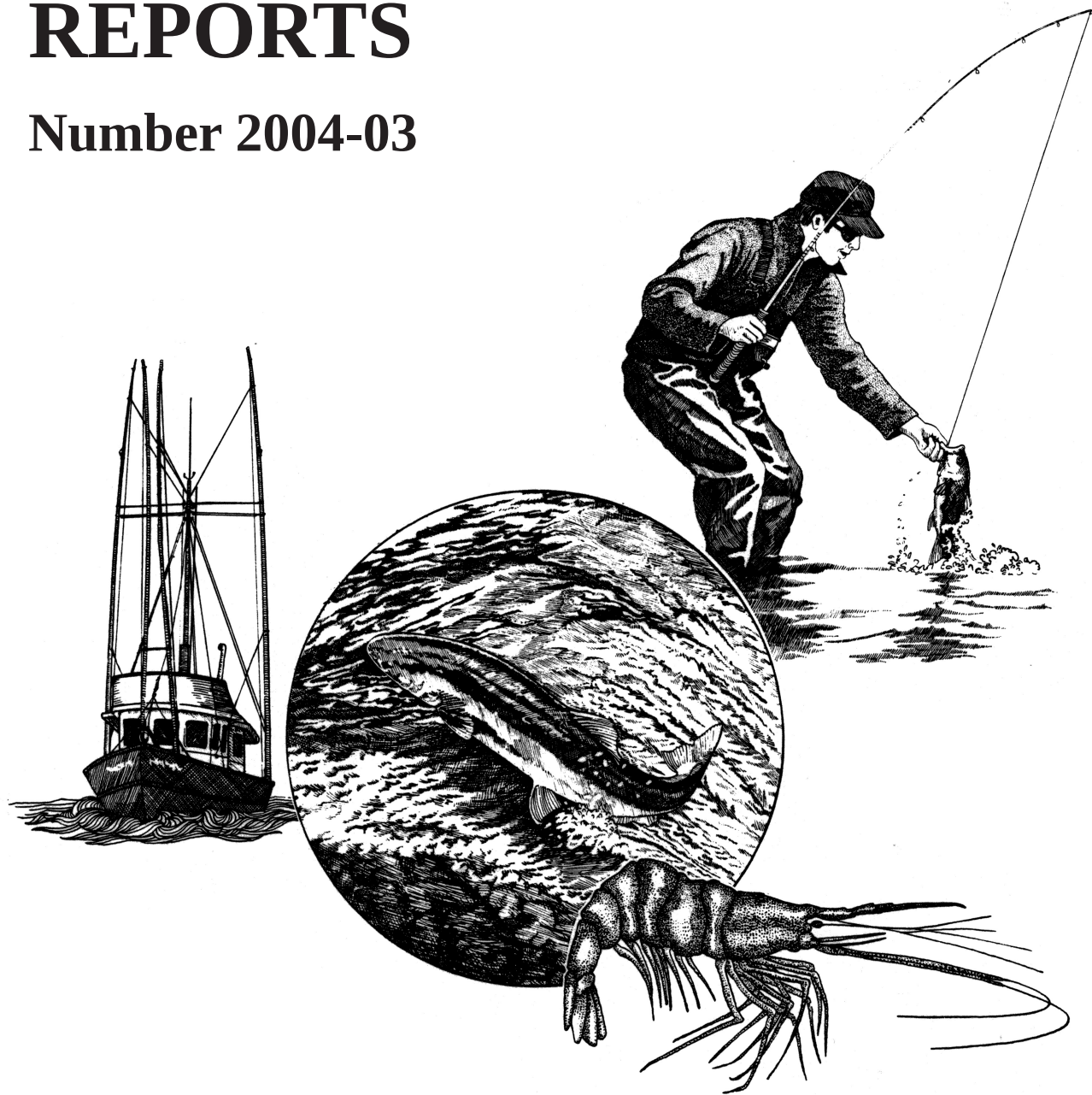


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Use of an Exempted Fishing Permit to Test a Discard Reduction Strategy for the
Deepwater Complex Trawl Fishery

**Use of An Exempted Fishing Permit To Test a Discard Reduction Strategy for the
Deepwater Complex Trawl Fishery**

Robert W. Hannah
Steven J. Parker

Oregon Department of Fish and Wildlife
Marine Resources program
2040 SE Marine Science drive
Hatfield Marine Science Center
Newport, Oregon 97365
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Introduction

The Problem

The U.S. west coast groundfish trawl fishery is currently managed using monthly or bi-monthly cumulative landing limits. The choice of this management system, as opposed to an “olympic style” quota management system, is based on the benefits of providing a year round flow of fish products to processing plants. One of the main disadvantages of this system is that in some instances, the limits can cause high “regulatory discard”. The term “regulatory discard” refers to marketable fish that are discarded only because the cumulative landing limit for that species has been met. The other primary types of discard would be “market discard” and discard of prohibited species. Market discard refers to fish that are discarded because they are not marketable, sometimes due to the species type, small size or flesh quality or because of a landing limit set by processing plants.

In choosing limit-based management, fishery managers assume that vessel operators have some ability to target particular species for harvest. They assume that after a limit is met for one species, further fishing can effectively target other species. Considering a broad range of species, it is unquestionable that vessel operators can use a variety of strategies to effectively target some specific stocks. This is especially true for species with specific habitat preferences, such as pelagic Pacific hake (*Merluccius productus*). It’s also true for species with very specific depth preferences such as starry flounder (*Platichthys stellatus*) or sand sole (*Psettichthys melanostictus*), which are captured in very shallow water. However, for many of the wide variety of species encountered in the west coast groundfish trawl fishery, the targeting ability of fishing vessels is poorly understood. Moreover, while the ability of any vessel to effectively target a particular species may be high, the factors influencing the vessel operator's decision to target a particular species are poorly understood. Clearly a variety of economic factors must influence this decision, including travel costs to different grounds, time spent to adjust gear and time spent sorting the catch, to name a few. At times, vessel operators may examine these tradeoffs when a catch limit is met and simply choose to continue to fish the same way and discard fish as needed to stay within allowable limits. Accordingly, efforts to reduce regulatory discard must take into account both the targeting ability of a trawl fleet as well as the economic costs and incentives that influence their fishing decisions.

