Rockfish Bycatch:
Spatial Analysis Using Observer Data in the Aleutian Islands and Bering Sea

Prepared for Alaska Marine Conservation Council

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DRAFT REPORT

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Executive Summary

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North Pacific rockfish, marine fish belonging to the genera *Sebastes* and *Sebastolobus*, share unique biological and life history traits. The biological characteristics of rockfish, including longevity, high age at maturity, habitat preferences, and physiology, elevate their susceptibility to localized depletion and over-harvest. The collapse of rockfish populations off the Pacific coast of California, Oregon, and Washington have heightened concerns about the effects of fishing on rockfish populations.

In Alaska, no rockfish species are designated as overfished, but high rates of rockfish bycatch, localized depletion, and over-harvest have the potential to threaten rockfish populations. For example, reproductively isolated populations could be overfished inside a region or sub-area, such as the Aleutian Islands, without exceeding the overfishing level of the broader management area. Similarly, there is the risk of overfishing individual species that are managed as part of a species group, while the complex catch as a whole remains within allowable catch guidelines.

In the Bering Sea and Aleutian Islands (BSAI), NOAA Fisheries and the North Pacific Fishery Management Council (NPFMC) manage twelve rockfish species. Pacific ocean perch, northern, shortraker and rougheye rockfish are managed as individual species and stocks across the BSAI management area. Eight other species are aggregated into a single "other rockfish" management complex, which is dominated by dusky and shortspine thornyhead rockfish. Pacific ocean perch is the only rockfish species for which there is a directed commercial fishery; the rest are taken as bycatch in other target fisheries. Although some rockfish bycatch is retained and sold, most is discarded. For example, in 2003, approximately 89% (4,623 metric tons) of the combined trawl catch of northern, rougheye, shortraker and "other" rockfish was discarded.[1] Of those discards, 96% were northern rockfish, taken primarily in the Aleutian Islands Atka mackerel fishery.

In June 2004, the NPFMC prioritized issues facing rockfish management as part of their programmatic policy level goals and objectives. Subsequently, the NPFMC requested a review of rockfish management issues that included an analysis of fishing rates, habitat considerations, and spatial as well as temporal bycatch information. In this analysis we use North Pacific groundfish observer data to identify rockfish bycatch hotspots because decisions regarding bycatch reduction can be better informed with spatially explicit information.

Summarized to 10 km fishing blocks, trawl and longline observer data collected from 1990 - 2002 is mapped to locate areas with persistent bycatch of northern, rougheye, shortraker, sharpchin, shortspine thornyhead, dusky, and dark rockfish. Persistent

[1] FIS 2004. Discards in the North Pacific Groundfish Fisheries 2003. Prepared for the Alaska Marine Conservation Council. Fisheries Information Services, August 2004.

rockfish bycatch is defined and scored by annual frequency of catch and catch per unit effort (CPUE). Blocks are sorted according to this persistence score and areas with high scores representing 20, 40, 60, and 80% of the bycatch of each rockfish species are described in tables and many of these scenarios are mapped. These maps include target species associated with trawl and longline rockfish bycatch in the Aleutian Islands and Bering Sea.

The highest scored blocks where 20% of each rockfish species was caught are combined to locate areas of high frequency of rockfish bycatch and high CPUE for one or more of the rockfishes in the study. These bycatch hotspots are overlaid on the Aleutian Islands Habitat Conservation Area (HCA), a trawl closure area that will take effect by August 2006. Bycatch hotspots are also presented for the Bering Sea. This analysis shows that the HCA will have a negligible impact on reducing rockfish bycatch since a majority of the area with high CPUE and persistent rockfish bycatch will still be open to trawling.

The rockfish bycatch areas identified in this report provide a starting point for discussing spatially-based management practices designed to minimize rockfish bycatch. This analysis displays bycatch hotspots that if protected, could significantly decrease rockfish bycatch of the profiled species. Any future management measures to limit rockfish bycatch, however, should consider other information including the biological and economic costs and benefits that may result if trawling is restricted in the areas highlighted in this report.

Objectives

The objectives of this analysis are to use National Marine Fisheries Service (NMFS) observer data in the Aleutian Islands (AL) and Bering Sea (BS) to:

- ***Locate 10 x 10 km blocks where specific rockfish species were persistently caught from 1990 – 2002***
- ***Rank the blocks according to the frequency of catch for each species and catch per unit effort***
- ***Identify the percentage of catch that falls within and outside blocks of various rankings***
- ***Determine the location and quantity of rockfish bycatch associated with each target species***

Introduction

The intended purpose of this report is to help AMCC begin location-specific discussions with regional and local stakeholders about rockfish conservation in the Bering Sea and Aleutian Islands. Within this region, rockfish are frequently caught in large quantities as bycatch when groundfish fishers are targeting species such as Atka mackerel, Pacific cod, and Pollock. This persistent bycatch issue, particularly among trawlers, is often linked to habitat destruction and detrimental impacts on the marine food web (Enticknap and Childers, 2004). This report also presents an alternative methodology for using NMFS groundfish observer data to identify areas (10km x 10km blocks) within each region where bycatch of specific rockfish species has occurred from 1990-2002. These areas are ranked in priority according to various criteria that are explained in our methodology. Decisions regarding bycatch reduction can be better informed with spatially explicit information.

In the following section, we present four scenarios representing areas encompassing various percentages of the total rockfish catch derived from observed tows. The methodology uses trawl data summarized by the prevalent Northern Rockfish, a rockfish species that is caught and discarded as bycatch more than any other rockfish in the

Aleutian Islands and Bering Sea. Northern Rockfish is second only to Pacific Ocean Perch as the most abundant Alaskan Rockfish (AFSC, 2004). It should also be noted that as of 1997, the National Marine Fisheries Service prohibited targeted fishing for this species in the Aleutian Islands and it has historically only been caught as bycatch in the Bering Sea (Clausen and Heifetz, 2002).

Methodology and Results

Section I

The methodology for determining hotspots using 10 x 10 km blocks with persistent catch was developed using Northern Rockfish in this analysis and can be applied to Rougheye, Shortraker, Sharpchin, Shortspine Thorneyhead, Light Dusky, and Dark Dusky rockfish. We begin by defining a "hotspot" in the same manner as Reuter and Spencer in the *2003 BSAI Other Rockfish* report by locating areas where a rockfish species was consistently caught over a given time period. The time period chosen for this analysis is 1990 through 2002, which is the extent of our NMFS observer rockfish datasets. Before 1990, Northern Rockfish in trawl surveys were not differentiated from the Pacific Ocean Perch Complex or the Slope Rockfish Assemblage. Consequently, Northern Rockfish catch statistics on observed hauls are unavailable prior to 1990 (Clausen and Heifetz, 2002).

To better understand which regions and blocks had been observed consistently from 1990 to 2002, we scored each block by the number of years that tows were observed (Figure 1). The Bering Sea was much more heavily observed than the Aleutian Islands. In the Bering Sea, trawling was observed for all 13 years in 131 blocks, or 3.8% of 3,446 observed blocks. Only 5 trawled blocks, 1.1%, in the Aleutian Islands were observed every year out of a total of 447 observed blocks.

To determine how often Northern Rockfish were caught in observed blocks, we compared the number of years Northern Rockfish catch was reported between 1990 and 2002 (Figure 2). This figure indicates the number of years that Northern Rockfish were observed caught in trawled blocks.

Due to the very small number of blocks where Northern Rockfish were caught every year, it is apparent that we need to include blocks that were not observed every year, but had Northern Rockfish catch during all years when catch was observed. Each block is assigned a value according to the ratio of catch score to trawl score as shown in Figure 3; the catch score is the number of years rockfish were caught and the trawl score is the number of years the block was observed.

A catch to trawl score ratio of 1 indicates that Northern Rockfish was caught in each year that trawls were observed. As another example, a ratio of 0.60 denotes Northern Rockfish catch in 6 out of the 10 years (6/10) that the block was observed.

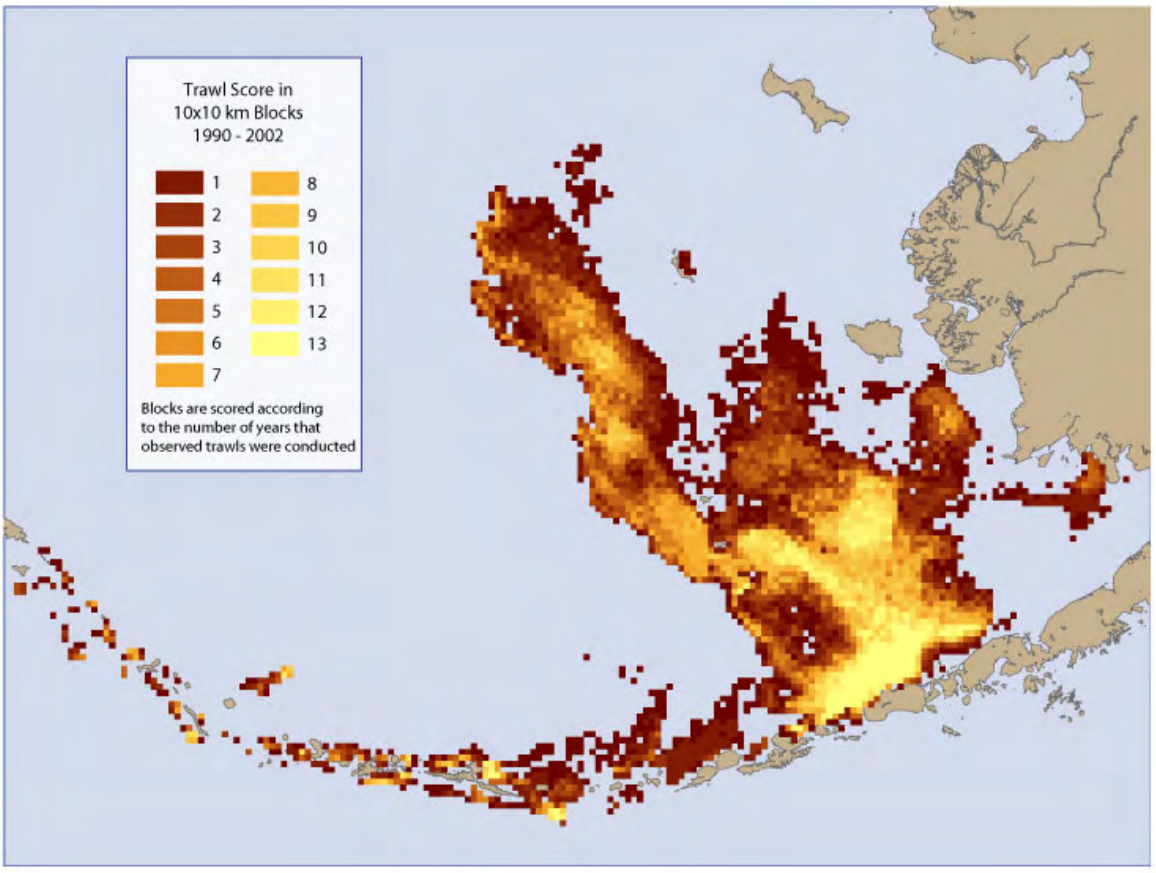


Figure 1. Observed trawl tows, 1990 –2002
Blocks are scored according to the number of years that trawl tows were observed.

