# 4.0 Impacts of the Alternatives

## 4.1 Introduction

In this chapter, the potential impacts of the six alternatives, including no action, are analyzed by evaluating seven types of effects required by NEPA: direct and indirect, cumulative, short and long term, and irreversible and irretrievable effects.

Each of the six alternatives would establish a bycatch mitigation program, including mitigation policies and the types of measures that would be used to reduce bycatch and bycatch mortality as much as practicable. Each alternative also would establish the bycatch reporting methodology necessary to support the bycatch mitigation program.

Bycatch mitigation effects fall into four broad categories:

- Avoid catching fish that will not be kept and avoid catching other animals
- Reduce the mortality of fish and other animals that are caught and released
- Reduce the waste of fish that are caught and are dead or will die as a result of being caught
- Avoid unobserved mortality of fish and other animals that directly results from fishing gear.

In addition, there are social and economic effects. The highest priority of bycatch mitigation is to reduce the capture of any marine plant or animal that is unintended or unwanted. The goal is to harvest desired groundfish with the minimum impact on all other fish and animals. The second priority is to minimize damage to fish and animals that should or would not be caught in a perfectly selective fishery.

To evaluate the effects and effectiveness of various mitigation tools, it is useful to understand some basic relationships and linkages. The amount of catch of any fish or other animal is related to the amount of fishing effort, the selectivity of the gear, and the number of animals present. To reduce catch, any or all of these three factors can be modified.

The complicated relationships among these factors become evident when one considers more than one species at a time. No gear is equally selective for two species because of differences, however small, in species shape, size and behavior. Also, species abundance and distribution are never identical. This means that with any amount of fishing effort, the catch of two species will never be the same. The extent of geographic overlap affects the co-occurring catch, as does the degree of similarity in size and shape. While overall averages can be computed, those ratios may not provide the necessary information to develop comprehensive solutions.

We describe the capture methods of the various fishing gears, including selectivity features and placement factors (that is, where and in what conditions can they be used?). We identify non-gear related regulations that can be used, such as harvest specifications, allocation, retention limits, catch/mortality limits, time/area management, and limiting access (reducing fleet size). Collectively, we refer to these management measures as the bycatch mitigation toolbox. Potential effects of each tool are then described. Next, we rank the effects and effectiveness of each tool, and then apply those ranks to each alternative. In this stepwise process, we provide the basis for modifying any alternative to better achieve the intended goals, taking into account the costs associated with any changes.

We describe in some detail the effects of each tool, focusing on effectiveness, collateral/side effects, etc. We also discuss the economic factors that influence fishing behavior, including costs of capturing unwanted fish and of avoiding their capture.

Recognizing that each alternative is a combination of objectives, emphasis, and mitigation tools, we then describe the combined effects of each alternative. Synergistic and antagonistic effects are identified and described to the extent possible.

Next, we rank the alternatives as to how well they achieve the desired results, noting the administrative and user costs associated with each. The bycatch mitigation programs described in each of the alternatives have differing levels of practicability and/or costliness. Each of the alternatives is rated for its practicability in terms of its effects on management and enforcement costs.

The emphasis, levels of effects, and degree of impacts on biological and fishing communities vary among the different alternatives. One objective of this analysis is to illustrate this tension and evaluate pros and cons, benefits and costs of each alternative. Impacts of alternatives to groundfish, non-groundfish, ecosystem and habitat, and social/economic environment will be evaluated. As this EIS is programmatic in nature, critical comparative methods will be used. Possible analytical methods that might be used to quantify impacts of more specific plans to reduce bycatch, bycatch mortality, and to improve accountability are described. Cost estimates of alternative monitoring programs, where available, are provided.

### 4.1.1 How this Chapter is Organized

##Revise this after you've figured out the end sections##
This section generally follows the organization of Chapter 3. This chapter outlines available bycatch mitigation tools and general impacts of their application. The methods used to evaluate alternatives are described next. Each alternative is presented with corresponding tools used to mitigate for bycatch, bycatch mortality, and to address bycatch accountability. Direct and indirect effects are

described in Sections 4.2 through 4.11 Impacts to physical environment are outlined in Section 4.2. Impacts of the seven alternatives on the biological environment are described in Section 4.3. Detailed effects of alternatives on groundfish are contained in Appendix B. Section 4.4 provides analysis of impacts on the social and economic environment. Section 4.5 summarizes impacts of each alternative proposed monitoring program. Section 4.6 summarizes impacts to the biological environment. Section 4.7 describes socioeconomic impacts.

### 4.1.2 Description of Critical Comparative Methods Used: The Ranking System

Fishing has both intended effects (catching desirable fish) and unintended effects. The costs and benefits of these effects can rarely be measured or evaluated precisely, and are often subjective, based on the perspective of the observer. Bycatch and bycatch mortality of living resources are unintentional side effects of fishing; they can be viewed as collateral damage to other living marine resources. These effects can broadly be described as direct effects, indirect effects, and cumulative; short-term and long-term; reversible and irreversible. Some effects equate to irretrievable costs, meaning permanent change that cannot be undone, or would require such a huge investment that attempted retrieval/correction would be futile.

Fisheries data reporting and monitoring are human activities to determine the effects of fishing activities. Some can be accomplished by the fishers themselves; other monitoring is most effectively done by professionals trained in data recording and/or monitoring. Often it is impossible for the fisher or vessel crew to perform both fishing activities and data activities simultaneously; it requires additional manpower. Some data collection and monitoring can be done on shore, some can only be done at-sea. Enforcement programs are also an element of an effective management plan.

The fishery management tools chosen to mitigate intentional and unintentional effects of fishing, such as bycatch and bycatch mortality, are compared for each alternative. In addition, different approaches to fishery monitoring used to estimate total catch and improve accountability are compared.

A numerical ranking scheme is used to help evaluate differences and determine significance of direct, indirect, and cumulative effects. This ranking scheme also contributes to a practicability analysis; that is, it will help determine how practicable a particular tool or alternative may be. The ranking scheme uses ranges of scores. A narrow range (a scale of 1 - 2) is used where there is little difference in effects across alternatives and species, or where the distinction is very clear. For example, the effect either occurs or does not occur, and there is no median. A broader range (for example, a scale of 1 to 5) is used where the tools (or their application) have a wider range of effects on bycatch, bycatch reduction, and accountability. This is useful where there is a gradation of effects or

effectiveness. Anticipated costs are also ranked (high or low). The analysts assigned the ranks based on documented research, previous analyses, personal experience and best professional judgement. In each case these are qualitative judgements, and the ranking are not intended to be viewed as objective measurements or calculations. A lower numerical score (for example, 1) indicates the tool has a greater effect on reducing bycatch, bycatch mortality, or it increases accountability compared to the status quo alternative and possibly other alternatives.

The following example of catch limits uses a scale of 1 - 4. The example is provided to help clarify the ranking system. Differences in ranking between alternatives are due to differences in degree of effectiveness in the application of a tool (See Section 4.1.5).

Catch limits in various forms may be used to reduce bycatch of groundfish species (see Tables 4.3.1 - 4.3.12 in Section 4.3). For Alternatives 1-3, the Council would use a score card approach to keep track of soft allocations or divisions of a total catch OY, but reaching a predicted value does not trigger sector closure. Alternative 4 uses individual vessel caps for overfished species and hard sector caps; these do trigger closure either for individual vessels or for the entire sector. Alternative 5 uses a combination of individual fishing mortality limits (called RSQs in this document), a 100% retention requirement for overfished species, and IFQs for other groundfish. Individual vessels must stop when they reach a quota. Alternative 6 combines no-take marine reserves, RSQs, IFQs, and a 100% retention requirement for all groundfish. Alternative 7, the preferred alternative initiates sector based catch limits outlined in alternative 4 and contemplates future use of IFQs described in alternative 5.

Soft sector score cards are less effective at controlling bycatch, in part because there is no retention requirement. A catch cap with a retention requirement is a more effective tool for reducing bycatch. This is especially true when combined with a higher level of monitoring, incentives to keep the catch, or means to purchase additional catch share. Ranking of the catch limit tool for each alternative, therefore, is influenced by the specific application of the tool and by other tools that act as catalysts, increasing or decreasing the effectiveness of the tool.

In this example, Alternatives 1, 2 and 3 each receive a score of 4 (lowest effectiveness) because they use soft sector score card catch limits; that approach is less effective at reducing bycatch and bycatch mortality compared to other bycatch mitigation tools. Sector caps in Alternative 4 receive a rank of 2 (moderately effective) for overfished groundfish and 3 (less effective) for other groundfish. For Alternatives 5 and 6, the application of catch limits as RSQs and IFQs receive a rank of 1 (most effective) at controlling bycatch and bycatch mortality for overfished species. Alternatives 5 and 6 have different ranks for other groundfish because the retention requirements are not the same. Alternative

7 receives a rank of 1 for overfished groundfish and 2 for other groundfish as increased monitoring and full retention requirements are phased in.

The following steps are used to evaluate the tools and alternatives that employ them:

- **Identify bycatch factors** - Bycatch and bycatch mortality are the products of several factors related to stock status, past and present management strategies, fishing strategies, fish behavior, and other biological characteristics. In combination, these factors make fish more or less vulnerable to bycatch and bycatch mortality. Key factors and characteristics affecting bycatch and bycatch mortality are summarized at the beginning of each species section.
- **Rationalize the mitigation effect** - Each tool has a way (or ways) of reducing bycatch, bycatch mortality, or improving accountability. Where possible, direct and indirect effects for different tools are justified or rationalized. Rationale is based on literature, case studies, and testimony of experts familiar with bycatch issues.
- **Identify direct and indirect effects** by bycatch issue, and species impacted, for the various tools - Different application of a tool may reduce bycatch in different way or to a different degree.
- **Rank the effects of tools and alternatives** - Some tool alternatives are explicit in terms of level of effect anticipated. If a tool/alternative can reasonably be expected to have significant impact compared to status quo, it would be ranked higher than status quo. If a tool/alternative has a significant impact compared to status quo and another alternative, it would be ranked higher than status quo and the other alternative. Rankings are based on evidence provided in literature, reports, or best professional judgement. Impacts of the various alternatives and tools on groundfish species are summarized in section 4.3.1. Impacts on non-groundfish species are summarized. This EIS describes methods that could be used to quantify measures where possible.
- **Rank the effects of approaches used to improve accountability** - Data reporting, recordkeeping, and monitoring approaches are also evaluated for each alternative. Each alternative is then ranked as to its relative effect at improving a particular bycatch accountability issue.
- **Summarize cumulative and indirect effects**.
- **Rank the tools and alternatives** - Mitigation effect, rationale, and scores are summarized for tools within each alternative and between alternatives. First, the tools are ranked by alternative as to their relative ability to reduce bycatch, bycatch mortality, and improve accountability. A lower number indicates better performance in reducing bycatch or improving fisher accountability. Ranking includes summary effects of different monitoring approaches used by each alternative. Next, each alternative is ranked for its relative effect at addressing a particular bycatch issue. Relative ease of enforcement and anticipated compliance costs are ranked for each alternative as well.

## 4.1.3 Bycatch Mitigation Tools

Management measures, referred to here as mitigation tools, are the rules and requirements to control fishing activities and to mitigate the effects of fishing on fishery resources and other components of the natural environment. Management measures are the tools used to achieve the goals and objectives of a management program. In the context of this EIS, they are the means for reporting, monitoring, and reducing bycatch and bycatch mortality. Their purpose is to contribute to achievement of the bycatch management strategy.

**Table 4.1.1 Bycatch Mitigation Tools: The Mitigation Toolbox**

| | |
|---|---|
| **Harvest Levels** | |
| | ABC/OY |
| | sector allocations |
| | trip (landing) limits |
| | catch limits |
| | individual quotas |
| **Discard Caps** (limits and prohibitions) | |
| **Gear Restrictions** | |
| **Trawl** | mesh size |
| | footrope diameter/length |
| | net height |
| | codend mesh and dimensions |
| | design: on-bottom or pelagic |
| | bycatch reduction devices (BRDs) |
| **Line** | number of hooks |
| | hook size |
| | line length |
| | retrieval requirements |
| **Pot/trap** | number of pots |
| | pot size |
| | escape panel in net/pot |
| | retrieval requirements |
| **Other** | setnets (gill and trammel nets) |
| **Time/Area Restrictions** | |
| | seasons |
| | area closures |
| | depth closures |
| | marine reserves |
| **Capacity (number of participants)** | |
| | permits/licenses/endorsements |
| | limited entry |
| **Capacity (Vessel Restrictions)** | |
| | vessel size |
| | engine power |
| | vessel type |
| **Monitoring/Reporting Requirements** | |
| | permits/licenses |
| | registrations |
| | Fish tickets (commercial landings/ sales receipts) |
| | Vessel logbooks |
| | Surveys |
| | Punch cards/tags (recreational) |
| | Port sampling/on-shore observers |
| | On-board observers |
| | Vessel monitoring systems (VMS) |
| | Onboard video recording devices |
| | Enforcement |

### *4.1.3.1 Establishing Definitions to Characterize Management Strategies*

In analyzing the utility, effects, practicability and effectiveness of various management measures, it is necessary to understand the cause and effect relationships as well as the linkages between tools, toolboxes, objectives, policies and goals. Tools and toolboxes are most easily described by their function, along with a specific vocabulary for function-related characteristics. For example, we can describe a wrench as a tool used to tighten or loosen nuts. Although it could also be used to pound, pry, and dig, it does not do those activities as effectively as other tools would. Similarly, we can describe a hammer as a tool used to pound nails, flatten metal, align parts, and separate attached components. Combined with a chisel, it can be used to shape objects. Incorrect or careless use of a hammer or management tool can result in unintended results; thoughtful or imaginative use can result in several desired effects simultaneously.

### *4.1.3.2 Description of Bycatch Mitigation Tools*

The primary components of a fishery that can be managed are gear, vessels, harvest levels, times and areas fished, and capacity (number of vessels and potential effectiveness of those vessels). Other management tools include monitoring/ reporting requirements. Bycatch mitigation tools, or measures, are the means used to manage these components. The following is a description of the different tools.

**Harvest Level Specifications:** Groundfish harvest specifications are the first level of conservation and management to ensure that harvest stays within sustainable levels. Harvest specifications are typically set biennially[1/] and are based on stock assessments whenever possible.[2/] Assessment scientists follow rigorous scientific procedures throughout the stock assessment process, taking into account as many factors as possible to determine the past, present and future condition of the stock. A harvest rate is applied to the best estimate of current stock abundance, taking into account age structure of the population, anticipated reproduction in future years, and other information on stock condition. Different species are capable of sustaining different harvest rates; typically, fast growing species that reproduce rapidly can be harvest at higher rates than slow growing species that reproduce slowly or sporadically. Many rockfish species fall into this second category, while flatfish are more prolific.

Assessment scientists apply the appropriate rate to the biomass estimate to calculate an *ACCEPTABLE BIOLOGICAL CATCH* (ABC). For stocks below 40% of their unfished population size (biomass or productivity level), the FMP harvest control rule adjusts the harvest downward to encourage population growth; this harvest level is the *OPTIMUM YIELD* (*OY*) for the stock. In the case of an *OVERFISHED* stock (one that is below 25% of its unfished population estimate), OY is set to rebuild the stock to the 40% level, according to a rebuilding plan. The default formula for calculating OY is described in detail in the FMP and SAFE document, and is commonly referred to as the *40-10 OY* adjustment. OY can apply to total catch of a single species or species group; it can apply throughout the entire region or to smaller management areas. Estimated bycatch (discard) levels are also taken into account so the best estimates of total catch do not exceed the intended levels.

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[1/] Historically, the Council has set harvest specifications on an annual basis. Amendment 17 to the FMP introduced a biennial process and the first two-year fishing period will be 2005-2006.

[2/]The stock assessment process is described in detail in the groundfish FMP and SAFE documents. Comprehensive stock assessments have been prepared for only about 20 species due to data limitations. In some cases, harvest specifications are based on historical harvest levels.

In some cases, the calculated OYs of species in an assemblage are out of proportion with the typical catch ratios in the fishery. This is especially true in assemblages that include overfished stocks. In those cases, harvest rates for abundant stocks may need to be restricted in order to protect the weak stock(s). In such cases, the OY for an abundant stock may be reduced to reflect the expected smaller harvest.

OYs for several stocks are subdivided and allocated among Tribal, recreational and commercial fisheries. The commercial allocation is typically further subdivided between the *LIMITED ENTRY* and *OPEN ACCESS* sectors. In a few cases, most notably sablefish and whiting, a limited entry allocation may be further subdivided.

**Trip Limits, Bag Limits, and Catch Limits**: *Trip limits* are retention and landing limits (by species or species complex) that apply to individual commercial fishers, vessels, permits, gear groups, or other defined groups in a given area for a given period of time. *Bag limits* are the equivalent for recreational fishers. Any groundfish captured beyond a specified trip or bag limit are classified as bycatch (if discarded) or a violation (if retained). Trip and bag limits, as they have traditionally been applied, do not require fishers to stop fishing when the specified limit has been reached. As long as the fisher/vessel does not retain more fish than the limit, additional fishing is allowed. The intention of trip and bag limits is to remove the incentives to catch more fish. Any fish beyond the limit must be released or discarded, even if it is dead. This creates an incentive to avoid catching the fish, or, conversely, a level of disincentive based largely on the cost of sorting and extra handling, or a feeling of being wasteful. The incentive/ disincentive is not a specified monetary amount, and is not equal in all individuals. On the other hand, failure to release or discard excess groundfish (or other species) is a fishing violation. Each fisher has (potentially) the same monetary incentive to discard, which may be stronger than the incentive to avoid catching.

Over the years, the Council and NMFS have revised the definition and use of trip limits, partly in response to fishermen's concerns about discard and waste of useable fish. Fishers and managers realized that waste would occur and, as a policy decision, the FMP acknowledged a level of discard was inevitable and acceptable. This was reflected in the definition of OY, which originally included only those fish that could be captured and retained under the gear and retention limits adopted each year. The public ethic concerning fisheries waste has changed over the years, as reflected in the 1996 *SUSTAINABLE FISHERIES ACT* mandate to minimize bycatch to the extent practicable.

Initially, trip limits were designated as per-trip limits, and sometimes the number of trips was also restricted (for example, not more than one trip per week might be allowed).

*Catch limits*, on the other hand, restrict the amount of fish that may be *caught*, whether landed or discarded. Catch limits require fishers to stop fishing when a limit is reached. Catch limits have not been used in the federal groundfish management program but are included in three of the alternatives under consideration in this EIS.

*INDIVIDUAL QUOTAS* (IQS)**,** sometimes referred to as *INDIVIDUAL FISHING QUOTAS* or IFQS, are a tool that can be set up to be driven by market/economic incentives. IQs can be allocated to an individual, group, corporation, or vessel. IQs can be transferable (ITQs) or non-transferable. They can be based on a share of the total OY, or a specified amount of fish. They can grant ownership, or grant an opportunity to catch.

IQs can be defined as landing limits or as catch limits. If they are applied as catch limits, fishermen still have the option to discard unwanted fish, but those fish would count against their quota. This would increase the incentive to keep the fish rather than use them as bycatch. It would also mean the quota holder would have to stop fishing immediately upon reaching any quota limit or acquire additional quota share.

It may be useful to distinguish categories of species based on their stock status or other factors. For example, overfished species would likely be more restricted than healthy stocks. A designation such as *RESTRICTED SPECIES QUOTA* (*RSQ*) might be useful to distinguish overfished groundfish stocks from prohibited species. Catch limits applied to prohibited species are typically called prohibited species catch (PSC) limits or caps.

**Discard Caps (limits and prohibitions)**: Discard caps (sometimes called discard limits in this EIS) have not been used in managing the West Coast groundfish fisheries. However, vessels participating under an Exempted Fishing Permit in the shorebased Pacific whiting fishery are prohibited from sorting and discarding fish at sea. This could be interpreted as a discard cap of zero. As discard caps might be applied more generally, they would place a limit on the amount of any species that could be discarded after it is captured. Two general purposes have been identified for discard limitations. First, under the Magnuson-Stevens Act, fish are only considered bycatch if they are discarded. By limiting (or prohibiting) the amounts that may be discarded, bycatch can be directly reduced or eliminated. Second, discard prohibitions (caps set at zero) can facilitate shore-side observations of bycatch instead of shipboard observations. In order to be effective, some method of verification is necessary.

Few groundfish captured near the seafloor in deep water (for example, water deeper than 100 fathoms (600 feet)) survive the trauma of temperature and pressure change, crushing and abrasion (in trawl nets), and other physical effects. Notable exceptions are sablefish and lingcod, both of which lack an air bladder susceptible to excessive expansion. Pacific halibut is another species that appears

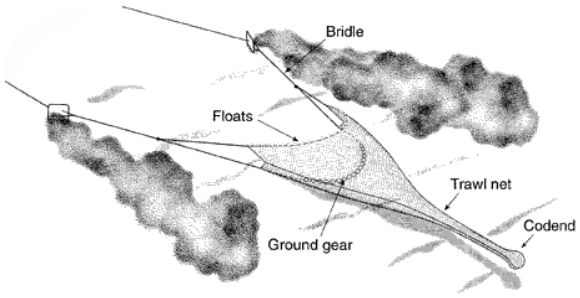
to be less vulnerable to these effects, although survival of trawl-caught halibut is only about 50% at best. Bycatch mortality rates of these species would increase if discard caps were established. Rockfish, on the other hand, are particularly susceptible to barotrauma; essentially all shelf and slope rockfish brought from depth to the surface die. Discard caps on these species would not increase mortality rates.

Discarded groundfish, other fish and offal from fishing vessels are scavenged by a variety of marine animals, including seabirds, marine mammals, and various fish and benthic invertebrates. The contribution of discard to these trophic levels has not been assessed quantitatively. Reduction of discarded groundfish and other species would likely have unquantifiable adverse impacts on such species.

Discard caps and prohibitions would require that bycatch be delivered to shore and sold or retained for personal use. For commercial fishers, this would mean delivery and sale to a processing facility. For recreational fishers, it would mean retention until the fisher returns to shore. Commercial fishers would have to find a willing buyer to purchase fish that may not be desirable to established or typical markets. Failing to find a purchaser that would purchase and use these species, a commercial fisher would need to dispose of that bycatch either on shore or at sea.

**Gear Definitions and Restrictions**: West Coast groundfish fishermen are allowed to use 4 basic gear types to catch groundfish: *TRAWLS*, *HOOK-AND-LINE*, traps (*POTS*), and, in part of California, set nets. (Recreational fishers may also use spears.) These gears capture fish in different ways, and fishermen know how their gear catches fish, what types of fish the gear catches better, and how to best operate the gear to maximum advantage. Every commercial fisherman's intent is to catch fish to make money, and each has an idea of how to make more money at less cost. Catching unwanted species creates costs of sorting the wanted from the unwanted. Fishing in an area with many seafloor hazards can increase costs through damaged or lost gear; refining the gear by adding protective components or tuning it can reduce the risks. Gear definitions, requirements and restrictions can be effective in achieving some management objectives, often at the expense of harvest efficiency. Much of the history of fishing and fishery management is the result of fishermen's efforts to improve their catching efficiency and management trying to reduce their efficiency.

*Trawl:* West Coast commercial fishers use a variety of otter trawl types. This diversity of gear types is a result of the diversity of fisheries (fishing strategies) and bottom types in the region. The specific gear design used is typically a result of the target species complex (whether they are on the seafloor or higher in the water column) and whether the seafloor is smooth or rough, soft or hard.




Otter trawls are not just simple sieves used to collect everything in their path; they are actually very complex systems designed to target specific types of fish in specific conditions. Trawl gear has several components, including the doors (otter boards), bridles, *FOOTROPE* (ground gear), and the net body, including the *CODEND*. Trawl doors can be of various sizes and designs to match the target strategy and net. Their purpose is to help sink the net to the desired depth, hold the mouth of the net open, and help move fish towards the net. Bridles connect the doors to the net and can be chain, bare wire, or covered wire. The footrope is attached to the bottom front of the net and can include chain-wrapped wire, rubber cookies, rollers, bobbins, and tickler chains.

Bottom trawls are designed to capture fish that are on or near the seafloor, such as *FLATFISH* (flounders). Fish herding is an important aspect of trawl design and depends upon the hydrodynamic forces of the doors and the sediment clouds generated by the ground rigging and footrope. In *BOTTOM TRAWLS*, the footrope is designed to get the fish up off the bottom. The net body can vary based on the head rope height, the amount of overhang, and the mesh sizes of the various net panels. The top of the net typically has floats attached to help hold it open. The doors, ground rigging behind the doors, and the footrope can come into contact with the seafloor. With the exception of the doors, trawl gear must be relatively light on the bottom to maintain its shape and effectiveness. The net itself typically does not drag along the bottom but may sometimes contact the seafloor, especially when there are obstructions. Chafing gear, a protective covering fastened to the underside to prevent abrasion, tearing, and other damage, may be attached to protect the underside of the net from snagging and tearing.

In a cutback trawl, the floats are behind the footrope (ground gear) or the top of the net above the footrope is constructed of wide meshes (or open) so that any fish can escape by swimming upward. This type of net will be required for nearshore fisheries use north of 40°10' N. lat. beginning in 2005. The gear has been tested and shown to be successful at avoiding rockfish, which typically are slightly off-bottom or swim up when startled. Flatfish tend not to swim as far upward, and therefore may not escape as readily.

*MIDWATER* (*PELAGIC*) *NETS* are used to target Pacific whiting. Smaller mesh (3 inch minimum) is used, compared to 4½ inch mesh used for bottom trawls. Prior to about 1987, midwater nets used for whiting were smaller than those typically used since then. Midwater nets use the doors, bridles, and large mesh to herd fish towards the codend, rather than sediment clouds, and typically do not come into contact with the seafloor.

*BYCATCH REDUCTION DEVICES* (BRDs) are typically not used in West Coast groundfish trawls but are used by groundfish trawlers in Alaska (to reduce bycatch of Pacific halibut) and by West Coast shrimp and prawn trawlers (to reduce groundfish bycatch).

Potential tools for mitigating trawl gear bycatch deal with several components of a typical trawl that address selectivity and/or placement: mesh size, type of footrope, net size and shape, chafing gear, type or design (on-bottom or off-bottom/pelagic), and use of bycatch reduction devices.

Mesh size - The size and shape of a net's mesh are related to the size and shape of fish it will capture, and these can be adjusted to select for fish of different sizes and shapes. Larger mesh increases the chances for small fish to escape. Smaller trawl mesh catches more small fish along with the larger fish. Mesh selectivity can never be perfect, but much research over the years has been conducted to improve the catching efficiency and selectivity of trawl gear. For the past several years, regulations have specified 4½ inches as the minimum mesh size in West Coast groundfish bottom trawls and 3 inches minimum in midwater trawls. The minimum mesh size in bottom trawls was increased in the early 1990s from 4 inches to 4½ inches to increase escapement of small fish, especially those below marketable size.

Footrope diameter- The footrope of a bottom trawl is the line (a cable, for example) along the bottom front edge of the net that contacts the ocean floor. The footrope is important in making sure the trawl stays in contact with the seafloor but does not dig into the mud or snag on rocks or other structures. The diameter of the footrope can be increased by attaching rollers or bobbins; larger diameter footropes tend to move over the seafloor more smoothly and easily. Larger diameter footropes allow trawls to be used in areas where the seafloor is rough, such as rock piles. Without the protection of large rollers, trawls cannot be fished effectively in those areas. This relationship between footrope diameter and fishing location has been used since 2000 to reduce trawl fishing in rocky areas where overfished rockfish tend to be concentrated. Based on an industry proposal, the Council and NMFS reduced trip limits for most species for vessels that used footropes over 8 inches in diameter. This would reduce trawl encounters with fish species in rocky, high relief areas, especially on the continental shelf.

Trawl size/configuration - Trawls range in size from relatively flat, small, bottom trawls to very wide, tall midwater trawls. The catching capacity of a trawl is related to the dimensions (width and height) of the net; a small net cannot catch as much as a large net. Taller nets cover more of the water column; in bottom trawls, they tend to catch species (such as some rockfish) that hover above the bottom or try to escape upwards. ODFW has been testing a flat-body selective flatfish trawl net. It has had experimental success at avoiding rockfish bycatch. NMFS is proposing to require its use in nearshore trawling north of 40°10' N. lat.,

beginning in 2005. One way to reduce catching capacity would be to limit net size. This could be accomplished by restricting the maximum length of the footrope, which must match the width of the net.

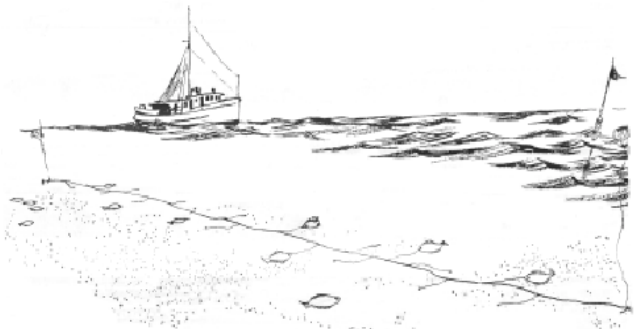
The size of the codend is related to the amount of fish that can be captured and held at any one time. In the early years of the whiting joint venture fishery (e.g., with the USSR and Poland), the processing ships produced fillets and headed/gutted products. Both the size of deliveries and the rate of delivery were controlled to match the processing rates. Production rates were limited by the equipment to prepare these products, and bruised, crushed whiting were too difficult to cut. American catcher vessels were required to make small deliveries using relatively small codends (compared to those used later by vessels delivering to processing ships that produced surimi). In an attempt to keep the high-volume surimi operations out of the whiting fishery (in order to maintain a longer season), some U.S. fishers proposed setting a limit on the size (volume) of codends that could be used. The suggested regulation was not approved for several reasons including the allocative effects and impact on economic efficiency. Effects of small trip limits, need for reduced harvest of overfished stocks, and bycatch reduction requirements may provide justification to consider adoption of size restrictions for bottom trawls.

Chafing gear - Chafing gear is used to protect the underside (belly) of the net, including the codend. The types of material used for chafing gear are restricted by regulation to prevent reducing the effectiveness of minimum mesh regulations (i.e., reducing selectivity). Currently, further restrictions are placed on chafing gear in conjunction with the small footrope requirement to reduce the use of trawls in rocky, rough-bottom seafloor areas.

Bottom versus pelagic - Bottom trawls and pelagic/midwater trawls have different uses and selectivities that can be used to achieve certain bycatch reduction objectives. For example, a requirement to use pelagic trawls (which must have unprotected footropes and no chafing gear) would greatly reduce the encounter with animals that live on or in the seafloor. However, the use of large midwater nets could increase the encounter rate with pelagic species that should be avoided.

Bycatch reduction devices (BRDs)- Bycatch reduction devices, as they apply to trawls, are mechanisms that guide or force unwanted species or sizes out of the net and reduce the likelihood they will be captured. They are gear selectivity devices. BRDs have been effective in reducing catches of halibut in certain groundfish trawl fisheries in Alaska. BRDs are also used in other regions to mitigate trawl bycatch of turtles, finfish and other animals. In particular, they are used in West Coast trawl fisheries for pink shrimp and prawns to reduce bycatch of canary and other rockfish. Often BRDs reduce catch rates of the target species, but in some cases fishers can improve gear performance with experience and practice. BRDs have not been investigated in the West Coast groundfish trawl

fishery. However, development of effective rockfish excluder devices could result in increased catches of other species.



*Hook-and-Line:* West Coast commercial and recreational fishers use a variety of hook-and-line gears. This diversity of gear types is a result of the diversity of fisheries (fishing strategies) targeting various species in the region. The specific hook-and-line gear design used is typically a result of whether the target species or species complex lives on the seafloor or higher in the water column and whether it is sedentary or mobile. Many commercial groundfish vessels are included in the federal groundfish limited license program for stationary (fixed) longline gear. Another name for this is setline gear. Vessels typically fish this gear along the ocean floor for sablefish (blackcod) and/or Pacific halibut, but may take other groundfish and non-groundfish species also.

Other hook-and-line gears are considered *OPEN ACCESS* which means any commercial fisher (including limited entry vessels) may use them in accordance with state or federal regulations. (Fixed longline gear may also be used by any commercial groundfish vessel, but harvest levels are restricted). Some hook-and-line gear is pulled (trolled) through the water; other longline gear extends vertically from the surface towards the bottom and may drift with the current. Rod and reel is included in the hook-and-line category; this is the typical recreational gear type.

Potential tools for mitigating hook-and-line gear bycatch include the number of hooks, whether the gear is stationary (fixed), pulled (trolled) or free-drifting, the type and size of hooks, how the fixed gear is marked/labeled, maximum length of the line, and how long it may be left unattended. In addition, bycatch reduction devices (BRDs) have been found to reduce bycatch of seabirds in other fisheries by making baited hooks less available or less attractive to birds feeding nearby.

Number of hooks - For the recreational fishery, limits on the number of hooks have been used to reduce the potential catch of overfished rockfish. This is not a selective method to protect any particular species, but rather it reduces the potential catch of all species that might be taken. It may be used in combination with other restrictions, such as the amount of weight that may be attached to the line, and the number of fishing rods an individual may use.

Stationary (setline) versus mobile gear - Mobile gear is being defined here as all hook-and-line gear that is not anchored at both ends, and it includes a variety of

configurations. The distinction is used primarily for setting separate trip limits for limited entry and open access sectors. However, these gears often have substantially different selectivity and applicability. For example, setline gear cannot be effectively used to catch many pelagic (off-bottom) species. It can be fished throughout the water column and need not contact the seafloor, although some mobile line gear does contact the bottom (for example, dingle bar gear typically is bounced along the seafloor). Vertical longlines (sometimes called Portuguese longlines) are multi-hook lines, weighted at the bottom, that hang vertically from a vessel or a float, drifting with the current. Fly gear is trolled nearer the surface. Also, a variety of hook-and-line gear is used to catch nearshore (shallow water) groundfish and other species for the live fish market.

Type and size of hooks - Hook size and type can affect selectivity. For example, commercial sablefish fishers now use circle hooks because they tend to retain more fish and to hook the fish more in the lip rather than deeper in the mouth. In earlier years, the J-hook was the primary gear. The use of small hooks can increase selectivity for small-mouth fish (such as sand-dabs, a type of flatfish) and avoid larger-mouth rockfish. Also, barbless hooks are required in some (non-groundfish fisheries) to improve survival of fish that must be released. Where the species suffer from *BAROTRAUMA* (pressure change), barbless hooks have little utility.

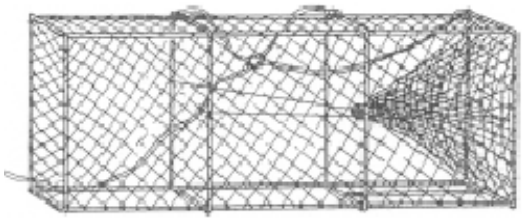
Gear marking (identification) requirements - Federal regulations require that fixed-longline gear be clearly and visibly marked at both ends with the vessel or fisher's identification and with a flag, or radar reflector. (Other line gears do not have this requirement because they are not left unattended.) Marking requirements serve both a safety and enforcement function. The safety requirement is that the gear be marked so it does not present a navigation hazard (collision or entanglement). The identification is so the owner of any lost or illegal gear can be identified. These requirements have little if any affect on bycatch other than to aid in recovery of lost gear.

Gear retrieval requirements - Baited setlines continue to fish as long as any hooks remain baited. At the end of the fixed-gear sablefish season, vessels may be required to stop fishing at a specific time. Retrieving gear is a fishing activity, so a stop fishing order means any gear must be left in place. Typically, after a specified period of time, the gear may be retrieved, although it may be necessary to release any fish. Any fish that must be released are considered bycatch. To prevent excessive bycatch of this type, gear must be retrieved within a specified period of time, unless the vessel is incapable of retrieving it (for breakdown, weather or safety reasons).

Bycatch reduction devices (BRDs) - Bycatch reduction devices, as they apply to longline fisheries in other regions, are devices that deter seabirds from chasing baited hooks as the gear is set. One method is to deploy the gear through a tube that extends below the water surface; another method is to use flags or other

objects that intimidate birds from chasing the bait. Thus, the BRDs reduce the likelihood seabirds will be killed. This is particularly important for listed species such as short-tailed albatross. Seabird deterrents devices have been effective in reducing seabird bycatch in Alaska groundfish longline fisheries and Pacific Ocean pelagic longline fisheries. The need for seabird BRDs has not been investigated in the West Coast groundfish longline fishery. The NMFS Observer Program records information on groundfish longline-seabird interactions; that information will be evaluated to determine the number of seabird mortalities and the need for BRDs.

Pot/Trap: The words "pot" and "trap" are used interchangeably to mean baited cages set on the ocean floor to catch various fish and shellfish. They can be circular, rectangular or conical and may be set out individually or fished in strings. All pots contain entry ports that allow fish to enter. Current regulations require that all pots used for groundfish must have biodegradable escape panels or fasteners that are intended to disable the trap if it becomes lost or abandoned. Otherwise, lost traps could continue to capture fish, a condition known as *GHOST FISHING*. Individual groundfish pots must be marked at the surface; strings of pots must be marked at each terminal end with a pole and flag and a light or radar reflector.



Traditionally, groundfish pots have been used on the West Coast primarily to target sablefish. Commercial groundfish pot gear is included in the federal groundfish limited licence program for stationary (fixed) gear. Vessels typically fish this gear along the ocean floor for sablefish. Pots are also considered an open access gear, which means any commercial fisher (including limited entry vessels) may use them in accordance with state or federal regulations. Trap gear is also used to target live fish.

Potential tools for mitigating pot bycatch include size and shape, mesh size, number of pots, how the gear is marked/ labeled, requirements to prevent ghost fishing if the trap is lost, and how long gear may be left unattended (retrieval time requirements).

Size and shape - Larger pots potentially can capture and hold larger numbers of fish, but typically would not affect the species mix. Setting a maximum pot size would thus not affect selectivity but would affect harvest capacity. There are no groundfish pot size restrictions at this time.

Mesh size - The mesh size of a trap is related to the size of fish the trap will retain. Mesh size can be adjusted to select for fish of different sizes. Larger mesh increases the chances for small fish to escape. Smaller trawl mesh catches more

small fish along with the larger fish. There are no mesh size restrictions at this time.

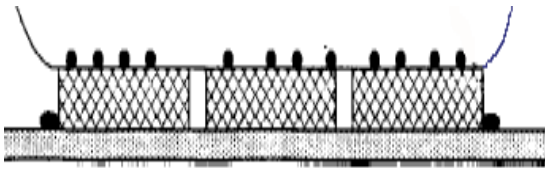
Number of pots - A maximum number of pots an individual fisher or vessel may use can be specified. The effect of pot limits is to reduce individual and/or fleet capacity. This can be useful in highly overcapitalized fisheries to slow the pace of the race for fish and to reduce bycatch during closed seasons (for example, after the season closes). There are no groundfish pot restrictions at this time.

Escape panels - Escape panels create an opening in the pot to allow fish to escape. This is important because a pot can continue to ghost fish as long as it remains in the water. The size of the opening can be regulated, as can be the material that creates the opening. For West Coast groundfish, the federal regulation specifies the use of biodegradable twine (sometimes called "rotten cotton") that should disintegrate if the pot remains in the water too long.