Specific conditions contribute to the likelihood of high regulatory discard. Whenever a group of species is well mixed throughout the fishing grounds it is more difficult for vessels to effectively trawl for one species and avoid those for which the landing limit has been met. For well-mixed stocks, when the ratio of landing limits also departs strongly from the ratio of these species encountered on the fishing grounds, high regulatory discard will almost certainly result. Comments from fishermen suggested that these conditions existed for the deepwater complex trawl fishery off Newport, Oregon in spring and summer of 2003. The deepwater complex trawl fishery or “DTS” fishery, targets Dover sole (*Microstomus pacificus*), shortspine thornyhead (*Sebastolobus alascanus*), longspine thornyhead (*Sebastolobus altivelis*) and sablefish (*Anoplopoma fimbria*). These are some of the most abundant commercially valuable fishes found on the upper continental slope. Generally, longspine thornyheads can be

effectively targeted because of their deeper depth distribution (Jacobson and Vetter 1996), however the other three species are often found together. In the summer of 2003, comments from Newport fishermen indicated high regulatory discard of sablefish and shortspine thornyheads (SST) was occurring while fishermen pursued the much higher limits for Dover sole (Table 1). Research haul data from similar depths and areas off Newport from the same time period (Figure 1, ODFW unpublished data) show that the relative magnitudes of the landing limits and those of research haul catch rates were very different. While the limit was about three times higher for Dover sole than for sablefish, mean research catch rates were almost three times higher for sablefish than for Dover sole, suggesting that the choice of limits may have been contributing greatly to the discard problem. Given the high ex-vessel value of sablefish (Table 1), concerns about high levels of regulatory sablefish discard and associated mortality were understandable.

Table 1. Example DTS limits and prices, by size grade from May-June 2003.

Species	Size	Price/lb	Bimonthly landing limit	Maximum value
Dover Sole	All Marketable	\$0.33	31,000 lbs	\$10,230
SST	Over 16"	\$1.12	2,800 lbs	\$3,136
	10-15"	\$0.79		
	8.5-10"	\$0.42		
Sablefish	Large	\$1.80	10,000 lbs	\$18,000
	Medium	\$1.61		
	Small	\$1.48		
	Extra Small	\$0.98		
Total				\$31,366

A Proposal For A Solution

Newport fisherman Terry Thompson developed a strategy to reduce regulatory discard in this fishery, based on the experiences of spring and summer 2003. The proposal was to allow fishermen to retain shortspine thornyhead and sablefish that would otherwise have been discarded, presumably with very low survival rates, and count them towards the large Dover sole limit. With this approach, it was thought that the combined DTS limits would be reached more quickly and with much less discard. Given the much higher ex-vessel value of shortspine thornyhead and sablefish, it was also thought that this approach might be amenable to fishermen because it would modestly increase the value of fish landed. Throughout this report,

we will refer to this discard reduction strategy as the “LVDTS” strategy because all of the lower value (LV) DTS species and grades are landed as if they were Dover sole. The objective of this report is to detail efforts by the Oregon Department of Fish and Wildlife’s Marine Resources Program to test the feasibility of the LVDTS strategy as a management approach to