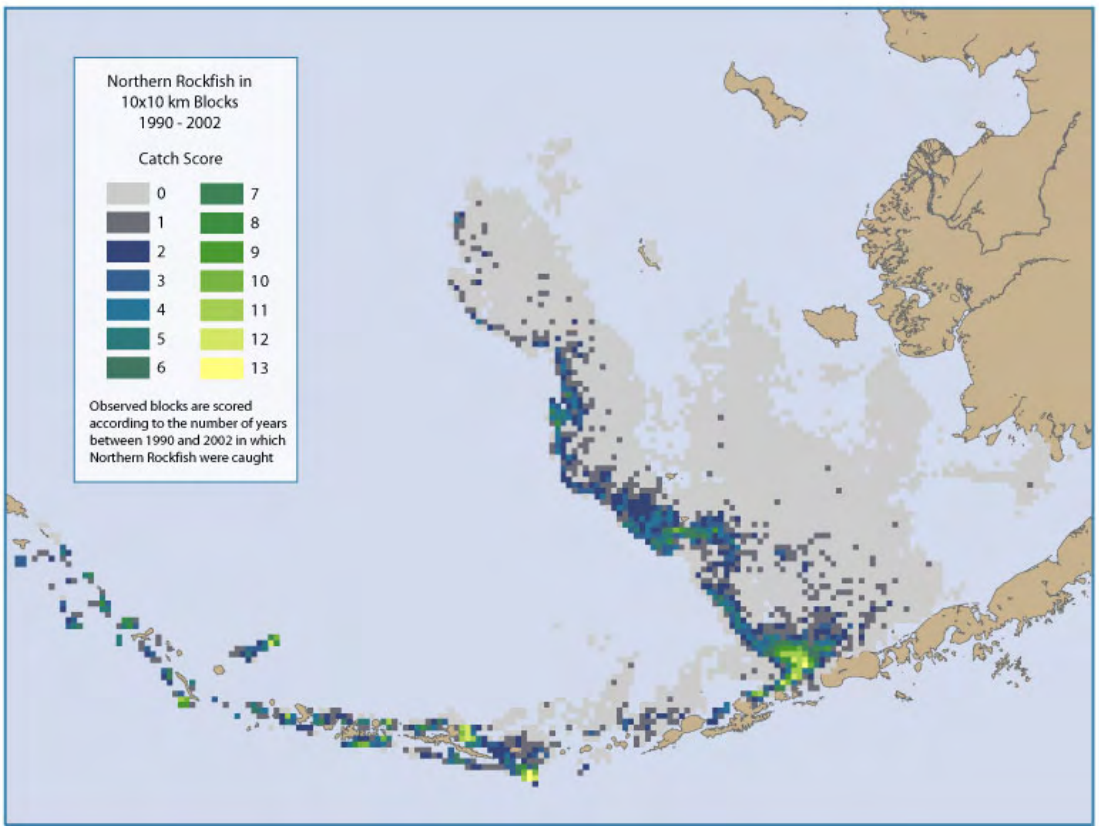


Figure 2. Number of years Northern Rockfish was caught with trawl gear in observed tows, 1990 – 2002.

In both the Aleutian Islands and the Bering Sea, Northern Rockfish were consistently caught during all 13 years in only three (0.07%) of the 3,893 observed 10 x 10 km blocks. Northern Rockfish was observed caught for 12 years in nine (0.23%) of the blocks and six or more years in 998 (26%) of the blocks.

In 240 (6%) of 3,893 observed blocks in both the Bering Sea and Aleutian Islands, the catch to trawl ratio is one, indicating that the number of years in which Northern Rockfish were caught equals the number of years in which tows were observed (Figure3). The Bering Sea has, on average, lower ratio scores than the Aleutian Islands.

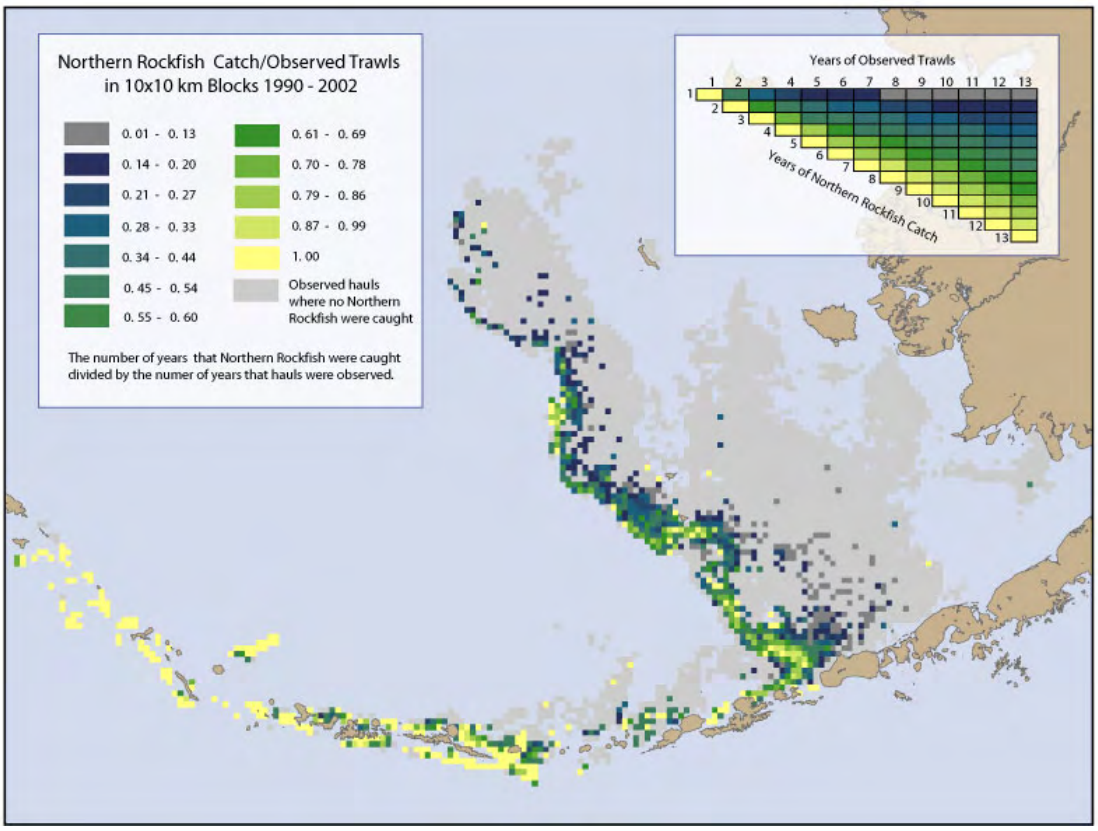


Figure 3. Ratio of Northern Rockfish catch to observed trawls, 1990 – 2002

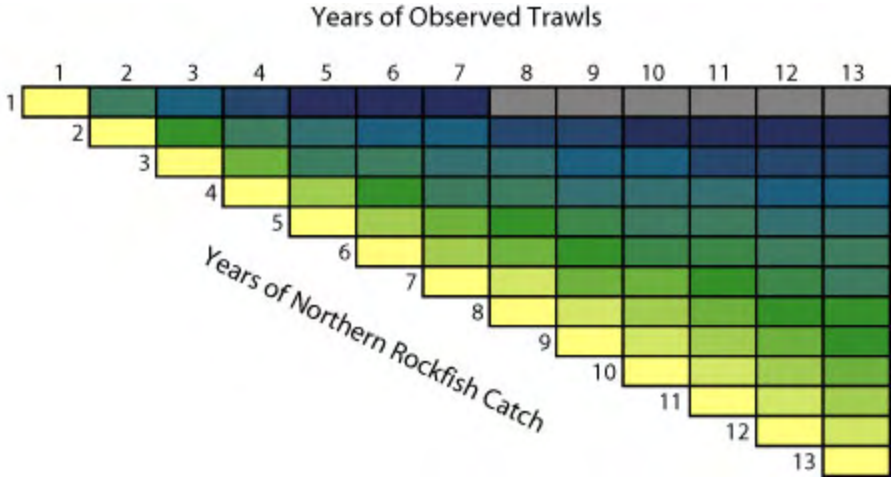


Figure 3.1 Catch to Trawl Matrix.

The values in this matrix, which are the number of years of Northern Rockfish catch divided by the years of observed trawls, correspond to the colored fishing blocks in Figure 3.

In the Aleutian Islands, 188 blocks have a catch to trawl ratio of 1, and in the Bering Sea, 52 blocks have a catch to trawl ratio of 1. Given the prevalence of ratio scores equal to one, we further refined our scoring of blocks to reflect catch per unit effort (CPUE). Each 10 x 10 km block was summarized by the total number of hauls and the total Northern Rockfish catch. The total catch in metric tons was divided by the total number of hauls to calculate the Northern Rockfish CPUE in each block fish as shown in Figure 4.

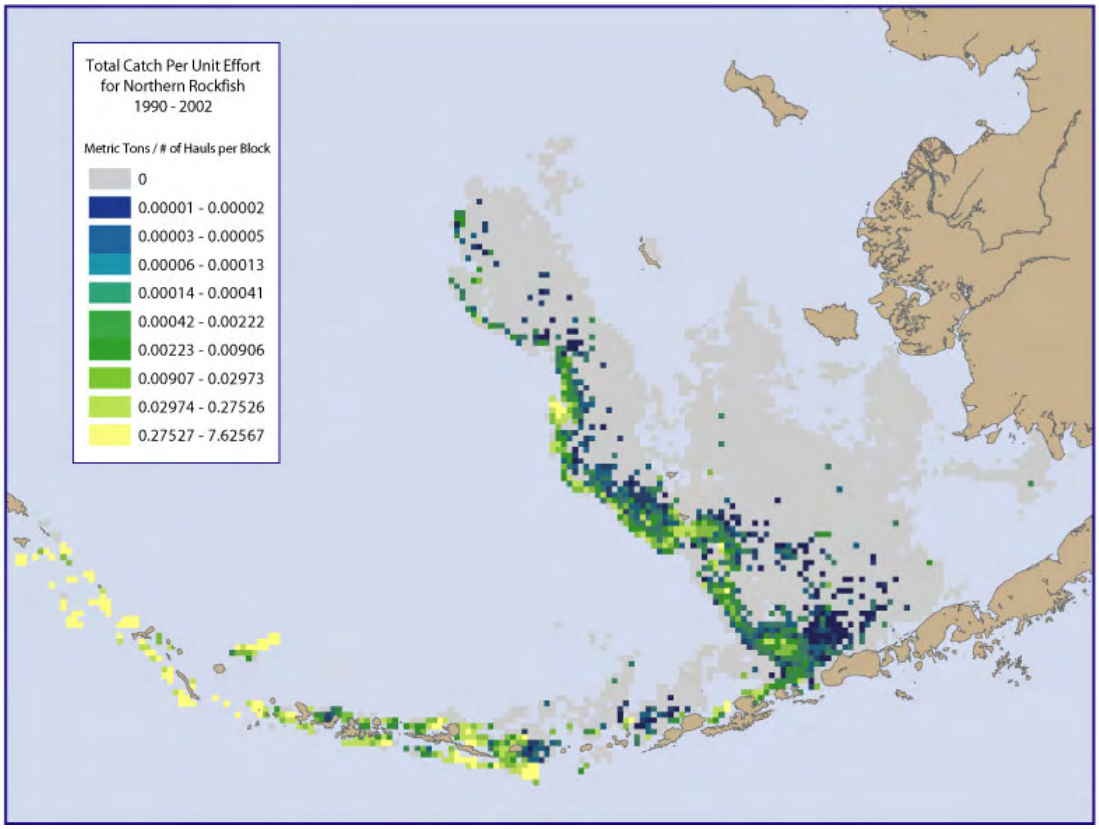


Figure 4. Trawl catch per unit effort (CPUE) for Northern Rockfish, 1990 – 2002. CPUE, total catch in metric tons divided by the number of hauls, varies drastically between the Aleutian Islands and the Bering Sea. Fewer hauls caught more Northern Rockfish in the Aleutian Islands than in the Bering Sea.

Figures 3 and 4 display the substantial differences between the Bering Sea and Aleutian Island regions in terms of both the catch to trawl ratio and CPUE. The data is separated

by region for the next steps of our analysis to provide a more localized context for rockfish catch.

Section II

To incorporate both the catch to observed tow ratio and CPUE, we assign an adjusted abundance score to each block. Several steps were taken to calculate the adjusted abundance score. First, all blocks with Northern Rockfish catch were partitioned into 4 quantiles (a partition of a distribution into equal and ordered groups) sorted in descending order by CPUE. The blocks were scored from 0 to 5 as explained in Table 1.

