

A close-up photograph of a large pile of fresh fish. The fish are of various species, including flatfish like flounder and sole, and roundfish like cod and haddock. The fish are piled together, with some showing their gills and eyes. The lighting is dramatic, highlighting the textures of the fish scales and the moist surfaces. The text "Executive Summary" is overlaid in the center in a white, serif font.

*Executive
Summary*

Photo on previous page: Trawl contents, including bycatch.
Photo: C. Nolan, MRAG Americas, under contract to the
NMFS Observer Program.

INTRODUCTION

Bycatch occurs when fishing operations result in discard of fish and invertebrates or interactions with marine mammals, seabirds, and sea turtles. Discard of fish may occur because certain species, sexes, or sizes are not marketable or are of lower value than other components of the catch, or because regulations prohibit retention of specific species, sexes, and/or sizes. Bycatch impacts living marine resources worldwide and occurs in both commercial and recreational fisheries. It is of particular concern if bycaught species are overfished, threatened, or endangered. When bycatch estimates are available, they may be included as a component of overall fishing mortality during stock assessment or status evaluation. Thus, such estimates are essential to effective management of all living marine resources.

Development of this first National Bycatch Report was motivated by recognition of the need to review the status of information on bycatch in the Nation's fisheries, consistent with the National Oceanic and Atmospheric Administration's (NOAA's) statutory obligations as set forth in the U.S. Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), and the reauthorized Magnuson-Stevens Fishery Conservation and Management Act (MSA). This Executive Summary provides an overview of report results; the full document, which is provided on the enclosed CD, contains the technical details.

The National Bycatch Report provides the first national compilation of bycatch estimates for living marine resources of the United States that are managed by NOAA's National Marine Fisheries Service (NMFS). The NMFS has prepared this report to evaluate the extent to which reliable quantitative bycatch information exists for federally managed commercial fisheries and fisheries with relevant Federal data-collection programs. The report also documents bycatch estimates and bycatch estimation methods for all fisheries for which this information was available in 2005.¹ In addition to reviewing the state of bycatch data and estimation, this report establishes a baseline for tracking changes in bycatch over time, and is designed to assist NMFS in meeting legislative mandates for bycatch reduction, guiding policy, and setting priorities.

Data sources for estimating bycatch

Data sources vary among regions, as well as among fisheries, primarily due to differences in data-collection program goals, objectives, priorities, and available resources.

¹ The year 2005 was selected as a base year during the report's development in 2006 since it was the most recent year for which complete information was available. The National Marine Fisheries Service intends to publish updated information in future editions of this report. Note that for some rare-event species (species that do not occur frequently as bycatch), multiple years of data were utilized to develop bycatch estimates.

Definition of bycatch

BYCATCH, for the purposes of this report, is defined as discarded catch of any living marine resource and as unobserved mortality² due to a direct encounter with fishing gear. Since information on unobserved mortality of fish is rarely available, it is not included in this report. Unobserved mortality is included in bycatch estimates for protected species where the data permit.

Commercial fisheries vary greatly in scale and fishing practice and these factors vary greatly, and in some cases constrain, bycatch data-collection programs. The major sources of data used for the bycatch estimates presented in this report were observer data and self-reported logbook data. Multiple data sources were available for some fisheries. Total landings by fishery are provided for each NMFS region for consistency with other published reports. However, aggregate landings at the species level were obtained from the NMFS centralized landings database.³

Observer programs are conducted in all six NMFS regions, and observer data were available for 110 U.S. commercial fisheries in 2005 (72% of the subset of fisheries considered by the National Bycatch Report; Figure 1). Fisheries observers are trained biologists who collect data on fishing activities onboard commercial vessels (and at processing plants in some instances). Observers collect both quantity and composition information on catch and bycatch, as well as information on fish discards (e.g., released alive vs. dead) and condition of protected species bycatch (e.g., location of entanglement and/or hooking, condition of animal upon release). Biological samples, gear type, environmental conditions, economic data, and other information useful for stock assessments are also collected by observers. Observer data are considered the most reliable source of information on bycatch. Furthermore, observer data are subjected to rigorous quality-assurance procedures.

Data from commercial fisheries logbook programs, which are required under regulations for 39 fishery management plans (FMPs) established under the MSA, were used in

² Unobserved mortality describes the mortality of living marine resources due to a direct encounter with fishing gear that does not result in the capture of the species. This includes mortality due to lost or discarded fishing gear, as well as mortality of fish and other species that escape from fishing gear before it is retrieved but die due to the stress or injury resulting from the encounter (NMFS 2004b).

³ <http://www.st.nmfs.noaa.gov/st1/commercial/index.html>.

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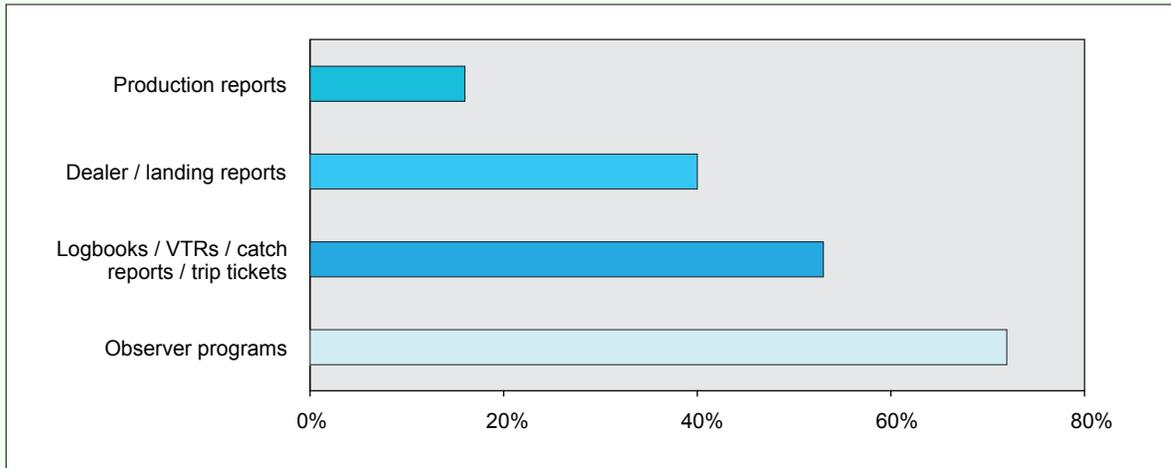


Figure 1

Primary data sources used in bycatch estimation for fisheries and species identified in the National Bycatch Report. Data are from the year 2005, except for some rare-event species that required data from a range of years. Note: Percentages do not total 100, as multiple data sources were used to estimate bycatch in some fisheries.

bycatch estimation for 80 U.S. commercial fisheries (53% of the subset of fisheries the U.S. National Bycatch Report focused on; Figure 1). Logbooks are completed on board the vessel by a designated crew member. Reporting requirements for logbooks (which may also be called vessel trip reports or VTRs, catch reports, or trip tickets) differ by NMFS region and fishery. Logbook data may be used to estimate bycatch in the absence of observer data, or may be used as supplemental data for extrapolating to the unobserved portion of the fishery. Logbooks are self-reported and the bycatch data are typically compared to data from observer programs for verification; this is possible only if an observer program has been implemented for the same fishery. If no observer data are available, logbook under-reporting and other sources of bias are potential sources of error in estimating bycatch.

Additional data were provided through dealer or landings reports, production reports, and protected species stranding and entanglement reports. The data provided by these programs were not generally used alone to calculate bycatch, but served as ancillary information for estimation of overall bycatch when observer data were available for only a portion of a fishery. Data collected through dealer/landings reports were available for 61 fisheries (40%; Figure 1). Data collected through production reports were available for 25 Alaskan fisheries (16%).

Data from stranding and entanglement reports were used to assess relative levels of bycatch only when more reliable data sources were not available, the report was considered reliable, and the report clearly described a mortality or a serious injury that was likely to lead to mortality of the entangled animal. Strandings information is not included in Figure 1 but was used in marine mammal bycatch estimates for the Alaska and Northeast regions.

BYCATCH DATA QUALITY

Tier classification system

Precise and accurate bycatch estimates require high-quality data; these estimates contribute to improved understanding of the impact of bycatch among all species and fisheries, and are essential to managing the Nation's fisheries. Annual catch limits, fish and protected species stock assessments, and bycatch reduction measures all depend on the availability of this high-quality information. A tier classification system was developed to evaluate the quality of bycatch data and the reliability of bycatch estimation methods for selected U.S. fisheries (for details, see Section 3). The tier classification system provides a basis for defining the current state of knowledge regarding levels of bycatch, and quality of data and estimation methods; this establishes a benchmark point for defining the need for improvements in data collection and analysis, and evaluating these improvements over time.

Tier descriptions

(refer to Chapter 3 for details)

■ ■ ■ ■ For Tier 4 fisheries, bycatch estimates were available and were based on the highest quality data and analytical methods.

■ ■ ■ For Tier 3 fisheries, bycatch estimates were also generally available but higher quality data (e.g., data that are more reliable, accurate, and/or precise) were utilized to compute these estimates.

■ ■ For Tier 2 fisheries, bycatch estimates were generally available. However, these estimates would have benefited from improvements in data quality and/or analytical methods (such as improved sampling designs, increased coverage levels, and peer review of methods). Where bycatch estimates were not available, methods are being developed.

■ For Tier 1 fisheries, bycatch data were available but were generally unreliable (e.g., from unverified or potentially biased sources). In some cases, higher quality data were available but analytical methods had not been implemented.

□ For Tier 0 fisheries, bycatch data-collection programs or estimation methods did not exist, and therefore, bycatch estimates were not available.

The subset of fisheries evaluated through the tier classification, which is referenced throughout the report, consists of 152 federally managed fisheries and fisheries with relevant Federal data-collection programs. These fisheries were assessed based on a series of criteria and assigned to one of five tiers. The major criteria used in the tier classification system were: 1) adequacy of bycatch data collected through observer programs and self-reported industry logbooks; 2) availability of supplemental data (used as expansion factors for unobserved components of the fishery,

for stratification and imputation, as model covariates, and to verify self-reported industry data); 3) database and information technology considerations (used to link data to generate timely bycatch estimates); and 4) quality of analytical approaches (bycatch estimation method assumptions, peer reviews, statistical bias of estimators, and availability of uncertainty estimates). Adequacy of observer data and quality of analytical approaches were more heavily weighted and, therefore, tier determination was primarily driven by these criteria.