Gear marking (identification) requirements - Federal regulations require that groundfish pots must be clearly and visibly marked at both ends with the vessel or fisher's identification and with a flag, or radar reflector. (Other line gears do not have this requirement because they are not left unattended.) Marking requirements serve both a safety and enforcement function. The safety requirement is that the gear be marked so it does not present a navigation hazard (collision or entanglement). The gear identification is so the owner of any lost or illegal gear can be identified. These requirements have little if any affect on bycatch other than to aid in recovery of lost gear.

Gear retrieval requirements - Baited pots continue to attract and catch fish as long as they maintain their structural integrity. At the end of the fixed-gear sablefish season, vessels may be required to stop fishing at a specific time. Retrieving gear is a fishing activity, so a stop fishing order means any gear must be left in place. Typically, after a specified period of time, the gear may be retrieved, although it may be necessary to release any fish. Any fish that must be released are considered bycatch. To prevent excessive bycatch of this type, gear must be retrieved within a specified period of time, unless the vessel is incapable of retrieving it (for breakdown, weather or safety reasons).

Unbaited pots may also attract fish because they may provide structure. Pots left on the grounds after the end of the season will continue to ghost fish unless they are de-activated by leaving an open escape route such as an open door or escape panel. Any fish left in a closed trap eventually die and become bait for other fish. By requiring that pots be removed soon after the end the season, this can be minimized.



*Setnet (Gill and Trammel Nets):* [The Groundfish FMP recognizes setnets as

legal groundfish gear only in California south of Point Reyes (near San Francisco). Regulations controlling their configuration and use are implemented by the State of California. The FMP does not allow the use of drift nets for taking groundfish, nor does it allow the use of setnets in other areas. Potential management tools are listed below but are not described. ]

Setnets are flat, rectangular nets that hang vertically in the water from a buoyed cork line and weighted along the bottom with a lead line. Setnets must be anchored, and they hang fairly vertically in the water column. They tend to bulge under the effect of currents. The nets are intended to be slack rather than taut, because fish swimming into a taut section of webbing tend to bounce away rather than become entangled. Nets are made of a lightweight multi-filament nylon or monofilament strands with certain specific mesh sizes to select the catch. Mesh size of gillnets is selected so the heads of the desired fish go through the mesh, but their bodies do not. When a fish tries to escape it tends to become entangled in the net.

A trammel net is a net made with two or more walls joined to a common float line. The inner net is made of smaller mesh and hangs deeper than the outer webbing. Fish pass through the outer webbing, strike the inner webbing and carry through to the larger webbing on the opposite side. Fish thus become trapped in the pocket formed by the intertwined webbing.

Potential tools for mitigating setnet bycatch include mesh size, size (height and length), number of panels, how the gear is marked/labeled, how long gear may be left unattended, and where it may be used.

**Time/Area Restrictions (including closures, marine protected areas and reserves)**: Closures, as a management tool, have both a spatial (area) and temporal (time) dimension. Some area closures are long term to address a long term problem or condition. Examples of this would be to protect areas with special habitat, historical significance, or scientific or other value. Marine reserves are an example of a long-term area closure where all or certain activities may be restricted, depending on the objective and designation. Short term closures may be for an entire region (such as a season) or for a more localized area (such as a spawning area to protect eggs and/or young when they are present).

In recent years, area closures based on depth contours have been used to reduce the likelihood certain overfished groundfish species might be caught. This approach may be especially effective for species (cowcod, for example) that are relatively sedentary, that move only short distances. Often, however, juveniles concentrate at different depths or habitats than adults, and in some cases may be caught in different fisheries or by different gear types. Some species migrate seasonally; a permanent area closure would have to consider the entire migratory range, while a seasonally-adjusted or moving closure might provide a similar

degree of protection while allowing greater fishing opportunities for other species. Also, where multiple species are in need of protection, the individual distributions must be taken into account.

NMFS regulatory guidance on EFH suggests time/area closures as possible habitat protection measures. These measures might include, but would not be limited to: closing areas to all fishing or specific equipment types during spawning, migration, foraging, and nursery activities; and designating zones for use as marine protected areas to limit adverse effects of fishing practices on certain vulnerable or rare areas/species/life history stages. To the extent that such an identified species or assemblage is taken as bycatch in the groundfish fishery, area closures may be an effective bycatch reduction approach.

**Capacity Limits**: Capacity limits are used to restrict access to the fish resource. Tools to limit capacity include permits and licenses and are intended to restrict the number of participants in a fishery. (They also serve as a mechanism to monitor participation in the fishery.) The maximum number of commercial longline, pot and groundfish trawl vessels participating in the limited entry fisheries was set by the license limitation program that took effect in January 1994.

Fishing power is also a term sometimes used to describe capacity that is managed with the use of gear restrictions and other tools. Permits and licenses can be used in a number of ways to limit capacity. A permit can specify the type of vessel or gear that may be used, the amount of fish that may be caught or retained, or who may do the fishing. That is, permits can apply to vessels, gear or fishers, and the number of permits can be limited. All groundfish limited entry permits designate the maximum length overall (LOA) of the vessel. Permits may be combined and applied to a larger vessel in accordance with a formula established in the limited entry regulations. Once combined, permits cannot be separated.

Once the number of permits has been limited, as in the West Coast groundfish fishery, it may be necessary to reduce the number of participants in a fishery. This can be accomplished through a buyback program, by the government cancelling or revoking permits, or by requiring participants to obtain multiple permits (for example, buying them from other fishers/vessels or joining into cooperatives). A trawl buyback program was completed late in 2003, resulting in the elimination of 91 trawl permits and vessels, roughly 35% of the trawl fleet. This result is less than the 50% reduction called for in the Council's Strategic Plan, and it addresses only the trawl fishery.

**Vessel Restrictions**: Restrictions on the type, size and/or power of a fishing vessel can be used as a management tool, typically to address fishing capacity. In the West Coast groundfish fishery, only vessel length is restricted. Vessel restrictions in themselves often have limited effect on capacity or fishing power, and many potential vessel restrictions are rarely used because they are easy to

circumvent. Combined with other tools, they may be an effective means of achieving a particular management goal, although the effectiveness may be difficult to predict.

**Data Reporting, Record-keeping, and Monitoring Requirements**: Monitoring and reporting requirements are essential fishery management tools. Without monitoring and reporting, there is no effective measure to either ensure compliance with the tools used or to determine if the bycatch mitigation tools have been effective. Monitoring and reporting tools include permits/licenses, registration, fish tickets, logbooks, port sampling/onshore observers, on-board observers, *VESSEL MONITORING SYSTEMS* (VMS), onboard video recording devices, surveys, punch cards/tags, and enforcement activities. The current federal reporting requirements include permits/endorsements for the limited entry sector of the commercial fleet, reporting requirements for the at-sea whiting fleet (catcher/processor and mothership/processor vessels), an onboard observer (scientific data collection) program, and a VMS program beginning in 2004. Federal licenses are not required for the commercial open access sector or for the recreational sector. The current fish ticket and commercial logbook reporting requirements are conducted by the states.

*Permits/licenses/endorsements* - Permits and licenses confer permission to conduct specified activities. For fisheries, they may be a registration of vessel, gear, species, or amounts. There may or may not be a limited number of licences/permits available, and there may or may not be a cost to obtain them. In the groundfish fishery, trip limits apply to vessels rather than to permits. Endorsements are added to permits to provide specific conditions or permissions. For example, each limited entry permit includes a vessel length and gear endorsement. Also, a sablefish endorsement was created to identify those longline and pot vessels eligible to participate in the primary season and the amount of sablefish they may harvest during the season.

*Registration* - Vessels may be required to report in advance their intention to fish in a certain area, fishery, or time period. This provides a record of intention and may confer permission. NMFS published (in 2003) a final rule to require that operators of any vessel registered to a limited entry permit and any other commercial or tribal vessel using trawl gear, including exempted gear used to take pink shrimp, spot and ridgeback prawns, California halibut and sea cucumber, to declare their intent to fish within a conservation area specific to their gear type, in a manner that is consistent with the conservation area requirements. That is, the vessel must notify NOAA Fisheries before it enters an area closed to fishing.

*Fish tickets* (commercial landings/sales receipts) - Fish tickets are a record of the amount and species of fish landed by a commercial fishing vessel. They are required by each state, and the information required may differ among states. Typically, fish tickets may also indicate gear used, area fished and other specified

information. This information is entered into an electronic data system and transmitted to a centralized database (PacFIN, maintained by PSMFC).

*Vessel logbooks* - Logbooks are a vessel's record of activities and estimated amounts of fish caught and retained. The trawl logbook program is conducted by the states (with the help of PSMFC). Vessels are required to complete and submit these records as specified by state regulation. Fishing location is required, as well as amounts of fish retained in each set/haul/tow. Currently, only retained catch is recorded. Selected logbook information is keypunched into an electronic database and compared to fish ticket records. Although states require some non-trawl vessels to fill out logbooks, only trawl logbook information is entered into the federal data system. Electronic logbooks are used in some fisheries.

*Surveys* - Surveys are a series of questions, verbal or in writing, designed to collect useful information. Surveys may be conducted in person (as in a port sampling survey), by phone (as in the survey of recreational fishing), or by mail. Typically, participation in a survey is voluntary.

*Punch cards/tags* (recreational) - Punch cards and tags may serve as a license/permission and as a catch record. There are no federal requirements at this time for West Coast groundfish.

*Port sampling/on-shore observers* - When a vessel or fisher returns to port, he/she may be met by an official surveyor who collects specified fishing-related information. This may be biological information about the fish, fishing locations and methods, ocean conditions, marine animals observed, or other scientific information. Species information may be incorporated into the data system to provide more specific information than recorded by other methods. For example, a fish ticket may not record the weight of each species or even a complete list of species, but a port sampler/observer may provide that information. Port sampling is typically conducted by the states, in conjunction with *PSMFC*.

*On-board observers* - Commercial vessels fishing for groundfish are required to allow an agency-certified fishery observer aboard to collect scientific information. The current federal observer program for the West Coast groundfish fishery has resources to observe about 10% of the commercial (limited entry) groundfish fishing trips. Currently, the West Coast observer program focuses on discarded fish, recording amounts, species, and some biological information about the fish. Other information, such as time, location, and gear may also be recorded. Observers can also record observations or measurements of seabirds and marine mammals and other useful scientific information. The federal observer program is not intended or designed to be a compliance or enforcement program.

A compliance monitoring program could be established, as in conjunction with an individual fishing quota program, to help ensure vessels maintain appropriate records and comply with the fishery management program requirements. For

example, a compliance monitor could record discarding activities and fishing location.

*Vessel monitoring systems (VMS)* – A mobile vessel monitoring system (VMS) is a tool that allows vessel activity to be monitored in relation to geographically defined management areas (PFMC 2003e). VMS transceivers automatically determine and report the vessel's position using Global Positioning System (GPS) satellites. Generally, the vessel's position is determined once per hour, but the position determinations may be more or less frequent depending on the fishery. VMS transceivers are designed to be tamper resistant. In most cases, the vessel owner is not aware of exactly when the unit is transmitting and is unable to alter the signal or the time of transmission. VMS is a technological tool that can be used to improve bycatch management by providing location data that can be used in conjunction with observer data collections. (See the 5/22/03 *Federal Register* "Proposed Rule for a Vessel Monitor System" for additional information.)

*Onboard video recording devices*, sometimes called Electronic Monitoring, are used in some areas to monitor vessels' fishing activities. Cameras mounted on vessels can record fishing times and provide a general view of catch, as well as certain fishing-related activities. Limited bycatch (discard) and species composition information can be obtained by this method. (See Appendix C for additional information.)

*Enforcement* activities include a variety of data collection methods and information. Traditional techniques used to monitor marine fisheries include monitoring from air and surface craft. Monitoring from aircraft provides fishing location, vessel counts, and other general information. It could provide only limited bycatch information, such as whether discarding has occurred (such as visible, floating fish).

### 4.1.4 General Effects of Bycatch Mitigation Tools

Catch is related to fishing effort, selectivity of the fishing gear and methods, and species abundance. Reducing unwanted catch is the highest priority in a bycatch mitigation program. Bycatch mitigation tools or management measures vary in their application and effect at reducing bycatch, bycatch mortality and in improving catch accountability. Few tools have only one effect, and thus it is often a case of choosing tools that effectively address a variety of goals. Likewise, it is important that the chosen tools work in harmony to achieve the objectives, rather than work in opposition to each other. In theory, an optimum management program would use a few tools that work together synergistically to achieve the desired effects. In this EIS, traditional tools and some new tools never before used in managing West Coast groundfish fisheries are evaluated.

#### *4.1.4.1 Tools and Their Linkage to Species Associations*

The utility, effects, and effectiveness of various management measures are linked to key attributes of species we seek to manage. Some tools are more effective at reducing bycatch of rockfish than flatfish for example. Other tools designed to reduce the bycatch of one species may have different impacts on another species. In this EIS, example groundfish species have been highlighted for the analysis. These include all of the overfished groundfish species and selected emphasis groundfish species representing a sample of the over 80 groundfish species managed under the Groundfish FMP. These species represent a cross section of groundfish, and have differences in stock status, behaviors, life history, and habitat associations.

**Table 4.1.2. Species Associations and Attributes Important to Application of Bycatch Mitigation Tools**

**Overfished**
- **Canary rockfish**
- **Lingcod**
- **Yelloweye rockfish**
- **Bocaccio**
- **Cowcod**
- **Widow rockfish**
- **Pacific Ocean perch**
- **Darkblotched rockfish**
- **Pacific whiting (in review)**

**Rocky-bottom shelf habitat**
- **Canary rockfish**
- **Lingcod**
- **Yelloweye rockfish**
- **Bocaccio**
- *Yellowtail rockfish*
- *Chilipepper*

**Non-rocky shelf habitat**
- *Dover sole*
- *English sole*
- *Petrale sole*
- *Arrowtooth flounder*

**Slope**
- **Darkblotched rockfish**
- **Pacific Ocean Perch**
- *Dover sole*
- *Sablefish*
- *Shortspine thornyhead*
- *Longspine thornyhead*

**Pelagic or Semi-pelagic**
- **Widow rockfish**
- **Pacific whiting**
- *Yellowtail rockfish*

**Nearshore**
- *Black rockfish*
- *cabezon*

**Migratory**
- **Pacific whiting**

**Longevity**
- Rockfishes - longest
- Flatfishes - intermediate
- **Lingcod** and *cabezon* - intermediate
- **Pacific whiting** - shortest

**Productivity Index**
- Rockfishes - very low
- Flatfishes - low
- **Lingcod** and *cabezon* - low
- **Pacific whiting** - low

**Handling survivability**
- Rockfishes, Pacific whiting - little or no survival
- Flatfishes - some survival escaping from mesh
- **Lingcod**, *cabezon*, sablefish - some survive release

Overfished species - **Bold**, Emphasis species-*italic*

Several other important non-groundfish emphasis species have also been chosen for the analysis.

Knowledge of species attributes is key to understanding if a tool can be used to reduce bycatch and how effective it will be. For example, several of the overfished groundfish species are rockfishes that have a high degree of association with rocky-bottom shelf habitat (see Table 4.1.1). Some of these habitats are well defined areas on the continental shelf. Area management tools (such as MPAs or the current GCAs) may be very effective at controlling vessel encounters with concentrations of canary rockfish and cowcod. However, canary rockfish also occur outside of present GCA boundaries in lower concentrations, and thus area management alone may not minimize incidental encounter with them. A combination of area

management and other tools may be more effective in minimizing incidental canary rockfish catch.

Lingcod is another overfished species that is associated with rocky-bottom shelf habitats and partially overlaps canary rockfish distribution. However, lingcod are also found in non-rocky bottom and nearshore habitats. Area management tools designed to protect canary rockfish will reduce encounters with lingcod within the canary management area, but to minimize lingcod bycatch, additional measures (or area) would be necessary.

Many species have a much broader distribution across shelf and slope habitats. Generally, younger fish settle in shallow water areas and gradually move offshore as they mature. Others make small scale seasonal migrations to feed on the shelf during the summer or spawn offshore in the winter. Lingcod move inshore to spawn during the winter.

Flatfishes as a group are broadly distributed, while Pacific whiting make extensive migrations between southern and northern limits of their range. Because they are so broadly distributed, area management tools would have to be extremely broad and greatly reduce areas for fishing for other species. Gear restrictions, on the other hand, could be used to for flatfish, and seasonal restrictions on Pacific whiting to do so.

Another important attribute to be considered in designing and applying bycatch mitigation tools is a species' sensitivity to handling. Rockfishes have swim bladders that expand to the point of bursting when they are brought to the surface from seafloor depths greater than a few fathoms. Few rockfish survive this kind of trauma. Thus, regulations that require release of rockfish will likely result in near 100% bycatch mortality. Species that lack swim bladders, such as lingcod and cabezon, appear to be more durable and may be less traumatized by capture and release. Size, bag and trip limits may not contribute to high bycatch mortality rates for these species.

#### *4.1.4.2 Effects of Bycatch Mitigation Tools*

The primary components of bycatch that can be managed are through harvest levels, gear, who, when and how many (that is, which vessels, times and areas, and capacity (number of vessels and characteristics of those vessels). Other tools include monitoring/ reporting requirements. These tools have different effects on mitigating for incidental catch, bycatch, bycatch mortality, and accountability . The following is a description of the range of effects for different management tools.

**Harvest Level Specifications**: Harvest specifications (such as ABC, TAC, MSY and OY) are the first level of conservation and management to maintain sustainable fisheries. For West Coast groundfish, harvest specifications are set to

either maintain or rebuild various stocks. When stocks are not equally available (or available in the same proportions), specified harvest levels may not match the relative abundance (ratios) of all the species. OYs are the annual harvest targets for groundfish. Other management measures are designed to achieve but not exceed those targets. OYs provide the basic framework for management, but the fishery management measures to achieve them have more direct relationships to incidental catch and bycatch.

A relatively small OY for an incidental species, in conjunction with larger OYs for target species, may generally result in an increased probability and level of regulatory induced discard. Exceptions to this have to do with the distributional characteristics of the species and other management measures that might be applied. A widely dispersed species with a small OY is likely to have a higher encounter rate when fishers target other co-occurring species. Most of an OY would likely be used as incidental catch allowance for fisheries directed at co-occurring species.

Allocations of OY at the highest level (to major limited entry gears, open access, and recreational fishers) will also have potential impacts on bycatch due to differing selectivity of gears involved. Other tools, discussed below, may be used to mitigate for fishing impacts of small OYs.

The balance of OY and fleet size/capacity is critical to bycatch. If a stock is very abundant, and few vessels or anglers fish for it, there is unlikely to be any regulatory discard. However, any abundant stock that is underutilized is likely unmarketable. A large stock biomass in conjunction with a large (but not overcapitalized) fleet can also result in very low regulatory discard. Even a small stock in conjunction with a small fleet may not have much regulatory discard. However, if that stock is mixed with abundant but unwanted species, the level of economic (non-regulatory) discard may be excessive.

And finally, a species may have a large ABC but also have harvest constraints to reduce impacts on a small OY species. The result would likely be a large regulatory discard. This is a result not of the OY directly, but rather the management measures to achieve two or more OYs that are out of balance. This is the case with species such asyellowtail rockfish that have large OY levels but which have their catch constrained by co-occurring species with a smaller OYs such as canary and widow rockfish.

For other species with relatively large OYs, bycatch may not necessarily decrease, as there are many non-regulatory sources of bycatch that are proportional to the size of catch. Some non-regulatory sources of bycatch are related to market limits on fish size, quality, and quantity. Another different set of tools may therefore be needed to reduce non-regulatory forms of bycatch that are associated with species having high OYs.

**Trip Limits, Bag Limits, and Catch Limits**: *Trip limits* are retention and landing limits (by species or species complex) that apply to individual commercial fishers, vessels, permits, gear groups, or other defined groups in a given area for a given period of time. Bag limits are the equivalent for recreational fishers.

In a study of West Coast groundfish, discard rates were found to vary inversely with the size of the trawl trip limits imposed (Pikitch *et al.* 1988). Restrictive limits may therefore result in a higher catch and bycatch mortality of overfished species compared to alternatives that provide larger trip limits, or alternatives that use a different set of management tools. Vessel trip limits for overfished species are typically designed to allow for retention of small, non-targeted amounts that are caught incidentally. In a few cases, limited target fishing for some overfished species may be allowed with some gear types during part of the fishing year, such as for Pacific whiting, widow rockfish, and lingcod. Cumulative 1 or 2 month limits are used to help minimize regulatory discard.

Trip limits are often structured to preserve a ratio of catches reflective of a fishing strategy that results in a particular mixture of species. Often times the mixture contains one or more species that is either overfished or under precautionary management. Catches are constrained so that the ratio is preserved and the overfished or precautionary species OY is not exceeded. Fishers may attempt to develop strategies to maximize value of joint catches of the mixture. If actual fishing experience on the grounds and optimal values for a species mixture matched the average ratios applied when trip limits are set, regulatory bycatch should be minimized. Catches of individual species tend to be highly variable, leading to a significant tow-by-tow and trip-by-trip variation in ratios. Although rare, there are times when an encounter with an isolated school of rockfish can lead to bycatch that is several times larger than the incidental catch limit. This problem (which is sometimes referred to as a "disaster tow") can be significant for overfished rockfish with a trip limit set at a low level.

In an analysis of Oregon *ENHANCED DATA COLLECTION PROGRAM* (EDCP) observer data, a small percentage of the trips were found to be responsible for a large fraction of discard (Methot *et al.* 2000). Similar variability in bycatch rates of darkblotched rockfish occurs in the shoreside based whiting fishery. The rare disaster tow can have 2,000 times the low end of the range of variability of darkblotched bycatch (PFMC 2003d). This high degree of variability is related to the aggregating nature of some of the species in the mixture (see above discussion on species associations).

In addition, market forces stemming from price, quantity, and size may result in fishers seeking an alternative mixture of species. Catch of undersized or lower valued species can, therefore, be coupled with regulatory limits leading to discard. This problem generally increases with smaller limits. In the same analysis of EDCP observer data, predicted discard was found to be an increasing function of

the amount of DTS complex landed and a decreasing function of the remaining limit available for that species (Methot *et al.* 2000).

Some fishing strategies do not take significant amounts of overfished species. The amount of overfished species varies between strategy, target species, and overfished species (See Tables D-5 through D-13 of Proposed Acceptable Biological Catch and Optimum Yield Specifications and Management Measures for the 2004 Pacific Coast Groundfish Fishery (PFMC 2003d)). Trip limits on some species of groundfish may not result in significant regulatory discarding, as many of the trips fall short of the cumulative limits. On the other hand, market factors such as size, quantity, quality and price limitations may also lead to discard if fishers continue to fish for other more valued species.

During three years of the EDCP study (1997-99), onboard observers attempted to record the reasons for discarding a species. "Market" was listed 66% of the time, followed by "regulations" at 24% and "quality" 10% of the time (Saelens and Creech 2003), for all species discarded. Regulations were cited as the primary reason for discarding overfished species, whereas market conditions were cited as the primary reason for discarding other emphasis species except for sablefish and shortspine thornyheads. Regulations were given as the primary reason for discard of these two species (Table 4.1.3).

Table 4.1.3. Reasons given for discard during three years (1997-99) of the Oregon Enhanced Data Collection Project (EDCP). Percentages based on recorded reasons for discard of species (market, quality, or regulation). Species discarded for an unspecified or unknown reason were not included in record count. Enviroment refers to classification given for species used in EIS analysis, not necessarily the location where the reason for discard was determined by the EDCP observer. Overfished species in bold and emphasis species in italic. Species below MSY and under precautionary management are noted with (p).

| | | | 1997-99 | | |
|---|---|---|---|---|---|
| **Environment** | **Species** | **Number of EDCP Records** | **Market** | **Quality** | **Regulation** |
| Northern Shelf | **Canary rockfish** | 31 | 0% | 3% | 97% |
| | **Lingcod** | 309 | 6% | 2% | 93% |
| | **Yelloweye rockfish** | 0 | | | |
| | *Yellowtail rockfish* | 66 | 20% | 9% | 71% |
| | *Arrowtooth Flounder* | 115 | 91% | 9% | 0% |
| | *English sole* | 214 | 74% | 25% | 0% |
| | *Petrale sole* | 29 | 100% | 0% | 0% |
| Southern Shelf | **Boccacio** | 0 | | | |
| | **Cowcod** | 0 | | | |
| | Chilipepper | 12 | 100% | 0% | 0% |
| Slope | **Darkblotched rockfish** | 0 | | | |
| | **Pacific Ocean Perch** | 3 | 0% | 33% | 67% |
| | *Dover sole (p)* | 645 | 58% | 16% | 25% |
| | *Sablefish (p)* | 1,163 | 9% | 8% | 83% |
| | *Shortspine thornyhead (p)* | 514 | 39% | 7% | 54% |
| | *Longspine thornyhead* | 336 | 82% | 11% | 7% |
| | *Unsp. thornyhead* | 208 | 50% | 16% | 34% |
| Pelagic | **Widow rockfish** | 41 | 37% | 0% | 63% |
| | *Pacific whiting* | 962 | 88% | 11% | 2% |
| Nearshore | *Black rockfish* | 0 | | | |
| | *Cabezon* | 0 | | | |
| Grand Total | | 4,648 | 48% | 11% | 41% |
| All Species Total Including Non-GF | | 8,920 | 66% | 10% | 24% |

Since the EDCP study, cumulative limits and depth based management have significantly altered fishing conditions. Current information on the reasons for discard are not available. We make the following simplifying assumptions with regard to trip limit effects based on the discussion and past studies cited above:

- Trip limits affect the amount of trawl discard in particular, resulting in higher discard rates as trip limits decline. Such bycatch is more likely to be regulatory discard. Overfished species tend to have more restrictive trip limits. Therefore, we assume much of the overfished species bycatch becomes regulatory discard.
- Trip limits also regulate the catch of other groundfish in order to control the annual harvest goal or OY or to minimize impacts on overfished species. Fishers may optimize value while minimizing incidental take of a constraining species above the overfished level, or an overfished species. We assume a mixture of regulatory and market induced discard results in bycatch of these species.
- Some OYs and trip limits are liberal enough that fishers are primarily limited by market conditions. We assume that those species having liberal trip limits that can be taken without taking a high percentage of a constraining species are primarily discarded due to economic or market limiting reasons.
- Finally, trip limit management for West Coast groundfish has a 20 year history. We assume that there has been some amount of regulatory discard for any trip limit level. Some alternatives may result in increased trip limit size. While this may reduce regulatory discard, it will not eliminate it.

Bag and size limits in recreational fisheries contribute to regulatory discard. In nearshore (shallow) waters, bycatch mortality of rockfishes due to the effects of barotrauma are lessened. Some species subject to bag limits and size limits, such like lingcod and cabezon, can tolerate effects of hooking, handling, and release better than rockfish.

*Catch limits* (or fishing mortality limits) restrict the amount of fish that may be caught or killed, whether landed or discarded. These limits require fishers to stop fishing when a limit is reached. Catch limits have not been used in the federal groundfish management program because they would require extensive and expensive monitoring.

Catch limits, when effectively monitored and enforced, provide a very high incentive for vessels to develop methods to avoid restricted species. Vessel catch limits would apply either annually or to specified 2-month periods; sector limits would likely be annual. These limits may or may not be transferable, and trip/catch limits may or may not expire at the end of each period.[3/]

[3/] Under current definitions, trip limits apply to vessels rather than permits, and trawl vessels may have only one permit. By assigning trip/catch

At the September 2003 Council meeting, trawl and environmental representatives made a presentation on British Columbia's Individual Vessel Quota (IVQ) program. Prior to implementation of the IVQ program, harvest capacity and effort were increasing, which resulted in smaller trip limits for groundfish and high levels of unreported discard (Larkin *et al.* 2003). The presenters wanted to provide the Council, NMFS and other attendees with a clear description of an effective management program that resolved many economic and bycatch problems. Alternative 5 in this draft PEIS is modeled in large part on that Canadian program. The term *RESTRICTED SPECIES CAP* or *QUOTA* (*RSQ*) is used to designate an individual vessel quota for overfished species; an individual vessel quota for other groundfish called an *INDIVIDUAL FISHING QUOTA* (*IFQ*) or simply an individual quota (IQ). Generally, individual quotas allow managers to eliminate or minimize the use of trip limits as a management tool or to restrict fishing when quotas are reached. This has the potential to reduce regulatory induced discard, especially for overfished species. IQ programs generally work best in conjunction with extensive monitoring to ensure accountability in a catch accounting system. This typically means 100% observer coverage or other reliable catch verification system. When effectively monitored, catch limits (or catch mortality limits) increase the incentive to keep any useable fish.

A clear distinction must be made between retention quotas and catch or mortality quotas. Retention quotas are much less effective at reducing incidental catch, bycatch and discard. This is especially apparent where the value of different sized fish is substantial. In that case, high-grading would be likely, as a fisherman (who is in the fishing business for his economic and financial benefit) will seek to maximize his profit. Retention limits can be effectively monitored on shore through landings receipts and sampling deliveries. Catch limits, on the other hand, must be monitored at sea. The exception to this is if discarding is prohibited; in that case, an onboard video system would be relatively effective in monitoring discard activities, but would not be effective in distinguishing which species are discarded.

Establishment of transferable IQs typically results in some level of industry consolidation. For example, a groundfish trawl IFQ program would likely result in fewer trawl vessels participating in the groundfish fishery. Some trawl quota share holders would likely elect to sell (or lease) shares and switch to some other fishery or stop fishing. Each of the remaining vessels would have a larger share of the resource on average. The impacts of this scenario are less easily resolved. By acquiring more quota shares of overfished species (that is, RSQs), a trawl fisher could increase his access to other groundfish.

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limits to permits and allowing vessels to have multiple permits, vessels could increase their catch amounts. This process is called permit stacking. Without this or some method of transferring catch limits between vessels, a trawler could be required to stop fishing after even a single dirty tow.

**Gear Restrictions**: Gear regulations are often intended to reduce the efficiency of the various gear types. Gear regulations can also be used to change the gear's selectivity. Gear selectivity is related to catch and bycatch, and thus selectivity can be adjusted to mitigate for the effects of fishing and reduce bycatch. Unobserved bycatch mortality may still occur even though bycatch as measured through observer programs is reduced. Gears can be modified to reduce the take of undersized fish, change the species composition, reduce the take of prohibited species, decrease overall efficiency, or force the gear to be used in particular habitats. Through the *EXEMPTED FISHING PERMIT* (*EFP*) process, fishers, agencies, and gear manufacturers are actively experimenting with modified gears designed to reduce the take of overfished species.

*Trawl*: West Coast commercial fishers use a variety of otter trawl types. Bottom trawls are used to fish for rockfish, flatfish, and sablefish. Gear restrictions on bottom trawl gear have had a significant impact on bycatch rates and amounts of overfished and other groundfish species. The minimum mesh size for trawl gear was increased from 4 inches to 4½ inches in 1995, based in large part on a mesh size study conducted in the late 1980s. The study demonstrated reduced retention of small, unmarketable groundfish. Larger mesh reduces the catch of undersized fish that would otherwise be sorted and discarded at sea. Changes in the type and use of chafing gear is also believed to have increased escapement of juvenile rockfish, flatfish and sablefish. However, there is likely to be some level of bycatch mortality for fish escaping through the meshes (Davis and Ryer 2003).

Large diameter roller gear has permitted bottom trawls to be used in hard bottom areas preferred by shelf rockfish species. Beginning in 2000, restrictions on the use of rollers larger than 8 inches effectively reduced directed rockfish fishing on these rocky-bottom shelf areas. A study by Hannah (2003) showed that trawlers avoided rocky reef areas on the shelf as a result of the regulation, and that encounter rates of overfished species were reduced.

EFPs are currently being used to test the selectivity of special flatfish trawls designed to reduce rockfish catches. These nets have large, cut-back sections of net in the upper panel of the trawl and reduced trawl height compared to conventional trawls. Preliminary results from an ODFW study using this experimental trawl in 50-180 fm indicated a 61% reduction in canary rockfish catch with an increase in flatfish catch rates (Parker 2003).

Other regulations could be used to change selectivity and efficiency of trawl gear. Smaller trawls could reduce bycatch by reducing the area swept by the trawl, which in turn would reduce bottom disturbance and catch. If navigation methods were sufficiently accurate, smaller trawls may be able to reduce contact with sensitive habitat species. Reduced trawl net height would reduce the capture of rockfish distributed in the water column above the bottom.

Most rockfish species do not survive after being brought to the surface after capture with trawl gears. Sablefish, cabezon, lingcod, and flatfishes (including halibut) lack swim bladders and have a better chance at survival. Thornyheads do not have a swim bladder, but are usually badly descaled due to contact with other fish and trawl webbing.

In addition to catching other non-groundfish marine finfish, all bottom trawls have some contact with the sea floor that results in the bycatch of benthic epifauna and shellfish. Marine plants, corals, sponges, sea urchins, and sea stars are taken as bycatch, some of which is unobserved. Bottom trawl doors, bridles and footropes also disturb rocks and sediments. Indirect impacts of this type of disturbance are poorly understood but are thought to reduce or modify fish habitats.

Midwater (pelagic) nets are used to target Pacific whiting and can be used to target semi-pelagic species such as widow and yellowtail rockfish. Pelagic trawls typically have lower bycatch rates of benthic organisms than bottom trawl gear.

Bycatch reduction devices (BRDs) are typically not used in West Coast groundfish trawls but are used by groundfish trawlers in Alaska (to reduce bycatch of Pacific halibut) and by West Coast shrimp and prawn trawlers (to reduce groundfish bycatch). Studies by the ODFW show a significant reduction in the bycatch of finfish species when fish excluders are used in shrimp trawls (Hannah *et al.* 1996). States currently manage the shrimp fishery and require the use of excluder devices to help reduce the take of canary rockfish.

*Hook-and-Line*: Hook-and-line gear refers to both stationary longlines (setlines) and mobile or trolled hook-and-line gear. The gear may extend vertically or horizontally, and be on-bottom or off-bottom. Fish harvested with hook-and-line gear typically have minimal physical damage from the gear itself. Puncture wounds from hooks are often limited to the mouth and may result in relatively low mortality rates in released/discarded fish. Swallowed hooks result in higher mortality rates. De-scaling is a less typical effect, compared to trawl capture. Hook size and shape also affect the degree of injury. Physical stress resulting from rapid decompression, temperature change, exposure to air and physical handling result in some level of mortality.

West Coast commercial and recreational fishers use a variety of hook-and-line gears, with sablefish being the one of the most popular target species. Levels of discard or sablefish are currently being evaluated by the NMFS observer program. Sablefish is a relatively hardy species, but some hooking mortality occurs in released fish. Small fish or fish damaged by sand fleas or bites from predators typically make up the discard. A study of the Alaskan sablefish fishery indicated that sablefish bycatch as discard including bycatch mortality was less than 12% of the total allowable catch (TAC) (Richardson and O'Connell 2002). In a comparison of sablefish pot and longline gear survey methods, Pacific rattail

made up more than half of the total catch of all species in gear placed in deep water (600 fm) (Matteson *et al.* 2001). Most longline gear is fished shallower than this, and low bycatch rates were observed in this study.

Open access and recreational fishers use a diverse array of hook-and-line gears. Each gear type and configuration has its own selectivity characteristics, which results in catches of different species mixtures. Fishers typically discard small fish and those with specified trip limits. Fish taken with hook-and-line gear, when released, have some chance of survival, depending on the species, depth fished, and other factors. Barotrauma (resulting from rapid depth decompression) inflicts high mortality rates for rockfish taken in deeper water. A study of different handling methods showed no significant difference in survival rates between quillback rockfish vented with a hypodermic needle or brought more slowly to the surface compared to un-vented fish or those brought more rapidly to the surface. Survival was significantly improved if fish were rapidly returned to depth (Berry 2001). Similar findings for black rockfish were observed by ODFW researchers (Rankin 2003). Mortality rates for lingcod, cabezon, and sablefish are less as they do not have swim bladders. However, ultimate survival of all of these species handled in such a manner is poorly understood.

Little information is available on encounter rates with marine bird species, and BRDs have not been required in the West Coast groundfish longline fishery. The NMFS Observer Program will provide better information on encounter rates. BRDs have been successfully used in longline fisheries in Alaska and elsewhere to reduce seabird mortality.

*Pot/Trap*: Pot gear causes minimal physical damage to fish. However, some level of predation (including cannibalism) occurs within the traps. In addition, physical strain resulting from rapid decompression, temperature change, exposure to air and physical handling result in some level of mortality.

Pot or trap gear is principally used to target sablefish in the West Coast limited entry fixed gear groundfish fishery. It is highly selective for sablefish. Bycatch in the commercial fishery is made up of undersized fish. A pilot survey study conducted by the ODFW comparing pot and longline gears indicated that sablefish made up more than 99% of the pot gear catch over a broad range of depths (Matteson *et al.* 2001). West Coast traps are typically equipped with 3½ inch mesh allowing escapement of some small fish. Some fishers use larger mesh in order to target larger sablefish that command higher exvessel prices.

Little is known about the mortality of released sablefish. Some studies indicate that bringing sablefish through an abrupt temperature change, such as the thermocline present offshore during the summer, can lead to stress and mortality (Davis and Ryer 2003).

Pot gear is also used by open access and limited entry participants in nearshore live fish fisheries. These small pots facilitate handling of fish and reduce injury so that fish will have a higher rate of survival when transported and held in the market place.

There is no limit on the number of pots that may be used in the limited entry fixed gear fishery. However, the State of Oregon limits the number of pots used by the only nearshore fisher holding a developmental fisheries pot permit for nearshore species to constrain effort.

Some ghost fishing can occur with lost pots and traps. To minimize losses gear is marked so it can be found and biodegradable lacing is required to disable any lost pot by creating a large hole as the lacing dissolves. Mortality due to lost gear is not well understood or documented.

*Setnet (Gill and Trammel Nets)*: Mitigation tools used by the State of California for managing setnets are similar to those used for other nets. California placed observers onboard many vessels using setnets during the 1980s. Based on those observations, the State uses area restriction as a primary bycatch mitigation tool. Setnets are prohibited in areas where bycatch of marine mammals and seabirds was observed, especially in nearshore areas and feeding grounds. In addition, mesh size restrictions are used to reduce bycatch of small fish. Tools for managing setnets are not discussed here because this gear is managed by the State of California.

**Time/Area Restrictions (Marine Protected Areas, No-take Reserves, Seasons and Closures):** Time/area closures reduce bycatch by reducing fishing in areas where restricted species are most abundant. If the designated time/area restriction coincides with the majority of the species' population, capture of that species can be greatly reduced. This tool can be especially effective for localized populations of sedentary species. Time/area restrictions are less effective for mobile or migratory species and for species that are broadly distributed over large geographic areas.

Large scale, depth-based marine protected areas (MPAs), designed to protect several overfished species, are now in effect. Federal regulations refer to the suite of MPAs intended to protect overfished groundfish species as "Groundfish Conservation Areas" or "GCAs." GCAs include species-specific closures like the Yelloweye Rockfish and Cowcod Conservation Areas, as well as the coastwide gear-specific closures known as "Rockfish Conservation Areas" or "RCAs." While these closures and restrictions have not been designated as permanent, they are likely to remain in effect for several years as integral tools in strategies to rebuild overfished shelf rockfish. Little marine habitat is set aside as no-take marine reserves or research reserves, which are typically designated as long-term (permanent) areas closed to most or all fishing activities. Fishing activities in the

GCAs, in particular on-bottom fishing, are restricted; fishing with certain gear types is still allowed.

