Using an Exempted Fishing Permit for a Large-scale Test of a Selective Flatfish Trawl in the Continental Shelf Flatfish Fishery

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Abstract
The Oregon Department of Fish and Wildlife and the Northwest Fisheries Science Center of NOAA conducted an Exempted Fishing Permit fishery test of a new selective flatfish trawl to estimate bycatch rates in the continental shelf flatfish fishery. Eight vessels participated, with observer coverage from May through October 2003. The trawl performed well and reductions in bycatch observed were consistent with the effects previously demonstrated in the controlled experiments. We recommend that a flatfish target fishery using this trawl be developed for use on the continental shelf off the west coast as a mechanism to reduce bycatch of some critical rockfish species.

Introduction
From 2000 through 2002, the Oregon Department of Fish and Wildlife (ODFW), working cooperatively with Oregon State University and the National Marine Fisheries Service, developed and tested a modified flatfish trawl, comparing its performance to a typical west coast sole trawl using an alternate haul sampling design (King et al. 2004). This experiment showed reductions in bycatch for several overfished species of 34 – 97%, despite the selective flatfish trawl being a larger trawl and having increased catches of flatfish.

Currently a large portion of the continental shelf, known as the rockfish conservation Area or RCA, is closed to groundfish trawling to limit the bycatch of several overfished species, notably canary rockfish *Sebastes pinniger*, yelloweye rockfish *S. ruberrimus*, and widow rockfish *S. entomelas* (PFMC, 2002). The depth range of the groundfish trawl RCA varies seasonally, but during the summer shelf flatfish fishery, it is approximately 137 – 366 m (PFMC, 2002). Although this area contains a large amount of high relief rockfish habitat, it also contains a vast amount of highly productive flatfish habitat, and is the primary location of several exploited flatfish species during their movement onto the shelf during summer months (*e.g.* Petrale sole *Eopsetta jordani*, Dover sole *Microstomus pacificus*) (Hagerman 1952, Ketchen and Forrester 1966). Access to these flatfish stocks is therefore restricted due to the lack of selectivity of conventional bottom trawl gear. Because the selective flatfish trawl showed such significant reductions in bycatch of overfished rockfish species, its implementation as a management tool has the potential to re-open some portion of the traditional shelf flatfish fishery and assist the Pacific Fishery Management Council in achieving the goals set forth in the federal fishery management plan for west coast groundfish, such as to maximize the value of the groundfish resource while preventing overfishing (PFMC, 2003).

The original alternate haul experiment using the selective flatfish trawl (King et al. 2004) was conducted off the central coast of Oregon, and tows were made primarily in rockfish habitat to most quickly learn about the bycatch reduction potential of the new trawl, given the patchy distribution of rockfish. Therefore, the experimental design, although good for measuring bycatch reduction, did not provide explicit information for managers to estimate bycatch rates for fishermen using the selective flatfish trawl in the traditional shelf flatfish fishery, where rockfish are not targeted. However to provide this information, the fishermen would need access to the closed RCA. To allow monitored access to the RCA, the ODFW and the Northwest Fisheries Science Center of NOAA

(NWFSC) developed an Exempted Fishing Permit (EFP) fishery to document the effectiveness of this type of trawl in the shelf flatfish fishery.

Given the large amount of comparative haul data presented in King et al. (2004), the performance of the selective flatfish trawl design was not in question. The EFP fishery documented the bycatch rates for species of concern with fishermen conducting normal flatfish fishing operations along different areas of the west coast both inside and outside of the RCA. The results could then be compared to the research data, and the West Coast Observer Program (WCOP) estimates of bycatch rates as descriptors of a potential fishery. The EFP therefore, was a feasibility test to determine if the idea tested in the research experiment could be scaled up to a fishery level and be useful for management.

In addition, because different vessels require nets of different sizes and other specifications, we developed measurable net design criteria, which 1) allowed fishermen to modify or build nets for their vessels that still have the functional components of the selective flatfish trawl, and 2) were objective and able to be enforced by federal and state enforcement agencies both in port and at sea. The ultimate objective of the EFP fishery was to generate information on how bycatch of overfished species might be reduced by introduction of the selective flatfish trawl to the nearshore component of the west coast groundfish trawl fishery.

Methods

The selective flatfish trawl is technically a legal fishing gear. Therefore, the EFP was essentially designed to allow two normally illegal actions to take place.

1) To permit fishing to take place within the RCA
2) To permit fishermen to land modified fishing-period limits to provide a financial incentive to construct a selective flatfish trawl, and configure and test the new gear.

Net Design

Trawl nets employed in the EFP fishery were required to meet design specifications similar to the original selective flatfish trawl (King et al. 2004). Some vessel owners modified an existing trawl to fit our criteria, while several owners had new trawls built to match the selective flatfish trawl design but scaled it to the appropriate size for their vessel. The design criteria were that the net must have a headrope at least 30% longer than the footrope, that the expected rise of the net could not exceed 1.5 m, that the headrope must not have any floats along the center 50% of its length, and that it must be a two-seam trawl. Otherwise, the trawl had to be a legal small-footrope trawl as defined in federal regulations.

EFP Design

Although allowing the two illegal actions required the EFP, many more restrictions were needed to ensure that catches of overfished species were not exceeded either by an individual vessel or by the project as a whole, and to allow data collected during the fishery to be stratified and analyzed effectively. A single EFP was issued to the state of Oregon and vessel behavior was regulated through state-vessel contracts.

Scope

The project was designed to span the entire shelf flatfish fishing season, including the two-month limit periods of May – June, July – August, and September – October, 2003. Although the project was administered by the state of Oregon, geographic coverage was maximized by selecting three vessels from Charleston, OR, two from Newport, OR, and three from Astoria, OR (Table 1). The number of vessels was constrained to eight because of the limited number of federal fishery observers available and because of the limited amount of canary rockfish mortality that could be incurred while conducting the project.

Table 1. Characteristics of the eight vessels and their selective flatfish trawls selected to participate in the selective flatfish trawl EFP, 2003.

Vessel name	Vessel length (m)	Port	Headrope length (m)	Footrope length (m)	Expected headrope height (m)
Columbian Star	15.8	Astoria	22.5	17.1	1.2
Searcher I	13.7	Charleston	27.7	21.3	1.5
Miss Linda	23.1	Charleston	40.3	31.2	1.4
Amak	21.3	Coos Bay	29.4	21.2	1.4
Prospector	17.7	Newport	34.9	24.8	1.3
Aja	22.2	Newport	40.3	30.8	1.5
Cygnet II	15.2	Warrenton	22.5	17.1	1.2
Home Brew	16.5	Warrenton	22.5	17.1	1.2

Fifty vessels were solicited by mail, based on their recent landing history of shelf flatfish. Each interested vessel owner submitted a net plan based on the defining criteria we supplied. We received 15 applications from interested fishermen (7 Astoria, 3 Newport, and 5 Charleston). We chose vessels by port, from those that submitted net plans closest in design to the original selective flatfish trawl. If necessary, we worked with the fishermen to modify their net plans to result in an acceptable configuration. The eight designs chosen had a range of sizes and footrope lengths (Table 1).

The three vessels chosen in Astoria were smaller vessels that fished in the shallow-water flatfish fishery and did not have the ability to fish seaward of the RCA. To try to collect more information on the fishing practices of these vessels, the project allowed vessels to choose an option where they must restrict their fishing from shore to 183 m as a single fishing area (shallow-water only option), versus fishing either shoreward, inside or seaward of the RCA on a given trip (mixed-shelf option). For the latter option, access to the RCA was limited to east of the 275-m management line (150 fm). The three Astoria vessels chose the shallow-water only option. The other five vessels were required to constrain all their tows on a given trip to within one of the three fishing zones (shoreward of RCA, in the RCA, or seaward of RCA).

