DESCRIPTION AND RESULTS OF ANALYTICAL TOOLS

Appendix C

TO THE
RATIONALIZATION OF THE PACIFIC COAST
GROUNDFISH LIMITED ENTRY TRAWL FISHERY
FINAL ENVIRONMENTAL IMPACT STATEMENT

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C.1 A Comparative Advantage Analysis Illustrating the Potential for Regions to be Made Better or Worse Off by Rationalization of the Non-Whiting Trawl Fishery

Several variables determine the amount of fishing activity occurring in different ports, including access to fishing grounds, port infrastructure, and fish purchasing and processing, among other things. In a rationalized fishery, the incentives created by market-based management and individual accountability may impose additional forces that will alter the decision that vessel operators make regarding the location of fishing activity, the delivery location, and home-port location for a given vessel. Assuming profit is the motivating factor for fishermen engaged in commercial fisheries, the decision framework created by a rationalized fishery will tend to shift the location of fishing and delivery activity.

Under status quo management, vessels are not held individually accountable for the amount of fish they catch, provided their landings are within their cumulative landing limit. In addition, operators cannot choose to grant their cumulative limit to another, potentially more profitable, operator. Under a rationalized fishery, both scenarios change, and fishermen are held individually accountable and can transfer their fishing privilege to another vessel. The aspect of individual accountability will tend to put pressure on operators to fish in areas with lower encounter rates of constraining overfished species. The ability to transfer catch privileges also allows the fleet to consolidate to fewer, but more profitable, vessels as the market directs quota in a more economically efficient manner.

In a rationalization program, more economically efficient vessels are expected to remain in the fishery, while less efficient vessels are expected to drop out of the fishery. Economic efficiency is determined by several variables including the ability of the operator to generate gross revenues and the vessel's cost structure. Cost structure is determined by variable costs such as fuel, fixed costs, "transfer costs," and day-to-day operations. Ports that have a higher degree of fishing support business (agglomeration) tend to make it easier and more efficient for operators to conduct day-to-day activities. This makes the cost of running a fishing business, acquiring parts, and negotiating work relationships lower than in other ports.

Given these arguments, it is reasonable to expect ports with vessels that have a relatively long travel time to fishing grounds, relatively unsuccessful operators, relatively costly vessels, and relatively few support businesses to be at a disadvantage when compared to other regions. In addition, ports that are adjacent to fishing grounds with high constraining overfished species abundance would also tend to be at a disadvantage as the presence of constraining overfished species would encourage operators to move to areas with lower abundance. Given enough disadvantaging (or advantaging) factors in a port, that port may find itself losing (or gaining) trawl groundfish activity after rationalization, absent some mitigation tool that the Council may elect to implement as part of the program.

Information is available to illustrate these relationships and provide information indicating which ports or areas may be at a relative advantage or disadvantage. Available information includes the following:

- Logbook data can be used to show the preferred fishing grounds of trawl vessels categorized by homeport (e.g., we can identify the preferred grounds for Astoria-based trawlers). This information can be combined with west coast groundfish observer program data to show whether preferred fishing grounds of vessels in some ports are in areas with relatively high bycatch rates of constraining overfished species. Those ports with vessels fishing in areas with relatively lower bycatch rates may be at an advantage in a rationalized fishery.

- West coast fishing community profiles provide information about community business and infrastructure. In addition, industry members, extension agents, and extension publications are sources of this information. Using the theory of agglomeration, those communities with larger amounts of support business and infrastructure may be at an advantage in a rationalized fishery.

- The fleet consolidation model can be used to identify the geographic effects of consolidation based on the most likely vessels to drop out of the fishery and the most likely vessels to stay in the fishery.

- The initial distribution of quota can be used to show which ports will receive more or less quota relative to status quo and relative to the initial distribution made to other ports. This will determine the initial state of harvest privileges on a regional basis, and this initial state may influence the future location of fishing activity.

The output of this analysis illustrates the relative advantage or disadvantage each port has with respect to several variables. These variables include 1) bycatch rates of constraining stocks that are in preferred fishing grounds of various ports, 2) relative economic efficiency of vessels in that port, 3) the relative amount of fishing business and infrastructure that exists in that port, and 4) the initial distribution of quota shares to those ports relative to status quo and relative to the distribution made to other ports.

C.1.1 Geographic Assessment of Constraining Bycatch

In this analysis, bycatch rates in various areas are assessed based on the constraining nature of the bycatch species. An area with a relatively high bycatch rate of a highly constraining species is assessed differently than an area with a moderately constraining overfished species. For example, since canary rockfish is a highly constraining species to fishing opportunity, an area with a relatively high canary bycatch rate will be labeled as a high bycatch area. An area with a relatively high bycatch rate of a less constraining species, like darkblotched, will be labeled as a moderately high bycatch area. This labeling scheme creates three categories for bycatch areas that are A) not a relatively constraining bycatch area, B) a moderately constraining bycatch area, and C) a highly constraining bycatch area.

The effect of these areas on the comparative advantage of a port relies on the integration of the preferred fishing grounds of various ports with those areas. If vessels from a port fish exclusively in a high bycatch area, then that puts that port at a disadvantage, whereas if vessels from a port spend only some of their time fishing in a high bycatch area, then the presence of that high bycatch area may not necessarily influence the comparative advantage of that port. In this analysis, we determine whether a port is at an advantage or disadvantage based on where the majority of the catch has occurred. If greater than 50 percent of a port’s catch has occurred in a high bycatch area, then we determine that port to be at a disadvantage.

The following figures illustrate the preferred fishing grounds of non-whiting trawlers based on their port of landing. These figures also identify areas of relatively high bycatch of constraining overfished species. Areas that are highly constraining are indicated by the presence of a shaded box with hash marks. An area with an overfished species that is not typically as constraining is indicated by a shaded box without hash marks. This figure shows one moderately constraining area off Oregon and three highly constraining areas off the west coast.

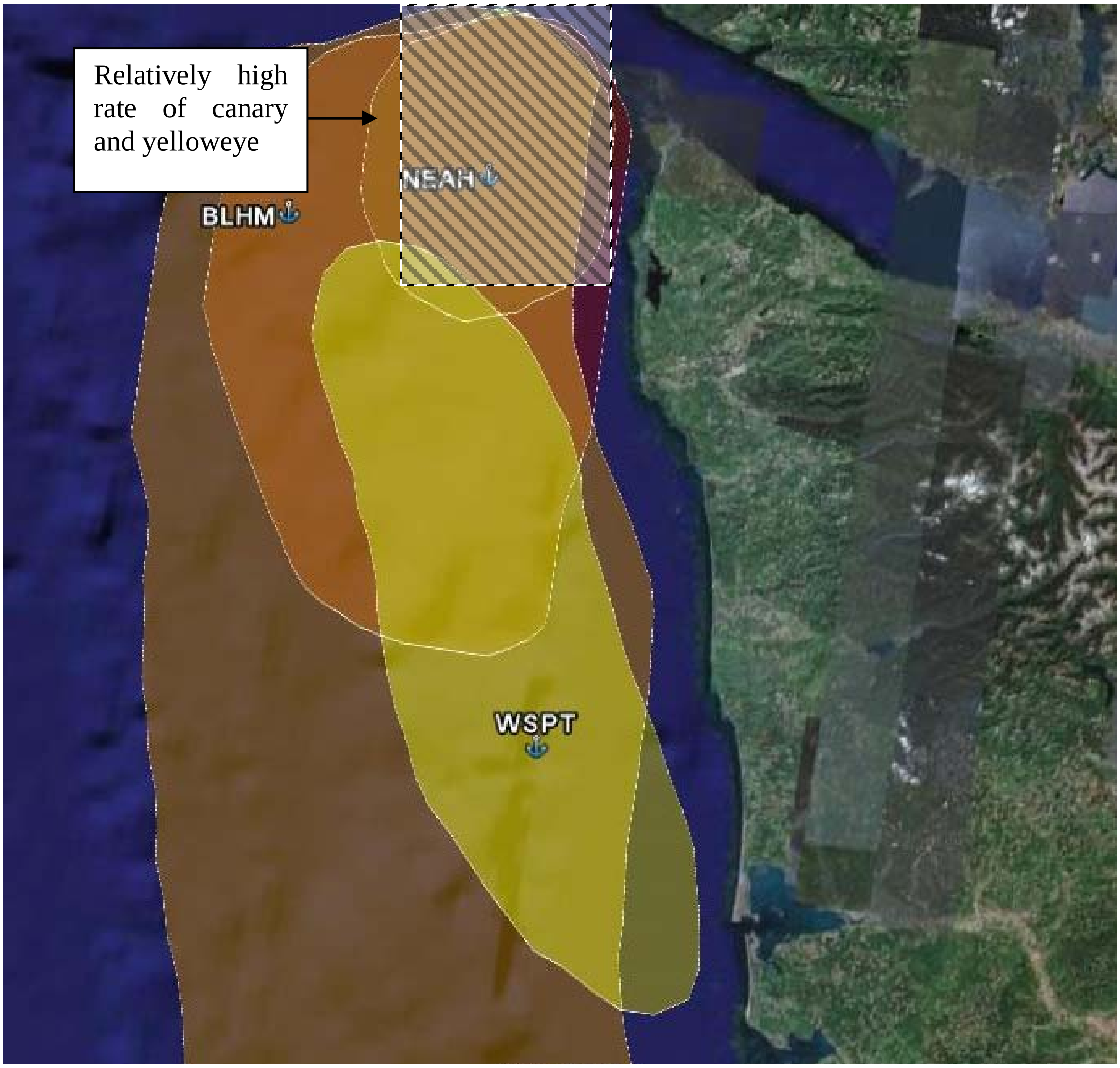

Figure C-1. Preferred fishing grounds of non-whiting trawlers based on their port of landing, Washington.