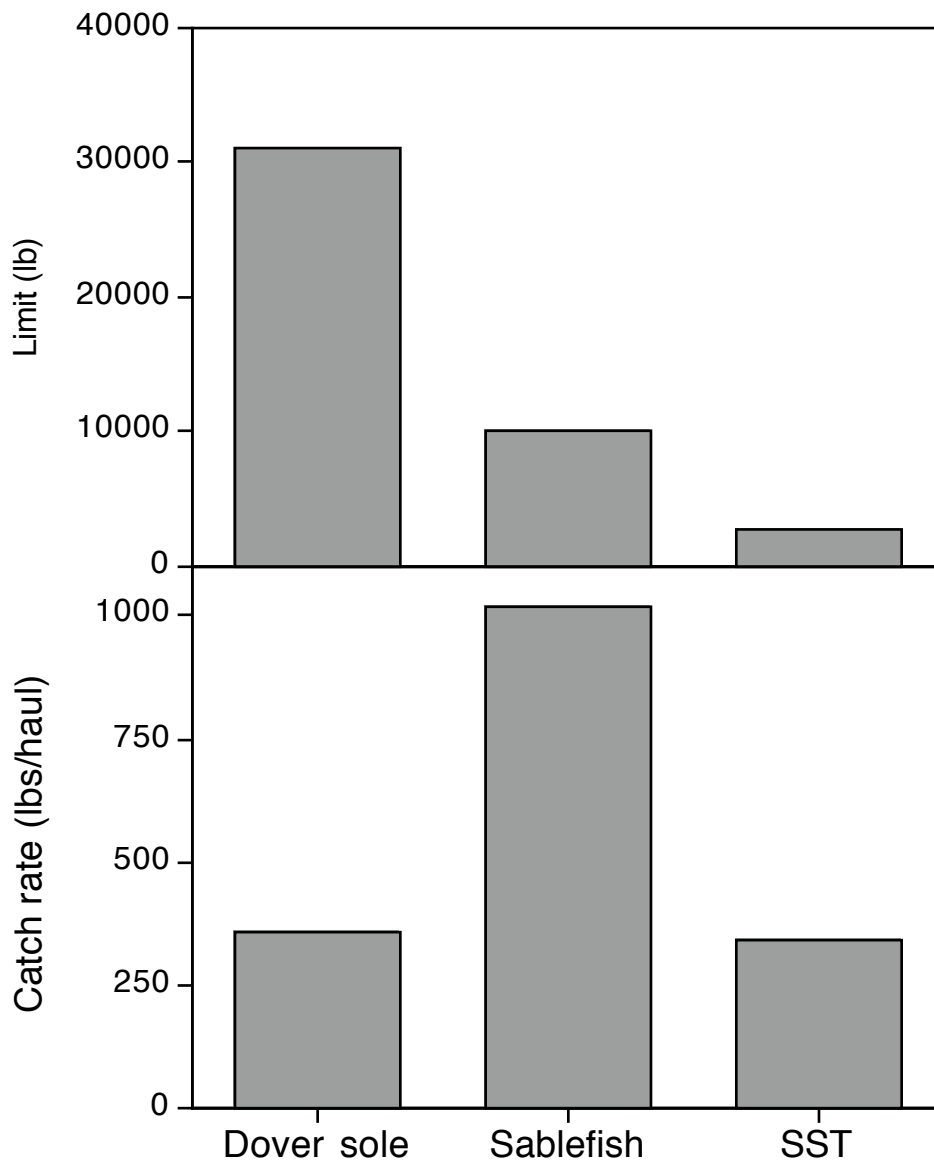


Figure 1. Comparison of bimonthly landing limits (lbs) and research catch rates (lbs/haul) for Dover sole, sablefish and shortspine thornyhead from May-June 2003 off Newport, Oregon.

achieve discard reduction in the DTS fishery, using an "exempted fishing permit" fishery, also known as an "EFP".

Methods

To evaluate the feasibility of the LVDTS strategy first required developing the details of the proposal such that implementation for a large fleet of trawl vessels was possible given current federal and state management regulations and monitoring resources. With very limited coverage levels in the west coast observer program (about 10% in 2003), any discard reduction strategy that required 100% observer coverage for the entire DTS trawl fleet was deemed unworkable. Therefore, the details of the LVDTS strategy were developed to minimize or eliminate economic incentives to discard fish. It was hoped that this would allow the testing of a strategy that, if successful, could actually be used as a management tool given limited resources for observers.

Details of the EFP

The LVDTS strategy is based on fishermen examining the available limits for the three main species (*e.g.* Table 1) and then redefining those limits based on their knowledge of which species and grades are most likely to be encountered. The redefined limits allow retention of these species and grades, counting them towards attainment of the larger Dover sole limit. An example of how this could be structured is shown in Table 2. In this example, the fish grades that are most likely to be retained because of their high value are landed under the existing limits for that species; in this case medium and large sablefish under the "high-value sablefish" limit, and medium and large shortspine thornyhead under the "high-value shortspine" limit. The grades that are likely to be discarded in trying to attain the large Dover sole limit, but are still marketable, are combined with Dover sole under one market category called LVDTS. To eliminate incentives for selective retention of fish within this category, a principal requirement under this EFP was that all fish sold as LVDTS must be sold at the same price per pound.

Working with a processing plant, each vessel interested in participating in the EFP was asked to develop their own "retention plan" similar to Table 2. The plan was required to include an "LVDTS complex" including Dover sole and at least one grade of sablefish and one grade of shortspine thornyhead, all at the same price. This retention plan specified the grades and prices of all DTS that would be sold/purchased, and worked within the existing landing limits for DTS species. In other words, the three basic limits had to stay the same, but some grades of sablefish and thornyhead could be moved into the Dover sole limit to form a complex.

Retention plans were put into effect through a group of written agreements between the vessel operator, the processor and ODFW. The complexes and the species/grades included were set forth in writing, before the start of the 2-month fishing period and were fixed for the entire limit period. Neither the processor nor the vessel was allowed to change the definitions of the grades or the composition of a market category during the limit period. Prices could be changed by submitting a new written agreement at any time, but flat pricing within the LVDTS complex had to be maintained. An additional restriction was that the vessel was required to sell

all groundfish landed during the limit period to the processor participating with the vessel in the EFP.

There were also other administrative requirements of vessels and processors. Each vessel had to agree to carry a NMFS observer for all fishing during the EFP period. The vessel had to track the limits as specified in their retention plan, and after reaching any of the redefined limits, retain all additional marketable DTS caught under that limit, but forfeit the value of that catch to the state of Oregon. The vessel was required to retain all rockfish, regardless of species or size. Finally, each vessel had to cease groundfish fishing for the limit period when any two of the three redefined limits were met, to keep regulatory discard low. Processors had to agree not to set separate market limits on LVDTS component species, to accept landings of all rockfish and DTS required to be retained by the vessel and to forfeit to the state of Oregon all proceeds from fish landed in excess of limits listed in the retention plan.

Table 2. An example of DTS limits and how they could be redefined to reduce discard under the LVDTS strategy.

Species	Catch limit	New limit category	Limit	Species	Size grade
Dover sole (all)	31,000 lbs	Low-value DTS Complex	31,000 lbs	Dover sole	All Marketable
				SST Sablefish	8.5-10" Small
				Sablefish	Extra Small
SST (all)	2,800 lbs	High-value SST	2,800 lbs	SST	Over 16"
				SST	10-15"
Sablefish (all)	10,000 lbs	High Value Sablefish	10,000 lbs	Sablefish	Large
				Sablefish	Medium

This EFP was designed to be a small-scale feasibility test of the LVDTS discard reduction strategy. The study design anticipated one participating boat in each of three ports; Astoria, Newport and Charleston. The initial sampling design called for the EFP to be implemented for two limit periods, March-April and May-June, 2004.