All the rules of the EFP were detailed in signed state-vessel agreements. Additional processing rules and allowance for processors to have otherwise illegal amounts of some

species in possession due to the EFP were detailed and enforced through state-processor agreements.

Observers

The NWFSC provided federal observers to cover all the vessel's trips during the EFP period. If a vessel requested an observer but one was not available, the vessel was allowed to go fishing, but only outside the RCA. However, because of limited observer availability and concern for data quality, a 100% observer requirement was instituted in mid-August for the remainder of the project. Observers counted and weighed the catch of all rockfishes by species (*Sebastes* genus only), and also conducted normal observer sampling of discarded fish so that total catch could be reconstructed. Only data from observed trips was used for bycatch analysis.

Bycatch Caps

Minimizing mortality of overfished species was paramount for this EFP, especially for canary rockfish, because any large catches could have severe impacts on other fisheries operating coast wide. Therefore, we developed catch projections and overall catch caps for several overfished species (Table 2). If the total catch for any one of the overfished species was exceeded, then the EFP would terminate and all access by the vessels to the RCA would be eliminated. As an additional protection, each vessel also had individual monthly bycatch caps for selected species (Table 2). If a vessel exceeded its cap during the month, as determined by the observer and corresponding landing weights, the vessel was not allowed to fish in the EFP for the remainder of the month. If this occurred twice, the vessel would be removed from the EFP permanently to constrain bycatch for the remaining vessels.

Table 2. Vessel and program catch caps for overfished species in the selective flatfish trawl EFP, 2003. Estimated catch was derived from experimental trawl data from King et al. (2004). Sole catches are in addition to normal fishery landing limits. NA = Not Applicable

Species	Estimated monthly vessel catch plus 10% (kg)	Total program catch cap (mt)	Vessel bycatch cap per month (kg)*
Canary rockfish	42	4.0	154
Widow rockfish	NA	9.9	154
Yelloweye rockfish	18	1.2	104
Darkblotched rockfish *S. crameri*	33	2.1	227
Dover sole	3,175	203	NA
Petrale sole	680	44	NA
Pacific ocean perch *S. alutus*	NA	<0.5	NA
Bocaccio *S. paucispinus*	NA	NA	NA
Cowcod *S. levis*	NA	NA	NA
Lingcod *Ophiodon elongatus*	500	13.0	NA
Pacific hake *Merluccius productus*	500	NA	NA

* Vessel caps are total weight of listed species captured per calendar month.

Catch Documentation

Each vessel was required to retain all rockfishes (genus *Sebastes*) to collect information on what would be landed with this trawl under a full retention fishery. All dead lingcod *Ophiodon elongatus* were also retained and landed with no penalty to the vessel. Vessels operated under modified trip limits to provide a modest financial incentive to participate in the project and to cover costs such as building a new trawl and accommodating an observer (Table 3). Any species required to be retained over normal landing limits was processed as normal and the proceeds forwarded to the state as a legal overage. Vessels were responsible to remain under trip limits for species not under full retention. At-sea observers determined total catch of rockfishes. Landing tickets were used to determine the species composition and weights of all other species. Landing tickets were monitored monthly and logbooks were collected periodically to monitor fishing distribution, catch and bycatch levels.

Table 3. Period landing limits allowed under the EFP detailed by fishing strategy option. Species not listed were either not limited or limits were the same as normal landing limits. Limits are two-month cumulative limits unless noted.

Species / complex	Mixed-shelf flatfish	Shallow-water flatfish
Sablefish	10,000 lbs	7,000 lbs
Longspine thornyheads	14,000 lbs	NA
Shortspine thornyheads	2,800 lbs	2,400 lbs
Dover Sole	39,000 lbs, not more than 35,000 lbs in one month	30,000 lbs
Arrowtooth flounder	200,000 lbs	5,000 lbs
All other flatfish	103,000 lbs, not more than 33,000 lbs may be Petrale sole	75,000 lbs, not more than 25,000 lbs may be Petrale sole
Lingcod	800 lbs	800 lbs
Canary rockfish	300 lbs per month	300 lbs per month
Yellowtail rockfish	200 lbs per month	200 lbs per month
Minor Slope rockfish	1,800 lbs, no more than 200 lbs darkblotched rockfish per month	1,800 lbs, no more than 200 lbs darkblotched rockfish per month
Pacific ocean perch	1,000 lbs	NA
Minor shelf rockfish, widow	1,000 lbs per month, no more than 200 lbs yelloweye, and no more than 200 lbs widow rockfish	1,000 lbs per month, no more than 200 lbs yelloweye, and no more than 200 lbs widow rockfish
Minor nearshore rockfish	300 lbs per month	300 lbs per month

Bycatch rates were calculated using two different measurements. First, bycatch rates of overfished species were calculated as the weight (kg) of the bycatch species divided by the sum (kg) of all target species caught, matching the stratum from the WCOP (Flatfish target: 0-100 fm: for each trip limit period). The target species consisted of all marketable flatfishes except Pacific halibut (*e.g.* Petrale sole, Dover sole, English sole, and rex sole). Variance calculations for the catch ratios were provided by the WCOP for

expanded observer data from 2001-2002 (NOAA, 2003) at the tow level. Variance estimates for research data were also calculated at the tow level, but EFP data was collected and analyzed at the trip level, with variance estimates for the catch ratios following Cochran (1977).

Second, the bycatch rates were calculated as the weight (kg) of each bycatch species divided by the sum (kg) of all groundfish species for each stratum. The term "Groundfish" includes all catch except overfished species (J. Hastie, NOAA, Personal Communication). For these data, the species included are listed in Appendix I. This denominator was used to match the methodology used by the PFMC to estimate bycatch rates from the federal WCOP.

Results

The EFP project resulted in 141 trips and 1,371 tows spanning the continental shelf along all of Oregon and Washington during the three landing limit periods (Figure 1). However, because federal observers were not always available to cover every EFP vessel when the vessel wanted to fish, 15 trips (10.6%) were not observed. Non-observed trips occurred infrequently and proportionally for all vessels (Table 4). These trips did not enter into the RCA, except for three tows from two trips (Figure 2), and the catch data was not included in further analysis because of the lack of discard information. Of the three non-observed tows in the RCA, two start positions were estimated via LORAN and depth information to be within 1 km of the edge of the RCA, and one (with Lat: Lon) to be inside the RCA by less than 300 m. Typically, vessels fished shallower than the 275-m boundary for mixed-shelf flatfish strategy vessels and always shallower than the 183-m boundary for shallow-water flatfish strategy vessels (Figure 3).

In addition to unobserved trips, 11 observed trips were made to fish seaward of the RCA, mostly to target longspine thornyheads. These trips were identified by plotting all tow start points and identifying tow locations west of the RCA (defined as 137 – 366 m lines by NOAA) using GIS. Because the target fishery was different than the shelf flatfish fishery, these trips were removed from the bycatch analysis, but are included in Appendix II, which details the total catch landed during the EFP. The eastern RCA boundary changed from 91 m to 137 m on July 1st. Trips that fished in the area between the 91-m and 137-m lines in May or June were analyzed as fishing in the RCA. Lastly, three trips were removed from analysis because the vessel fished both inside the RCA and west of the RCA on the same trip. Our analysis focused on estimating bycatch in the shelf flatfish fishery and comparing catch data with WCOP data, so trips that fished entirely in the RCA or east of the RCA were included. The resulting database used to calculate bycatch rates consisted of 112 trips and 1,125 tows, with 721 tows in the RCA, and 404 shallower than the RCA (Table 4).