Table 1. Abundance score explanation
The abundance scores group together blocks with similar CPUE characteristics. In order to determine the relative annual variation in CPUE, the quantile breakdown values indicated in the table as low, medium, high, and highest are different numbers for each year.

Abundance Score	Explanation
0	No observed tows conducted
1	Observed tows conducted, no Rockfish caught
2	Rockfish species caught, lowest CPUE
3	Rockfish species caught, medium CPUE
4	Rockfish species caught, high CPUE
5	Rockfish species caught, highest CPUE

The abundance score was averaged across all years for each block. Only scores greater than zero were used to calculate the abundance score average. Scores of 0 were excluded because the average would have been lowered due to scores of zero when blocks were not observed.

As shown in Table 2, this average was then multiplied by the catch to trawl ratio, which is the total years Northern Rockfish were caught divided by the total years that the block was observed. The product is the *adjusted abundance*, a score that reflects CPUE, the number of times the block was observed, and the frequency of Northern Rockfish catch in the block.

Table 2. Calculation of Adjusted Abundance for each block

Average Abundance (0-5 score of CPUE)	x	Years of Northern Rockfish catch / Years the block was observed	=	Adjusted Abundance

The data was sorted by the adjusted abundance score as a way of ranking the relative significance of each block for Northern Rockfish catch. The sum of the Northern Rockfish catch for each adjusted abundance score was calculated to make Charts 1 and 2.

Chart 1. Aleutian Islands Northern Rockfish trawl catch by block, sorted by adjusted abundance

From 1990 to 2002, a total of 30,216 metric tons of Northern Rockfish were observed caught in 282 blocks in the Aleutian Islands. Cumulative Northern Rockfish catch is plotted against cumulative number of 10 x 10 km blocks. When the blocks are plotted according to the associated catch at each adjusted abundance score, the steep slope on the left signifies that most of the total catch occurred in approximately 1/3 of the total blocks that were observed. As the curve flattens, the marginal catch per block declines, showing that the blocks with lower adjusted abundance scores account for little of the total metric tons caught. The orange points correspond to 20, 40, 60, and 80% of the total metric tons of Northern Rockfish caught.

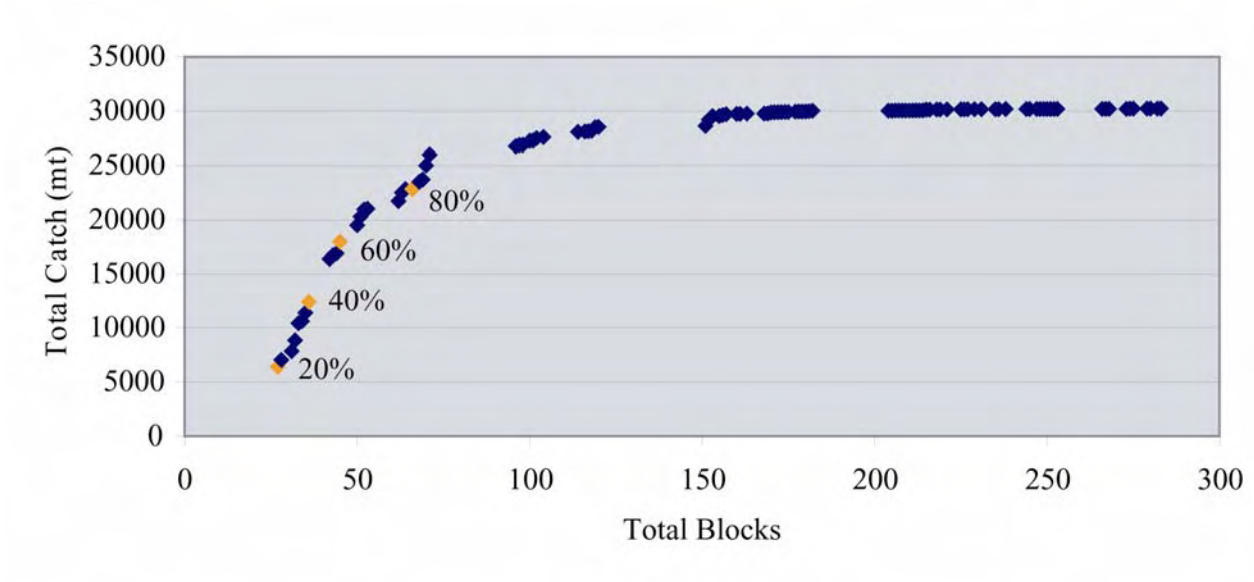


Chart 2. Bering Sea Northern Rockfish trawl catch by block, sorted by adjusted abundance

From 1990 to 2002, a total of 3893 metric tons of Northern Rockfish were observed in trawl catch from 750 blocks in the Bering Sea. This data was sorted and summarized in the same way as the data from the Aleutian Islands, including the orange points that correspond to 20, 40, 60, and 80% of the total metric tons of Northern Rockfish caught. The slope is even steeper for Bering Sea, emphasizing the significance of a small number of blocks to the total Northern Rockfish catch.

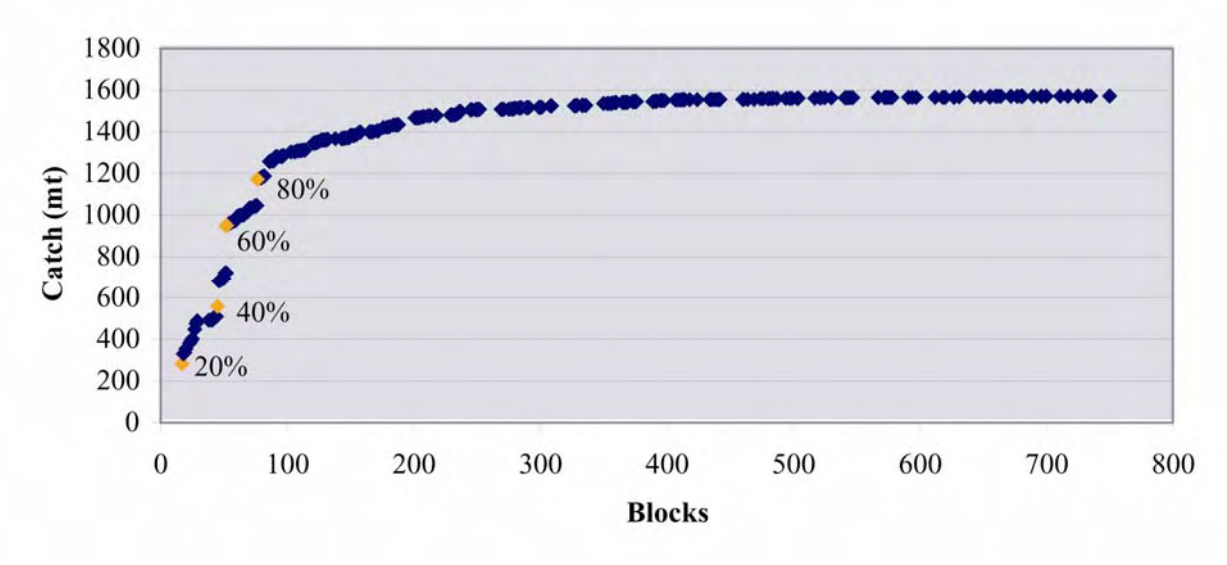


Chart 3. Aleutian Islands Northern Rockfish longline catch by block, sorted by adjusted abundance

From 1990 to 2002, a total of 161 metric tons of Northern Rockfish were observed in longline catch from 238 blocks in the Aleutian Islands.

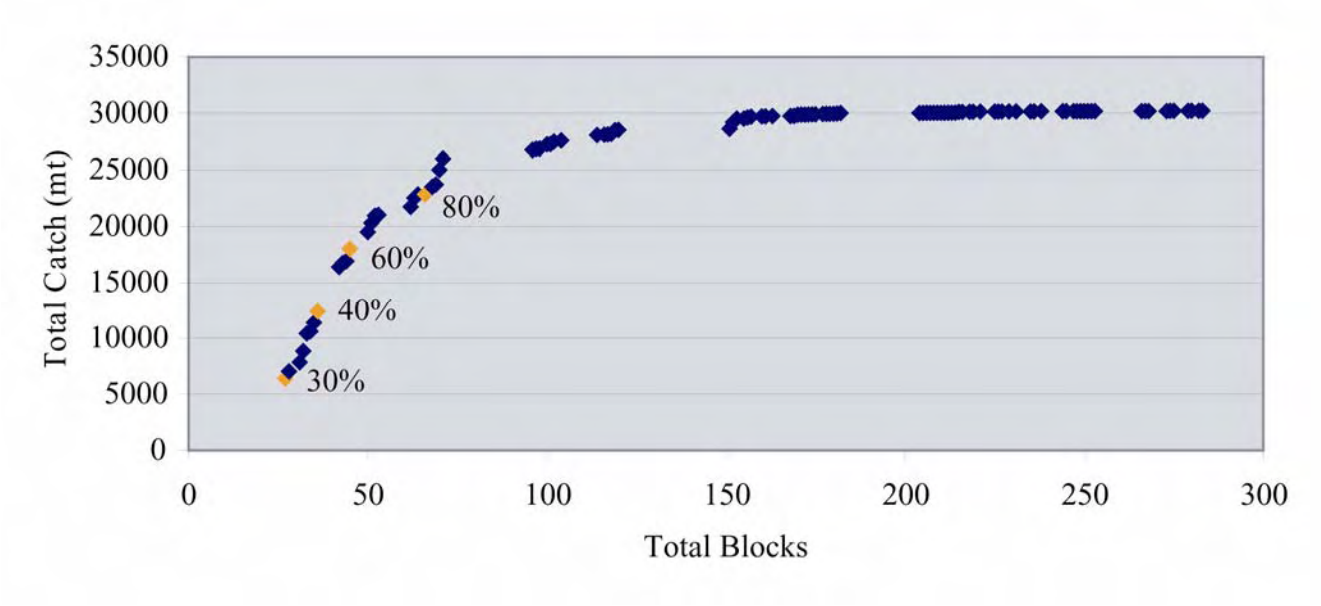
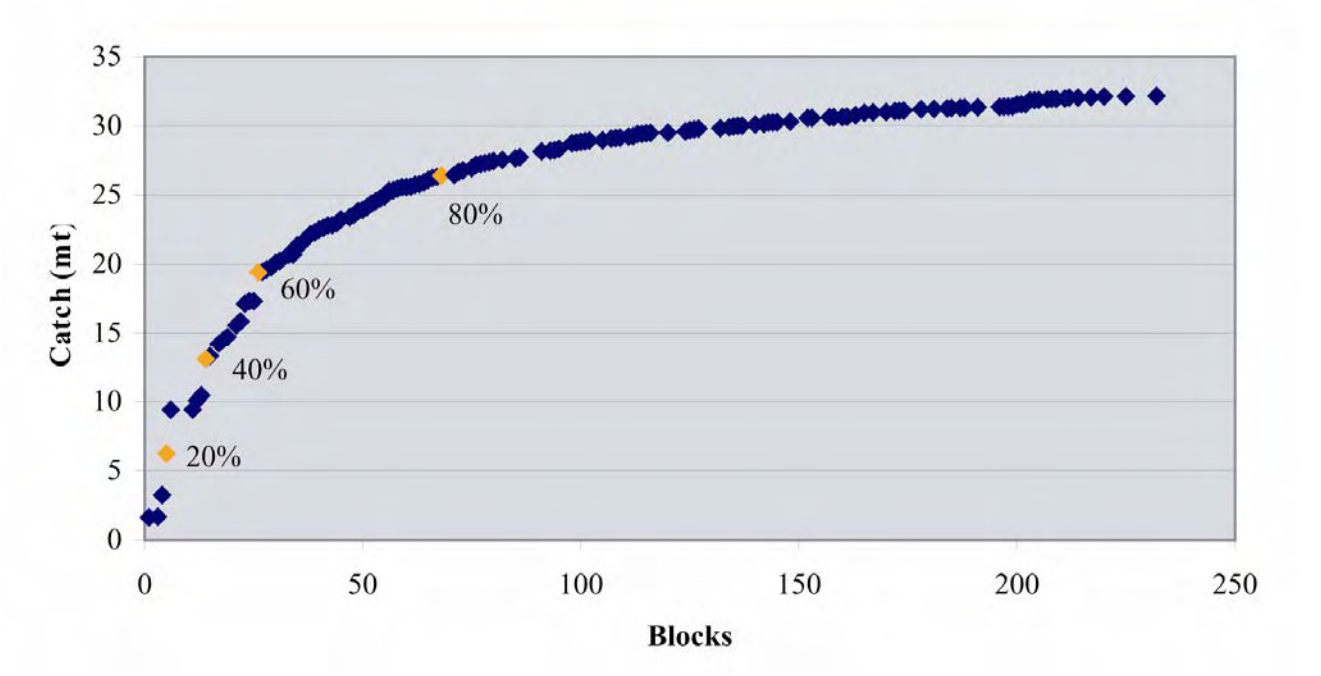


Chart 4. Bering Sea Northern Rockfish Longline catch by block, sorted by adjusted abundance

From 1990 to 2002, a total of 32 metric tons of Northern Rockfish were observed in trawl catch from 232 blocks in the Bering Sea.