Assumptions of the LVDTS Strategy

The appeal of the LVDTS strategy is based on a few key assumptions.

1. The landing limits for Dover sole will generally be much higher than limits for sablefish and shortspine thornyhead.

2. The current price structure, in which sablefish and SST prices are size based, and Dover sole a low value species, will be persistent (otherwise trading shortspine thornyhead and sablefish discard against Dover sole limits would reduce vessel revenue).
3. High regulatory discard in the DTS fishery results from a lack of reliable, nearby concentrations of clean Dover sole fishing (otherwise operators would not have high regulatory discard of shortspine thornyhead and sablefish, they would just target Dover sole effectively to complete their DTS limits).
4. Given the opportunity to retain fish that would otherwise be wasted, without a price incentive, fishermen will not alter their fishing patterns so that they catch more shortspine thornyhead and sablefish than they normally would (if they do, excessive harvest of sablefish or SST could result).

Although these assumptions seem reasonable, one main objective of the EFP was to gain insight on the validity of these assumptions.

Data Collection

The data collected during this study included fish landing ticket information, discard data and vessel logbook data. For vessels participating in the EFP, observers from the National Marine Fisheries Service Northwest Fisheries Science Center (NWFSC) collected discard information and ascertained that all EFP retention requirements were met. All of the EFP trips were covered by NWFSC observers. One non-EFP vessel fishing out of Newport was also covered by NWFSC observers as part of the normal groundfish observer coverage, however those data were not available for this summary report. In addition, participating vessels and processing plant representatives provided comments on the EFP, and on the effectiveness and any potential problems caused by the LVDTS discard reduction strategy.

Questions To be Addressed

1. Did the EFP reduce regulatory discard for the participating vessels?
2. Did the EFP increase revenue for these vessels?
3. Did the EFP reduce effort expended by EFP vessels to meet limits?
4. Were any of the assumptions listed above validated or proven to be incorrect by the EFP fishery?

Estimation of DTS Discard and Discard Rates

Vessels participating in the EFP were required to retain all rockfish, including thornyheads, and all marketable DTS. Since vessels were not discarding normally, discard had to be estimated for species of interest. For Dover sole and sablefish, discard was calculated by summing the total poundage of unmarketable fish discarded or "weighed back" by the processing plants along with any marketable fish retained above cumulative landing limits (forfeited overages). For thornyheads, discard was estimated directly from forfeited overages. For all other species, discard was not estimated for this study but could be estimated from

NWFSC observer data. Discard rates were calculated on a species by species basis by dividing discard estimates by the total estimated catch of the target species (percentage of the total catch). Discard was also broken down into two kinds of discard, regulatory and market discard, as described above.

Spatial Analysis of Fishing

To evaluate assumptions 3 and 4 above, we examined spatial patterns in the choice of fishing location that might indicate successful target fishing for Dover sole. We used logbook data for both the EFP boats and other boats that landed into the same ports during the same time periods. The spatial analysis was conducted to determine if the more liberal retention of the LVDTS strategy changed the spatial pattern of fishing and the degree of targeting on Dover sole. Using logbook data for all the boats participating in the DTS fishery that landed into the same port as the EFP boats, we first calculated an index of how "well targeted" each haul was for Dover sole. The index was simply the weight of Dover sole hauled divided by the total weight of all Dover sole, sablefish and shortspine thornyhead hauled. We then plotted a frequency distribution of the index and inspected it for evidence of a bimodal distribution indicative of some hauls that very effectively targeted Dover sole and others that did not. The nadir in this frequency distribution was then used to divide the hauls into two classes, hauls with either high or low proportions of Dover sole in the catch. This kind of analysis is complicated by the fact that discard is not included in logbook hauls, so some tows would provide biased estimates of the proportion of Dover sole caught. We assumed that such bias would not strongly influence the spatial grouping of hauls that produced a high proportion of Dover sole catch. The start locations of these tows were mapped to see if the two classes of hauls were grouped spatially. We assumed that if hauls with a higher proportion of Dover sole were spatially grouped, then this was likely due to fish distribution and not to any bias from not hauling discard. The targeting behavior of EFP vessels was then evaluated by comparing how many hours of trawling they completed in the areas represented by the spatial groupings.

Other Data

We also examined what influence the LVDTS strategy had on ex-vessel revenue by comparing the total gross landing receipts of EFP boats with other boats landing DTS into the same ports during the same time period. Logbooks were also used to estimate the total hours trawled to determine if the LVDTS strategy reduced fishing effort.

Results

Scope of the EFP

Despite a very broad solicitation for vessels to participate in the EFP, only two vessels applied to participate, both from the port of Newport. Particular vessels we thought might be interested in this EFP were subsequently contacted directly, however no additional vessels applied to participate. Reasons given for not participating in the EFP were varied. Some vessel operators felt it was a very complicated EFP and likely to provide only a small financial benefit. Others decided to extend participation in the Dungeness crab (*Cancer magister*) fishery through the

first EFP period (March-April) because of good catch rates and high crab prices. One fisherman cited the excellent petrale sole (*Eopsetta jordani*) fishing during the January-February period as making it difficult for him to complete and submit the application by the deadline. We concluded that to increase participation in future EFP's, higher financial incentives may be needed.

Table 3. Total catch and estimated discard for F/V Prospector, March-April, 2004 (n/a - not available).

