Economic Revenue and Distributional Impacts Associated with Overfished Species Management in West Coast Commercial Groundfish Fisheries

1. Introduction

The management of West Coast groundfish fisheries is heavily centered on the need to rebuild seven overfished groundfish species. A species is considered overfished when its biomass is below 25% of estimated unfished biomass level. West Coast groundfish stocks are highly inter-mixed, meaning that overfished species co-occur and are caught in common with more abundant groundfish stocks. This inter-mixed nature of groundfish stocks means that eliminating the directed targeting of overfished species usually does not achieve the catch reductions needed to meet rebuilding goals. To adequately constrain total catch of overfished species, management must also constrain targeted fishing on healthy stocks that co-occur with overfished species in order to reduce incidental overfished species catch. This need to constrain harvest of healthy stocks has economic implications to sectors and communities engaged in fish harvesting and processing, because of the loss in landings and revenue that could have been derived from both overfished species and many target species that co-occur with those overfished species.

According to the Magnuson-Stevens Fishery Conservation and Management Act, when a fishery is overfished, any fishery management plan, amendment, or proposed regulations shall:

A) specify a time period for ending overfishing and rebuilding the fishery that shall—

i) be as short as possible, taking into account the status and biology of any overfished stocks of fish, the needs of fishing communities, recommendations by international organizations in which the United States participates, and the interaction of the overfished stock of fish within the marine ecosystem; and

ii) not exceed 10 years, except in cases where the biology of the stock of fish, other environmental conditions, or management measures under an international agreement in which the United States participates dictate otherwise;

B) allocate both overfishing restrictions and recovery benefits fairly and equitably among sectors of the fishery

The MSA defines a fishing community as a “community which is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew and United States fish processors that are based in such community.” Social scientists and economists have struggled to come to a resolution with this definition of fishing community. Several perspectives have been proposed to identify fishing communities and include, for example: a collective fishing sector such as the “West Coast bottom trawl community”, a geographic port of landing such as “the community of Astoria, Oregon,” or a neighborhood within a large city such as the “Ballard fishing community” of Seattle, Washington where multiple fishing families have lived for generations. In the end, it may be worthwhile to consider any of the above possibilities when “taking into account…the needs of fishing communities.”

The analysis in this document is provided with the intention that it can be used to consider both the needs of fishing communities, and the fair and equitable distribution of overfishing and recovery benefits (FMP Objective #13). Analyses in this document include: an analysis of changes in commercial fishery sector specific revenues associated with reductions in the mortality of overfished species, an identification of sectors most likely to be affected by management designed to reduce mortality of overfished species – the assumption being that those sectors with the highest impact of overfished species are more likely to be constrained by management designed to achieve reductions in overfished species mortality, and an identification of ports affected by management designed to achieve reductions in overfished species mortality.

2. Approach

The Pacific Fishery Management Council's Groundfish Management Team (GMT) has developed several models for estimating the catch of overfished species in commercial groundfish fisheries. These models have used data from the West Coast Groundfish Observer Program, state fish ticket programs, and state logbook programs to estimate the correlation in catch of target species and overfished species that occur on depth and latitudinal bases. The NMFS Northwest Regional Office augmented these models with economic data to directly compare exvessel revenue and overfished species mortality. NMFS ran several simulations with these models to develop an exvessel revenue – overfished species mortality relationship. The assumption in this approach was to keep exvessel revenue at the highest possible level given a set of area closures and the relative price per pound of target species. In the case of a fishery with multiple targets, such as the nearshore fixed gear groundfish fishery, or the bottom trawl groundfish fishery, reductions in the allowable take of target species were prioritized toward target species with the lowest price per pound. Taking this approach assures that vessels are more able to continue prosecuting high value target species, while achieving reductions in the take of overfished species with reductions in the targeting of less valuable species. In the case of a fishery with a single target such as the Pacific whiting or fixed gear sablefish fisheries, a reduction in the mortality of overfished species is directly proportional to the catch of target species, and (if one assumes a constant price per pound), directly proportional to reductions in exvessel revenue.

To identify likely distributional affects of reductions in overfished species mortality, we (NMFS Northwest Region working with members of the GMT) constructed a relational database. This database used available data on the interaction of fishery sectors with overfished species, and historical management actions that have been taken to achieve management targets of overfished species. We also used information from the 2005 groundfish stock assessments to identify the distributional range of various overfished species, and then analyzed it in conjunction with the size of fishing sectors on a regional basis. The resulting combined effect of relative stock size and relative fleet size helps identify the risk that a regional component of a fishing sector poses to a stock of an overfished species. In this case, "risk" is the potential catch that a particular regional sector has the potential to attain relative to the OY and relative to the capability of other sectors operating in the same area. Using this information on the relationship of groundfish stock and fleet sizes, we constructed a data set that identifies sectors that have high, med-high, med-low, and low or no impact on each overfished species, within a coastwide series of latitude-bounded management areas. Fishing sectors that were analyzed include:

1. limited entry bottom trawl – deep;
2. limited entry bottom trawl –shelf;
3. limited entry midwater trawl – Pacific whiting;
4. limited entry fixed gear – sablefish;

5. limited entry fixed gear – nearshore;
6. limited entry fixed gear – dogfish;
7. open access fixed gear – sablefish;
8. open access fixed gear – nearshore; and
9. open access fixed gear – dogfish.

Although other commercial sectors arguably exist, one can reasonably assume that these other sectors are minor compared to those listed, or can be considered a component of one of those sectors listed. Our data set further divided sectors by coastal management area where different overfished species commonly occur: north of 40˚ 10' N. lat., between 40˚ 10' N. lat. and 38˚ N. lat., between 38˚ N. lat. and 36˚ N. lat., and south of 36˚ N. lat... The area north of 40˚ 10' N. lat. is a traditional area used for management of commercial fisheries and tends to have the highest degree of impact for several overfished species, including darkblotched rockfish, yelloweye rockfish, and Pacific ocean perch. In the area between 38˚ N. lat. and 40˚ 10' N. lat., darkblotched rockfish populations are more moderate, Pacific ocean perch is nearly non-existent, and the area, and the northern portion the assessed portion of bocaccio rockfish begins. The area south of 38˚ N. lat. and north of 36˚ N. lat. contains few, if any, of the more northern overfished species such as darkblotched rockfish, but canary rockfish still tend to be caught in the area, as well as more southern oriented stocks such as bocaccio rockfish. Few canary rockfish occur south of 36˚ N. lat., but this area contains both bocaccio rockfish and cowcod.

Information from the Pacific Coast Fisheries Information Network (PacFIN) was used to identify vessels that participate in each of the sectors, and a principal port for those vessels was also identified. Vessels were assumed to participate in a sector based on a filter of specific gear type, and if 50 percent of landings for that vessel occurred at any time over the past 4 years, though in the case of the LE trawl sector only 2004 and 2005 were used because that sector has changed substantially since the 2003 buyback program. The methods used to identify sectors in this case are the same methods used to identify historic catch by sector for the November 2005 Groundfish Allocation Committee meeting. The end result is a list of sectors and ports that are likely to be affected at some level based on the assumption that relatively high impact fisheries are likely to be most constrained to achieve reductions in overfished species mortality.

3. Exvessel Revenue – Overfished Species Catch Tradeoffs in Commercial Fisheries

This section presents the result of analysis displaying the tradeoff between the catch of overfished species and exvessel revenue of individual fishery sectors. In this case, catch of overfished species is defined as landings plus discard. In general, this analysis shows that reductions in the catch of overfished species become increasingly more costly in a sector with multiple targets, whereas reductions in the catch of overfished species in a single target sector is proportional to changes in exvessel revenue.

The analyses presented in this section are two-dimensional. That is, these analyses examine the relationship between exvessel revenue and overfished species catch by analyzing the relationship between catch of target species and catch of overfished species. These relationships will change as area management changes; however, for this analysis, area management is assumed to be constant.

3.1. Revenue – Overfished Species Catch Tradeoffs in the Pacific Whiting Fishery

The Pacific whiting fishery is a single target sector. Often the catches of overfished species in this sector are characterized by a random disaster tow where large amounts of overfished species are caught in a single tow of a trawl net. However, in more recent years the total annual catch of overfished species in this sector has become roughly proportional to the size of the Pacific whiting catch, though large random catches of overfished species still occasionally occur. Although random disaster tows still occur, for general diagnostic purposes, it is reasonable to analyze changes in the catch of overfished species mortality as being proportional to exvessel revenue to the Pacific whiting sector, while realizing that variability in the proportions (and therefore predicted relationships) will and do occur.

Figure 1 shows the relationship between exvessel revenue and overfished species caught in the Pacific whiting fishery. From this figure it is evident that widow rockfish is the predominant overfished species caught in this sector, and that a reduction in the catch of widow that is on the order of 25 metric tons without area-based management would correspond to a reduction in Pacific whiting revenues of $5.8 million. Because the catch of overfished species is predicted to be proportional to the catch of Pacific whiting, reductions in the metric tonnage catch of widow rockfish appear to be less costly per ton than reductions in the metric tonnage catch of other overfished species.