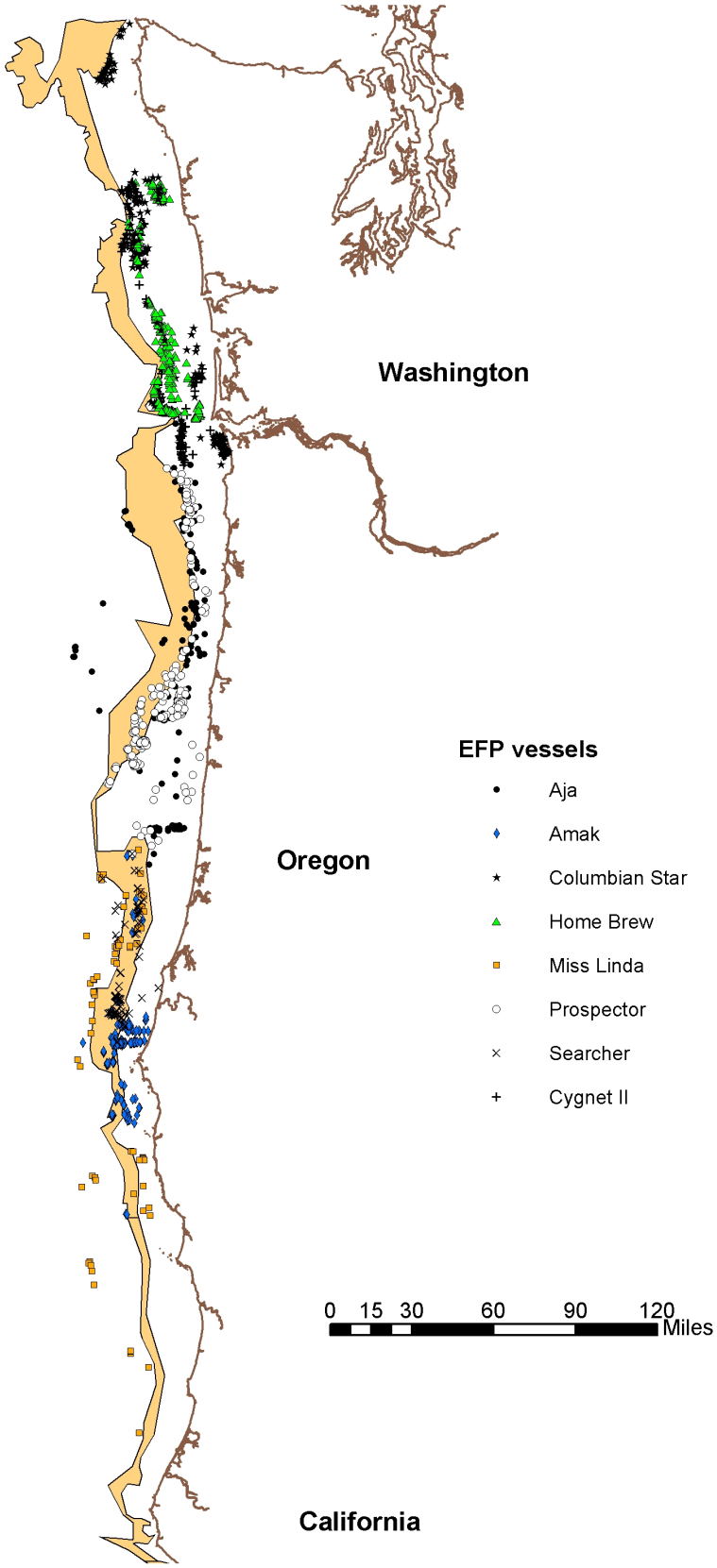

Figure 1. Tow locations for all tows conducted under the selective flatfish trawl EFP, 2003. Symbols are vessel specific. Polygon shows trawl RCA (137 - 366 m).

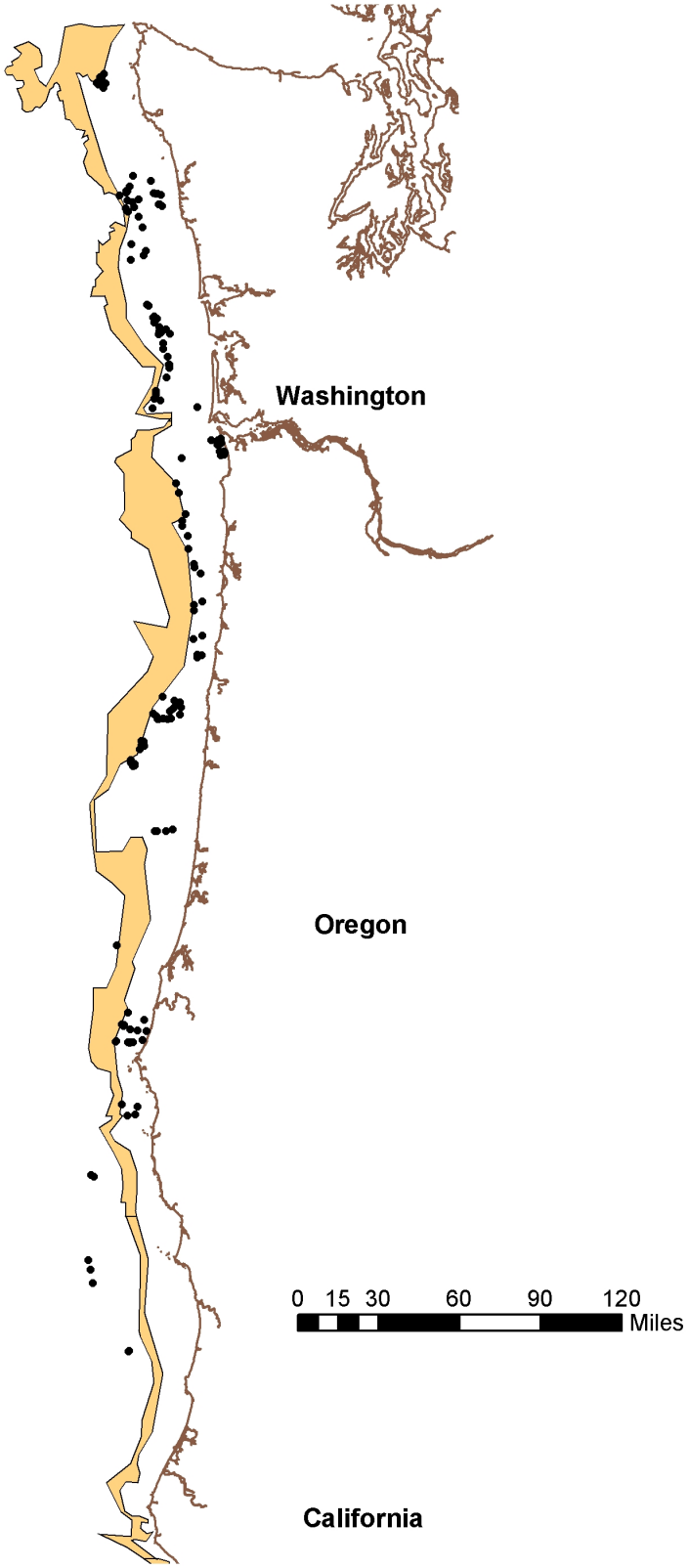

Figure 2. Tow locations for all unobserved trips in the selective flatfish trawl EFP fishery, 2003. Polygon shows trawl RCA (137 - 366 m).