Protected areas are best used when the migratory range of species is limited and species have strong site affinity for specific habitat types that can be identified and isolated through regulatory means. Protected areas have significantly reduced the bycatch of overfished canary rockfish, bocaccio, and cowcod. Seasonal restrictions can afford similar protection to species that aggregate during spawning migrations. Winter closures have been effective at reducing the catch of lingcod in nearshore spawning areas for example.

MPAs affect other species, both inside and outside of the boundaries. Catch of co-occurring species within an area is eliminated if the area is closed to all fishing activities. If some fishing is allowed, the amount of catch will be proportional to the effort, gear selectivity and abundance of the various species. If such an area encloses the majority of a species' population, only a small number of fish would be present outside the area. For that species, even if effort increases substantially the catch will remain very small. However, increased effort outside the closed area would result in increased catch of other species, again depending on selectivity and abundance.

**Capacity Limits**: Capacity limits are used to restrict access to the fish resource. Reducing capacity is a goal of the Council's *Strategic Plan for Groundfish*. Generally, capacity reduction in most forms reduces the need for other controls that may lead to regulatory induced bycatch in particular. Non-regulatory bycatch may also be reduced if there are fewer boats to supply market demands.

Capacity reduction is intended to reduce fishing effort; in the catch equation, if effort is effectively reduced, there is a proportional reduction in catch (if other factors remain constant). The problem is there is only a vague relationship between the number of vessels or fishers (or other standard effort measure) and the level of effective effort. Fishers, both commercial and recreational, tend to fish harder, change gear, change location, and learn from experience. Thus, few methods are good at reducing effective effort, especially to a predictable degree.

IQ programs typically have a direct effect of reducing capacity if fishers sell their shares and leave the fishery. Impacts would be similar to other capacity reduction methods that consolidate vessel permits into a smaller fleet. By defining quotas as catch or mortality limits, catch is directly controlled regardless of other factors. Effective individual quota programs require close monitoring. However, this should be kept in perspective: <u>any</u> truly effective management program requires close monitoring.

**Vessel Restrictions**: The links between vessel size and fishing efficiency and capacity are very indirect, and thus size restrictions are not an effective tool for

mitigating either bycatch or bycatch mortality. Likewise, horsepower and other vessel restrictions are similarly ineffective.

**Data Reporting, Record-keeping, and Monitoring Requirements**: Monitoring and reporting requirements are essential fishery management tools. Accountability and accuracy of these programs is proportional to the amount of observer coverage and catch verification that can be accomplished. Higher levels of monitoring will yield more complete, accurate, and timely estimates of total catch including bycatch. Direct benefits would include in-season adjustments based on current season data and higher compliance rates. Indirect benefits would include improved stock assessments and tracking of rebuilding plans.

#### *4.1.4.3 Summary of Tool Effects and Rationale for Direct and Indirect Effects*

The rationales for each tool used to describe direct and indirect effects are summarized in Tables 4.1.1 and 4.1.2. The rationales are based discussions above and on past studies and PFMC documents.

The potential impact of a tool on reducing bycatch and bycatch mortality may be due to direct or indirect effects. Effects and commensurate impacts vary according to tool and by species. These effects are summarized by tool, species association, and potential effective use in Table 4.1.3.

Bycatch and bycatch mortality reduction strongly and directly affected by the tool are indicated by 'D'. A lesser but still indirect effect is indicated by 'd'. Likewise, strong or less pronounced indirect effects are indicated by 'I' or 'i' , respectively.

### 4.1.5 General Economic Factors and Effects: Economic Dimensions of the Bycatch Issue

#### *4.1.5.1 Incentives and Disincentives to Discard*

Before trying to analyze the effectiveness of measures to reduce bycatch it is important to understand the reasons why discarding occurs and why it may become a problem. Fish are discarded for a number of reasons, but the Magnuson-Stevens Act definition of bycatch suggests that the driving forces behind the practices of discarding can be divided into two major categories: economic and regulatory. In this document, non-regulatory discards by recreational fishers is often included with economic discards and referred to as *NON-REGULATORY DISCARD*.

The process of discarding is often an economic activity associated with other commercial fishing activities (Pascoe 1997). There is an economic incentive to discard those fish for which the price received does not compensate the vessel

operator for the costs involved in their catching, handling and sending to market (Pascoe 1997). From a production perspective, unintended catches and discards are simply an input to the production of fish that are retained and marketed. In short, it is often a business decision to discard. Fish may have a low market value or be completely non-marketable for several reasons: they may be of the wrong species, size or sex; they may be damaged (caused by gear, predation in nets or mis-handling); or they may be incompatible with the rest of catch (e.g., slime, abrasion or rapid spoilage could cause damage to target species) (Clucas 1997).

Within the category of economic discards there are two distinctly different types (Clucas 1997). So-called "trash fish" sometimes caught in trawling operations are an example of the first type. Such fish are almost invariably of little or no value and therefore typically discarded whenever caught. For example, spiny dogfish sharks caught in commercial bottom trawl nets typically are several times less valuable than other groundfish species. This category of discards also includes marine life generally considered inedible, such as corals and sponges.

The other type of discarding for economic reasons, often called *HIGH GRADING*, is more situation-specific and occurs when certain attributes of a fish (size, sex or physical condition) make it more marketable and therefore more valuable than another. In general, high grading occurs when the price differential between high- and low-valued fish is greater than the cost of discarding and replacing the catch. For example, there is an incentive to high grade if a landing limit forms a binding constraint on the quantity of fish that maybe retained and sold. It is rational in such cases to discard low-valued sizes species in order to fill the landing limit with more valuable fish. The incentive to high grade is enhanced if the cost to catch additional fish is very low. For example, if an operator chooses to high-grade by discarding 25% of his marketable catch, he will end up having to catch 33% more fish than he would have if he did not engage in high-grading. The incentive to high grade may vary from trip to trip and even within a trip, depending on the various catch rates and catch compositions. For some trips, it may not be rational to discard at all if the landing limit is not reached. However, some fishermen may discard part of their catch early during the trip in anticipation of catching more valuable fish later. In other cases, fishermen may chose to store lower valued fish and discard these only when the landing limit is reached.

Related to high grading, commercial fishers may not have a market for all the fish they catch, even when the fish are of sufficient quality. This occurs when processing plants impose market limits to prevent market gluts or to match their processing capacity. For example, a processor may have too few or inexperienced filleters to handle larger quantities or certain species. A commercial fisher who catches more than his market limit may high grade if there is a price differential, or may simply dump the entire excess regardless of size or other factors.

Table 4.1.4. Direct effect of tool on regulatory and non-regulatory bycatch, habitat, and monitoring, and rationale for the effect.

| | ***Effect*** | | | | |
|---|---|---|---|---|---|
| | *Reduce Regulatory Bycatch* | *Reduce Non-regulatory Bycatch* | *Reduce Bycatch Mortality* | *Reduce Habitat Impacts* | *Increase Accountability* |
| **Harvest Levels** | | | | | |
| ABC/OY | Low OYs often require management measures such as low cumulative landing limits under some alternatives that made lead to discard. On the other hand, higher OYs may result in higher levels of effort and catch. Depending on alternatives, higher discard may also result. | Many species limited by markets do not reach OY limits, due to the market limit and other constraints placed on fisheries by overfished species OYs. | If OYs are reduced, regulatory bycatch mortality may increase for some species if trip limits are reduced. If overall effort is reduced due to restrictions, overall bycatch and bycatch mortality may be reduced. | Lower OYs should reduce fishing effort. Reducing effort should result in reduced habitat impacts. | Lower OYs required for rebuilding of some species may make it difficult to accurately track total catch under some alternatives. |
| Sector allocations 1/ | Distributed OY may have a postive effect in reducing bycatch. Risk and consequences of encountering a "disaster tow" can be spread out among several boats within the sector. | Early attainment of overfished species limits within a sector may result in reduced overall effort due to fishery closures. Overall catch of species having primarily non-regulatory bycatch (market limited) may be reduced as a result. Non-regulatory bycatch may be reduced due to | Under a given OY, catch is allocated and distributed to fishery sectors in some alternatives. Distributed OY may have a postive effect in reducing bycatch mortality to the degree risk of bycatch can be spread and managed by the sector. | Allocating OY to specific sectors would not have habitat effects except in cases where:a) allocations are made on a geographic basis; b) allocations are shifted from higher habitat-impact gear sectors to lower habitat-impact gear | Sector allocations would work best with a robust monitoring program. With increased monitoring, There would be less incentive to discard allocated fish, as it would count against the allocation. |
| Trip (landing) limits 2/ | If landing limit increases, bycatch is reduced. Studies have shown that as trip limits decline or cumulative limits are approached, bycatch increases. As cumulative limits are reached, there are stronger incentives to keep higher valued fish and discard species that are close to the limit in order to continue fishing for species | Economic factors such as price, demand, and minimum fish size needed for processing often determine market limits on the amount of fish landed. These factors can lead to discarding of fish after a market limit is reached. | If bycatch is reduced due to increased landing limit, bycatch mortality is also reduced. If limits are increased due to larger OYs, bycatch and bycatch mortality may increase due to higher harvest levels. | For restricted access sectors, landings limits variations are not likely to affect habitat. Where access is not restricted, higher landings or bag limits may bring more participants into the fishery, increasing the effect of those fishery sectors on habitat. | If landing limits increase, regulatory induced discard is reduced. Reducing discard increases accuracy of estimating total catch at lower levels of fishery monitoring. |
| Catch limits | Vessel catch limits reduce bycatch when fishing ceases and/or there is a retention requirement. Effect is enhanced when limit is on individual boat, when applied to all groundfish, and monitoring is robust. | If all groundfish catch is retained (Alternative 6), vessel catch limit will have no market induced bycatch, although discards (disposal) on land would increase. | Vessel catch limits should reduce bycatch mortality as there is less need to compete to catch fish (no derby fishery). Same pattern of effect as with regulatory bycatch. | Vessel catch limits may reduce hours trawled through incentives and efficencies to maintain strict catch caps under some options. Reducing trawl hours should reduce habitat impacts. | Catch limits may provide more flexibility by relaxing or eliminating landing limits and reducing discarded catch of those species that are not market limited. Thus, accountability is improved, if full retention is required and/or observer coverage is significantly increased. |

Table 4.1.4 (continued). Effect of tool on regulatory and non-regulatory bycatch, habitat, and monitoring, and rationale for the effect.

| | ***Effect*** | | | | |
|---|---|---|---|---|---|
| | *Reduce Regulatory Bycatch* | *Reduce Non-regulatory Bycatch* | *Reduce Bycatch Mortality* | *Reduce Habitat Impacts* | *Increase Accountability* |
| **Gear Regulations** 4/ | Regulatory induced bycatch may be reduced by allowing modified gear or alternative gear types that are more selective for non-overfished species and less selective for overfished species. | Allowing modified or alternative gears that are more selective for marketable species may reduce market induced bycatch. Gear changes to select against overfished species may interact with market induced bycatch both positively and negatively. | Making gears less efficient or more selective may result in some species or sizes being avoided, thus reducing bycatch mortality. | Gear modifications may reduce impacts to habitat. Smaller roller gear requires fishers to avoid high relief habitat. Other alternatives allow use of fixed gear to take unused portions of OY. In the latter case, habitat interactions are different, but likely | Flexible gear regulations may permit experimentation, and use of alternative and more selective gears to access unused portions of OY. Coupled with observers, species selective gears should reduce discarded fish and improve |
| **Time/area restrictions** 5/ | Time/area closures eliminate regulatory bycatch within the closed area by eliminating fishing effort. Unless effort is reduced outside the closed area, regulatory bycatch could increase outside the closure. | Time/area closures eliminates non-regulatory bycatch within the closed area by eliminating fishing effort. Unless effort is reduced outside the closed area, non-regulatory bycatch could increase outside the closure. | Bycatch mortality would be reduced within the closed area. Bycatch mortality could increase outside of the closed area if fishing effort increases. | Habitat impacts would be reduced or eliminated within closed areas. Habitat impacts could increase outside of closed areas if effort increases outside the closure. | Accountability would be increased through VMS verification of fishing location |
| **Capacity Reduction** | Capacity reduction could occur through a buyback program or through sales of IQs. Reduced effort should allow more flexibility in vessel landing limits that would likely reduce regulatory induced bycatch. | If overall effort is reduced as a consequence of capacity reduction, bycatch of species with low or no value would be reduced. Fewer boats may induce buyers to relax market limits (supply and demand response) and effort could increase. Non-marketable or low valued fish would still | Reduced effort should have a positive impact in reducing bycatch mortality. Fewer boats could result in increased hours fished, possibly offsetting positive effects. | Reduced effort should reduce habitat impacts. Fewer boats could result in increased hours fished, possibly offsetting positive effects. | If number of fleet participants were reduced, currently available observer program funds could cover a greater percentage of the fleet's participants. |

Table 4.1.4 (continued). Effect of tool on regulatory and non-regulatory bycatch, habitat, and monitoring, and rationale for the effect.

| | ***Effect*** | | | | |
|---|---|---|---|---|---|
| | *Reduce Regulatory Bycatch* | *Reduce Non-regulatory Bycatch* | *Reduce Bycatch Mortality* | *Reduce Habitat Impacts* | *Increase Accountability* |
| **Data Reporting** | | | | | |
| Observers | If observers are used as in current West Coast observer programs, as biologist-samplers, no effect. If observers are used as compliance monitors, observers could have deterrent effects on vessel operators in full-retention programs. | No effect. | The presence of observers on board a vessel may have a minimal effect on bycatch mortality, in that vessel operators may be more likely to use safe handling techniques in releasing prohibited species. Otherwise, no effect. | If observers are used as in current West Coast observer programs, as biologist-samplers, no effect. If observers are used as compliance monitors, observers could have deterrent effects on vessel operators | Increased observer coverage under some alternatives would increase accountability by ensuring retention, if required, or accurately accounting for discarded fish. |
| Vessel monitoring system 6/ | VMS can directly reduce regulatory bycatch by improving compliance with area closures designed to protect overfished species. | No effect. | VMS can directly reduce regulatory bycatch mortality by improving compliance with area closures designed to protect overfished species. | VMS is a deterrent enforcement tool intended to monitor and deter potential fisheries incursions into closed areas. VMS can increase closed area compliance, thereby protecting habitat from gear impacts by fisheries prohibited from | VMS increases accountability by verifying fishing location. |
| Electronic monitoring | EM can reduce regulatory bycatch in full-retention fisheries by improving compliance with full retention requirements. EM can also act as a deterrent, similar to VMS. | No effect. | EM can reduce regulatory bycatch mortality in full-retention fisheries by improving compliance with full retention requirements. EM can also act as a deterrent, similar to VMS. | Unless specifically designed to monitor fishery participation in particular areas, no effect. Some EM devices can be programmed to have area-monitoring functions | EM directly monitors fishery participants, increasing accountability. |

1/ PFMC, 2003d.

2/ Pikitch, 1988, Methot, 2000.

3/ Larkin, 2003.

4/ Hanna, 2003 and Davis, 2003.

5/ PFMC, 2001.

6/ PFMC, 2003e.

Table 4.1.5 Management tools and potential actions using each tool that have potential to reduce bycatch or bycatch mortality, and potential direct and indirect impacts of each action.

| | | | | **Potential Effective Uses** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D = Direct effect<br>d = minor direct<br>I = Indirect effect<br>i = minor indirect | | | Potential bycatch reducing actions: | Reduce catch in excess of vessel limits? | Reduce proportion of overfished species? | Reduce encounters with overfished species? | Reduce fishing in high relief seafloor areas? | Reduce catch proportion of on-bottom species? | Reduce catch proportion of off-bottom species? | Reduce catch proportion of small fish? | Reduce catch of unwanted finfish species? | Reduce potential for "ghost fishing"? | Reduce catch of marine mammals? | Reduce catch of seabirds? | How easily enforced/ monitored? | Compliance Costs (to vessel) |
| Species associations most impacted | | | | Overfished | Overfished | Overfished | Overfished rockfish | Overfished rockfish and lingcod, some of flatfish | Widow rockfish and Pacific whiting, yellowtail rockfish | Flatfish, rockfish, sablefish | Halibut, salmon, skates, rays, and sharks | Sablefish | | | | |
| **Type of bycatch most impacted** | | | | Regulatory | Regulatory | Regulatory | Regulatory | Regulatory | Regulatory | Non-regulatory | Non-regulatory | Non-regulatory | Regulatory | Regulatory | | |
| | | **Alternatives** | | | | | | | | | | | | | | |
| **Harvest Levels** | | | | | | | | | | | | | | | | |
| | ABC/OY | 1-6 | larger OYs | i | I | d | | d | d | | i | | | | | low |
| | sector allocations | 4 | | i | I | i | | d | d | I | i | I | | | | low |
| | vessel landing limits | 1-4 | larger trip limits | d | D | i | I | D | D | I | d | | | | easy | med |
| | vessel catch limits | 5,6 | individual species caps | D | D | D | I | D | D | I | D | | | | difficult | high |
| | individual quotas | 5,6 | | D | D | D | | D | D | I | D | | | | difficult | high/low |
| **Gear Restrictions** | | | | | | | | | | | | | | | | |
| Trawl | mesh size | 1-6 | increase mesh size | D | | | | | | D | D | | | | med | high |
| | footrope diameter/length | 1-6 | restrict large diameter | D | | d | D | D | D | | | | | | diff/med | high |
| | net height | | lower net height | I | D | D | | | D | | D | | | | diff | high |
| | codend | 1-6 | Increase mesh size, restrict overall size | D | | | | | | | | | | | med | high |
| | design: on-bottom or pelagic | | require pelagic trawl | | D | D | D | D | D | | i | | | | med | high |
| | bycatch reduction devices | | require | | | | | | | | D | | | | | |
| Line | number of hooks | | reduce number | D | | d | | | | | i | D | | | dif | low |
| | hook size | 1 | increase size/ decrease | | d | | | | | D | D | | | | dif | low |

Table 4.1.5 Management tools and potential actions, continued.

| | | | | **Potential Effective Uses** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D = Direct effect<br>d = minor direct<br>I = Indirect effect<br>i = minor indirect | | Potential bycatch reducing actions: | Reduce catch in excess of vessel limits? | Reduce proportion of overfished species? | Reduce encounters with overfished species? | Reduce fishing in high relief seafloor areas? | Reduce catch proportion of on-bottom species? | Reduce catch proportion of off-bottom species? | Reduce catch proportion of small fish? | Reduce catch of unwanted finfish species? | Reduce potential for "ghost fishing"? | Reduce catch of marine mammals? | Reduce catch of seabirds? | How easily enforced/ monitored? | Compliance Costs (to vessel) |
| Species associations most impacted | | | Overfished | Overfished | Overfished | Overfished rockfish | Overfished rockfish and lingcod, some of flatfish | Widow rockfish and Pacific whiting, yellowtail rockfish | Flatfish, rockfish, sablefish | Halibut, salmon, skates, rays, and sharks | Sablefish | | | | |
| **Type of bycatch most impacted** | | | Regulatory | Regulatory | Regulatory | Regulatory | Regulatory | Regulatory | Non-regulatory | Non-regulatory | Non-regulatory | Regulatory | Regulatory | | |
| Pot/trap | number of pots | | | | | | | | | | | | | | |
| | | | reduce number | D | | d | | | | D | D | | | med | low |
| | pot size | | | | | | | | | i | D | | | med | med |
| | escape panel in net/pot | 1-6 | require | | | | | | | D | D | | | med | low |
| | soak time | 1-6 | retrieval requirement | I | i | d | | | i | i | D | | | Dif | low |
| **Time/Area Restrictions** | | | | | | | | | | | | | | | |
| | seasons | | | | | | | | | | | | | | |
| | | 1-6 | close sensitive time/area | d | d | d | | i | i | d | D | | d | d | easy | low |
| | area closures | 1-6 | depth based mgt. | d | D | D | D | i | i | d | D | D | D | D | med | high |
| | depth closures | 1-6 | | d | D | D | I | i | i | D | D | I | d | d | difficult | high |
| | marine reserves | 6 | semi-permanant to permanent | d | D | D | D | i | i | d | D | D | D | D | | high |
| **Capacity/number of participants** | | | | d | | | I | | | | i | | | | easy | |
| | permits/licenses/endorsements | 2 | reduce number | I | I | d | I | I | I | I | i | D | | | easy | |
| | IQs | 5,6 | establish IQ system | | | | | | | | | | | | | |
| | limited entry | 2 | no open access | I | I | d | | | | | i | D | | | easy | |
| **Capacity (vessel restrictions)** | | | | | | | | | | | | | | | | |
| | vessel size | 1-6 | | I | | N | | | | | | | | | Easy | high |
| | engine power | | | I | | N | I | | | | I | | | | med | high |
| | vessel type | | | I | | N | I | | | | | | | | Easy | high |

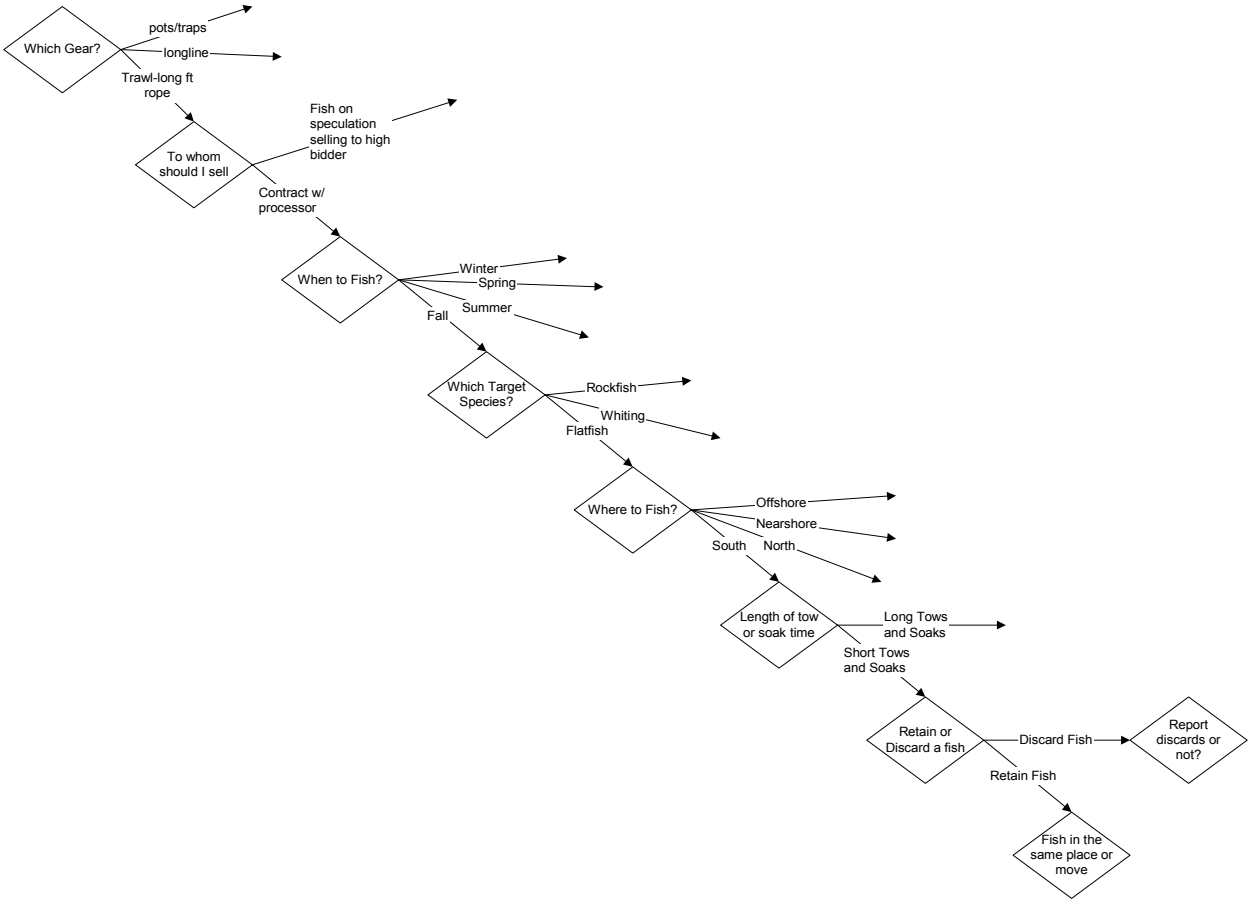
*REGULATORY DISCARDS* includes fish which, by regulation, fishermen are required to discard whenever caught. Such regulations remove the incentive to target the fish in question by eliminating the economic benefits. For example, it is unlawful for any commercial limited entry vessel to retain any species of salmonid caught with limited entry fishing gear, except in very limited circumstances. Also, State and federal regulations prohibit the landing of Dungeness crab incidentally caught in trawl gear off Washington and Oregon. Regulatory discards also include fish that could otherwise be legally retained and sold but have been caught in a closed season, by a prohibited gear, or in a closed area and therefore must be released or discarded. In addition, regulatory discarding occurs in multi-species fisheries where trip limits or bag limits do not match the actual composition of the catch (Clucas 1997). This means that a commercial vessel or recreational fishery may reach the limit for one particular species while there is still an unfulfilled quota or allowance of other species. As a commercial vessel approaches or has reached its landing limits for one species, there is a strong incentive for the vessel to high grade and discard that species as he continues fishing for other species to fill his remaining species allowances. This is the type of discard most often found in the West Coast groundfish fisheries.

The various incentives and disincentives to discard fish in the West Coast groundfish fisheries under the current management regime can be further clarified by identifying the various decisions that participants in those fisheries face. These decisions include the following:

**Decision Point:** Which gear should I use when I fish?
**Decision Point:** When should I fish?
**Decision Point:** For which species should I fish?
**Decision Point: Where do I fish?**
**Decision Point: How long should I tow, or how much gear should I set?**
**Decision Point: Should I keep a particular fish or discard it?**
**Decision Point: Should I fish again in the same place or should I move to a different location?**

**This series of decision points is depicted graphically in Figure 4.1. Each decision point and the incentives and disincentives are described below in order to gain a better understanding of the behaviors of fish harvesters with respect to bycatch. While most of the discussion focuses on commercial fishing, similar decisions apply to recreational fishers.**

Figure 4.1. Harvester decisions regarding bycatch (trawl used as example).



**Decision Point: Which gear should I use when I fish?** Catch is proportional to the amount of effort applied and the abundance or availability of fish, as modified by the effectiveness of the gear. Thus, all things being equal, the most effective gear would typically be chosen. However, fishers develop preferences and expertise with certain gears, and certain gears are more effective for different species. In addition, regulations place bounds on the types of gear that may be used. The commercial limited entry system largely determines which general gear type any commercial vessel is allowed to use. The limited entry system has produced the positive effect of limiting the amount of groundfish fishing effort (the number of vessels) and limiting the gear a vessel is authorized to use. However, this also reduces the opportunity fora given operator to try different gear types (e.g., switching from trawl to nontrawl gear) that might reduce unwanted catches. For example, there may be methods to selectively harvest abundant rockfish species with hook-and-line gear while having little catch of overfished rockfish species, but trawl gear may not be capable of selectively catching these species. Within the category of trawl gear, however, different configurations and variations can effectively catch flatfish with minimal incidental catch of rockfish. Overall, however, the negative effect of the constraint on changing gears on bycatch is likely to be smaller than the positive impact derived from the limited entry systems restrictions on the amount of gear being used.

Cumulative trip limits have greatly reduced the race for fish in all sectors of the groundfish fishery where they have been applied. Because fishers do not have to compete against each other for a share of the fleet-wide harvest quota during any given period, they do not necessarily place themselves at a competitive disadvantage by adopting fishing practices that reduce the catch of unwanted fish. Therefore, vessel operators may be more willing to modify their gears (within the constraints of specified gear regulations) to reduce unwanted catches. For example, a commercial trawl vessel could experiment with a smaller net (shorter footrope), flatter net (smaller vertical opening), or use large mesh escape panels. The decision to make these gear adjustments will primarily depend on how they affect the profitability of the fishing operation. Under the current conditions of extremely restrictive trip limits for overfished species such as canary rockfish, however, experimentation may be perceived as having greater risk of hitting a limit.

**Decision Point: For which species should I fish (What is my target strategy)?** Successful commercial vessel operators typically may employ a variety of fishing strategies. On an individual trip, the decision about target strategies depends on several factors. The most important is market demand, as identified by the buyers or processors to whom the fish will be delivered. There is typically some formal or informal coordination of targets between the operator and the processor, both before a trip begins and during the trip as fish are caught and identified. Other factors that drive the target strategy are the amounts of unharvested trip

limits for various species and the catchability of various species in the particular area and time of year the vessel is operating.

**Decision Point: When should I fish?** Catch is related to the amount of effort and the abundance (or availability) of fish. Therefore, the time of highest abundance/availability requires the least effort. The current management system has a direct impact on timing decisions. Currently, the commercial fishing year is divided into 6 two-month periods, and trip limits are set for each period. If a vessel does not operate during a period, there is no opportunity to make up that lost revenue. Within each period, fishers have discretion of when to schedule their fishing operations. The Council develops trip limit recommendations for the entire year that take into account seasonality factors. The *GROUNDFISH ADVISORY SUBPANEL* (*GAP*) and *GROUNDFISH MANAGEMENT TEAM* (*GMT*) consult extensively to develop trip limits that will effectively spread harvesting opportunities over the year. The *BYCATCH MODEL* uses landings and bycatch data from previous years and anticipated co-occurrence rates by time, depth and area to calculate how much catch would occur under various alternative strategies. In an ideal situation, vessels and processors would focus on a particular species when the species generated the most value for both the processor and harvester, or when the greatest overall value could be achieved (within the constraints of rebuilding plans and overfished species limitations). For example, Dover sole that are aggregated to spawn during winter months can be harvested with relatively little incidental catch of canary rockfish, so the Dover sole trip limits are typically larger at this time. Petrale sole and other flatfish provide similar opportunities. In other cases, the value at that time may be higher depending on consumer preferences. Examples of this are the pre-Easter Lenten season and the Japanese holiday season. By spreading out fishing across the year, cumulative trip limits allow some targeting during these peak fishing periods. However, this approach is probably less than optimal with respect to avoiding overfished species, maximizing catch of other species, and maximizing total economic values.

**Decision Point: Where do I fish?** Catch is related to the amount of effort and the abundance (or availability) of fish. Therefore, the area of highest abundance/availability requires the least effort. The decision of where to fish depends on market demands and the costs of fishing a particular area. In the absence of regulatory constraints on fishing location, the area with the highest perceived potential net revenue will be chosen, which would typically be the area of highest *CATCH PER UNIT OF EFFORT* (*CPUE*) of desirable species and the area nearest home port or market. However, substantial constraints have been applied to reduce the likelihood of catching certain overfished rockfish stocks. Under these conditions, and the fact that cumulative trip limits have eliminated the race for fish, the area with lower probability of encountering overfished species is likely to be chosen, especially if an observer is aboard. In other words, under the current management regime harvesters are likely to take into account bycatch

minimization in their decision of where to fish, although they may not necessarily give this factor the same weight as other economic considerations.

**Decision Point: How long should I tow? Or, how much gear should I set?** Catch is related to the amount of effort applied and the amount of fish present. Thus, the length of time (or distance) a unit of trawl gear is fished can have a significant effect on bycatch. Likewise, the amount on nontrawl gear used can affect bycatch rates and amounts. Long tows with trawl gear and large sets of fixed gear are more likely to increase the catch of non-target species as well as desirable species. Shorter tows and smaller sets provide the harvester with precise feedback on the type of fish being caught — feedback that cannot be attained with the best electronic sensors. The slower pace of fishing under cumulative trip limits increases the incentive for vessel operators to take the time to check their catch more often. Of course, checking catches more frequently can increase operating costs. Harvesters will weigh the negative effects of catching overfished species or other undesirable species against the additional costs of retrieving gear.

**Decision Point: Should I keep a particular fish or discard it?** The decision to discard or retain a fish may depend on a number of factors, including the value of the fish, trip limit amounts remaining, the presence of an observer and the likelihood that keeping the fish may affect future earnings. In general, fish caught in the groundfish fisheries can be categorized as follows:

1. Desirable Species - fish (including non-groundfish) that are not overfished, garner a sufficient market price and can be legally landed.
2. Overfished Species - fish from a stock or stock complex that has been determined to be below its minimum stock size (overfished/rebuilding) threshold.
3. Prohibited Species - species or species groups which must be returned to the sea as soon as is practicable with a minimum of injury when caught and brought aboard except when their retention is authorized by other applicable law.
4. Undesirable Species - fish that have no market value.

The decision to discard fish in categories 3 and 4 is straightforward — the law requires prohibited species to be discarded, while there is no economic reason to retain undesirable species. The decision to retain or discard desirable species is primarily a matter of available trip limit amounts. If a vessel's landings of the species in the 2-month period are less than the cumulative trip limit, it is likely the catch will be landed. There may be cases where a vessel high grades fish of a desirable species. For example, larger fish may fetch significantly higher prices than smaller fish. If the price difference is large enough, the operator may be able to generate higher revenue by discarding lower value fish now and incurring the cost of catching additional fish later. The presence of an observer on board is likely to skew the decision toward retention, particularly if there is a possibility

that the amount of observer coverage could increase if there is widespread evidence of high grading.

The decision to retain or discard overfished species depends on the specific situation. If the vessel has already landed the full trip limit for that species, the decision to discard is again straightforward. If the operator can land the fish within his or her trip limit and there is an observer on board, the reasonable decision is to retain the fish. Even if an observer is not on board, there are incentives to retain the overfished species: the fish typically has economic value and could increase the total revenue for the trip. In addition, a fisher may believe it is the right thing to do for the resource. On the other hand, there may be incentives to discard the overfished species. For example, trip limits for the species could increase (or at least stay the same) if no one else lands the species and catch estimates are skewed downward; if managers believe few of the species have been caught, trip limits for other species may be increased (or not reduced) later in the year, improving the possibility of higher revenues in the long run; the belief that everyone else in the fleet is doing it; and a low probability of being caught doing the wrong thing for the resource.

In general, the fleet as a whole is likely to be better off if everyone discards most (but not all) of their overfished species when observers are not present. If all overfished species are discarded when no observers are present, there would be clear evidence that the fleet was under-reporting. However, if all vessels retain small amounts (i.e., amounts under trip limits but less than are actually caught), it may appear as though actual catches are less than they really are, and that could cast doubt on the accuracy of catch estimates of observers. If it appears that catches of an overfished species are reduced, there may be a greater possibility that OYs for cooccurring abundant species will be increased (or reduced less).

**Decision Point: Should I fish again in the same place or should I move to a different location?** After the gear is retrieved and the deck is cleared, a final decision faces the vessel operator — should the gear be redeployed in the same area or should the vessel be moved? Again, catch is related to effort and fish abundance/availability. This decision is influenced by the species composition of the last unit of effort, the likelihood that more optimal grounds can be located, and the estimated cost of moving to alternative areas. If there is a possibility that the catch of overfished or prohibited species is less in the alternative location and all other factors are equal, it is likely the vessel will move because cumulative trip limits have effectively eliminated the race for fish. Under an intense race for fish, moving to avoid bycatch is unlikely, as any time not fishing is revenue lost.

#### *4.1.5.2 Costs of Bycatch*

The economic losses or costs associated with the act of discarding can also be divided into a number of categories. The categories presented below are drawn largely from Clucas (1997) and Pascoe (1997). It is important to note that many

of the costs listed are not unique to the problem of discarding — they would occur regardless if the fish are discarded or retained. For example, the costs associated with fishery interactions would not be eliminated if there were a total ban on discards. Consequently, the problem is more accurately framed as the costs of catching fish that are unwanted (for economic or regulatory reasons) rather than as the costs of discarding per se.

**Costs associated with catching, sorting and throwing the unwanted or prohibited catch over board**. Extra costs associated with capture and subsequent discarding include higher fuel consumption in active fishing operations (such as trawling), longer on-deck times for target species while the catch is sorted, leading to a reduction of quality and therefore value of the fish, employment of extra crewmembers required to sort and remove the unwanted catch from the target catch, and greater wear and tear on the fishing gear and vessels employed (Clucas 1997). For at-sea processors, lower factory throughput efficiencies and higher processing crew costs may occur due to the additional time required to separate discards from the retained catch. These various costs differ across fisheries and fishing operations. For example, the costs of removing fish from gear may be relatively small for trawl gear, as the fish typically do not need to be physically detached from the gear (Pascoe 1997). Moreover, estimating the economic costs of sorting and discarding fish is difficult due to the problems in determining the opportunity cost of the crew's time (Pascoe 1997). For example, the crew may be otherwise inactive if not sorting the fish.

**Foregone catch as a result of mortalities imposed on recruits to the target fisheries**. An economic loss also occurs where discard-induced mortalities affect immature individuals or non-legal sexes of the target species (Clucas 1997). The taking of undersized or juvenile fish can produce a number of negative economic effects (Pascoe 1997). Catching undersized fish results in potential *GROWTH OVERFISHING* and *RECRUITMENT OVERFISHING*. With growth overfishing, the juvenile fish could be taken at a later date at a larger, more valuable size. Hence, the overall potential yield of the fishery (and similarly, the value of the yield) is reduced. With recruitment overfishing, the taking of juvenile fish reduces the potential spawning stock size, resulting in lower levels of future recruitment. The lower level of future recruitment can be a direct cost to all participants in the fishery in the form of foregone income (Pascoe 1997).

Discarding over-quota fish (whether as the result of a global quota, individual quota or trip limit) also produces costs (Pascoe 1997). A proportion of these fish could have potentially been caught in the next year, reducing the costs of fishing in order to achieve next year's quota. These costs are again incurred by all fishers in the fishery, including the fisherman who discarded the over-quota catch.

Reducing the potential level of landings can also affect consumers through a reduction in consumer surplus (Pascoe 1997). *CONSUMER SURPLUS* is the area under the demand curve and above the price received. A loss in consumer surplus

can occur through a reduced quantity of landings which increases the price to consumers. The loss is related to the responsiveness of price to quantity landed (the price flexibility). If prices are inflexible with respect to quantity landed, then varying the quantity landed will not affect the price received. Consumer surplus in such cases is zero for all levels of landing. However, if prices do respond to the quantity landed, then a reduction in landings will result in an increase in price and a loss of consumer surplus.

**Foregone catch resulting from mortalities imposed on target fisheries by fisheries targeting other species**. A third economic loss occurs when a fishery discards fish of economic importance to another fishery. The result can be an indirect cost to persons involved in the harvesting, processing, marketing or consumption of the species discarded by the target fishery (Pascoe 1997). This fishery interaction situation can be compounded by quota systems which permit individual fishermen to only land specific species (Clucas 1997).

It is important to note that discard mortalities induced by a fishery on species of value to other commercial or recreational fisheries are also often associated with high social costs. For obvious reasons, these sorts of mortalities often spawn bitter conflict between fishery participants and lead to political infighting over resource allocation and bycatch removal quotas (Alverson et al. 1994).

**Costs of endangered or threatened species bycatch.** Apart from the negative effects on the fishing industry and fish consumers, bycatch can have a negative effect on others in society who may value the species being discarded and therefore may experience some loss through the death of the animals following discarding (Pascoe 1997). If a bycatch species is severely depleted, threatened or endangered, the cost to society may be especially high. For example, where the species reaches a threatened status, there may be a loss of existence value as there is a possibility that the population may collapse and the species become extinct (consequently, this bycatch is referred to as "critical bycatch" (Hall 1995 cited in Pascoe 1997)). While the value of threatened or endangered species is difficult to measure, an indication of the non-market value of such species can be gauged by the reaction of individuals to their death as a result of any discarding.