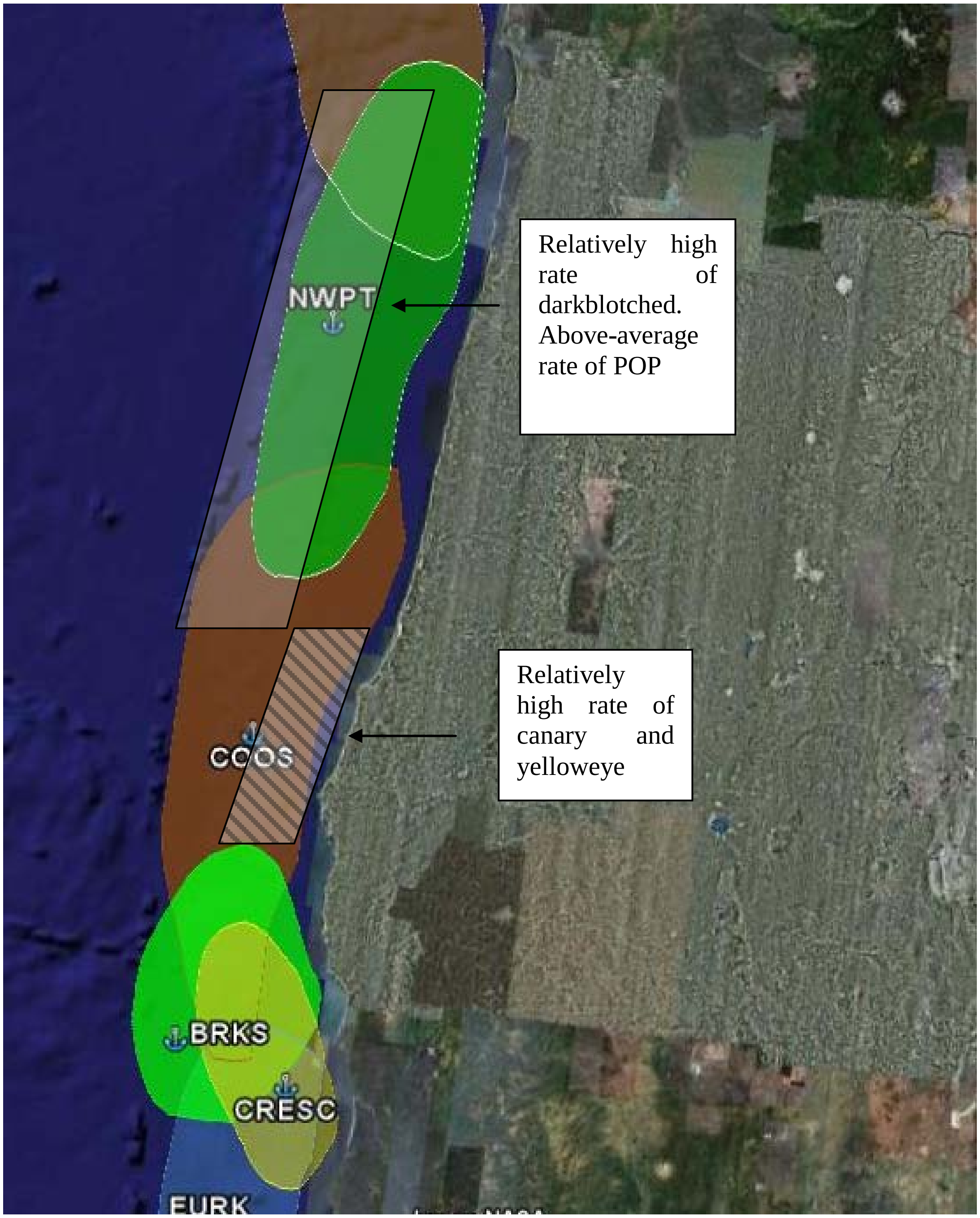

Figure C-2. Preferred fishing grounds of non-whiting trawlers based on their port of landing, Oregon and northern California.

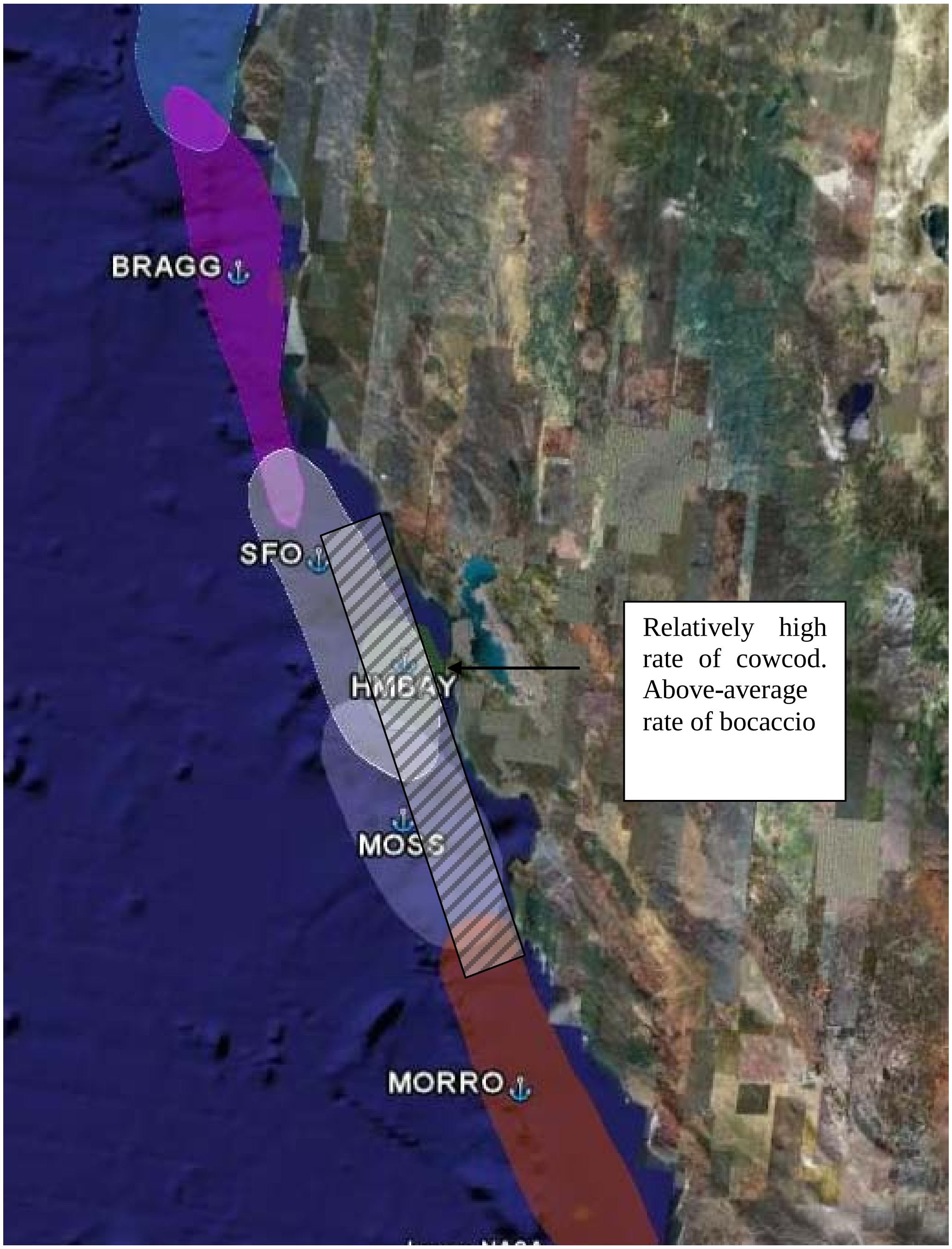

Figure C-3. Preferred fishing grounds of non-whiting trawlers based on their port of landing, central California.

By using logbook data, we assess the percentage of catch that has occurred within several areas of the coast (defined by seaward or shoreward of the RCA, and by latitude). We then trace each vessel's catch to a port of landing based on the port of landing associated with a trawl logbook record. If 50 percent of a port's landings are associated with a high bycatch area, we assign a double negative score for that port because the majority of its catch can be considered "at risk" due to the relative difficulty vessels will have in accessing their target species relative to vessels fishing in other areas. For ports with activity in a moderately high bycatch area, we assign a single negative score. However, it is important to keep in mind that other variables influence the amount of fishing activity that will occur in a port, and the presence of a high bycatch area can be overcome by other variables such as an efficient fleet or substantial presence of shoreside infrastructure. The following table illustrates the data constructed as a result of this exercise. Areas shaded in grey are moderately high and high bycatch areas. This information shows that Bellingham, Neah Bay, Newport, and Princeton/Half Moon Bay have greater than 50 percent of their non-whiting trawl catch occurring in areas identified as a moderately high or high bycatch area. It is also important to note that the high bycatch area where the Newport fleet fishes is a moderately high bycatch area because it is made up of species that are less constraining to harvest activity (POP and darkblotched) than the other grey shaded areas.

Table C-1. Percent of non-whiting trawl catch by port and area.