Charts 1 through 4 clearly show the relative significance of blocks with high adjusted abundance scores, data points on the left with steep slopes between them, as compared to blocks with low adjusted abundances, data points in the flatter sections to the right. Since

no clear cut-off point exists between significant and insignificant adjusted abundance scores, we devised a method of showing four different presentations of the data, each one including more blocks with progressively lower adjusted abundances.

Section III

Four scenarios of trawl data and four of longline data were created with the adjusted abundance scores. Blocks in each scenario are displayed based on four decreasing threshold values of adjusted abundance that correspond with approximately 20, 40, 60 or 80% of the total metric tons of Northern Rockfish caught. The scenarios are based on the adjusted abundance scores in Tables 3 through 6. For example, trawl scenario one in the Aleutian Islands is defined as blocks with adjusted abundance scores of 5, signifying that Northern Rockfish were caught in the block every year that it was observed and the CPUE in these blocks was always in the highest quantile. There are 26 blocks in scenario one, which represents 9% of the area where Northern Rockfish were observed. In these 26 blocks, 6,213 mt of Northern Rockfish were caught, which is 21% of the total Northern Rockfish catch in this region. Scenarios 2, 3, and 4 include progressively higher number of blocks and cumulative catch for trawl and longline gear.

Table 3. Trawl scenario defining adjusted abundance scores in the Aleutian Islands.

Trawl Scenario	Total Catch (%)	Adjusted Abundance	Blocks (#)	Blocks (%)	Catch (mt)
1	21%	5	26	9%	6414
2	41%	4.69	35	12%	12396
3	60%	4.57	44	15%	18010
4	78%	4.17	68	24%	23717

Table 4. Trawl scenario defining adjusted abundance scores in the Bering Sea

Trawl Scenario	Total Catch (%)	Adjusted Abundance	Blocks (#)	Blocks (%)	Catch (mt)
1	18%	5	17	0.7%	282
2	35%	3.61	45	6%	559
3	61%	3.36	54	7%	960
4	80%	2.63	86	11%	1258

Table 5. Longline scenario defining adjusted abundance scores in the Aleutian Islands
The adjusted abundance score of five is associated with a higher total catch (29%) in this region with longline gear than in any other region or gear type that was included in our study.

Longline Scenario	Total Catch (%)	Adjusted Abundance	Blocks (#)	Blocks (%)	Catch (mt)
1	29%	5	25	11%	46
2	44%	4.8	28	12%	70
3	58%	4.5714	35	15%	94
4	80%	3.75	82	34%	129

Table 6. Longline scenario defining adjusted abundance scores in the Bering Sea

Longline Scenario	Total Catch (%)	Adjusted Abundance	Blocks (#)	Blocks (%)	Catch (mt)
1	19%	3.5	5	2%	6
2	41%	2.9	14	6%	13
3	60%	2.0	26	11%	19
4	80%	1.1	62	27%	26

Section IV

Two datasets were used in the following mapped scenarios due to NMFS confidentiality rules, which prohibit the release of data pertaining to blocks where less than three observed vessels caught the same target species per year. One dataset, which includes a higher total catch, lacks a predominant species associated with Northern Rockfish catch and the other dataset, with a smaller total catch, specifies the predominant species. As shown in Figures 5 through 12 of the Aleutian Islands and Bering Sea, there are several blocks colored orange with scenario defining adjusted abundance scores that are not associated with a predominant species due to this confidentiality rule. The predominant species with associated Northern Rockfish bycatch are Atka mackerel, Rockfish or Pacific Ocean Perch, and Pacific cod. Other predominant species associated with $\leq$ 0.1% of the Northern Rockfish catch are Arrowtooth/ Kamchatka flounders, pollock, sablefish, other flatfish, and halibut.

Observer data does not identify the intended target species for each haul but procedures have been developed to determine the probable target species (Ackley and Heifetz, 2001). Using this methodology with data from 1990- 1998, "the predominant species by weight in a haul was usually determined to be the target" (Clausen and Heifetz, 2002). The following mapped scenarios generalize that predominant species is the same as target species.

In the Aleutian Islands, Northern Rockfish were caught with trawl gear in 282 (63%) of the 447 observed blocks. Out of 30,216 mt of Northern Rockfish caught on observed tows, 26,017 mt (86%) are associated with a predominant species. The blocks without a predominant species association are the result of confidentiality in the NMFS dataset.

In Figures 5 through 12, note that the charts of "Estimated Percentage of Total Northern Rockfish Catch Associated with a Target Species" represent the target species breakdown by total Northern Rockfish catch in the yellow blocks. Only target species representing > 0.1% of the Northern Rockfish catch are included in the maps. When the associated target species is "Rockfish," the specific target species is generally Pacific Ocean Perch, which is currently the only economically viable targeted rockfish species in this region (Morgan, 2004). Northern Rockfish is bycatch in the Bering Sea and, since 1997, NMFS has prohibited targeting Northern Rockfish in the Aleutian Islands (Clausen and Heifetz, 2003).

Blocks with high adjusted abundances are labeled with a letter to more clearly show how areas change in shape depending on the percentage of Northern Rockfish included. The scenarios showing 80% of the Northern Rockfish catch are labeled alphabetically. The alphabetical labeling is intentionally discontinuous in scenarios displaying less than 80% of the catch because fewer 10 x 10 km blocks are included.

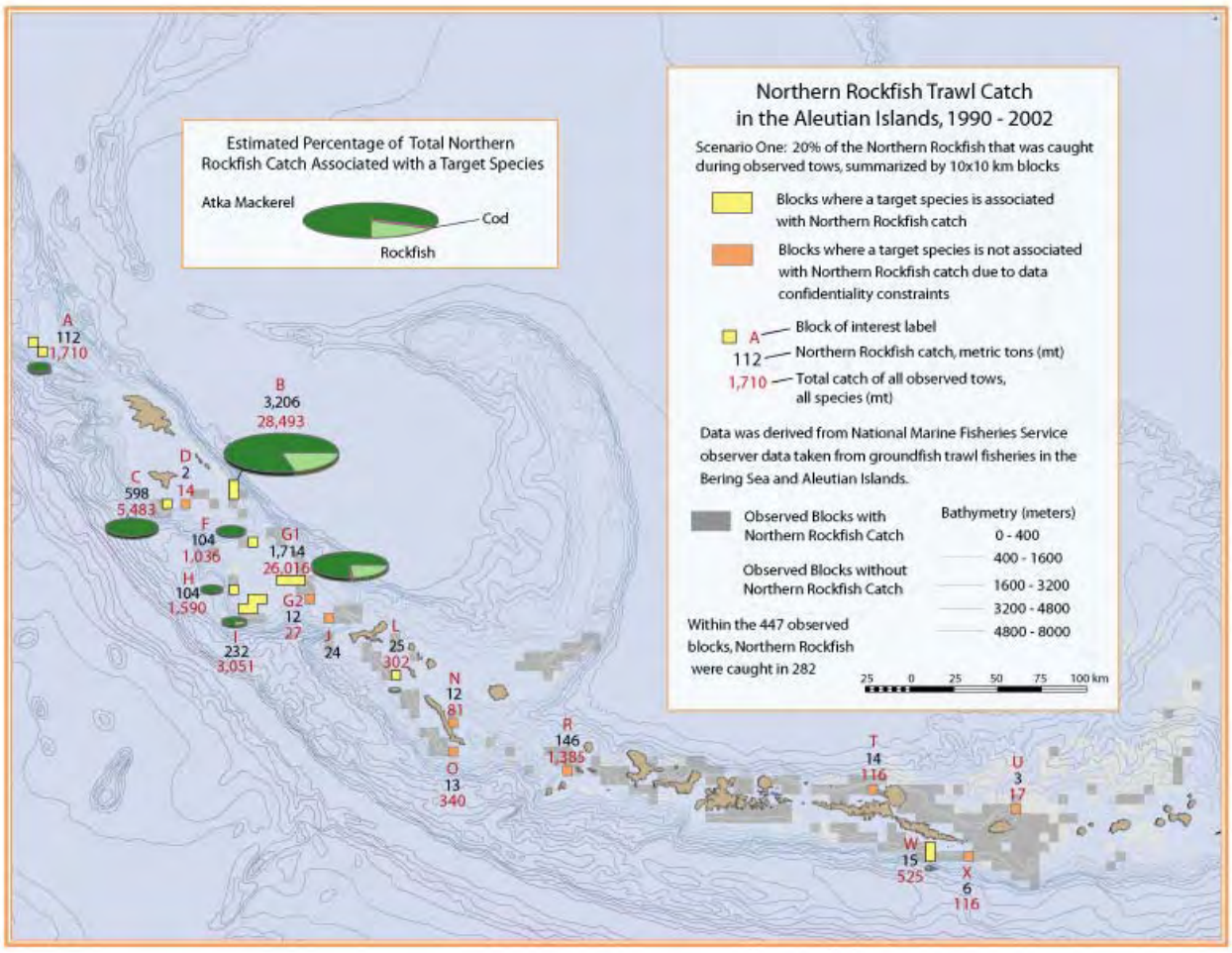


Figure 5. Trawl Scenario 1: Aleutian Islands, 20% of the Total Northern Rockfish Catch
In the Aleutian Islands, 6,414 metric tons of rockfish were caught within the colored blocks and 23,802 metric tons were caught in the dark gray blocks.