**Disruption of marine food chains and ecosystems**. A fifth economic loss may occur when the bycatch of one species has a negative effect on the status of other species through predator, prey, or other biological interactions. These modifications of biological community structures in ecosystems can have indirect effects on fishery resources.

Ecosystem level impacts of bycatch (that is, both the catch and discard components of bycatch) can also negatively affect non-fishery resources. The result of the adverse effects of catch and discard on ecosystems and associated species may be that some members of society experience a loss of existence value and other values derived from the preservation of nature. It is important to note,

however, that reduction of either component will not necessarily have a positive impact on marine ecosystems. For example, measures to reduce the discard component in some fisheries would reduce the food supply of scavenging seabirds and could have a severe impact on the ecological balance in wildlife communities (Furness 1999).

**Bycatch monitoring costs**. A sixth stream of costs associated with bycatch is the money that is spent each year on monitoring the level of incidental catches and discards. The main problem facing many fisheries managers is not the fact that discarding takes place per se, but that the level of discarding is not known (Pascoe 1997). Discarded fish represent catches that are not documented in landing statistics, but are nevertheless real removals from the stock (Pascoe 1997). In the case of unrecorded high grading, not only would actual mortality rates be higher than apparent mortality rates, but the age and size distribution of landed catch would be different from the size distribution of the initial harvest (prior to discards) (National Research Council 1999). Without information on discarded catch, it is difficult for fishery managers to calculate the size of a species' population and offer accurate advice toward the conservation of that stock. As a result, attempts to a manage a particular fishery may be based on incorrect assumptions and may allow unwittingly for the overexploitation of that resource. Under precautionary management standards, it is also possible to overestimate the amount of discarded catch, resulting in foregone catch.

**Ethical concerns regarding waste in fisheries**. From an economic perspective, the discarding of fish is a problem only if it precludes higher valued uses of those or other fish. It is important to note, however, that there may be societal concerns related to the discarding of fish that lie outside the economic-utilitarian paradigm. Specifically, some individuals may consider discarding fish to be wasteful and morally wrong. According to this viewpoint, fish that cannot be used should not be harvested. There are a number of variants of this philosophy. For example, some people may hold the view that nature has rights; to exploit nature is just as wrong as to exploit people (Nash 1989). Other persons may contend that non-human species are intrinsically valuable, independent of any use they may be to humans (Callicott 1986). The latter conviction may be related to religious principles, such as a belief in the sacredness of all or certain life forms. Still other individuals may simply have an undefined sense that uselessly killing life forms is improper behavior and should be avoided.

All of these moral arguments are inconsistent with the economic paradigm of trade-offs between money and preservation of species or ecosystems, because they present individuals with the moral imperative that we ought to preserve plants and animals (Stevens et al. 1991). While many of the costs associated with bycatch can be thought of as economic costs and can be quantified, at least in principle, the value that some people assign to eliminating waste in fisheries can not be expressed in monetary terms. These values are presented by their proponents as moral imperatives and, thus, do not lend themselves to analyses of

economic tradeoffs. As Costanza et al. (1997) and Pearce and Moran (1994) note, concerns about the preferences of future generations or ideas of intrinsic value translate the valuation of environmental assets into a set of dimensions outside the realm of economics. Nevertheless, these ethical concerns can have economic implications. For example, it can be costly to harvesters and processors if consumers object to the waste and refuse to purchase related products. The importance of product differentiation in some fisheries through labels (such as the "dolphin-safe" labeling of canned tuna, "turtle-safe" labeling of boxes of shrimp, or the publication of "seafood watch" lists judging species abundance levels) is an indication of the economic effect these ethical standards can have (See Roheim (2003) for a discussion of the market impacts of eco-labeling of seafood).

#### *4.1.5.3 Bycatch Costs as Externalities*

Economic theory says a commercial fisher will continue catching and discarding unwanted fish up to the point at which the costs of this practice begins to have a negative effect on the profitability of his operation. However, under most management programs, an individual fisher does not bear all of all the costs discussed above. In fact, only the costs associated with catching, sorting and throwing the unwanted or prohibited catch over board are fully borne by the individual discarding the fish. While the act of catching juvenile fish affects the potential future benefit to the individual fisherman, it affects all other fishermen in the same fisheries as well. These costs are the product of the combined activities of all participants in the fishery and are therefore outside the control of the individual (Pascoe 1997). The individual vessel operator who chooses to invest in fishing gear and practices that reduce bycatch may be placing himself at a competitive disadvantage if others do not follow suit. The free-riders that do not minimize discards will likely increase their relative share of fleet-wide profits.

Nor does the individual fisher fully bear the other bycatch costs described above, if he bears any of them. Rather, the costs of catch and discard are transferred to other members of society as well. These costs are external to fishermen's accounting of costs in that they do not appear in their ledgers and, therefore, are not considered when fishermen calculate whether a particular fishing strategy is profitable. These circumstances, in which certain costs are external to (i.e., do not influence) the fisherman's production decision (Pascoe 1997), result in the individual fisher making inadequate efforts to control bycatch. What this means is that if an individual fisher does not recognize and take account of these *EXTERNAL COSTS*, he will receive signals or incentives that are inconsistent with society's values. That means his decisions will be viewed as wrong decisions from the perspective of society as a whole, and perhaps also from the perspective of the fishermen as a group (NMFS 1996). The result is that the level of bycatch will be higher than the socially optimal level.

Economic theory says that profit-maximizing operations will use an input up to the point that the cost for an additional unit of the input is equal to the revenue

that additional unit produces.[4/] Since society has not developed a method to charge the fishing vessel for its use of discarded fish, the profit maximizing vessel operator will treat the unwanted fish as a non-binding constraint in his production. In other words, while the fishing vessel operator treats fish that are eventually discarded as a free good, society places a higher value on those fish, creating conflict between fishers and society.

From an economic perspective, the tendency of the fishing industry to discard fish is not so much a failure of the fishing industry to act responsibly as it is a consequence of the various costs and revenues tradeoffs that businesses make when determining how best to produce the goods that society values. The fact that discards often do not play an explicit role in the profit and loss calculation of fishermen is primarily a failure of society to organize its markets and regulations in a way that charges fishing operations a price that represents the value society places on that resource. This perspective can be used to develop solutions that could lead to changes not only in the way that fishing vessels treat their incidental catch, but also influence their decisions to avoid catching those fish at all.

## 4.2 Impacts to The Physical Environment

Changes to the physical environment from bycatch and any bycatch mitigation program are minimal and superficial when compared to the vast expanse of the physical marine environment. The basic geological structure and bathymetry of the seafloor would not be expected to be affected, nor the chemical properties of seawater, current patterns or climate.

Small scale changes to the seafloor surface, including surface sediments, have resulted from groundfish fishing activities in the past and are anticipated to continue under all the alternatives. These changes include movement of rocks, suspension and resettling of sediments, and movement, removal and destruction of corals, sponges and other structure-forming invertebrates. The amount and distribution of previous impacts is largely unknown, and the amount and distribution of future impacts is likewise unknown. Currently, NMFS is preparing an EIS for groundfish essential fish habitat that will compile all the available information on bathymetry, sediment distribution, and living structures. That EIS is also expected to identify which habitat features constitute essential habitat and which habitats are vulnerable to fishing operations.

In general, bycatch mitigation alternatives that reduce bycatch of benthic fishes such as corals, sponges and clams will tend to reduce impacts to the physical

[4/] For example, as long as each dollar invested makes some profit, it would be a prudent choice to continue increasing one's investment there. When an individual gets back only one dollar for each additional dollar invested, it would be prudent to invest any additional money somewhere else.

seafloor. Specific bycatch mitigation tools that reduce these impacts include marine protected areas, and tools that restrict or reduce the amount of contact between fishing gears and the seafloor.

Natural and human factors and events affect the coastal marine environment (ecosystem) in a variety of ways. Large and small scale climatic factors sometimes cause dramatic changes in biological productivity, species abundance and biodiversity.

## 4.3 Impacts to The Biological Environment

Primary production (*PHYTOPLANKTON* abundance) and secondary production (zooplankton abundance) influence the abundance of higher trophic level organisms, including fish populations targeted by fishers. None of the alternatives, including the status quo (no action), is expected to impact either phytoplankton or *ZOOPLANKTON* abundance. Similarly, none of the alternatives is expected to impact vegetation, either positively or negatively. Kelp forests off the Washington, Oregon and northern California coasts are not expected to be affected, nor eel grass communities.

From an *ECOSYSTEM* perspective, human fishing activities might be viewed as large-scale predation that consumes species at a variety of trophic levels and may also affect other tropic levels directly or indirectly. Effects of fishing on species abundance, species diversity, community structure and physical environment have been described in numerous studies.

For example, top predators may be removed, resulting in increases of species lower in the food web. At the other trophic extreme, removal of large amounts of krill or other zooplankton can result in reduced productivity and mortality of higher trophic animals. Fishing practices can also affect habitats, community structure and biodiversity. The cumulative effects of 100 years of West Coast groundfish fishing (and fishing for other species) have helped shape present day ecosystem structure. Forage species (including groundfish and non-groundfish) captured in the course of groundfish fishing may be removed from the environment. Top level predator species may also be removed, resulting in increases of their prey species. Or, their competitors may increase, making it difficult to regain their previous position in the hierarchy. In either case, fishing increases the mortality rate of unfished populations. These and other changes could alter trophic dynamics, abundance and biodiversity of the ecosystem. It is difficult, however, to separate many of these fisheries-related changes from environmental ones.

### 4.3.1 Impacts of the Alternatives on Groundfish Resources

This section lists, discusses and analyzes the impacts of the seven alternatives on groundfish resources. The analytical approach and techniques, including the ranking system, were explained in section 4.1.2.

Outside of environmental influences, fishing mortality accounts for the primary impact on groundfish resources. The Council controls fishing mortality through harvest management in order to attain the OY for each species. This is complicated by the fact that groundfish are caught in a suite of mixed species fisheries that correspond to ecological species groupings and reflect fishing strategies as well as stock condition of individual species components. The amount of groundfish taken results from the interplay between the OY specifications, management measures established for rebuilding some species, allocation among competing uses, and facilitating access to healthy stocks of groundfish.

Overfished species play a central role in the consideration of alternatives. Current stock levels reflect a combination of recent and poor environmental conditions leading to lower levels of recruitment and productivity, effects of management of groundfish in the absence of sufficient stock assessment and life history information, increases in fishing efficiency and effort, and unknown impacts of multi-species fishing strategies where discard has contributed to un-accounted for fishing mortality. Abundance of several groundfish species has declined below the overfishing threshold. Some species, such as canary rockfish and bocaccio are at very low stock levels and co-exist with a wide variety of groundfish species across broad latitudinal and bathymetric ranges. Rebuilding these species requires major constraints on harvests of other healthier stocks of groundfish - reducing overall OYs significantly.

Certain groundfish and non-groundfish species have been selected to represent a range of biological resources having significant and different bycatch issues. The application of different management tools can be tailored to address these issues. In our analysis, we attempt to look at how these tools address regulatory and non-regulatory bycatch for *OVERFISHED SPECIES* and select *EMPHASIS SPECIES* (Table 4.3.1)

- *OVERFISHED SPECIES* are the nine groundfish species (bocaccio, canary rockfish, cowcod, darkblotched rockfish, lingcod, Pacific whiting, Pacific ocean perch, widow rockfish, and yelloweye rockfish that have fallen below 25% of spawning biomass levels and have or soon will have rebuilding plans. Most of these species are long-lived rockfish that prefer rocky habitats and have behaviors that may concentrate them in time and space. In addition, rockfish have generally high market acceptance and in many cases high value. These characteristics have made them vulnerable to target fishing, contributing to their present overfished state. Rockfishes are subject to

*BAROTRAUMA* and typically do not survive capture. Much of the recent discard of rockfish has been regulatory due to fishers reaching trip limits. Dispersion of these species can be fairly broad and in lower concentrations than preferred habitats, making them vulnerable to capture as incidental catch in fisheries targeting other species. Tools that require retention of overfished species, increase trip limit size, or provide refuge areas tend to reduce bycatch of overfished species.

- *EMPHASIS SPECIES* include 11 species of groundfish from a broad range of habitats. While not overfished, some species are under precautionary management. Others are healthy but their catches are constrained by measures to limit the take of overfished or other species. Flatfishes as a group are also represented. They have a broad dispersion and several do not have significant regulatory bycatch issues. Bycatch in the form of economic discard for this group is often related to size and other market related restrictions. Tools that increase trip limit size for emphasis species constrained by trip limits, require retention, or eliminate the take of undersized fish tend to reduce bycatch of emphasis species.

The analytical methods are intended to reveal the effect of each tool in isolation from other tools, and in combination with other tools grouped together to form a distinct alternative.

Impacts of alternatives on groundfish resources are evaluated in a building block fashion with a special focus on overfished species as these tend to constrain healthier stocks of groundfish. Species under precautionary management, and those above target biomass levels will also be addressed in context with each environmental division and relationship to overfished species.

This EIS addresses the following interactions:

- Catch and bycatch - (direct effects)
- Predatory/prey interactions (indirect effects)
- Fishing strategy interactions (indirect effects)

The analysis of seven alternatives is done within an ecological and biogeographical framework as opposed to an individual species by species analysis of impacts. Direct and indirect effects of alternatives will reference keystone species, such as those under a rebuilding plan, other emphasis species of groundfish at or above MSY, and for other non-groundfish species. For purposes of this analysis we have identified the following ecological and biological groupings:

- Northern Shelf Environment
- Southern Shelf Environment
- Slope Environment

- Pelagic Environment
- Nearshore Environment

Analysis of overfished and emphasis species also reflects important latitudinal differences associated with species distributions along the coast (e.g. north and south of 40° 10' N. Lat.).

Impacts to groundfish are ranked by alternative and summarized in Tables 4.3.1 through 4.3.6.

#### *4.3.1.1 Impacts of Alternative 1 (Status quo/ No Action)*

*Summary:* The bycatch policy goal of Alternative 1 is to reduce bycatch of groundfish species by continuing fishery management as provided by the FMP and current groundfish implementing regulations. Relevant Council objectives include maintaining a year-round groundfish fishery, preventing overfishing, and rebuilding overfished stocks. Bycatch and bycatch mortality are minimized by limiting the number of commercial fishing vessels, restricting gear efficiency and usage, seasons and area management, including marine protected areas. Trip limits (which are based on previous years' observations of the encounter and discard rates of various groundfish species and fishing strategies), are used to discourage fishing in certain times and areas. Gear restrictions are used where possible to reduce potential bycatch rates. Marine protected areas are also used to reduce or prohibit fishing in areas of the continental shelf where certain overfished groundfish species are more likely to be caught. Management relies on catch monitoring and reporting through commercial landings receipts ("fish tickets"), trawl vessel logbooks, port sampling, and observer coverage of a portion of the groundfish fleet.

*Tools Used:* The following mix of management measures are applied to create Alternative 1. Tool ranks for Alternative 1 are summarized in Table 4.3.1.

Table 4.3.1. Summary of bycatch mitigation tools as applied in Alternative 1.

| |
|---|
| **Harvest levels** Total catch levels (ABCs and OYs) for groundfish are set based on science-based stock assessments. Overfished species OYs are set in accordance with rebuilding plans. |
| **Trip limits** Set at levels to maintain year round fishing, based on a variety of target species or strategies; trip limits vary by time (season), area, depth, gear, etc. The NOAA Fisheries "bycatch model" is used to determine target species catch levels for each fishing strategy. |
| **Vessel catch limits** Not used |
| **Gear regulations** Gear restrictions are used to reduce the take of undersized fish and overfished species, and to reduce bycatch and bycatch mortality |
| **Time/area management** Extensive use of MPAs to limit fishing in areas and times where overfished species are most likely to be encountered |
| **Capacity reduction** includes recent 35% reduction in trawl fleet |
| **Data reporting, record-keeping, and monitoring** 100% of the at-sea whiting fleet monitored by onboard observers; shore-based whiting landings observed on shore; approximately 10% observer coverage of commercial fleet. Trawl logbooks and state fish ticket programs provide much of the commercial catch data. |

- Harvest Levels Total catch levels (ABCs and OYs) for groundfish are set from scientific stock assessments. Overfished species OYs are set in accordance with rebuilding plans. Harvest rates of overfished stocks must be lower than those of "healthier" stocks; a larger fraction of an overfished species population must be allowed to grow and reproduce in order for the stock to rebuild in a timely manner. OYs for overfished species are total catch (mortality) limits.[5/] These OYs, in combination with anticipated catch in various regions by various fisheries, are used to determine catches of non-overfished groundfish based on expected catch/bycatch ratios. In contrast to some of the alternatives in this PEIS, Alternative 1 applies these as 'soft' guidelines that are used primarily to keep track of expected catch in each of the various fishery sectors. This approach results in harvest opportunities for healthy stocks that may be lower than the total catch OYs for those species.

[5/] Rebuilding OYs are set below the ABCs; if catches unintentionally exceed OY, future catch may need to be reduced in order to "catch up" to the rebuilding schedule. Catches above ABC are defined as overfishing, which is not authorized except in very limited circumstances.

(Landings could be lower than landed catch OYs also, if landed catch OYs are established). The GMT monitors commercial fishery landings through the PacFIN quota species monitoring (QSM) program. Recreational catches are monitored through RecFIN and State monitoring programs. These catch statistics (inseason estimates) are periodically compared to the harvest guidelines, and the Council recommends in-season adjustments as needed to ensure overall catches do not exceed the OYs.

- Vessel trip limits Trip limits are used to keep catches and bycatch amounts within the specified OYs. Trip limits are currently defined as retention limits, and vessels may continue fishing after reaching a trip limit so long as they do not retain more than the specified limits. In order to provide opportunities for several fishing strategies, the Council develops trip limits based on a variety of target species or strategies; these trip limits vary by time (season), area, depth, gear, etc. Target species catch levels for each of those fishing strategies are determined with the help of the NOAA Fisheries bycatch model. Trip limits are used to constrain harvests of both overfished and non-overfished groundfish.
- Vessel catch limits Vessel catch limits are not explicitly used as a tool in this alternative.
- Gear regulations Gear restrictions are used to reduce the take of undersized fish and overfished species, and to reduce bycatch and bycatch mortality. Mortality and survival rates of fish that escape fishing gear is unknown. Exempted Fishing Permits (EFPs) are issued to provide participating fishers the opportunity to experiment with various gear modifications intended to reduce bycatch and bycatch mortality of overfished species in particular.
- Time/area management Extensive use of MPAs is intended to limit fishing in areas and times where overfished species are most likely to be encountered, thus reducing bycatch and bycatch mortality. Large areas of the continental shelf are closed to most directed groundfish fishing; some open access and recreational fishing may still occur within MPA boundaries.
- Capacity reduction Further capacity reduction is not explicitly considered under this alternative. The 2003 trawl buyback program has reduced the number of trawl permits by roughly 35%, including many top performers.
- Data reporting, record-keeping, and monitoring Under Alternative 1, 100% of the at-sea whiting fleet is monitored by onboard observers; shore-based whiting vessels are required to retain all fish brought aboard (as required by an EFP, and soon by regulation) and landings are observed on shore; and approximately 10% of the remaining commercial groundfish fleet is monitored with on-board observers. Commercial landings data and observer data are used to estimate the total catch and catch ratios of overfished species co-occurring with other groundfish. These data are updated annually and used to change forecasts of OYs and trip limit impacts by fishery sector for the annual specifications process.

*Summary of Impacts on Groundfish:* Ranking of effects of Alternative 1 on reducing groundfish bycatch, bycatch mortality, and increasing accountability are

summarized in Table 4.3.1. Effects are ranked in comparison to the other alternatives. Smaller numbers indicate a greater effect.

Overfished groundfish: A major source of impacts to groundfish resources is regulatory discard of groundfish due to small trip limits. Primary species affected include (1) overfished groundfish and (2) high value groundfish that are constrained by limits on co-occurring overfished species. While current management is consistent with rebuilding strategies, a significant fraction of the overall groundfish OY is discarded or not harvested due to constraints on overfished species. Gear restrictions and MPAs are established to minimize fishing where overfished stocks are most at risk of being caught. By limiting fishing in those areas, fisheries outside the MPAs require less restriction because bycatch rates of those species are lower. However, target species catch rates may also be lower, and even low bycatch rates can result in unacceptably high catches of overfished species. The current GCAs have the added benefit of reducing bycatch of Pacific halibut and those benthic organisms that occur within the GCA boundaries. Pelagic trawling still occurs within the boundaries of GCAs, and there is measurable catch and/or bycatch of Pacific whiting, widow rockfish, and yellowtail rockfish.

Experimentation with gear designs and configurations may result in reduced observed bycatch of overfished species. Some level of unobserved bycatch mortality may occur to fish that encounter fishing gear but do not come onboard; the fate of fish excluded from fishing gears is largely unknown, and fish that escape are likely to suffer some level of bycatch mortality.

Emphasis species: Alternative 1 provides fishing opportunities outside the GCAs while conserving overfished groundfish. Cumulative trip limits are set to reflect ratios that protect vulnerable species while allowing harvest of healthier stocks. Ratio management under Alternative 1 tends to result in lower-than-OY catches of some species, and possibly an increased rate of bycatch/discard for other species. The Dover sole, thornyhead, and sablefish (DTS) complex reflects this dilemma. The DTS complex is managed in part to prevent overfishing of shortspine thornyhead. Under current management, Dover sole, sablefish, and shortspine thornyhead discard rates are often high. Catches of longspine thornyhead (and sometimes sablefish) may be below their OYs.

Midwater trawl fisheries continue to provide some fishing opportunity within RCA boundaries for the shelf dwelling yellowtail rockfish, a relatively pelagic (off-bottom) species.

Seaward and shoreward of the RCA boundaries, current management measures do not significantly affect economic discard/bycatch (bycatch resulting from discard of undersized fish or fish having low or no present market value).

**Effects of Harvest Levels under Alternative 1:** Groundfish harvest limits are established through annual specification[6/] of ABCs and OYs. Measures to protect overfished species constrain access to healthier groundfish stocks. An OY managed as a harvest cap, as it is for overfished species, may limit or mitigate bycatch and bycatch mortality when used in combination with other tools, such as time/area closures. The Council prepares a catch scorecard to track estimated mortalities by species and target strategy. These are not allocations, but rather pre-season estimates of fishing mortality. Performance of the various fishery sectors is measured against this scorecard during the fishing season using the best estimates of in-season landed catch and anticipated bycatch. No portion of any OYs is held in reserve. Fishery sectors may or may not be further restricted to keep from exceeding these scores. The no action alternative ranks the same as or lower than other alternatives with respect to effective performance standards, use of OY reserve, and application of sector limits. Observer data gathered in-season along with other fishery information such as logbook data are used to update estimated mortalities annually.

*Effects on Overfished Groundfish:* Most of the overfished groundfish species primarily inhabit the continental shelf and are referred to as shelf species" Under the no action alternative, overfished groundfish of the Northern and Southern Shelf Environments are expected to take decades to rebuild. Measures to reduce capture/bycatch of canary and yelloweye rockfish will constrain catches of other species in the Northern Shelf Environment for many years as these species rebuild. Measures to rebuild canary rockfish, cowcod, and bocaccio will constrain harvest of other groundfish within the Southern Shelf Environment. Lingcod, which is also an overfished shelf species, co-occurs with other overfished and healthier rockfish species. However, the lingcod OY is relatively large (that is, the northern portion of the stock is more nearly rebuilt to its MSY). Thus, it will not be a constraining stock, although lingcod catches are expected to remain well below OY.

Overfished species OYs are typically not allocated among all user groups, but harvest guidelines ("scorecard" values, as described above) are often established in order to accommodate incidental catch needs of various fisheries targeting healthier groundfish species. Most harvest guidelines are 'soft' limits, in the sense that they are pre-season estimates of amounts expected to be caught, and a fishery sector (or target strategy) may not be totally closed if it reaches the expected catch level. Measures may be adjusted to keep catches near these guidelines. Flexibility to adjust scorecard amounts is allowed if overall catches are projected to be below the OYs.

[6/] Beginning with 2005, ABCs and OYs will be set every two years rather than yearly.

Previous analyses for rebuilding plans and annual specifications have demonstrated that fisheries affectct stocks differently. For example, the recreational fishery tends to catch a larger proportion of juveniles of some species, compared to the commercial fishery. Canary rockfish is an example: a higher proportion of younger fish in the recreational catch results in a higher "per-ton" impact on rebuilding (PFMC 2003b).

Widow rockfish is an overfished pelagic environment species. In past years, widow rockfish OY levels were large enough to allow targeting with midwater trawl gear, and the midwater whiting fleet took a large proportion of the annual catch. Widow rockfish trip limits were structured to allow a significant portion of the OY to be taken in this way. OYs set to rebuild widow rockfish will be much lower than catch levels of the past decade, which means near future catches of widow rockfish will be far below recent years. In order to keep catches to those limits, it may become necessary to constrain the whiting fishery. However, without some form of allocation or specified harvest limit for widow rockfish, there may not be a basis for controlling the whiting fishery to control widow rockfish harvest.

*Effects on Emphasis Species*[7/] Emphasis species include abundant and important shelf groundfish such as yellowtail rockfish, chilipepper, and shelf flatfishes (such as arrowtooth flounder, petrale sole, and English sole). Important slope complex species include Dover sole, shortspine and longspine thornyhead, and sablefish (the 'DTS' complex).

Unless bycatch avoidance methods are developed, catches and landings of some groundfish species in the near future will be well below their OYs because fisheries are constrained to protect overfished species and species under precautionary management. These constraints have a significant and direct impact on fishing opportunities. Yellowtail rockfish catches are substantially below OY due to measures to reduce catch of canary rockfish and bocaccio. Harvest of the Dover sole, thornyhead, and trawl-caught sablefish (DTS) complex on the continental slope is constrained to prevent overfishing of shortspine thornyhead. DTS trip limits based on expected catch ratios of these species allow access to healthier Dover sole and longspine thornyhead stocks (see discussion on trip limits below). Ratio management may lead to regulatory discard of sablefish and shortspine thornyhead as fishers pursue attainment of Dover sole and longspine thornyhead OYs. Current catches of Dover sole and sablefish are their OYs. Shortspine thornyhead landings are typically near OY, while longspine

[7/] The term "emphasis species" is used in this EIS to designate non-overfished groundfish species that are particularly important to commercial, recreational and/or Tribal groundfish fishers. They are species for which information is available to support at least qualitative analysis of environmental impacts, and used as indicators of effects on the broader groundfish resource.

thornyhead landings are well below OY. Undersized and lower priced sablefish may be discarded in favor of larger more valuable fish– a practice known as "high-grading." .

In other cases, OY is underachieved due to existing market limits that are not linked to regulatory limits. For example, landings of English sole and chilipepper rockfish typically are well below their ABCs. Some level of bycatch and bycatch mortality is likely to occur for both of these species. Forgone catch may indirectly reduce bycatch and bycatch mortality, if OYs for overfished species result in reduced catch of other groundfish.

**Effects of Trip Limits under Alternative 1**: Trip limits for the trawl and other commercial fisheries are published each year in the Federal Register (for example, see NMFS, 2003). Trip limits are designed to slow landings rates to maintain year-round commercial fishing opportunities and to provide incidental catch allowances for non-target species caught with co-occurring targeted groundfish. Some trip limits for overfished species are very small to discourage any targeting. Most contemporary trip limits are cumulative 2- month period limits. Cumulative limits have the effect of minimizing regulatory bycatch/discard of groundfish (catches in excess of the limit) until the late in the period.

Recent analysis of 2002 observer data suggests that significant bycatch occurs in the form of both regulatory and non-regulatory discard, even when cumulative trip limits are based on ratios of anticipated bycatch (PFMC 2003d). Smaller trip limits are associated with higher bycatch/ discard rates (see discussion of Pikitch *et al* 1988, below). Alternative 1 has the smallest trip limits of the alternatives because the fleet is the largest and the season is longest. The application of trip limits in Alternative 1 is ranked 4 (not very effective) on a scale of 1 - 4 as a tool to reduce bycatch and bycatch mortality for most species, compared to other alternatives that do not rely on retention limits.

*Effects on Overfished Groundfish* Over time, trip limits have been modified to better match species associations and relative abundances as reflected in landed catches. Improved knowledge and understanding of depth distributions and associations has provided the basis for trip limits for sub-groups of co-occurring species. For example, trip limits were created for rockfish within the larger *Sebastes* complex to discourage targeting on overfished species. Species assemblages in nearshore, shelf and slope environments are managed more discretely than in past years. (See Table 2.1-12 of the 2003 Groundfish Annual SEIS (PFMC 2003b)). A high percentage of OY for the subgroup was left unharvested. Yellowtail rockfish is an example of a shelf rockfish species with a harvest well below OY due to recent trip limit constraints applied to shelf rockfish in order to protect canary rockfish (currently, area closures have the same consequence).

In 2000, reduced trip limits for shelf rockfish were coupled with restrictions on the size of trawl roller gear that could be used on the continental shelf. A study by Hannah (2003, In Press) showed that reductions in trip limits prior to 2000 already began reducing fishing effort in areas of 'prime trawlable rockfish habitat.' The same study also demonstrated that fishing continued adjacent to the harder bottomed, high relief, rockfish habitat areas. However, OY reductions in 2003 and application of species catch ratios resulted in to more restrictive management in 2003.

Trawl logbook and observer data are used to project expected catch ratios of overfished species to other target groundfish species. Individual trip limits are adjusted to keep overfished species OY from being exceeded. If actual ratios of overfished species to target species differ from estimated levels, regulatory bycatch and bycatch mortality are likely to result. If the actual proportion of overfished species is higher than expected, overfished species may be discarded. On the other hand, if the actual proportion of overfished species is lower than expected, target species may be discarded. However, in either case the rates are likely lower than those of past years because the NOAA Fisheries observer program has provided improved bycatch data.

In a study of West Coast groundfish, discard rates were found to vary inversely with the size of the trawl trip limits (Pikitch *et al.* 1988). Trip limits under Alternative 1 are expected to be smaller than all the alternatives. Therefore, this alternative could be expected to result in more catch and bycatch mortality of overfished species than alternatives that allow larger trip limits, or alternatives that use a different set of management tools. Vessel trip limits for overfished species are very restrictive under current effort levels and OYs, and are designed to provide for non-target incidental catch (although some target fishing is allowed for lingcod). Generally, restrictive landing limits can lead to higher regulatory bycatch and bycatch. Cumulative 1- or 2-month limits are used to help minimize discard. Under Alternative 1, regulatory discard/bycatch of overfished species would be higher in comparison with other alternatives that use other approaches to maintain catch within OY, encourage landing of more of the catch, or avoid take of overfished groundfish.

*Effects on Emphasis Species* As noted in the preceding section, regulatory discard/bycatch may be high if trip limits to protect a weak stock constrain the retention of more abundant co-occurring species. Much of the success using ratios to manage trip limits depends on the how well ratios reflect actual catch proportions. In addition, the target 'mixture' sought by fishers is sensitive to prices of various components of the catch. Currently, catch ratios are applied to the DTS complex to prevent overfishing of shortspine thornyhead. While the Dover sole harvest is usually near the OY, significant fractions of the longspine thornyhead and sablefish OYs may be left unharvested. Previous discard rates for Dover sole are thought to be related to undersized fish and are estimated to be 5% (Sampson and Wood 2002). Recent analysis of the 2002 observer data show that

Dover sole discard/bycatch may be a high as 17% (PFMC 2003d). However, the discard/bycatch rate of shortspine thornyhead is estimated to average 30%, and there is some evidence that sablefish discard/bycatch rates may be as high as 40%. This suggests that catch ratios may not be accurate, that high-grading may be occurring, or that ratio application does not take into account the degree of variability that occurs under actual fishing practices. Discard of small sablefish may be the result of high grading (i.e., economic discard/bycatch) because fishers receive a higher price per pound for larger fish, and the most recent assessment suggests a strong incoming year-class (and therefore a higher proportion of small fish in the population).

While regulatory discard of species such as English sole and other shelf and nearshore flatfish species may be low or absent, there may be economic reasons to discard. Trip limits for English sole are liberal under current effort levels and OY, and few vessels attain the trip limits. Market limits set by processors/buyers may result in economic discard/bycatch of large English sole. Undersized English sole are also a major component of discarded catch (See **Gear restrictions**, below).

With respect to the limited entry fixed gear (non-trawl) sablefish fishery, a permit stacking and cumulative limit program provides many of the effects of an individual quota program, including an extended season. In the past, the primary nontrawl sablefish fishery was managed as a competitive derby rather than as a year-round season. Trip limits were used to restrict fishing that occurred outside the primary season. The current program assigns eligible vessels/permits to one of three tiers that assures access to a set amount of sablefish. This program may reduce the need to discard fish compared to other sectors without IQs, as fishers have more time to move to areas with higher concentrations of marketable fish. However, it also provides more opportunity for vessels to high grade, keeping only larger, more valuable sablefish. A substantial fraction of sablefish that are caught and carefully released survive (see discussion of handling in the following section on **Gear restrictions**).

**Effects of Catch Limits under Alternative 1**: Vessel catch limits are not explicitly used as a tool in this alternative. Therefore this tool is ranked 4 (no effect) on a scale of 1 - 4.

**Effects of Gear Restrictions under Alternative 1**: The groundfish FMP and implementing regulations specify and describe gears that may legally be used by commercial and recreational fishers to fish for groundfish. Gear restrictions are specified to modify the selectivity and placement of fishing gears. Some restrictions, such as the minimum mesh size in trawl nets, are intended to minimize bycatch of small fish (juveniles, undersized target species, small species of fish with little market value, etc.); larger mesh allows more fish to escape. Smaller (3 inch) mesh is allowed in midwater trawls that seldom contacts the bottom. Restrictions on the maximum diameter of footropes used with trawl nets,

coupled with depth restrictions, reduces the effectiveness of trawl gear in rocky areas of the continental shelf seafloor; this restriction eliminates the use of roller gear that is used to prevent the gear from snagging on rocks and other seafloor structures where rockfish congregate. These and other gear restrictions under Alternative 1 reduce capture/ bycatch of groundfish. This general application of the gear restriction tool is ranked 2 (moderately effective) on a scale of 1 - 3.

*Effects on Overfished Groundfish* Gear restrictions, modifications, and deployment practices can reduce bycatch and bycatch mortality of overfished species. The minimum legal size of trawl mesh in bottom groundfish trawls is set at 4½ inches to allow escapement of juvenile rockfish, small flatfish, and other small fish. Survival rates of fish that escape through the webbing are not known, however. Species such as lingcod that lack a swim bladder are more likely to survive than rockfish when caught with trawl gear. To protect overfished rockfish, the Council initially recommended very small trip limits for vessels using large footrope trawl gear (roller gear) on the continental shelf. Larger trip limits were established for trawl vessels fishing primarily for flatfish with small diameter footrope gear. A study by Hannah (2003) demonstrated that trawlers avoided rocky reef areas on the shelf as a result of the regulation, and that encounter rates of rockfish species were reduced. However, the Council and NOAA Fisheries further restricted fishing to reduce the likelihood that overfished shelf rockfish would be encountered by establishing large marine protected areas. This was necessary because even rare encounters with canary rockfish, yelloweye rockfish, and bocaccio could result in catches greater than the specified OYs. Gear restrictions outside these protected areas allow for targeting non-overfished species while maintaining relatively low bycatch rates. These measures have a direct effect of eliminating bycatch and bycatch mortality of all species, including overfished groundfish, inside the GCAs. However, increased fishing effort outside the GCAs creates challenges to keeping catches below overfished species OYs, even when encounter rates outside the GCAs remain very low. Geographic shifts in fishing effort outside of the GCA boundaries can also have a direct impact, increasing (or decreasing) bycatch and bycatch mortalities.

The States of Washington, Oregon, and California have recently required the use of fish excluder devices in shrimp trawl nets to reduce rockfish bycatch in that fishery. With use of fish excluders, the catch of rockfish and bycatch mortality in the shrimp trawl fishery should be lower in comparison with nets that do not use these devices, even though survival rates of fish excluded by these devices are largely unknown (Davis and Ryer 2003). Few fish caught in trawls without excluder devices can escape through the small meshes used in shrimp trawls, so most fish would be discarded when brought to the surface. Video observation of fish excluders has shown that many fish actively seek and find exits or are passively excluded from shrimp trawls, while the net is at fishing depth. Escaping rockfish avoid barotrauma associated with being brought to the surface and discarded. Studies have shown that time on deck (Parker *et al.* 2003) and temperature gradient (Davis and Ryer 2003) are important factors in survival of

fishes without swim bladders, such as lingcod and sablefish. While these species may be more likely to survive when released at the surface, trauma inducing factors are avoided altogether when fish excluders are effective (Hannah 2003b). Some delayed morality may still occur. Laboratory studies have shown that direct mortality can still occur and behavioral impairment can cause additional delayed mortality (Davis and Ryer 2003). Under *status quo*, state requirements for excluder gear would have a positive and direct impact, reducing bycatch over gears that did not use these devices. Excluders and the selectivity effects of mesh size in general are likely to have a direct impact, causing an unquantifiable amount of bycatch mortality that is lower than would occur without these measures.

Catch of overfished species is expected to be low in fixed gear groundfish fisheries. Although 20 mt of lingcod may be taken by fixed gear limited entry fishers, the overall OY is not likely to be attained. Bycatch and bycatch mortality lingcod caught with fixed gear is related to the minimum size limit of 24 inches and handling effects on fish described above. Little is known about survival rates of fish escaping gear prior to it being brought on board.

*Effects on Emphasis Species* Gear restrictions, modifications, and deployment practices can reduce bycatch and bycatch mortality of groundfish. The minimum 4½ inch mesh size aids in the escapement of juvenile or small sablefish and flatfish, although enough small fish are retained to contribute to significant size-related discard/bycatch. Sablefish lack a swim bladder and have a relatively high survival rate if quickly and carefully released.

Mesh size studies have shown that discard of undersized English sole may make up more than 50% of the catch in numbers (TenEyck and Demory 1975). Nearly all of the males and approximately 19% of the females were discarded. English sole have a prominent anal fin spine that has a tendency to catch on trawl meshes. The most recent English sole stock assessment used an assume rate of discard/bycatch of 12.4% during the period 1985-1992 (Sampson and Stewart 1993). Rates of survival of escaping fish are not known.

All trawls, including those using small footropes that are effective at fishing flatfish in non-rocky areas, are currently (2003) prohibited within the GCAs to reduce the incidental capture of overfished rockfish species. Trip limits are structured to effectively limit practical use of large footrope gears for deeper water species, seaward of RCAs.

The use of fish excluder devices and other state efforts to reduce canary rockfish catch in the shrimp trawl fishery also affect the catch of other groundfish species as well (Hannah *et al.* 1996). Survival rates of excluded fish are not known and there is no estimate of bycatch mortality (see discussion above under *Overfished Groundfish*). Direct impacts include reduced bycatch, reduced bycatch mortality

for some of the fish, and some increased unobserved bycatch mortality of fish interacting with excluder gear.