		LATITUDE AREA							
Depth	**Port**	**N 47.40**	**45.35 - 47.40**	**43.55 - 45.35**	**42.3 - 43.55**	**40.10 - 42.3**	**38.25 - 40.10**	**36.08 - 38.25**	**34.25 - 36.08**
Sea-Ward Of The RCA	Bellingham/ Blaine	29.8%							
	Neah Bay								
	Westport	26.9%	9.9%						
	Astoria	16.9%	36.1%						
	Newport			58.4%					
	Coos Bay			28.6%	48.5%				
	Brookings				55.4%	41.8%			
	Crescent City					57.6%			
	Eureka					77.1%			
	Fort Bragg						85.9%		
	Moss Landing							72.0%	
	Princeton / Half Moon Bay								
	San Francisco						12.2%	74.4%	
	Morro Bay								97.6%
Shore-Ward Of The RCA	Bellingham/Blaine	69.9%							
	Neah Bay	95.5%							
	Westport		59.6%						
	Astoria	12.0%	34.0%						
	Newport			28.4%					
	Coos Bay				14.6%				
	Brookings								
	Crescent City					40.7%			
	Eureka					13.7%			
	Fort Bragg								
	Moss Landing							25.1%	
	Princeton / Half Moon Bay							94.7%	
	San Francisco							11.8%	
	Morro Bay								

Note: Totals may not sum to 100 percent because of confidentiality.

While the above information shows that several ports are engaged in relatively high constraining bycatch areas, other factors will influence the comparative advantage that vessels have in a rationalized fishery. These other factors include the relative efficiency of vessels that deliver to the various ports, the amount of agglomeration in shoreside business and infrastructure that exists in various ports, and the initial state of harvest privileges in each port as determined by the initial distribution of fishing quota.

C.1.2 Assessment of Industry Agglomeration by Port

The concept of agglomeration is used routinely in regional economic literature. When similar businesses are located near one another, the cost of doing business tends to decrease. Agglomeration cost savings come from the clustering of economic activity, that is, an attraction for other firms affected by noncollusive proximity economies once a cluster begins to form (Maki and Lichty 2000). Several sources of agglomeration exist including the folowing:

- Internal agglomeration. Internal sources of agglomeration typically occur as a firm increases in size and is able to specialize and use standardized inputs.
- Localization economies. These types of economies include situations where a business locates near its suppliers.
- Urbanization economies. These economies stem from a diverse labor force found in metropolitan areas, a large number of people, frequency of communication, and research and development in a populated area that may spur new ideas.
- Industry linkages. These linkages create cost savings from such things as transportation. These linkages typically occur in close proximity to one another.
- Public facilities and infrastructure. Government facilities and infrastructure comprise a set of units that can complement clustering of private enterprise.

In this section, we describe a series of factors that lead to an assessment of whether a port has a relatively high or relatively low level of agglomeration that would benefit a trawl sector. The concept that agglomeration results in cost savings can have implications as a trawl fishery is rationalized and quota flows toward the greatest return.

Table C-2. Description of port infrastructure.

Community	Infrastructure
Bellingham/ Blaine	Bellingham is home to 2 processors of trawl groundfish. Bellingham also has access to a large seafood cold storage facility and has a relatively well-developed level of port infrastructure. Bellingham is located on the I-5 corridor, which enhances access to distribution facilities in the Seattle area.
Neah Bay	There are no known processing facilities of trawl groundfish in Neah Bay. Port and harbor facilities are limited, and the location is considered remote and removed from distribution and transportation networks.
Westport	Westport has one known processing facility engaged in trawl groundfish. This facility concentrates primarily on Pacific whiting. Westport is somewhat removed from distribution centers.
Astoria	Astoria has several processing facilities engaged in trawl groundfish. In addition, several support businesses are known to exist in the area, and dock and harbor facilities are fairly well developed. Astoria is fairly removed from distribution centers.
Newport	Newport has several processing facilities engaged in trawl groundfish. In addition, several support businesses are known to exist in the area and dock and harbor facilities are fairly well developed. Newport is fairly removed from distribution centers.
Coos Bay	Coos Bay has several processing facilities engaged in trawl groundfish. In addition, support business and fabrication services are known to exist in the area, and dock and harbor facilities are fairly well developed. Coos Bay is fairly removed from distribution centers.
Brookings	Brookings has no known processing facilities of trawl groundfish. Brookings is fairly removed from distribution networks, but has a well-developed shallow draft port. Infrastructure necessary to service the trawl sector is limited with one icehouse and some small metalworking capabilities.
Crescent City	Available information shows that Crescent City has one processing facility that has engaged in small quantities of trawl groundfish in recent years. Crescent City is fairly removed from distribution centers. Crescent City has one of the principal vessel fabrication companies used by trawlers on the west coast. Crescent City has a number of fish hoists.
Eureka	Eureka has one large processing facility engaged in trawl groundfish. An icehouse exists in the area, as well as a new yard with several hoists. A ship hoist (cradle) exists that can service moderately sized trawl vessels.
Fort Bragg	Fort Bragg has one known processing facility engaged in trawl groundfish. Fort Bragg is relatively close to the distribution centers in San Francisco. An icehouse exists as well as a fuel dock.
Moss Landing	Moss Landing is not known to have any processing facilities engaged in trawl groundfish. Transportation networks are nearby. Limited infrastructure exists to service trawl vessels.
Princeton / Half Moon Bay	Princeton/Half Moon Bay is known to have three processing facilities engaged in trawl groundfish, but limited processing of trawl groundfish occurs. Several fish hoists exist in the area.
San Francisco	San Francisco has several small processing facilities engaged in trawl groundfish. San Francisco has a relatively developed port and harbor infrastructure. San Francisco is one of the primary distribution centers on the west coast.
Morro Bay	Morro Bay has no known processing facilities engaged in trawl groundfish. Morro Bay is relatively removed from distribution facilities. Infrastructure exists in the harbor area to support commercial fishing operations.

Sources: A) Northwest Fisheries Science Center. 2007. Community Profiles for West Coast and North Pacific Fisheries. Washington, Oregon California, and other U.S. States. NOAA Technical Memorandum NMFS-NWFSC-85
B) Leipzig, Peter. 2008. Personal Communication.

C.1.3 Cost Efficiency of Harvesters

The cost efficiency of the local fleet will likely have an impact on how a port fares as a result of rationalization and the consolidation that occurs as a result. Using information from the cost efficiency and fleet consolidation model, we are able to identify the relative efficiency of vessels delivering to various ports. While this information is based on vessels that currently exist in the fishery (and in the longer run, we would expect newer vessels to be constructed that are in the efficient range), the initial state can have long-term impacts. In other words, ports with relatively efficient trawl vessels at the start of a rationalization program may end up better off than ports with relatively inefficient vessels. The following tables show the number of non-whiting trawl vessels delivering to each groundfish trawl port over the 2004 to 2007 period and the weight of catch being delivered by efficient and inefficient vessels.

Table C-3. Number of non-whiting vessels making deliveries by port and efficiency category (2004 to 2007).

Port	Efficient Size	Inefficient Size
Astoria	13	25
Bellingham*	4	7
Brookings	5	8
Charleston (Coos Bay)	13	14
Crescent City	2	10
Eureka	6	21
Fort Bragg*	0*	12
Monterey	1	4
Morro Bay	5	8
Moss Landing	5	16
Neah Bay	3	4
Newport	11	19
Princeton / Half Moon Bay	1	17
San Francisco	5	15
Westport	1	6

* Fort Bragg has four vessels that are very near the efficient size category. It may be reasonable to assume that these vessels will remain in the fishery. Bellingham vessels must travel long distances to reach fishing grounds. While there are several vessels that deliver to Bellingham in the "efficient range," this travel distance suggests these vessels may be more appropriately categorized as "inefficient."

Note: These are not unique records, and they should not be summed.

Table C-4. Weight of non-whiting groundfish landed by port and vessel efficiency category (2004 to 2007).

Port	Efficient Size	Inefficient Size
Astoria	16,310,277	34,106,827
Bellingham Bay	4,596,540	5,876,909
Brookings	2,382,507	3,998,491
Charleston (Coos Bay)	15,820,364	7,013,554
Crescent City	C	2,854,037
Eureka	6,293,634	11,831,280
Fort Bragg		11,474,450
Monterey	C	1,054,166
Morro Bay	383,468	1,403,130
Moss Landing	2,034,403	1,118,074
Neah Bay	515,476	2,921,366
Newport	4,841,903	11,630,108
Princeton / Half Moon Bay	C	1,901,957
San Francisco	591,719	3,963,064
Westport	C	3,032,000

C.1.4 Initial Allocation of Quota Shares

The initial allocation of quota will likely tend to favor some geographic areas more than others, and such geographic differences are likely to extend to the level of fishing activity expected for a given location. Using the initial allocation rules being considered, the following table was developed. This information shows the amount of quota pounds that would be allocated to each port if existing harvest volumes were maintained. This information is broken into two major fields with one field reflecting an initial allocation rule where the buyback history is allocated equally across recipients. The second field reflects an initial allocation made based purely on catch history. This information shows that clear patterns exist regardless of the initial allocation, and they tend to put a large share of quota into some ports. Using the average across all ports as an indicator of those standing to be successful, all ports shown in the table from Astoria to Moss Landing stand to be successful regardless of the initial allocation. Princeton/Half Moon Bay may be successful depending on the initial allocation rule. It is important to note that the average in this case is the average across all ports, including those that were aggregated into the "other" category in the table below. The "other" category consists of 12 ports. These averages result in 600 to 640 mt being allocated to ports on average under the equal sharing of buyback options, while 1,400 mt is the approximate average for the catch-history-based options.

Table C-5. Quota pounds attributed to west coast ports (assume status quo harvest amounts).