Fisheries with low overall scores were assigned to lower tiers (Tier 0, Tier 1), and fisheries with high overall scores were assigned to higher tiers (Tier 3, Tier 4). It is important to note that tier scores are based on 2005 information, and that improvements to bycatch data collection and estimation may have occurred in some fisheries subsequently. Fisheries classified in Tier 0 typically lacked bycatch data-collection or estimation methods while fisheries classified in Tier 4 were considered to provide reliable bycatch estimates based on long-term observer data.

Results of the tier classification

The tier classification system was applied to the subset of 152 fisheries included in this report. The system was applied separately (on a fishery-by-fishery basis) for fish managed under the MSA, for marine mammals, and for all other protected species (ESA-listed fish and sea turtles, and all seabirds). This was done because some fisheries were grouped to be consistent with MMPA fishery definitions (and associated protected species bycatch estimation methods), and in some fisheries, bycatch data were only available for protected species. As a result, a total of 400 tier classifications were generated; 142 fisheries were evaluated for quality of fish bycatch data and estimation; 129 fisheries were evaluated for marine mammal bycatch data and estimation quality, and the same number were evaluated for protected species.

The majority of fisheries (41%) were classified in Tier 3, while 15% fell into Tier 2, and 16% into Tier 1. Only 4% were classified in Tier 4. Overall, bycatch data-collection programs and/or estimation methods did not exist for 24% of the fisheries evaluated and these were therefore classified as Tier 0 (Figure 2).

Results of the tier classification reveal some variation among the quality of data and estimation methods for different bycatch types (Figure 3). For fish bycatch, only 13% of the fisheries were classified in Tier 0, while 41% were classified in Tiers 1 and 2, and 46% in Tiers 3 and 4. For marine mammals and other protected species, 30% of the fisheries were classified in Tier 0, while approximately 25% were classified in Tiers 1 and 2, and 45% in Tiers 3 and 4. This suggests that there is less data-collection specifically

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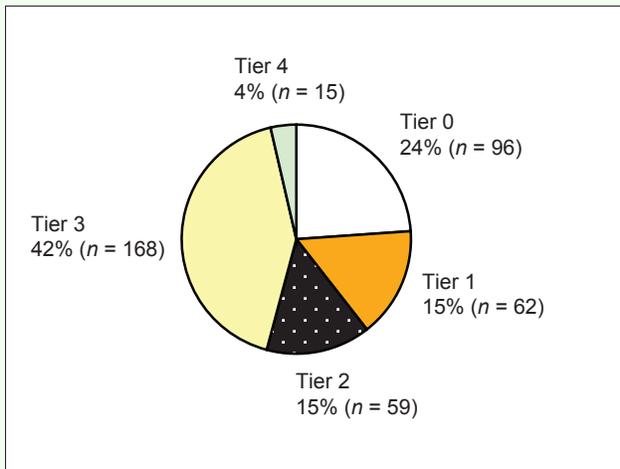
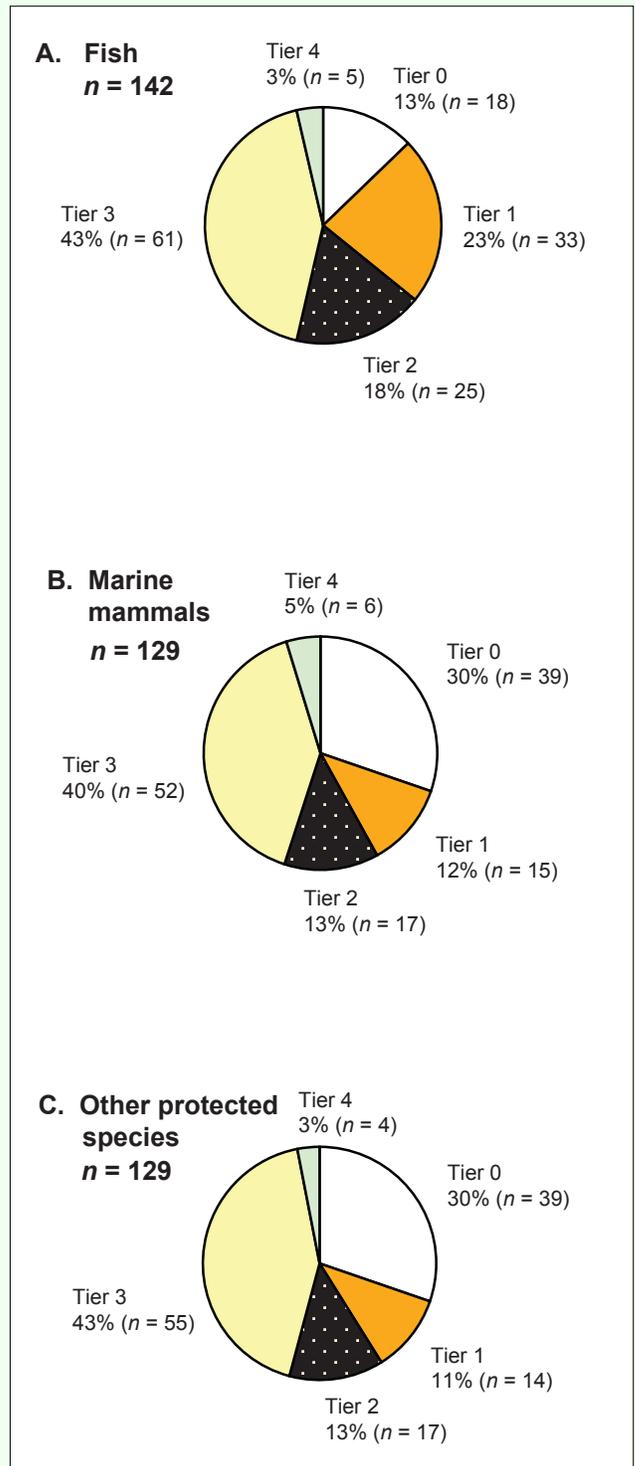


Figure 2 (above)

Distribution of tier scores for the quality of bycatch data and estimation summed across fisheries, regions, and bycatch categories. The total number of tier scores derived for this report was 400: fish (142) + marine mammals (129) + other protected species (129).

Figure 3 (right)

Distribution of tier scores for bycatch data and estimate quality summed across fisheries and regions for A) fish, B) marine mammals, and C) other protected species.



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targeted to bycatch of marine mammals and other protected species than to bycatch of fish (more than double the percentage of fisheries were Tier 0 for marine mammals and other protected species). However, of the fisheries where data were available, the quality of the bycatch data and estimates was similar for fish species and for marine mammals and other protected resources (i.e., around 45% of fisheries in Tiers 3 and 4).

DESIGNATION OF KEY STOCKS

A subset of fish and protected species was identified for use in monitoring bycatch trends over time. In this report, stocks in this subset are referred to as *key stocks*,⁴ and are defined as those stocks that have high bycatch levels, have special importance to management, and/or for which there are stock status concerns (for details, see Section 3). Note that all ESA-listed species were automatically considered to be key stocks, but non-ESA-listed fish, marine mammals, and seabirds were evaluated based on the factors listed above before being listed as key stocks. Changes in bycatch of key stocks over time will provide an indicator of how well NMFS is meeting the bycatch reduction goals of the ESA, MMPA, and MSA.

A total of 396 fish, marine mammal, seabird, and sea turtle stocks and populations were classified as key stocks. Stocks occurring in multiple regions were listed as “key” in each region where bycatch was of concern. The number of key fish stocks varied by region, with the Southwest Region identifying the highest number, 94 (35% of the total number of key fish stocks). Because no fish bycatch estimates were available in the region, all stocks of management importance were placed on the list of key stocks as a precautionary measure. Of the 269 key fish stocks, 68% are included in the NMFS Fish Stock Sustainability Index (FSSI) and 22% are listed under the ESA. Seventy-one marine mammal stocks (18% of the total number) were identified as key stocks, with the highest number in the Alaska Region (18). All sea turtle populations were classified as key stocks since they are listed under the ESA as either endangered or threatened. A total of 30 seabird populations were identified as key stocks. Detailed descriptions of key stocks, by region, are included in Section 4 of this report.

⁴The term *key stock* is used broadly in this report to include stocks, populations, species, and species groups.

PERFORMANCE MEASURES

Two performance measures were developed based on the information contained in this report: the tier scoring system and the key stocks concept. They will be used to monitor bycatch trends and changes in the quality of bycatch data collection and estimation over time.

Tier scores: As improvements are made to bycatch data collection, and new methods for estimating bycatch are developed and implemented, the tier scores of individual fisheries are expected to increase. This system provides a measure of the relative quality of bycatch estimates within and between regions, bycatch categories, stocks, and fisheries that is available to fisheries managers for use in fisheries conservation and management activities.

Key stocks: Future editions of the report will compare new estimates of key stock bycatch to those of previous editions. Monitoring bycatch trends over time for key stocks identified herein will provide an indicator of how well NMFS is meeting the bycatch reduction goals of the ESA, MMPA, and MSA. Additionally, key stocks showing increasing levels of bycatch may be identified for increased research and/or bycatch reduction efforts.

Because this is the first edition of the U.S. National Bycatch Report, it was not possible to evaluate changes in performance over time. Information presented in this report will, however, provide a baseline for such evaluation. Future editions of the report will define management targets for these performance measures.

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NATIONAL AND REGIONAL BYCATCH SUMMARIES

Estimated fish bycatch for the U.S. commercial fisheries considered in this report totaled 1.22 B pounds, while associated landings for these fisheries totaled almost 6.068 B pounds (Table 1). The resulting estimated overall bycatch ratio (defined as the ratio of bycatch to total catch, where total catch equals landings plus bycatch) for fish bycatch in all U.S. commercial fisheries considered in this report is 0.17 (rounded from the actual calculated ratio of 0.167543 on which Table 2 is based). The ratio 0.17 is referred to as the “overall bycatch ratio” in the following discussion. The computation of an overall bycatch ratio did not include bycatch of protected species; for fisheries considered in this report, estimated bycatch of marine mammals totaled 1,887 individual animals, estimated bycatch of sea turtles totaled 11,772 animals, and estimated bycatch of seabirds totaled 7,769 animals.

