	0.000	0.013	0.000	0.013	0.000	0.000	0.000	5
	517+518	785	3,368,627	10,033,597	0.014	0.005	0.008	0.001	0.000	0.000	0.004	0.001	0.003	0.000	0.000	0.000	32
	519	27	49,796	149,420	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4
	521	3,924	21,123,121	62,467,632	0.019	0.005	0.009	0.003	0.000	0.002	0.004	0.001	0.004	0.001	0.000	0.000	36
	523	184	964,648	2,762,849	0.073	0.028	0.033	0.002	0.000	0.010	0.017	0.008	0.010	0.001	0.000	0.004	13
2006	514+524	577	3,782,862	11,261,268	0.011	0.002	0.000	0.007	0.000	0.002	0.002	0.001	0.000	0.002	0.000	0.001	17
	541	452	948,325	2,759,017	0.027	0.016	0.006	0.000	0.006	0.000	0.006	0.005	0.002	0.000	0.003	0.000	11
	542	†															
	543	†															
	610	471	1,019,972	2,796,725	0.026	0.018	0.005	0.000	0.000	0.003	0.015	0.012	0.003	0.000	0.000	0.002	14
	620	181	354,774	996,777	0.020	0.001	0.018	0.000	0.000	0.000	0.011	0.001	0.011	0.000	0.000	0.000	11
	630	†															
	Total	8,287	39,712,357	116,987,588	0.020	0.006	0.010	0.002	0.000	0.001	0.002	0.001	0.002	0.000	0.000	0.000	
	509+512	557	2,631,737	7,567,217	0.020	0.001	0.018	0.001	0.000	0.000	0.005	0.001	0.005	0.001	0.000	0.000	13
	513	548	2,983,317	9,068,944	0.039	0.031	0.002	0.005	0.000	0.001	0.013	0.013	0.001	0.003	0.000	0.000	18
	516	70	452,236	1,292,505	0.019	0.000	0.019	0.000	0.000	0.000	0.010	0.000	0.010	0.000	0.000	0.000	5
	517+518	545	2,657,713	7,901,162	0.059	0.051	0.002	0.003	0.000	0.003	0.012	0.012	0.001	0.001	0.000	0.001	25
	519	†															
	521	2,929	16,861,014	49,282,347	0.055	0.023	0.002	0.027	0.000	0.003	0.006	0.003	0.001	0.005	0.000	0.001	34
	523	179	858,860	2,354,835	0.027	0.024	0.000	0.001	0.000	0.002	0.016	0.016	0.000	0.001	0.000	0.002	13
2007	514+524	406	2,620,015	7,631,787	0.035	0.004	0.001	0.026	0.000	0.005	0.007	0.001	0.001	0.006	0.000	0.002	12
	541	404	941,285	2,600,363	0.012	0.007	0.004	0.000	0.001	0.000	0.008	0.006	0.003	0.000	0.001	0.000	6
	542	83	258,191	713,248	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
	543	150	471,476	1,276,741	0.027	0.008	0.000	0.019	0.000	0.000	0.020	0.005	0.000	0.019	0.000	0.000	3
	610	296	874,729	2,454,055	0.023	0.022	0.001	0.000	0.000	0.000	0.009	0.009	0.001	0.000	0.000	0.000	9
	620	112	276,436	830,917	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4
	630	†															
	Total	6,345	31,993,708	93,274,021	0.042	0.021	0.004	0.015	0.000	0.002	0.003	0.002	0.001	0.002	0.000	0.000	

Appendix 6.-- Mean seabird bycatch rates (Catch-per-unit-effort (CPUE) or number caught per 1,000 hooks) by year and NMFS management area for the turbot fishery.