ODFW, has sponsored trawl gear experiments, through the use of EFPs. Experimental net designs are intended to catch healthier groundfish stocks without catching overfished rockfish. Experiment results indicate that selective flatfish trawl nets effectively catch species that stay very close to the seafloor but allow other species to escape over the top. Future trawl gear modifications may allow greater catches of flatfish with minimal bycatch of overfished rockfish. Such gear modifications could have a net overall beneficial effect reducing bycatch and bycatch mortality of overfished species. NMFS is proposing to require the use of selective flatfish trawl nets in the nearshore area north of 40°10' N. lat., beginning in 2005. CDFG will experiment in 2004 and possibly 2005 to determine whether selective flatfish trawl gear is also effective at reducing rockfish bycatch south of 40°10' N. lat.

Gear restrictions or prohibitions are effective at reducing bycatch within the GCAs. Little is known about the fate of fish caught by trawl and fixed gears that manage to escape through meshes or become freed from hooks. Additional gear measures beyond those under Alternative 1 may be needed to reduce bycatch impacts outside of GCAs.

Sablefish caught by hook or pot gear are known to be susceptible to mortality due to sand flea infestation. Studies in Alaska have found this source of mortality to be small and that all sources of discard amounted to only 12% of the total allowable catch (TAC) in the directed fishery (Richardson and O'Connell 2002). Sablefish may be caught and escape from hooks or through meshes of traps. Survival rates of these fish are not known but are likely high. In addition, fixed gear fishers release undersized sablefish contributing to bycatch and bycatch mortality. In 2002, the Council recommended a reduction in size limit from 22 inches to 20 inches to minimize the amount of sablefish regulatory discard. Studies (cited above) indicate that temperature gradient may influence survivability of sablefish. Time of year fish are harvested therefore influences the potential impact of temperature gradients. The individual cumulative tier limits and the extended fixed gear sablefish season may contribute to a reduction in regulatory bycatch and bycatch mortality (see discussion above under **Trip limits**). However, high grading (economic bycatch) may be more prevalent than in past years.

**Effects of Time/Area Management under Alternative 1**: Marine protected areas and seasonal closures effectively reduce bycatch and bycatch mortality within the boundaries of the closed area (or closed period). This effect only applies to those fisheries closed or restricted from fishing during such time/area closures. Outside the MPA boundaries, bycatch and bycatch mortality may increase, if fishing effort shifts to open areas. Unless an MPA is designated as a no-take reserve, some fishing may be allowed depending on the specified

restrictions. To the degree the authorized fishing gears and methods selectively avoid catching the species being protected, bycatch and bycatch mortality of those species would be reduced by such MPAs. Reduced bycatch and bycatch mortality of other species in the area would also be expected.

*Effects on Overfished Groundfish:* The MPA strategy under Alternative 1 is to restrict or eliminate fishing activities (effort) where there is a high encounter rate of overfished species, and to redirect effort outside of the closed area where encounter rates are relatively lower. The specific application of GCAs under Alternative 1, are based on depth, time of year (seasonality), and gear restriction designed to minimize the likelihood of encountering canary and yelloweye rockfish in the Northern Shelf Environment, and cowcod and bocaccio in the Southern Shelf Environment. Because of the seasonal distributional behavior of rockfish, encounter rates and fishing patterns are monitored and adjustments are made to keep overall harvest within total catch OYs. Some rockfish have a wider distribution than others, or make seasonal movements, which would require the use of larger protected areas.

Canary rockfish are seasonally more abundant shoreward of the current RCAs boundaries, and trip limits are adjusted to reflect this seasonal distribution to minimize encounter rates. Seasonal mobility and aggregating behavior of canary rockfish within and outside of RCAs may affect ratios of incidental catch of this species to other groundfish. Under Alternative 1, adverse changes to ratios may not be accounted for until the end of the fishing season. Bycatch and bycatch mortality may increase as a consequence. Recent changes to the boundaries (depth limits) of the northern RCA are intended to reduce potential encounters with large concentrations of canary rockfish.

The cowcod conservation areas (CCAs) off the coast of southern California are smaller than the southern shelf RCAs. The cowcod protection areas are designed to protect mature fish that have a high site affinity for habitats consisting of rocky reefs with overhangs and sheltering caves. That is, they never move far and are rarely found away from this habitat.

The marine protected areas (RCAs/CCAs) under Alternative 1 effectively eliminate fishing in areas where overfished rockfish are concentrated.

*Effects on Emphasis Species:* RCAs may concentrate effort both shoreward and seaward of the boundaries. Seaward of the boundaries, catch, bycatch, and bycatch mortality of the DTS complex could increase due to effort shifting.

Several species of groundfish move onto the shelf during certain times of the year. The GCAs may reduce the vulnerability of these other species to harvest, thereby reducing bycatch and bycatch mortality, depending on the timing and application of the GCA.

Fishing for English sole and other shelf and nearshore flatfish with small footrope trawls is allowed in the North Shelf Environment shoreward of 50 or 100 fm (the inner RCA boundary), depending on time of year. The current RCAs restrict access to these flatfish to some degree, although a substantial proportion of the biomass is shoreward of 50 fm. If effort concentrates shoreward of RCAs, catch, bycatch, and bycatch mortality of these and other shallow water species may increase.

**Effects of Capacity Reduction under Alternative 1:** Further capacity reduction is not explicitly considered under this alternative. (The 2003 trawl buyback program has reduced the number of trawl permits by roughly 35%, including many top performers. The effects of this are estimated but actual results may differ.) As this tool is not used, it is assigned a rank of 3 (no effect) on a scale of 1 - 3.

**Effects of Data reporting, Record-keeping, and Monitoring under Alternative 1:** Monitoring and reporting requirements are essential fishery management tools. Accountability and accuracy of these programs is proportional to the amount of observer coverage and catch verification that can be accomplished. Higher levels of monitoring yield more complete, accurate, and timely estimates of total catch including bycatch. Indirect benefits would include improved stock assessments and tracking of rebuilding plans. Under Alternative 1, 100% of the at-sea whiting fleet is monitored by onboard observers; shore-based whiting vessels are required to retain all fish brought aboard (as required by an EFP) and landings are observed on shore; and approximately 10% of the non-whiting commercial groundfish landings are monitored with on-board observers. Commercial landings data and observer data are used to estimate the total catch and catch ratios of overfished species co-occurring with other groundfish. These data are updated annually and used to change forecasts of OYs and trip limit impacts by fishery sector for the annual specifications process. This application of the tool is ranked 5 (least effective among the alternatives) on a scale of 1 - 5. Observer program data reports and analyses are provided as Appendix A of this FEIS.

Table 4.3.2 Effects of bycatch mitigation tools as applied in Alternative 1. Relative rank of the tools used to reduce bycatch and bycatch mortality. Overfished species in **bold** and emphasis species in *italic*. Species below MSY and subject to precautionary management are noted with (p).

| Environment | Species | ABC/OY | Performance standard and OY reserves | Trip limits | Catch limits | Retention requirement | Gear restrictions | Capacity reduction | Time/area management | Monitoring program |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | None | Yes | Soft sector scorecard | Pacific whiting EFP | Yes | None | RCAs | 10% Observer coverage |
| Northern Shelf | **Canary rockfish** | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| | **Lingcod** | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| | **Yelloweye rockfish** | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| | *Yellowtail rockfish* | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| | *Arrowtooth flounder* | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| | *English sole* | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| | *Petrale sole* | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| Southern Shelf | **Boccacio** | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| | **Cowcod** | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| | *Chilipepper* | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| Slope | **Darkblotched rockfish** | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| | **Pacific Ocean Perch** | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| | *Dover sole (p)* | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| | *Sablefish (p)* | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| | *Shortspine thornyhead (p)* | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| | *Longspine thornyhead* | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| Pelagic | **Widow rockfish** | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| | *Pacific whiting (incl.discard)* | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| Nearshore | *Black rockfish* | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| | *Cabezon* | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 5 |
| | **Scale** | 1 | 1 to 3 | 1 to 4 | 1 to 4 | 1 to 2 | 1 to 3 | 1 to 3 | 1 to 3 | 1 to 5 |

### 4.3.1.2 Impacts of Alternative 2 (Larger trip limits - fleet reduction)

*Summary:* The policy goal of this alternative is to minimize bycatch by reducing harvest capacity (specifically, reducing the number of limited entry trawl vessels) and increasing trip limits, while continuing to manage for year-round fishing and marketing opportunities and minimizing the costs of fishery monitoring. In this alternative, bycatch and bycatch mortality are mitigated in part by reducing effort and restricting gear efficiency.

*Tools Used:* The following mix of management measures are applied to create Alternative 2. Tool ranks for Alternative 2 are summarized in Table 4.3.4.

Table 4.3.3. Summary of bycatch mitigation tools as applied in Alternative 2.

| |
|---|
| **Harvest Levels** Same as Alternative 1 |
| **Vessel trip limits** Used, expected larger than Alt 1 |
| **Vessel catch limits** Not used |
| **Gear regulations** Same/ similar to Alternative 1 |
| **Time/area management** Same as Alternative 1 |
| **Capacity reduction** 50% reduction of the trawl sector relative to the 2002-2003 level (additional 15% reduction from 2002-2003 level). |
| **Data reporting, record-keeping, and monitoring** Increased observation rate due to smaller fleet compared to Alternative 1 |

- Harvest Levels (harvest policy, rebuilding) ABCs and OYs are assumed to be the same as under Alternative 1. Proportionately more catch would be available to each individual vessel remaining in the fleet compared to Alternative 1.
- Vessel trip limits Vessel trip limits are used and would increase under this alternative due to a 50% reduction of the trawl sector relative to the 2002-2003 level. Regulatory bycatch/discard of groundfish is inversely proportional to trip limit size; by increasing trip limits, this alternative would reduce bycatch and associated mortality. However, the relationship between trip limit size and bycatch is not directly proportional. That is, if trip limits are doubled, bycatch/discard would not be cut by half because other factors (such as relative abundance) influence catch rates.
- Vessel catch limits Vessel catch limits are not explicitly used as a tool in this alternative.

- Gear regulations Gear regulations under this alternative would be the same or similar to those in Alternative 1. It is not anticipated that capacity reduction of this alternative would permit the use of large footrope gear within current RCA boundaries.
- Time/area management The application of GCAs would be the same as Alternative 1. Large areas of the continental shelf would remain closed to most directed groundfish fishing; some open access and recreational fishing may still occur within GCA boundaries. This tool effectively reduces bycatch within the GCA but may result in concentrated fishing and higher bycatch of some species outside the area. A 50% reduction in fishing effort (from 2002-2003 levels) might allow redefinition of the timing and application of closed areas to provide more opportunities to access other groundfish resources within current GCA boundaries.
- Capacity reduction 50% reduction of the trawl sector relative to the 2002-2003 level. Catch is related to effort, selectivity and species abundance. Effort must be viewed in terms of effective effort, or effort that produces an average catch of groundfish per (trawl) hour fished. Trawl fleet reduction that reduces effective effort would allow trip limits to be increased and would increase the efficiency of other bycatch mitigation tools. However, *effective* effort is the causative agent, and the magnitude of net decrease in catch depends on the net decrease in effective effort.
- Data reporting, record-keeping, and monitoring. Catch reporting, record-keeping, and monitoring through the use of observers may improve over Alternative 1. Assuming the number of observer days remains the same, a higher proportion of total trips and catch would be observed due to the reduced fleet size, larger trip limits, and (perhaps) reduced total number of trips. If effort increases, trip limits may have to be reduced, and the level of observer coverage would be similar to Alternative 1.

*Summary of Impacts on Groundfish:* The effects ranking for Alternative 2 for reducing groundfish bycatch, bycatch mortality, and increasing accountability are summarized in Table 4.3.4. Effects are ranked in comparison to the other alternatives. Lower rank numbers indicate a greater effect.

Overfished groundfish This alternative is similar to Alternative 1 in that trip limits, gear restrictions, MPAs, and a relatively low cost sampling program would be used to reduce bycatch. Alternative 2 differs significantly in that trawl effort is reduced 50% relative to previous years and 15% compared to Alternative 1. The primary effect of effort reduction is that trip limit size would be increased. Reduced effort also tends to make other bycatch reduction tools work more efficiently. Studies have shown that regulatory bycatch rates and the size of trip limit are (roughly) inversely proportional. Because overfished species have the smallest trip limits, they would be expected to be most affected by larger trip limits. That is, larger trip limits would reduce bycatch/discard of these species the most. Thus, effects of trip limits on bycatch reduction on overfished species rank higher than for most emphasis groundfish species (see below).

Emphasis species Larger trip limits would reduce regulatory bycatch/discard of some groundfish species more than others. Species that are relatively unconstrained by current trip limits may be largely unaffected. Species such as chilipepper rockfish and many of the flatfishes would be included in this group. Bycatch/discard of these species is more economic than regulatory. Even if trip limits for overfished and other target species were increased, discard of such flatfish and small rockfish species would not change. For high-value target species that are constrained by trip limits, however, bycatch/discard would likely be reduced. That is because a higher proportion of the bycatch/discard is currently due to regulations, and relaxing the regulations would directly reduce discard/bycatch. Species such as longspine thornyhead, sablefish, yellowtail rockfish, and shortspine rockfish certainly fall into this category, and probably Dover sole, other large rockfish, and lingcod. In short, larger trip limits reduce regulatory bycatch more than economic bycatch. In fact, economic bycatch could increase if trip limits resulted in more catch of low value species.

Capacity reduction would have the greatest positive effects on shelf and slope species because most of the trawl effort occurs in those areas. The effects of increasing trip limits and capacity reduction would be less on nearshore groundfish such as black rockfish and cabezon, which are caught principally by the recreational and open access fisheries. (See gray shaded boxes under trip limit and capacity reduction columns in Table 4.3.4).

**Effects of Harvest Levels under Alternative 2**: ABCs and OYs are assumed to be the same as under this alternative. Proportionately more catch would be available to each individual vessel remaining in the fleet compared to Alternative 1. Although harvest level specifications can reduce bycatch, this alternative is no more effective than any other alternative. Therefore, this tool is ranked 3 (least effect) on a range of 1 - 3

**Effects of Trip Limits under Alternative 2**: Trip limits would increase, especially outside of GCAs, as a consequence of a 50% reduction in effective capacity of the commercial fleet. Effects of increased trip limits described above under General Effects of Fishery Management Tools are likely to be significant compared to *status quo* and are given a rank 2 or 3 on a scale of 1 - 4 scored for other alternatives, depending on the species. (Some alternatives are given a rank of 1 due to elimination of trip limits as a tool.)

*Effects on Overfished Groundfish* Increased trip limit size may have a direct and positive impact, making possible an increase in per vessel retained catch of overfished groundfish and reducing bycatch associated with regulatory induced discards. In a study of west coast groundfish, discard rates were found to vary inversely with the size of the trawl trip limits imposed (Pikitch *et al.* 1988). All limits of overfished rockfish are low under *status quo* compared to historical levels. Reducing discard by increasing trip limit size would still depend on the appropriate application of RCAs and ratio management. A fine balance would be

needed to allow more overfished species to be caught as incidental catch to other target strategies, without creating a trip limit large enough to encourage targeting of the overfished species.

The Council could elect to keep limits lower in an attempt to rebuild overfished species faster. Bycatch and bycatch mortality might be reduced in comparison to the above scenario due to a reduction in overall harvest opportunity. The smaller limits might offset this reduction due to the effect of smaller trip limits on regulatory induced bycatch.

Effects of increased trip limits result from capacity reduction. The alternative has a ranks of 2 in terms of ability of the trip limit tool to reduce bycatch and bycatch mortality of overfished species.

*Effects on Emphasis Species* Vessel trip limits could increase outside of RCAs boundaries as a consequence of a 50% reduction in effective capacity of the commercial fleet. Ratio management would allow more access to other groundfish as long as catch of overfished species did not exceed OY. Under status quo, several species of groundfish are harvested well below OY due to constraints on overfished species such as shortspine thornyhead currently under precautionary management. Under *status quo,* for example, there appears to be a lack of attainment of OYs for sablefish and longspine thornyhead at the same time there may be high discard rates of sablefish and shortspine thornyhead. A larger trip limit may help fishers gain access to OY and may reduce discarding.

Increased trip limit size should have little impact on some species that are more limited by markets than regulatory trip limits under status quo. For example, landings of English sole are limited by size and market limits, not trip limit size.

Because increased trip limit size may not result in a change in harvest for many emphasis species due to existing non-regulatory constraints such as undersized fish and market limits, the trip limit tool used in Alternative 2 is ranked 3 on a scale of 1 - 4.

Since it is assumed most of the capacity reduction would apply to the trawl fleet, this tool would have less impact on trip limits for cabezon and black rockfish compared to other species. Cabezon and black rockfish are caught primarily by commercial limited entry or open access hook and line fishers and the recreational fishery. The effectiveness of Alternative 2 trip limits on reducing bycatch and bycatch mortality for nearshore species such as black rockfish and cabezon is ranked 4 (little effect) on a scale of 1 - 4.

**Effects of Catch Limits under Alternative 2**: Vessel catch limits are not explicitly used as a tool in this alternative. Therefore this tool is ranked 4 (no effect) on a scale of 1 - 4.

**Effects of Gear Restrictions under Alternative 2**: Gear restrictions under this alternative would be the same as under *status quo*. Therefore, the Alternative 2 application of gear tools is ranked the same as for the *status quo*, or 2 on a scale of 1 - 3 (Table 4.3.4).

*Effects on Overfished Groundfish* It is not anticipated that the level of trawl fleet reduction under this alternative would allow the use of large footrope gear in MPAs or other liberal modifications. The effects on overfished groundfish is the same as Alternative 1.

*Effects on Emphasis Species* Current regulations prohibit fishing within GCAs by most gear types, including groundfish trawl gears, with the exception of pelagic trawls. A 50% reduction in effort may allow use of small foot rope trawl gears within the GCAs. An analysis of Oregon and Washington trawl logbook data showed that both trip limits and the 8 inch size restriction on trawl roller gear were effective in reducing or eliminating trawl effort over prime trawlable rockfish habitat (Hannah 2003). Current shelf RCAs have a significant amount of non-rocky ground still trawlable with small footrope trawl gears. If fishing with these trawls were allowed within GCAs, bycatch and bycatch mortality could increase for both overfished and healthy groundfish stocks.

**Effects of Time/Area Management under Alternative 2**: The timing, bathymetric limits, and gear restrictions associated with the current marine protected areas would remain the same as under *status quo*. These MPAs and seasonal closures effectively reduce bycatch and bycatch mortality within the boundaries of the closed area (or closed period). This effect only applies to those fisheries closed or restricted from fishing during such time/area closures. Outside the MPA boundaries, bycatch and bycatch mortality may increase, if fishing effort shifts to open areas. Unless an MPA is designated as a no-take reserve, some fishing may be allowed depending on the specified restrictions. To the degree the authorized fishing gears and methods selectively avoid catching the species being protected, bycatch and bycatch mortality of those species would be reduced by such MPAs. Reduced bycatch and bycatch mortality of other species in the area would also be expected. The Alternative 2 application of time/area management is ranked 3 on a scale of 1 - 3, the same as the no action alternative (Alternative 1).

*Effects on Overfished Groundfish* Same as Alternative 1. The MPA strategy under Alternative 2 would be to restrict or eliminate fishing activities (effort) where there are high encounter rates of overfished species, and to redirect effort outside of the closed areas where encounter rates are relatively lower. The specific application of MPAs are based on depth, time of year (seasonality), and gear restriction designed to minimize the likelihood of encountering canary and yelloweye rockfish in the Northern Shelf Environment, and cowcod and bocaccio in the Southern Shelf Environment. Because of the seasonal distributional behavior of rockfish, encounter rates and fishing patterns would be monitored and adjustments made to keep overall harvest within total catch OYs.

The CCAs off the coast of southern California, which are smaller than the southern shelf RCAs, would be continued. The conservation areas are designed to protect mature fish that have a high site affinity for habitats consisting of rocky reefs with overhangs and sheltering caves. That is, they never move far and are rarely found away from this habitat.

The GCAs under Alternative 2 would effectively eliminate fishing in areas where overfished rockfish are concentrated.

*Effects on Emphasis Species* Bycatch and bycatch mortality would remain similar to *status quo* levels. The RCAs may concentrate effort both shoreward and seaward of the boundaries. Seaward of the boundaries, catch, bycatch, and bycatch mortality of the DTS complex could increase due to effort shifting.

The RCAs may reduce the vulnerability of several species of groundfish that move onto the shelf during certain times of the year, thereby reducing bycatch and bycatch mortality. Effects would depend on the timing and application of the RCAs.

Fishing for English sole and other shelf and nearshore flatfish with small footrope trawls would be allowed in the North Shelf Environment shoreward of 50 or 100 fm (the inner RCA boundary), depending on time of year. The RCAs would continue to restrict access to these flatfish to some degree, although a substantial proportion of the biomass is shoreward of 50 fm. If effort concentrates shoreward of RCAs, catch, bycatch, and bycatch mortality of these and other shallow species may increase.

**Effects of Capacity Reduction under Alternative 2**: The trawl fleet would be reduced by 50% from 2002-2003 levels. The November 2003 trawl buyback program removed 91 permits from the fleet (about 35%); Alternative 2 would further reduce the fleet by about 15%. Effects of capacity reduction described above under "General Effects of Fishery Management Tools" are likely to be significant compared to *status quo* and other alternatives. The application of capacity reduction in Alternative 2 is ranked 2 or 3 on a scale of 1 - 4, depending on the species.

*Effects on Overfished Groundfish* Assuming an additional 15% reduction beyond the trawl buyback, a roughly proportionate increase in overfished species trip limit size would be anticipated. Thus, effort reduction would have an indirect impact on reducing bycatch and bycatch mortality.

*Effects on Emphasis Species* Trip limits for several species of groundfish at or near MSY would increase as a consequence of effort reduction under this alternative. Effort reduction would have an indirect effect on reducing bycatch and bycatch mortality of other groundfish.

The trawl fleet has relatively little impact on nearshore species such as cabezon and black rockfish. Such nearshore species are caught primarily by recreational and commercial hook-and-line fishers. Therefore, further trawl capacity reduction would have little or no effect on reducing bycatch and bycatch mortality for nearshore species such as black rockfish and cabezon

**Effects of Data Reporting, Record-keeping, and Monitoring under Alternative 2**: Higher levels of monitoring yield more complete, accurate, and timely estimates of total catch including bycatch. Indirect benefits would include improved stock assessments and tracking of rebuilding plans. Under Alternative 2, 100% of the at-sea whiting fleet would be monitored by onboard observers; shore-based whiting vessels wold continue to be required to retain all fish brought aboard (as required by an EFP, and soon by regulation) and landings would be observed on shore; and approximately 10% of the non-whiting commercial groundfish fleet would be monitored with on-board observers. Commercial landings data and observer data would be used to estimate the total catch and catch ratios of overfished species co-occurring with other groundfish.

Under Alternative 2, catch reporting, record-keeping, and monitoring through the use of observers may improve over Alternative 1. Assuming the number of observer days remains the same, a higher proportion of total trips and catch would be observed due to the reduced fleet size and (perhaps) reduced total number of trips. If effort increases, trip limits may have to be reduced, and the level of observer coverage would be similar to Alternative 1. This tool is ranked 4 (low, relative to Alternatives 4-7) on a scale of 1 - 5.

Table 4.3.4. Effects of bycatch mitigation tools as applied in Alternative 2. Relative rank of the tools used to reduce bycatch and bycatch mortality. Overfished species in bold and emphasis species in italic. Species below MSY and subject to precautionary management are noted with (p).

| Environment | Species | ABC/OY | Performance standard and OY reserves | Trip limits | Catch limits | Retention requirement | Gear restrictions | Capacity reduction | Time/area management | Monitoring program |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | None | Larger trip limits | Soft sector scorecard | None | Yes | 50% trawl fleet reduction from 2002-2003 | RCAs | 10% Observer coverage |
| Northern Shelf | **Canary rockfish** | 1 | 3 | 2 | 4 | 2 | 2 | 2 | 3 | 4 |
| | **Lingcod** | 1 | 3 | 2 | 4 | 2 | 2 | 2 | 3 | 4 |
| | **Yelloweye rockfish** | 1 | 3 | 2 | 4 | 2 | 2 | 2 | 3 | 4 |
| | *Yellowtail rockfish* | 1 | 3 | 2 | 4 | 2 | 2 | 2 | 3 | 4 |
| | *Arrowtooth flounder* | 1 | 3 | 3 | 4 | 2 | 2 | 2 | 3 | 4 |
| | *English sole* | 1 | 3 | 3 | 4 | 2 | 2 | 2 | 3 | 4 |
| | *Petrale sole* | 1 | 3 | 3 | 4 | 2 | 2 | 2 | 3 | 4 |
| Southern Shelf | **Boccacio** | 1 | 3 | 2 | 4 | 2 | 2 | 2 | 3 | 4 |
| | **Cowcod** | 1 | 3 | 2 | 4 | 2 | 2 | 2 | 3 | 4 |
| | *Chilipepper* | 1 | 3 | 3 | 4 | 2 | 2 | 2 | 3 | 4 |
| Slope | **Darkblotched rockfish** | 1 | 3 | 2 | 4 | 2 | 2 | 2 | 3 | 4 |
| | **Pacific Ocean Perch** | 1 | 3 | 2 | 4 | 2 | 2 | 2 | 3 | 4 |
| | *Dover sole (p)* | 1 | 3 | 2 | 4 | 2 | 2 | 2 | 3 | 4 |
| | *Sablefish (p)* | 1 | 3 | 2 | 4 | 2 | 2 | 2 | 3 | 4 |
| | *Shortspine thornyhead (p)* | 1 | 3 | 2 | 4 | 2 | 2 | 2 | 3 | 4 |
| | *Longspine thornyhead* | 1 | 3 | 3 | 4 | 2 | 2 | 2 | 3 | 4 |
| Pelagic | **Widow rockfish** | 1 | 3 | 2 | 4 | 2 | 2 | 2 | 3 | 4 |
| | *Pacific whiting (incl.discard)* | 1 | 3 | 2 | 4 | 2 | 2 | 2 | 3 | -- |
| Nearshore | *Black rockfish* | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 4 |
| | *Cabezon* | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 4 |
| | **Scale** | 1 | 1 to 3 | 1 to 4 | 1 to 4 | 1 to 2 | 1 to 3 | 1 to 3 | 1 to 3 | 1 to 5 |

### 4.3.1.3 Impacts of Alternative 3 (Larger trip limits - shorter season)

*Summary* The policy goal of Alternative 3 is to minimize bycatch by increasing trip limits and shortening the fishing season by as much as 50%. In this alternative, bycatch and bycatch mortality are controlled in part by modifying effort and gear efficiency. Alternative 3 would reduce each vessels's fishing without reducing fleet size. This alternative supports Council objectives of preventing overfishing, rebuilding overfished stocks and keeping monitoring costs low. It would not maintain year-round groundfish fishing opportunities for individual vessels, but could be designed to maintain some level of groundfish product flow to markets over the entire year. If individual commercial vessel fishing periods were staggered, a year-round supply of fish would be available for some fish buyers and processors.

*Tools Used* The following mix of management measures are applied to create Alternative 3. Tool ranks are for Alternative 3 summarized in Table 4.3.5.

Table 4.3.5. Summary of bycatch mitigation tools as applied in Alternative 3.

| |
|---|
| **Harvest Levels** Same as Alternative 1 |
| **Vessel trip limits** used, expected larger than Alt 1, similar to Alt 2 |
| **Vessel catch limits** not used |
| **Gear regulations** same/ similar to Alternative 1 |
| **Time/area management** may be same as Alternative 1 or different, depending on application |
| **Capacity reduction** same as Alt 1 |
| **Data reporting, record-keeping, and monitoring** Similar to Alt 1; Could be higher or lower observation rate, depending on timing of fishing activities |

- Harvest Levels (harvest policy, rebuilding) Harvest levels are assumed to be the same as under Alternatives 1 and 2.
- Vessel trip limits This alternative assumes the season would be shortened for fishing vessels and that some form of *PLATOONS* would be used to maintain fishing throughout the year. (Platoon systems divide vessels into two or more groups that operate on different schedules.) Vessel trip limits under this alternative are assumed to be the similar to those under Alternative1. However, seasonal patterns would likely be different, and bycatch of some species would likely be different.
- Vessel catch limits Vessel catch limits are not explicitly used as a tool in this alternative.
- Gear Regulations Alternative 3 would maintain the same gear regulations as Alternative 1 and be structured to keep catches within overfished species

OYs. This alternative would not permit the use of large footrope gear within current RCA boundaries, because that would increase the potential for catching overfished rockfish species. However, small footrope gear may be re-introduced into GCAs.

- Time/area management In addition to the GCAs used in Alternative 1, this alternative compresses the fishery through seasonal closures or other restrictions on fishing time for each commercial vessel. For instance, each platoon would be allowed only 6 months of fishing.
- Capacity reduction No further capacity reduction is considered under this alternative.
- Data reporting, record-keeping, and monitoring Catch reporting, record-keeping, and the monitoring program would be the same as Alternatives 1 and 2. The compressed season would mean that the percentage of total trips covered by observers would increase over Alternative 1.

*Impacts on Groundfish* Effects of tools used in Alternative 3 to reduce groundfish bycatch, bycatch mortality, and increasing accountability are ranked and summarized in Table 4.3.6. Effects are ranked by in comparison to the other alternatives. Lower numbers indicate a greater effect.

Overfished groundfish Under Alternative 3, trip limit size would be increased to reduce bycatch and the season would be shortened so that larger trip limits could be maintained. By dividing the commercial fleet into two or more platoons, some level of landings and market flow would be maintained year-round. However, individual vessels would fish groundfish only during a designated portion of the year. Fleet response to this approach is hard to predict, especially if vessels were allowed to choose when they would fish without some pre-registration requirement. (The full year's trip limits must be determined before the beginning of the fishing year, January 1.) The shortened season could result in some fishers choosing alternative non-groundfish fisheries, or electing to fish at a particular time of the year. If increased fishing resulted at a time of year when encounter rates of overfished species is higher, more of those overfished species would be likely to be killed. Subsequent fishing later in the year would have to be curtailed to compensate for such unexpected occurrences. If fishers were allowed to freely choose in advance which period they would fish, it is likely product flow would be inconsistent or interrupted, because many would choose to fish groundfish when they could not fish for shrimp, crab, albacore or other species. Some level of groundfish bycatch would likely occur during those fisheries, and target trip limits would have to be reduced to compensate. Aside from these concerns, the impacts of a reduced season and larger trip limit size should be similar to Alternative 2, without the costs of further fleet reduction programs.

Emphasis species As was described above under Alternative 1, bycatch of DTS complex species may be the result of several factors, including size, attainment of regulatory limits, and high grading (for example, sablefish). A 50% reduction in fishing season and increased trip limits would tend to reduce regulatory bycatch/

discard. Larger trip limits for shortspine thornyhead would be expected to reduce bycatch/discard of this species. High grading of sablefish may still occur, however.

Larger trip limits for the "other flatfish" category would have relatively little effect on bycatch because market factors play an important role. Trip limits under the status quo are typically quite liberal and are larger than most vessels' landings. Bycatch and bycatch mortality are more related to market limitations such as size, price, and quantity. If a primary vessel response to reduced groundfish fishing time is to drop out of the fishery (or to spend more time in alternative fisheries rather than to fish harder during their groundfish openings), the overall catch of groundfish target species may be reduced. That would result in reduced bycatch and bycatch mortality of other groundfish as well.

As with Alternative 2, larger trip limits and shorter fishing time would have less effect on nearshore fisheries, unless open access commercial and recreational fishing seasons are also reduced. (See gray shaded box under trip limit column in Table 4.3.6).

**Effects of Alternative 3 on Harvest Level Specifications**: Objectives for setting optimum yield would remain the same as in Alternatives 1 and 2. Under Alternative 3, fishing periods would be compressed or the season shortened. Other than soft sector allocations similar to *status quo*, there would be no performance standards or OY reserves. Ranking of this tool as used in Alternative 3 would be the same as *status quo*, or 3 on a scale of 1 - 3.

*Effects on Overfished Groundfish* On a per vessel basis, a shorter season may allow larger shares of OY per trip due to potentially larger trip limits compared to *status quo*, and would have an impact similar to Alternative 2, reducing bycatch and bycatch mortality of overfished species.

*Effects on Emphasis Species* Objectives for optimum yield would remain the same as in *status quo.* On a per vessel basis, a shorter season may allow larger shares of OY per trip compared to *status quo*. Several species of groundfish at or above MSY are currently under-harvested due to constraints on overfished stocks or market limits. One possible consequence of this alternative is that more OY would go unharvested due to the reduced season.

**Effects of Trip Limits under Alternative 3**: Vessel trip limits would initially be the same as those in Alternative 2. The season would be shortened to match the new trip limit. The shortened season would allow access to more of the overall OY for groundfish species. Much would depend on fleet response to a shortened season and larger cumulative limits. Platooning of the fleet would be done to maintain a supply of groundfish year-round. If fishers increase effort to compensate for the reduced season, season length would be reduced to maintain trip limit size. The compressed season anticipated larger trip limits should have a

significant impact on reducing bycatch and bycatch mortality compared to *status quo*. Although trip limits should be similar to Alternative 2, the capacity reduction alternative, this alternative ranks lower as it may be difficult to optimize trip limits and season length in such a fashion as to minimize bycatch and bycatch mortality compared to Alternative 2.

*Effects on Overfished Groundfish* Vessel trip limits would increase, especially outside of GCAs as a consequence of a 50% reduction in the fishing season. The fleet would be platooned into two or three groups with shortened fishing periods. This would create a more even flow of fish and supports the current Council goal of maintaining a year-round season. In either case, the larger trip limit sizes would tend to decrease bycatch and bycatch mortality associated with regulatory induced discards. If fishers compensate for the shortened season and larger trip limit by increasing effort, the benefits of a shortened season might not be realized. Too much effort could result in the season being reduced. A shorter season may reduce harvest if some fishers elect not fish during the openings. Bycatch and bycatch mortality would be reduced but product flow may be interrupted.

*Effects on Emphasis Species* Vessel trip limits would increase, especially outside of GCAs as a consequence of a 50% reduction in the fishing season.

As was described above under the *status quo,* bycatch of species within the DTS may be the result of several factors, including size, attainment of regulatory limit, and high grading related price structure of different sizes of sablefish. A 50% reduction in fishing season and increased trip limits for components of the complex would tend to reduce regulatory induced discard. Within the DTS complex, bycatch of shortspine thornyhead may be reduced if a larger trip limit for this species were allowed. High grading of sablefish may still occur, however.

The potential increase in trip limit size not likely a significant factor for some species of groundfish like those in the other flatfish category. Landing limits under *status quo* are quite liberal compared to current catches and attainment of the cumulative limit under Alternative 3 is not likely. Bycatch and bycatch mortality is related to market limitations for undersized fish, price, and constraints on quantity. If fleet response to the shortened season is to seek some alternative fishery rather than increase effort during season openings, bycatch and bycatch mortality may be reduced due to a reduction in overall harvest levels.

**Effects of Catch Limits under Alternative 3:** Vessel catch limits are not explicitly used as a tool in this alternative. Therefore this tool is ranked 4 (no effect) on a scale of 1 - 4.

**Effects of Gear Regulations under Alternative 3**: Gear regulations alternative would be similar to *status quo* and structured to keep catches within the OY limits for overfished species. Gear restrictions are likely to remain the same as under *status quo* in the near future due to rebuilding requirements of overfished species,

however. Alternative 3 application of gear tools therefore ranks the same as *status quo*, or 2 on a scale of 1 - 3.

*Effects on Overfished Groundfish* It is not anticipated that a 50% reduction in fishing season would permit the use of large footrope gear within current RCA boundaries. However, small footrope trawls could be re-introduced into GCAs if overall OYs for overfished species could be maintained. Currently, lingcod and yelloweye catches remain below OY. Lingcod in particular may be harvested at a higher rate if small footrope trawls are reintroduced. Even with more liberal trip limits and new gear options, canary rockfish catch is very close to OY, thus would constrain access to fishing within the GCAs. Thus, bycatch and bycatch mortality within GCAs could increase over *status quo,* if management measures similar to those used in 2000-2002 were employed within the GCAs. Current canary rockfish, therefore may preclude use of small roller gear within the GCAs. A similar circumstance exists for the southern shelf area - bocaccio catch under *status quo* is very close to OY.

*Effects on Emphasis Species* Larger trip limits stemming from a shorter season may allow access to species of groundfish within the GCA that are precluded from harvest under *status quo.* Harvest levels for several species of shelf groundfish are below current OY levels. Use of small footrope gear could allow more access to Dover, English and petrale soles found on the shelf. Unfortunately, canary rockfish and bocaccio catches under *status quo* are very close to OY, so the use of such gear is unlikely.

**Effects of Time/Area Management under Alternative 3:** Fishing seasons would be significantly different than the other alternatives. The primary effect of seasonal closures is modeled under the trip limit tool for this alternative (see above).

GCAs similar to *status quo* would be used. GCAs are likely to remain the same as under *status quo* in the near future due to rebuilding requirements of overfished species, however. Alternative 3 application of time/area closures therefore rank the same as *status quo*, or 3 on a scale of 1 - 3.

*Effects on Overfished Groundfish* The principal tool for this alternative is to reduce time on the water using seasonal closures. Reducing time on the water would allow larger trip limits during open periods. As was pointed out above, this would have a positive benefit as larger trip limits tend to reduce bycatch in the form of regulatory induced discard of overfished species. Platooning of the fleet would be done to maintain a year-round flow of groundfish to markets, thus impacts would be comparable to Alternative 2. Compared to *status quo*, this alternative would still have a positive benefit in reducing bycatch and bycatch mortality of overfished species due to the general effect of increased trip limit size. The season may have to be shortened in order to maintain trip limit size. If the season is too short, some fishers may be elect not to fish. Overall catch of

overfished species may decline or trip limits could be increased. The impact of effort reduction due to fishers opting out, would be a reduction in bycatch and bycatch mortality of overfished species.

*Effects of on Emphasis Species* In addition to the GCAs described under Alternative 1, the principal tool for this alternative is to reduce time on the water using seasonal closures. Depending on the timing of a seasonal closure, bycatch and bycatch mortality may be reduced. If platooning is considered as an option, fisheries outside of the GCAs might be feasible as increased trip limits would provide some flexibility in application of ratio management. For example, the DTS fishery could provide year round opportunities for a platooned fleet with larger trip limit sizes. In addition, a significant proportion of flatfish are distributed shoreward of RCAs; there may be an opportunity to have exceptions to closures for the shallow water flatfish fishery.

**Effects of Capacity Reduction under Alternative 3**: Capacity reduction is not used as a tool in this alternative. Therefore this tool is ranked 3 (no effect) on a scale of 1 - 3.

**Effects of Data Reporting, Record-keeping, and Monitoring under Alternative 3**: Higher levels of monitoring yield more complete, accurate, and timely estimates of total catch including bycatch. Indirect benefits would include improved stock assessments and tracking of rebuilding plans. Under Alternative 3, 100% of the at-sea whiting fleet would be monitored by onboard observers; shore-based whiting vessels wold continue to be required to retain all fish brought aboard (as required by an EFP, and soon by regulation) and landings would be observed on shore; and approximately 10% of the non-whiting commercial groundfish fleet would be monitored with on-board observers. Commercial landings data and observer data would be used to estimate the total catch and catch ratios of overfished species co-occurring with other groundfish.