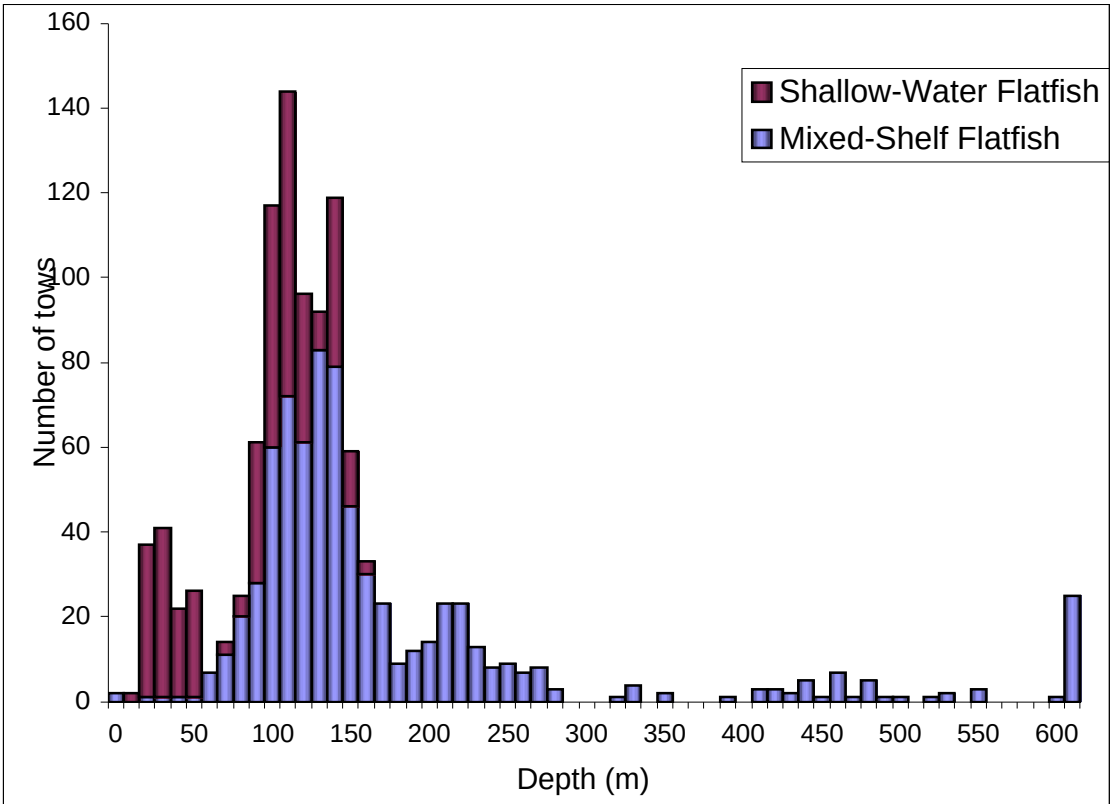

Figure 3. Distribution of all tow depths for vessels targeting mixed-shelf flatfish and shallow-water flatfish in the 2003 selective flatfish trawl EFP fishery.

Table 4. Frequency of unobserved trips and excluded trips for the eight vessels participating in the flatfish trawl EFP fishery, 2003.

Vessel	Number trips	Trips unobserved	Percent unobserved	Other trips excluded	Analyzed trips
Aja	21	2	9.5	3	16
Amak	21	2	9.5	2	17
Columbian Star	16	3	18.8	0	13
Cygnet II	16	2	12.5	0	14
Home Brew	16	1	6.3	0	15
Miss Linda	13	2	15.4	7	6
Prospector	19	2	10.5	0	17
Searcher I	17	1	5.9	2	14
Total	141	15	10.6	14	112

All eight vessels reported excellent net performance and were pleased with their high catch rates for flatfish and with the near complete elimination of Pacific hake using their selective flatfish trawl. Two vessels had some initial trouble tuning the net (*e.g.* net was digging), but following the addition of flotation along the wings, the nets fished well.

Species composition was very different between the mixed-shelf flatfish and the shallow-water flatfish strategies. Vessels had very large landing limits for "other flatfish" and were required to land all rockfish and dead lingcod (Table 3), so compositions for those species can be compared. Landings of Dover sole, Sablefish, and shortspine thornyheads were limited and are therefore similar among strategies. Percent of landed catch for each species shows that the shallow-water flatfish strategy trips caught many times nearshore flatfish species such as butter sole, starry flounder (200x), sand sole (10x), and curlfin sole (10x) (Figure 4). They landed three times the amount of yellowtail per trip because of the northern distribution of those trips, and outpaced the mixed-shelf flatfish strategy for other shelf species such as rex sole, sand dab, and English sole. The mixed-shelf flatfish strategy landed far more lingcod, Pacific ocean perch, and darkblotched rockfish, as expected. Surprisingly, although both strategies could fish out to 183 m, the shallow-water flatfish strategy landed less skates and Petrale sole, along with less canary rockfish and yelloweye rockfish.