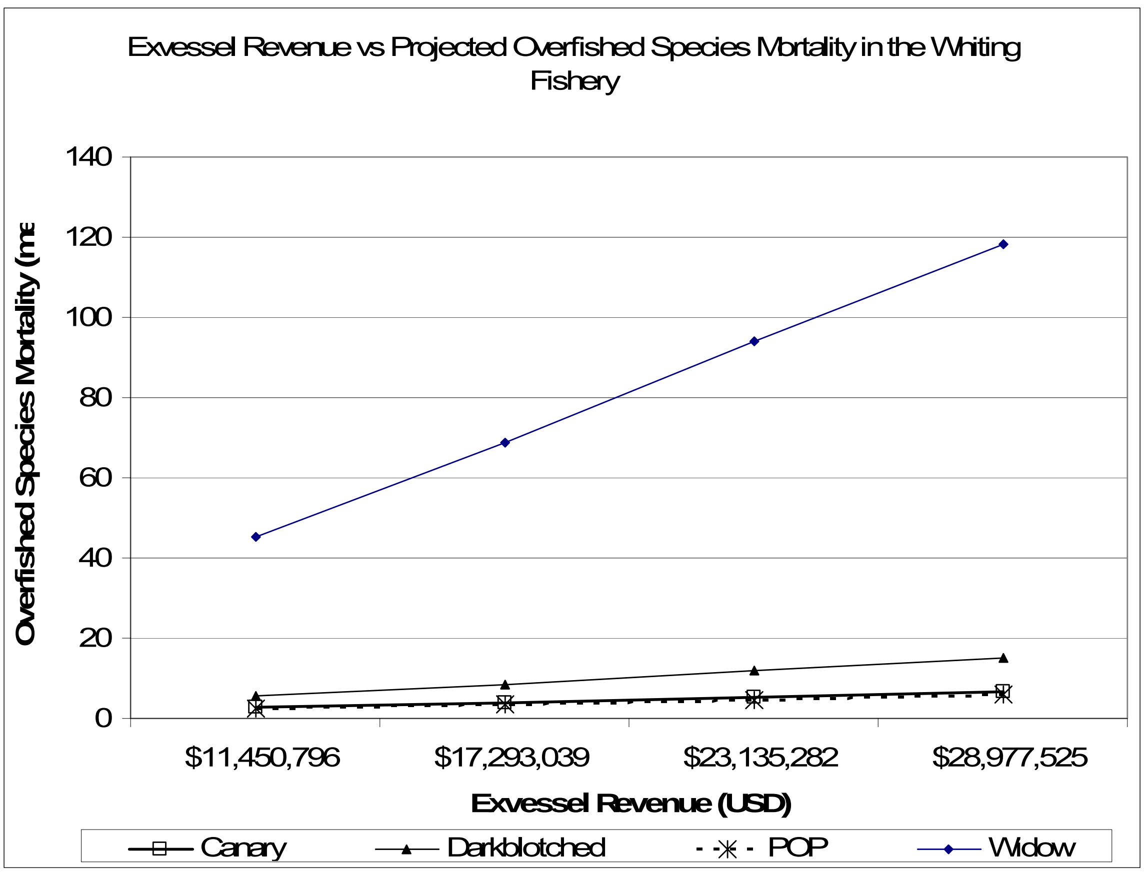

Figure 1. Exvessel Revenue vs Projected Overfished Species Catch in the Whiting Fishery

Figure 2 provides a better perspective on the relationship between overfished species other than widow rockfish and exvessel whiting fishery revenue. This figure shows the relationship between darkblotched rockfish, POP, and canary rockfish and exvessel revenue in the whiting fishery. From this figure, it is evident that darkblotched rockfish is predicted to be the second highest component of overfished species catch, followed by canary and POP respectively, and that a reduction in the catch of darkblotched rockfish that is on the order of 3 metric tons would correspond to a reduction in Pacific whiting revenues of $5.8 million.

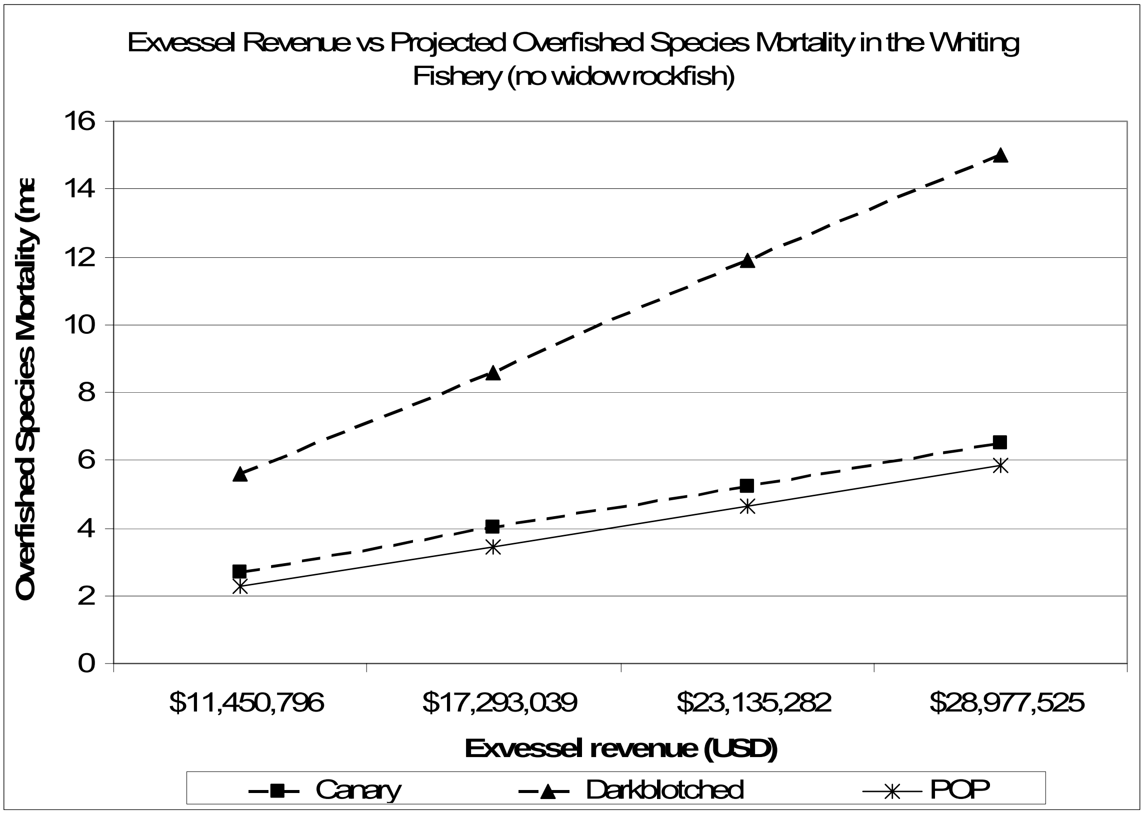

Figure 2 Exvessel Revenue vs Projected Overfished Species Catch in the Whiting Fishery (no widow rockfish)

3.2. Revenue – Overfished Species Catch Tradeoffs in the Fixed Gear Sablefish Fishery

Like the Pacific whiting fishery, the fixed gear sablefish fishery is a single target fishery. This sector is comprised of both open access and limited entry components, but both components are subject to the same area-based management, and therefore, the catch rate of overfished species in each component is assumed to be the same. While trawl fisheries are prone to "disaster tow" events where large quantities of overfished species can be caught in a single tow, fixed gear fisheries are typically not characterized by disaster-type catch events of the same degree. This means that it is likely the variability in the assumed proportion of overfished species to sablefish catch is small from year to year relative to trawl fisheries.

Figure 3 shows the predicted relationship between overfished species mortality and exvessel revenue. Based on these predictions, yelloweye rockfish is the largest component of overfished species mortality in this sector, and a reduction of approximately 0.2 metric tons of yelloweye rockfish in this sector would correspond to a reduction of approximately $1.8 million in exvessel revenues (holding area closures constant), while a reduction of 0.1 metric tons of darkblotched would correspond to a reduction of $1.8 million in exvessel revenue.

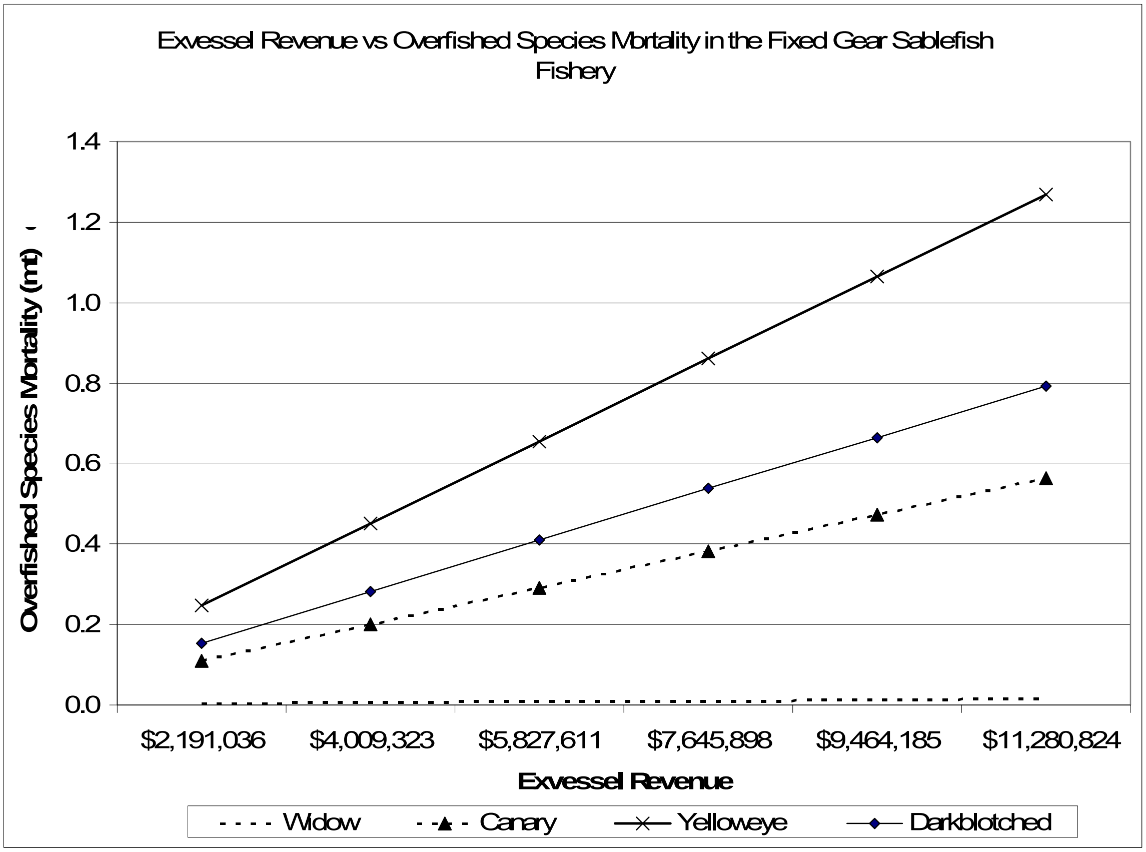

Figure 3 Exvessel Revenue vs Overfished Species Mortality in the Fixed Gear Sablefish Fishery