Port	Initial Allocation made with Equal Sharing of Buyback History			Initial Allocation made Based Entirely on Catch History		
	75% Hvstr ES	**87.5% Hvstr ES**	**100% Hvstr ES**	**100% Hvstr HS**	**87.5% Hvstr HS**	**75% Hvstr HS**
Astoria	4,497	4,472	5,068	4,248	4,150	4,115
Coos Bay	2,313	2,365	2,648	2,043	1,944	1,876
Newport	1,891	1,949	1,529	1,046	1,003	999
Eureka	1,573	1,594	1,425	1,005	1,000	1,008
Fort Bragg	1,144	1,180	1,357	966	919	873
Bellingham/ Blaine	1,054	991	1,372	1,192	1,197	1,216
San Francisco	754	808	961	744	689	636
Brookings	714	743	724	517	495	477
Moss Landing	695	717	769	611	588	567
Princeton/Half Moon Bay	568	612	459	428	409	391
Neah Bay	472	519	550	483	440	401
Morro Bay	447	414	412	317	340	364
Crescent City	363	355	300	226	238	252
Westport	292	304	355	303	288	275
Monterey	209	203	200	176	180	185
Other	497	502	456	389	383	380

C.1.5 Development of the Assessment Tool

Based on the information described above, we established the following summary of relative comparative advantage. While this information does not allow us to quantify the relative degree of comparative advantage in each port, several patterns seem apparent from this information. In particular, the port of Neah Bay appears as one community that may be at a disadvantage in a rationalized fishery because of fleet efficiency, the lack of shorebased infrastructure, and the high degree of dependence that vessels in this port have on areas defined as "high bycatch." Inversely, the ports of Astoria and Coos Bay appear to be at a relative advantage compared to other ports. Astoria has the benefit of a relatively large number of efficient vessels, a relatively large presence of shorebased infrastructure, and a low dependence on fishing grounds located in high bycatch areas. Coos Bay also appears to be at a relative advantage because of fleet efficiency and the relatively large amount of shorebased infrastructure. While catch landed in Coos Bay historically has been caught in high bycatch areas, this amount of catch does not constitute the majority. Therefore, it is likely that vessels originating in Coos Bay will adjust fishing practices to avoid bycatch, but the community is not likely to suffer as a result.

Other communities are less certain. Bellingham and Half Moon Bay may experience their vessels bearing a relatively high degree of constraint because of their reliance on fishing grounds in high bycatch areas. The efficiency of vessels in Half Moon Bay is relatively low; while Bellingham has a number of vessels that fall within the efficient range, vessels from that area have a much longer travel distance to and from fishing grounds relative to vessels from other ports. This raises cost for those vessels relative to vessels from other ports, suggesting that these vessels may be more appropriately categorized as inefficient.

The effect on Fort Bragg and Crescent City is also somewhat uncertain. While several scores appear to work in Fort Bragg's favor, this community does not score in the top bracket on any of the determinant variables and may have a fleet consisting of inefficient vessels, though several vessels are close to the efficient range. Crescent City scores in the negative category on several variables and positively in others. The overall effect on Crescent City may depend on the relative importance of the variables. If bycatch dependency is the overall, driving factor, then Crescent City may actually be at an advantage, even though it has a relatively inefficient fleet and a relatively small amount of quota initially allocated to it.

Table C-6. Summary of ports' relative comparative advantage.

Port	Fleet Efficiency Score	Bycatch Dependent Area Score	Shorebased Infrastructure	Initial Allocation of Grndfish	Score
Astoria	+	+	+ +	+ +	+
Bellingham	?	– –	+ +	+	
Brookings	+	+	–	+	
Charleston (Coos Bay)	+	+	+ +	+	+
Crescent City	–	+	+	–	
Eureka	+	+	+	+	+
Fort Bragg	–	+	+	+	
Morro Bay	?	+	–	–	
Moss Landing	–	– –	+	+	
Neah Bay	–	– –	– –	–	–
Newport	+	–	+ +	+	
Princeton/Half Moon Bay	–	– –	+	+	
San Francisco	–	–	+ +	+	
Westport	–	+	+	–	

C.1.6 *The Potential for Geographic Shifts in Fishery Patterns*

The regional comparative advantage structure will also influence the geographic nature of fish harvesting activities. When the variables described above are combined, the comparative advantage of different regions will influence the level of fishing effort occurring in the fishing grounds of those ports.

Individual accountability in a rationalization program is likely to result in cleaner fishing practices. In particular, the individual accountability associated with constraining overfished species will encourage vessels to modify gears as well as to fish in areas where overfished species are less abundant. In addition, the rationalization program will tend to slow the pace of Olympic style fisheries that exist in the shorebased and mothership sectors of the whiting fishery. Both of these measures will tend to adjust fishing patterns at a geographic level. Cleaner fishing practices are likely to result in some pressure to move away from areas where there are relatively high encounters of constraining species like canary, yelloweye, and cowcod. A rationalized whiting fishery will tend to slow the pace of harvesting, and, given that the whiting stock tends to migrate north over the course of the year, this is likely to result in more midwater trawl effort occurring further to the north than under an Olympic style fishery. These effects may be enhanced or restrained by the economic activity and efficiency of fishing fleets that focus on certain areas. For example, if the fleet originating in a particular port tends to concentrate its effort in an area with a relatively high abundance of overfished stocks, we would expect that fleet to move or for quota shares from that fleet to be sold to other areas of the coast because it would be more profitable to do so[1]. However, if that fleet is relatively efficient, and there are shoreside support businesses and infrastructure in ports adjacent to those grounds that make fishing activity in those areas more attractive, vessels may continue to fish in those areas, even though constraining stocks are relatively more abundant. This is because the economic effectiveness that exists because of an efficient fleet and the presence of shoreside infrastructure can outweigh the effect that a relatively high presence of constraining stocks can have on regional fishing patterns.

Geographic shifts in fishing effort in the non-whiting trawl fishery are assessed by whether a port is at a relative advantage or disadvantage. If a port is at a disadvantage, then it is inferred that their fishing grounds are likely to be trawled less intensively than under status quo. In addition to the port-based comparative advantage structure, areas defined as relatively high bycatch are assumed to have less trawl effort than under status quo. This is true even if a port is at a relative advantage. The rationale is that ports with a relative advantage may gain trawl activity compared to status quo, but vessels fishing out of those ports are still likely to avoid high bycatch areas in order to stay away from constraining stocks and attain higher catch rates of target species. This analysis uses the same information as described in the above section. This information shows that several areas may be trawled less intensively than status quo, including sites off northern Washington, central Oregon, southern Oregon, and Central California.

<u>Areas Likely to be Trawled Less Intensively than Under Status Quo</u>

- Northern Washington
  – shoreward of the RCA
- Northern and North/Central Oregon – seaward of the RCA
- Central Oregon
  – shoreward of the RCA
- Central California
  – shoreward of the RCA

[1] Moving or selling quota to another area of the coast would be more profitable in this case because more target species could be accessed per unit of constraining overfished species in a relatively low bycatch area. For example, if vessels can leverage 100 pounds of target species per pound of canary rockfish in one area, but 500 pounds of target species per pound of canary rockfish in another area, more effort would be expected to occur in the second area in order to maximize harvest potential.

C.2 An Analysis Illustrating the Potential to Reduce the Catch Rate of Overfished Species and the Associated Potential for Increased Target Species Catch and Revenue

The reduction in the bycatch rate of overfished species is envisioned as one of the principal outcomes of a trawl rationalization program. One large implication of reductions in the bycatch rate of overfished species is the ability to access more target species and generate higher levels of revenue than under status quo. Under status quo management, fishing opportunities have been reduced to protect overfished species. In some cases, opportunities to catch species that have historically been large targets of the trawl sector have been eliminated because of their relatively high degree of correlation with overfished species (yellowtail and chilipepper rockfish, for example). In many cases, those species that are not highly correlated with overfished species have also seen target opportunities reduced. For example, the catch of sablefish (one of the primary targets for the trawl sector) has been less than the total trawl allocation by several hundred tons in recent years, and this represents a substantial economic loss in ex-vessel revenue. It is envisioned that a rationalization program will encourage fishermen to operate in a manner that avoids overfished species more effectively than the command and control type of management that exists in the status quo regime. This expected change in behavior is directly related to the individual accountability aspect of a rationalization program and the fact that there are individual rewards (because of access to target species) result from decreases in the bycatch rate. Some changes in the way fishing opportunities are prosecuted to change bycatch rates include changing the location of fishing, changing the gear that is used to prosecute those activities, and changing the time of fishing.

C.2.1 Non-Whiting Fishery Bycatch

Several sources of information can be used to show how the bycatch rate of overfished species can change in a rationalized fishery and the implications of that bycatch rate reduction. This information can be used to modify the NMFS/GMT trawl bycatch model[2] that predicts overfished species catch, target species catch, and ex-vessel revenue given an estimated overfished species bycatch rate and a set of assumed ex-vessel prices. By modifying the bycatch rate, the model can be used to simulate potential changes in harvest outcomes that will occur in a rationalized fishery.

Information that can be used to estimate changes in the bycatch rate of overfished species in a rationalized fishery includes exempted fishing permit (EFP) fisheries have been conducted with requirements that are nearly identical to what would likely be required under a rationalized fishery.

The Washington Arrowtooth Flounder EFP was a project that occurred over four years with requirements nearly identical to what would be expected under a rationalized fishery. In this EFP, vessels carried observers and were given an overall cap on the amount of overfished species. Vessels were also given individual vessel limits on overfished species. Vessels that could avoid overfished species and stay within their limits had access to arrowtooth flounder and petrale sole in excess of the normal two-month limits that were in place and to areas within the trawl Rockfish Conservation Area (RCA). When a vessel reached or exceeded the individual cap, that vessel was no longer allowed to participate in the EFP and was required to fish under normal two-month limits and RCA restrictions while still carrying an EFP observer. In other words, observations were collected while fishing under the EFP and while the vessel was fishing under status quo regulations (the latter serves as the control on

[2] The Trawl Bycatch Model was originally developed by staff at the Northwest Fisheries Science Center for use in setting regulations that manage the non-whiting trawl fishery. This model was reviewed and endorsed by the Scientific and Statistical Committee (SSC) in 2003.

the experiment). In addition to information collected on overfished species and target species catch, information on non-marketable discards was collected during the first year of the program. This information can be used to show order of magnitude estimates regarding the amount of regulatory discard occurring under status quo management and the increased amount of revenue that can be attributed to the fishery via an elimination of regulatory discards.