In some fisheries, insufficient data were available for analysis. For other fisheries, analytical methods for estimating some types of bycatch were not available when this report was compiled (e.g., bycatch estimates were not provided for fish species in the Southwest Region or for seabirds in the Northeast and Southwest Regions). In addition, fish

bycatch estimates were provided in numbers of individuals for some Southeast and Northwest Region fisheries, and these estimates were not included in the calculation of total U.S. bycatch, because factors for converting numbers to weights were not available.

Table 2 provides estimates of overall regional and national fish bycatch (i.e., bycatch associated with all U.S. fisheries including those with bycatch estimates included in this report and summarized in Table 1 and those without bycatch estimates and, therefore, excluded from Table 1). For each region, the calculated bycatch ratio (0.167543) was applied to the total landings for those fisheries not considered in the U.S. National Bycatch Report to compute an estimate of fish bycatch (i.e. calculating the unknown bycatch using the bycatch ratio for known bycatch and total landings). Computation employed the formula $\text{bycatch} = (\text{0.167543} \times \text{Landings}) / (1 - \text{0.167543})$, where 0.167543 is the calculated bycatch ratio. This provided a means for estimating total bycatch for each region, and the resulting bycatch estimates were summed to provide an overall national bycatch estimate of 1.934 B pounds.

Bycatch ratios for U.S. commercial fisheries published by the Food and Agriculture Organization of the United Nations (FAO) (Kelleher 2004) and Harrington et al. (2005) for the period 2002–2003 were higher than the estimate cal-

Table 1

Total estimated fisheries landings and bycatch by type for each NMFS region included in the National Bycatch Report. Data are generally from 2005, except for some rare-event species estimates for which bycatch data from a range of years may have been used. Weights are rounded to the nearest thousand pounds. Note that details of individual regional calculations are described in Section 4 of the report.

Region	Fish bycatch (lb)	Fish landings (lb)	Marine mammal bycatch (individuals)	Sea turtle bycatch (individuals)	Seabird bycatch (individuals)
Northeast	165,888,000	1,006,370,000	1,287	1,062	Not available
Southeast	682,691,000	219,086,000	233	10,671 ^a	186
Alaska	338,573,000	4,487,167,000	62	0 ^b	7,280
Northwest	25,564,000	332,396,000	37	0 ^b	106
Southwest ^c	Not available	–	242	1	Not available
Pacific Islands	8,556,000	23,000,000	26	38	197
Totals	1,221,272,000	6,068,019,000	1,887	11,772	7,769

^a The Southeast sea turtle bycatch estimate includes mortality estimates from the NMFS 2002 biological opinion on the shrimp fisheries of the Southeastern United States (NMFS 2002). Since that time, effort in the shrimp fishery, and associated bycatch, has decreased markedly.

^b Sea turtle bycatch has not been observed in the Alaska or the Northwest Regions.

^c Southwest Region landings are not included because fish bycatch estimates from the region were not available.

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Table 2
Fish landings and bycatch by NMFS region for fisheries included, and estimated regional bycatch ratios.

Region	2005 landings (lb)				2005 bycatch (lb)			
	Fisheries considered in the National Bycatch Report	Fisheries not considered in the National Bycatch Report	Total	% of total landings sampled	Fisheries considered in the National Bycatch Report	Regional bycatch ratio ^{a,b}	Fisheries not considered in the National Bycatch Report	Total
Northeast	1,006,370,000	385,816,000	1,392,186,000	72	165,888,000	0.14	77,651,000	243,539,000
Southeast	219,086,000	1,093,033,000	1,312,119,000	17	682,691,000	0.76	219,987,000	902,678,000
Alaska	4,487,167,000	1,164,140,000	5,651,307,000	79	338,573,000	0.07	234,299,000	572,872,000
Northwest	332,396,000	523,464,000	855,860,000	39	25,564,000	0.07	105,354,000	130,918,000
Southwest	–	367,830,000	367,830,000	0	Not available	–	74,031,000	74,031,000
Pacific Islands	23,000,000	9,244,000	32,244,000	71	8,556,000	0.27	1,860,000	10,416,000
National totals	6,068,019,000	3,543,527,000	9,611,546,000	63	1,221,272,000	0.17	713,182,000	1,934,454,000

^a Regional bycatch ratios are for fisheries included in this report only.

^b Weights derived using the calculated bycatch ratio of 0.167543 and the formula $\text{bycatch} / (\text{bycatch} + \text{landings})$.

culated herein, which is based on 2005 data (Table 3). Correspondingly, the overall total bycatch estimate provided in this report is lower (1.934 B pounds) than those reported by FAO (Kelleher 2004; 2.045 B pounds) and Harrington et al. (2005; 2.333 B pounds). These reports obtained bycatch estimates and associated landings data from published and grey literature, while the estimates used here are based on raw data, as well as data obtained from a range of published and unpublished reports. In addition, FAO (Kelleher 2004) reports that their database may be bi-

ased in favor of fisheries with high discards and this would result in an overall overestimate of bycatch. This type of positive bias is also likely for the Harrington et al. (2005) report, which also included a subset of fisheries.

Since both reports drew information from a smaller subset of fisheries than this report and, apparently, were more likely to include information on fisheries with noteworthy bycatch concerns, higher overall bycatch ratio estimates might be expected. Since this report is more comprehen-

Table 3
Comparison of fish bycatch estimates for U.S. commercial fisheries from the National Bycatch Report with previously published estimates. Bycatch ratios are calculated as the total bycatch divided by the total catch (bycatch plus landings).

Reference	Year of source data	Total bycatch estimate (lb)	Total landings (lb)	Bycatch ratio
National Bycatch Report (2011)	2005	1,934,454,000	9,611,546,000	0.17
FAO (Kelleher 2004) ^a	2002	2,045,006,000	7,373,224,000	0.22
Harrington et al (2005) ^a	2002–03	2,332,894,000	8,194,516,000	0.22

^a Converted from metric tons.



Credit: NMFS

Strategic offal discarding is a seabird bycatch reduction measure required in some parts of the Hawaii longline fishery.

sive, the bycatch ratio estimate in this report should be considered to be the best estimate currently available. It is apparent that the authors of the FAO (Kelleher 2004) and Harrington et al. (2005) reports encountered considerable difficulty in obtaining comprehensive and accurate catch and bycatch data and found it necessary to make extrapolations based on a range of assumptions. This report, while drawing on more data, also required extrapolation of estimates for some fisheries and species due to data limitations. This serves to emphasize the need for reporting of accurate and comprehensive information of the type presented here, and the importance of updating this report frequently and expanding its scope as information on additional U.S. fisheries becomes available.

Bycatch estimates for marine mammals, sea turtles, and seabirds were recently reported by Moore et al. (2009), who estimated total national bycatch only for marine mammals. This estimate was 3,029–3,187 animals annually for the period 1990–99, while our estimate is 1,887 animals annually (a baseline of 2005 data was used, plus data from a range of years). Because the data presented in Moore et al. (2009) were based on averages across a time-frame earlier than that utilized in this report, a direct comparison with estimates presented herein is not possible. In a broad comparison, the U.S. National Bycatch Report contains lower bycatch estimates, but this report does not speculate as to why the estimates are different.

Fishery bycatch estimates

Fishery bycatch ratios were calculated only for a subset of the fisheries considered during preparation of this report (63 of 152 fisheries; 41.5%) due to limitations in available data, as explained in the body of the report. Each fishery bycatch ratio was calculated as the total bycatch of all species caught within a fishery, divided by the total catch (bycatch plus landings of all species) for that fishery. Fisheries with bycatch ratios greater than 0.17 (the median of available fishery bycatch ratios) were designated as fisheries of focus, indicating a potential bycatch concern. Bycatch ratios for the fisheries included here range from 0.0 to 0.76,

and vary by region (note that fishery bycatch ratios are for bycatch of fish only; bycatch of protected species is discussed in the next sections).

In general, the fisheries with the highest bycatch ratios were bottom trawl and bottom longline fisheries (Figures 4 and 5A). Relatively high bycatch ratios were estimated for some Alaska and Northeast bottom trawl fisheries and for the Southeast Gulf of Mexico shrimp trawl fishery; these ratios should, however, be considered in the context of overall fishing operations within each region. For example, bottom trawl fishing represents a small fraction of overall trawl fishing effort in Alaska (midwater trawl fishing effort is markedly higher); primary discards from Northeast trawl fisheries are non-marketable species bycaught when targeting commercially important species; and shrimp trawling effort in the Gulf of Mexico has declined substantially in recent years. The highest bycatch ratios among bottom longline fisheries occurred in the Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska sablefish longline fishery; the BSAI Greenland turbot longline fishery; and the Northeast bottom longline fishery. Pelagic longline fisheries (Figure 5B) had lower bycatch ratios than some bottom longline fisheries. However, the average bycatch ratio for pelagic longline fisheries was similar to that of bottom longline fisheries (0.25 and 0.23, respectively).

In the Northeast Region, bycatch ratios were also high for several large-mesh gillnet⁵ fisheries (Figure 6). These included the New England large-mesh and extra-large-mesh gillnet fisheries, and the mid-Atlantic extra-large-mesh gillnet fishery. Bycatch ratios were generally lowest for fisheries using more selective gear types, such as troll, pot and traps, dredge, and jig gear (Figure 7). The federally managed West Coast salmon troll fisheries were the only fisheries using other gear types that had bycatch ratios above the cutoff value of 0.17 (0.23 and 0.19 for non-tribal and tribal fisheries, respectively).

⁵Gillnet size categories for the Northeast Region include small (mesh size less than 5.5 inches), large (mesh size 5.5 inches or greater but less than 8 inches), and extra-large (mesh size greater than 8 inches).