Under Alternative 3, catch reporting, record-keeping, and monitoring through the use of observers may improve over Alternative 1. Assuming the number of observer days remains the same, a higher proportion of total trips and catch would be observed due to the reduced fleet size and (perhaps) reduced total number of trips. If effort increases, trip limits may have to be reduced, and the level of observer coverage would be similar to Alternative 1. This tool is ranked 4 (low), the same as Alternative 2, on a scale of 1 - 5.

Table 4.3.6. Effects of bycatch mitigation tools as applied in Alternative 3. Relative rank of the tools used to reduce bycatch and bycatch mortality. Overfished species in bold and emphasis species in italic. Species below MSY and subject to precautionary management are noted with (p).

| Environment | Species | ABC/OY | Performance standard and OY reserves | Trip Limits | Catch limits | Retention requirement | Gear restrictions | Capacity reduction | Time/area management | Monitoring program |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | None | Larger trip limits | Soft sector scorecard | None | Yes | None | RCAs and shortened season | 10% Observer coverage, 100% logbook coverage, verification |
| Northern Shelf | **Canary rockfish** | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| | **Lingcod** | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| | **Yelloweye rockfish** | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| | *Yellowtail rockfish* | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| | *Arrowtooth flounder* | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| | *English sole* | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| | *Petrale sole* | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| Southern Shelf | **Boccacio** | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| | **Cowcod** | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| | *Chilipepper* | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| Slope | **Darkblotched rockfish** | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| | **Pacific Ocean Perch** | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| | *Dover sole (p)* | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| | *Sablefish (p)* | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| | *Shortspine thornyhead (p)* | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| | *Longspine thornyhead* | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| Pelagic | **Widow rockfish** | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| | *Pacific whiting* | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 4 |
| Nearshore | *Black rockfish* | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 4 |
| | *Cabezon* | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 | 4 |
| | **Scale** | 1 | 1 to 3 | 1 to 4 | 1 to 4 | 1 to 2 | 1 to 3 | 1 to 3 | 1 to 3 | 1 to 5 |

### 4.3.1.4 Impacts of Alternative 4 (Sector and vessel catch limits)

*Summary* The policy goal of this alternative is to reduce bycatch by modifying the definition of "trip limit" to include *CATCH LIMITS* for overfished stocks, establishing vessel catch limits for each 2-month period, setting annual catch limits for the various fleet sectors, and establishing an in-season catch monitoring or verification program to ensure all catch is recorded. Trip (retention) limits for non-overfished groundfish would also be used in combination with vessel catch limits. Catch limits and retention limits would expire at the end of each period. Vessels carrying observers would have access to larger trip limits of non-overfished groundfish. In this alternative, control of bycatch and bycatch mortality is done by controlling overall catch and gear efficiency and requiring vessels to stop fishing for all groundfish when a catch limit is reached. Direct control of catch and individual vessel accountability set this alternative apart from the previous alternatives. Individual vessel performance would contribute to sector performance. A fishing sector could, therefore, be closed when the portion of OY allocated to that sector were reached. Other sectors would continue fishing unless an overall OY were reached.

This goal supports Council objectives of preventing overfishing, rebuilding overfished stocks, maintaining a year-round fishing season, and increasing individual and group accountability for their groundfish catches. Fishery monitoring would be increased over Alternative 1; monitoring costs would be higher.

*Tools Used* The following mix of management measures are applied to create Alternative 4. Tool ranks for Alternative 4 are summarized in Table 4.3.7.

Table 4.3.7. Summary of bycatch mitigation tools as used in Alternative 4.

| |
|---|
| **Harvest Levels** ABCs/OYs Same as Alternative 1; sector allocations established |
| **Vessel trip limits** Used; perhaps more variations than Alt 1 - 3 due to more sectors. Larger trip limits for vessels with catch limits and observers. |
| **Vessel catch limits** Used for vessels that pay for observers |
| **Gear regulations** Same/ similar to Alternative 1 |
| **Time/area management** Generally similar to Alternative 1; possible limited exemptions for vessels with catch limits and observers |
| **Capacity reduction** Same as Alt 1 |
| **Data reporting, record-keeping, and monitoring** Similar to Alt 1, but more coverage expected due to incentives for vessels to pay for (additional) observers |

- Harvest Levels (harvest policy, rebuilding) Objectives for optimum yield and rebuilding would remain the same as in Alternatives 1, 2, and 3. The harvest policy would be modified from the previous alternatives in that OYs would be subdivided into overfished species limits and non-overfished species guidelines for each fishing sector. Each sector would be monitored separately throughout the season for its progress towards those guidelines and caps. Broad fishery sectors would be specified: three limited entry whiting sectors, limited entry bottom trawl, limited entry fixed gear, open access, and recreational. Because several stocks show geographic variation north to south, the non-whiting sectors could be further subdivided, for example north and south of Cape Mendocino at 40°10' N. Lat. A portion of non-overfished groundfish OYs could be set aside in reserve for the fishery sector with the lowest bycatch to provide further incentive to reduce catch rates of overfished species. When a sector reached any cap, all vessels in the sector must stop fishing for groundfish. When a sector reached a guideline for a non-overfished species, the Council would evaluate whether sufficient OY remains to allow continued fishing without reducing opportunities for other sectors.
- Vessel trip limits Vessel trip limits for non-overfished groundfish species would be established sector-by-sector. They would reflect the number of vessels in the sector and the allocations for that sector. Some trip limits might initially be similar to those under Alternative 1, based on previously observed joint catch ratios of overfished and co-occurring groundfish species. Trip limits would likely be larger than under the previous three alternatives because they would be based more directly on OYs for those species and on the membership and participation of the various sectors.
- Catch Limits Restricted species catch limits for overfished groundfish (and perhaps other species needing reduced harvest) would be established for those limited entry vessels that pay the costs for their own observer coverage. These catch limits would exempt the vessel from sector allocations and would likely be combined with larger trip limits for non-overfished species. Catch limits may differ among vessels based on target species or strategy, gear, cooperative research fishing, participation in an EFP, etc. Vessels participating in the same EFP or a small cooperative would likely have similar catch limits. As with trip limits, these catch limits would not be transferable and would expire at the end of each period (that is, they could not be carried over to the next period). In contrast to trip limits, a vessel must stop fishing when it reaches any restricted species catch limit until the next period begins. When a vessel is observed to reach a restricted species catch limit, it must stop fishing for the remainder of the period. When an annual sector cap is reached or projected to be reached, vessels with unattained catch limits would continue fishing. The increased incentive to avoid catching overfished groundfish and the reduction of incentives to discard under this provision would be expected to reduce bycatch of overfished groundfish substantially. Facing the possibility of being shut down due to reaching a restricted species catch limit or sector cap, vessels would be more likely to retain all usable fish.

- Gear Regulations Gear regulations under this alternative would be the same or similar to Alternative 1, and would be structured to keep catches within the OY limits for overfished species. Incentives would be stronger to modify gear in order to reduce bycatch and bycatch mortality, due to strict caps and robust monitoring system of this alternative. Gear modifications that reduced the take of overfished rockfish outside of RCAs would have a direct beneficial impact on bycatch and bycatch mortality, compared to the first three alternatives. The fate of excluded fish is unknown. Fish interacting with and escaping fishing gear may succumb to delayed mortality even though bycatch in the form of discards is reduced.
- Time/Area Management Initially, time and area closures would be similar to those under Alternative 1, and would be based on the previously observed catch ratios of various groundfish species. Some additional flexibility might be possible due to increased monitoring and updating of catch ratios and performance of the fishing sectors. This alternative may allow changes in time or depth of RCAs based on more extensive monitoring data, since the observer program would likely be more finely stratified than under the *status quo* alternative. Reduction in the extent of the current GCAs would be intended not to allow increased catch/bycatch of overfished species, but could result in bycatch of other species.
- Capacity Reduction Further capacity reduction is not included in this alternative.
- Data Reporting, Record-keeping, and Monitoring This alternative would establish a more robust catch reporting, record keeping, and monitoring program than Alternative 1. Full (100%) logbook coverage would be required to improve the accuracy of estimated catch by commercial and charter boats. A subset of vessels within each sector would be chosen randomly and observed. (For vessel caps to be fully functional, every vessel would have to be observed.) Incidental catch rates of observed vessels would be quickly tabulated and applied to non-observed vessels of the sector. Vessels within a sector could also voluntarily pay for and carry an observer in order to have access to higher trip limits. Recreational sampling would be also be increased. In-season monitoring of commercial and recreational fisheries would ensure caps would not be exceeded by any given sector. These controls would have a direct effect of reducing bycatch of overfished species compared to the first three alternatives.

*Impacts on Groundfish* The effects of the tools and tool applications used to reduce groundfish bycatch, bycatch mortality, and to increase individual and sector accountability in Alternative 4 are ranked and summarized in Table 4.3.8. Effects are ranked in comparison to the other alternatives. Lower numbers indicate a greater effect.

Overfished species Under this alternative, overfished species OYs would be subdivided into caps for each fishing sector; non-overfished species OYs would be subdivided into guidelines for each sector. A subset of vessels in each sector would be observed and catch/bycatch rates expanded to unobserved vessels inseason. Within each sector, overfished species catch limits (RSCs) would be assigned to each vessel. When a vessel reached a catch limit (RSC), it would be required to cease fishing. When a sector cap was reached or projected to be reached, all vessels in that sector would have to stop fishing. Intensive monitoring (observer coverage) would ensure success of this bycatch mitigation program. The primary direct effect of this alternative would be reductions in bycatch of overfished species due to strict caps, individual vessel catch limits, and monitoring of these species. It is highly likely that the shelf dwelling canary rockfish and bocaccio will present the biggest challenge to sectors because of their wide distributions and susceptibility to diverse gears. Current harvest levels for these two species are very close to the OYs. Catches of some other overfished species are below their OYs largely due to fishing constraints caused by canary rockfish and bocaccio. Thus, impacts of trip or catch limits on the various species would differ. Bycatch reduction impacts on overfished species with catch limits would rank higher than other emphasis groundfish species (see below).

There is some question as to whether incentives work on a fishery sector basis. Huppert *et al.* (1992) suggested that sector based incentive systems tend to penalize those participants who adopt methods of reducing bycatch of prohibited species, because fewer target species are likely to be caught. Sector based incentive programs work best for relatively small and discreet fishing units like fishing co-operatives. The Pacific whiting fishery sector uses a similar program to limit the incidental catch of salmon. Catch limits for overfished species applied to individual vessels and closely monitored should provide stronger incentives than sector limits alone. Impacts of catch limits on individual vessels under a comprehensive monitoring program would be similar to Alternative 5.

The limited entry fixed gear fleet might be successful in limiting the sector's bycatch of certain non-target species of concern (halibut, lingcod, and overfished rockfish), as the catch of those species is relatively small and fishing methods relatively selective. In contrast, the large recreational sector may have a difficult time controlling catch of overfished species through an incentive program because there are many and diverse participants. Thus, other means of controlling this sector's catch would likely be necessary.

Cumulative trip limits for non-overfished groundfish species would be increased for those vessels carrying observers. Cumulative trip limits for the entire sector could be relaxed in size to the extent fleet sectors were able to minimize bycatch of overfished species. Gear modifications would be encouraged to reduce the take of overfished species.

Emphasis Species Close monitoring of sector caps for overfished species could further constrain harvest of co-occurring (non-overfished) groundfish, especially if unobserved participants in a sector did not apply bycatch reducing fishing tactics. A reduction in effort could result from early attainment of restricted species catch limits and overfished species sector caps. This may result in less harvest of other groundfish, thus reducing bycatch and bycatch mortality at the expense of lost economic opportunity. On the other hand, incentives, in the form of larger trip limits for observed vessels, and access to a reserve later in the year for the fishing sector, may change enough of each sector's fishing practices to reduce bycatch of overfished species and increase catch of other groundfish. Individual vessel restricted species catch limits would apply only to overfished species, with trip limits applied to other species. Sector harvest guidelines rank lower than restricted species catch limits for their effectiveness in reducing bycatch (See shaded boxes under "Trip Limits" and "Catch Limits" columns in Table 4.3.8).

Increased cumulative retention limits might result if bycatch of overfished species were well controlled using vessel restricted species catch limits, sector caps, incentives and gear modifications. This could result in increased access to those non-overfished groundfish with higher market value or demand. Bycatch may be reduced for some species such as Dover sole, shortspine thornyhead, sablefish, and yellowtail rockfish. Increased cumulative limits would have less impact on species that are constrained by market limits (some flatfishes and chilipepper rockfish, for example) rather than regulatory limits.

**Effects of Harvest Levels under Alternative 4**: Objectives for optimum yield and rebuilding would remain the same as in s*tatus quo.* Harvest policy would be modified from *status quo* in that OYs would be subdivided into caps allocated to each fishing sector with in-season monitoring of caps. Performance standards and sector allocations with OY reserves should have a significant effect, reducing potential bycatch and bycatch mortality compared to Alternatives 1-3. This tool, as used in Alternative 4, is ranked 2 (highly effective) on a scale of 1- 4.

*Effects on Overfished Groundfish* Under this alternative, overfished species OYs would be broken down into caps for each fishing sector with in-season monitoring of caps. When OY is reached, further fishing would be prohibited or severely curtailed. A portion of other groundfish OY would be set aside in reserve for each fishery sector to provide an incentive to lower catch rates of overfished species. If successful, the primary direct effect of this alternative would be reductions in bycatch of overfished species due to strict caps and monitoring of these species. It is highly likely that the shelf dwelling canary rockfish and bocaccio will present the biggest challenge to sectors. Current harvest levels under *status quo* conditions are very close to OY. Catch of other overfished species are below OY largely due to fishing constraints caused by these two species.

There is some question as to whether incentives work on a fishery sector basis. Huppert *et al.* (1992) suggested that sector based incentive systems tend to penalize those participants who adopted methods of reducing bycatch of prohibited species, because fewer target species are likely to be caught. Sector based incentive programs work best for relatively small and discreet fishing units like fishing co-operatives. The Pacific whiting fishery sector utilizes a similar program to limit harvest of salmon incidental catch.

The limited entry fixed gear fleet would likely be successful limiting bycatch of non-target species of concern (halibut, lingcod, and overfished rockfish), as the catch of overfished species is small. In contrast, the recreational sector may have a difficult time controlling catch of overfished species through an incentive program, because there are many and diverse participants. Thus, other means of controlling this sectors' OY cap would likely be more effective.

*Effects on Emphasis Species* Close monitoring of sector caps for overfished species could further constrain harvest of co-occurring other groundfish, especially if sector participants ignored incentives and did not apply bycatch reducing fishing tactics. A reduction in effort could result from early attainment of overfished species sector caps. The direct impact of OY caps may result in less harvest of other groundfish, thus reducing bycatch and bycatch mortality at the expense of lost economic opportunity. On the other hand, incentives, in the form of additional OY for the fishing sector may change enough of the sectors' fishing practices to reduce bycatch of overfished species and increase catch of other groundfish. If bycatch is proportional to catch, bycatch and bycatch mortality may increase for other groundfish.

**Effects of Vessel Trip Limits under Alternative 4**: Vessel trip limits would initially be the same as *status quo* and based on previously observed joint catch ratios of overfished species and various groundfish species. Trip limits might be relaxed (increased) depending on the performance of fleet sectors at maintaining catch caps. Trip limits under this alternative are given a rank of 2 (very effective) for some species and 3 (somewhat effective) for other species on a scale of 1 - 4.

*Effects on Overfished Groundfish* Vessel trip limits could be altered compared to the status quo due to more careful monitoring of catch, and vessel incentives to minimize catch and bycatch of overfished species, as the season progresses. To the degree that limits were liberalized, bycatch and bycatch mortality of overfished species may be reduced. Alternative 4 applies caps on a sector basis. Individual vessels may not have as strong of an incentive to avoid overfished species as in Alternatives 5 and 6. Therefore, it is likely that the greatest source of bycatch reduction is likely to be due to increased retention rates for bottom trawlers.

Studies of Alaska fisheries have shown that sector caps work with small identifiable fishing units, like cooperatives. The west coast whiting fleet is

organized along similar lines and appear successful at implementing voluntary caps on bycatch of prohibited species. Under this alternative, a pelagic fishery catch cap for overfished shelf rockfish and widow rockfish may effectively managed by Pacific whiting cooperatives.

*Effects on Emphasis Species* Limit changes under this alternative are not likely to affect those species with catch levels below existing cumulative catch limits, especially if they are market limited. Effects of potential limit changes on these species were ranked lower than overfished species (see shaded scores under Trip limits in Table 4.3.4). Catches of more desirable species, like yellowtail rockfish, currently harvested below cumulative catch limits due to constraints associated with overfished species may be more accessible if the vessel sector incentive program is successful.

**Effects of Catch Limits under Alternative 4**: Sector caps may or may not be effective incentives for individual vessels to improve their bycatch performance. In the absence of individual vessel caps, unobserved vessels may have increased incentive to maximize revenues before a sector cap is reached. This could result in discarding all overfished species to avoid contributing to the landed catch accounting system, increased highgrading, and other changes in fishing behavior. If effectively monitored, Alternative 4 would be expected to reduce bycatch of overfished groundfish substantially. Facing the possibility of being shut down due to reaching a restricted species catch limit or sector cap, vessels would be more likely to retain all usable fish. [However, this could have unintended consequences. For example, catch projections could be compromised if only target species landings are monitored and static ratios applied . Managers may not be aware of increased retention rates and would continue to apply co-occurrence rates that would be higher than the actual bycatch rates (which could be declining).] Individual catch caps, increased monitoring, and larger trip limits would be expected to work towards reduced regulatory and economic bycatch. In addition, catch limits would enable relaxation of redundant restrictions (possibly including seasons and area restrictions), which could make it more profitable for vessels to truly minimize their bycatch to the extent practicable with less regulation. Only through individual performance will sector performance improve. Without incentives and opportunities for individual improvement, progress will be slow and bycatch rates could even deteriorate.

Vessel catch limits for overfished groundfish (and perhaps for other species needing bycatch reduction) would be established for limited entry vessels that carry an observer at their own expense. These caps may be different for different vessels depending on target strategy, gear, area, etc. This management tool may provide enough incentive to significantly reduce bycatch of overfished species through changes in fishing strategy and gear deployment. As with trip limits, these catch limits would not be transferable and would expire at the end of each period (that is, they could not be carried over to the next period). In contrast to IQs, they could not be bought and sold as needed for greater economic efficiency.

In contrast to trip limits, when a vessel reaches any catch limit, it must stop fishing until the next period begins.

One possible variation of sector caps and vessel catch limits could be for smaller groups of vessels to form cooperatives, pooling their individual catch limits so as to spread the risk of reaching any limit. This could be particularly effective for vessels that conscientiously strive to minimize their bycatch and are willing to experiment and cooperate to achieve optimum results.

This tool is ranked 2 (highly effective) for overfished species and some emphasis species and 3 (somewhat effective) for others on a scale of 1 to 4 (where 1 is the most effective and 4 is the least effective at reducing bycatch and bycatch mortality). However, due to the higher costs of full observer coverage (both to vessels and to the management agencies), this approach to minimizing bycatch may not be practicable, especially in the short term. If the observer program can be augmented over time, and vessel revenues improved enough to enable them to contribute to observer funding needs, this approach may become practicable.

*Effects on Overfished Groundfish* The increased incentive to avoid catching overfished groundfish and the increased incentives to retain more fish under this alternative would be expected to reduce bycatch of overfished groundfish substantially. Facing the possibility of being shut down due to reaching a vessel catch limit, vessels would be likely to fish more carefully and retain more usable fish. Full monitoring would be required.

*Effects on Emphasis Species* The creation of vessel catch limits for overfished species, combined with larger trip (retention) limits for other emphasis species, could increase the overall harvest of some other groundfish species up to OY. Some species will continue to be limited by markets; increased retention requirements would reduce the economic discard of these species and would encourage market development. Increased limits and retention of species such as Dover sole, shortpine thornyhead, sablefish, and yellowtail rockfish may reduce regulatory bycatch of these species under Alternative 4.

**Effects of Gear Restrictions under Alternative 4**: Management under Alternative 4 would include incentives to modify gear as an aid in reducing bycatch and bycatch mortality and keeping under strict vessel and sector caps. Gear restrictions as applied under Alternative 4 are assigned a rank of 2 on a scale of 1 - 3 among alternatives.

*Effects on Overfished Groundfish* Gear modifications that reduced the take of rockfish outside of RCAs may have a direct positive impact on bycatch and bycatch mortality of overfished species, compared to the first three alternatives. Depending on the type of gear modification, some un-observed impacts may occur, leading to bycatch mortality. Little is known about the survivability of fish escaping through meshes or escape panels. Fish excluder devices that eliminate

overfished rockfish species provide a better opportunity for survival than sorting and discarding fish at the surface, which is generally lethal for rockfishes (see discussion under Alternative 1 *status quo* and Davis and Ryer (2003 )). Cut-back trawls are being experimented with under EFPs. These nets are thought to be highly selective for flatfish and may allow rockfish to avoid capture without contact (Parker 2003).

With caps applied on a sector basis however, individual vessels may not have as strong of an incentive to modify gear to eliminate take of overfished species as in Alternatives 5 and 6 (see discussion above under **Harvest Levels**).

*Effects on Emphasis Species* It is hoped that incentives to modify gear to reduce bycatch and bycatch mortality of overfished species would be strong, due to strict caps and a robust monitoring system. If sector based caps are successful at minimizing bycatch of overfished species, more of the OY for other groundfish should be accessible. The midwater trawl fishery may be successful in taking yellowtail rockfish without excessive bycatch of widow rockfish for example. The DTS fishery might enjoy a large portion of overall OY if, through incentives, undersized sablefish and shortspine thornyhead bycatch could be reduced. Impacts to nearshore flatfish bycatch and bycatch mortality are unknown as changes in gear are likely to be done to reduce impacts to overfished species. As pointed out above, the strength of the incentives depends on changes in gear and behavior on the part of the entire sector in order. There may not be as strong as incentive as possible if caps were applied on an individual vessel basis (See Alternatives 5 and 6).

**Effects of Time/Area Management under Alternative 4:** Initially time and area closures (RCAs) would be similar to those under *status quo*, and would be based on the previously observed catch ratios of various groundfish species. Some limited additional flexibility in defining RCAs might be possible if fleet sector response to sector caps reduces bycatch. Time/area management as applied under Alternative 4 is given a rank of 3 (no additional effect over the *status quo*) on a scale of 1 - 3.

*Effects on Overfished Groundfish* This alternative may allow changes in time or depth of seasonal RCAs if fleet sectors are successful at maintaining harvest levels of overfished species at or below OY sector caps. Impacts to bycatch and bycatch mortality of overfished species would likely be the same as under *status quo*. Gains made due to successful fleet response to sector caps may be offset somewhat if managers change RCA boundaries to allow new opportunities to harvest other groundfish. Encounter rates with overfished shelf rockfish could increase as a result. If fishers retain overfished species, overall bycatch should be less than *status quo.*

*Effects on Emphasis Species* Initially time and area closures (RCAs) would be similar to those under *status quo*, and would be based on the previously observed catch ratios of various groundfish species. Impacts to bycatch and bycatch mortality would likely be the same as under *status quo.* If RCA boundaries are changed to allow more access to other groundfish, catch, bycatch and bycatch mortality of other shelf groundfish could increase somewhat.

**Effects of Capacity Reduction under Alternative 4**: Further capacity reduction is not included in this alternative. Therefore, it is ranked as 3 (no effect) on a scale of 1-3.

**Effects of Data Reporting, Record-keeping, and Monitoring under Alternative 4**: Higher levels of monitoring yield more complete, accurate, and timely estimates of total catch including bycatch. Indirect benefits would include improved stock assessments and tracking of rebuilding plans. Under Alternative 4, 100% of the at-sea whiting fleet would be monitored by onboard observers; and shore-based whiting vessels wold continue to be required to retain all fish brought aboard (as required by an EFP, and soon by regulation) and landings would be observed on shore.

Under Alternative 4, observer coverage would be redesigned to ensure that each sector's bycatch of overfished groundfish species is accurately assessed and recorded, with results available for management purposes inseason. A minimum rate observation of each sector would be approximately 10% or as determined by statistical sample design methods. Full (100%) logbook coverage for each sector would be required to improve the accuracy of estimated catch by commercial and charter boats. Commercial landings data and observer data would be expanded sector-by-sector to all vessels in each sector. Vessels observed to achieve any catch limit of overfished species (or other restricted species catch limit) would be required to stop fishing for the remainder of the designated period. Vessels observed to stay below all restricted species limits would be authorized to continue fishing for additional target species; that is, larger trip limits would be available for vessels carrying observers. It may be possible to use video monitoring in conjunction with full retention and shoreside sampling to achieve the same level of catch verification.

The catch reporting, record keeping, and monitoring program established by Alternative 4 would be substantially more robust than Alternatives 1, 2 and 3. For vessel caps to be fully functional, every vessel would have to be observed. Vessels within a sector could also voluntarily pay for and carry an observer in order to have access to higher trip limits. Recreational sampling would be also be increased. In-season monitoring of commercial and recreational fisheries would ensure caps were not exceeded by any given sector. These controls would have a direct effect of reducing bycatch of overfished species compared to the first three alternatives. Discard may also be reduced in the commercial fishery compared to the first three alternatives as fishers are more likely to retain catches of all usable

fish, including overfished species. Bycatch mortality of fish caught and released in the recreational fishery is unknown. The application of this tool is ranked 2 to 3 (highly effective) on a scale of 1 - 5 compared to the alternatives. The ranking depends on the level of observer coverage (whether 100% coverage is achieved or some lesser coverage rate of each sector).

Table 4.3.8. Effects of bycatch mitigation tools as applied in Alternative 4. Relative rank of the tools used to reduce bycatch and bycatch mortality. Overfished species in bold and emphasis species in italic. Species below MSY and subject to precautionary management are noted with (p).

| Environment | Species | ABC/OY | Performance standard and OY reserves | Trip limits | Catch limits | Retention requirement | Gear restrictions | Capacity reduction | Time/area management | Monitoring program |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Catch ratios- allocate to sector with reserve | Yes | Vessel and Sector caps | None | Yes | None | RCAs | Increased Observer coverage commercial and CPFV, in-season est. |
| Northern Shelf | **Canary rockfish** | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| | **Lingcod** | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| | **Yelloweye rockfish** | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| | *Yellowtail rockfish* | 1 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 |
| | *Arrowtooth flounder* | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| | *English sole* | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| | *Petrale sole* | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| Southern Shelf | **Boccacio** | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| | **Cowcod** | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| | *Chilipepper* | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| Slope | **Darkblotched rockfish** | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| | **Pacific Ocean Perch** | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| | *Dover sole (p)* | 1 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 |
| | *Sablefish (p)* | 1 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 |
| | *Shortspine thornyhead (p)* | 1 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 |
| | *Longspine thornyhead* | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| Pelagic | **Widow rockfish** | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| | *Pacific whiting (incl.discard)* | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| Nearshore | *Black rockfish* | 1 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 |
| | *Cabezon* | 1 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 |
| | **Scale** | 1 | 1 to 3 | 1 to 4 | 1 to 4 | 1 to 2 | 1 to 3 | 1 to 3 | 1 to 3 | 1 to 5 |

Figure 4.7.

### 4.3.1.5 Impacts of Alternative 5 (Individual Fishing (Catch) Quotas and Increased Retention)

*Summary* The policy goal of this alternative is to significantly reduce bycatch by limiting every limited entry commercial vessel's groundfish catches through the use of annual, transferable, restricted species catch quotas (RSQs) for overfished species and transferable individual fishing quotas (IFQs) for other groundfish. These quotas would be mortality limits for each species. Direct control of catch and individual vessel accountability sets this alternative apart from Alternatives 1, 2 and 3; the use of annual catch limits that are transferable sets this apart from Alternative 4. A robust monitoring or catch verification program would be implemented to ensure reporting of all catch. Discarding of overfished species would be prohibited; discarding of other species would not be prohibited, but all catch would apply towards the IFQs. Gear regulations would be relaxed, allowing fishers the ability to modify gear and operations to avoid catch of overfished species and reduce unwanted bycatch of all species. Regulations could be amended to allow trawl vessels to use non-trawl gears where increased selectivity for certain species is possible. A portion of some OYs would be reserved for vessels with the lowest bycatch rates or amounts.

This goal supports Council objectives of preventing overfishing, rebuilding overfished stocks, and maintaining a year-round fishing season. Fishery monitoring is increased substantially over Alternatives 1, 2 and 3, and less substantially over Alternative 4. Increased monitoring also means increased costs.

*Tools Used* The following mix of management measures are applied to create Alternative 5. Tool ranks are summarized in Table 4.3.9

Table 4.3.9. Summary of bycatch mitigation tools as applied in Alternative 5.

| |
|---|
| **Harvest Levels** ABCs/OYs same as Alternative 1; allocations of catch shares to eligible vessels |
| **Vessel trip limits** not used for limited entry, with possible exceptions for small vessels. For open access, continued use. |
| **Vessel catch limits** vessel allocations are catch limits; transferable; some discard prohibitions |
| **Gear regulations** same/similar to Alternative 1; may be relaxed. |
| **Time/area management** generally similar to Alternative 1; may be relaxed for vessels with IFQs and observers |
| **Capacity reduction** none specified; fleet reduction expected to result from IQ program |
| **Data reporting, record-keeping, and monitoring** Full coverage of vessels in IFQ program |

- Harvest Levels OYs would remain the same as in Alternative 1, however distributions of available OYs would be broken down into individual quotas (mortality limits) for each commercial limited entry vessel. A reserve of various species could be set aside for vessels with the lowest catches or catch ratios of overfished species. Any unused OYs would be made available to those vessels that had not taken their overfished species limits.
- Vessel trip limits Vessel trip limits would be relaxed or absent, as each vessel would have individual caps on overfished and other groundfish species.
- Vessel Catch Limits Individual vessel caps in the form of dedicated access privileges (such as transferable restricted species catch limits (RSQs) for overfished stocks and individual transferable fishing quotas for other groundfish species) would be established with this alternative. Vessels must stop fishing upon reaching any catch quota or obtain additional quota to continue fishing. Vessels with the lowest catch rates of overfished species would have the greatest access to additional fishing.
- Gear Regulations Gear regulation would be more flexible than under Alternative 1. Gear modification, and perhaps the use of alternative gears, would be allowed. Commercial limited entry trawl fishers would be encouraged to experiment with different methods to reduce bycatch of overfished species. The distinction between limited entry longline and pot permits could be eliminated, and/or those vessels allowed to use open access line gear to reduce their catch of overfished species. Strict caps and a robust catch monitoring system would reduce the need for gear regulations as the primary bycatch mitigation tool.
- Time/Area Closures In the short term, MPAs would be applied in a manner similar to the first four alternatives. However, under an RSQ/IFQ program, GCAs as they are currently used may become less important and less necessary as a tool to reduce groundfish bycatch. Once an individual vessel's RSQ/IFQ is attained, the vessel would be required to cease fishing for groundfish until additional quota is obtained. There may some limited circumstances where continued fishing might be allowed where the likelihood of encountering the particular species would be highly unlikely. Under an individual vessel catch limit/quota program, vessels would have a greater incentive to improve the selectivity of their fishing gear and techniques, fishing in areas where they can maximize their profits. MPAs for overfished species would tend to be redundant under this program. However, MPAs for other purposes, such as habitat areas of particular concern, or research reserves, might continue to be appropriate or necessary.
- Capacity Reduction No direct reduction in capacity is considered under this alternative. (See discussions under Alternatives 1 and 2). However, some degree of industry consolidation would be expected under an individual quota program. Capacity reduction accomplished through RSQ/ IFQ sales could have a positive direct effect on overfished species, if a species cap for a vessel is not used by the vessel. Excess quota could be re-distributed to active fishers or left in reserve.

- Data Reporting, Record-keeping, and Monitoring Increased observer coverage would be required. Although onboard observers would likely monitor fishing locations to a certain extent, VMS would be used to ensure more precise location and to verify vessels did not fish within an MPA or closed area (PFMC 2003e). Recreational sampling would also be increased under this alternative. Each IFQ vessel would be required to closely track its catches so it would know when it must stop fishing or purchase additional quota. In-season monitoring of the limited entry fishery would thus be vessel-by-vessel; monitoring of the recreational and commercial open access fisheries would be by sector, but increased monitoring may be necessary in order to ensure the quotas of the IFQ fishery are not eroded.

*Impacts on Groundfish* The effects of tools used in Alternative 5 on reducing groundfish bycatch, bycatch mortality, and increasing accountability are ranked and summarized in Table 4.3.10. Effects are ranked in comparison to the other alternatives, lower numbers meaning that the tool is expected to be more effective. Greater individual accountability is the hallmark of this alternative. Gear restrictions would be flexible (with the possible exception of gear requirements inside MPAs, where use of bottom fishing gears would likely remain limited). Performance standards (individual quotas and close monitoring) would provide strong incentives for individuals to modify their fishing gear and practices to reduce bycatch of overfished groundfish, minimizing the need for other regulatory intervention. RSQ and IFQ sales would lead to industry consolidation, including further fleet reduction .

Overfished groundfish OY for overfished species would be broken down into RSQs for each fishing vessel, with in-season monitoring of caps. When OY is reached, further fishing would be prohibited or severely curtailed. A portion of the OYs of various species would be reserved for vessels with the lowest catches or catch ratios of overfished species. Any unused or reserved OY for other groundfish would be made available to those vessels that had not taken their RSQs.

Catches of canary and bocaccio rockfish are currently very close to their OYs, and the protective harvest levels for these species constrain catches of other co-occurring groundfish. The small individual catch quotas (RSQs) established by Alternative 5 would create strong incentives for vessels to develop gear modifications and fishing strategies to avoid taking the most constraining species. Quota transferability would be important to provide at least limited fishing opportunities even where encounter rates of these two species is low. RSQs for these two species would be very small, perhaps less than 100 pounds per vessel per year. Some fishers would reach their limits prematurely and be closed for much of the year. Some may choose to sell out rather than face the frustration of failure. Some will actively buy up quota share in order to maintain or expand their fishing activities. It is likely many vessels would self-separate into different

fishing strategies where they believe they would have the greatest chance of success.

With respect to overfished species, the primary direct effect of this alternative would be reductions in both encounters and discard/bycatch. Individual catch quotas coupled with complete observer coverage would greatly improve catch and bycatch reporting. Vessels would be required to stop fishing or obtain additional quota whenever they reached an RSQ limit. They would actively try to avoid encounters of the most restrictive species. They would be required to retain all overfished species. Thus, overfished species bycatch (discarded catch) should be reduced or eliminated with this alternative. If an overfished species OY were reached, further fishing would be prohibited or severely curtailed.

Trip limits would no longer be used for the commercial limited entry fishery but would likely be used for the open access sector. Gear restrictions would be relaxed to facilitate experimentation in bycatch avoidance methods. In the short term, GCAs would be maintained (although perhaps their boundaries revised) to limit potential encounters with overfished species. In the longer term, such regulatory constraints would be less necessary for overfished species, but may be continued to mitigate bycatch of other species.

Emphasis Species OYs for non-overfished groundfish species would be allocated as IFQs for each limited entry vessel. A portion of some OYs may be reserved for vessels with the lowest catches or catch ratios of overfished species. Any unused OYs would be made available to those vessels that had not taken their overfished species allotments (RSQs).

As was pointed out above, there may be strong incentives to buy and sell RSQ and IFQ shares in order to continue fishing and to develop new strategies. Fishers are currently constrained from fully using several groundfish that are near MSY levels. Under an IFQ program, many may still not be able to fully harvest their IFQs because they used their RSQs in other strategies or to cover unexpected catches. By purchasing additional RSQs of some species (such as canary rockfish), some vessels would be able to make fuller use of their yellowtail rockfish IFQ.

If previous bycatch rate assumptions were lower than actual encounter rates of overfished species, it is likely short term landings of non-overfished species would be reduced. This is because the expanded observer/reporting program would more accurately record bycatch rates. Over time, fishers would improve their ability to avoid overfished species or will be unable to succeed financially. If previous bycatch estimates overestimated the true encounter/bycatch rates, landings would increase because vessels would be able to fish longer than expected. Those fishing strategies that most successfully avoid constraining species while maintaining harvest of healthy stocks will prevail; those with the worst bycatch rates will be phased down. Bycatch of Dover sole, shortspine

thornyhead, and sablefish would be expected to be reduced significantly as a consequence, as this complex can often be harvested with low encounter rates of canary rockfish and bocaccio. Under Alternative 5, other groundfish that are not overfished are not required to be retained. The result may be an increase in bycatch and bycatch mortality of other groundfish due to higher catch attainment. Thus, impacts of catch limits on emphasis species have slightly lower ranking compared to overfished species (See gray shaded boxes under catch limit and retention requirement columns in Table 4.3.10).

Some bycatch and discard mortality could still occur if a vessel approaches attainment of its IFQ. There may be some incentive to finish out the season by spreading out the remaining IFQ in order to maintain the supply of groundfish to the market. In addition, some bycatch and bycatch mortality beyond the IFQ could occur on the last trip when the IFQ is reached. Provisions to carry-over unused quota, or borrow from the next year's, would mitigate this.

Market limits may still have an impact on bycatch and bycatch mortality, as they would continue to exist in the absence of regulatory limits. Low bycatch rates of some species would remain low due to restrictions in MPAs.

If midwater trawl vessels targeting whiting (or widow rockfish) were allowed to operate in areas closed to bottom trawling, incidental catch of emphasis species would occur, but at a lower rate.

**Effects of Harvest Level Specifications under Alternative 5**: Harvest Levels would differ from *status quo* in that OYs would be allocated to individual vessels in the form of RSQ and IFQ shares with a portion held in reserve. Performance standards and OY reserves are required by this alternative. Harvest caps could not be exceeded by individual vessels and overfished species would have to be retained. Shares may be purchased in order to continue fishing. This alternative ranks 1out of a range of 1 - 3 in terms of performance standards and OY reserves.

*Effects on Overfished Groundfish* OY for overfished species would be broken down into RSQs for each fishing vessel with in-season monitoring of caps. When OY is reached, further fishing would be prohibited or severely curtailed. A reserve of various species would be set aside for vessels with the lowest catches or catch ratios of overfished species. Any unused or reserve OY for other groundfish would be made available to those vessels that had not taken their overfished species OY share.

Canary rockfish and bocaccio catches are currently very close to OY, and constrain catches of other co-occurring groundfish. Under this alternative, incentives would be strong to develop specific gear modifications and adopt new fishing strategies to avoid taking these species. Without transferability, it might be impossible to conduct a fishery where encounter rates of these two species is high. OY shares under this alternative will be very small on a per vessel basis.

One indirect effect will be a partitioning of the fleet into different fishing strategies, as vessel owners buy and sell RSQ and IFQ shares to make fishing practical and profitable for a particular strategy.

The primary direct effect of this alternative would be reductions in bycatch due to strict caps and monitoring of overfished species harvest. Thus, overfished species bycatch (discarded catch) should be reduced or eliminated with this alternative as there would be less incentive to do so. Discarded fish counts against the IFQ and observer coverage under this alternative is 100% of the commercial fleet. Some discarding could continue in minor nearshore and recreational fisheries.

*Effects on Emphasis Species* OY for other groundfish would be broken down into IFQs for each fishing vessel with in-season monitoring of caps. A reserve of various species would be set aside for vessels with the lowest catches or catch ratios of overfished species. Any unused OY would be made available to those vessels that had not taken their overfished species allotment. When OY is reached, further fishing would be prohibited or severely curtailed, unless additional IFQ share were purchased.