Species	Retained catch (lb)	Estimated total discard (lb)	Estimated regulatory discard (lb)	Estimated market discard (lb)	Retained plus discard (lb)
Dover sole	43,700	7,726	0	7,726	51,426
Sablefish	25,850	1,521	1,518	3	27,371
Shortspine thornyhead	7,407	1,717	0	1,717	9,124
Longspine thornyhead	822	1,103	0	1,103	1,952
Rex sole	2,002	n/a	n/a	n/a	n/a
English sole	326	n/a	n/a	n/a	n/a
Arrowtooth flounder	8,962	n/a	n/a	n/a	n/a
Petrale sole	202	n/a	n/a	n/a	n/a
Slope rockfish	952	596	0	596	1,548
Widow rockfish	0	48	48	0	48
Darkblotched rockfish	386	0	0	0	0
Pacific ocean perch	644	0	0	0	0
Skates	8,551	n/a	n/a	n/a	n/a
Miscellaneous	192	n/a	n/a	n/a	n/a

Table 4. Total catch and estimated discard for F/V Corsair, March-April, 2004 (n/a - not available).

Species	Retained catch (lb)	Estimated total discard (lb)	Estimated regulatory discard (lb)	Estimated market discard (lb)	Catch plus discard (lb)
Dover sole	31,378	4,375	86	4,461	35,753
Sablefish	28,987	508	508	0	29,495
Shortspine thornyhead	17,301	2,919	0	2,919	20,220
Longspine thornyhead	593	731	0	731	1,324
Rex sole	1,591	n/a	n/a	n/a	n/a
English sole	103	n/a	n/a	n/a	n/a
Arrowtooth flounder	11,554	n/a	n/a	n/a	n/a
Petrale sole	0	n/a	n/a	n/a	n/a
Slope rockfish	1,223	7	0	7	1,230
Darkblotched rockfish	16	0	0	0	16
Pacific ocean perch	392	0	0	0	392
Skates	4,006	n/a	n/a	n/a	n/a
Miscellaneous	0	n/a	n/a	n/a	n/a

Table 5. Bimonthly cumulative limits (large footrope) during the 2 EFP periods.

Species or complex	Bimonthly cumulative limit (lb) March-April	Bimonthly cumulative limit (lb) May-June
Dover sole	67,500	32,000
Sablefish	9,300	16,000
Shortspine thornyhead	3,150	4,500
Longspine thornyhead	15,000	18,000
Minor slope rockfish	4,000	8,000
Pacific ocean perch	3,000	3,000

The two participating vessels, the F/V Prospector and the F/V Corsair completed 5 and 6 trips, respectively, under the EFP during the March-April period. Total landings by species for each vessel are shown in Tables 3 and 4. Two different processing plants also participated, Hallmark Fisheries and Pacific Shrimp Company. Both vessels dropped out of the EFP for the second period, May-June. Both vessel operators stated that with the large decrease in cumulative limits for Dover sole for the May-June period (Table 5), they were likely to be discarding Dover sole while trying to reach their sablefish limit and this would eliminate any financial benefit from discard retention.

Retention Plans

The retention plan submitted by the F/V Prospector combined all shortspine thornyheads less than 16 inches long with extra small and small sablefish (less than 2 and 3.5 lbs, respectively) and Dover sole into the LVDTS market category, priced initially at \$0.38/lb, with a limit of 67,500 lb. Accordingly, the 3,150 lb shortspine thornyhead limit included only fish over 16 inches in length and the 9,300 lb sablefish limit included only sablefish over 3.5 lbs. Midway through the 2-month period, the F/V Prospector submitted a modified price for the LVDTS complex of \$0.40/lb. Just prior to the last trip of the 2-month period, the LVDTS price for this vessel was increased again to \$0.45/lb. Prices for the other market categories did not change throughout the period.

The retention plan submitted by the F/V Corsair was very similar to the F/V Prospector's, with the same market categories and a starting price for LVDTS of \$0.38/lb. Midway through the limit period, the LVDTS price for the F/V Corsair was increased to \$0.48/lb. The increases in the price paid for the LVDTS market category probably resulted from the large amounts of high-value sablefish being retained as LVDTS (Tables 3 and 4).

Discard Estimates for EFP Boats

As expected, the EFP vessels generated very little regulatory discard (Tables 3 and 4) and total discard rates were similar between the two participating boats (Table 6). The great majority of the estimated DTS discard consisted of Dover sole and thornyheads that were too small to be marketable. Compared to the high regulatory discard observed in spring and summer 2003, the LVDTS strategy clearly helped to reduce regulatory discard. However, the degree to which discard was reduced for EFP boats in relation to other boats fishing out of Newport during the same time period is unknown. Only one other boat fishing out of Newport in March-April carried an observer, a very marginal sample size for a meaningful comparison.

Spatial Analysis of Fishing and Discard

The catch of Dover sole by haul (all Newport vessels), as a proportion of total DTS in the haul, shows a clearly bimodal distribution indicating that some tows were effectively targeting Dover sole during the March-April time period, while others were not (Figure 2). This frequency distribution suggested dividing hauls into high and low Dover sole catches at a nadir of about 0.6, with proportions above 0.6 representing "well targeted" Dover sole hauls. Mapping of these hauls shows clearly that well targeted Dover sole tows were more common

south of Newport (Figure 3), while hauls with a lower proportion of Dover sole in the catch were located further north, mostly north of Newport. In general, the two EFP boats fished mostly in areas north of Newport, with the F/V Prospector fishing more in the south while the F/V Corsair fished somewhat more in the north (Figure 4).