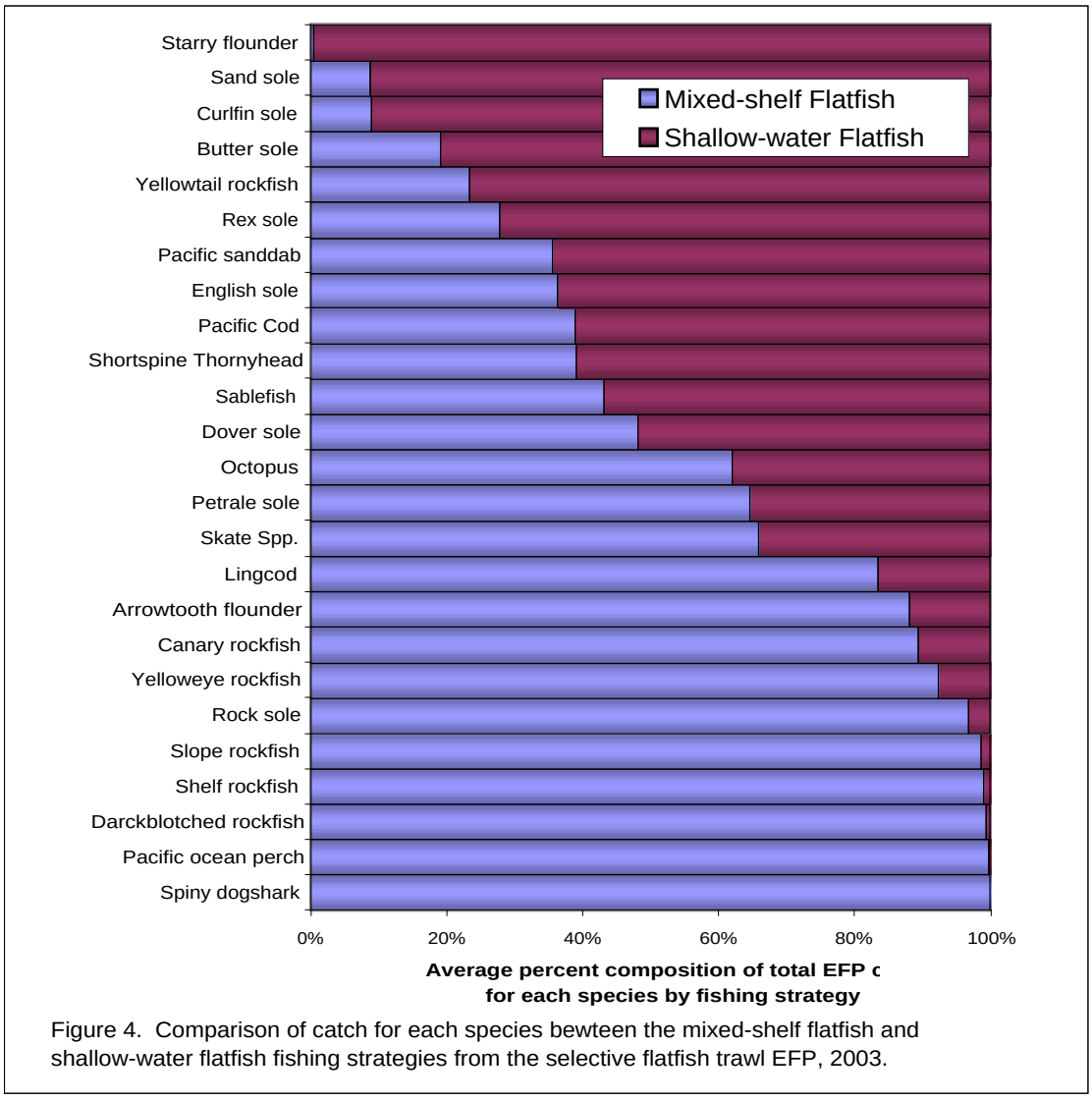

Figure 4. Comparison of catch for each species bewteen the mixed-shelf flatfish and shallow-water flatfish fishing strategies from the selective flatfish trawl EFP, 2003.

Bycatch for all rockfish species, and lingcod was low (Table 5). No bocaccio, widow rockfish, or Cowcod were captured at all. Catch of canary rockfish was well below the EFP cap of 4.0 mt. However, the monthly vessel-specific bycatch caps were exceeded; once by the Aja, and once by the Miss Linda. In both instances the darkblotched rockfish cap was exceeded, suggesting that the overall cap for this species was set too low (2.1 mt vs the 3.2 mt captured). Catches for all other overfished species were under the bycatch caps set in the EFP.

Table 5. Catches (kg) of all overfished rockfish and lingcod by vessel from the selective flatfish trawl EFP fishery, 2003.

	Charleston			Newport		Astoria			All
Species	Amak		Miss Linda	Aja	Prospector	Columbian Star	Cygnet II	Home Brew	Total
Bocaccio	0	0	0	0	0	0	0	0	0
Canary rockfish	108	234	35	174	185	16	5	29	786
Cowcod	0	0	0	0	0	0	0	0	0
Darkblotched rockfish	223	593	1,291	731	355	0	2	7	3,201
Pacific ocean perch	0	260	34	23	209	0	0	0	525
Widow rockfish	0	0	0	0	0	0	0	0	0
Yelloweye rockfish	2	9	0	22	3	2	0	0	39
Lingcod	1,680	737	428	5,119	2,973	495	539	397	12,368

Note: Although hake is overfished, it was not landed under the EFP so catch data is not available.

As with most bycatch data, the rates (kg / kg target) were variable among species, and among periods (Figure 4, Appendix III). For canary rockfish, bycatch estimates from the WCOP and control research tows (King et al. 2004) were similar, except where the research tows targeted rockfish habitat. Bycatch estimates for each EFP class were lower than WCOP or experimental research tows in all three periods. This same pattern was true for most species with the exceptions of darkblotched rockfish and Pacific ocean perch. Darkblotched rockfish were not found often in the 2001 WCOP data because the stratum was limited to 0 – 183 m. The EFP data and the research tows occurred at depths out to 275 m, reaching into darkblotched habitat. A similar pattern was observed for Pacific ocean perch, which also inhabit the deeper portion of the RCA. Widow rockfish and yelloweye rockfish were encountered very infrequently in all data sets, and the bycatch estimates are low but variable. Although fishing occurred south to 41°N, no bocaccio were captured. Lingcod are not excluded by the selective flatfish trawl (King et al. 2004), and for this species, rates were similar between the WCOP and the mixed-shelf flatfish strategy. Lingcod were encountered less frequently in the shallow-water flatfish strategy. Although hake was not retained, fishermen reported that hake catch was extremely low, supporting the results from research tows trawl.

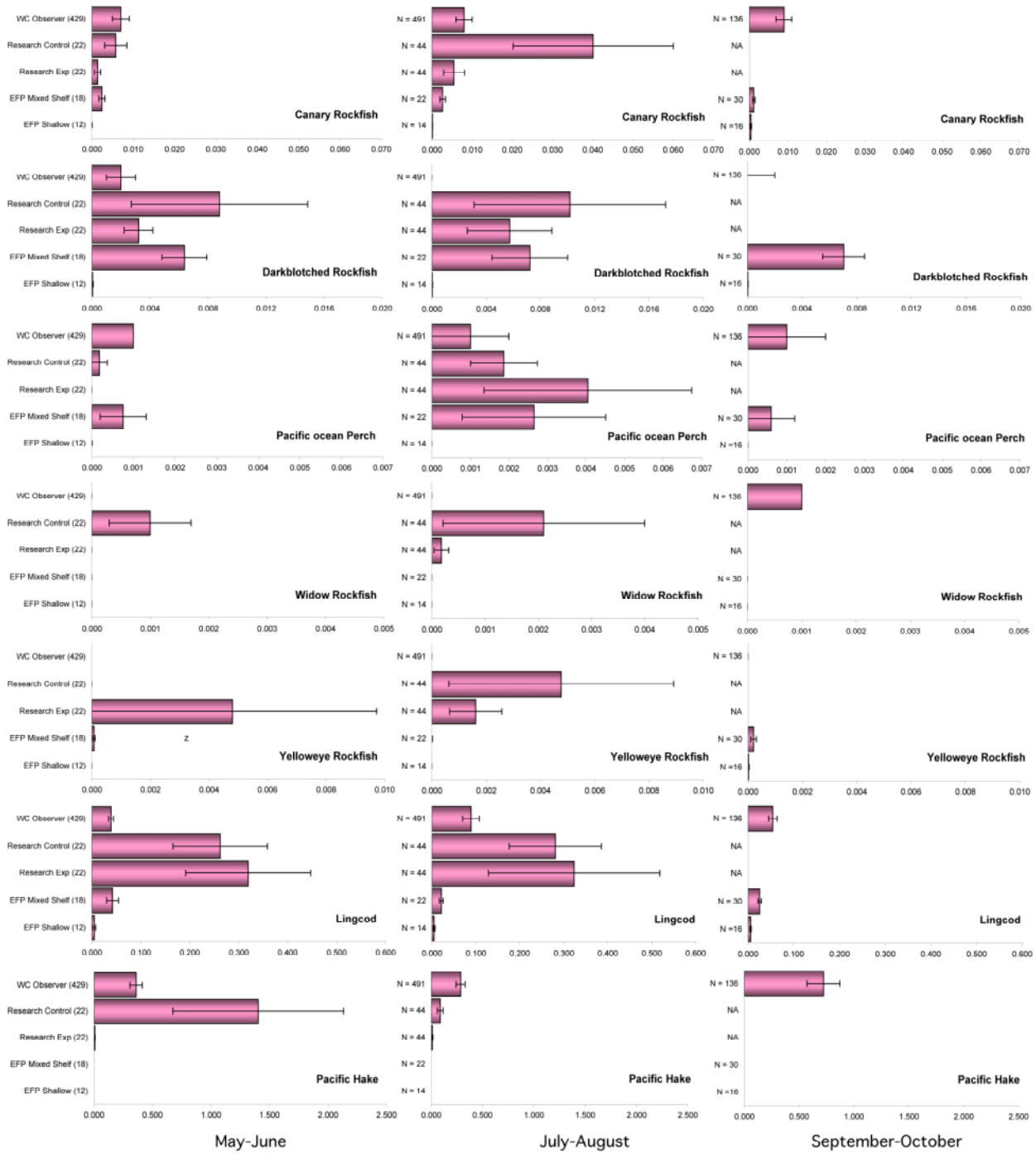

Figure 5. Comparison of bycatch ratios for seven species collected from the west coast observer program in 2001-2002, Research control and experimental tows from King et al. (2004), mixed-shelf flatfish target strategy EFP vessels, and shallow-water flatfish strategy EFP vessels in 2003. No research tows were done in September or October.