As was pointed out above, there may be strong incentives to buy and sell RSQ and IFQ shares in order to more selectively fish using different strategies. Fishers are not currently able to access other groundfish at or near MSY levels. As an example, some fishers may successfully modify gear and/or purchase enough canary rockfish RSQ to take advantage of yellowtail rockfish IFQ.

If enough fishers are successful at acquiring RSQ shares and/or are able to make appropriate gear modifications to catch more OY of other groundfish then catches of more species may move toward OY levels. The result may be an increase in bycatch and bycatch mortality of other groundfish due to higher catch attainment.

Some bycatch and discard mortality could still occur if a vessel approaches attainment of the IFQ. There may be some incentive to finish out the season by spreading out the remaining IFQ in order to maintain the supply of groundfish to the market. In addition, some bycatch and bycatch mortality could occur on the last trip when the IFQ is reached.

**Effects of Trip Limits under Alternative 5**: Vessel trip limits would be relaxed or absent. Essentially, the trip limit would amount to the RSQ or IFQ that could be taken on an annual basis. Markets may influence trip size, however, and some bycatch and bycatch mortality may occur as a consequence. See discussion above under **Harvest Levels**. Trip limits under this alternative rank 1 on a scale of 1 - 4.

*Effects on Overfished Groundfish* There would be no need for a trip limit as each vessel would have an individual cap on overfished species and an ITQ for other groundfish species. Direct effects expected under this alternative compared to

status quo would be a reduction in regulatory induced discard of overfished species due to relaxed trip limits.

*Effects on Emphasis Species* Vessel trip limits would be relaxed or absent, as each vessel would have an individual RSQ cap on overfished species and an IFQ for other groundfish species. Under this alternative, regulatory induced discards of other groundfish are not anticipated. Market induced discard resulting from size, price, and quantity requirements would be expected.

**Effects of Catch Limits under Alternative 5**: Transferable individual vessel RSQs for overfished species would be established with this alternative. Transferable IFQs would be established for other groundfish species (See discussion under **Harvest Levels**). Overfished species would have to be retained and discarded catch of other species would count against a vessels quota. Bycatch and bycatch mortality would therefore be significantly reduced. compared to other alternatives not using individual quotas. Vessel catch limits in the form of RSQs and IFQs are ranked 1 for those species currently constrained by trip limits, and 2 for species that are currently constrained by market, on a scale of 1 - 4.

*Effects on Overfished Groundfish* Individual catch limits should work positively to reduce discard of overfished species to near zero, due to a 100% retention requirement and relaxed trip limits. Regulatory induced discard associated with trip limits should be also be eliminated. OY reserves would provide incentives to minimize catch of overfished species.

RSQ shares would need to be purchased if a fisher needed more share of groundfish to continue fishing. Shares of canary rockfish and bocaccio in particular would be very small on a per vessel basis. Fishers are likely to purchase RSQ shares to participate in a fishing strategy that increases the likelihood of encountering canary rockfish and bocaccio. Direct effects expected under this alternative compared to status quo would be a reduction in regulatory induced discard of overfished species.

*Effects on Emphasis Species* Individual transferable quotas (IFQs) would be established for other groundfish species. Regulatory induced bycatch for some species of other groundfish like yellowtail rockfish and shortspine thornyhead could be avoided due to relaxed trip limits. IFQ shares will need to be purchased if a fisher needed more share of groundfish to continue fishing. Vessel catch limits are not expected to change bycatch and bycatch mortality of some groundfish species currently limited by market factors. Sablefish is not currently overfished and 100% retention would not be required. Some high-grading and discard is likely to occur with this species. English sole is another example of a species limited primarily by market factors. Bycatch of some species could increase if a vessel owner sold IFQ shares for some species and continued to fish in an area for other species.

**Effects of Gear Restrictions under Alternative 5**: Gear restrictions would be more flexible than *status quo*. Individual fishers would have the choice to modify gear to reduce efficiency, but would not be required to do so. Since regulatory gear requirements would be relaxed, fishers could also develop gear to more efficiently take a particular species. As a bycatch and bycatch mortality reduction tool, a rank of 1 (highest) on a scale of 1 - 3 was assigned to the approach used in this alternative, because gear innovation would be facilitated and encouraged by the economic incentives for vessels to achieve optimal bycatch rates.

*Effects on Overfished Groundfish* Gear modification would be facilitated, allowing fishers to experiment with different methods to reduce bycatch of overfished shelf rockfish species. Strict caps and a robust catch monitoring system would allow relaxation of the EFP process normally required for modified gear. To the degree gear modifications were successful, this alternative may have a positive direct effect of reducing bycatch and bycatch mortality of overfished species. A more likely scenario is a reduction in bycatch due to higher retention rates, as fishers by and sell RSQ shares to develop selective fishing strategies that allow more access to other groundfish..

*Effects on Emphasis Species* Gear regulation would be more flexible, allowing experimentation and modification to reduce bycatch and bycatch mortality of overfished species. The impact of such modifications on other groundfish is unknown.

**Effects of Time/Area Management under Alternative 5**: Time/Area management would be based more on need to protect sensitive species, to protect essential fish habitat, and protect other benthic animals such as corals and other invertebrates. In order to accomplish this, the alternative proposes closures of areas to groundfish gears that make bottom contact. The method this tool is used in Alternative 5 is ranked 2 on a scale of 1-3 for its effectiveness in reducing bycatch and bycatch mortality of demersal bottom dwelling species, as compared to the alternatives.

*Effects on Overfished Groundfish* The cowcod conservation areas would remain in effect to accomplish rebuilding. The GCAs established to conserve other overfished shelf species would also remain in effect, minimizing bycatch and bycatch mortality within those areas. Fishing with midwater trawl gear for Pacific whiting and widow rockfish would be allowed within the GCAs, the same as under Alternatives 1-4. Some reduction in the catch, bycatch and bycatch mortality of Pacific whiting and widow rockfish would continue to result from restrictions on bottom trawls and other gears in the GCAs.

*Effects on Emphasis Species* The anticipated effects would be similar to those for overfished species; some reduction in the catch, bycatch and bycatch mortality of non-overfished groundfish would continue to result from restrictions on bottom trawls and other gears in the GCAs.

**Effects of Capacity Reduction under Alternative 5**: No direct reduction in capacity is applied under this alternative. Some level of fleet consolidation would occur as market forces would favor more efficient vessels. Thus, capacity reduction would be an indirect effect of this approach rather than an intentional or specified result. However, capacity reduction would occur in all sectors, not just the trawl fleet as in Alternative 2. Therefore, this tool is ranked 1 on a scale of 1-3.

*Effects on Overfished Groundfish* Some capacity reduction may occur if vessel owners sell RSQ and IFQ shares and elect to fish in a non-groundfish fishery. Capacity reduction accomplished through RSQ and IFQ sales could have a positive direct reducing bycatch of overfished species. Some vessel owners may also choose to fish in other fisheries and hold onto RSQ and IFQ shares. To the degree shares were unused, catch, bycatch, and bycatch mortality would be reduced.

*Effects on Emphasis Species* See discussion above.

**Effects of Data Reporting, Record-keeping, and Monitoring under Alternative 5**: Alternative 5 would require 100% observer coverage of all limited entry commercial vessels and increased monitoring of other groundfish fisheries.

Under Alternative 5, observer coverage would be redesigned to ensure that each commercial limited entry vessel's bycatch of overfished groundfish species is accurately assessed and recorded, with results available for management purposes inseason. Logbooks would not be required or used. Vessels reaching any catch limit of overfished species (or other restricted species catch limit) would be required to stop fishing until they obtain additional quota. This would be until the beginning of the next year unless they purchased quota from a shareholder. A program to monitor quota transfers would be required.

The catch reporting, record keeping, and monitoring program established by Alternative 5 would be substantially more robust than Alternatives 1, 2, 3 and 4, as every limited entry vessel would be observed and monitoring of other sectors would be increased substantially. This would have a direct effect of reducing encounter/bycatch of overfished species compared to the first four alternatives. Discard/bycatch would also be reduced in the commercial fishery compared to the first four alternatives as fishers would be required to retain all overfished groundfish and more likely to retain catches of all usable fish, since all fish would count towards their individual quotas. This tool is ranked 1 (most effective) on a scale of 1 - 5 for its incentive to avoid catching unwanted fish and 2 for reducing discard/bycatch.

Table 4.3.10. Effects of bycatch mitigation tools as applied in Alternative 5. Relative rank of the tools used to reduce bycatch and bycatch mortality. Overfished species in bold and emphasis species in italic. Species below MSY and subject to precautionary management are noted with (p).

| Environment | Species | ABC/OY | Performance standard and OY reserves | Trip Limits | Catch limits | Retention requirement | Gear restrictions | Capacity reduction | Time/area management | Monitoring program |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Yes with OY reserve | None | Individual vessel RSQ and IFQs | Retain overfished | Flexible | RSQ & IFQ sales | Areas closed to bottom fishing | 100% Observer coverage commercial and CPFV, Inseason est. |
| Northern Shelf | **Canary rockfish** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| | **Lingcod** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| | **Yelloweye rockfish** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| | *Yellowtail rockfish* | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| | *Arrowtooth flounder* | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| | *English sole* | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| | *Petrale sole* | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| Southern Shelf | **Boccacio** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| | **Cowcod** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| | *Chilipepper* | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| Slope | **Darkblotched rockfish** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| | **Pacific Ocean Perch** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| | *Dover sole (p)* | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| | *Sablefish (p)* | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| | *Shortspine thornyhead (p)* | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| | *Longspine thornyhead* | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| Pelagic | **Widow rockfish** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| | *Pacific whiting (incl.discard)* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| Nearshore | *Black rockfish* | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 |
| | *Cabezon* | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 |
| | **Scale** | 1 | 1 to 3 | 1 to 4 | 1 to 4 | 1 to 2 | 1 to 3 | 1 to 3 | 1 to 3 | 1 to 5 |

### 4.3.1.6 Impacts of Alternative 6 (No-take Reserves, Individual Catch Quotas, and Full Retention)

*Summary* The policy goal of this alternative is to reduce bycatch to near zero by establishing large no-take reserves in areas where overfished groundfish are most likely to be encountered, prohibiting discard of most groundfish, and accurately accounting for all catch. This alternative reduces bycatch and bycatch mortality by direct controls on catch, effort, and gear efficiency.

This alternative supports Council objectives for protecting and rebuilding depleted groundfish stocks, but at higher cost for monitoring than *status quo*.

*Tools Used* The following mix of management measures are applied to create Alternative 6. Tool ranks are summarized in Table 4.3.11.

Table 4.3.11. Summary of bycatch mitigation tools as applied in Alternative 6.

| |
|---|
| **Harvest Levels** ABCs/OYs same as Alternative 1; allocations of catch shares to eligible vessels |
| **Vessel trip limits** Not used for limited entry, with possible exceptions for small vessels. For open access, possible continued use. |
| **Vessel catch limits** Vessel allocations are catch limits; transferable; extensive discard prohibitions |
| **Gear regulations** Tighter regulations, gear certifications required. |
| **Time/area management** Greater use of area closures (MPAs and reserves) |
| **Capacity reduction** None specified; fleet reduction expected to result from IQ program |
| **Data reporting, record-keeping, and monitoring** Full coverage of all commercial groundfish vessels; increased monitoring of open access and recreational sectors |

- Harvest Levels OYs would remain the same as in Alternatives 1-5, however the limited entry portion of OYs would be allocated among limited entry vessels as overfished species catch limits (RSQs) and IFQs for non-overfished species. Monitoring of the limited entry fleet would be vessel-by-vessel; monitoring would be substantially increased for the open access and recreational fisheries. If a sector (recreational, open access or limited entry) reached its allocation, that fishery would be closed or severely curtailed to protect the other fisheries. If a species overall OY were reached, further fishing would be prohibited or severely curtailed to prevent overfishing. A portion of the OYs of various species would be reserved for vessels with the

lowest catches or catch ratios of overfished species. Any unused OY would be made available to those vessels that had not taken their overfished species allotment.

- Vessel trip limits Vessel trip limits would be relaxed or absent, as each vessel would have individual caps for overfished and other groundfish species.
- Vessel Catch Limits Individual vessel caps in the form of RSQs for overfished stocks and IFQs for other groundfish would be established. All groundfish would be retained. Thus, groundfish bycatch (discard) would be near zero.
- Gear Regulations Gear regulation would be actively used to reduce bycatch and bycatch mortality. The use of gears that produce higher bycatch rates or overfished groundfish or other marine species would be phased out. Fishers would be required to adopt gear modifications, use only certified gear types, and/or adopt approved fishing strategies that have been certified to minimize the impacts on marine species and the physical environment. Increased groundfish retention requirements would stimulate vessels to develop gear modifications and fishing strategies that avoid capture of undersized and overfished groundfish.
- Time/Area Closures would take the form of large permanent or semi-permanent no-take marine reserves. The placement and size may differ significantly from the other alternatives. For purposes of this analysis, we assume reserves would be patterned after Option 3a of the Council's Phase I Technical Analysis of marine reserves (PFMC 2001). This type of reserve would be tailored to protect overfished species and would set aside 20% of the habitat or biomass with a similar reduction in harvest of the species. Marine reserves would directly reduce bycatch and bycatch mortality of all fish within the closed area. The amount of reduction in bycatch and bycatch mortality resulting from a reserve would be in proportion to the proportion of a species' habitat set aside compared to the total amount of habitat vulnerable to fishing. This would vary depending on the species protected and design of the reserve. The 100% retention requirement would still be the primary means of reducing bycatch outside of reserves.
- Capacity Reduction No direct reduction in capacity is considered under this alternative.
- Data Reporting, Record-keeping, and Monitoring Full (100%) observer coverage and near 100% retention of all groundfish would be required for all limited entry vessels. Sampling/monitoring of the recreational and open access fisheries would be substantially increased under this alternative. Real-time catch reporting would be developed to ensure each fishery stays within its designated catch limits.

*Summary of Impacts on Groundfish* Effects of tools used in Alternative 6 on reducing groundfish bycatch, bycatch mortality, and increasing accountability are ranked and summarized in Table 4.3.12. Effects are ranked in comparison to the other alternatives. Lower numbers indicate a greater effect.

Overfished groundfish OYs for overfished species would be allocated between limited entry, open access, and recreational fisheries as under the other six alternatives. The limited entry allocation would be further subdivided and allocated among all vessels as individual restricted species catch limits (RSQs). Each sector would be closed upon reaching its allocation; all sectors would be closed or severely curtailed if the OY for an overfished species were reached. This would effectively keep catches from exceeding the most constraining specified OYs. Catches of other overfished stocks would likely be below their OYs, being constrained by the most constraining stock. Individual shares of canary rockfish and bocaccio would be very small, perhaps substantially less than 100 pounds per year, resulting in severely limited fishing opportunity for many vessels. Many vessels would attempt to purchase additional quota to pursue whatever they perceive to be their best fishing strategies. Large no-take reserves would reduce the likelihood of encountering overfished species, but unless the closed areas covered a species' entire range, encounter/bycatch would occur in open areas, although at a lower rate.

Non-certified gears would be phased out; only those gears certified as low-bycatch or low-impact would be allowed. Such restrictions would likely reduce catch and bycatch of overfished species. No-take reserves would eliminate all fishing for groundfish inside the reserves, reducing bycatch of overfished species and minimizing impact to overfished species habitats.

Unobserved recreational trips would be the primary source of overfished species bycatch.

Emphasis Species The overall harvest policies of Alternative 6 would be the same as the other six alternatives. Limited entry allocations would be subdivided into individual annual vessel catch quotas, which may be larger than the trip limits in Alternatives 1-4 but the same as the IFQs in Alternative 5. Any sector reaching its allocation of a non-overfished species would be curtailed or closed, depending on the species and whether other sectors' allocations were threatened. Any unused allocations would be made available to those vessels that had not taken their overfished species allotments. IFQ shares would have effects similar to Alternative 5. However, the establishment of large no-take reserves more restrictive gear requirements could make it more difficult for vessels to take their IFQs. Also, the most constraining RSQ limits (for canary and bocaccio rockfish) would increase the likelihood that substantial amounts of target species quotas would not be taken. This alternative differs from Alternative 5 in that all groundfish must be retained (only overfished groundfish must be retained in Alternative 5). The primary direct effects of this alternative would be reduced groundfish discard/bycatch and likely reduced catches and catch rates of many target groundfish species as well. The no-take reserves and gear restrictions could result in intensified fishing with certified gears and methods in open areas. Catches of all groundfish species would be eliminated within the reserve

boundaries; over time, abundance of target groundfish species could increase around the edges of reserves as fish migrate outward.

**Effects of Harvest Level Specifications under Alternative 6**: OYs would remain the same as in *status quo;* however, distributions of available OY would be broken down into caps for each fishing vessel with in-season monitoring of caps. Performance standards and OY reserves are required by this alternative. Harvest caps cannot be exceeded by individual vessels and overfished species must be retained. Shares may be purchased in order to continue fishing. This alternative ranks 1 on a scale of 1 to 3 in terms of performance standards and OY reserves.

*Overfished Groundfish* OY for overfished species would then be broken down into caps or RSQs for each fishing vessel with in-season monitoring of caps. When OY is reached, further fishing would be prohibited or severely curtailed. A reserve of various species would be set aside for vessels with the lowest catches or catch ratios of overfished species. Any unused OY would be made available to those vessels that had not taken their overfished species allotment.

The impacts of application of this tool within Alternative 6 is similar to the impacts described under Alternative 5. Small individual shares of RSQ for some species like canary rockfish and bocaccio would have to be purchased and sold to consolidate enough share to fish under certain strategies. The primary direct effect of this alternative would be reductions in bycatch due to strict caps and 100% retention of all groundfish. Thus, overfished species bycatch (discarded catch) should be near zero with this alternative due to the 100% retention requirement. Unobserved recreational trips would be the primary source of overfished species bycatch.

*Emphasis Species* Objectives for optimum yield would remain the same as under *status quo.* OY for overfished species only would then be broken down into caps for each fishing vessel with inseason monitoring of caps. When OY is reached, further fishing would be prohibited or severely curtailed. A reserve of various species would be set aside for vessels with the lowest catches or catch ratios of overfished species. Any unused OY would be made available to those vessels that had not taken their overfished species allotment. Tradable IFQ shares would have impacts similar to Alternative 5 in that shares are likely to be bought and sold to consolidate fishing strategies. This alternative differs from Alternative 5 in that all groundfish must be retained. The primary direct effect of this Alternative would be reductions in bycatch due to strict caps and 100% retention of all groundfish

**Effects of Trip Limits under Alternative 6**: Vessel trip limits would be relaxed or absent, as each vessel would have individual RSQ and IFQ caps on groundfish. Essentially the trip limit would take the form of an individual vessel annual quota.

Because trip limits would not be used, the application of this tool is given a rank of 1 (most effective).

*Overfished Groundfish* Vessel trip limits would be relaxed or absent, because each vessel would have an RSQ on overfished species. Direct effects expected under this alternative compared to status quo would be a reduction in regulatory induced discard of overfished species due to relaxed trip limits and a 100% retention requirement.

*Emphasis Species* Vessel trip limits would be relaxed or absent, because each vessel would have an individual cap on other groundfish. Direct effects expected under this alternative compared to status quo would be a reduction in size related and market-induced discard of other groundfish due to the 100% retention requirement.

**Effects of Catch Limits under Alternative 6**: Individual vessel caps for overfished stocks would be established with this alternative. 100% of all groundfish would be retained. Bycatch and bycatch mortality would therefore be significantly reduced. compared to other alternatives not using individual quotas and to Alternative 5. Vessel catch limits in the form of RSQs and IFQs rank 1 (most effective) on a scale of 1 - 4.

*Overfished Groundfish* The impacts to overfished groundfish would be similar to those under Alternative 5. The 100% retention requirement and 100% observer coverage would reduce bycatch of overfished species to near zero. Regulatory induced bycatch would be eliminated. See discussion above under Alternative 5.

*Emphasis Species* Individual transferable quotas would be established for other groundfish with this alternative. This application of catch limits in this alternative be similar to Alternative 5. Impacts would be different due to the 100% retention requirement and 100% observer coverage. Bycatch of other groundfish would be near zero and regulatory and market related bycatch would be eliminated.

**Effects of Gear Restrictions under Alternative 6:** Gear restrictions would be applied more fully than under *status quo.* This application of gear restrictions is given a rank of 1 or 2 on a scale of 1 - 3. All gears would have to be certified as low bycatch or low impact under this alternative. This would effectively reduce all bycatch below Alternatives 1-4. In the short term, it would likely be more effective than Alternative 5 also, as all vessels would be required to use certified gears. In the long term, however, the incentives and flexibility to experiment with various gear modifications under Alternative 5 would likely lead to continual improvement in bycatch avoidance and minimization.

*Overfished Groundfish* Fishers would be required to fish only with gears that have been certified to reduce bycatch, and vessels must stay within RSQs. Unless opportunities for gear experimentation were provided, the best gears at reducing

bycatch might not be identified. Some unseen mortality could take the form of overfished species caught but excluded by fishing gears. The bycatch mortality of escaping fish is unknown.

*Emphasis Species* Fishers would be required to fish only with gears that have been certified to reduce bycatch, and vessels must stay within IFQs. The 100% retention requirement may be very challenging for some fishers seeking ways of selecting against unmarketable fish. For example, fishers may use a larger mesh-size to in an attempt to eliminate most of the undersized fish. Reduction of catch of unwanted fish would contribute to the reduction in bycatch. However, unseen mortality could take the form of undersized fish caught but excluded by the gear. Impacts of direct and delayed mortality of escaping fish is poorly understood.

**Effects of Time/Area Management under Alternative 6**: Time/area management would take the form of permanent or semi-permanent marine reserves. The placement and size may differ significantly from all of the other alternatives. These areas would set aside at least 20% of the habitat or biomass of the overfished species would be set aside, and that biomass available for harvest would be similarly reduced. MPAs would be more permanent than GCAs described in previous alternatives. Areas established under this alternative would be closed to all fishing. This tool ranks 1 on a scale of 1-3.

*Overfished Groundfish* Extensive habitat and species distribution mapping would be needed in order to define new boundaries for overfished species. Because there are several overfished species, the proportion of area set aside to total fishable area may be larger or smaller than 20%. Impacts will be difficult to determine until the location and composite size of these areas are determined.

No-take marine reserves directly reduce bycatch and bycatch mortality of overfished species within the closed area. The amount of reduction in bycatch and bycatch mortality of an overfished species due to a reserve would be in proportion to the amount of habitat set aside compared to the total amount of its habitat vulnerable to fishing. Movement of fish into and out of reserves may confound efforts to protect mobile/migratory species. If catch levels were not reduced, effort would likely shift to adjacent areas, increasing impacts of fishing outside the boundaries. Bycatch and bycatch mortality could increase unless catch were reduced in proportion the area set aside.

Studies of groundfish trawl fishery of the coast of British Columbia suggest fishing changes species composition and spatial structure of the fishery. Movement of trawlers through redistribution of effort and fish movement appears to reduce vulnerability (Walters and Bonfil 1999). The authors suggested use of individual effort quotas (rather than catch) and use of carefully placed protected areas to protect sensitive stocks.

Impacts of various MPA and no-take reserve options for bocaccio, Pacific ocean perch, and lingcod are described in the Phase I Council report on marine reserves (PFMC 2001). Reserves appear to reduce rebuilding time, similar to that which could be achieved by reducing the exploitation rate. An additional benefit would be reduced habitat impacts. Some loss of fishing opportunity would occur with reserves that included a reduced harvest rate (option 3a in the Phase I document).

The 100% retention requirement would still be the primary means of reducing overfished species bycatch. Some indirect benefits to the overfished species would likely occur due to reduced disturbance of habitat afforded by a no-take reserve.

*Emphasis Species* Time/area management would include establishment of permanent or semi-permanent no-take marine reserves. The placement and size may differ significantly from all of the other alternatives. Such reserves would directly reduce bycatch and bycatch mortality of other groundfish species within the closed area. The amount of reduction in bycatch of any particular groundfish species due to a no-take reserve would be in proportion to the vulnerable population inside and outside the boundaries.

The 100% retention requirement would be the primary means of reducing discard/bycatch outside of marine reserves.

**Effects of Capacity Reduction under Alternative 6:** No direct reduction in capacity is applied under Alternative 6. Some level of fleet consolidation would occur as market forces would favor more efficient vessels. Thus, capacity reduction would be an indirect effect of this approach rather than an intentional or specified result. However, capacity reduction would occur in all sectors, not just the trawl fleet as in Alternative 2. Therefore, this tool is ranked 1 on a scale of 1 to 3.

*Effects on Overfished Groundfish* Some capacity reduction may occur if vessel owners sell RSQ and IFQ shares and elect to fish in a non-groundfish fishery. Capacity reduction accomplished through RSQ and IFQ sales could have a positive direct reducing bycatch of overfished species. Some vessel owners may also chose to fish in other fisheries and hold onto RSQ and IFQ shares. To the degree shares were unused, catch, bycatch, and bycatch mortality would be reduced.

*Effects on Emphasis Species* See discussion above.

**Effects of Data Reporting, Record-keeping, and Monitoring under Alternative 6:** Alternative 6 would require 100% observer coverage of all commercial groundfish vessels and increased monitoring of recreational groundfish fisheries. Under Alternative 6, observer coverage would be redesigned to ensure that each commercial vessel's bycatch of overfished

groundfish species is accurately assessed and recorded, with records available almost immediately for management purposes. Logbooks would not be required or used. Vessels reaching any catch limit of overfished species (or other restricted species catch limit) would be required to stop fishing until they obtain additional quota. This would be until the beginning of the next year unless they purchased quota from another shareholder. A program to monitor quota transfers would be required.

The catch reporting, record keeping, and monitoring program established by Alternative 6 would be similar to Alternative 5 with increased monitoring of open access and recreational sectors. This would have a direct effect of reducing encounter/ bycatch of overfished species compared to the Alternatives 1-4. Discard/bycatch would also be reduced in the commercial fisheries as fishers would be required to retain nearly all groundfish and all fish would count towards their individual catch limits. This tool is ranked 1 (most effective) on a scale of 1 - 5 for its effectiveness in reducing groundfish bycatch.

Table 4.3.12. Effects of bycatch mitigation tools as applied in Alternative 6. Relative rank of the tools used to reduce bycatch and bycatch mortality. Overfished species in bold and emphasis species in italic. Species below MSY and subject to precautionary management are noted with (p).

| Environment | Species | ABC/OY | Performance standard and OY reserves | Trip limits | Catch limits | Retention requirement | Gear restrictions | Capacity reduction | Time/area management | Monitoring program |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Yes, with OY reserve | Relaxed | Individual vessel RSQ and IFQs | Retain all groundfish | Yes | RSQ & IFQ sales | Areas closed to all groundfish fishing | 100% Observer coverage commercial and CPFV, in-season est. |
| Northern Shelf | **Canary rockfish** | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| | **Lingcod** | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| | **Yelloweye rockfish** | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| | *Yellowtail rockfish* | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| | *Arrowtooth flounder* | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| | *English sole* | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| | *Petrale sole* | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| Southern Shelf | **Boccacio** | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| | **Cowcod** | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| | *Chilipepper* | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| Slope | **Darkblotched rockfish** | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| | **Pacific Ocean Perch** | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| | *Dover sole (p)* | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| | *Sablefish (p)* | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| | *Shortspine thornyhead (p)* | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| | *Longspine thornyhead* | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| Pelagic | **Widow rockfish** | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| | *Pacific whiting (incl.discard)* | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| Nearshore | *Black rockfish* | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| | *Cabezon* | 1 | 1 | 1 | 1 | 1 | 1-2 | 1 | 1 | 1 |
| | **Scale** | 1 | 1 to 3 | 1 to 4 | 1 to 4 | 1 to 2 | 1 to 3 | 1 to 3 | 1 to 3 | 1 to 5 |

### 4.3.1.7 Impacts of Alternative 7 (*Preferred* - Sector and vessel catch limits, future IFQ)

*Summary* The policy goal of this alternative is to reduce bycatch by setting annual catch limits for the various fishery sectors and then rewarding those sectors with the least bycatch. Fishery sectors would become the primary management unit, with overfished species mortality limits set for each sector. Landings of target species by each sector would be monitored through the season; bycatch species catch amounts would be estimated based on the bycatch model co-occurrence rates. Over the next several years, the Council will move to creating the necessary inseason catch/bycatch monitoring infrastructure. Initially, this would include revising the PacFIN inseason tracking system (called quota species monitoring or QSM). The observer program would also be expanded so that each sector's progress towards its limits could be directly determined quickly during the season (rather than estimated based on target species). The definition of "trip limit" would be revised to include catch limits, which would refer to a species mortality limit as opposed to a retention limit. Initially, catch limits would likely be established for overfished groundfish stocks; over time, as the monitoring infrastructure comes online, additional species would likely be added. Ultimately, individual fishing quotas or *DEDICATED ACCESS PRIVILEGES* would be established for those sectors and vessels as the Council deems appropriate. Vessel catch limits would be established for vessels that carry an observer at the vessel's expense, would be set for each two-month period (or other amount of time), and would expire at the end of each period (just as trip limits expire). Trip (retention) limits for non-overfished groundfish may be used in combination with vessel catch limits. Vessels with catch limits may have larger trip limits for non-overfished species than vessels without observers. A fishing sector would be closed when any catch limit for that sector is reached or projected to be reached. Other sectors would continue fishing unless an overall OY were reached.

Vessel catch limits are expected to be an incentive to carry observers, because eligible vessels would get a guaranteed portion of the sector allocations and be eligible for larger trip limits. These catch limits would enable the vessel to alter its strategy and gear to stay within the cap without the risk of being closed by other vessels' high bycatch rates. This could be especially important if sectors are large and include diverse fishing strategies. For example, vessels predominantly fishing deepwater species (e.g., DTS complex) may want not to be lumped with vessels fishing nearshore flatfish. It is important to recognize that sectors may not be limited entry units; that is, once a sector is closed a vessel having permits to fish within another open sector may be free to do so.

This alternative supports Council objectives of preventing overfishing, rebuilding overfished stocks, maintaining a year-round fishing season, and increasing individual and group accountability for their groundfish catches. Fishery monitoring would be increased over Alternatives 1through 4; monitoring costs would be higher.

*Tools Used* The bycatch mitigation tools summarized in Table 4.3.13. are combined to create Alternative 7.

Table 4.3.13. Summary of bycatch mitigation tools as applied in Alternative 7.

| |
|---|
| **Harvest Levels** ABCs/OYs same as Alternative 1; sector allocations established |
| **Vessel trip limits** Used; similar to Alternative 4 and applied by sector. Larger trip limits for vessels with catch limits and observers. |
| **Vessel catch limits** Used for vessels that pay for observers; support for future development of IFQ programs, as appropriate. |
| **Gear regulations** Similar to Alternative 1, but may be relaxed for vessels with catch limits and observers. |
| **Time/area management** Generally similar to Alternative 1, with limited exemptions for vessels with catch limits and observers |
| **Capacity reduction** Same as Alt 1; moving towards Strategic Plan capacity goals and supporting future development of dedicated access privileges/IFQs. |
| **Data reporting, record-keeping, and monitoring** Similar to Alt 1, but more coverage expected due to incentives for vessels to pay for (additional) observers |

- Harvest Levels, Including Sector Caps (harvest policy, rebuilding) Overall objectives for optimum yield and rebuilding would remain the same as in Alternatives 1-6. The harvest policy would be modified from the Alternatives 1-3, 5 and 6 in that OYs for overfished species (and/or other designated species) would be subdivided and allocated to each fishery sector (the same as in Alternative 4). These allocations would be total mortality limits for the designated species. Each sector would be monitored separately throughout the season for its progress towards those allocations. When a sector reaches (or is projected to reach) any catch mortality allocation, all fishing by that sector will be closed. Harvest guidelines for other species also may be established if the Council believes they will help minimize bycatch to the extent practicable.

  Broad fishery sectors would be specified initially: limited entry bottom trawl, limited entry fixed gear, three limited entry whiting sectors, open access, and Tribal fisheries. Sectors could be defined by target fishery, by gear, or other criteria. Depending on how they are defined, sectors could be open to any eligible vessels, with free movement in and out, or they could be closed. They could be voluntary sectors or they could be defined by a permit or endorsement. Because several overfished stocks show geographic variation

north to south, the non-whiting sectors could be further subdivided, for example north and south of Cape Mendocino at 40°10' N. latitude. A portion of any OY could be set aside in reserve for the fishery sector or sectors with the lowest bycatch to provide further incentive to reduce bycatch or bycatch rates. When a sector reaches any species mortality cap, all vessels in the sector must stop fishing. (Depending on how sectors are defined, regulations could define whether this would mean stop all fishing for groundfish, stop fishing with a particular gear or for a particular target species, stop fishing in an area, continue fishing only with a bycatch reduction device, etc.) If a sector reached a guideline for a non-overfished species, the Council would evaluate whether vessels may continue fishing along with other sectors. Reaching an OY for any species would result in closing all sectors that take that species.

- Vessel trip limits Vessel trip limits would be established and adjusted sector-by-sector to reflect the number of vessels participating in the sector and its allocations. Some trip limits might initially be similar to those under Alternative 1, based on previously observed joint catch ratios of overfished and co-occurring groundfish species. In the long term, catch/bycatch data on a sector-by-sector basis would be available inseason; in the short term, there will probably be little or no change.
- Catch Limits Catch limits may be included in the definition of "trip limit," referring to a one- or two-month period, or defined separately as a period or annual vessel limit. Catch limits could be applied sector by sector for any species, but initially would likely refer to overfished groundfish or other species needing bycatch reduction. Catch limits would require some method of verification, such as on-board observers, which may limit their application to very small limited entry vessels and open access vessels. Vessels may choose to carry an observer at the vessel's expense in order to receive vessel catch limits, which would exempt the vessel from a sector allocation. Vessek catch limits may be the same for all vessels or may vary depending on fishing strategy; they may be increased in conjunction with an EFP, for research activities, or other specified purpose. As with trip limits, these catch limits would not be transferable and would expire at the end of each period. That is, they could not be carried over to the next period, unless specified. In contrast to trip limits, a vessel must stop fishing when it reaches any restricted species catch limit for the remainder of the period. In contrast, when an annual sector cap is reached or projected to be reached, all vessels in that sector must stop fishing for the remainder of the year or until allowed to start again.

  Individual vessel catch limits would be expected to greatly increase the incentive to avoid catching overfished groundfish and to retain all usable fish. They could also provide exemption from other restrictions and/or be used in conjunction with larger trip limits for healthy stocks. In the future, they could provide a basis for IFQs.
- Gear Regulations Gear regulations under this alternative would be the same or similar to Alternative 1, and would be structured to keep catches within the

OY limits for overfished species. If gear improvements and bycatch reduction methods are identified, they could be required for all vessels in a sector. Vessels that carry an observer at their own expense and operate under catch limits may be granted exemption from certain gear regulations.

- Time/Area Management Initially, time and area closures would be similar to those under Alternatives 1 - 4, with boundaries based on the previously observed catch ratios of various groundfish species. However, vessels with bycatch caps (catch limits) and on-board catch/bycatch monitors may be able to achieve the groundfish bycatch minimization goals without such closed areas. Therefore, exemption from certain GCA restrictions may be authorized for observed vessels.[8/] This alternative may allow changes in RCA boundaries based on more extensive monitoring data, because the observer program would likely be more finely stratified than under the *status quo*. Reduction in the extent of the current GCAs would be intended not to allow increased catch/bycatch of overfished species, but could result in bycatch of other species.
- Capacity Reduction Further capacity reduction is not included in this alternative until and unless dedicated access privileges are developed. The Council has indicated its intention to consider IFQs.
- Data Reporting, Record-keeping, and Monitoring This alternative would establish a more robust catch reporting, record keeping, and monitoring program than Alternative 1-3. Logbook coverage would be the same as under the no action alternative. To make Alternative 7 distinguishable from the no action alternative, the observer program would be augmented and the sampling plan revised to monitor each sector. The necessary differences include monitoring a subset of vessels within each sector and providing observer data inseason for management purposes. For vessel catch limits (caps) to be fully functional, each vessel would have to be observed. In the short term, incidental catch rates of observed vessels would be tabulated annually and expanded to non-observed vessels of the sector. Each sector's bycatch rates used in the bycatch model would be updated annually, and management measures for each sector revised according to the FMP procedures. Unanticipated changes in catch and/or bycatch rates could result in any sector exceeding an allocation in a year (just as under the status quo and Alternatives 2, 3 and 4; this would be discovered in a retrospective analysis). Corrective action would be taken when updated data and analysis become available. In the longer term, sectors would be managed based on current year observations and the risk of sector overage would be reduced.

  Vessels could voluntarily pay for and carry an observer in order to have access to higher trip limits. This would exempt the vessel from sector

[8/]However, future time/area restrictions could be established for non-groundfish species or essential fish habitat (EFH) reasons as the observation database improves over the years.

allocations and other specified restrictions. The vessel would agree to stop fishing when data indicate it has reached its vessel catch limit.

In order to protect each sector's allocations, each sector's catch and bycatch would need to be monitored adequately. Therefore, recreational sampling also would be increased.

*Impacts on Groundfish* The effects of the tools and tool applications used to reduce groundfish bycatch, bycatch mortality, and to increase individual and sector accountability in Alternative 7 are ranked and summarized in Table 4.3.14. Effects are ranked in comparison to the other alternatives. Lower numbers indicate a greater effect.

Effects on Overfished Groundfish Under Alternative 7, overfished species would be allocated as species mortality caps for each fishing sector. A subset of vessels in each sector would be observed and catch/bycatch rates expanded to unobserved vessels. In the long term, this data would be available inseason. Within each sector, overfished species catch limits would be assigned to each vessel that carries an observer at its own expense. When a vessel reaches an RSC, it would be required to cease fishing. When a sector cap is reached or projected to be reached, all vessels in that sector must stop fishing. Vessels that provide observer coverage at their own expense would have access to larger limits of target species and be guaranteed a portion of a restricted species sector cap. A vessel catch limit would be the equivalent of a non-transferable IQ. Full observer coverage would ensure success of this part of the bycatch mitigation program. The primary direct effect of this alternative would be reductions in bycatch of overfished species due to strict caps, individual vessel catch limits, and monitoring of these species. It is likely that bocaccio and canary rockfish will present the biggest challenge to sectors because of their wide distributions and susceptibility to diverse gears. Much of the current focus of the groundfish management program is to reduce and maintain harvest levels for these two species below their OYs. Catches of many species (both overfished and healthy stocks) are likely to remain below their OYs largely due to fishing constraints for canary rockfish and bocaccio. Thus, impacts of trip limits and catch limits on the various species would differ. Bycatch reduction benefits to overfished species with catch limits would be greater than to other emphasis groundfish species (see below).

Some researchers and analysts have questioned whether incentives work on a fishery sector basis. For example, Huppert *et al.* (1992) suggested that sector-based incentive systems tend to penalize those participants who adopt methods of reducing bycatch of prohibited species because those efforts may also reduce their catch of target species. However, sector-based incentive programs may work well for relatively small and homogeneous sectors, such as co-operatives. For example, the at-sea whiting sectors actively share each vessel's daily catch and bycatch information in order to minimize their bycatch of salmon and rockfish species. In larger or more diverse sectors, individual vessel catch limits would be

expected to more effectively minimize bycatch. However, due to the need for full observer coverage, this approach may not be practicable, at least until a sufficient monitoring infrastructure has been established. On the other hand, individual vessel catch limits (for overfished groundfish species), coupled with larger cumulative trip limits of non-overfished species, could provide a mechanism for some vessels to generate enough revenues to pay the increased costs of full observer coverage.