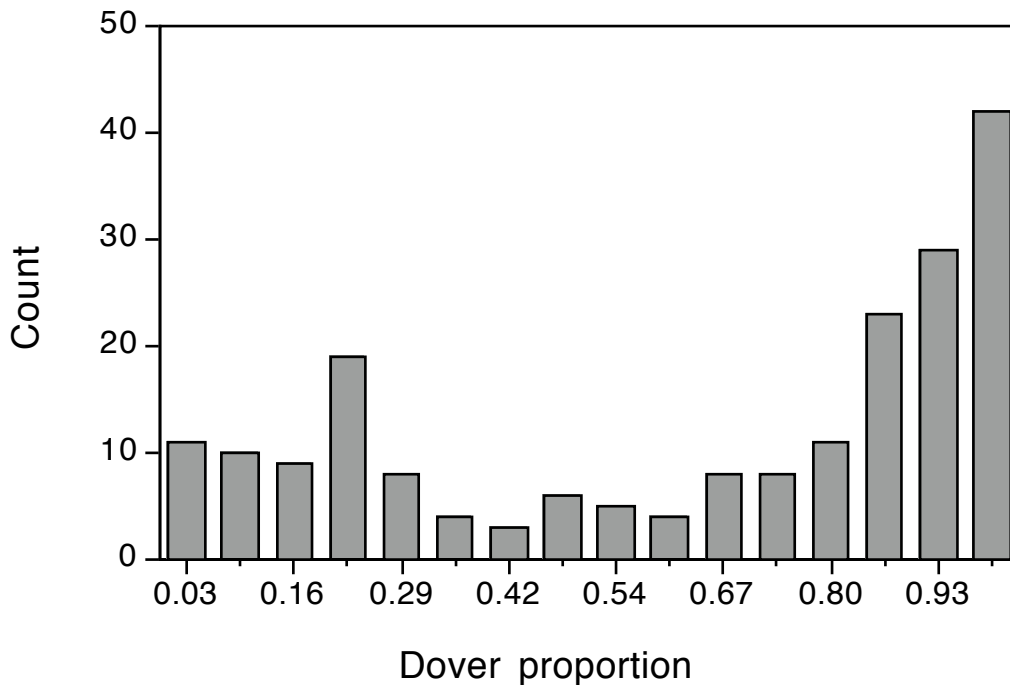


Figure 2. Frequency distribution of logbook hauls by the proportion of Dover sole hauled (Dover sole divided by total DTS) for boats landing DTS species in Newport, March-April, 2004.

Applying this kind of spatial analysis to the other vessels fishing out of Newport in March-April shows a wide variation in the amount of time different vessels spent fishing the DTS grounds south of about 44.24° N. latitude, where effective targeting of Dover sole was found. Observer data is not available for most of these non-EFP vessels, so discard is not known. However, note the correlation between the proportion of Dover sole in the DTS landed by each vessel and the proportion of time spent fishing these more southern grounds (Figure 5).

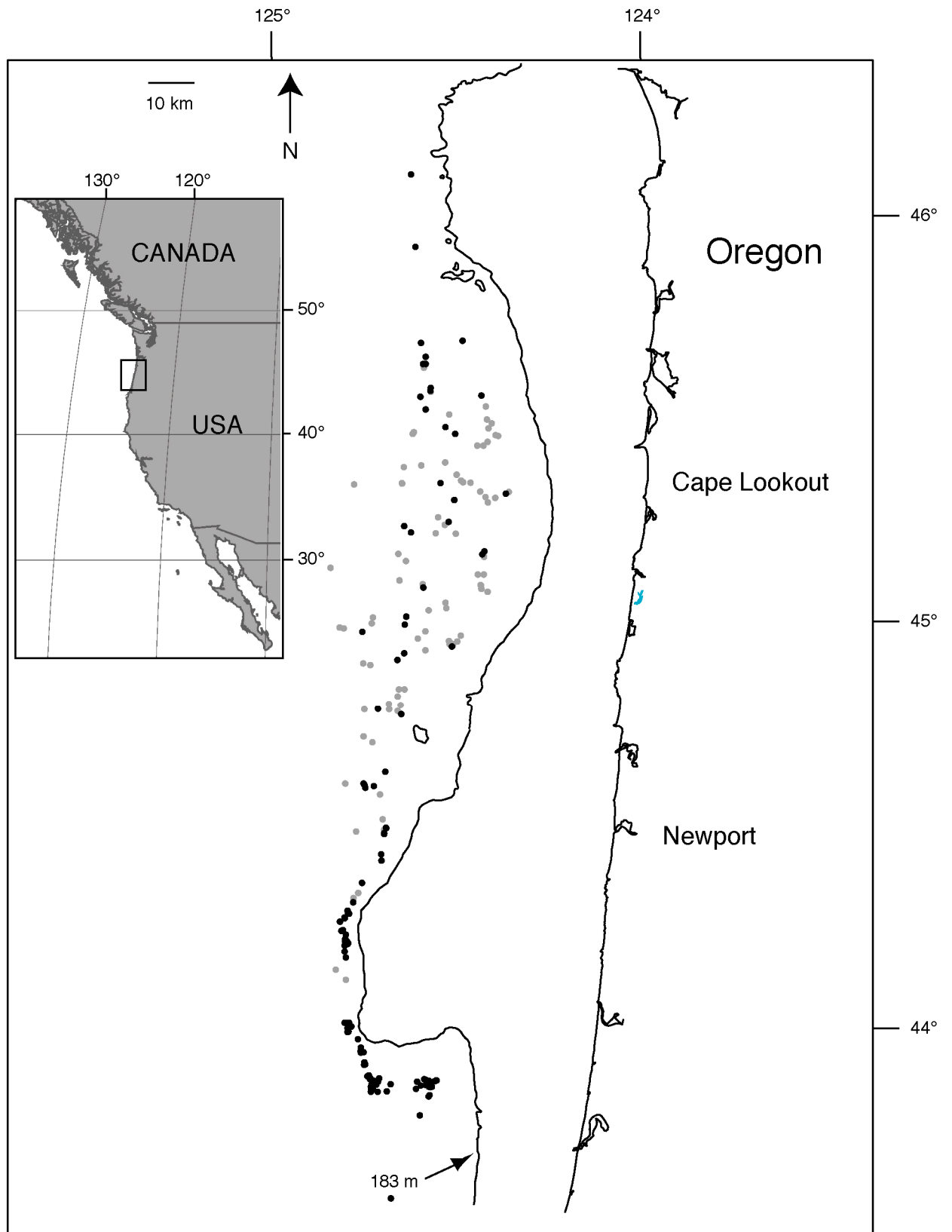


Figure 3. Spatial distribution of hauls made by boats fishing deepwater complex species with more than (solid black circles), or less than (solid grey circles), 60% Dover sole by weight as a percentage of all DTS species hauled, March-April, 2004.