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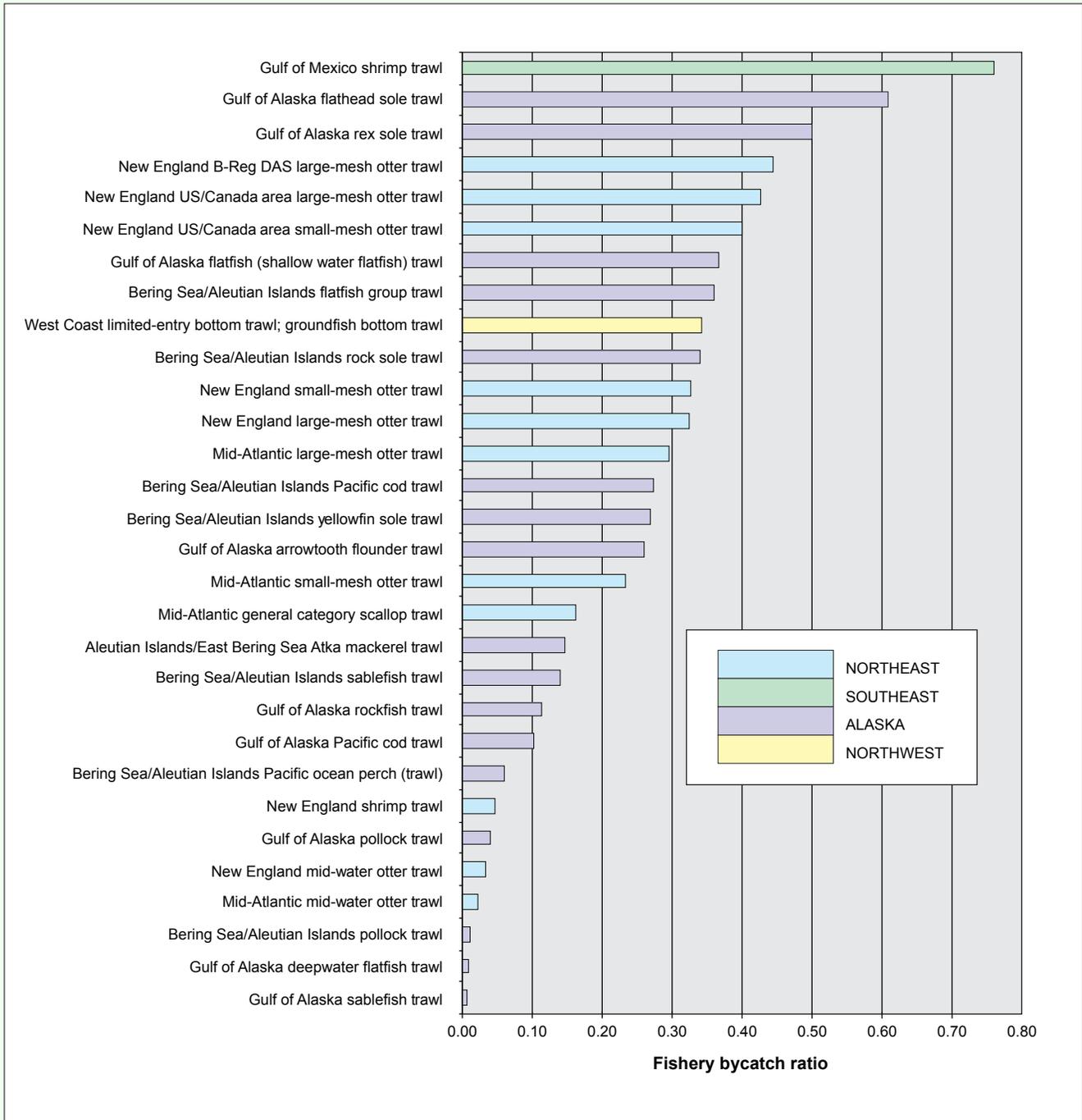


Figure 4

Fish bycatch ratios for U.S. commercial trawl fisheries by NMFS region (2005 data). The Bering Sea/Aleutian Islands Flatfish Group (arrowtooth flounder, flathead sole, and other flatfish) trawl fishery has been abbreviated as "BSAI Flatfish Group Trawl."

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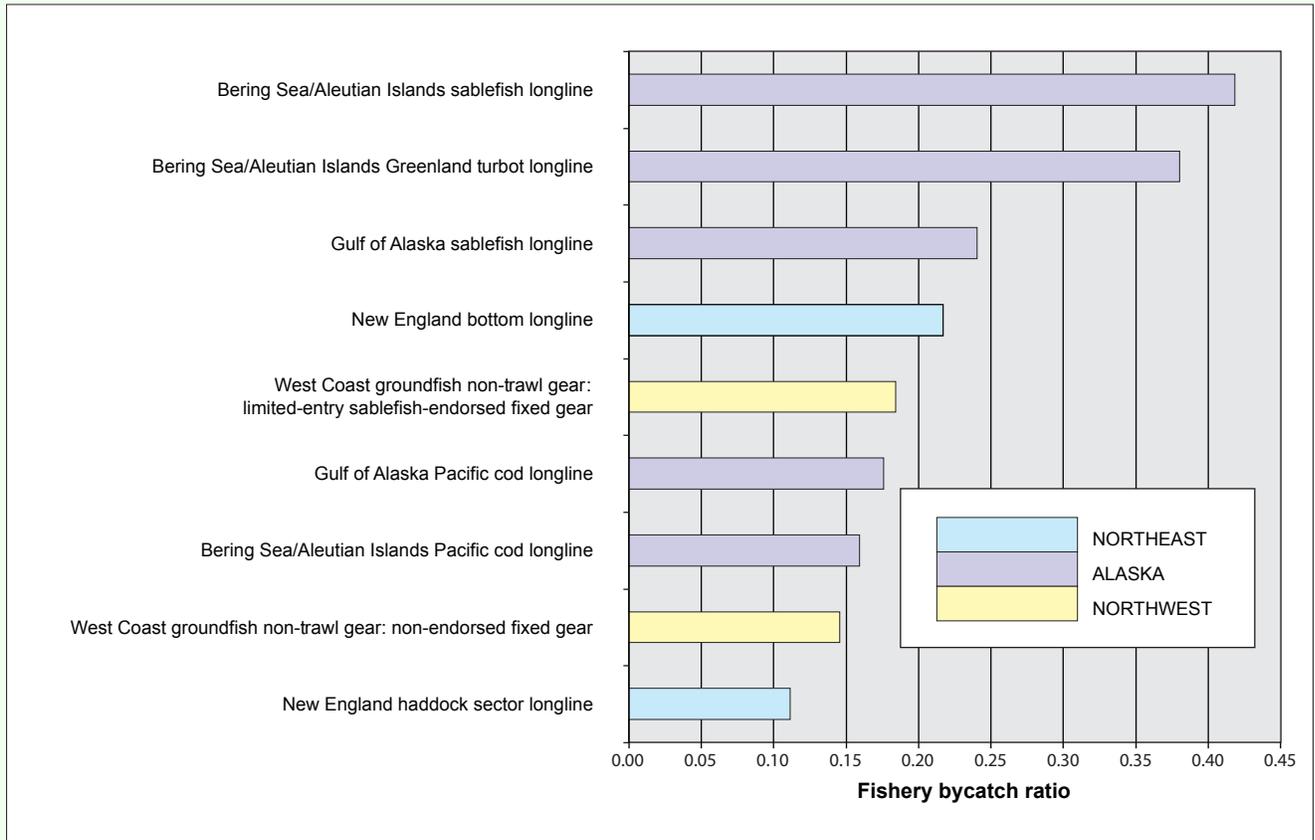


Figure 5A Fish bycatch ratios for U.S. commercial bottom longline fisheries by NMFS region (2005 data).

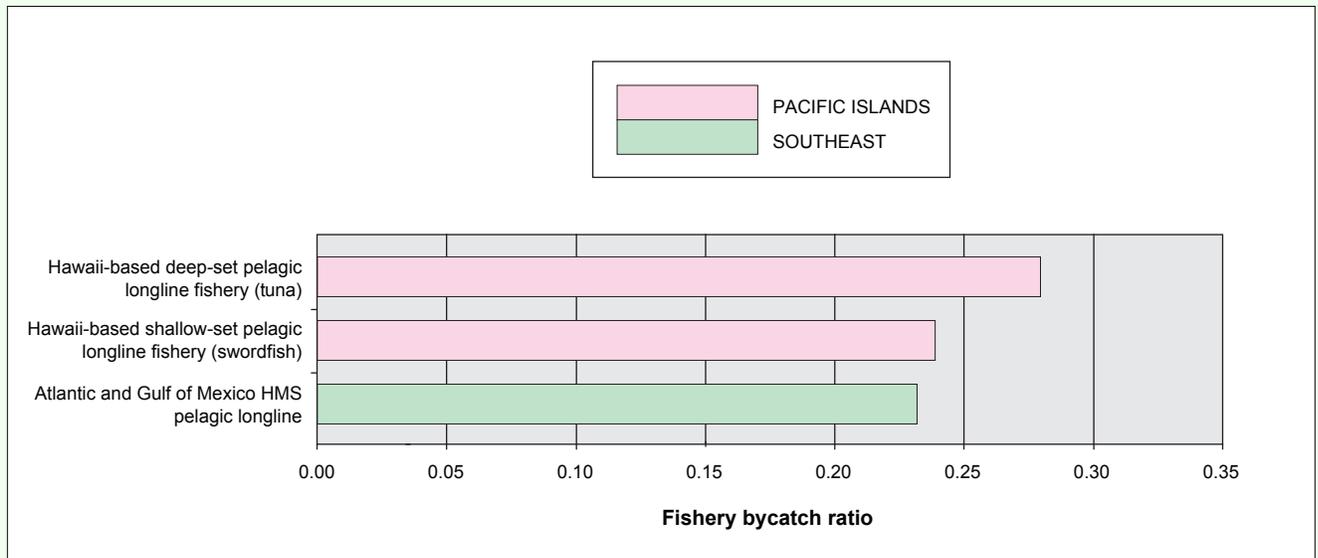


Figure 5B Fish bycatch ratios for U.S. commercial pelagic longline fisheries by NMFS region (2005 data).