3.3. Revenue – Overfished Species Catch Tradeoffs in the Nearshore Open Access Groundfish Fishery

The nearshore open access fishery is a fishery that targets multiple species. Target species include shallow and deeper nearshore groundfish, cabezon, kelp greenling, black rockfish, and blue rockfish amongst others. Available data shows this fishery operates shallower than 50 fathoms, and primarily shallower than 20 fathoms. The targets in this fishery are often bound for different markets, and therefore have different prices per pound. In areas south of 40˚ 10’ N. lat., the most valuable species are shallow nearshore rockfish, followed by cabezon, kelp greenling, and deeper nearshore rockfish, respectively. In areas north of 40˚ 10’ N. lat., the most valuable species are “other minor nearshore rockfish” followed by kelp greenling, cabezon, black rockfish, and blue rockfish respectively. By prioritizing reductions in target species catch toward those species that are least valuable on a price per pound basis, reductions in the catch of overfished species can be achieved more cheaply than by reducing the catch of all target species on a proportional basis to achieve reductions in overfished species catch. To analyze reductions in overfished species catch, we prioritized those reductions toward the least valuable species, because vessels can alter their behavior to focus on or avoid different target species. This sector was analyzed as two components--north and south of 40˚ 10’ N. lat. We analyzed these two areas separately because management objectives have historically differed in the two areas.

Figure 4 shows the relationship between exvessel value and the mortality of canary rockfish in areas south of 40˚ 10’ N. lat. Based on West Coast groundfish observer data, canary rockfish is the only overfished species that is caught in this sector and region. The figure shows that a reduction in the catch of canary rockfish from 0.33 metric tons to 0.07 metric tons would cost approximately $400,000 (holding area closures constant), while a reduction in the catch of canary rockfish from 0.07 metric tons to 0.01 metric tons would cost over $1 million. However, over a range of values (approximately $1.3 million to $800,000) there is little or no reduction in the catch of canary rockfish. This is because over this revenue range, the approach taken to reduce the catch of overfished species is mostly being attributed to reductions in the catch of cabezon. Based on the depth range where cabezon is primarily caught, there is very little incidental catch of canary rockfish, and discard survival is high relative to deeper depths. Therefore, reducing the allowable cabezon catch in the area south of 40˚ 10’ N. lat. may not be necessary to achieve reductions in overfished species mortality.

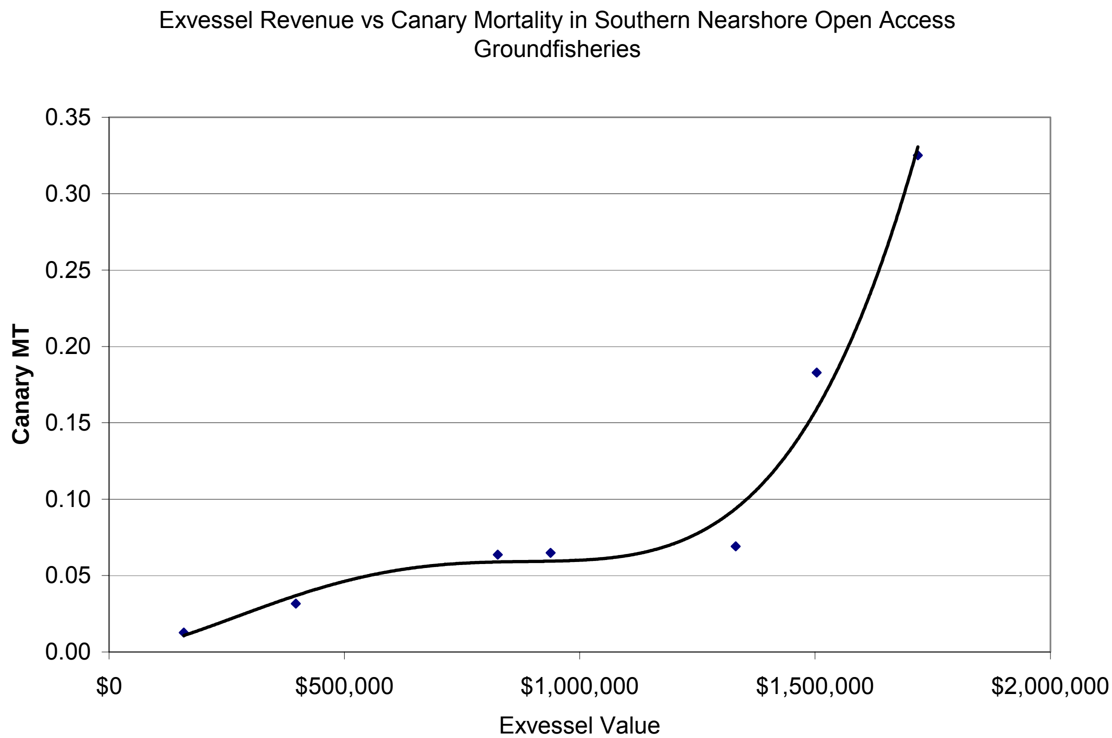

Figure 4 Exvessel Revenue vs Canary Mortality in Southern Nearshore Open Access Fisheries

Figure 5 shows the relationship between the catch of overfished species and exvessel revenue in areas north of 40˚ 10’ N. lat. This figure shows that yelloweye rockfish is the most frequently caught overfished species, followed by canary rockfish, and–although not shown on the figure–there are also small amounts of widow rockfish caught in the fishery. Information shown in this figure suggests that a reduction of yelloweye catch from 1.9 metric tons to 1 metric ton while holding area closures constant would decrease exvessel revenue by $400,000, while a reduction from 1 metric ton to 0.25 metric tons would decrease exvessel revenue by $500,000. A reduction in the catch of canary from 1.5 metric tons to 0.75 metric tons would decrease revenues by $400,000, and a reduction in the catch of canary from 0.75 metric tons to 0.25 metric tons would decrease exvessel revenues by approximately $500,000.

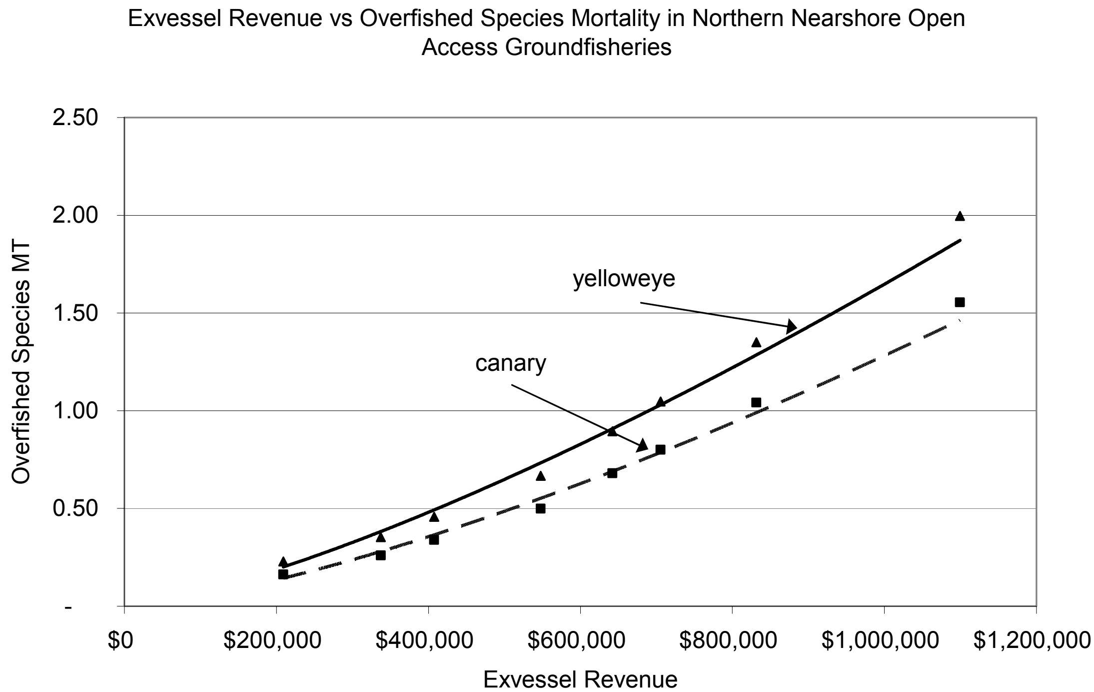

Figure 5 Exvessel Revenue vs Overfished Species Mortality in Northern Nearshore Open Access Fisheries

3.4. Revenue – Overfished Species Catch Tradeoffs in the Limited Entry Bottom Trawl Fishery

The limited entry bottom trawl fishery is a fishery that targets multiple species that include Dover sole, thornyheads, sablefish, petrale sole, arrowtooth flounder, Pacific sanddabs, and English sole, amongst others. This fishery operates on both the continental shelf and continental slope, and therefore has a relatively large impact on several overfished species including bocaccio rockfish, canary rockfish, darkblotched rockfish, cowcod, and Pacific ocean perch. The targets in this fishery all have a different price per pound. Typically sablefish and petrale sole have been the most valuable species on a price per pound basis, while arrowtooth has the lowest price per pound. Dover sole, Pacific sanddabs, English sole, and other types of flatfish tend to have a more moderate price per pound with Dover sole traditionally being one of the more valuable flatfish species.