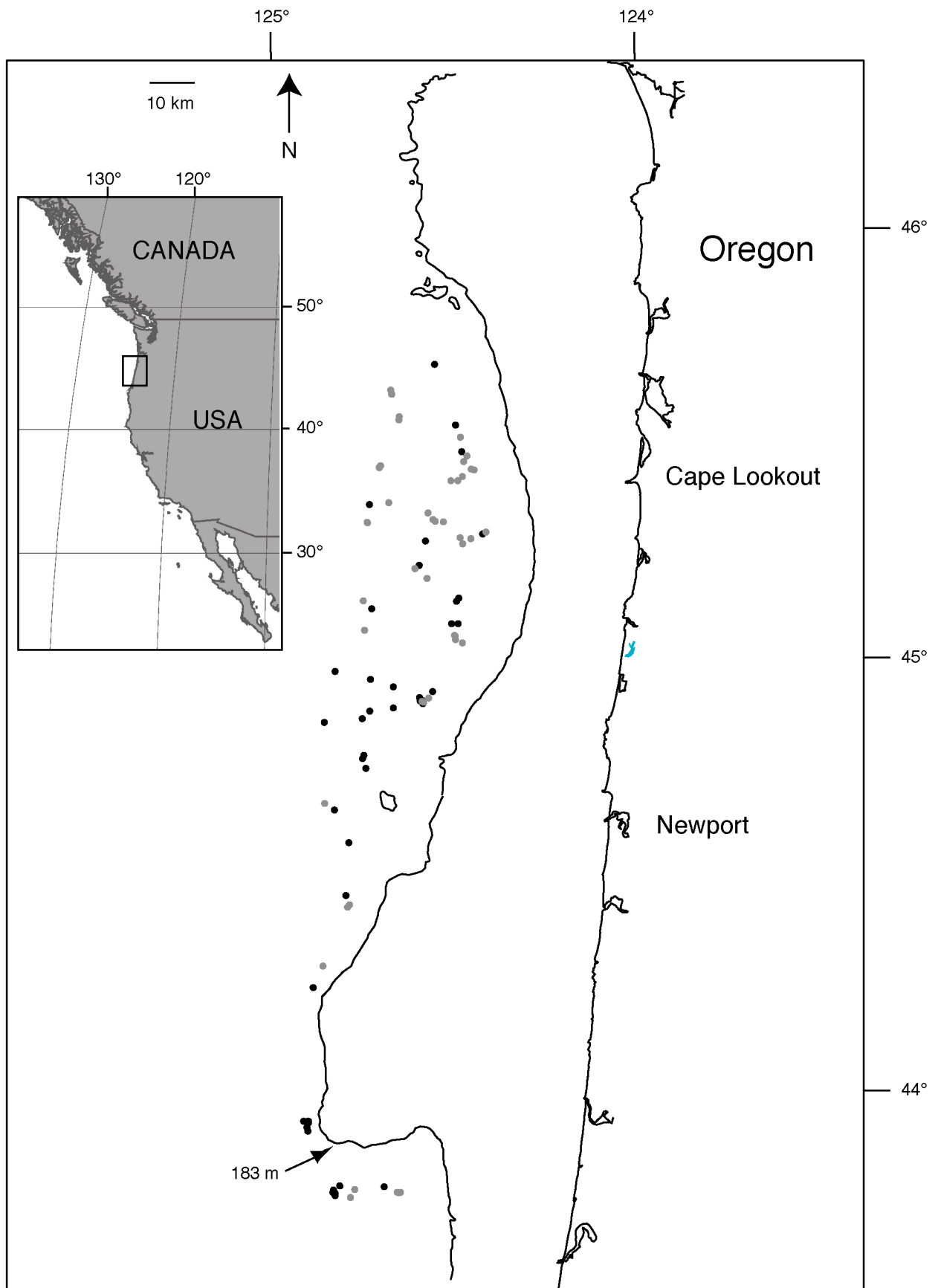


Figure 4. Spatial distribution of haul start locations for the F/V Prospector (solid black circles) and the F/V Corsair (solid grey circles).

Table 6. DTS discard rates, by species, for EFP vessels, March-April, 2004.

Species	Total Discard Rates	
	F/V Prospector	F/V Corsair
Dover sole	0.150	0.122
Sablefish	0.056	0.017
Shortspine thornyhead	0.188	0.144
Longspine thornyhead	0.552	0.552

Effort Expended

The number of trawl hours expended during March-April by Newport boats with useable logbooks is shown in Table 7. In contrast to expectations, EFP boats spent more time fishing for DTS species than any of the other Newport boats fishing in March-April for which we have logbook data. This is most likely a result of several factors, including vessel size and the fact that some boats quit fishing well before they met the 67,500 lb cumulative limit for Dover sole. However, comparing only vessels that came close to the cumulative limit for Dover sole, the LVDTS strategy still increased fishing time (Table 7). This is very surprising since the LVDTS strategy was expected to allow vessels to meet limits in less fishing time. The most likely explanation is the different spatial targeting observed for the EFP boats and other vessels. Vessels that spent more time on the southern grounds had much higher Dover sole catch rates (823 lbs/h versus 161 lbs/h for the northern grounds) and caught their limits more quickly.