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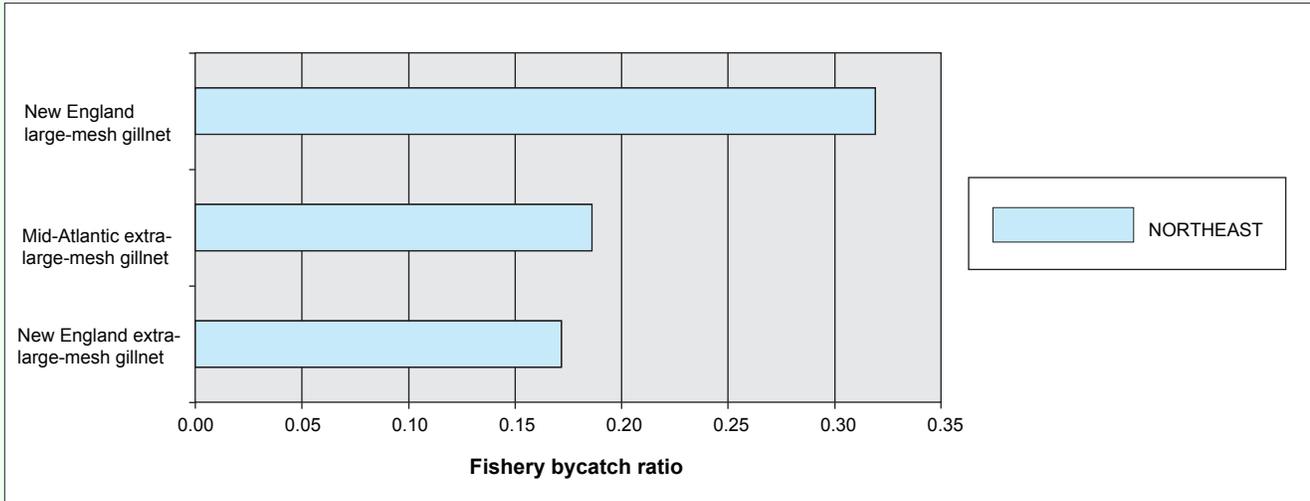


Figure 6 Fish bycatch ratios for U.S. commercial gillnet fisheries by NMFS region (2005 data).

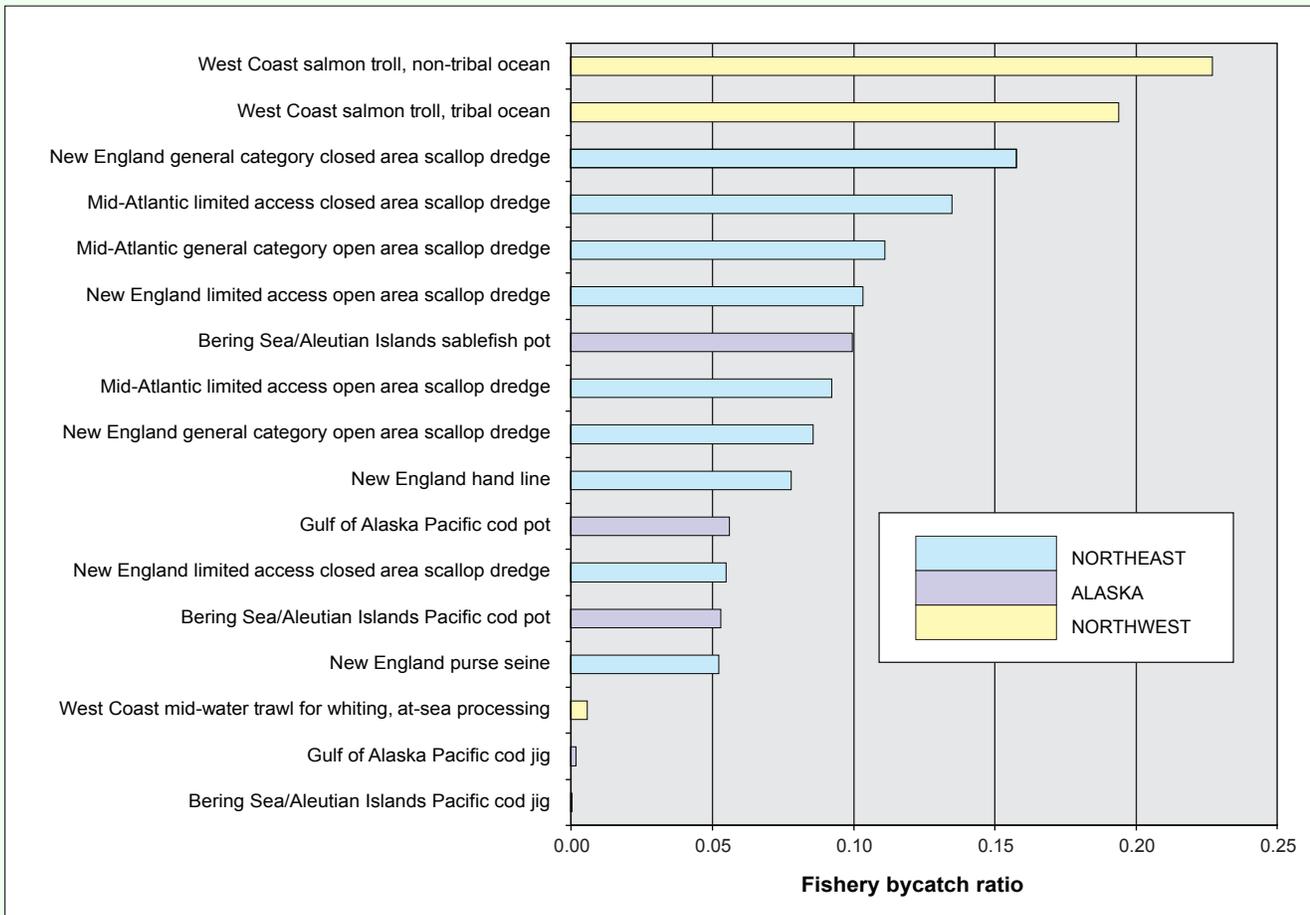


Figure 7 Fish bycatch ratios for fisheries using gears other than trawls, longlines, and gillnets by NMFS region (2005 data).



Credit: NMFS

Longline fishery bycatch: a bigeye thresher shark.

STOCK BYCATCH ESTIMATES

Fish bycatch

While the number of fish bycatch estimates varies by region, estimates are reported for a total of 480 fish stocks nationwide (“stock” is used broadly within this report to include stocks, populations, and species groups). Stock bycatch ratios⁶ were available for only 93 (19.4%) of these, principally because for some fisheries, only numeric bycatch estimates were available (precluding calculation of weight-based ratios); or total catch-weight estimates were available only for species groups (where the group members were undefined), so that individual stock-specific ratios could not be calculated. Developing conversion factors to estimate bycatch by weight and resolving grouping issues are recommended by this report, and should increase the number of stocks for which bycatch ratios are available.

Stock bycatch ratios ranged from 0.01 to 1.0. It is difficult to compare bycatch estimates across regions due to the large number of stocks included in this report and differences in the quantity and quality of data among regions, as well as the fact that the same stock may be bycaught in multiple regions. Stocks with bycatch ratios greater than 0.127 (the median of available stock bycatch ratios), and which met certain criteria for management importance, were designated as key stocks (Figure 8).

It is important to evaluate stock bycatch ratios and key stock classifications in relation to other factors, such as landings, management regulations, and public concern. For example, the highest fish bycatch ratios for Pacific Island stocks were for ocean sunfish (1.0) and escolar (0.88).⁷ The high

ratios for these stocks reflect how seldom they are landed (a high ratio can occur when a stock is landed very rarely in relation to the frequency of catch). Thus, a stock may have a high bycatch ratio but it may not necessarily call for concern. These considerations and others, such as overfished/overfishing status, were taken into account during the selection of key stocks.

Stocks with the highest bycatch ratios were captured in bottom trawl, longline, and gillnet fisheries, including the following:

- Groundfish species, including windowpane flounder (0.91), Atlantic halibut (0.45), spiny dogfish (0.90), red hake (0.78), offshore hake (0.42), silver hake (0.27), and monkfish (0.18), are major bycaught species in the New England and mid-Atlantic otter trawl and gillnet fisheries.
- Atlantic croaker, Gulf of Mexico stock (0.90), is a major bycaught species in the Gulf of Mexico shrimp trawl fishery.
- Arrowtooth flounder (0.44), rock sole (0.32), and flathead sole (0.23) are bycaught species in Alaska Region flatfish trawl fisheries. However, biomass estimates of arrowtooth flounder are three times the Bmsy level, with stocks continuing to increase in abundance. In 2005 the species was not considered marketable for human consumption but the industry continues to develop markets for this species to reduce the amount of discard.
- Northwest Region species with high bycatch ratios include cowcod (0.97), bocaccio (0.79), spiny dogfish (0.70), lingcod (0.69), canary rockfish (0.68), and arrowtooth flounder (0.40), the majority of which are taken in the bottom trawl fishery.⁸

⁶That is, the ratio of bycatch of a single stock to total catch of that stock (within a region), versus a fishery bycatch ratio (as discussed in the previous section), which refers to the ratio of total fishery bycatch to total fishery catch.

⁷Marketability of escolar bycatch (landed as Hawaiian butterfish) has increased over the past decade, and it is expected that bycatch ratios are currently lower.

⁸In 2005, it was prohibited to retain cowcod in all sectors of the groundfish fishery. Bocaccio and canary rockfish had very restrictive retention limits in some sectors of the groundfish fishery and were prohibited in others, but some overall retention was still allowed in the 2005 fishery.