The curves shown in this section are developed by taking the approach of reducing the catch of less valuable species (arrowtooth) first, and reducing the catch of the most valuable species (sablefish and petrale sole) last while attempting to maintain the same level of annual catch opportunity for target species both north and south. This approach assumes that vessels can alter their behavior to focus on or avoid different target species. For example, a reduction in the trip limit for the “other flatfish” complex in the northern areas is accompanied by an equivalent reduction in the southern areas. The effect of this approach is that it becomes increasingly more costly to reduce the catch of overfished species in this sector.

Figure 6 shows the relationship between the catch of canary rockfish and exvessel revenues in the LE bottom trawl fishery. Based on the curve that has been fitted to the various data points, reducing the catch of canary rockfish in this sector from 10 metric tons (a level comparable to 2005 estimated catch in this sector) to 8 metric tons would reduce exvessel revenues by approximately $2 million, while a reduction from 4 metric tons to 2 metric tons would reduce revenues approximately $7 million meaning that initial reductions in the catch of canary rockfish are relatively inexpensive per metric ton compared the cost per metric ton of more dramatic reductions.

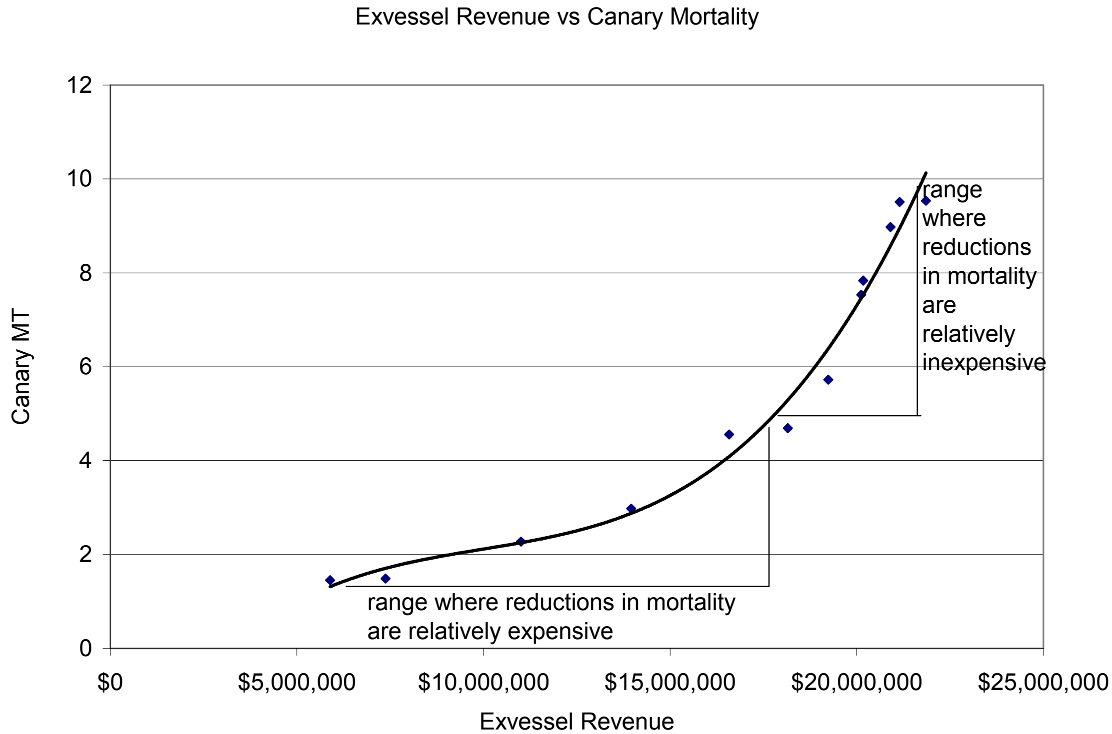

Figure 6 Exvessel Revenue vs Canary Mortality in the LE Bottom Trawl Sector

Figure 7 shows the relationship between Pacific ocean perch and exvessel revenues. According to Figure 7, reducing the catch of Pacific ocean perch in the bottom trawl sector from 100 metric tons to 80 metric tons would decrease revenues by approximately $3 million, while a reduction from 45 metric tons to 25 metric tons would decrease revenues by approximately $7 million. This shows that initial reductions in the catch of Pacific ocean perch in the bottom trawl fishery are relatively inexpensive per metric ton compared to the cost per metric ton of more dramatic reductions.

Also shown in the relationship between exvessel revenue and the catch of Pacific ocean perch is that the initial reductions in the catch of low valued species have little effect on the catch of Pacific ocean perch (the range of POP mortality corresponding to $20-$22 million). Since initial reductions in the allowable catch were targeted toward those species with a low price per pound (arrowtooth flounder), this means that the management of low valued species, such as arrowtooth flounder, have a relatively small impact on the catch of Pacific ocean perch compared to more moderately priced species such as Dover sole. Therefore, reductions in the mortality of Pacific ocean perch are likely to come from reductions in the targeting of more valuable species.

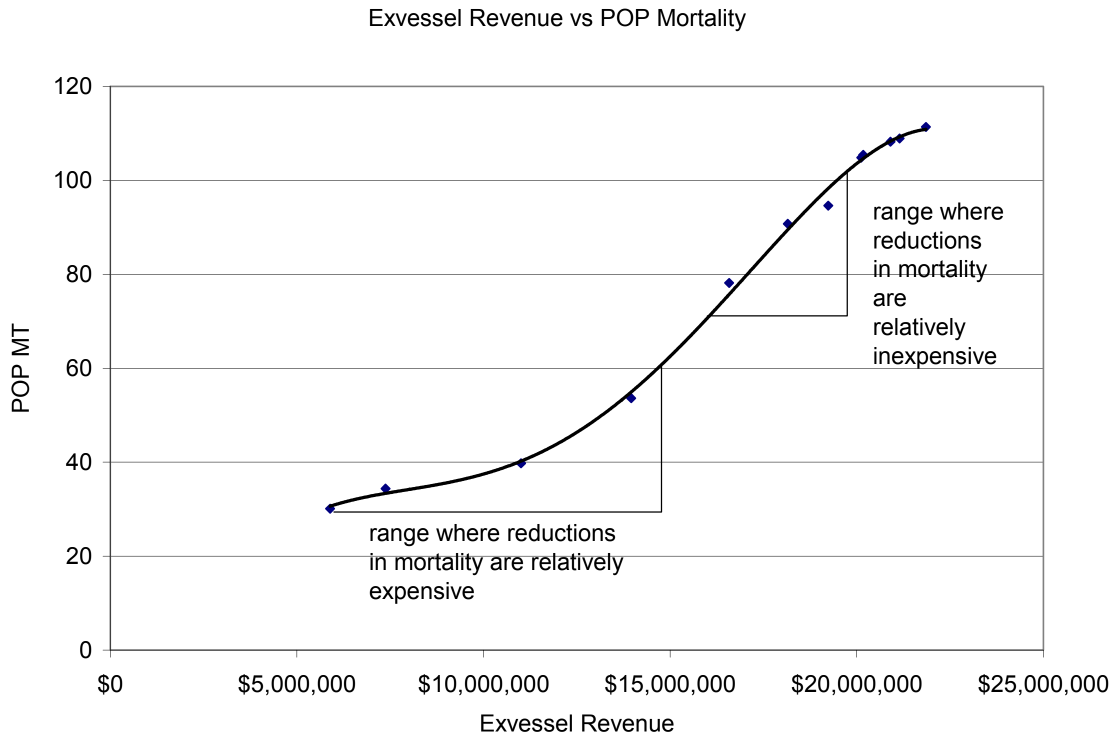

Figure 7 Exvessel Revenue vs Pacific Ocean Perch Mortality in the LE Bottom Trawl Sector

In Figure 8 the relationship between exvessel revenue and the mortality of darkblotched rockfish shows that reducing the catch of darkblotched rockfish from 140 metric tons to 120 metric tons would decrease revenues by approximately $2 million, while a reduction in the catch of darkblotched rockfish from 60 metric tons to 40 metric tons would decrease exvessel revenue by approximately $6 million. This shows that initial reductions in the catch of darkblotched rockfish in the bottom trawl fishery are relatively inexpensive per metric ton compared to the cost per metric ton of more dramatic reductions.

Like Pacific ocean perch, also shown in the relationship between exvessel revenue and the catch of darkblotched rockfish is that the initial reductions in the catch of low valued species have little effect on the catch of darkblotched (illustrated at the range of darkblotched mortality corresponding to $20-$22 million). Since initial reductions in the allowable catch were targeted toward those species with a low price per pound (arrowtooth flounder), this means that the management of arrowtooth flounder has a relatively small impact on the catch of darkblotched rockfish compared to more moderately priced species such as Dover sole, and reductions in darkblotched mortality are likely to correspond to reductions in the targeting of high valued species.