The information collected when vessels fished outside the EFP is directly comparable to bycatch information collected from the West Coast Groundfish Observer Program in a fishery that is not rationalized, while information collected in the EFP illustrates the bycatch rates that would be expected in a rationalized fishery. While the actual bycatch rates collected in this area cannot be used on a coast wide basis (the EFP occurred off northern Washington, which has different overfished species interactions than other areas of the coast), the percentage difference between EFP-based observations and non-EFP observations using the same observers can be used to show the reduction in bycatch rates that can be expected, and to estimate how coast wide bycatch rates collected through the WCGOP should be modified to reflect bycatch under a rationalized fishery.

The figure below illustrates the recorded canary bycatch rates for vessels participating in the EFP by year. The information below shows the bycatch rate when those vessels were participating in the EFP and the bycatch rate when those vessels were fishing under normal (non-EFP) fishing conditions. As is shown on the figure, in 2001 and 2002, the difference in EFP and non-EFP bycatch rates was substantial, while in 2003 and 2004 the difference was less, though still very noticeable. The explanation for this change is indicated in the figure. In 2003, gear modifications were required of vessels participating in the EFP, and those gears (which had demonstrably lower bycatch rates) were used outside the EFP as well. In 2004, those vessels became more accustomed to using those gears, and only gears that had demonstrated “satisfactory” results were used (which further reduced bycatch rates). In 2003 and 2004, the RCAs were in place during the months when observations were recorded; thus, the bycatch rate for non-EFP observations fell because vessels were no longer fishing in areas with high canary bycatch.

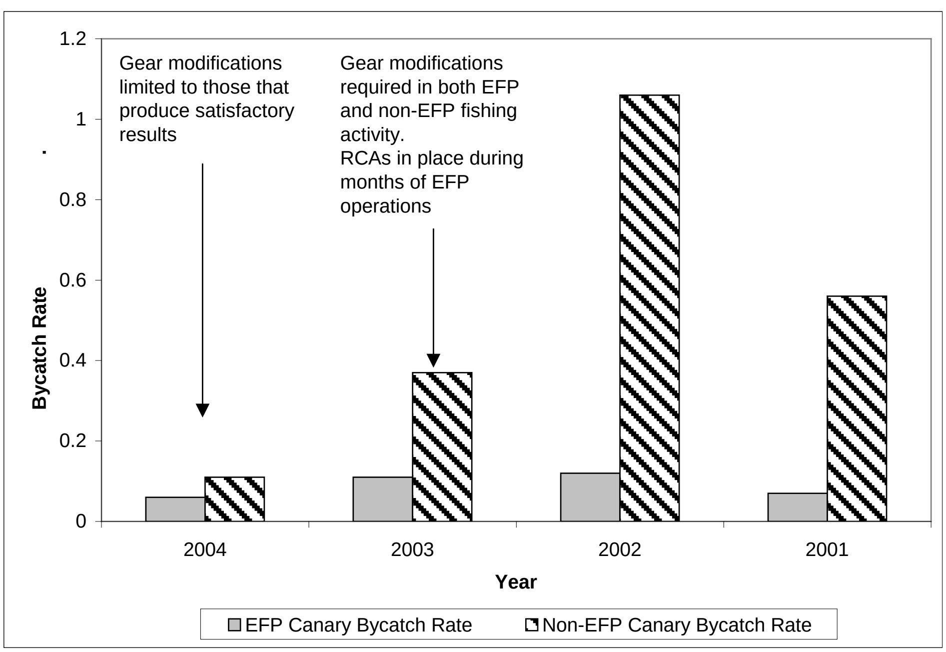

Figure C-4. Observed canary bycatch rates in the Washington arrowtooth EFP.

Table C-7. Summary statistics reflecting differences between EFP and non-EFP fishing activity.

	Canary Rockfish Bycatch Rates by Year and EFP vs. Non-EFP Activity Bycatch rate = (kg Canary / kg target species)*100%			
	2001	**2002**	**2003**	**2004**
Non-EFP Canary Bycatch Rate	0.56%	1.06%	0.37%	0.11%
EFP Canary Bycatch Rate	0.07%	0.12%	0.11%	0.06%
EFP as a % of Non-EFP	13%	11%	30%	55%
P(T<=t)	(insufficient data)	(0.002)	(0.206)	(0.135)

Comments received during the review of proposed methodology questioned whether the bycatch rates in the arrowtooth EFP changed because overfished species were being avoided, or whether they changing because the denominator, or set of target species, was shifting between EFP and non-EFP fishing activity. If the denominator, or set of target species, differs between EFP and non-EFP activity, then the argument was that the results shown above may not be indicative of what could occur under a rationalization program because they could be explained by differences in targeting behavior. To examine this question, bycatch rates were estimated in several additional ways: the first method examined canary bycatch relative to the amount of revenue generated by fishing activity; the second method examined canary bycatch relative to the amount of shelf target species; and the third method examined canary relative to the amount of shelf target revenue. All three additional approaches show substantial differences in the bycatch of canary rockfish in directed EFP activity compared to non-EFP activity. Canary rockfish is examined in this case because it was the most constraining species to target fishing activity during the four years of the EFP (because of the individual accountability measures of the program). Along other portions of the coast, other species such as darkblotched rockfish would likely be more constraining; therefore, substantial reductions in darkblotched would be expected instead.

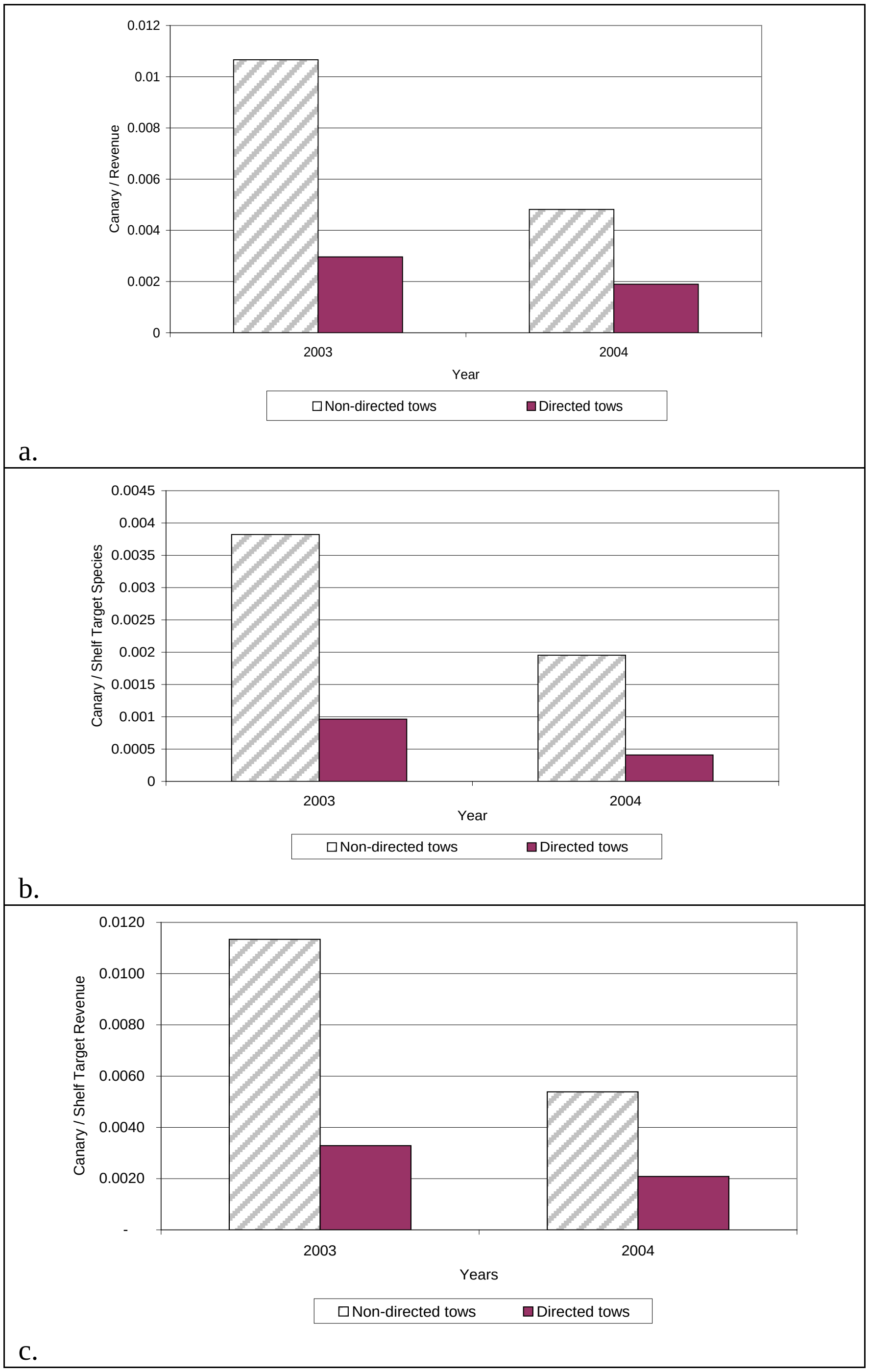

Figure C-5. Rate of canary rockfish encounters where (a) ex-vessel revenue is the denominator, (b) retained pounds of shelf target species is the denominator, (c) ex-vessel revenue of shelf target species is the denominator.