					Mean						Standard Error of Mean						
Year	Region	N sets	Sampled hooks	Total hooks	Total bird CPUE	Fulmar CPUE	Gull CPUE	Shear-water CPUE	Albatross CPUE	Other CPUE	Total bird CPUE	Fulmar CPUE	Gull CPUE	Shear-water CPUE	Albatross CPUE	Other CPUE	# vessels
2004	517+518+519	63	148,501	415,841	0.017	0.017	0.000	0.000	0.000	0.000	0.013	0.013	0.000	0.000	0.000	0.000	12
	521+524	205	596,742	1,641,056	0.023	0.017	0.000	0.000	0.004	0.002	0.008	0.007	0.000	0.000	0.003	0.002	12
	523	125	435,645	1,258,718	0.009	0.007	0.000	0.000	0.000	0.002	0.005	0.005	0.000	0.000	0.000	0.002	11
	541+542+543	55	66,111	190,375	0.064	0.000	0.000	0.000	0.064	0.000	0.033	0.000	0.000	0.000	0.033	0.000	3
	Total	448	1,246,999	3,505,990	0.023	0.012	0.000	0.000	0.010	0.001	0.006	0.004	0.000	0.000	0.004	0.001	
2005	517+518+519	26	62,035	165,160	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6
	521+524	372	1,128,764	3,169,032	0.047	0.026	0.000	0.016	0.003	0.002	0.009	0.007	0.000	0.005	0.002	0.001	10
	523	66	226,073	658,539	0.005	0.000	0.000	0.002	0.000	0.002	0.004	0.000	0.000	0.002	0.000	0.002	8
	541+542+543	45	92,707	273,900	0.011	0.000	0.000	0.000	0.011	0.000	0.011	0.000	0.000	0.000	0.011	0.000	7
	Total	509	1,509,579	4,266,631	0.036	0.019	0.000	0.012	0.003	0.002	0.007	0.005	0.000	0.004	0.002	0.001	
2006	517+518+519	41	80,576	228,490	0.019	0.010	0.009	0.000	0.000	0.000	0.013	0.010	0.009	0.000	0.000	0.000	12
	521+524	185	571,772	1,734,320	0.082	0.082	0.000	0.000	0.000	0.000	0.029	0.029	0.000	0.000	0.000	0.000	11
	523	78	245,955	728,529	0.029	0.026	0.000	0.000	0.003	0.000	0.011	0.011	0.000	0.000	0.003	0.000	8
	541+542+543	152	350,017	1,011,113	0.007	0.000	0.003	0.000	0.003	0.000	0.005	0.000	0.003	0.000	0.003	0.000	10
	Total	456	1,248,320	3,702,452	0.042	0.038	0.002	0.000	0.002	0.000	0.012	0.012	0.001	0.000	0.001	0.000	
2007	517+518+519	21	66,144	178,201	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5
	521+524	209	778,973	2,124,218	0.095	0.054	0.000	0.038	0.000	0.003	0.019	0.013	0.000	0.015	0.000	0.002	8
	523	67	208,404	568,796	0.068	0.028	0.000	0.036	0.004	0.000	0.022	0.015	0.000	0.017	0.004	0.000	5
	541+542+543	135	239,773	707,510	0.008	0.008	0.000	0.000	0.000	0.000	0.008	0.008	0.000	0.000	0.000	0.000	9
	Total	432	1,293,294	3,578,725	0.059	0.033	0.000	0.024	0.001	0.002	0.010	0.007	0.000	0.008	0.001	0.001	

Appendix 7.-- Mean seabird bycatch rates (Catch-per-unit-effort (CPUE) or number caught per 1,000 hooks) by year and NMFS management area for the sablefish fishery.

					Mean								Standard Error of Mean								
Year	Area	N Sets	Sampled hooks	Total hooks	Total bird CPUE	Fulmar CPUE	Gull CPUE	Shear-water CPUE	Albatross Unid. CPUE	LAAL CPUE	BFAL CPUE	Other CPUE	Total bird CPUE	Fulmar CPUE	Gull CPUE	Shear-water CPUE	Albatross Unid. CPUE	LAAL CPUE	BFAL CPUE	Other CPUE	# vessels
	BS	18	41,790	110,970	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3
	541	124	203,544	554,308	0.014	0.005	0.000	0.000	0.000	0.009	0.000	0.000	0.010	0.005	0.000	0.000	0.000	0.009	0.000	0.000	8
	542+543	78	116,099	335,820	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4
	610	243	428,637	1,210,396	0.012	0.000	0.009	0.000	0.000	0.004	0.000	0.000	0.007	0.000	0.006	0.000	0.000	0.003	0.000	0.000	15
2004	620	103	164,085	459,875	0.006	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.006	0.000	0.000	0.000	0.000	0.000	0.006	0.000	12
	630	296	470,237	1,341,476	0.007	0.000	0.007	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.005	0.000	0.000	0.000	0.000	0.000	33
	640	252	359,199	1,022,679	0.013	0.000	0.003	0.000	0.000	0.000	0.010	0.000	0.007	0.000	0.003	0.000	0.000	0.000	0.006	0.000	29