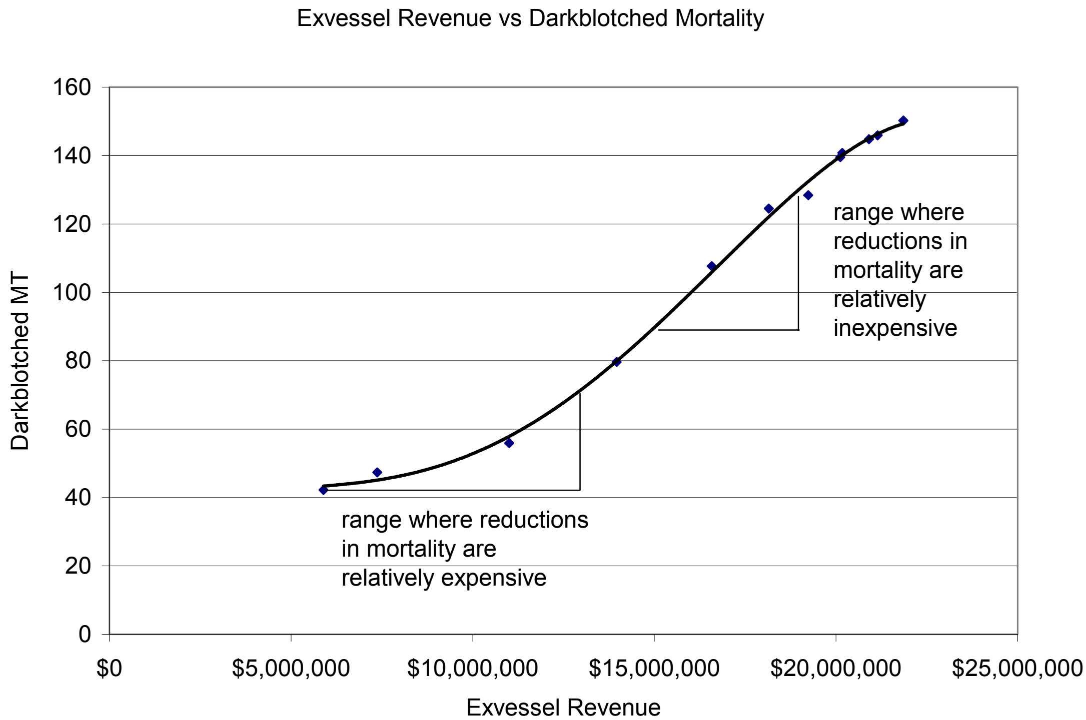

Figure 8 Exvessel Revenue vs Darkblotched Mortality in the LE Bottom Trawl Sector

Figure 9 shows the relationship between exvessel revenue and the catch of bocaccio rockfish. From this figure, reducing the catch of bocaccio rockfish from 45 metric tons to 25 metric tons would decrease exvessel revenues by approximately $2 million, while reducing the catch of bocaccio rockfish from 20 metric tons to 10 metric tons would decrease revenues by approximately $5 million. This shows that initial reductions in the catch of bocaccio rockfish in the bottom trawl fishery are relatively inexpensive per metric ton compared to the cost per metric ton of more dramatic reductions.

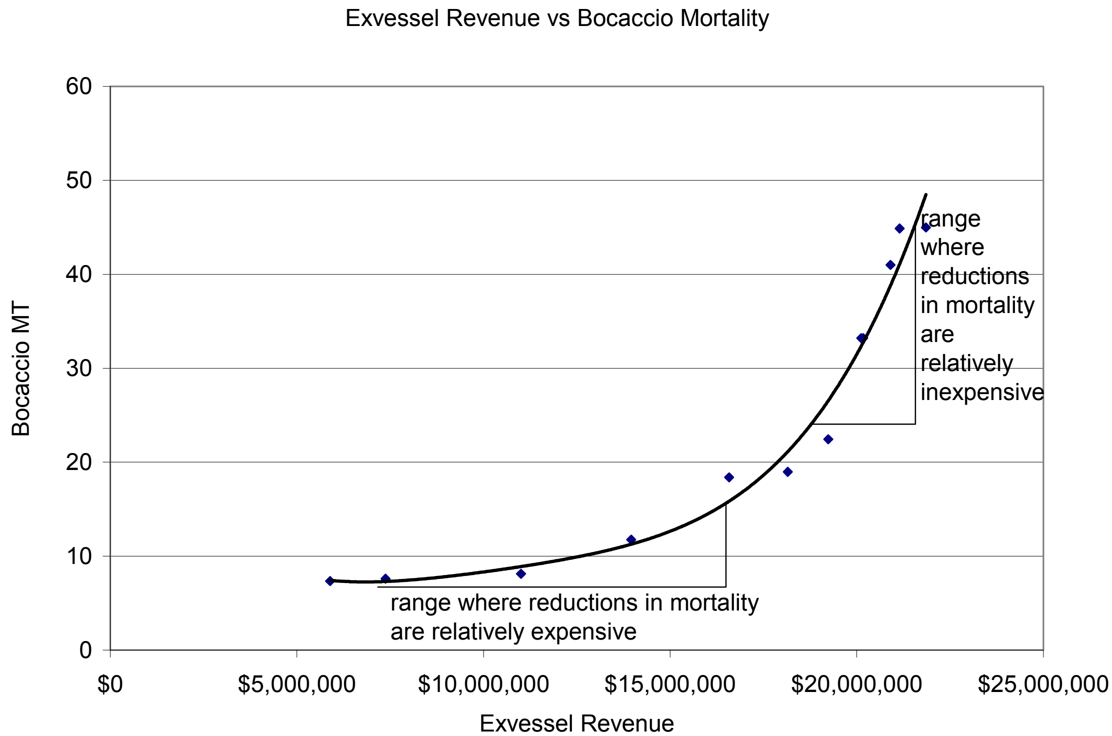

Figure 9 Exvessel Revenue vs Bocaccio Mortality in the LE Bottom Trawl Sector

Figure 10 shows the relationship between the catch of cowcod and exvessel revenue in the limited entry bottom trawl sector. This figure shows that reducing the catch of cowcod from 2 metric tons to 1.5 metric tons would decrease revenues by approximately $1 million, while reducing the catch of cowcod from 1 metric ton to 0.5 metric tons would decrease exvessel revenues by approximately $4 million.

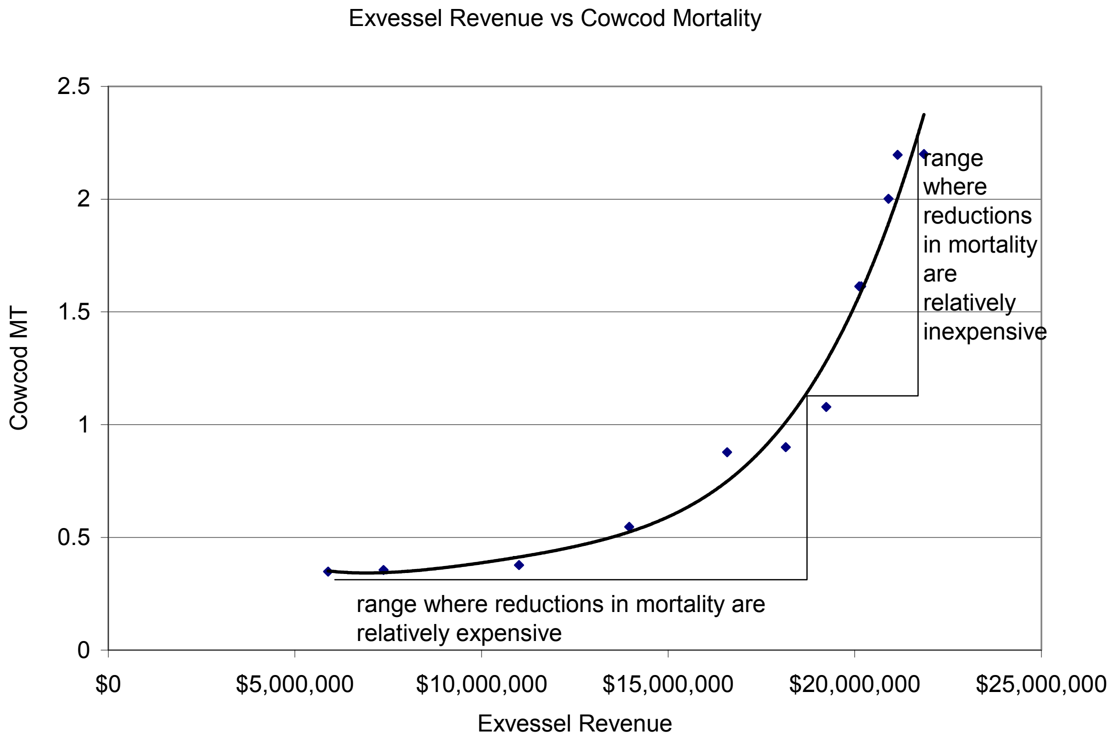

Figure 10 Exvessel Revenue vs Cowcod Mortality in the LE Bottom Trawl Sector

Figure 11 plots the mortality of all overfished species (in percentage terms) against exvessel revenue. In this case, the mortality of overfished species is normalized by estimating it as a percentage of initially predicted mortality in the 2006 fishery. The 100 percent mark is equivalent to predicted 2006 mortality. The difference between Figure 11 and other figures is that mortality is expressed on a percentage basis and compared to exvessel revenues, thus making changes in the mortality of overfished species more comparable.