Looking into the data further, we compare canary bycatch rates at the haul level and stratify those hauls based on the dominant target strategy.[3] Target strategy is estimated at a species level and is determined

[3] Although the EFP was designed primarily to test targeting of arrowtooth flounder (and to a lesser extent, petrale sole), there is evidence in the data to suggest that some hauls were directed at different species.

based on the species that makes up the majority of catch in a tow. We establish nine different target species strategies from the project: arrowtooth flounder, Dover sole, petrale sole, "other flatfish," Pacific cod, sablefish, shortspine, arrowtooth and petrale combined, and a mixed target species strategy.[4] Of these, we find that the arrowtooth strategy is the largest category by weight for both directed and non-directed EFP activity, followed by Pacific cod. The third through sixth largest strategies by weight are the mixed stock strategy, the combined arrowtooth and petrale strategy, the Dover sole strategy, and the petrale strategy, respectively. After categorizing the data in this fashion, we compare canary rockfish bycatch rates in directed and non-directed activity. At this point, it is worthwhile to reiterate that canary rockfish is used because that was the constraining bycatch limit species in this EFP, so canary rockfish was the primary species with which fishermen were concerned.

After categorizing data according to a species-specific target strategy, we find insufficient observations to compare directed and non-directed bycatch rates in cases where the haul appears directed at sablefish and shortspine. This is not surprising, however, given that shortspine and sablefish are found along deep areas of the continental shelf and along the continental slope and that the EFP was conducted in areas along the shelf where flatfish are more common. Because there were insufficient observations to compare directed and non-directed tows from these species, we do not include a comparison of bycatch rates for these target strategies.

Finally, bycatch rates for canary rockfish were stratified according to whether they occurred in depths outside the RCA or both inside and outside of the trawl RCA. This separation is intended to isolate the effect of bycatch reduction measures that could be implemented via regulation (implementation of an RCA) from those bycatch reductions that would occur because of fishermen's behavior. We do not show a comparison of directed and non-directed activity within the RCAs because non-directed activity was conducted according to regular management measures, and, therefore, data do not exist on non-directed activity within the RCA. We do, however, compare directed EFP activity that occurred in all areas (both inside and outside the RCA) with non-directed activity outside the RCA. This is intended to provide an order of magnitude estimate that compares the effect on bycatch reduction from fishermen's behavior versus a bycatch reduction as a result of regulation. This comparison is labeled in the following table as "Inside and Outside RCA."

The following table shows the result of the categorizations described above. This table shows canary bycatch rates by directed EFP activity and non-directed activity. Those data are further stratified according to bycatch rates that occurred by target species strategy outside the RCA and a comparison of target species strategies for all areas (directed EFP activity took place within and outside the RCA). These data show that, for all target strategies listed, the bycatch rate of canary rockfish was lower in directed-EFP activity in every case except when petrale sole target tows in directed EFP activity that occurred inside the RCA are included in the comparison. This suggests that fishermen's behavior was more effective at reducing bycatch than regulatory mechanisms in all cases except for when those vessels targeted petrale sole. In the case of petrale sole targeting, fishermen's behavior would tend to reduce the bycatch rate of canary rockfish (as shown in the comparison between directed and non-directed activity outside the RCA), but the implementation of RCAs would result in a lower canary bycatch rate during petrale sole targeting activity than relying on fishermen's behavior alone.

[4] A mixed target strategy is a tow where a dominant species does not appear to be caught in the tow.

Table C-8. Canary bycatch rate in arrowtooth flounder EFP by target strategy and relation to RCA.

Strategy	Non-Directed Bycatch Rate Outside RCA	Directed Bycatch Rate Outside RCA	Directed Inside And Outside The RCA
Mixed Species Strategy	0.011	0.000	0.001
Arrowtooth/ Petrale	0.003	0.002	0.002
Pacific Cod	0.002	0.001	0.001
Dover Sole	0.001	0.000	0.000
Petrale	0.002	0.000	0.003
Arrowtooth	0.002	0.001	0.001

The data used from the Arrowtooth EFP project compare observed bycatch rates that occurred in depths outside (deeper or shallower than) the trawl RCA. Including observations outside the RCA is consistent with the expectation that RCAs will remain in place under a rationalization program and provides a more direct comparison between a rationalized fishery and status quo management (which relies on RCAs). This involves using observations from 2003 to 2004 that occurred outside the RCA. The percentage difference between EFP and non-EFP rates are applied to coast wide bycatch rates estimated from the West Coast Groundfish Observer Program. These modified rates are then used in the NMFS/GMT bycatch model for estimating the change in target species catch and ex-vessel revenue that would be expected in a rationalized fishery given the expected reduction in the encounters of constraining overfished species.

It is important to note the uncertainty associated with using the Arrowtooth EFP data in a manner for predicting coast wide changes in the bycatch rate. While available information clearly shows that changes in the bycatch rate of constraining stocks should be expected to occur under a rationalized fishery, the degree to which the quantitative results can be extended along the entire coast is uncertain. It is likely that other areas of the coast will be constrained by a different set of overfished species than the northern Washington coast (where the EFP was conducted), and it is not entirely clear how bycatch rates will change when another species is the constraining factor on target opportunity. For example, darkblotched rockfish do not tend to aggregate in the same fashion as canary rockfish (Steve Parker, personal communication), and, therefore, a different approach may be necessary in order to avoid darkblotched compared to canary rockfish, which tend to aggregate to a greater degree. Furthermore, bycatch rates in status quo management are representative of status quo fishing opportunity. Using the EFP results to modify bycatch rates collected under the status quo regime may be reasonable to inform bycatch rate associated with species that are currently targeted such as flatfish, sablefish, and thornyheads. The bycatch rate associated with species that are not currently targeted (such as chilipepper and yellowtail rockfish) is not well understood; therefore, the change in the bycatch rate associated with these species that should be expected in a rationalized fishery is also not well understood. In light of these uncertainties, the prediction of coast wide catch and ex-vessel revenue is displayed as a range, and that range should be treated as an order of magnitude.

In addition to the change in target species catch that may occur as a result of changes in bycatch rates, the catch of one target species may be limited by the catch of another target species. This is particularly the case for target species that co-occur with sablefish and petrale sole because these two species are caught at levels near their OY under status quo management. In other words, any increase in co-occurring stocks will mean successful avoidance of sablefish and petrale to some degree, to facilitate increased catch of co-occurring target species. Based on available information, the target species most limited by sablefish and petrale sole are “other flatfish,” Dover sole in areas seaward of the RCA, shortspine thornyheads to some degree, and arrowtooth flounder to some degree. To assess the likely change in the co-occurrence of target species catch, we turn to recent patterns of landings and discard relative to catch limits, permit-specific fish tickets, and the expertise of analysts who have been involved in structuring and proposing fishing opportunity for the limited entry trawl fleet. Based on these data sets and information, it appears that the "other flatfish" category, Dover sole, and thornyheads are limited by the OYs of petrale sole and sablefish, though increases in the catch of those species still occur under a rationalization program. The following table shows a range in the modeling results that is meant to bracket the range of uncertainty and to provide target species catch estimates that fall within a realistic order of magnitude.

Table C-9. Estimated catch of select groundfish in the non-whiting trawl sector by bycatch reduction scenario.

Species	Low Catch	Med Catch	High Catch
Sablefish	2,371	2,371	2,371
Longspine	2,071	2,071	2,071
Shortspine	1,536	1,536	1,536
Dover	11,985	11,985	15,000
Arrowtooth	4,943	4,943	4,943
Petrale	2,223	2,223	2,223
Other Flatfish	2,547	2,547	4,800
Yellowtail	51	51	1,000
Chilipepper	46	2,000	2,000
Pacific cod	723	1,200	1,200
Lingcod	220	670	855
Slope Rockfish	680	1,120	1,120

C.2.2 Pacific Whiting Fishery Bycatch

It is likely that overfished species bycatch rates will also change in the mothership and shorebased sectors of the whiting fishery because those fisheries are operating as an Olympic fishery under status quo management. The whiting fishery operates under sector-wide bycatch limits that can close all sectors of the fishery if reached. Each sector has demonstrated a reduction in bycatch rates since bycatch limits were put in place, however the catcher-processor sector has demonstrated a lower rate of canary rockfish bycatch (the species that was most constraining from 2004 to 2006). From this information, we can infer that changes in the bycatch rates in the mothership and shorebased sectors of the whiting fishery are likely to occur if those sectors of the fishery are rationalized. It is important to note that it is not appropriate to assume the mothership and shorebased sectors of the whiting fishery would have the same bycatch rates as the catcher processor sector.