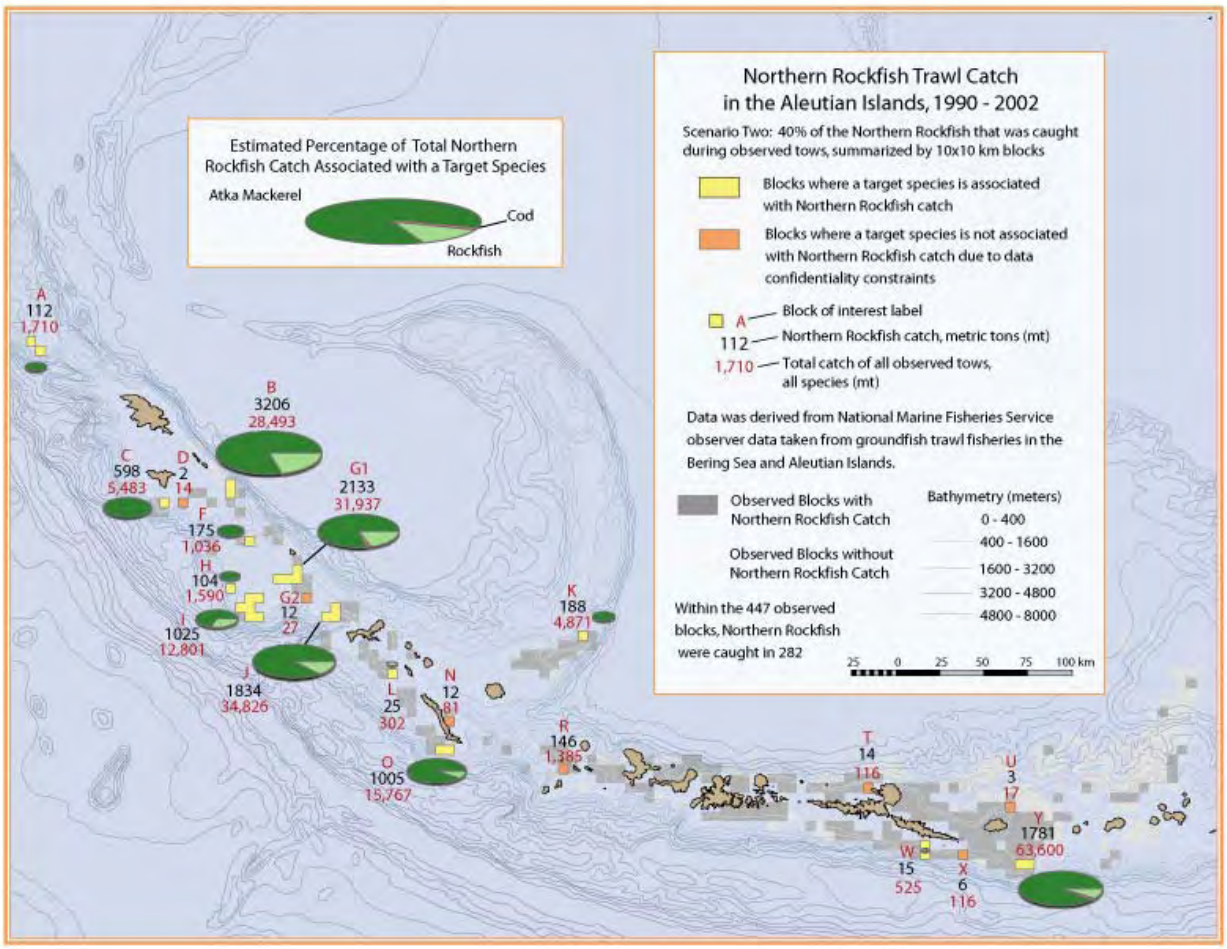


Figure 6. Trawl Scenario 2: Aleutian Islands, 40% of the Total Northern Rockfish Catch
In the Aleutian Islands, 12,396 metric tons of Northern Rockfish were caught within the colored blocks and 17,820 metric tons were caught in the dark gray blocks.

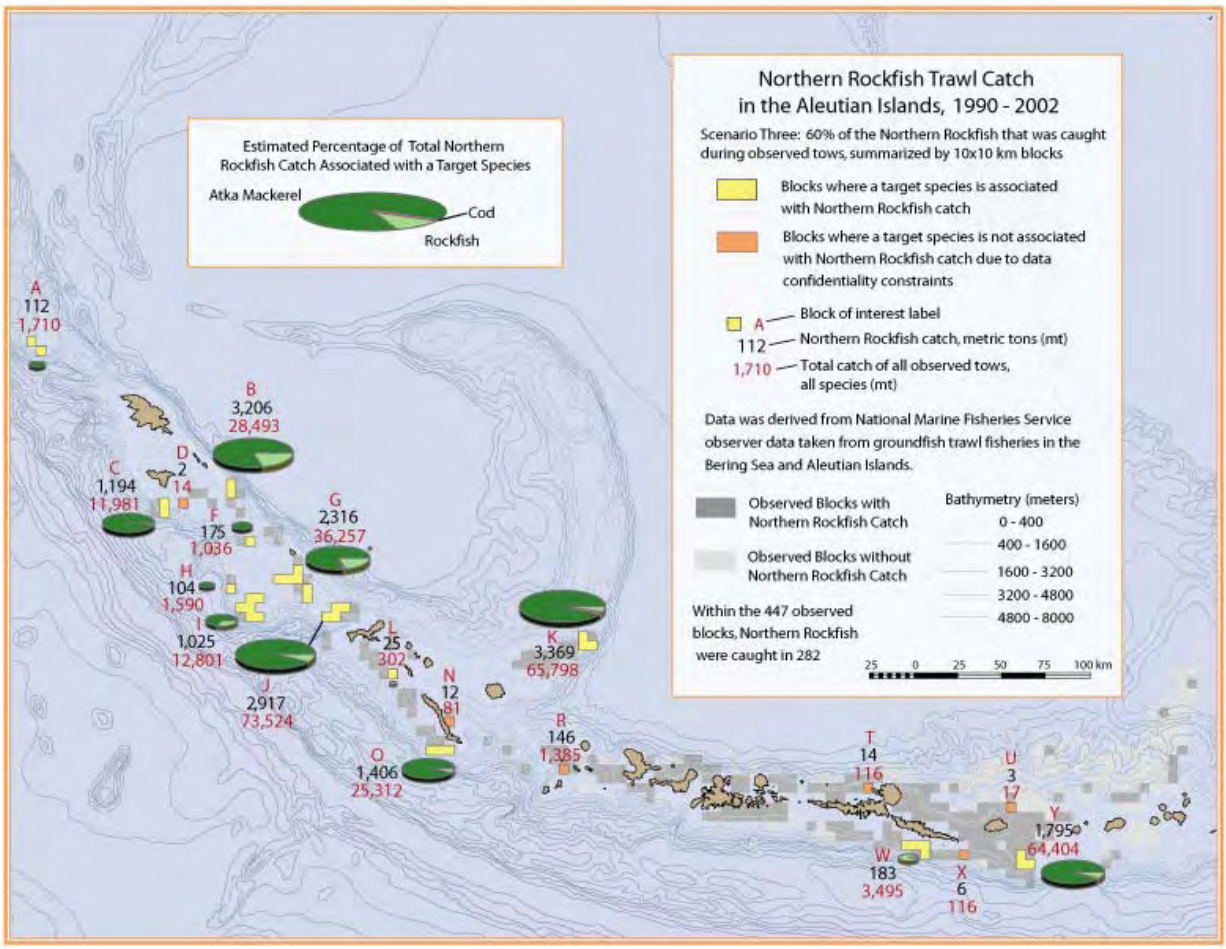


Figure 7. Trawl Scenario 3: Aleutian Islands, 60% of the Total Northern Rockfish Catch
In the Aleutian Islands, 18,010 metric tons of Northern Rockfish were caught within the colored blocks and 12,206 metric tons were caught in the dark gray blocks.

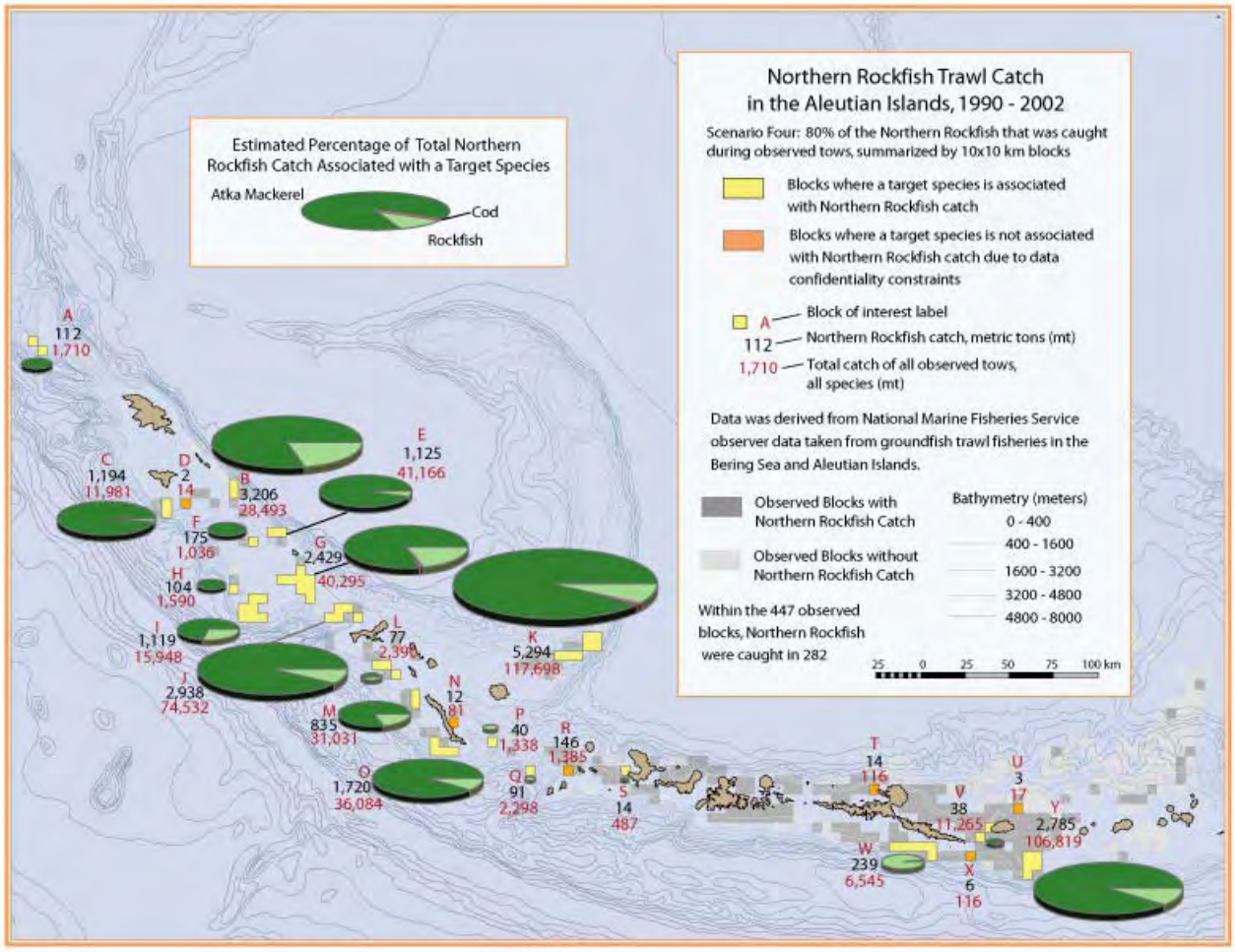


Figure 8. Trawl Scenario 4: Aleutian Islands, 80% of the Total Northern Rockfish Catch
In the Aleutian Islands, 23,717 metric tons of Northern Rockfish were caught within the colored blocks and 6,499 metric tons were caught in the dark gray blocks.

The majority of Northern Rockfish bycatch is associated with Atka mackerel in the Aleutian Island blocks where 20, 40, 60, and 80% of the total Northern Rockfish catch was made. The scenario maps highlight where the quantities and CPUE of bycatch are consistently large.

In the Bering Sea, Northern Rockfish were caught with trawl gear in 22% of the observed blocks. The entire observed area includes 3,446 10km x 10 km blocks and Northern Rockfish were caught in 750 of them. Out of 1,572 mt of Northern Rockfish caught on observed tows, 1,188 mt are associated with a predominant species.