Based on the information shown in Figure 11, percent reductions in the catch of darkblotched rockfish and POP are generally more costly than percent reductions in the catch of bocaccio rockfish and cowcod, while percent reductions in the catch of canary rockfish can be considered more moderate. The reason percent reductions in the catch of darkblotched and POP are more expensive than bocaccio, canary, and cowcod is because darkblotched and POP are caught in deep areas where more valuable species tend to be caught. Bocaccio rockfish and cowcod are caught largely on the shelf where less valuable flatfish are typically found. Canary rockfish on the other hand are primarily caught in the shelf areas, but small amounts of canary are also caught in deeper areas, thus making the value of a percent change in the catch of canary in-between the values of darkblotched and POP, versus bocaccio and cowcod. It is important to note that while some overfished species are caught together, many are not. Therefore, the information shown in Figure 11 should not be misinterpreted to mean that reductions in the mortality across multiple overfished species need to happen simultaneously.

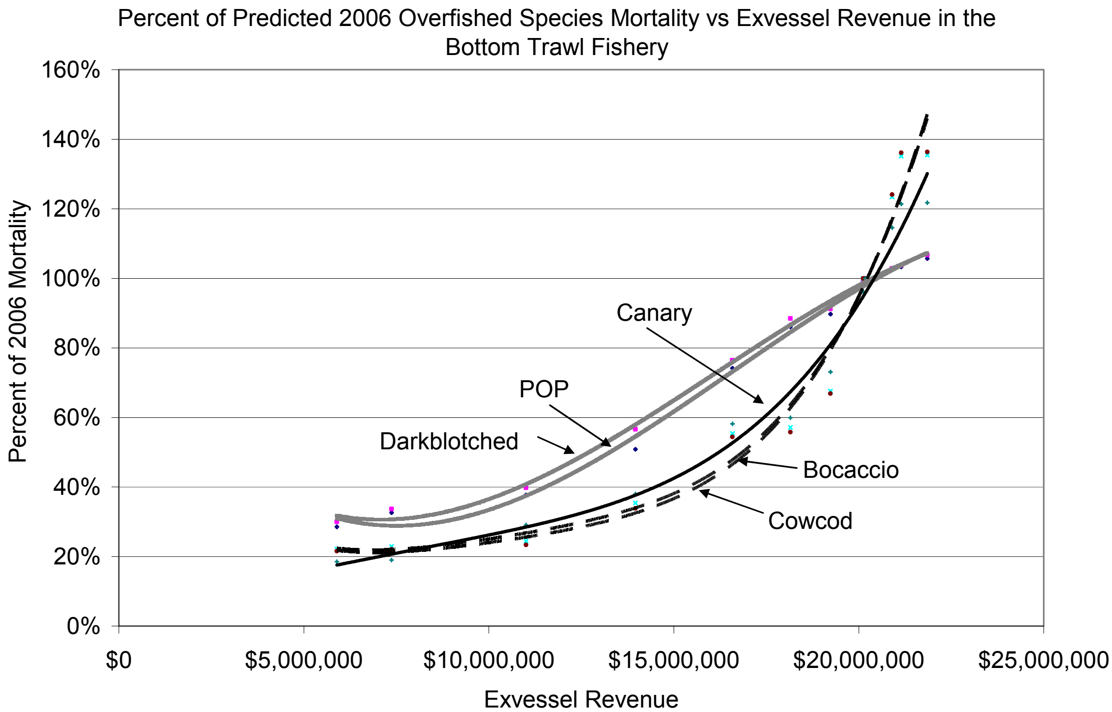

Figure 11 Exvessel Revenue vs Mortality for All Overfished Species

4. <u>Distributional Impacts of Changes in Overfished Species Catch in Commercial Groundfish Fisheries</u>

The analyses provided in the previous sections showed that overfished species have differential exvessel revenue associations and impacts across sectors. Some overfished species are primarily caught in a single sector, while other overfished species may be caught in multiple sectors. The sector and geographic distribution of economic impacts resulting from management designed to protect overfished species can be substantially different for each overfished species due to the occurrence of certain species across sectors, the latitudinal existence of overfished species, and the degree to which various ports are involved in different fisheries, among other things. This section provides information on the identification of sectors, regions, and ports that are affected by overfished species management, and identifies the degree to which those sectors, regions, or ports are likely to be affected by management that is designed to reduce the catch of overfished species. The underlying assumption is that fisheries with high impacts to overfished species are most likely to be restricted to achieve catch reductions in those overfished species. This assumption is reasonable given the fact that past approaches to achieve such reductions have prioritized catch reductions toward sectors with the highest degree of impact.

For reference purposes, available data on the range of overfished species, historical catch, and current catch of overfished species was used to show where overfished species are found and where they are currently caught in commercial fisheries. Areas where there are minimal amounts of overfished species caught were included, though in the next sections of the document, minimal amounts of impact are left blank and identified as a low or no impact. The relevance of the information shown in Table 1 and Table 2 is that commercial groundfish fisheries operating in the listed latitudinal areas pose some potential risk to the overfished stock even if that risk is minimal.

Table 1 Range Where Overfished Species are Currently Caught in the Commercial Fishery

	OVERFISHED SPECIES						
AREA	BOCACCIO	CANARY	COWCOD	DARKBLOTCHED	POP	WIDOW	YELLOWEYE
N 40 10		√		√	√	√	√
38 – 40 10	√	√		√		√	
36 - 38	√	√	√	√		√	
S 36	√		√				

1) although some of the species listed are caught outside the areas check-marked above, the check-mark only applies to the boundary where there is an ABC for these species
2) in some areas only minimal amounts of overfished species are currently caught. These areas are checked-marked

Table 2 Range Where Overfished Species are Potentially Caught in the Commercial Fishery

	OVERFISHED SPECIES						
AREA	BOCACCIO	CANARY	COWCOD	DARKBLOTCHED	POP	WIDOW	YELLOWEYE
N 40 10		√		√	√	√	√
38 – 40 10	√	√	√	√	√	√	√
36 - 38	√	√	√	√		√	√
S 36	√	√	√	√		√	

1) although some of the species listed are caught outside the areas check-marked above, the check-mark only applies to the boundary where there is an ABC for these species
2) in some areas only minimal amounts of overfished species have historically been caught. These areas are checked-marked

The following tables separate fishing sectors on a latitudinal basis and by the degree of impact on overfished species. We characterize each sector's overfished species effects as having one of four different possible degrees-of-impact: high, medium-high (MH), medium-low (ML), and low or no impact. The degree of impact was assigned relative to the ABC, the 2006 OY, and the relative 2004 and 2005 catch of overfished species estimated to have been taken in each sector. Table 3 shows the assigned level of impact criteria by region, sector, and overfished species. The criteria that were assigned are based partially on the catch of overfished species estimated to have been taken by sector in the 2004 and 2005 fisheries. If area boundaries and targeting opportunities were to be changed, these criteria may change as well. A blank cell means that sector has no, or low impact. While multiple cells are blank, it is important to note that does not necessarily mean a particular sector/area combination is ignored when it comes to reducing the catch of overfished species. In a relatively extreme case, sectors with a low impact may be constrained in addition to sectors with high, med-high, and med-low impacts. However, for the purposes of planning in the long term (one year or more), sectors with a low impact have not traditionally been subject to constraints to protect overfished species. Constraints on low impact fisheries have traditionally been limited to inseason actions.

Table 3 Level of Overfished Species Impact by Region and Groundfish Sector

		OVERFISHED SPECIES						
AREA	SECTOR	BCCCIO	CANARY	COWCD	D'BLTCH	POP	WIDOW	Y'EYE
N 40 10	LE FG-DOGFISH		ML					MH
	LE FG-NEARSHORE		ML					MH
	LE FG-SABLEFISH		ML					MH
	LE B-TRAWL-DEEP		ML		HIGH	HIGH		
	LE B-TRAWL-SHELF		HIGH					
	LE MW-TRAWL-WHITING		HIGH		ML	ML	HIGH	
	OA FG-DOGFISH		ML					MH
	OA FG-NEARSHORE		MH					MH
	OA FG-SABLEFISH		ML					MH
38 - 40 10	LE FG-NEARSHORE	ML	ML					
	LE FG-SABLEFISH	ML	ML					
	LE B-TRAWL-DEEP	ML	ML		MH			
	LE B-TRAWL-SHELF	HIGH	MH					
	OA FG-NEARSHORE	ML	ML					
	OA FG-SABLEFISH	ML	ML					
36 - 38	LE FG-NEARSHORE	ML	ML	ML				
	LE FG-SABLEFISH	ML	ML	ML				
	LE B-TRAWL-DEEP	ML	ML					
	LE B-TRAWL-SHELF	HIGH	ML	MH				
	OA FG-NEARSHORE	ML	ML	ML				
	OA FG-SABLEFISH	ML	ML	ML				
S 36	LE FG-NEARSHORE	ML		ML				
	LE FG-SABLEFISH	ML		ML				
	LE B-TRAWL-DEEP	ML						
	LE B-TRAWL-SHELF	HIGH		MH				
	OA FG-NEARSHORE	ML		ML				
	OA FG-SABLEFISH	ML		ML				

Table 4 and Table 5 show the relationship between fishery sectors and ports. In these tables, a check-mark identifies a port as being engaged in a particular sector. From this information it is apparent that the sablefish sectors are present in the largest number of ports, and the dogfish sectors are present in the fewest number of ports. What is not contained in this type of information is the scale and relative degree of dependence that each port has on the particular sectors that port is engaged in. However, if one defines a fishing community as a port, or as a port-sector combination, this information can be used to identify communities that are substantially engaged in commercial groundfish fisheries.