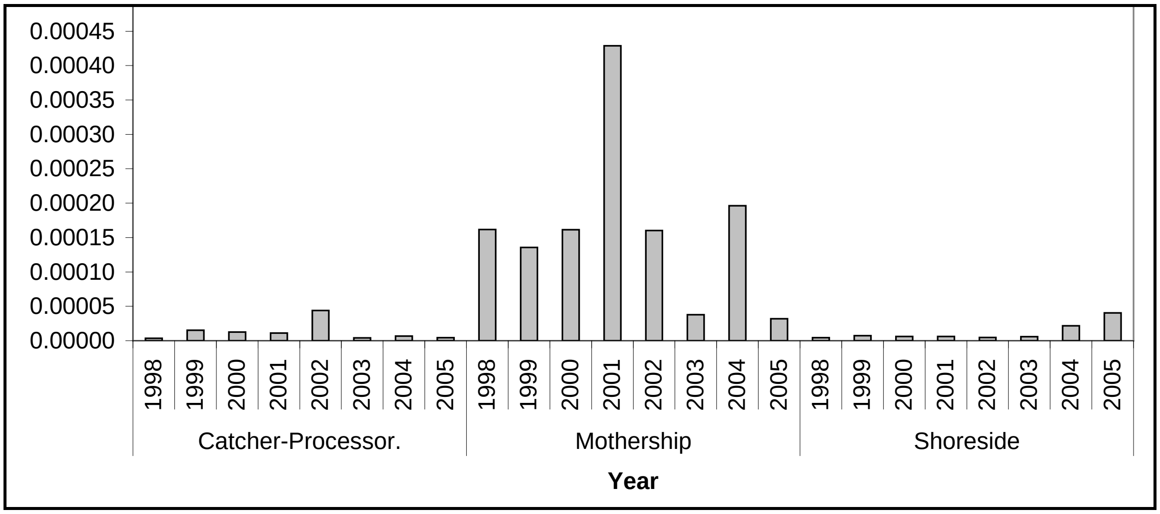

Figure C-6. Canary bycatch rate by year and whiting sector.

While it appears that bycatch rates in the mothership and shorebased sectors of the Pacific whiting fishery may decrease as a result of rationalization, such decreases are not expected to result in the same effect on the fishery as in the non-whiting fishery. Namely, the quantity of Pacific whiting harvested in the fishery has not been historically constrained by overfished species, with the exception of the 2007 season. Therefore, reductions in the bycatch rate of overfished stocks in the shoreside and mothership whiting sectors may not have an overall, aggregate economic impact in and of itself, though it is likely to change the behavior of harvesters in this fishery. Such behavior may have an indirect effect on the economics of the fishery if, for example, the timing of the fishery changes in order to respond to bycatch concerns.

C.3 Allocating Overfished Species on a Bycatch Rate (Proxy Species)

C.3.1 Introduction

This document describes a proposed methodology for allocating overfished species quota to LE trawl permits in the non-whiting sector based on a bycatch rate. This concept was originally proposed by the Groundfish Management Team (GMT) as a mechanism to allocate overfished species in a manner that would allow for the prosecution of current fishing practices given the constraints overfished species place on access to target species.

Empirical evidence from other quota programs throughout the world have shown that initial allocations of IFQ that differ substantially from current or recent fishing practices result in some negative consequences during the initial years of the program (dislocation of fishermen, high discard rates). Over time, these consequences are fixed through the natural trading of quota on the market, but a more refined initial allocation may still be able to avoid such negative consequences in the first place.

Preliminary analysis of initial allocation options has shown that, in general, if allocations of overfished species are made based on landings history, the distribution of overfished species quota would be heavily weighted toward a relatively few number of permits. This is because those were the permits that had previously targeted those species when they were abundant and because, under more recent regulations, catch of overfished species in the shoreside non-whiting fishery has been largely discarded rather than landed. For the near future, overfished species will constrain access to target species, so an argument can be made for a more refined and equitable distribution of overfished species to allow permits to gain access to target species. While the market is likely to end up making necessary adjustments to the ownership of quota, overfished species quota is likely to be extremely costly because it will constrain access to target species. This means that those permits not receiving enough overfished species quota would essentially be forced to buy into the fishery again at a high cost, or leave the fishery all together. Allocating overfished species based on a bycatch rate is an attempt at making the initial allocation more equitable and avoiding such negative consequences.

C.3.2 General Description

The objective of allocating based on a bycatch rate is to allocate those species in a way that accommodates the current and recent spatial fishing patterns of LE non-whiting trawl vessels, to the extent possible. The bycatch rate of overfished species exhibits clear patterns across depth and latitude, and matching those patterns in the bycatch rate against relevant target fishing patterns can result in allocations that better accommodate recent fishing practices. Several sources of information are available for making allocations in a manner that accommodates these fishing practices:

- Logbooks are required of LE trawl vessels that deliver shoreside. Logbook information shows location, depth, and quantity of species that have been harvested by a particular vessel, among other things.
- The West Coast Groundfish Observer program samples the LE trawl fishery and records depth and location of species caught in observed fisheries.
- Information from these two data sets can be merged to allocate overfished species based on the spatial distribution of catch by LE trawl vessels and the corresponding spatial bycatch rates as estimated from WCGOP data.

During a 2007 meeting of west coast fisheries management agencies, it was revealed that logbook compliance in the shoreside trawl fishery was over 90 percent in recent years for all three west coast states. This information was contrary to the belief that logbook compliance was around 60 to 70 percent in some cases. Based on this information, the GMT recommended using permit-specific logbook information to determine a vessel’s spatial and temporal catch history in recent years. In cases where there are no logbook records for a particular permit, then the fleet average would be used.

C.3.3 Data used in Application

The information used in this application includes fish ticket data, logbook data, and overfished species bycatch rates from the observer program. Fish ticket data are used because they are treated as the record of landed catch made by a vessel. Logbook data are used to stratify landed catch recorded on fish tickets into shoreward or seaward of the RCA locations in order to apply an overfished species bycatch rate and to identify the latitudinal area of catch. Observer program data are used for estimating shoreward and seaward bycatch rates of overfished species that are differentiated by latitudinal area. Several different latitudinal areas were considered, including 1) stratifying north and south of 40° 10’ North latitude and south of 40° 10’ North latitude, and 2) stratifying at 47° 40’ North latitude, 43° 55’ North latitude, 40° 10’ North latitude, and 38° North latitude. The Council’s decision resulted in a hybrid of those two options, using latitudinal stratifications at 47° 40’ North latitude, 43° 55’ North latitude, and 40° 10’ North latitude.

Logbook records are used for estimating the location of catch. Location of catch in this case is defined as a latitudinal area, and whether the area was shoreward or seaward of the RCA. These estimates of catch location are developed for those species categorized as “target species” in existing trawl management. Hypothetical catch location percentages (in terms of seaward and shoreward of the RCA) are shown in the table below.

Table C-10. Hypothetical percentage of target species catch that were caught shoreward and seaward of the RCA (2003 to 2006).

	Shoreward Catch Percentage	Seaward Catch Percentage
Dover	48%	52%
Longspine	5%	95%
Shortspine	12%	88%
Sablefish	11%	89%
Petrale	22%	78%
Other Flatfish	98%	2%
English sole	95%	5%
Splitnose	35%	65%
Pacific cod	88%	12%
Slope Rockfish	3%	97%
Arrowtooth	12%	88%

C.3.4 Model Development and Application

The model for this approach uses fish ticket data during the qualifying period, logbook data from 2003 to 2006, and observer data from 2003 to 2006. Quota shares of target species are first calculated from the fish ticket data, then target species quota shares are split by latitudinal area and by shoreward and seaward amounts based on catch depth recorded in 2003 to 2006 logbook data. This information is then multiplied by the trawl allocation amount of target species in place during the implementation year to get an estimate of implementation year quota pounds that are stratified by latitudinal area, and by seaward and shoreward of the RCA. These depth-stratified quota pounds are then multiplied by West Coast Groundfish Observer Program bycatch rates that are stratified by latitudinal area and by shoreward and seaward of the RCA from 2003 to 2006. The result is then converted to an overfished species quota share by dividing each permit's overfished species calculation by the sum of all non-whiting overfished species calculations.

1. The first step is to estimate each permit's target species quota shares.
2. The second step is to estimate the latitudinal area and depth of target species catch from logbooks for determining what each permit has caught by area from 2003 to 2006.
3. The third step is to stratify each permits' target species quota shares by latitudinal area and shoreward and seaward catch amounts based on each permits' depth stratified catch from step 1.
4. The fourth step is to multiply the depth and area stratified quota shares by the trawl allocation amounts during the initial implementation year to get quota pounds for the initial implementation year.
5. The fifth step is to multiply the corresponding latitudinal area and shoreward and seaward fleet average overfished species bycatch rates by the implementation year quota pounds of target species given to each permit.
6. The final step is to calculate overfished species quota shares by summing together the shoreward and seaward implementation year quota pounds for each permit and dividing that

amount by the total non-whiting trawl sector amount of implementation year quota pounds for those overfished species. This final step calculates the overfished species share.

The following tables illustrate the development and application of the proposed method. The table above (Table C-10) shows the first step in the model. The second step is to stratify each permit's target species quota shares into shoreward and seaward of the RCA portions and then estimate shoreward and seaward implementation year quota pounds. The following table shows an example of splitting quota shares for a hypothetical permit into seaward and shoreward areas.

Table C-11. Derivation of seaward and shoreward quota shares to a hypothetical permit.

Area	Species	Quota Share to Permit X	Shoreward Share	Seaward Share
North of 47 40	Dover	1%	48%	52%
	Longspine	2%	5%	95%
	Shortspine	3%	12%	88%
	Sablefish	3%	11%	89%
	Petrale	1%	22%	78%
	Other Flatfish	1%	98%	2%
	Pacific cod	1%	88%	12%
	English sole	1%	95%	5%
	Splitnose	0%	0%	0%
	Slope Rockfish	4%	3%	97%
	Arrowtooth	3%	12%	88%

The table below shows hypothetical quota shares for a permit that has only caught fish north of 47° 40' N latitude. Target species quota shares are differentiated as seaward and shoreward of the RCA from logbook information, as shown in the table above. The trawl allocation is then multiplied by those shares to derive an implementation year quota poundage of target species for that permit. This amount is shown in the right two columns of the table.

Table C-12. Hypothetical development of seaward and shoreward implementation year target species quota pounds.