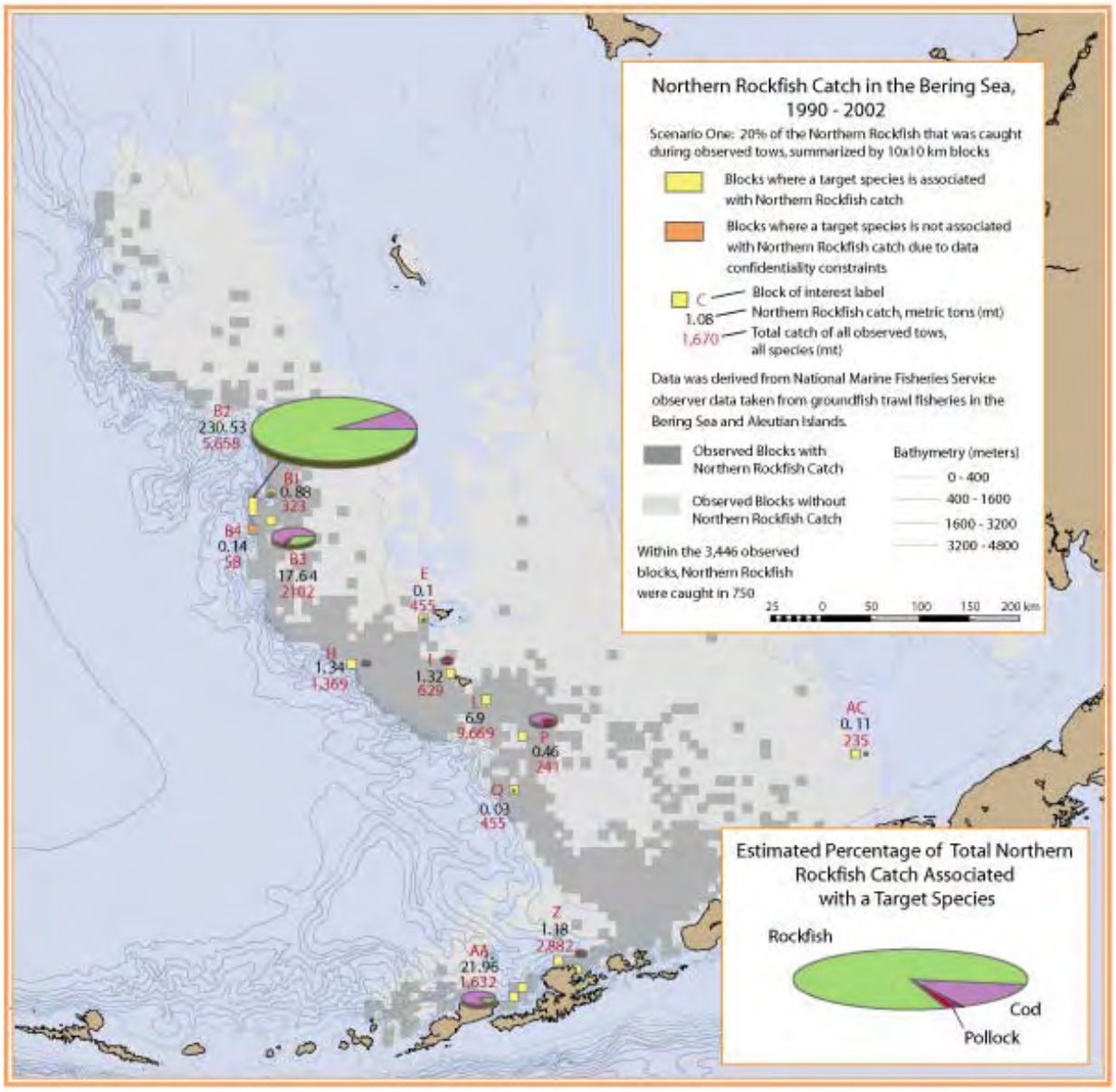


Figure 9. Trawl Scenario 1: Bering Sea, 20% of the Total Northern Rockfish Catch
In the Bering Sea, 283 metric tons of Northern Rockfish were caught in the colored blocks and 1289 metric tons were caught in the dark gray blocks.

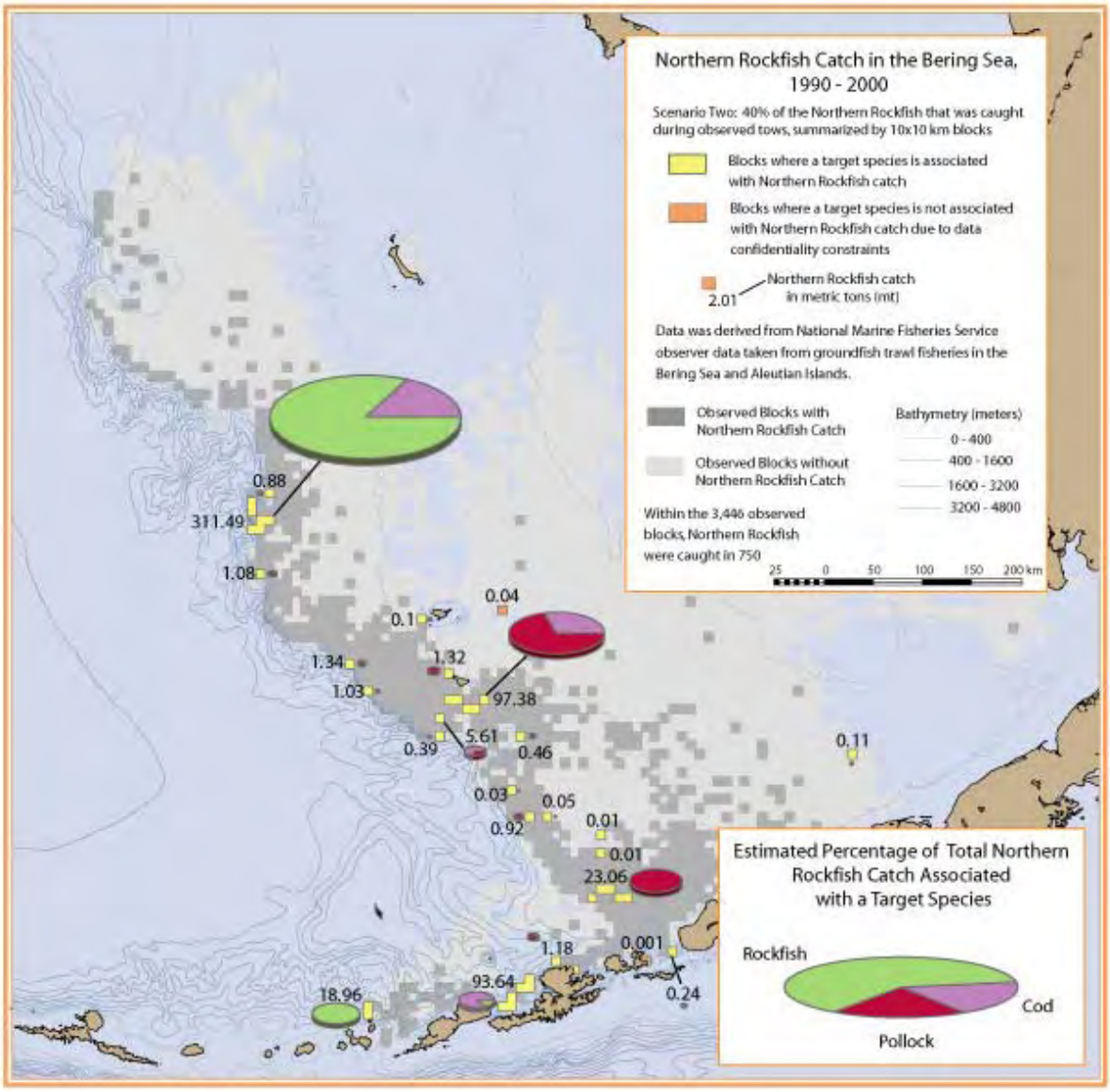


Figure 10. Trawl Scenario 2: Bering Sea, 40% of the Total Northern Rockfish Catch
In the Bering Sea, 559 metric tons of Northern Rockfish were caught in the colored blocks and 1013 metric tons were caught in the dark gray blocks.

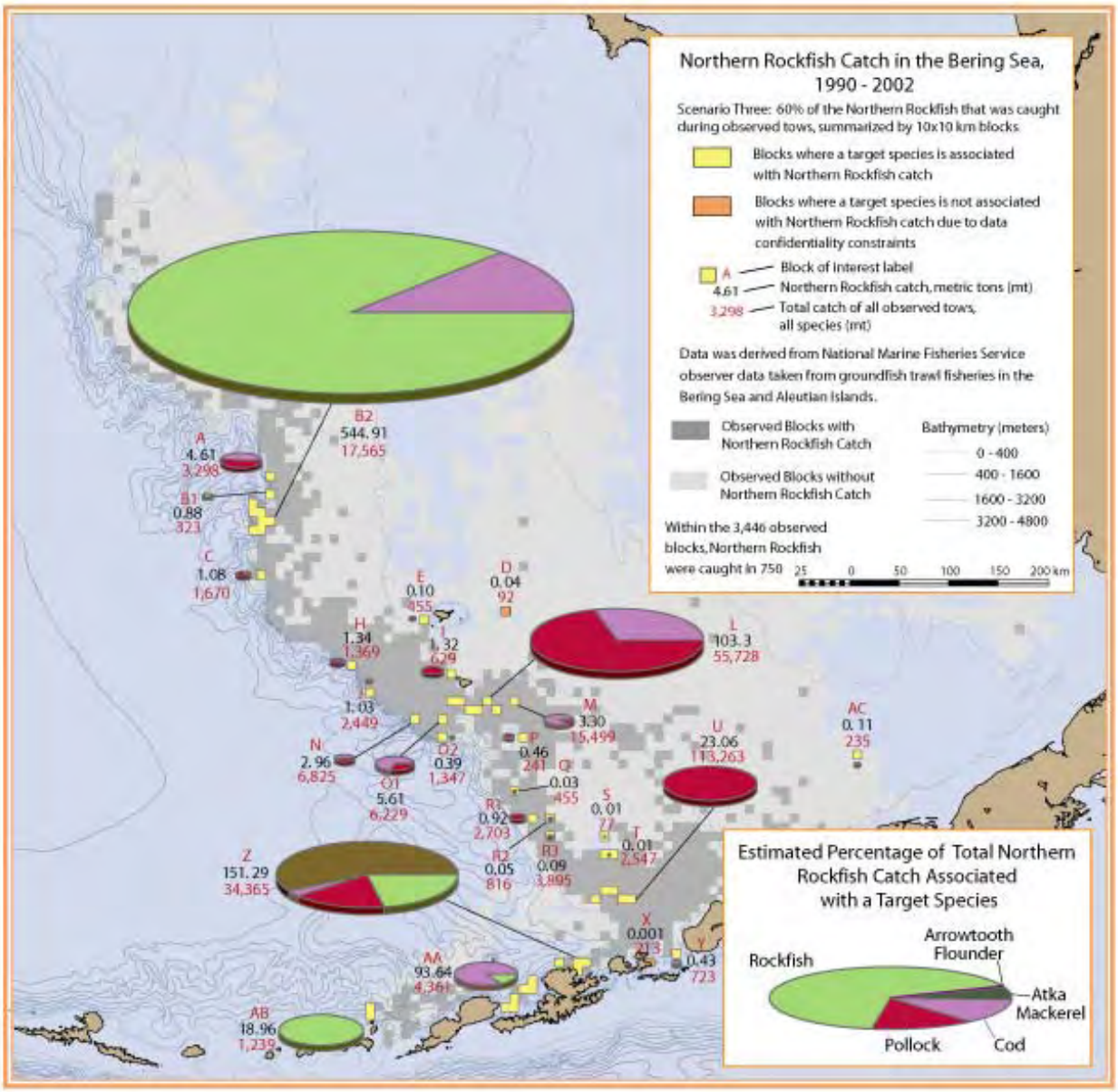


Figure 11. Trawl Scenario 3: Bering Sea, 60% of the Total Northern Rockfish Catch
In the Bering Sea, 960 metric tons of Northern Rockfish were caught in the colored blocks and 612 metric tons were caught in the dark gray blocks.