Table 4 Port Engagement in Groundfish Sectors in Areas North of 40 Degrees 10 Minutes Latitude

		SECTOR								
AREA	PORT	LE B-TRAWL-DEEP	LE B-TRAWL-SHELF	LE FG-DOGFISH	LE FG-NEARSHORE	LE FG-SABLEFISH	LE MW-TRAWL-WHITING	OA FG-DOGFISH	OA FG-NEARSHORE	OA FG-SABLEFISH
N 40 10	ABERDEEN									√
	ASTORIA	√	√		√	√	√			√
	BANDON									√
	BELLINGHAM BAY	√	√	√		√		√		√
	BLAINE	√	√	√		√				
	BROOKINGS	√	√			√			√	√
	CATHLAMET					√				
	CHARLESTON (COOS BAY)	√	√			√	√		√	√
	CHINOOK					√				√
	CRESCENT CITY	√	√		√	√	√		√	√
	DEPOE BAY								√	
	EUREKA	√	√			√	√		√	√
	EVERETT					√				
	FIELDS LANDING									√
	FLORENCE									√
	GARIBALDI (TILLAMOOK)					√			√	√
	GOLD BEACH								√	
	ILWACO					√	√			√
	LAPUSH					√				√
	MILL CREEK								√	
	NEAH BAY	√	√			√				√
	NEWPORT	√	√			√	√		√	√
	PACIFIC CITY								√	
	PORT ANGELES					√				√
	PORT ORFORD				√	√			√	√
	PORT TOWNSEND									√
	SEATTLE						√			√
	TOKELAND									√
	TRINIDAD								√	
	WESTPORT	√	√			√	√			√
	WINCHESTER BAY					√				√

Table 5 Port Engagement in Groundfish Fisheries in Areas South of 40 Degrees 10 Minutes Latitude

		SECTOR								
AREA	PORT	LE B-TRAWL-DEEP	LE B-TRAWL-SHELF	LE FG-DOGFISH	LE FG-NEARSHORE	LE FG-SABLEFISH	LE MW-TRAWL-WHITING	OA FG-DOGFISH	OA FG-NEARSHORE	OA FG-SABLEFISH
38 - 40 10	ALBION								√	
	BODEGA BAY					√			√	
	FORT BRAGG	√	√			√			√	√
	POINT ARENA								√	
	POINT REYES									√
	SHELTER COVE								√	
36 - 38	BIG CREEK								√	
	BODEGA BAY									√
	ELK									√
	MONTEREY	√	√			√			√	√
	MOSS LANDING	√	√			√			√	√
	PRINCETON / HALF MOON BAY	√	√			√			√	√
	SAN FRANCISCO	√	√		√	√			√	√
	SANTA CRUZ								√	
	SANTA CRUZ									√
S 36	AVILA					√			√	
	BERKELEY								√	
	DANA POINT					√				
	LONG BEACH					√				
	MISSION BAY					√				√
	MORRO BAY	√	√			√			√	√
	NEWPORT BEACH					√				
	OCEANSIDE					√				√
	OXNARD				√	√			√	√
	PLAYA DEL REY					√				
	POINT LOMA									√
	SAN DIEGO								√	√
	SAN PEDRO								√	
	SAN SIMEON								√	
	SANTA BARBARA				√				√	
	TERMINAL ISLAND					√				√
	VENTURA								√	√
	WILMINGTON				√					

Through the association of fishing sectors, management to achieve reductions in the catch of overfished species, and port of landing for vessels engaged in various fishing sectors, we can identify which ports would likely be affected by management designed to achieve reductions in the catch of certain overfished species. Table 6 associates regional fishing sectors with greater than a “low/no” impact to identify ports potentially affected if reductions in the catch of overfished species are necessary. This information shows that canary rockfish would potentially affect the largest number of ports, followed by bocaccio, yelloweye, cowcod, darkblotched, POP, and widow rockfish respectively. This table also shows that many ports in the north are potentially affected by up to five overfished species, while ports in the south are affected by two or three overfished species. Individual overfished species also have different regional impacts. For example, while cowcod and bocaccio may not impact the largest number of ports, they potentially affect all commercial groundfish ports south of 38˚ N. lat.

Table 6 Ports Potentially Impacted by Reductions in Overfished Species Catch

		OVERFISHED SPECIES						
AREA	PORT	BCACCIO	CANARY	COWCOD	DRKBLTCH	POP	WIDOW	Y'EYE
N 40 10	ABERDEEN		√					√
	ASTORIA		√		√	√	√	√
	BANDON		√					√
	BELLINGHAM BAY		√		√	√		√
	BLAINE		√		√	√		√
	BROOKINGS		√		√	√		√
	CATHLAMET		√					√
	CHARLESTON (COOS BAY)		√		√	√	√	√
	CHINOOK		√					√
	CRESCENT CITY		√		√	√	√	√
	DEPOE BAY		√					√
	EUREKA		√		√	√	√	√
	EVERETT		√					√
	FIELDS LANDING		√					√
	FLORENCE		√					√
	GARIBALDI (TILLAMOOK)		√					√
	GOLD BEACH		√					√
	ILWACO		√		√	√	√	√
	LAPUSH		√					√
	MILL CREEK		√					√
	NEAH BAY		√		√	√		√
	NEWPORT		√		√	√	√	√
	PACIFIC CITY		√					√
	PORT ANGELES		√					√
	PORT ORFORD		√					√
	PORT TOWNSEND		√					√
	SEATTLE		√				√	√
	TOKELAND		√					√
	TRINIDAD		√					√
	WESTPORT		√		√	√	√	√
	WINCHESTER BAY		√					√
38 – 40 10	ALBION	√	√					
	BODEGA BAY	√	√					
	FORT BRAGG	√	√		√			
	POINT ARENA	√	√					
	POINT REYES	√	√					
	SHELTER COVE	√	√					
36 - 38	BIG CREEK	√	√	√				
	BODEGA BAY	√	√	√				
	ELK	√	√	√				
	MONTEREY	√	√	√				
	MOSS LANDING	√	√	√				
	PRINCETON / HALF MOON BAY	√	√	√				
	SAN FRANCISCO	√	√	√				
	SANTA CRUZ	√	√	√				
	SANTA CRUZ	√	√	√				
S 36	AVILA	√		√				
	BERKELEY	√		√				
	DANA POINT	√		√				
	LONG BEACH	√		√				
	MISSION BAY	√		√				
	MORRO BAY	√		√				
	NEWPORT BEACH	√		√				
	OCEANSIDE	√		√				
	OXNARD	√		√				
	PLAYA DEL REY	√		√				
	POINT LOMA	√		√				
	SAN DIEGO	√		√				
	SAN PEDRO	√		√				
	SAN SIMEON	√		√				
	SANTA BARBARA	√		√				
	TERMINAL ISLAND	√		√				
	VENTURA	√		√				
	WILMINGTON	√		√				

Each sector/region combination has a different level of impact on overfished species, and therefore, a different likelihood that sector would be impacted by management if reductions in the catch of overfished species are necessary. Table 7 through Table 10 shows the relative likelihood that a particular area/sector/port combination would need to be restricted in order to achieve reductions in the aggregate catch of overfished species. Blank cells indicate a low/no likelihood that a particular area/sector/port combination would need to be restricted to achieve reductions in the aggregate catch of overfished species.

Table 7 Relative Likelihood of LE Trawl Ports Being Affected by Management to Reduce Overfished Species Catch

AREA	SECTOR	PORT	BCACCIO	CANARY	COWCOD	DRKBLTCH	POP	WDOW
N 40 10	LE B-TRAWL-DEEP	ASTORIA		ML		HIGH	HIGH	
		BELLINGHAM BAY		ML		HIGH	HIGH	
		BLAINE		ML		HIGH	HIGH	
		BROOKINGS		ML		HIGH	HIGH	
		CHARLESTON		ML		HIGH	HIGH	
		CRESCENT CITY		ML		HIGH	HIGH	
		EUREKA		ML		HIGH	HIGH	
		NEAH BAY		ML		HIGH	HIGH	
		NEWPORT		ML		HIGH	HIGH	
		WESTPORT		ML		HIGH	HIGH	
	LE B-TRAWL-SHELF	ASTORIA		HIGH				
		BELLINGHAM BAY		HIGH				
		BLAINE		HIGH				
		BROOKINGS		HIGH				
		CHARLESTON		HIGH				
		CRESCENT CITY		HIGH				
		EUREKA		HIGH				
		NEAH BAY		HIGH				
		NEWPORT		HIGH				
		WESTPORT		HIGH				
	LE MW-TRAWL-WHITING	ASTORIA		HIGH		ML	ML	HIGH
		CHARLESTON		HIGH		ML	ML	HIGH
		CRESCENT CITY		HIGH		ML	ML	HIGH
		EUREKA		HIGH		ML	ML	HIGH
		ILWACO		HIGH		ML	ML	HIGH
		NEWPORT		HIGH		ML	ML	HIGH
		SEATTLE		HIGH				HIGH
		WESTPORT		HIGH		ML	ML	HIGH
38 - 40 10	LE B-TRAWL-DEEP	FORT BRAGG	ML	ML		MH		
	LE B-TRAWL-SHELF	FORT BRAGG	HIGH	MH				
36 - 38	LE B-TRAWL-DEEP	MONTEREY	ML	ML				
		MOSS LANDING	ML	ML				
		PRINCETON / HALF MOON BAY	ML					
		SAN FRANCISCO	ML	ML				
	LE B-TRAWL-SHELF	MONTEREY	HIGH	ML	MH			
		MOSS LANDING	HIGH	ML	MH			
		PRINCETON / HALF MOON BAY	HIGH	ML	MH			
		SAN FRANCISCO	HIGH	ML	MH			
S 36	LE B-TRAWL-DEEP	MORRO BAY	ML					
	LE B-TRAWL-SHELF	MORRO BAY	HIGH		MH			