	650	164	237,332	658,423	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	25
	Total	1,278	2,020,923	5,693,947	0.008	0.000	0.004	0.000	0.000	0.002	0.003	0.000	0.002	0.000	0.002	0.000	0.000	0.001	0.001	0.000	
	BS	19	31,280	85,559	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	9
	541	111	212,057	595,099	0.015	0.000	0.007	0.000	0.000	0.008	0.000	0.000	0.009	0.000	0.007	0.000	0.000	0.006	0.000	0.000	8
	542+543	103	189,835	543,725	0.034	0.007	0.010	0.000	0.000	0.018	0.000	0.000	0.016	0.007	0.007	0.000	0.000	0.013	0.000	0.000	6
	610	310	592,311	1,625,525	0.047	0.020	0.021	0.001	0.000	0.005	0.000	0.000	0.012	0.008	0.007	0.001	0.000	0.003	0.000	0.000	18
2005	620	96	164,008	466,886	0.037	0.020	0.012	0.006	0.000	0.000	0.000	0.000	0.018	0.013	0.008	0.006	0.000	0.000	0.000	0.000	12
	630	309	500,906	1,454,651	0.013	0.008	0.000	0.002	0.000	0.000	0.000	0.002	0.005	0.004	0.000	0.002	0.000	0.000	0.000	0.002	32
	640	257	367,069	1,030,792	0.030	0.000	0.024	0.006	0.000	0.000	0.000	0.000	0.018	0.000	0.018	0.004	0.000	0.000	0.000	0.000	29
	650	153	236,565	634,177	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	25
	Total	1,358	2,294,031	6,436,414	0.026	0.008	0.011	0.002	0.000	0.003	0.000	0.001	0.005	0.002	0.004	0.001	0.000	0.001	0.000	0.001	
	BS	62	137,098	378,255	0.048	0.043	0.006	0.000	0.000	0.000	0.000	0.000	0.030	0.030	0.006	0.000	0.000	0.000	0.000	0.000	13
	541	98	168,842	480,031	0.013	0.000	0.000	0.000	0.000	0.013	0.000	0.000	0.013	0.000	0.000	0.000	0.000	0.013	0.000	0.000	7
	542+543	82	135,647	382,732	0.014	0.000	0.007	0.000	0.000	0.008	0.000	0.000	0.010	0.000	0.007	0.000	0.000	0.008	0.000	0.000	5
	610	335	575,365	1,650,697	0.014	0.006	0.005	0.000	0.000	0.000	0.003	0.000	0.006	0.003	0.004	0.000	0.000	0.000	0.003	0.000	15
2006	620	93	165,339	468,507	0.006	0.000	0.000	0.006	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.006	0.000	0.000	0.000	0.000	9
	630	288	454,319	1,294,376	0.045	0.008	0.033	0.000	0.000	0.000	0.002	0.002	0.017	0.004	0.016	0.000	0.000	0.000	0.002	0.002	28
	640	282	410,479	1,193,323	0.029	0.007	0.007	0.000	0.000	0.004	0.011	0.000	0.012	0.004	0.004	0.000	0.000	0.004	0.007	0.000	31
	650	146	200,031	566,226	0.021	0.000	0.012	0.000	0.000	0.000	0.009	0.000	0.014	0.000	0.012	0.000	0.000	0.000	0.006	0.000	22
	Total	1,386	2,247,120	6,414,147	0.025	0.006	0.011	0.000	0.000	0.002	0.004	0.000	0.005	0.002	0.004	0.000	0.000	0.001	0.002	0.000	
	BS	39	116,978	303,617	0.007	0.000	0.000	0.007	0.000	0.000	0.000	0.000	0.007	0.000	0.000	0.007	0.000	0.000	0.000	0.000	10
	541	106	165,670	468,284	0.027	0.000	0.013	0.000	0.000	0.007	0.000	0.006	0.016	0.000	0.013	0.000	0.000	0.007	0.000	0.006	7
	542+543	91	123,293	361,596	0.016	0.000	0.008	0.000	0.000	0.009	0.000	0.000	0.011	0.000	0.008	0.000	0.000	0.009	0.000	0.000	5
	610	281	559,134	1,543,615	0.056	0.040	0.012	0.000	0.002	0.000	0.000	0.002	0.019	0.017	0.005	0.000	0.002	0.000	0.000	0.002	14
2007	620	97	193,048	556,597	0.051	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.045	0.045	0.000	0.000	0.000	0.000	0.000	0.000	12
	630	260	478,810	1,358,512	0.110	0.065	0.030	0.004	0.000	0.000	0.008	0.002	0.034	0.028	0.014	0.004	0.000	0.000	0.004	0.002	33
	640	245	344,338	1,004,355	0.030	0.000	0.006	0.000	0.000	0.000	0.025	0.000	0.013	0.000	0.004	0.000	0.000	0.000	0.012	0.000	29
	650	124	183,062	479,715	0.017	0.012	0.005	0.000	0.000	0.000	0.000	0.000	0.010	0.008	0.005	0.000	0.000	0.000	0.000	0.000	21
	Total	1,243	2,164,333	6,076,291	0.051	0.028	0.012	0.001	0.000	0.001	0.007	0.001	0.010	0.008	0.003	0.001	0.000	0.001	0.003	0.001	