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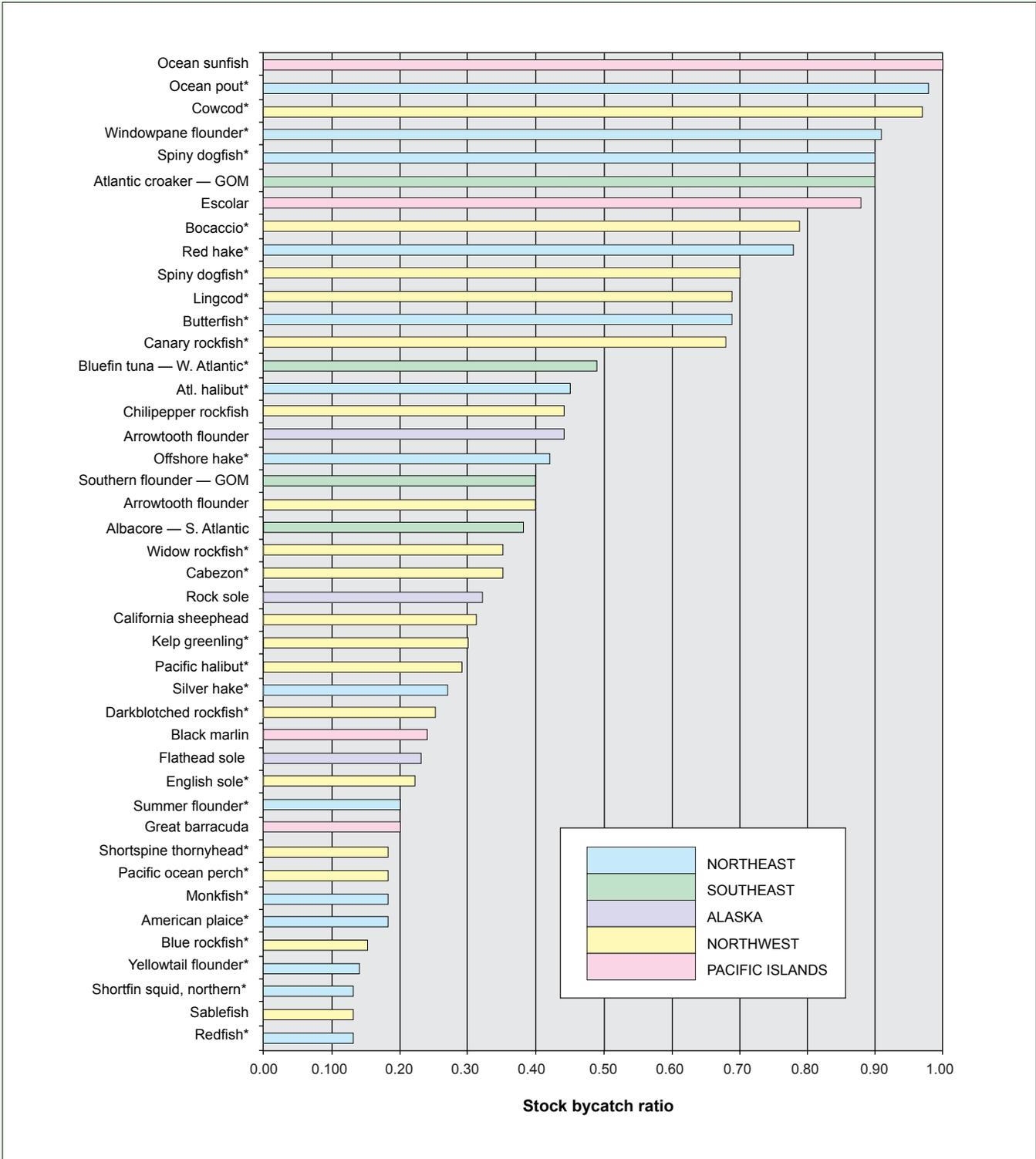


Figure 8
 Fish stocks with fish bycatch ratios greater than 0.127 by NMFS region (2005 data). * indicates a key stock. GOM = Gulf of Mexico.

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- Black marlin (0.24) and great barracuda (0.20), although they had high bycatch ratios, were rejected as key stocks due to low regional concern regarding these infrequently caught or landed species.

Marine mammal bycatch

Bycatch estimates for marine mammals, based on numbers of lethal takes and serious injuries, were calculated for 39 fisheries and totaled 1,887 animals from 54 stocks (Figures 9 and 10). The Northeast Region calculated marine mammal bycatch for 13 fisheries. This included 6 marine mammal stocks and a total bycatch estimate of 1,287 animals. The Pacific Islands Region calculated marine mammal bycatch for two fisheries, which encompassed 15 marine mammal stocks with a total of 26 bycaught animals.

The highest estimated marine mammal bycatch occurred in the Northeast Region and was comprised of harbor porpoise (652 animals), Atlantic white-sided dolphin (355), common dolphin (151), and long- and short-finned pilot whales (65). In the Southeast Region, bycatch of long- and short-finned pilot whales (135 animals) and the Western North Atlantic stock of Risso's dolphin (46) are being addressed through the Pelagic Longline Take Reduction Plan. The Bottlenose Dolphin Take Reduction Plan addresses both Southeast Region (105 animals) and Northeast Region (61) stocks of bottlenose dolphins. Bycatch of marine mammals in the Alaska, Northwest, and Southwest Regions is primarily composed of harbor porpoise in Alaska (36 animals), California sea lions in the Northwest and Southwest Regions (34 and 32, respectively), and northern right whale dolphins in the Southwest Region (18).

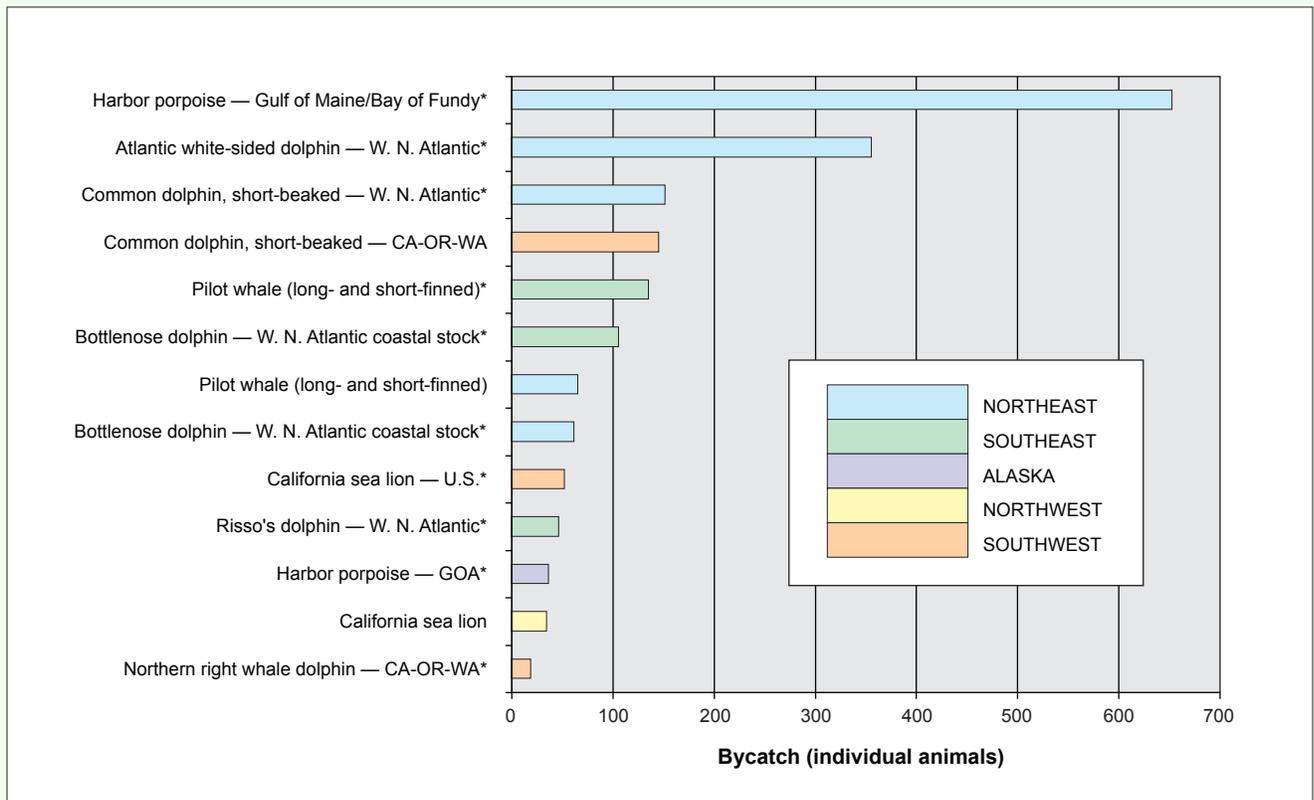


Figure 9
Marine mammal bycatch (lethal takes + serious injuries) for stocks with 10 or more bycaught animals by NMFS region. * indicates key stocks. The baseline year of data used in this report was 2005; however, for some rare-event species data from a range of years were used to generate a bycatch estimate. GOA = Gulf of Alaska.

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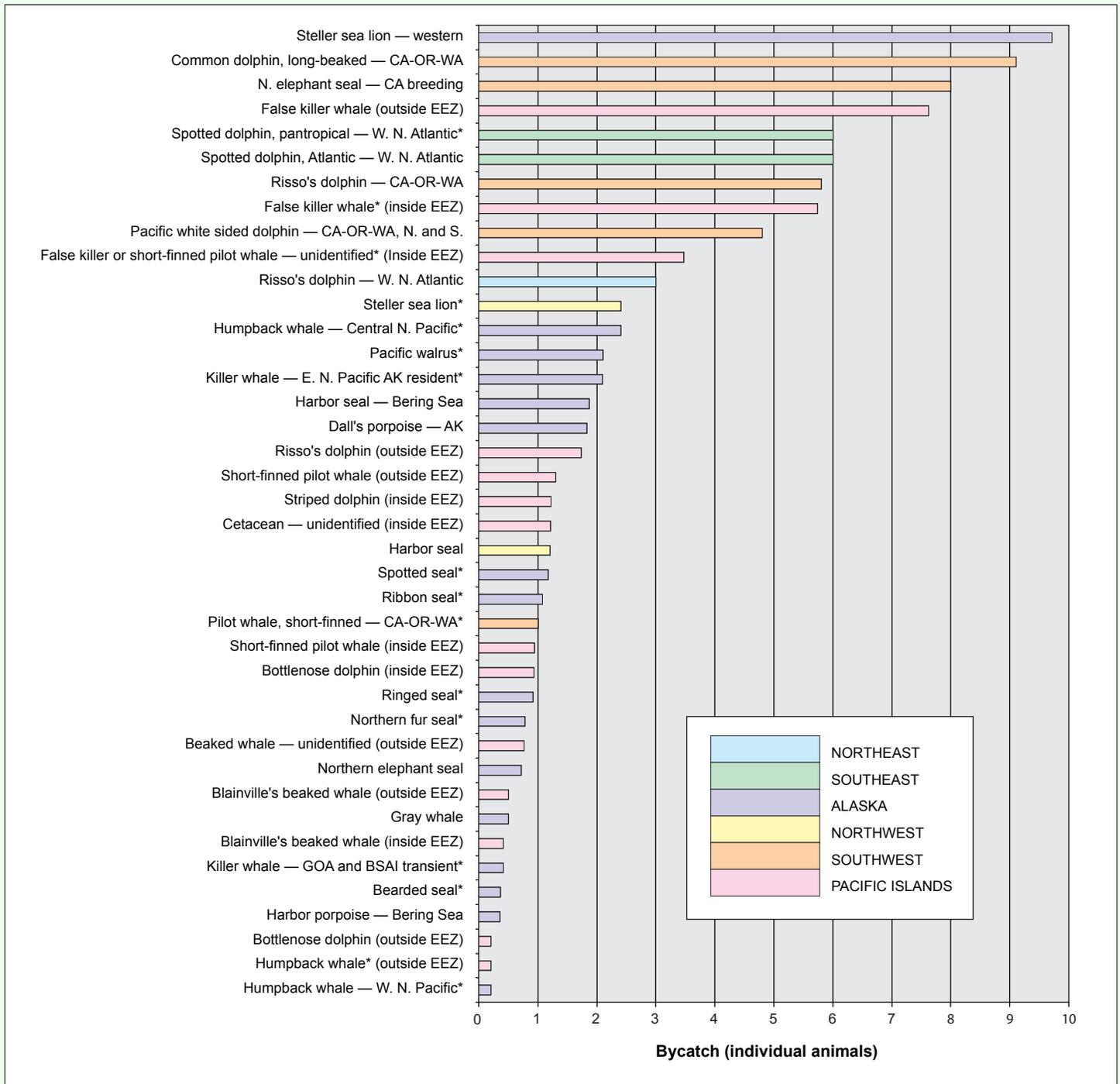