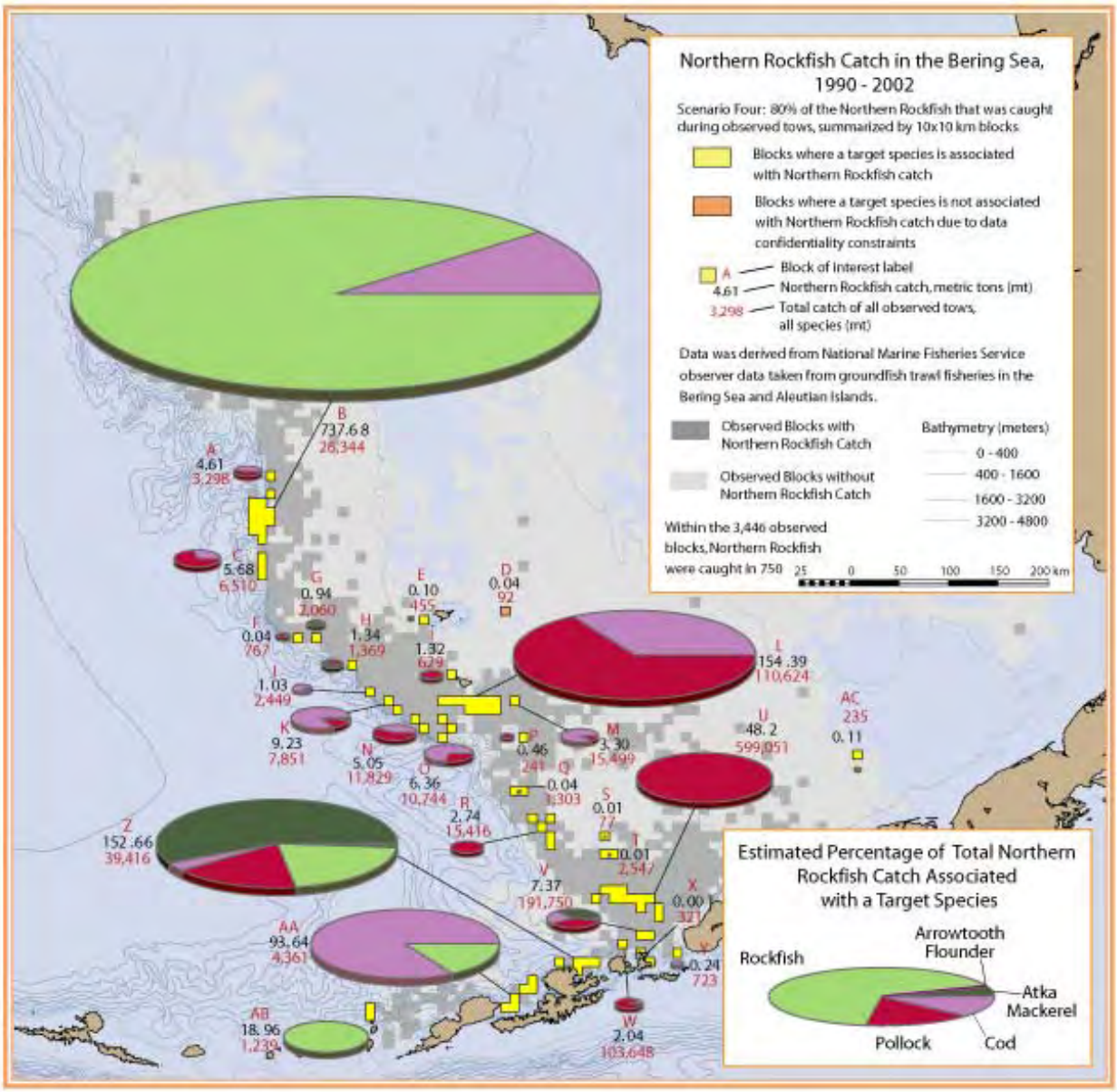


Figure 12. Trawl Scenario 4: Bering Sea, 80% of the Total Northern Rockfish Catch
In the Bering Sea, 1258 metric tons of Northern Rockfish were caught in the colored blocks and 314 metric tons were caught in the dark gray blocks.

In contrast to the Aleutian Islands, there is no dominant target species in a majority of the blocks of interest within Bering Sea trawl scenarios. The target species "Rockfish" or Pacific ocean perch, is associated with the highest total percentage of Northern Rockfish catch, but this number is largely a result of the northwestern cluster of yellow blocks in which the Northern Rockfish catch is substantially larger than any other contiguous

yellow blocks**.** Also note that Atka mackerel becomes a significant targeted species only when 60% or more of the total Northern Rockfish catch is included in the scenario.

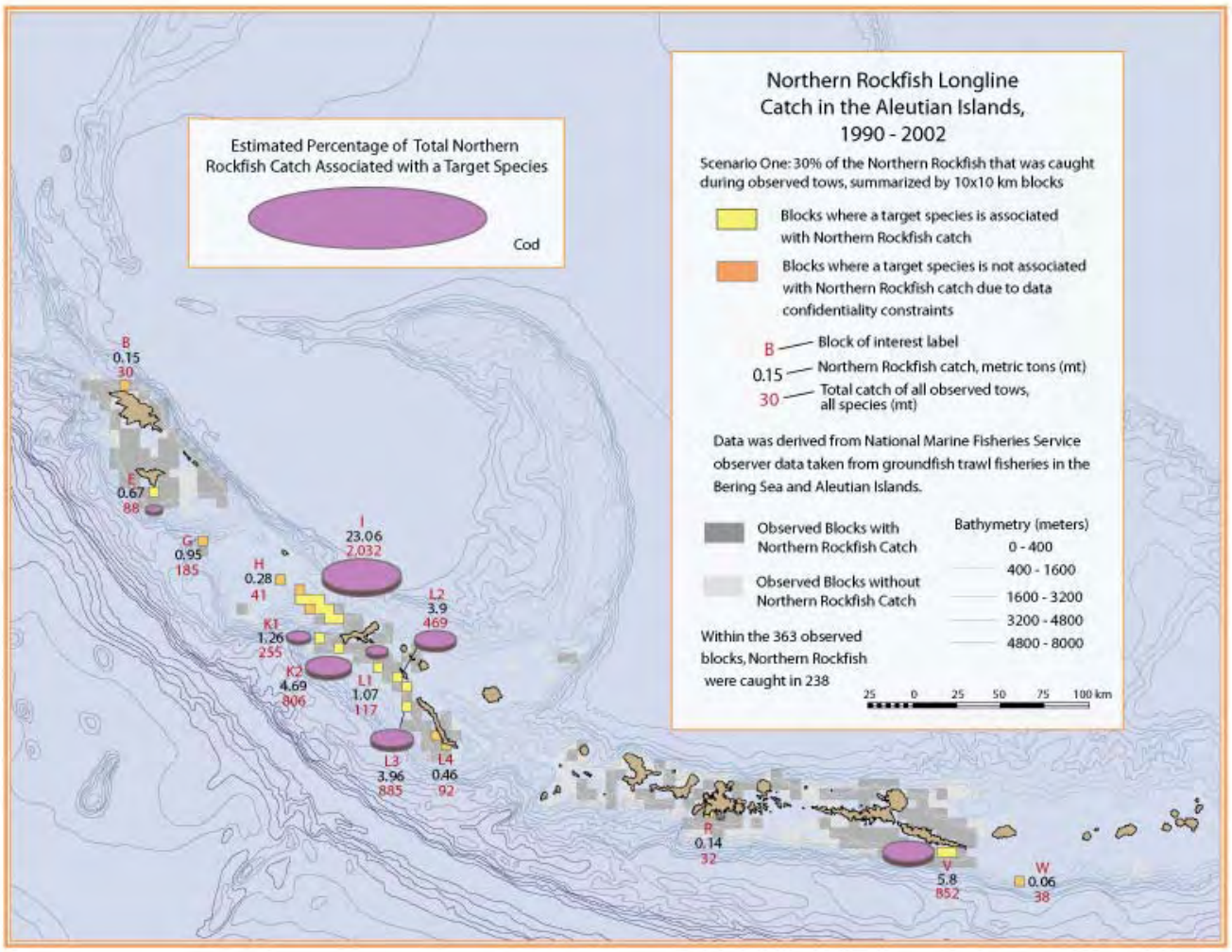


Figure 13. Longline Scenario 1: Aleutian Islands, 30% of the Total Northern Rockfish Catch
In the Aleutian Islands, 46 metric tons of Northern Rockfish were caught in the colored blocks and 115 metric tons were caught in the dark gray blocks.

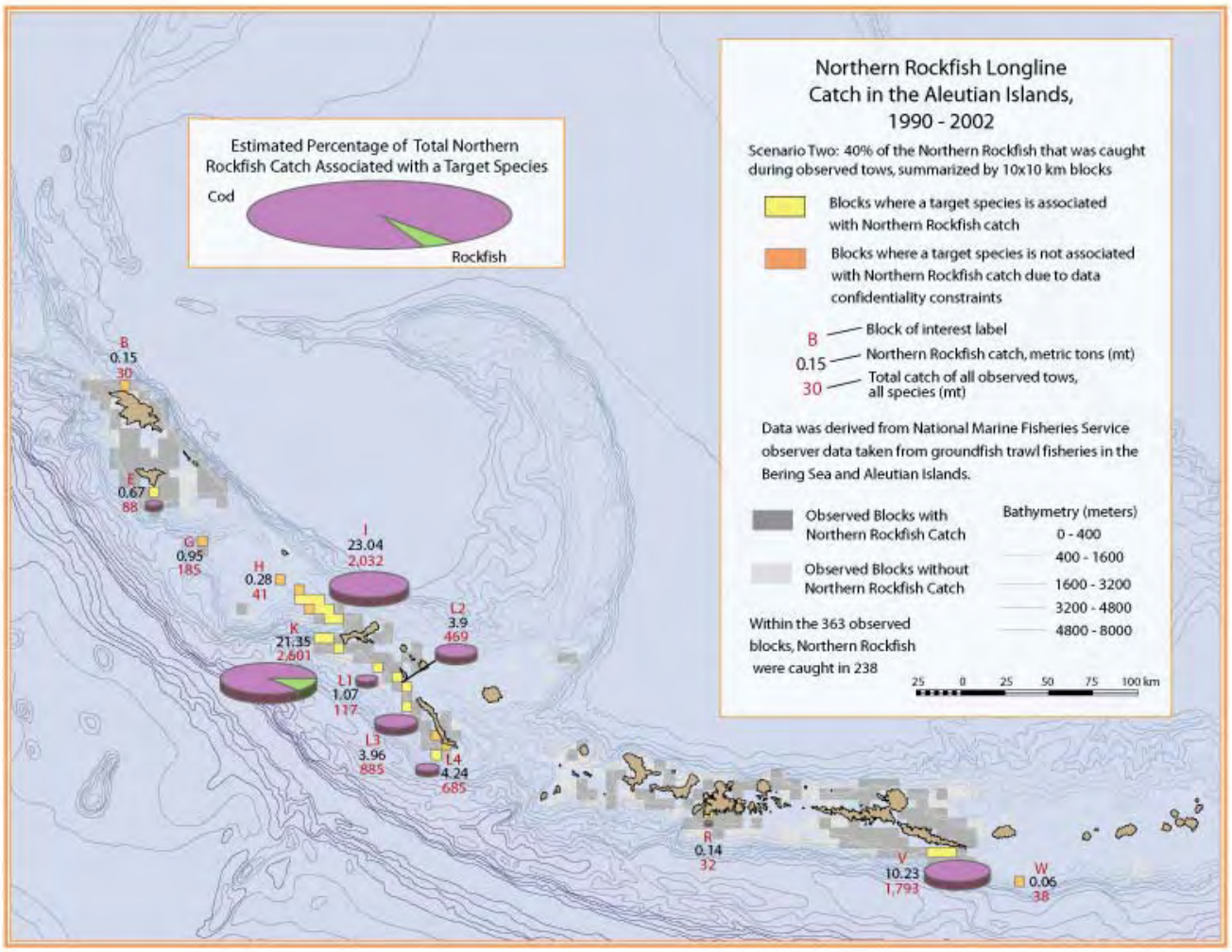


Figure 14. Longline Scenario 2: Aleutian Islands, 40% of the Total Northern Rockfish Catch
In the Aleutian Islands, 70 metric tons of Northern Rockfish were caught in the colored blocks and 91 metric tons were caught in the dark gray blocks.