Discussion

The selective flatfish trawl design worked well in the normal shelf fishery. Bycatch rates for species expected to escape were low. The fishermen involved all had positive impressions of the net and said they would continue to fish it even outside the EFP program because 1) it caught flatfish well, 2) they did not have to sort hake on deck, and

3) bycatch rates were much lower and would eventually be incorporated into management through the normal federal WCOP. To our knowledge, there are now 11 selective flatfish trawls in use by the fleet, and two additionally modified trawls, built by Foulweather Trawl called "Pioneer Trawls," are in use in Alaska flatfish fisheries. In addition, the selective flatfish trawl design has been included as a bycatch reduction option for a New England bottom trawl fishery.

Trawl performance and bycatch estimates from the EFP agreed well with the conclusions from the controlled study of the selective flatfish trawl (King et al. 2004). As expected, bycatch in the fishery is lower than that from research tows targeting rockfish habitat. However, with EFP fishing alone, one cannot separate the effects of gear performance and fishing behavior, such as choice of fishing location. Although not quantified, we understand from discussions with the EFP fishermen that fishing behavior varied among vessels from avoiding areas with rockfish habitat, to occasionally targeting rockfish habitat to verify for themselves that the net avoided catching rockfishes. King et al. (2004) measured the gear effect directly. Any fishing behavior effect would also be present in the WCOP data, which are the data that bycatch projections are currently based upon and is not a bias specific to the EFP.

The total number of EFP tows is slightly more than the 2001-2002 WCOP total for the stratum (1,125 vs. 1,056 tows). Fishing took place under the EFP from below the California border (41°N) to the Canadian border (Figure 1), and matched the WCOP's "100 fm flatfish" stratum well in scope. Any bias in EFP data compared to the WCOP "100 fm" stratum would be due to EFP tows deeper than 183 m (100 fm) because five of the EFP vessels could fish in the RCA to 275 m. Surprisingly, this did not occur that often (Figure 1). Most fishing in the RCA occurred along the shallow, eastern edge, and varied seasonally (Figure 5), supporting the notion that vessels were targeting flatfish as specified in the state – vessel contracts. Fishermen followed the seasonal migration of Dover sole and Petrale sole into shallower waters during the summer and back into deeper waters in the fall. Differences in bycatch rates for a given species among periods was likely due to changes in the distribution of fishing effort. Differences between the research experimental trawl tows and the EFP mixed-shelf flatfish bycatch ratios are due to the targeting of rockfish habitat in the research tows (*e.g.* widow rockfish, lingcod). For species that avoid capture with the selective

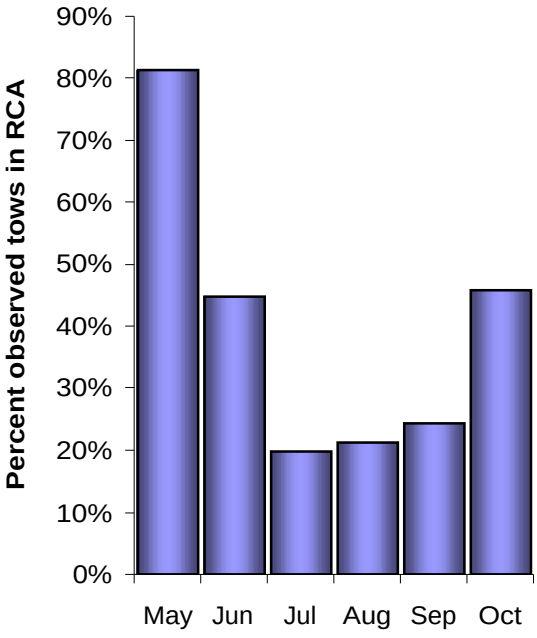

Figure 6. Distribution of fishing effort (tows) relative to the RCA during the selective flatfish trawl EFP, 2003.

flatfish trawl (*e.g.* canary, yelloweye rockfish, hake), the mixed-shelf flatfish strategy showed reductions in bycatch compared to the WCOP data. The reduction is not as dramatic as the reduction observed in King et al. (2004) because the research tows targeted rockfish habitat. However, reductions of more than 65% compared to WCOP rates could be realized by the fishery (Appendix III).

As an aid to implementing the use of this trawl in the fishery, ODFW and Oregon State Police developed objective criteria that could be used to define what characteristics a selective flatfish trawl would need to have in federal rule. These criteria, along with comparative drawings and an instructional video were prepared for enforcement personnel to be able to determine if the gear on a vessel was actually a selective flatfish trawl, and even be able to determine the type of trawl during setting or retrieving a net. This aspect was thought useful for coast guard personnel, or other at-sea enforcement for monitoring gear use.

Fishery Design

Because this trawl gear has different selectivities compared to traditional trawl gear for several important bycatch species, bycatch estimates for any fishery using this type of trawl should be specifically incorporated into the PFMC bycatch projection model. Given the research already conducted using this trawl (King et al. 2004), the number of tows involved in the EFP, and their geographic range, the bycatch rates presented here are the most appropriate rates to estimate future bycatch for fisheries using trawls with these defined characteristics.

As a bycatch reduction tool, we suggest that this trawl could be used in a continental shelf flatfish fishery. Although the final specifications must be developed and approved by the PFMC, we suggest a fishery with the following characteristics:

- The fishery should occur between 42°N latitude and the Canadian border. We have no data to address bocaccio bycatch rates with this trawl and consequently recommend additional controlled experiments in California to determine its effectiveness there.
- The fishery should require the use of a selective flatfish trawl as defined in federal regulations (as discussed above) and enforced by state and federal enforcement agents.
- The fishery could accommodate enhanced landing limits for Dover sole, Petrale sole, and other flatfish compared to the normal small footrope landing limits. The increase in flatfish catch should encourage switching to a more selective trawl gear, but not so large that flatfish landings increase dramatically and influence the market (Table 6). Trip limits for sablefish and shortspine thornyheads should remain at close to incidental levels to minimize discard of marketable fish but not lead to large effort shifts from the slope fishery.
- Until more data can be obtained from this trawl through normal WCOP coverage, we recommend using the most conservative rate generated using this trawl in the fishery, which was the mixed-shelf flatfish strategy segregated by trip limit period. By simply scaling the amount of flatfish catch in the fishery, the associated bycatch can be estimated using the recommended bycatch rates compared to rates from the 2001 –

Table 6. Comparison of trip limit structure (two-month periods, in pounds) for 2001 (the last year of RCA access), 2004, and proposed selective flatfish trawl for 2005, for May through October periods

Species / complex	2001 Small footrope	2004 Small footrope	2004 Large footrope	2005 Selective trawl[a]
Dover sole	20,000	21,000	45,000	35,000
Arrowtooth flounder	15,000	6,000	150,000	50,000
Petrale sole	30,000	25,000	100,000	35,000
Other flatfish	*	35,000	100,000	60,000
Sablefish	11,000	5,000	8,700	7,000
Shortspine thornyhead	1,500	1,000	2,100	1,500
Longspine thornyhead	6,000	1,000	10,000	5,000

* Petrale and all other flatfish limits were combined in 2001.