Figure 10

Marine mammal bycatch (lethal takes + serious injuries) for stocks with fewer than 10 bycaught animals by NMFS region. * indicates key stocks. The baseline year of data used in this report was 2005; however, for some rare-event species data from a range of years were used to generate a bycatch estimate. Data for marine mammal bycatch, which is considered a statistically rare event, are averaged over a number of years, occasionally resulting in a bycatch estimate that is a fraction. Note: zero estimates are not included in this figure, but are included in the regional chapters.

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Sea turtle bycatch

Bycatch estimates for sea turtles were calculated for 21 fisheries, and included all U.S. sea turtle populations, with a total of 11,772 individual animals (Figure 11). Sea turtle bycatch estimates were not calculated for Alaskan fisheries, since sea turtles do not typically occur in this region. Also, sea turtle bycatch was not observed in any Northwest Region fisheries. The highest sea turtle bycatch estimates were for the Southeast Region, with estimates reported for ten fisheries and four sea turtle populations (and also for unidentified turtles), with a total sea turtle bycatch estimate of 10,671 individuals (shrimp trawl fishery estimates only included mortalities). Most bycaught sea turtles were loggerhead (5,209 animals), Kemp's ridley (4,222), and leatherback (537). These turtles were bycaught mainly in the reef fish, Atlantic pelagic longline, and Southeastern Atlantic and Gulf of Mexico shrimp trawl fisheries.⁹ Note that the proportion of the stocks that these estimates represent is unknown because of the general lack of population size estimates for sea turtles.

⁹Bycatch estimates from the 2002 shrimp trawl fishery biological opinion (NMFS 2002). Since that time, effort in the shrimp fishery, and related bycatch, has decreased substantially.

Seabird bycatch

Bycatch of seabirds was estimated for 25 fisheries and totaled 7,769 animals with 28 individual estimates, including estimates for unidentified animals (Figure 12). Bycatch estimates were not calculated for the Northeast and Southwest Regions, although seabird data are collected by observer programs in these regions. This information will be analyzed and included in future editions of this report.

The highest reported bycatch levels were for the Alaska Region, which reported seabird bycatch in 19 fisheries, representing 12 seabird populations and totaling 7,280 seabirds. The major species of seabirds bycaught in the Alaska Region included northern fulmar (3,427 animals), gulls (2,101), shearwater (595), Laysan albatross (216), and unidentified seabirds (589; Figure 12). The majority of these seabirds were caught by trawl and longline fisheries. The Alaska Region has initiated cooperative work among industry, NMFS, Sea Grant, and the State of Alaska to develop gear modifications to reduce bycatch of seabirds. In addition, several studies have established methods to reduce seabird bycatch using streamers, which are now required by Federal regulation.

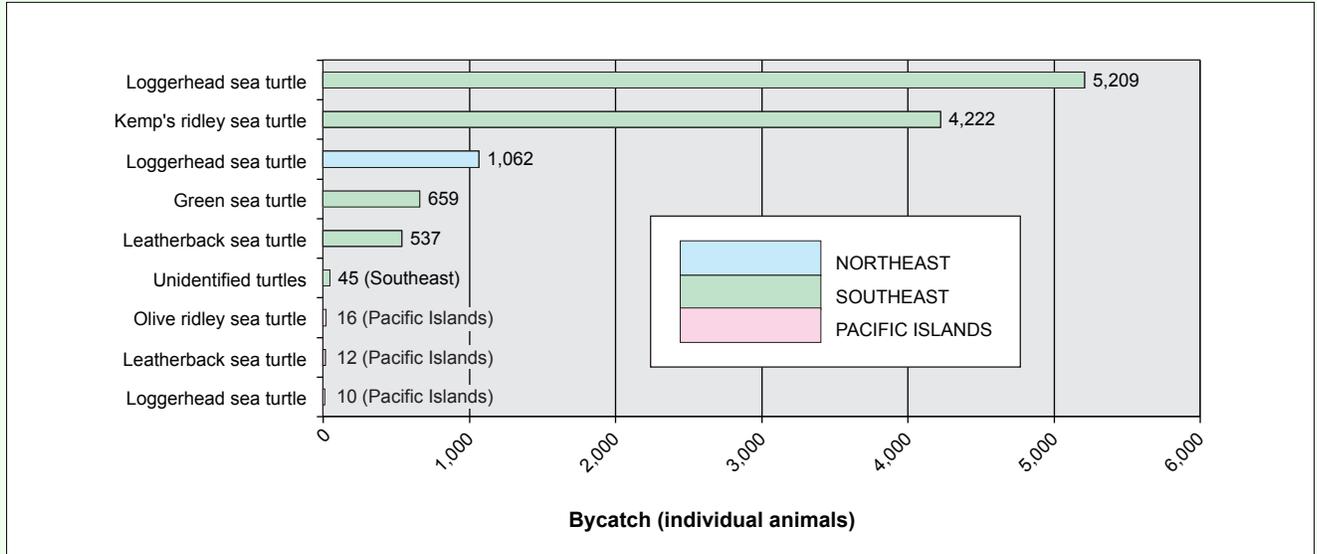


Figure 11

Bycatch estimates include mortalities and live releases for sea turtles. The baseline year of data used in this report was 2005; however, for some rare-event species data from a range of years were used to generate a bycatch estimate. Note that bycatch estimates for the Southeast and Gulf of Mexico shrimp trawl fisheries are from the 2002 shrimp trawl fishery biological opinion (NMFS 2002). Since 2002, effort and associated bycatch in the shrimp trawl fisheries have decreased substantially. Not shown is the bycatch of one olive ridley sea turtle in the Southwest Region.

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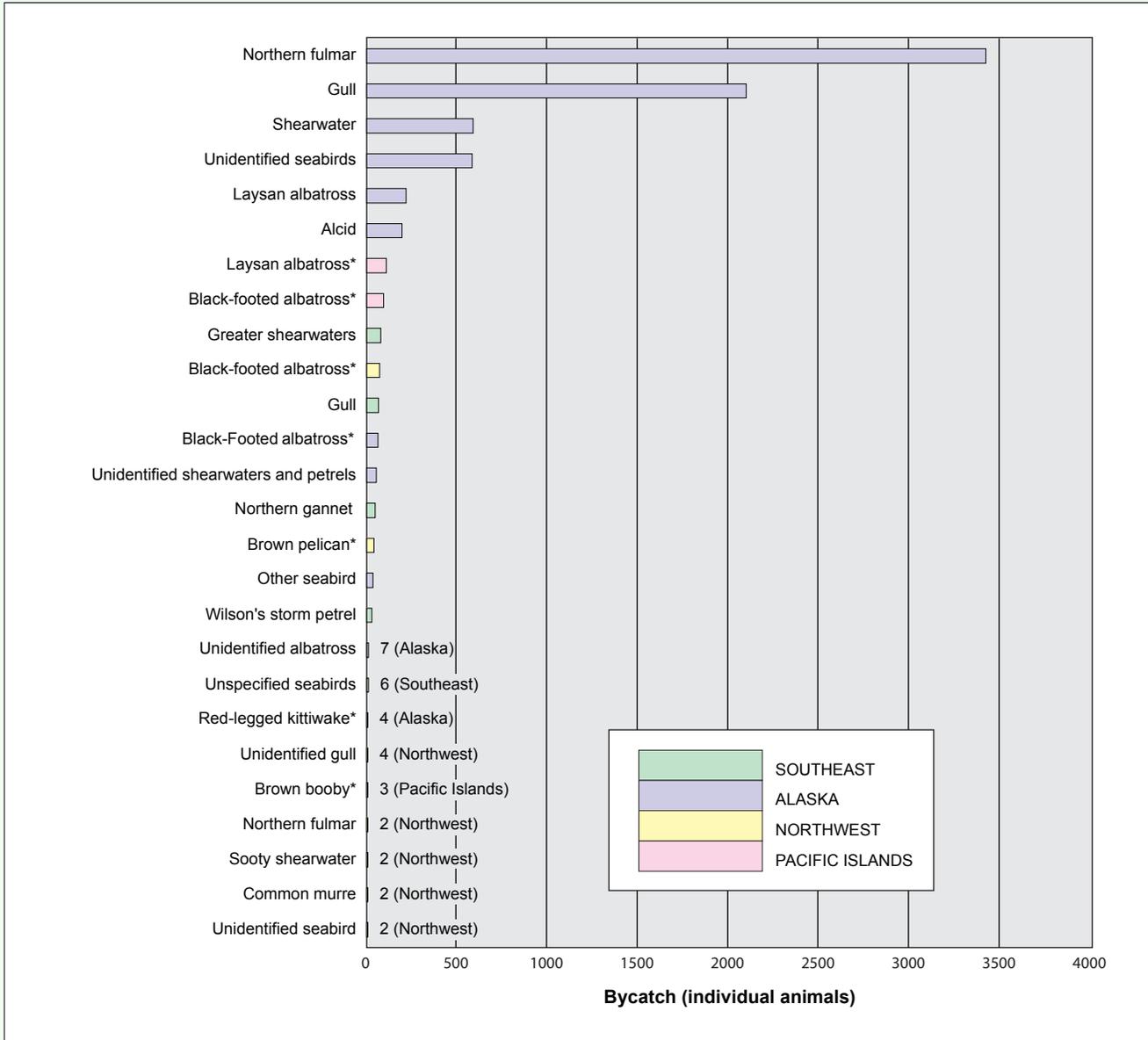


Figure 12

Estimated seabird bycatch by NMFS region. * indicates a key stock. The baseline year of data used in this report was 2005; however, for some rare-event species data from a range of years were used to generate the bycatch estimate. Note: zero estimates are not included.