Revenue Earned

The EFP vessels averaged \$38,900 in gross ex-vessel revenue during the March-April period. Considering only those non-EFP vessels that chose to fish long enough to closely approach the Dover sole limit of 67,500 lbs, non-EFP boats generated an average ex-vessel revenue of \$35,100. We estimate that the LVDTS strategy increased ex-vessel revenue by 10.8% for the EFP vessels.

Discussion

While it's clear that the LVDTS strategy results in very low regulatory discard and moderately increased vessel revenue, this EFP did not generate sufficient data to estimate the degree of discard reduction that the LVDTS strategy would cause if implemented on a fleet-wide basis, primarily because of a lack of sufficient comparative data for non-EFP boats. This is not a fatal flaw however, because the EFP data can be compared to official NMFS discard estimates for the March-April 2004 period when they become available in early 2006. More importantly, the EFP did provide sufficient information to evaluate the feasibility of the LVDTS strategy.

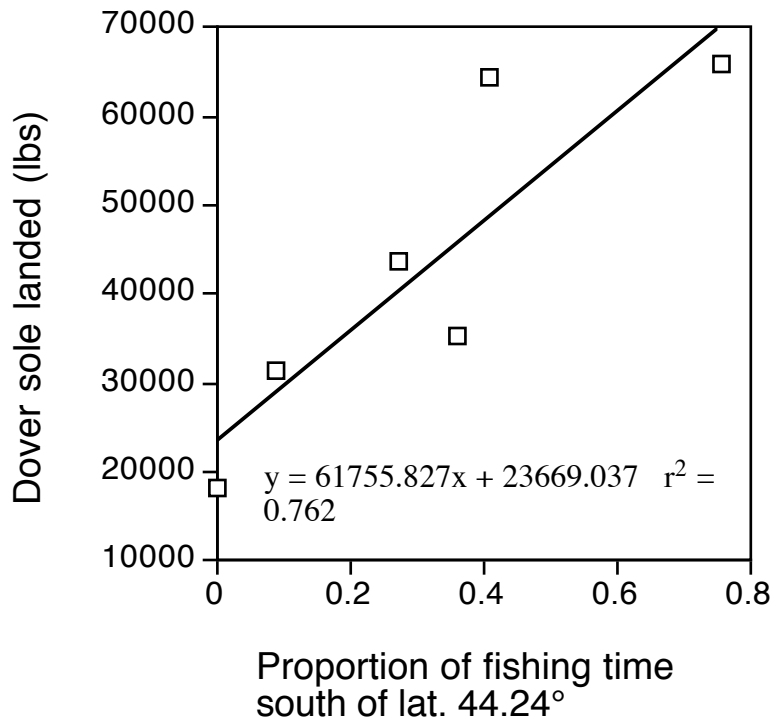


Figure 5. The proportion of total fishing time spent south of 44.24° N. latitude versus the total amount of Dover sole landed for vessels landing deepwater complex species into the port of Newport, March-April 2004 .

Table 7. Total hours of trawling effort for DTS species, by vessel, for six Newport vessels with useable logbooks in March-April, 2004. the percentage of trawling hours spent south of 44.24° N. latitude and total landings of Dover sole is also shown.

Vessel	Hours of trawling	Percentage of hours south of 44.24°	Dover sole landed (lbs)
Non-EFP #1	56.3	0.0	18,320
Non-EFP #2	82.2	36.2	35,220
Non-EFP #3	109.7	40.8	64,500
Non-EFP #4	122.7	75.7	65,800
F/V Prospector	188.8	27.5	43,700
F/V Corsair	182.0	9.1	31,378

The information collected uncovered some significant problems with the LVDTS strategy as well as some problems with the assumptions that support the LVDTS approach to discard reduction.

First and foremost, the data collected showed that the LVDTS strategy has the clear potential to alter spatial fishing patterns in ways that may not be desirable for fishery management (assumption number 4 is violated). By allowing vessels the option of fishing the northern grounds off Newport and retaining other DTS species as if they were Dover sole, as opposed to running further south for clean Dover sole fishing, the LVDTS strategy would likely increase exploitation rates on sablefish and shortspine thornyhead above levels originally forecast when landing limits were set. This results also from violation of assumption number 3, that clean Dover sole fishing was not available within a reasonable running distance of many ports. This EFP was a very short study, and for other ports or during other seasons, reliable concentrations of Dover sole may not be found within reasonable distances. This may have been the case during 2003 when very high discard was observed. There may also be differences in the knowledge base for different fishermen. Some may not be familiar with areas where Dover sole can be accessed with low bycatch of sablefish and shortspine thornyhead.

The withdrawal of vessels from this EFP just before the start of the May-June fishing period shows that assumption number 1, that Dover sole limits would always be much higher than limits for other DTS species, was also incorrect. The principal appeal of the LVDTS strategy was that directed fishing for low-value species was being reduced in exchange for increased retention of high-value discard. When limits change to a degree that the lower value species, such as Dover sole, becomes the discard species, the LVDTS strategy simply isn't attractive to vessel operators, because it would tend to reduce vessel revenue.

The more northerly spatial distribution of fishing observed for EFP boats in this study may also have increased the total fishing effort they expended in comparison to non-EFP boats, because they fished more hours on grounds with a lower density of Dover sole. One of the principal benefits of the proposed LVDTS strategy was that it would tend to reduce total effort, because limits would be met more quickly. It was thought that this reduction in effort might benefit other critical bycatch species, such as slope rockfish. The data collected in this EFP suggests that altering retention rules may have unpredictable effects on the spatial distribution of effort, catch rates and total effort expended. We conclude that a great deal more needs to be known about the targeting ability of vessels participating in various fisheries, variation in spatial and seasonal fishing patterns, as well as about how vessel operators make decisions about where to fish, before more successful market-based discard reduction strategies can be developed.

Acknowledgements

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3406 Cherry Ave. NE
Salem, Oregon 97303