Table 8 Relative Likelihood of LE Fixed Gear Ports Being Affected by Management to Reduce Overfished Species Catch

			OVERFISHED SPECIES			
AREA	SECTOR	PORT	BOCACCIO	CANARY	COWCOD	YELLOWEYE
N 40 10	LE FG-DOGFISH	BELLINGHAM BAY		ML		MH
		BLAINE		ML		MH
	LE FG-NEARSHORE	ASTORIA		ML		MH
		CRESCENT CITY		ML		MH
		PORT ORFORD		ML		MH
	LE FG-SABLEFISH	ASTORIA		ML		MH
		BELLINGHAM BAY		ML		MH
		BLAINE		ML		MH
		BROOKINGS		ML		MH
		CATHLAMET		ML		MH
		CHARLESTON		ML		MH
		CHINOOK		ML		MH
		CRESCENT CITY		ML		MH
		EUREKA		ML		MH
		EVERETT		ML		MH
		GARIBALDI		ML		MH
		ILWACO		ML		MH
		LAPUSH		ML		MH
		NEAH BAY		ML		MH
		NEWPORT		ML		MH
		PORT ANGELES		ML		MH
		PORT ORFORD		ML		MH
		WESTPORT		ML		MH
		WINCHESTER BAY		ML		MH
38 - 40 10	LE FG-SABLEFISH	BODEGA BAY	ML	ML		
		FORT BRAGG	ML	ML		
36 - 38	LE FG-NEARSHORE	SAN FRANCISCO	ML	ML	ML	
	LE FG-SABLEFISH	MONTEREY	ML	ML	ML	
		MOSS LANDING	ML	ML	ML	
		PRINCETON / HALF MOON BAY	ML	ML	ML	
		SAN FRANCISCO	ML	ML	ML	
S 36	LE FG-NEARSHORE	OXNARD	ML		ML	
		SANTA BARBARA	ML		ML	
		WILMINGTON	ML		ML	
	LE FG-SABLEFISH	AVILA	ML		ML	
		DANA POINT	ML		ML	
		LONG BEACH	ML		ML	
		MISSION BAY	ML		ML	
		MORRO BAY	ML		ML	
		NEWPORT BEACH	ML		ML	
		OCEANSIDE	ML		ML	
		OXNARD	ML		ML	
		PLAYA DEL REY	ML		ML	
		TERMINAL ISLAND	ML		ML	

Table 9 Relative Likelihood of OA Fixed Gear Ports North of 40 Degrees 10 Minutes Latitude Being Affected by Management to Reduce Overfished Species Catch

			OVERFISHED SPECIES			
AREA	SECTOR	PORT	BOCACCIO	CANARY	COWCOD	YELLOWEYE
N 40 10	OA FG-DOGFISH	BELLINGHAM BAY		ML		MH
	OA FG-NEARSHORE	BROOKINGS		MH		MH
		CHARLESTON (COOS BAY)		MH		MH
		CRESCENT CITY		MH		MH
		DEPOE BAY		MH		MH
		EUREKA		MH		MH
		GARIBALDI (TILLAMOOK)		MH		MH
		GOLD BEACH		MH		MH
		MILL CREEK		MH		MH
		NEWPORT		MH		MH
		PACIFIC CITY		MH		MH
		PORT ORFORD		MH		MH
		TRINIDAD		MH		MH
	OA FG-SABLEFISH	ABERDEEN		ML		MH
		ASTORIA		ML		MH
		BANDON		ML		MH
		BELLINGHAM BAY		ML		MH
		BROOKINGS		ML		MH
		CHARLESTON (COOS BAY)		ML		MH
		CHINOOK		ML		MH
		CRESCENT CITY		ML		MH
		EUREKA		ML		MH
		FIELDS LANDING		ML		MH
		FLORENCE		ML		MH
		GARIBALDI (TILLAMOOK)		ML		MH
		ILWACO		ML		MH
		LAPUSH		ML		MH
		NEAH BAY		ML		MH
		NEWPORT		ML		MH
		PORT ANGELES		ML		MH
		PORT ORFORD		ML		MH
		PORT TOWNSEND		ML		MH
		SEATTLE		ML		MH
		TOKELAND		ML		MH
		WESTPORT		ML		MH
		WINCHESTER BAY		ML		MH

Table 10 Relative Likelihood of OA Fixed Gear Ports South of 40 Degrees 10 Minutes Latitude Being Affected by Management to Reduce Overfished Species Catch

			OVERFISHED SPECIES			
AREA	SECTOR	PORT	BOCACCIO	CANARY	COWCOD	YELLOWEYE
38 - 40	OA FG-NEARSHORE	ALBION	ML	ML		
		BODEGA BAY	ML	ML		
		FORT BRAGG	ML	ML		
		POINT ARENA	ML	ML		
		SHELTER COVE	ML	ML		
	OA FG-SABLEFISH	FORT BRAGG	ML	ML		
		POINT REYES	ML	ML		
36 - 38	OA FG-NEARSHORE	BIG CREEK	ML	ML	ML	
		MONTEREY	ML	ML	ML	
		MOSS LANDING	ML	ML	ML	
		PRINCETON / HALF MOON BAY	ML	ML	ML	
		SAN FRANCISCO	ML	ML	ML	
		SANTA CRUZ	ML	ML	ML	
	OA FG-SABLEFISH	BODEGA BAY	ML	ML	ML	
		ELK	ML	ML	ML	
		MONTEREY	ML	ML	ML	
		MOSS LANDING	ML	ML	ML	
		PRINCETON / HALF MOON BAY	ML	ML	ML	
		SAN FRANCISCO	ML	ML	ML	
		SANTA CRUZ	ML	ML	ML	
S 36	OA FG-NEARSHORE	AVILA	ML		ML	
		BERKELEY	ML		ML	
		MORRO BAY	ML		ML	
		OXNARD	ML		ML	
		SAN DIEGO	ML		ML	
		SAN PEDRO	ML		ML	
		SAN SIMEON	ML		ML	
		SANTA BARBARA	ML		ML	
		VENTURA	ML		ML	
	OA FG-SABLEFISH	MISSION BAY	ML		ML	
		MORRO BAY	ML		ML	
		OCEANSIDE	ML		ML	
		OXNARD	ML		ML	
		POINT LOMA	ML		ML	
		SAN DIEGO	ML		ML	
		TERMINAL ISLAND	ML		ML	
		VENTURA	ML		ML	

5. Summary

In general, this document can be separated in two parts. The first section shows the relationship between exvessel revenue and overfished species mortality. The second section shows the relationship between sectors, ports, and regions and overfished species management. Each section has an implied management strategy that is somewhat different but complimentary. The first section implies that incidental catch of overfished species is achieved by reducing the targeting of least valuable species first in order to maintain the highest level of exvessel revenue. The second section implies that sectors that have the largest impact on overfished species will be the most likely sector to be restricted in order to achieve reductions in overfished species catch. While these approaches appear different, both are used on a routine basis in management. The management strategy implied within the first section is used on a within-sector basis, while the management strategy implied within the second section is used on an across-sector basis. That is, in order to achieve some level of mortality for a specific sector (like the limited entry bottom trawl or open access sector), management has historically been designed to maintain targeting of the most valuable species within that sector. If total reductions in overfished species mortality on a coastwide basis are necessary, management strategies are more likely to look for those reductions to come from sectors that have the largest degree of impact. This second approach is routinely used because a smaller percent decrease in exvessel revenues is more likely to achieve substantial reductions in overfished species mortality in a sector that has a high impact on overfished species than in a sector with a small impact on overfished species. Put in other words, if a 5 metric ton reduction in the mortality of widow rockfish is necessary, it is estimated that it would cost the whiting fleet 3% of revenues (assuming a decrease in the whiting OY from 280,000 to 270,392 mt) whereas if that reduction came from other sectors, it may require a complete closure of multiple sectors to achieve that same reduction.

The first section of this document showed that management measures protecting different overfished species have different exvessel revenue impacts on a particular sector. The catch of darkblotched rockfish in the bottom trawl fishery for example is generally associated with the catch of high valued target species, whereas the catch of bocaccio rockfish is more often associated with the catch of lower valued shelf flatfish species. This means that it is more costly to achieve a given percent reduction in darkblotched rockfish catch than to achieve that same percent reduction in bocaccio rockfish catch. In addition to different overfished species having different implied relative values, the distribution of these impacts across fishing communities can also be substantially different. While darkblotched rockfish arguably has a higher implied value in the bottom trawl fishery than bocaccio rockfish, management designed to achieve a reduction in bocaccio rockfish catch would affect many more ports and sectors than management designed to achieve reductions in darkblotched rockfish catch.

These findings have several implications depending on the management objective. If the objective is to affect the fewest number of ports and sectors, then it would arguably make sense to keep the catch of species that impact large numbers of ports and sectors like bocaccio relatively high. However, if the objective is to maintain total exvessel revenues at the highest possible level, then it arguably would make sense to keep the catch of species associated with high valued target species–such as darkblotched rockfish in the bottom trawl fishery–relatively high. In reality, the objective may be some combination of both.

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