Area	Species	Shoreward Share	Seaward Share	Implementation Year Trawl Allocation (mt)	Shoreward Lbs	Seaward Lbs
North of 47 40	Dover	48%	52%	16000	169,315	183,424
	Longspine	5%	95%	2000	4,409	83,776
	Shortspine	12%	88%	1200	9,524	69,842
	Sablefish	11%	89%	2600	15,763	127,537
	Petrale	22%	78%	2500	12,125	42,990
	Other Flatfish	98%	2%	7000	151,237	3,086
	Pacific cod	88%	12%	1000	19,401	2,646
	English sole	95%	5%	14000	293,214	15,432
	Splitnose	0%	0%	460	-	-
	Slope Rockfish	3%	97%	800	1,852	59,877
	Arrowtooth	12%	88%	10000	79,366	582,020

After determining a seaward and shoreward implementation year quota poundage, seaward and shoreward bycatch rates are applied to determine hypothetical darkblotched poundage. That poundage is then divided by the sum of all permits' poundage to derive a quota share of overfished species. The following table illustrates this method by continuing the use of shoreward and seaward implementation year quota pounds. Hypothetical darkblotched bycatch rates are multiplied by this amount in order to determine a darkblotched poundage. That poundage is then divided by a hypothetical fleetwide poundage to derive that permits quota shares of darkblotched rockfish.

Table C-13. Hypothetical derivation of darkblotched quota shares using proposed method.

Area	Species	Shoreward Lbs	Seaward Lbs	Shoreward bycatch rate	Seaward bycatch rate	Shoreward Drkbltchlbs	Seaward Drkbltch lbs	Total	Fleet total	Darkblotched QS
North of 47 40	Dover	169,315	183,424	0.0001	0.02	16.93	3,668.49			
	Longspine	4,409	83,776	0.0001	0.02	0.44	1,675.51			
	Shortspine	9,524	69,842	0.0001	0.02	0.95	1,396.85			
	Sablefish	15,763	127,537	0.0001	0.02	1.58	2,550.75			
	Petrale	12,125	42,990	0.0001	0.02	1.21	859.80			
	Other Flatfish	151,237	3,086	0.0001	0.02	15.12	61.73			
	Pacific cod	19,401	2,646	0.0001	0.02	1.94	52.91			
	English sole	293,214	15,432	0.0001	0.02	29.32	308.65			
	Splitnose	-	-	0.0001	0.02	-	-			
	Slope Rockfish	1,852	59,877	0.0001	0.02	0.19	1,197.55			
	Arrowtooth	79,366	582,020	0.0001	0.02	7.94	11,640.39			
								23,488	705,478	3%

C.4 Allocating Pacific Halibut to LE Trawl Permits in the Non-Whiting Trawl Fishery Based on a Bycatch Rate

C.4.1 Introduction

The catch of Pacific halibut may be regulated by way of individual bycatch quota in the trawl fishery after a rationalization program goes into place. Allocating Pacific halibut to individual trawl permits may prove to be difficult because there are no permit-specific records available with which to make an allocation based on catch history (outside the whiting fishery). This is because regulations prohibit the retention of Pacific halibut with gears other than hook and line gear. An initial allocation can be made to permits if it is done based on a bycatch rate to target species that have been landed and by the area that was fished. This paper describes a method for allocating Pacific halibut based on a proxy, or a bycatch rate.

C.4.2 General Description

Pacific halibut are encountered incidentally in trawl fisheries. Pacific halibut are a prohibited species, meaning their retention is not allowed in fisheries using trawl gear, so there are no permit-specific records of Pacific halibut catch. The incidental catch of Pacific halibut is documented through the West Coast Groundfish Observer Program, which samples the non-whiting trawl fishery. This information is used to estimate the total catch of Pacific halibut in the non-whiting trawl fishery based on an encounter rate to a target species. The approach described here proposes a method that is similar to the approach used for estimating total trawl mortality, but includes additional stratifications based on International North Pacific Fishery Commission (INPFC) area and whether a vessel was fishing seaward or shoreward of the trawl RCA. For practical purposes, seaward and shoreward are identified as being deeper or shallower than 115 fathoms. These additional stratifications are proposed to consider the known spatial abundance and encounter rates of Pacific halibut that exist, as well as the spatial fishing patterns exhibited by fishermen.

C.4.3 Data Used in Application

Several sources of information exist for deriving permit-specific catch histories of Pacific halibut. These sources of information include logbook data, West Coast Groundfish Observer Program data, and fish ticket data. These sources of information can be used similarly to the approach described for allocating overfished species based on a bycatch rate, however the approach described here has several of differences. The first difference is that the approach for allocating Pacific halibut uses two species that have been shown to have positive correlations with Pacific halibut—arrowtooth flounder and petrale sole—while the method for allocating overfished species uses all target species. The second difference is that this approach uses an area stratification that is based on landings of target species that have occurred north of 40° 10’ N latitude, and stratifies that area into two sub-areas. One sub-area is a combination of the Eureka and Columbia INPFC areas, and the other sub-area is the Vancouver INPFC area. These areas were chosen because available observer information shows a clear difference in encounters of Pacific halibut off northern Washington compared to areas to the south, and this INPFC area-based stratification can be readily accommodated with logbook data.

Limited-entry trawl logbook data are used in the same fashion as the approach taken for allocating overfished species, although the number of target species is lower because arrowtooth and petrale sole show positive correlations with Pacific halibut. Depth-based landings are used to distribute the fish ticket landings of individual permits between shoreward and seaward of the trawl RCA. In addition to using logbooks to determine depth of catch, logbook data are also used to determine latitudinal area of catch.

Table C-14. Hypothetical vessel average depth-based catch proportion of target species that were caught by a vessel fishing in the Vancouver area (2003 to 2006).

Area	Target Species	Average Seaward Catch Percentage	Average Shoreward Catch Percentage
Vancouver INPFC Area	Arrowtooth Flounder	48%	52%
	Petrale Sole	11%	89%

C.4.4 Model Development and Application

The model for this approach uses fish ticket data during the qualifying period. Petrale sole and arrowtooth flounder from these fish ticket records are split into shoreward and seaward amounts based on permit-specific catch depth from logbook data from 2003 to 2006 as shown in the above table, and by the Vancouver INPFC area and the combined Columbia and Eureka INPFC area based on logbook data. Where fish ticket records exist for a particular species, but logbook records do not, the fleet average depth or area distribution for harvests of that species is used. This information is matched against West Coast Groundfish Observer Program data that are stratified shoreward and seaward of the RCA for the years 2003 to 2006 and also stratified between the Vancouver and combined Columbia/Eureka INPFC areas. Quota shares for petrale sole and arrowtooth are then calculated for each permit and applied to the trawl allowable catch during the implementation year of IQs to estimate the implementation year quota pounds. These implementation year quota pounds are stratified by shoreward and seaward amounts and INPFC area, based on catch history. Each of these quota pound estimates are matched up to a corresponding depth and area Pacific halibut bycatch rate, and the result is summed. The result is a poundage estimate for Pacific halibut for each permit. That estimate is then divided by the fleet total to estimate each permit's quota share of Pacific halibut.

The following tables illustrate how the quota shares of arrowtooth and petrale sole are separated into shoreward, seaward, and latitudinal amounts. The table below uses the above table showing depth-based catch from logbooks. The first column of the table shows the species, and the second column of the table shows the quota share that permit would receive of arrowtooth and petrale sole. The third, fourth, and fifth columns then show the source area and depth of catch. In this case, the particular permit only has catch history from the Vancouver area. This hypothetical permit would receive 1 percent of the arrowtooth flounder share, 0.476 percent of which was caught seaward of the trawl RCA in the Vancouver area.

Table C-15. Hypothetical development of area-specific seaward and shoreward quota shares of target species.

Permit XXLE Catch History				
Target Species	**Quota Shares to Permit X**	**Area**	**Seaward Share**	**Shoreward Share**
Arrowtooth Flounder	1.00%	Vancouver	0.476%	0.524%
		Columbia/Eureka	0.0%	0.0%
Petrale Sole	3.00%	Vancouver	0.317%	2.683%
		Columbia/Eureka	0.0%	0.0%

The next table uses the information from the previous table to estimate the quota pounds a permit would get during the implementation period. This calculation uses the shoreward and seaward delineation of target species shares to estimate a shoreward and seaward quota poundage amount during the implementation year.

Table C-16. Hypothetical development of shoreward and seaward implementation year quota pounds.

Target Species	Area	Seaward Share	Shoreward Share	Implementation Year Trawl Allocation (mt)	Seaward Pounds	Shoreward Pounds
Arrowtooth Flounder	Vancouver	0.476%	0.524%	5,000	52,464	57,767
	Columbia/ Eureka	0%	0%			
Petrale Sole	Vancouver	0.317%	2.683%	16,000	111,744	946,474
	Columbia/ Eureka	0%	0%			

The next table then matches the shoreward and seaward quota pounds with the corresponding bycatch rates of Pacific halibut. That amount is then summed and divided by the fleet total to derive each permits' quota shares of Pacific halibut, shown in the last column.

Table C-17. Derivation of Pacific halibut quota shares.

Target Species	Area	Sea-ward lbs	Shore-ward lbs	Sea-ward Bycth Rate	Shore-ward Bycth Rate	Sea-ward Pacific Halibut LBS	Shore-ward Pacific Halibut LBS	Permit P. halibut Total	Fleet P. halibut Total	P. Halibut Share
Arrowtth Flounder	Vncvr	52,464	57,766	0.001	0.04	52	2,311			
	Colum/ Eureka	0	0	.00005	0	0	0			
Petrale Sole	Vncvr	111,744	946,473	0.001	0.04	112	37,859			
	Colum/ Eureka	0	0	.00005	0	0	0			
								40,334	**1,800,000**	**2.2%**

C.5 References

Maki, W. and R. Lichty. 2000. *Urban Regional Economics*: Iowa State University Press.