[a] In lieu of small footrope trawl limits

2002 WCOP or the rates used by the PFMC (Figure 7). It should be noted that current PFMC model rates are slightly lower than WCOP rates from 2001-2002 because fishing is now restricted to outside the RCA (though the RCA changes seasonally). The difference in bycatch generated by the two rates can be viewed as a savings that could be applied to this fishery or other fisheries facing bycatch constraints, especially from canary rockfish and yelloweye rockfish.

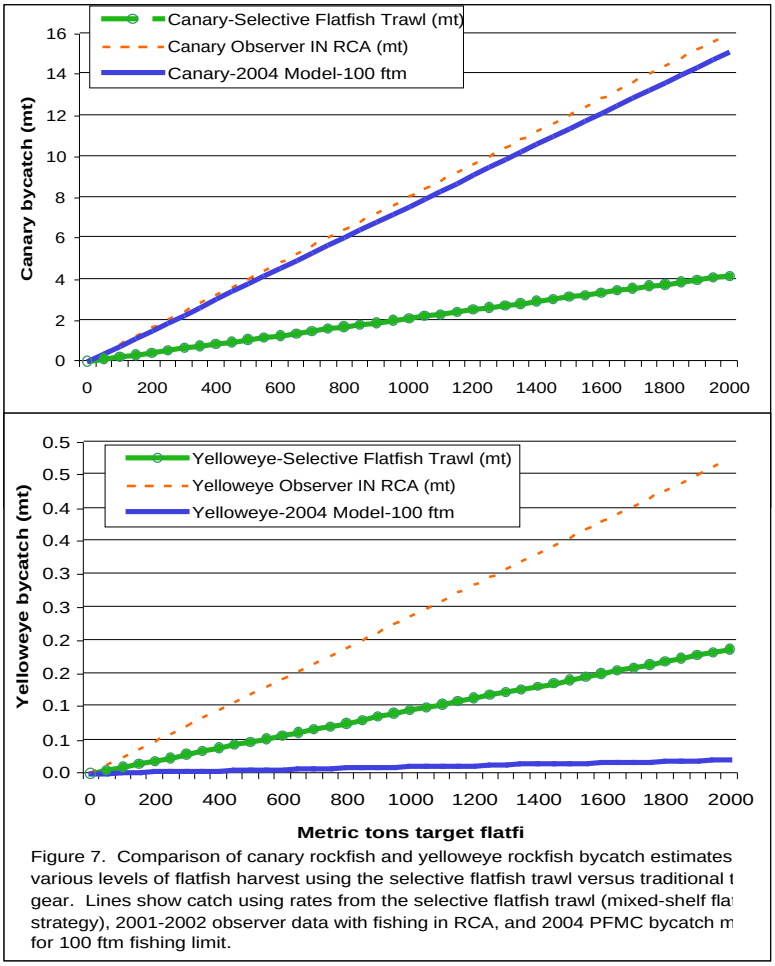

Figure 7. Comparison of canary rockfish and yelloweye rockfish bycatch estimates various levels of flatfish harvest using the selective flatfish trawl versus traditional t gear. Lines show catch using rates from the selective flatfish trawl (mixed-shelf fla strategy), 2001-2002 observer data with fishing in RCA, and 2004 PFMC bycatch m for 100 ftm fishing limit.

- It is clear from EFP data, from the shelf experiment (King et al. 2004), and from new slope work done with this trawl (ODFW, Unpublished data), that the selective flatfish trawl does not avoid the capture of darkblotched rockfish. The RCA for traditional bottom trawls is in place to avoid capture of species of concern (mainly canary, yelloweye and darkblotched rockfish). The RCA for the selective flatfish trawl should be appropriate for its catch characteristics. Therefore, any fishery developed using this gear should not be allowed deeper than about 183 m (100 fm), the shallow end of the darkblotched rockfish distribution (Orr et al. 2000, Rogers et al. 2000). Flatfish target fishing with this trawl could be allowed out to 183 depending on the amount of available canary and yelloweye rockfish, which will be dependent on the number of vessels using the trawl. In this way, fishing with the selective flatfish trawl occurs outside the RCA by definition.
- The shelf flatfish fishery traditionally follows the movement of flatfish into shallower waters in the summer, and back into deeper waters in the fall. In the summer months, fishermen typically fish east of the RCA (< 137 m), as observed in the EFP when they could have fished in the RCA and didn't during the summer months (Figure 5). The periods when fishermen would need access to fish deeper than 137 m are spring and fall. Therefore we suggest allowing the selective flatfish trawl fishery to occur from May through October with a depth restriction of 0 – 183 m (100 fm). This depth zone also facilitates using an already established RCA boundary at 183 m. If bycatch needs to be reduced further, the fishery could be restricted to less than 137 m for July – September, but this makes the fishery unnecessarily complicated given the small additional bycatch savings.
- Participation in this fishery would not require 100% observer coverage, but should fall under the normal randomly-assigned observer program coverage to collect data, which should provide approximately 20% coverage in 2005. Because the trawl can be objectively defined and compliance can be easily enforced (both at sea and at the dock), use of the trawl can be documented and enforced through normal methods. The effectiveness of the trawl has been documented through a controlled experiment, and trawl performance in the fishery has already been measured.
- The fishery should be open to all limited entry trawl vessels as an alternate trawl gear by creating separate limits for large footrope, normal small footrope, and the small footrope selective flatfish trawl (SFT). These limits would work like current large and small footrope limits, where vessels may fish with any trawl type during a landing period, but their limits would be the most restrictive limits given the gear type actually used during the period: similar to the current rule for use of small footrope gear. Each fisherman would then operate normally and determine the best option on a trip limit period basis. Landing limit structure will influence this turnover and once fishing with a selective flatfish trawl, there should be no reason to return to normal small footrope trawl gear.

- As an alternative to have three gear types in the long run, it may be possible to replace small footrope trawl gear with the selective flatfish trawl. We note that the restrictive limits on small footrope trawl use have resulted in a 46% reduction in small footrope trips between 2001 and 2003 in Oregon and Washington (Table 7). With the large decrease in trips using small footrope gear and with the large bycatch reductions realized using this trawl, it may be feasible to require the use of the selective flatfish trawl for the small footrope fleet and phase out traditional small footrope gear all together. The higher flatfish limits would more than compensate for any trawl modifications (Table 6). This action is not necessary but would simplify management logistics by removing the need to move the RCA shoreward boundary several times each year to accommodate the summer fishery.

Table 7. Number of small footrope and large footrope landings between 2001 and 2003 in west coast ports, May – October periods. Numbers in parentheses are the percent of total trips in that season (ODFW, unpublished data).