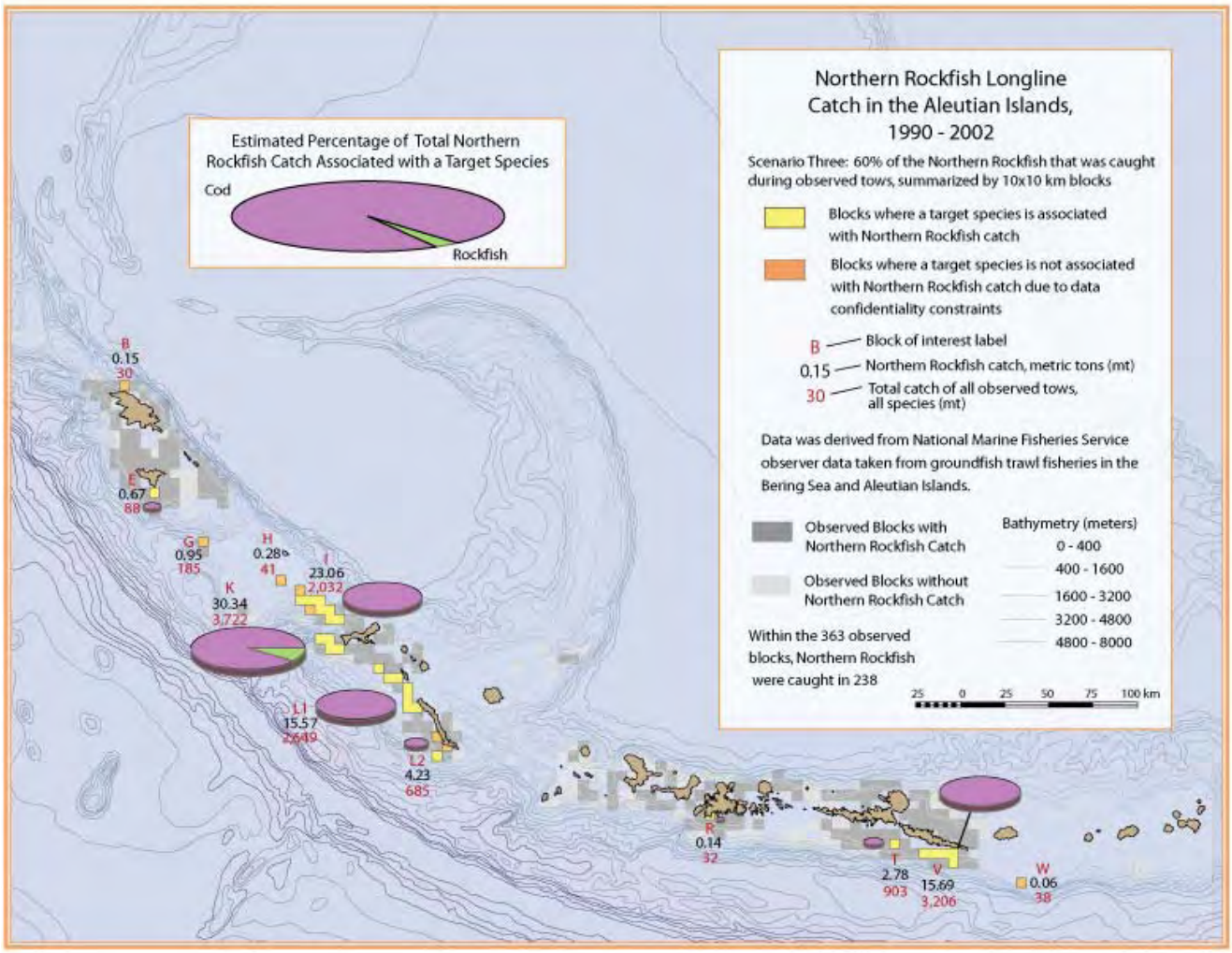


Figure 15. Longline Scenario 4: Aleutian Islands, 80% of the Total Northern Rockfish Catch
In the Aleutian Islands, 94 metric of Northern Rockfish were caught in the colored blocks and 67 metric tons were caught in the dark gray blocks.

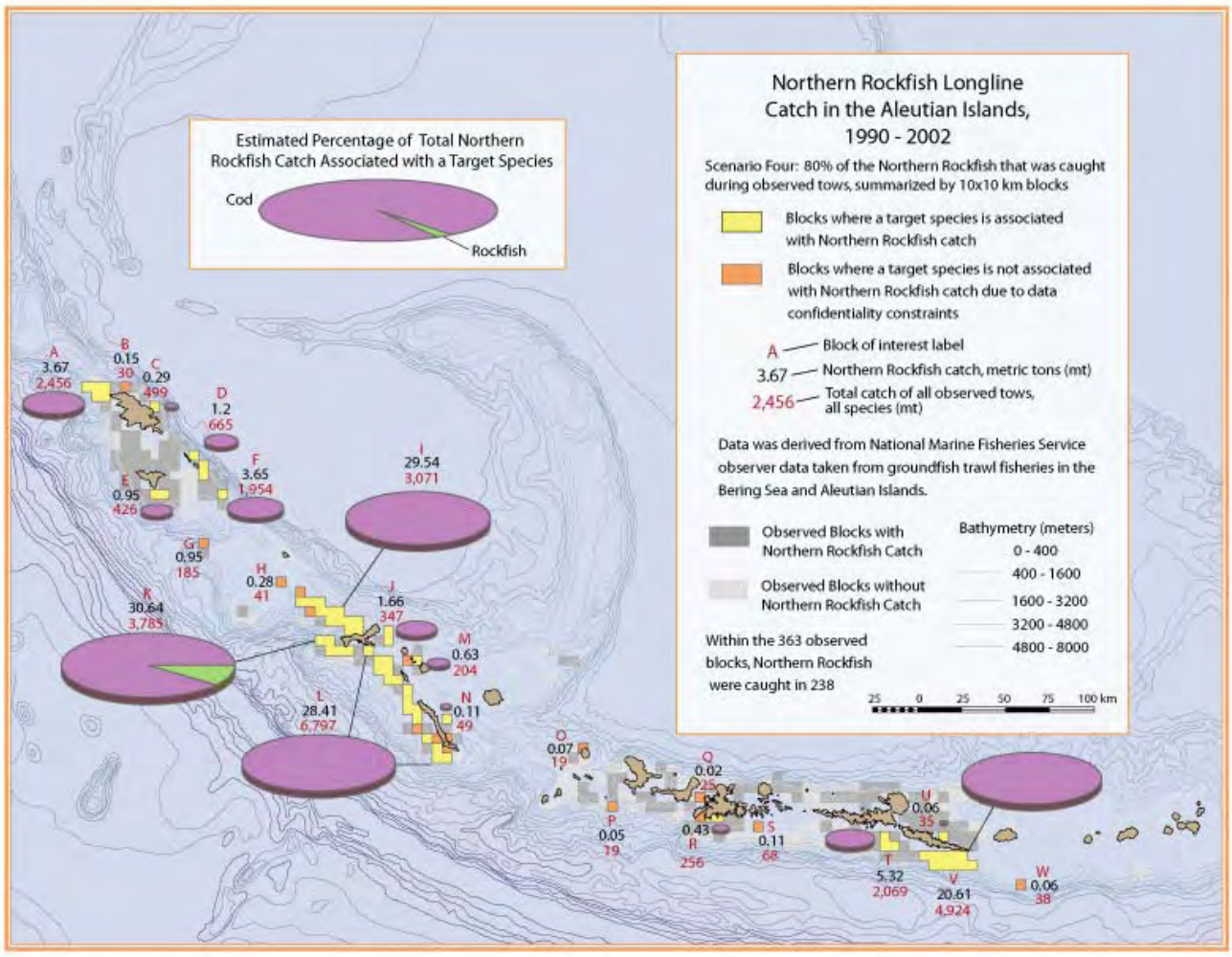


Figure 16. Longline Scenario 4: Aleutian Islands, 80% of the Total Northern Rockfish Catch In the Aleutian Islands, 129 metric tons of Northern Rockfish were caught in the colored blocks and 32 metric tons were caught in the dark gray blocks.

Cod is the primary target species associated with Northern Rockfish catch in the Aleutian Islands longline fishery. A relatively small quantity of Rockfish targeting occurs when ≥ 40% of the Northern Rockfish is included in the scenario.

Conclusions

In the Aleutian Islands trawl scenarios, this analysis presents several areas of high Northern Rockfish CPUE and total bycatch associated with the target species Atka mackerel. Although there is no dominant associated target-species in the Bering Sea, the

trawl analysis and maps highlight several blocks of high Northern Rockfish CPUE and bycatch. The highlighted blocks in each scenario are worth further investigation as potential areas to focus effort on bycatch reduction because these blocks account for a high percentage of the rockfish catch relative to the percentage of area that they cover. For example, as shown numerically in Table 2 and graphically in Figure 8, Trawl Scenario 4, 68 blocks, representing 24% of the total observed area, account for 80% of the total Northern Rockfish catch. Increased bycatch restrictions for Atka mackerel in these blocks could significantly decrease the total Northern Rockfish bycatch for the entire region.

The Bering Sea region has substantially more observer coverage, both in the area observed and the annual frequency of observed tows. This additional effort combined with smaller total Northern Rockfish catches results in considerably lower Northern Rockfish CPUE, and consequently, lower adjusted abundances. Despite the lower CPUE and smaller catches, Table 3 and Figure 12 Trawl Scenario 4 show that 80% of the Bering Sea Northern Rockfish catch was made in only 11% of the total observed blocks. Similar to the Aleutians, efforts focused on reducing bycatch in these prioritized blocks could greatly reduce the bycatch of this species for the Bering Sea region as a whole.

Longlining is associated with considerably less Northern Rockfish bycatch than trawling. In the Aleutian Islands, 30,216 mt of Northern Rockfish were observed caught with trawl gear compared to 1,572 mt caught with longline gear. Despite the significantly lower quantity of Northern Rockfish caught, it is still informative to rank the blocks by CPUE and the catch to trawl ratio to prioritize the areas where bycatch is most prevalent.

In the Aleutian Islands, Northern Rockfish bycatch is distributed among more blocks than in the other gear and area scenarios. The blocks in which 80% of the Northern Rockfish longline catch took place accounts for 34% of the blocks where this species was caught with this gear. In comparison, 80% of Northern Rockfish caught with trawl gear covers 24% of observed trawled blocks where this species was caught. Due to the wider longline block distribution and lower total catch of Northern Rockfish, efforts to reduce

bycatch should focus on trawl gear where bycatch is higher and more concentrated relative to longline bycatch.

We intend to extend this analysis to incorporate Dark Dusky, Light Dusky, Rougheye, Sharpchin, Shortspine Thorneyhead, and Shortraker Rockfish catch data. These species can be analyzed separately or grouped together. The total catches of these species are significantly smaller than the Northern Rockfish total catch. Grouping these other rockfish and scoring them together would identify blocks where several different types of rockfish are caught as bycatch. Alternatively, lumping species together may not be appropriate if they occupy very different habitats.

The maps of the predominant species associated with Northern Rockfish catch clearly show that Atka mackerel is associated with high levels of Northern Rockfish bycatch in the Aleutian Islands. However, we do not have the data to know how many metric tons of mackerel were caught in the blocks with high Northern Rockfish adjusted abundance. With more data we could answer the question of how many metric tons of target species catch are associated with the areas of high-adjusted abundance. Also, it would be informative to know the revenue from the target species caught in these blocks of high rockfish bycatch. Additional data requests would have to be made to obtain the information necessary to answer these additional questions.

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Data Sources

Bathymetry downloaded from USGS Bering and Chukchi Sea Databases

http://www.absc.usgs.gov/research/walrus/bering/bathy/nosbath.htm

Observer trawl and longline data provided by Alaska Fisheries Science Center (AFSC),

National Marine Fisheries Service (NMFS)