Estimated seabird bycatch in the Southeast Region totaled 186¹⁰ animals, with the highest bycatch of greater shearwater (75), gulls (61), northern gannet (44), and Wilson's storm petrel (24; Figure 12). The majority of these seabirds were bycaught in the Atlantic and Gulf of Mexico highly migratory species pelagic longline fishery and the South Atlantic coastal migratory pelagic longline fishery. In the

Northwest, seabird bycatch totaled 106 animals, with the main species being black-footed albatross (59) and brown pelican (36). In the Pacific Islands, a total of 197 seabirds were reported as bycatch, with Laysan (105 animals) and black-footed albatross (89) having the highest bycatch levels. The only species with bycatch estimates of zero was a key stock, the short-tailed albatross (estimates of zero for the Alaska and Pacific Islands Regions—not shown in Figure 12).

¹⁰The estimation of total seabird bycatch was performed separately from the individual -species estimates, thus the individual species estimates do not sum to 186.

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LOOKING AHEAD: IMPROVING BYCATCH DATA COLLECTION AND ESTIMATION

This report identifies eight national and regional recommendations to improve bycatch data collection and estimation. Maintenance and expansion of existing observer programs and implementation of new observer programs for fisheries and species with bycatch concerns are of particular importance. Funding levels for all existing regional observer programs, as of 2008, totaled \$53.1 M (Federal and industry funds). Many specific recommendations are made to improve observer program data, supplemental data, and analytical techniques within each region; these recommen-

dations are summarized here, and are presented in detail in the regional sections of Section 4. It was not possible to prioritize recommendations across regions due to the diversity in fisheries, management needs, and other factors. Eight national-level recommendations are provided below. These focus on improving data and estimation quality for fisheries and species considered in this edition of the U.S. National Bycatch Report, and on considering additional fisheries and species in future editions of the report. All recommendations should be considered high-priority, although some could be implemented relatively quickly and inexpensively, while others would require considerable investment of time and financial resources. As more fisheries and species are evaluated and reported, it is likely that additional resource needs will be identified.

Table 4
Resources needed to implement recommendations for improving bycatch data collection and estimation.^a

Resources ^a	National Observer Program	Northeast	Southeast	Alaska	Northwest	Southwest	Pacific Islands	Total
Days-at-sea (DAS) ^b needed to maintain current observer programs	na	13,208	4,085	39,000	4,596	329	9,739	70,957
DAS needed to expand current observer programs	na	16,181 ^e	11,790	29,160	792	430	855	59,208
DAS needed to implement new observer programs	na	615	5,752	0 ^f	1,058	20	0	7,445
Full-time staff needed to implement improvements to estimation methods ^c	10 ^d	17	7	13	1	1	6	55

^a Some recommendations may require additional resources such as equipment or staff support, which are not itemized.

^b DAS estimates for maintaining and expanding current observer programs are based on 2008 figures.

^c Observer program staffing and administrative needs are included when budgeting the cost for DAS and are not included in Table 4.

^d Staffing support would not be directly for the National Observer Program, but would be used to assist with implementation of national recommendations.

^e DAS estimate for the Northeast Region includes both fish and protected species needs; in some cases, this DAS estimate could be shared, and thus the overall number of DAS would be reduced.

^f For the Alaska Region, much of the increased coverage would be applied to fisheries and vessels that have not previously been observed.

**Recommendation #1:
Develop and adopt best
practices for estimating bycatch
in U.S. commercial fisheries.**

Methods for estimating bycatch vary by region and fishery. While all methods have been subjected to some level of review, many have not been formally peer reviewed. Further work to evaluate and improve current methods and to develop new approaches will lead to establishment of best practices, including procedures for estimation of variance and methods for extrapolating estimates from small sample sizes. Where count-based methods are currently employed, weight-based approaches should be developed and implemented. Improving the quantity and quality of bycatch estimates is essential to support information needs for management of commercial fisheries and protected resources. Providing measures of uncertainty associated with bycatch estimates is important for tracking improvements in both estimation methods and bycatch trends.

**Recommendation #2:
Improve national and
regional catch databases.**

Estimation of bycatch rates requires reliable information on total catch at the stock level. Inconsistencies between regional and national databases impeded estimation of stock bycatch ratios in a number of instances. Overall database improvements are necessary to resolve this problem. These improvements will enhance both quality and timeliness of bycatch estimates, as well as consistency of estimates made by different researchers.

**Recommendation #3:
Review and modify the tier classification
system for application to commercial and
recreational fisheries included in future
editions of the U.S. National Bycatch Report.**

Future editions of the U.S. National Bycatch Report should include bycatch estimates for additional commercial and recreational fisheries. The tier classification system developed in this report should be modified as necessary and applied to additional fisheries where possible. Coordination will be required with state, tribal, and international organizations to ensure accuracy and consistency. In order to maximize the usefulness of the tier system for tracking change and highlighting requirements for improvement, it will need to be as comprehensive as possible.

**Recommendation #4:
Increase the number of fishery
and species bycatch estimates
in future editions of the
U.S. National Bycatch Report.**

- **Commercial fisheries bycatch estimates:** Efforts should be made to develop bycatch estimates for all commercial fisheries where the necessary data are available. These estimates should be included in future editions of the U.S. National Bycatch Report. In the longer term, new data-collection programs should be implemented as a basis for bycatch estimation in those commercial fisheries identified as requiring bycatch monitoring.
- **Recreational fisheries bycatch estimates:** Inclusion of recreational bycatch estimates is necessary to estimate overall bycatch mortality for some species. Development of appropriate bycatch data-collection and analytical methods should be encouraged and supported.
- **Bycatch estimates for key stocks:** Lack of bycatch estimates for some of the key stocks identified in this report is of particular concern. Development of bycatch estimates for these stocks should be prioritized and these estimates should be included in future editions of the U.S. National Bycatch Report.

Additional stock- and fishery-specific bycatch estimates in future editions of the U.S. National Bycatch Report will provide new information to the public on the overall status of bycatch in the Nation's fisheries. Scientists and managers will be able to make use of this information for assessment and management, to evaluate the effectiveness of bycatch reduction measures, and to identify areas where improved management and/or innovative bycatch reduction methods are required.

**Recommendation #5:
Implement specific bycatch
data-collection and estimation
improvements in regional programs.**

Several recommendations are made for improving bycatch data-collection and estimation within the regions. These include discard mortality studies; outreach; database infrastructure improvements; and collection and processing of supplemental data, especially logbook, VMS, and strandings and entanglement data, which are often essential for estimating bycatch. These types of data are required in many bycatch estimation approaches but are often lacking or of poor quality. Thus these improvements will result in overall improvements in bycatch data quality and the number of fisheries and stocks for which bycatch estimates are available.

**Recommendation #6:
Maintain and expand existing
regional observer programs.**

Observer programs have been implemented in all NMFS regions; observer data are considered to be the most reliable source for bycatch estimation. Many U.S. observer programs are at suboptimal coverage levels, which vary depending on the characteristics of a fishery and the species of interest. Specific recommendations for maintaining and expanding observer coverage to optimal levels in existing programs are made in the regional sections. Maintenance of these programs is essential for ongoing estimation of bycatch and evaluation of mitigation measures. Expanding coverage of existing observer programs will improve the accuracy and precision of bycatch estimates in many instances.

**Recommendation #7:
Implement new observer programs
for fisheries and species with
bycatch concerns.**

New observer programs are recommended in most regions, for a total of 32 fisheries. These fisheries were identified through the fisheries of focus section process described in Section 3 (e.g., fisheries with a high bycatch ratio and bycatch of key stocks, or fisheries were identified through the qualitative process). Pilot observer coverage has been recommended by the relevant regional team as an initial step to address bycatch concerns in several instances. Recommendations for new observer programs also include electronic monitoring in some regions. Implementing new pilot observer programs will provide information on bycatch in fisheries where bycatch information is currently unavailable or available only in the form of unverified industry reports.

**Recommendation #8:
Evaluate electronic monitoring
systems, conduct pilot studies, and
operationalize electronic monitoring
technology where appropriate.**

Use of video cameras and other electronic data acquisition systems has increased markedly during the last decade. Electronic monitoring has been used successfully for compliance monitoring and verification of self-reporting, and can provide useful information on catch quantity and composition, although species identification is only possible in some instances. The approach holds promise for addressing certain objectives (e.g., monitoring for compliance with discard prohibitions) and should be able to provide more detailed information on catch and bycatch composition as the technologies advance.

CONCLUSIONS

The recommendations included in this report provide guidance to the NMFS in setting priorities for maintaining existing bycatch data-collection programs, expanding programs where more reliable bycatch information is needed, and implementing new bycatch data-collection programs for fisheries with potential bycatch concerns. Implementation of these recommendations will assist NMFS to increase baseline knowledge of bycatch levels, help identify fisheries and/or species with potential bycatch concerns, and improve the monitoring of bycatch levels over time. Improved bycatch estimates will support the implementation of MSA-required annual catch limits and new management approaches such as catch-share programs, and in general will aid NMFS in addressing fishery-specific conservation and management concerns.

Two performance measures have been developed from the information compiled in this report: 1) the tier classification system, which will be used to monitor the quality of bycatch estimates in U.S. commercial fisheries; and 2) a list of key stocks, which will be used to monitor bycatch trends over time. These performance measures will assist NMFS in continuing to improve the effectiveness of bycatch monitoring programs, as well as reducing bycatch in key fisheries.

This is the first in a series of U.S. National Bycatch Reports. This edition contains bycatch estimates for federally managed commercial fisheries or with relevant federal data-collection programs. Future editions will include timely and periodic updates of bycatch estimates for federal fisheries, as well as estimates for state, international, and tribal fisheries where data are available. Inclusion of bycatch estimates for stocks with high recreational bycatch mortality will also be considered. Over time, the U.S. National Bycatch Report will provide NMFS, other fisheries management organizations, and the public with reliable bycatch estimates for all living marine resources, which can be used to more effectively meet NMFS' stewardship mission.