Gear type	2001	2003	% Change
Small footrope			
Washington	336 (91%)	393 (86%)	-5%
Oregon	465 (52%)	225 (28%)	-46%
California	879 (79%)	391 (43%)	-45%
Large footrope			
Washington	32 (9%)	62 (14%)	57%
Oregon	427 (48%)	567 (72%)	67%
California	236 (21%)	509 (57%)	67%
Total trips	2,375	2,147	

- Because the number of vessels has been reduced through the vessel-buyback program, trip limits for shelf flatfish should increase at some point in 2004. The two interrelated pieces of information we lack to describe a selective flatfish trawl fishery for 2005 are 1) the trip limits for shelf flatfish in 2005 after adjustment for vessel reductions, and 2) how many vessels would participate in the program in 2005, effectively switching their bycatch rates from the model rates to the EFP recommended rates for each period. This latter number may be small since so few vessels made small footrope landings during May-October in 2003.

The higher flatfish limits and access to fishing grounds would provide an incentive to participate in the fishery, and also serve as a mechanism to move more selective flatfish trawls into other fisheries because it clearly has lower bycatch rates for many species of concern, and higher catch rates mostly for flatfishes. In a larger view, use of a selective flatfish trawl by many vessels is a positive step for bycatch reduction and should be encouraged.

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Appendix I**. List of all species considered "target" and "groundfish" when calculating bycatch rates.**

Target species	Groundfish species
English sole	Shelf rockfish:
Rock sole	Dusky rockfish
Petrale sole	Greenstriped rockfish
Dover sole	Harlequin rockfish
Rex sole	Puget Sound rockfish
Starry flounder	Pygmy rockfish
Butter sole	Redstripe rockfish
Sanddab	Rosethorn rockfish
Sand sole	Silvergray rockfish
Curlfin sole	Stripetail rockfish
Arrowtooth flounder	Slope rockfish:
Misc. flatfish	Aurora rockfish
	Redbanded rockfish
	Rougheye rockfish
	Sharpchin rockfish
	Shortraker rockfish
	Splitnose rockfish
	Yellowtail rockfish
	Shortspine thornyhead
	Longspine thornyhead
	Pacific cod
	Grenadier
	Sablefish
	Lingcod
	Spiny dogfish
	FMP shark
	Skate
	Green sturgeon
	English sole
	Rock sole
	Petrale sole
	Dover sole
	Rex sole
	Starry flounder
	Butter sole
	Sanddab
	Sand sole
	Curlfin sole
	Arrowtooth flounder
	Misc. flatfish
	Octopus

Appendix II. Detail of all landed catch (grouped by market category) during the Oregon selective flatfish trawl EFP 2003 by port (mt).

Species	Astoria	Newport	Coos Bay	Total
Arrowtooth flounder	3.873	37.145	21.808	62.825
Butter sole	0.081	0.000	0.000	0.081
Canary rockfish	0.048	0.359	0.376	0.783
Curlfin sole	0.297	0.032	0.019	0.347
Darkblotched rockfish	0.009	1.085	2.107	3.201
Dover sole	108.824	80.763	115.587	305.174
English sole	65.992	42.381	24.930	133.304
FMP shark	0.000	0.023	0.000	0.023
Green sturgeon	0.000	0.010	0.018	0.028
Grenadier	0.000	0.090	3.338	3.428
Lingcod	1.432	8.092	2.845	12.368
Longspine thornyhead	0.000	3.012	11.744	14.756
Misc. flatfish	3.230	0.000	0.059	3.289
Octopus	0.320	0.424	0.332	1.075
Pacific cod	23.172	19.063	2.910	45.145
Pacific ocean perch	0.000	0.231	0.293	0.525
Petrale sole	27.522	55.386	38.619	121.527
Rex sole	19.480	5.469	12.849	37.798
Rock sole	0.043	0.352	1.587	1.981
Sablefish	27.029	27.876	21.951	76.857
Sand sole	25.959	0.681	3.574	30.215
Sanddab	7.672	9.463	0.046	17.180
Shelf rockfish	0.024	3.488	2.470	5.981
Shortspine thornyhead	1.698	1.230	4.648	7.576
Skate	44.738	81.625	69.396	195.759
Slope rockfish	0.010	0.345	1.559	1.914
Spiny dogfish	0.000	1.264	0.011	1.275
Starry flounder	11.110	0.009	0.042	11.162
Yelloweye rockfish	0.002	0.025	0.011	0.039
Yellowtail rockfish	0.369	0.165	0.030	0.564

Appendix III. Overall bycatch rates for each overfished species captured in the selective flatfish trawl EFP, 2003. Bycatch rates are kg/kg groundfish, or kg/kg target species complex. Values are strategy ratios ± standard error.

Period	Strategy	Species	Bycatch per kg groundfish	SE	Bycatch per kg target	SE
May-June	Mixed-shelf flatfish	Canary rockfish	0.0036	0.0013	0.0024	0.0007
		Darkblotched rockfish	0.0095	0.0026	0.0064	0.0015
		Pacific ocean perch	0.0011	0.0009	0.0008	0.0006
		Widow rockfish	0.0000	0.0000	0.0000	0.0000
		Yelloweye rockfish	0.0001	0.0001	0.0001	0.0000
		Lingcod	0.0626	0.0176	0.0423	0.0123
May-June	Shallow-water flatfish	Canary rockfish	0.0001	0.0001	0.0000	0.0000
		Darkblotched rockfish	0.0001	0.0001	0.0000	0.0000
		Pacific ocean perch	0.0000	0.0000	0.0000	0.0000
		Widow rockfish	0.0000	0.0000	0.0000	0.0000
		Yelloweye rockfish	0.0000	0.0000	0.0000	0.0000
		Lingcod	0.0108	0.0063	0.0045	0.0032
July-August	Mixed-shelf flatfish	Canary rockfish	0.0060	0.0017	0.0027	0.0007
		Darkblotched rockfish	0.0160	0.0063	0.0072	0.0028
		Pacific ocean perch	0.0059	0.0040	0.0027	0.0019
		Widow rockfish	0.0000	0.0000	0.0000	0.0000
		Yelloweye rockfish	0.0000	0.0000	0.0000	0.0000
		Lingcod	0.0482	0.0138	0.0217	0.0043
July-August	Shallow-water flatfish	Canary rockfish	0.0004	0.0002	0.0001	0.0001
		Darkblotched rockfish	0.0001	0.0001	0.0000	0.0000
		Pacific ocean perch	0.0000	0.0000	0.0000	0.0000
		Widow rockfish	0.0000	0.0000	0.0000	0.0000
		Yelloweye rockfish	0.0000	0.0000	0.0000	0.0000
		Lingcod	0.0141	0.0067	0.0048	0.0022
September-October	Mixed-shelf flatfish	Canary rockfish	0.0021	0.0007	0.0012	0.0003
		Darkblotched rockfish	0.0130	0.0035	0.0070	0.0015
		Pacific ocean perch	0.0011	0.0011	0.0006	0.0006
		Widow rockfish	0.0000	0.0000	0.0000	0.0000
		Yelloweye rockfish	0.0004	0.0002	0.0002	0.0001
		Lingcod	0.0469	0.0076	0.0255	0.0037
September-October	Shallow-water flatfish	Canary rockfish	0.0015	0.0005	0.0004	0.0002
		Darkblotched rockfish	0.0001	0.0001	0.0000	0.0000
		Pacific ocean perch	0.0000	0.0000	0.0000	0.0000
		Widow rockfish	0.0000	0.0000	0.0000	0.0000
		Yelloweye rockfish	0.0001	0.0001	0.0000	0.0000
		Lingcod	0.0185	0.0048	0.0054	0.0013