The limited entry fixed gear fleet might be successful in limiting bycatch of certain non-target species of concern (halibut, lingcod, and overfished rockfish), because the catch of those species is relatively small, fishing methods relatively selective, and the allocation program provides a long fishing season. In contrast, the recreational sector is large and diverse, and identification of effective bycatch reduction incentives will be problematic. Thus, other means of controlling this sector's bycatch would likely be necessary.

The intent of sector allocations would be to minimize, to the extent practicable, bycatch rates of the entire sector. The best result would be for all vessels in each sector to minimize their individual bycatch rates. To the extent bycatch rates of overfished stocks are minimized, cumulative trip limits for other species taken by the sector could be increased; larger trip limits tend to result in lower regulatory bycatch. To achieve this desired result, individual vessels must have both incentive and opportunity to improve their bycatch avoidance methods and to share this information with other vessels in the sector.

Impacts of well-monitored vessel catch limit and sector cap program would be similar to Alternative 5.

Effects on Emphasis Species Effects on emphasized groundfish species and other emphasis species are difficult to predict. However, negative effects of bycatch should decline over time. In the short term, impacts could increase if vessels move into areas of higher abundance of emphasis species, or use methods that increase bycatch rates of those species. Close monitoring of sector caps could further constrain harvest of co-occurring (non-overfished) groundfish, especially if unobserved participants in a sector did not apply bycatch reducing fishing tactics. Early closure (and thus reduced fishing effort) could result from early attainment of sector caps or vessel catch limits. If the result is less harvest of other (healthy) groundfish, this catch/bycatch mortality reduction would be at the expense of lost economic opportunity. On the other hand, incentives, in the form of larger trip limits for observed vessels, and possible access to a reserve later in the year, may change enough of each sector's fishing practices to reduce bycatch of overfished species and increase catch of other groundfish.

Sector harvest guidelines rank lower than catch limits for their effectiveness in reducing bycatch (See shaded boxes under "Trip Limits" and "Catch Limits" columns in Table 4.3.14).

Trip (retention) limits would likely be increased if vessel catch limits, sector caps, incentives and gear modifications effectively minimize bycatch of overfished species. This could include increased access to those non-overfished groundfish with higher market value or demand. Regulatory bycatch may be reduced for some species such as Dover sole, shortspine thornyhead, sablefish, and yellowtail rockfish. However, larger trip limits are less likely to reduce economic bycatch of species that are constrained by market limits (some flatfishes and chilipepper rockfish, for example) rather than regulatory limits.

**Effects of Harvest Levels under Alternative 7**: Objectives for optimum yield and rebuilding would remain the same as in s*tatus quo.* Harvest policy would be modified from *status quo* in that OYs would be subdivided into caps allocated to each fishing sector with in-season monitoring of caps. Performance standards and sector allocations with OY reserves should have a significant effect, reducing potential bycatch and bycatch mortality compared to Alternatives 1-3. This tool, as used in Alternative 7, is ranked 2 (highly effective) on a scale of 1- 3 (where 1 is the most effective and 3 is the least effective at reducing bycatch and bycatch mortality).

*Effects on Overfished Groundfish* Under this alternative, overfished species OYs would be subdivided and allocated as species mortality limits for each fishing sector. By more finely subdividing OYs and managing each sector separately, there is greater potential to prevent overfishing of any overfished species, or at least mitigating the extent of overfishing. Improved monitoring over the long term will provide information for improved bycatch mitigation. Augmentation of inseason observer data would be necessary to achieve this result.

When a sector allocation (cap) is reached, further fishing by that sector would be prohibited or severely curtailed. (Reaching an OY would result in closure of all fishing that takes that species.) A portion of an OY or OYs could be set aside in reserve for each fishery sector or individual vessels that achieve bycatch minimization standards. Implementation details would be developed along with more detailed analysis at some time in the future.

Successful implementation of a sector cap program could result in reduced bycatch of overfished species. It is likely that canary rockfish and bocaccio will present the biggest challenge to most sectors because current harvest levels are very near the OYs. Catch of other many other groundfish species are below OY largely due to fishing constraints caused by these two species.

*Effects on Emphasis Species* Close monitoring of sector caps for overfished species could further constrain harvest of co-occurring other groundfish, especially if sector participants ignored incentives and did not apply bycatch reducing fishing tactics. A reduction in effort could result from early attainment of overfished species sector caps. The direct impact of sector caps may include reduced harvest of other groundfish, thus reducing bycatch and bycatch mortality

at the expense of lost economic opportunity. On the other hand, incentives, in the form of additional OY for the fishing sector may change enough of the sectors' fishing practices to reduce bycatch of overfished species and increase catch of other groundfish. If bycatch is proportional to catch, bycatch and bycatch mortality may increase for other groundfish.

**Effects of Vessel Trip Limits under Alternative 7**: To the degree that trip limits may be increased for some species, regulatory bycatch and bycatch mortality of those species may be reduced. This tool ranks 2 (highly effective) for species that currently are restricted by small trip limits. For less-constrained species with larger trip limits, this tool ranks 3 (somewhat effective). The effectiveness scale for this tool is 1 - 4 (where 1 is the most effective and 4 is the least effective at reducing bycatch and bycatch mortality).

Vessel trip limits would initially be the same as *status quo,* and based on previously observed joint catch ratios of overfished species and various groundfish species. Trip limits for a sector might be relaxed (increased) if the sector stays within its catch caps.

*Effects on Overfished Groundfish* Vessel trip limits could be different than those under the status quo due to more careful monitoring of catch, and vessel incentives to minimize catch and bycatch of overfished species could result in inseason increases as the season progresses. To the degree that trip limits are increased, regulatory bycatch and bycatch mortality would be expected to decline. Because the basic management unit in Alternative 7 is a sector, individual vessels within a sector would likely have less incentive to avoid overfished species compared to Alternatives 5 and 6. If this holds true, the greater source of bycatch reduction for bottom trawlers would be due to increased retention rather than avoidance.

Studies of Alaska fisheries have shown that sector caps work with small identifiable fishing units, like cooperatives. The West Coast whiting fleet is organized along similar lines and appears successful at implementing voluntary caps on bycatch of prohibited species. Under Alternative 7, a widow rockfish cap for the whiting sector may be an effective approach. However, this example points out the two-edged-sword of the approach; in 2004, a single tow by one whiting vessel captured over three times the total annual catch of canary rockfish anticipated for the entire sector. That single tow would have ended the season for the entire sector. However, closing a sector of the fishery would reduce the likelihood of a greater overage during the year.

*Effects on Emphasis Species* Limit changes under this alternative are not likely to affect those species with high levels of economic bycatch. Catches of such species are typically below current trip limits, usually due to market limits. Thus, trip limit increases are less effective for these species and the tool is ranked lower than for overfished species (see shaded scores under Trip limits in Table

4.3.14). More desirable species, such as yellowtail rockfish, currently harvested below cumulative catch limits due to constraints associated with overfished species, may be more accessible if the vessel sector incentive program is successful.

**Effects of Catch Limits under Alternative 7**: Sector caps may or may not be an effective incentives for individual vessels to improve their bycatch performance. In the absence of individual vessel caps, unobserved vessels may have increased incentive to maximize revenues before a sector cap is reached. This could result in discarding all overfished species to avoid contributing to the landed catch accounting system, increased highgrading, and other changes in fishing behavior. If effectively monitored, Alternative 7 would be expected to reduce bycatch of overfished groundfish substantially. Facing the possibility of being shut down due to reaching a restricted species catch limit or sector cap, vessels would be more likely to retain all usable fish. However, this could have unintended consequences. For example, catch projections could be compromised if only target species landings are monitored and static ratios applied. Managers may not be aware of increased retention rates and would continue to apply co-occurrence rates that would be higher than the actual bycatch rates (which could be declining). Such occurrences would be discovered in retrospective analyses. Individual catch caps, increased monitoring, and larger trip limits would be expected to work towards reduced regulatory and economic bycatch. In addition, catch limits would enable relaxation of redundant restrictions (possibly including seasons and area restrictions), which could make it more profitable for vessels to truly minimize their bycatch to the extent practicable with less regulation. Only through individual performance will sector performance improve. Without incentives and opportunities for individual improvement, progress will be slow and bycatch rates could even deteriorate.

Vessel catch limits for overfished groundfish (and perhaps for other species needing bycatch reduction) would be established for limited entry vessels that carry an observer at their own expense. These caps may be different for different vessels depending on target strategy, gear, area, etc. This management tool may provide enough incentive to significantly reduce bycatch of overfished species through changes in fishing strategy and gear deployment. As with trip limits, these catch limits would not be transferable and would expire at the end of each period. That is, they could not be carried over to the next period. In contrast to IQs, they could not be bought and sold as needed, resulting in greater economic efficiency. In contrast to trip limits, when a vessel reaches any catch limit, it must stop fishing until the next period begins.

One possible variation of sector caps and vessel catch limits could be for smaller groups of vessels to form cooperatives, pooling their individual catch limits so as to spread the risk of reaching any limit. This could be particularly effective for vessels that conscientiously strive to minimize their bycatch and are willing to experiment and cooperate to achieve optimum results.

This tool is ranked 2 (highly effective) for overfished species and some emphasis species and 3 (somewhat effective) for others on a scale of 1 to 4 (where 1 is the most effective and 4 is the least effective at reducing bycatch and bycatch mortality). However, due to the higher costs of full observer coverage (both to vessels and to the management agencies), this approach to minimizing bycatch may not be practicable, especially in the short term. If the observer program can be augmented over time, and vessel revenues improved to enable them to pay for all or part of observer costs, this approach may become practicable.

*Effects on Overfished Groundfish* The increased incentive to avoid catching overfished groundfish and the increased incentives to retain more fish under this alternative would be expected to reduce bycatch of overfished groundfish substantially. Facing the possibility of being shut down due to reaching a vessel catch limit, vessels would be likely to fish more carefully and retain more usable fish. Full monitoring would be required.

Should catch limits be transformed into IQs or dedicated access limits for individual vessels or small groups of vessels within a sector, this tool's rank would be upgraded to 1, especially if accompanied by a full retention requirement.

*Effects on Emphasis Species* The creation of vessel catch limits for overfished species, combined with larger landings limits for other emphasis species, could increase the overall harvest of some other groundfish species up to OY. Some species will continue to be limited by markets; increased retention requirements would reduce the economic discard of these species and would encourage market development. Increased limits and retention of species such as Dover sole, shortspine thornyhead, sablefish, and yellowtail rockfish may reduce regulatory bycatch of these species under Alternative 7.

**Effects of Gear Restrictions under Alternative 7 :** Under this alternative, vessels would have greater incentives to modify gear in order to reduce bycatch and bycatch mortality, due to strict caps and robust monitoring system of this alternative. Gear modifications that reduced the take of overfished rockfish outside of GCAs would have a direct beneficial impact on bycatch and bycatch mortality, compared to the first three alternatives. The fate of excluded fish is unknown. Fish interacting with and escaping fishing gear may suffer delayed mortality even though bycatch in the form of discards is reduced. This tool is ranked 2 (moderate effect) on a scale of 1 - 3 (where 1 is the most effective and 3 the least effective at reducing bycatch and bycatch mortality).

Management under Alternative 7 would include incentives to modify gear as an aid in reducing bycatch and bycatch mortality and in keeping under strict vessel catch limits and sector caps. Gear restrictions as applied under Alternative 7 are assigned a rank 2 (moderately effective) on a scale of 1 - 3 among alternatives

(where 1 is the most effective and 3 is the least effective at reducing bycatch and bycatch mortality).

*Effects on Overfished Groundfish* Gear modifications, such as the small trawl footrope requirement, have reduced the take of rockfish throughout the management area. Gear regulations that further reduce the catch of rockfish outside of GCAs would be expected to have additional direct positive impact on bycatch and bycatch mortality of overfished species, compared to the first three alternatives. Depending on the type of gear modification, some un-observed impacts may occur, leading to bycatch mortality. Little is known about the survival rates of fish escaping through meshes or escape panels. However, fish excluder devices that avoid or eliminate rockfish species provide a better opportunity for survival than sorting and discarding fish at the surface, which is generally lethal for rockfishes (see discussion under Alternative 1 *status quo* and Davis and Ryer (2003 )). Also, cut-back (selective flatfish) trawls recently tested in Oregon have been shown to be highly selective for flatfish and appear to avoid capturing some rockfish species without contacting them (Parker 2003).

It is clear that gear regulations can, in some cases, significantly reduce bycatch and/or bycatch mortality of some species. Gear restrictions are most effective when vessel operators support the bycatch objectives and develop their own modifications to optimize the effectiveness of these regulations. Under Alternative 7 sector allocations, there would be some incentive for such innovation. When combined with individual catch limits and larger trip limits there would be greater incentive and opportunity to innovate. However, this opportunity would be less than Alternative 5, where vessels would have the opportunity to acquire additional quota if an attempt failed or if and overfished species were inadvertently encountered. (Also see discussion above under **Harvest Levels**).

*Effects on Emphasis Species* Gear regulations can, in some cases, significantly reduce the catch of non-overfished species. Such gear restrictions are typically subverted, often at the expense of those species in need of bycatch reduction. Gear regulations are most effective when vessel operators understand and support the bycatch objectives and develop their own modifications to optimize the effectiveness of these regulations. The incentives provided by sector caps are limited; they may or may not prove stronger than under the no action alternative. Individual vessel catch limits, combined with larger trip limits for non-overfished species (including those emphasized here) provide greater incentive and opportunity for innovation than Alternatives 1-3 but less than Alternative 5.

This applies to economic bycatch as well as regulatory bycatch. For example, sablefish and shortspine thornyhead have often been constraining species in the DTS fishery. Bottom trawl gear and methods that selectively reduce the capture of shortspine thornyheads and small sablefish would result in increased revenues for those vessels. However, gear regulations intended to accomplish that result

can easily be subverted by unwilling fishers. Impacts to nearshore flatfish bycatch and bycatch mortality are unknown because gear changes are likely to reduce impacts to overfished species. As pointed out above, the strength of the incentives depends on changes in gear and behavior on the part of the entire sector. (See also Alternatives 5 and 6).

**Effects of Time/Area Management under Alternative 7:** Time and area closures are designed to reduce encounter rates with overfished stocks and other rockfish species. Any fishing that results in capture of rockfish will result in near 100% mortality of those fish; thus, avoidance is the most effective way to reduce bycatch mortality. Sectors that use gear and/or methods that avoid these species will have greater access to these restricted areas, other would be similar to those under *status quo*, at least in the short term, and would be based on the previously observed catch ratios of various groundfish species. Alternative 7 anticipates changes to the observer program that would improve the quality and quantity of catch and bycatch data over time. That information could provide the basis for changes to the GCA boundaries. In addition, vessels paying for their own observer coverage may be granted limited exemption from closed areas, generating additional data that would not otherwise be available. However, any differences in effects from the no action alternative are expected to be negligible, at least in the short term. Thus, time/area management as applied under Alternative 7 is given a rank of 3 (no additional effect over the *status quo*) on a scale of 1 - 3 (where 1 is the most effective and 3 is the least effective at reducing bycatch and bycatch mortality).

*Effects on Overfished Groundfish* Impacts to bycatch and bycatch mortality of overfished species would likely be the same as under *status quo*. Encounter rates with overfished shelf rockfish are greatly reduced under the no action alternative. Thus, time/area management as applied under Alternative 7 is given a rank of 3 (no additional effect over the *status quo*). However, in this the negative effects are greatly reduced from previous (pre-2002) years.

*Effects on Emphasis Species* Impacts on emphasis species would likely be the same as under *status quo.* If RCA boundaries are changed to allow more access to other groundfish, catch, bycatch, and bycatch mortality of other shelf groundfish could increase somewhat.

**Effects of Capacity Reduction under Alternative 7**: No direct reduction in capacity is applied under this alternative. Some level of fleet consolidation would occur as market forces would favor more efficient vessels. Thus, capacity reduction would be an indirect effect of this approach rather than an intentional or specified result. Therefore, this tool is ranked 2 on a scale of 1-3.

**Effects of Data Reporting, Record-keeping, and Monitoring under Alternative 7**: Higher levels of monitoring yield more complete, accurate, and

timely estimates of total catch including bycatch. Indirect benefits would include improved stock assessments and tracking of rebuilding plans.

Logbook coverage would continue to be the same as under the status quo alternative. Under Alternative 7, observer coverage would be redesigned to ensure that each sector's bycatch is accurately assessed and recorded; in the long term, results would be available for management purposes inseason. A minimum observation rate in each sector would be approximately 10%, or as determined by statistical sample design methods. Additional observer coverage is anticipated because commercial limited entry vessels will be offered incentives to pay for observer coverage. Commercial landings data and observer data would be expanded sector-by-sector to all vessels in each sector. Vessels observed to achieve any catch limit would be required to stop fishing for the remainder of the designated period. Vessels observed to stay below all catch limits would be authorized to continue fishing for additional target species; that is, larger trip limits would be available for vessels carrying observers. It may be possible to use video monitoring in conjunction with full retention and shoreside sampling to achieve the same level of catch verification.

The catch reporting, record keeping, and monitoring program established by Alternative 7 would be substantially more robust than Alternatives 1, 2 and 3. Vessel catch limits can be effective only when the vessels are fully observed. Incidental catch rates of observed vessels would be quickly tabulated and applied to non-observed vessels of the sector; data from vessels paying their own observer costs may not be applicable to vessels that remain in similar sectors. Recreational sampling would also be increased. If the observer program is upgraded to the point where catch and bycatch data are available inseason, annual/biannual OYs may be more closely achieved. If data are available only between seasons, management precision will be similar to the no action alternative, but data quality will be better. The application of this tool is ranked 2 to 3 (highly effective to moderately effective) on a scale of 1 - 5 compared to the alternatives (where 1 is the most effective and 5 is the least effective at reducing bycatch, bycatch mortality, and improving accountability).

Table 4.3.14. Effects of bycatch mitigation tools as applied in Alternative 7. Overfished species in **bold** and emphasis species in *italic* . Precautionary species management (p). Shaded areas reflect change in rank due to fisheries or species characteris

| Environment | Species | ABC/OY | Performance standard and OY reserves | Trip limits | Catch limits | Retention requirement | Gear restrictions | Capacity reduction | Time/area closures | Monitoring program |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Catch ratios-allocate fisning mortality limits to sector | Yes; larger for vessels that pay for observers | Individual vessel catch llimits for vessels that pay for observers | None | Yes | None | RCAs | >10% Observer coverage commercial and CPFV, increasing with data vailable inseason |
| Northern Shelf | **Canary rockfish** | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| | **Lingcod** | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| | **Yelloweye rockfish** | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| | *Yellowtail rockfish* | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| | *Arrowtooth flounder* | 1 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 |
| | *English sole* | 1 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 |
| | *Petrale sole* | 1 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 |
| Southern Shelf | **Boccacio** | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| | **Cowcod** | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| | *Chilipepper* | 1 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 |
| Slope | **Darkblotched rockfish** | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| | **Pacific Ocean Perch** | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| | *Dover sole (p)* | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| | *Sablefish (p)* | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| | *Shortspine thornyhead (p)* | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| | *Longspine thornyhead* | 1 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 |
| Pelagic | **Widow rockfish** | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| | *Pacific whiting (incl.discard)* | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| Nearshore | *Black rockfish* | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 2 |
| | *Cabezon* | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 2 |
| | **Range of Alternative Scores** | 1 | 1-3 | 1-4 | 1-4 | 1-2 | 1-3 | 1-3 | 1-3 | 1-5 |

### 4.3.2 Impacts on Pacific Halibut

Pacific halibut is a highly prized fish targeted by commercial, recreational and tribal fisheries along the West Coast. Directed halibut fishing is managed through a combination of gear, season, area and size restrictions. Only specified hook-and-line gear (see below) may be used to fish for halibut, and only halibut taken with hook-and-line gear may be retained. (The only exception is for tagged halibut, which may be retained regardless of gear, size or area. However, if a tagged halibut is retained, the tag must be returned to the *INTERNATIONAL PACIFIC HALIBUT COMMISSION* (*IPHC*).) The retained fish may only be sold if taken in authorized halibut fisheries, otherwise it may be only be kept for personal consumption. A minimum size limit also applies throughout the range of the species; only halibut over 82 cm (32 in) may be retained in any fishery. Again, the exception is that tagged halibut of any size may be retained.

During specific annual seasons/areas, legal-sized halibut may be retained and landed in recreational, commercial setline, and tribal setline fisheries. An allowance is also made for commercial salmon trollers, who are authorized to retain limited amounts of halibut caught while fishing for salmon. Any halibut taken with other gear, outside those seasons/areas, or under legal size, is considered bycatch and must be returned to the sea. Pacific halibut (unless tagged) may not be legally retained by trawl gear at any time and all that are caught are bycatch. Many halibut may survive if handled gently and returned to the sea quickly. Harvest regulations are established to attain but not exceed the estimated total allowable harvest for the year.

The bycatch of Pacific halibut off the West Coast has relatively little impact on the overall status of the population, but it does affect the total allowable harvest for directed West Coast halibut fisheries, including groundfish fisheries authorized to retain halibut. Halibut are migrants from northern waters off Canada and Alaska, where the bulk of the population resides. Little, if any, spawning occurs off the West Coast. Each year, the estimated bycatch of legal-sized fish off the West Coast is subtracted from the estimated yield to determine the allowable harvest for target fisheries. Consequently, the amount of bycatch has a direct impact on the recreational and setline fisheries for halibut. Pacific halibut are most frequently caught by bottom trawls operating in the 100-300 fathom depth range off Washington and Oregon, but also are taken at shallower depths on the shelf and off northern California. Few halibut are taken by midwater trawl gear.

Bycatch is estimated as a function of the halibut catch rate and effort fished for a particular time, area, depth, and target species category. Some of these categories have much higher catch rates than others and could be termed “halibut hot spots.” Much of the distribution of Pacific halibut falls within the GCAs. Therefore, bycatch has been reduced from previous years because bottom trawl effort is curtailed in these areas.

**Impacts of the Alternatives** Compared to Alternative 1 (status quo/no action), bycatch of Pacific halibut would not likely change much under Alternatives 2 and 3. The recent reductions in halibut bycatch would be maintained, to the extent that depth restrictions for on-bottom groundfish fishing are not expanded under these alternatives. However, this reduction could be partially offset if effort were concentrated in an area or time when halibut were also concentrated. For example, observed halibut bycatch rates by bottom trawl fisheries during the late 1990s were higher during the January through August period than during September through December. Therefore, if the fishing season (and effort) under Alternative 3 were concentrated during January through August, halibut bycatch and bycatch mortality could increase.

By further reducing the race for fish, Alternatives 4-7 increase vessels' flexibility to practice bycatch avoidance techniques. These alternatives may provide greater awareness and opportunity to conduct fishing operations in a manner that could lead to reduced bycatch and bycatch mortality of halibut. The desire to avoid halibut bycatch is likely comparable to the desire to avoid bycatch of overfished species, so halibut bycatch would tend to be reduced, at least in the same direction if not magnitude, as bycatch for overfished species. In addition, halibut bycatch under Alternative 6 would likely be reduced to the extent that closed areas are located in areas where halibut are concentrated. However, bycatch would be increased to the extent that greater fishing effort on bottom occurred in halibut hot spots because of closed areas elsewhere. Incentives for gear modifications and changes to fishing practices to remain within groundfish bycatch caps under these alternatives could increase or decrease halibut bycatch, depending on the modifications implemented.

Although not expressly included in the alternatives, Pacific halibut could be treated like a groundfish for purposes of applying restricted or prohibited species caps (Alternatives 5-7) or allowing vessels with low halibut bycatch to access a groundfish OY reserve (Alternatives 4, 5, and 7). If a cap were applied, then halibut bycatch would be reduced accordingly. If Alternative 6 were modified to require full retention of halibut (as for groundfish), then discard/bycatch would be eliminated.

Currently, trawl bycatch and bycatch mortality of Pacific halibut off the West Coast are primarily a function of the amount of bottom fishing effort in times and areas where halibut occur. Reducing trawl effort in these areas reduces bycatch, and increasing effort increases bycatch. To the extent that fishing effort patterns change with respect to halibut distribution and abundance, the impact of the alternatives will increase or decrease halibut bycatch. In addition, Alternatives 4, 5 and 6 would increase monitoring and reporting; improved halibut bycatch information would ultimately contribute to bycatch reduction.

Halibut bycatch in the groundfish fisheries may be more effectively reduced through the application of certain fisheries management tools than through the

measures described in alternatives. For example, allowing retention of Pacific halibut by the trawl fishery and by other fisheries outside of currently allowed seasons or areas could substantially reduce discard/bycatch. Similarly, gear modification through the use of halibut bycatch reduction devices, which have been used in trawl fisheries off Alaska, may be beneficial, although potentially costly, for reducing bycatch off the West Coast. Such regulatory changes would primarily be based on social and economic considerations that are not explicitly addressed in the alternatives. They could be included in any of the alternatives.

## 4.3.3 Impacts on Protected Species

This section examines interactions between protected species and groundfish fisheries under the programmatic alternatives being considered consideration in this EIS. As a point of clarification, interactions and incidental catches are different than bycatch. Interactions and incidental catches involve fishing gears and marine mammals, turtles and birds, while bycatch consists of discards of fish. Turtles, although defined as fish in the Magnuson-Stevens Act and thus technically bycatch, are included in this section because of their protected status (NMFS 1998).

### *4.3.3.1 Impacts on Pacific Salmon*

Pacific salmon are among the most highly prized species targeted by commercial, recreational and tribal fisheries on the West Coast. Directed salmon fishing is managed through a combination of catch limit, gear, season, area, size and fin-clip restrictions. Pacific coast fisheries in Council-managed waters (3-200 nm offshore) are directed toward and harvest primarily chinook (king) salmon and coho (silver) salmon. Small numbers of pink salmon are also harvested, especially in odd-numbered years. There are no directed fisheries for other Pacific salmon species, and they occur rarely (sockeye) or in very limited numbers (steelhead and chum) in Council-managed harvests.

Several salmon stocks on the West Coast are listed as threatened or endangered

Table 4.3.15. Salmon bycatch in the Pacific whiting fisheries, 1995-2002. At-sea data from NMFS Observer Data; shorebased data from ODFW.

| At-sea Whiting Sector | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|
| Chinook Salmon | 11578 | 1446 | 1,398 | 1477 | 4391 | 6260 | 2,568 | 1679 |
| Other Salmon 4/ | 4,414 | 279 | 924 | 27 | 802 | 115 | 770 | 173 |
| Total Salmon | 15992 | 1725 | 2,322 | 1,504 | 5,193 | 6,375 | 3,338 | 1,852 |
| Percent Chinook | 72.4 | 83.8 | 60.2 | 98.2 | 84.6 | 98.2 | 76.9 | 90.7 |
| No. Chinook/ mt | 0.1133 | 0.013 | 0.012 | 0.012 | 0.038 | 0.0546 | 0.0272 | 0.0267 |
| Shorebased Sector | | | | | | | | |
| Chinook Salmon | 2954 | 674 | 1,558 | 1,699 | 1,696 | 3,306 | 2,627 | 1,062 |

under the ESA. Salmon caught in trawl nets are classified as prohibited species; therefore, salmon captured by groundfish trawl fisheries and brought aboard must be returned to the sea as soon as possible and with minimal injury (after allowing for sampling by an observer).

Relatively few salmon are incidentally taken during commercial fishing operations for groundfish. As a result of the spatial/ temporal overlap between chinook salmon distribution and the midwater trawl fishery for whiting, most salmon bycatch is taken when fishing for Pacific whiting (Table 4.3.8). Salmon are most often present in the water column, rather than near the sea floor, and midwater trawl gear is primarily used to capture whiting. In the at-sea fishery, the trawl nets are emptied on the deck, and salmon can be removed from the catch and returned to the sea quickly. Nearly all vessels in the shore-based fishery empty their trawls directly into the hold, typically filled with refrigerated seawater, where the entire catch remains for several hours until offloaded at shore-based processing plants. Through Exempted Fishing permits (EFPs), these vessels have been exempted from requirements to sort all of the catch; all must be retained and delivered so all salmon and other species can be observed and tallied at the plant. All retained salmon must be relinquished to the appropriate State.

The 1992 *BIOLOGICAL OPINION* (BO) analyzing the effects of the Pacific Coast groundfish fishery on salmon stocks listed under the ESA established limits to bycatch of chinook salmon. Currently the limit is set at 0.05 chinook salmon per metric ton of Pacific whiting, with an associated total catch of 11,000 chinook for the coastwide Pacific whiting fishery. This BO was subsequently reviewed and the allowable chinook catch level reaffirmed in 1993, 1996 and 1999.

The 1992 BO also requires the Council to provide for monitoring of salmon bycatch in the midwater trawl fishery for whiting, but not in the bottom trawl fishery for groundfish. Currently, this monitoring requirement is based on not jeopardizing the existence of listed salmon species, including the Snake River fall chinook, lower Columbia River chinook, upper Willamette River chinook, and Puget Sound chinook. At present, the at-sea whiting fishery has 100% observer coverage. In recent years, a cooperative voluntary effort between the fishing industry and management agencies has been implemented to facilitate observer coverage and collect information on directed whiting landings at shoreside processing plants. Participating vessels are issued *EXEMPTED FISHING PERMITS* (EFPs), which allow vessels to land unsorted catch at designated processing plants. Permitted vessels are not penalized for landing prohibited species, including Pacific salmon, nor are they held liable for overages of groundfish trip limits. In 2003, 99% of the whiting catch by the shoreside fishery was landed under an EFP.

**Impacts of the Alternatives** In general, the impacts of the alternatives on salmon bycatch is relatively minor. Compared to Alternative 1, bycatch of Pacific salmon in the whiting fisheries would not likely change much under

Alternatives 2, 3, and 4. Alternatives 5 and 6 would substantially increase observer coverage and thus provide a more comprehensive understanding of salmon bycatch. Alternative 7 would provide an intermediate level of observer coverage between Alternative 4 and Alternatives 5 and 6. Improved bycatch information could lead to some improvements. However, given the voluntary efforts by whiting fishers to avoid salmon bycatch in these fisheries, little bycatch reduction would likely occur in these fisheries.

#### *4.3.3.2 Impacts on Seabirds*

Interactions between seabirds and fishing operations are wide-spread and have led to conservation concerns in many fisheries throughout the world. Abundant food in the form of offal (discarded fish and fish processing waste) and bait attract birds to fishing vessels. Of the gear used in the groundfish fisheries in the North Pacific, seabirds are occasionally taken incidentally by trawl and pot gear, but they are most often taken by longline gear. Around longline vessels, seabirds forage for offal and bait that has fallen off hooks at or near the water's surface, and are attracted to baited hooks near the water's surface, during the setting of gear. If a bird becomes hooked while feeding on bait or offal, it can be dragged underwater and drowned.

Besides entanglement in fishing gear, seabirds may be indirectly affected by commercial fisheries in various ways. Change in prey availability may be linked to directed fishing and the discarding of fish and offal. Vessel traffic may affect seabirds when it occurs in and around important foraging and breeding habitat and increases the likelihood of bird strikes. In addition, seabirds may be exposed to at-sea garbage dumping and the diesel and other oil discharged into the water associated with commercial fisheries.

In the Pacific Coast groundfish fisheries, groundfish observers collect information on interactions between seabirds and groundfish fisheries. Catcher-processors and motherships participating in the Pacific whiting fishery have had full observer coverage since the mid-1970s. The non-whiting portion of the groundfish fishery has had observer coverage only since the fall of 2001. Between September 2001 and October 2002, approximately 10% of the coastwide limited entry trawl landed weight and 30% of the limited entry fixed gear landed weight was observed.

The incidental take of seabirds by the at-sea whiting fleet is rare and infrequent. The species that have been taken by the at-sea whiting fleet include black-footed albatross, northern fulmar, and unidentified puffin. In the limited entry groundfish fisheries, few interactions with seabirds have been observed (Table 4.3.16).

**Table 4.3.16. Interactions between seabirds and the Pacific Coast groundfish fisheries documented by West Coast Groundfish Observers between September 2001 and October 2002.**

| Species | Gear Type | Type of Interaction |
|---|---|---|
| Unidentified Gull (*Larus species)* | Trawl | 1 Individual Taken |
| Unidentified Seabird | Trawl | 4 Individuals Taken |
| Short-tailed Albatross (*Phoebastria albatrus*) | Longline and Trawl | Feeding on Discard |
| California Brown Pelican (*Pelecanus occidentalis californicus*) | Rod and Reel | Feeding on Discard |
| Marbled Murrelet (*Brachyramphus marmoratus*) | Trawl | Landed on Deck |
| Black-footed Albatross (*Phoebastria nigripes*) | Trawl, Longline, and Pot | Feeding on Discard |
| Leach's storm-petrel *(Oceanodroma leucorhoa***)** | Trawl | Landed on Deck |
| Cassin's auklet *(Ptychoramphus aleuticus)* | Trawl | Landed on Deck |
| Pigeon guillemots *(Cepphus columba***)** | Pot | Feeding on Discard |
| Laysan albatross *(Phoebastria immutabilis)* | Pot | Feeding on Discard |
| Unidentified Cormorant (*Phalacrocorax species)* | Rod and Reel | Feeding on Discard |
| Unidentified Storm Petrel (*Oceanodroma species*) | Longline | Landed on Deck |
| Unidentified Shearwater (*Puffinus species*) | Pot | Feeding on Deck |

In response to increased national concern about the incidental take of seabirds, NMFS, USFWS, and the Department of State collaborated in 2001 to develop the U.S. *National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries*. The purpose of this plan is to provide national-level policy guidance on reducing the incidental take of seabirds in U.S. longline fisheries and to require NMFS, in cooperation with USFWS, to conduct an assessment of all U.S. longline fisheries to determine whether an incidental take problem exists. Using the West Coast Groundfish Observer Program's first year of data, NMFS drafted a preliminary assessment of seabird interactions with the groundfish longline fleet in 2003. There were no incidental takes of seabirds by longline vessels documented by NMFS groundfish observers during September 2001 to October 2002; however, a number of interactions between seabirds and longline

vessels were observed (see Table 4.3.8). Additionally, this National Plan of Action further requires NMFS, in cooperation with USFWS, to work through the regional fishery management council process in partnership with longline fishery representatives to develop and implement mitigation measures in those fisheries where the incidental take of seabirds is a problem. Therefore, NMFS will continue to work with the USFWS to better understand the interactions between seabirds and the groundfish fisheries and evaluate the need for seabird incidental take mitigation and management measures.

In order to predict the effects of the bycatch reduction alternatives on Pacific Coast seabird populations, it is important to have knowledge of the distribution, intensity, and duration of fishing effort associated with the groundfish fisheries. This information is currently unavailable for the groundfish fleet, but additional sources information should soon become available.

As of January 1, 2004, all vessels are required to carry Vessel Monitoring System (VMS) equipment while fishing for groundfish. VMS equipment identifies precise vessel location information. Additionally, information on the distribution of fishing effort is being developed as part of an Essential Fish Habitat Risk Assessment scheduled to be available in the spring of 2004. Because of the temporal and spatial overlap between seabird populations and groundfish fishing effort, projected harvest levels and proposed area closures will be used as a proxy for predicting the bycatch reduction alternatives on seabird populations.

**Incomplete or Unavailable Information** As required by CEQ's NEPA implementing regulations, any time there is incomplete or unavailable information, the federal agency must not only identify that such information is unavailable, but also make an assessment of the importance of that information and what would be the agency's evaluation of the predicted environmental impacts (i.e., best professional judgement) (40 CFR Part 1502.22). Accordingly, NMFS acknowledges that information on the distribution, intensity, and duration of fishing effort is incomplete with no current means of accurately tracking this information. This information is important in order to quantify fishing effort and predict the potential risks of interactions with seabirds. Thus, the following paragraphs shall present a best professional judgement (i.e., qualitative assessment) of the predicted environmental impacts of the alternatives on seabirds.

Under Alternative 1, interactions between the Pacific Coast groundfish fishery and seabirds are expected to be similar to the seabird/fishery interactions during the 2002/2003 groundfish fishery. Based on West Coast Groundfish Observer data, the combined use of trip limits, gear restrictions, and area closures has resulted in few interactions between the groundfish fleet and seabirds (Table 4.3.8). Seabirds may benefit from the temporal and/or spatial distribution of fishing effort associated with trip limit management and area closures, provided that these management measures do not concentrate fishing effort in areas

important to seabird foraging and/or breeding. As more information is gathered on seabird interactions with the groundfish fleet, gear restrictions and area closures may be modified to reduce interactions with seabirds.

Under Alternative 2, the number of commercial groundfish trawl vessels would be a reduced to 50% or 2000 levels. This reduction in fleet size, paired with gear restrictions and area closures, would likely reduce the trawl fleet's interactions with seabirds. Additionally, by increasing the trip limits for various groundfish species, any race for fish should be further reduced, potentially allowing fishing behavior to be modified to avoid interactions with seabirds.

Alternative 3 would implement a shorter fishing season, as opposed to the current year-round groundfish fishery, as well as gear restrictions and trip limits designed to discourage fishing in certain areas. Under this alternative, the number of vessels would not be reduced, but fishing would be concentrated in shorter seasons. If fishing activities were concentrated into seasons where there was limited seabird activity along the Pacific Coast, the number of interactions may be reduced under Alternative 3. However, if fishing were to be concentrated into seasons important for seabird foraging and/or breeding, interactions with seabirds may increase under Alternative 3. During closed periods, all interactions with seabirds would be greatly reduced. The overall effect of Alternative 3 is difficult to predict but it likely depends on the seasonality of the concentrated groundfish fishery.

Alternative 4 would continue the use of trip limits but with additional restrictions on the amount of groundfish catch that can occur. The objective of Alternative 4 is to provide extended groundfish fishing opportunities for vessels with low rates or low amounts of groundfish bycatch. The effects on seabird/ fishery interactions due to additional catch restrictions are difficult to predict; however, it is likely that they would be similar to those under Alternative 3.

Alternative 5 would establish individual vessel groundfish catch quotas (IFQs and RSQs) as a means to mitigate groundfish bycatch and would relax some gear restrictions to encourage fishers to develop individual groundfish bycatch avoidance techniques. While establishment of groundfish quotas may be an effective way to limit bycatch of groundfish species, IQs alone would not directly reduce interactions between seabirds and the Pacific Coast groundfish fleet. However, it is likely that the establishment of individual groundfish catch quotas would result in further reducing the number of trawl vessels. IQs should also provide a much greater opportunity for vessels to choose when and where they will fish. Additionally, an IQ program may require 100% observer coverage to ensure effectiveness; therefore, the level of information on seabird interactions (as well as seabird distribution) would likely increase substantially. As more is understood about the interactions between groundfish vessels and seabirds along the Pacific Coast and as this information is passed along to fishers, Alternative 5 has the potential to reduce interactions with seabirds.

Under Alternative 6, no-take marine reserves and vessel caps would be used to mitigate bycatch by groundfish vessels. Marine reserves would likely be designed to reduce or prevent incidental take of overfished groundfish species, although they could also be designed to reduce bycatch of other species. Should these areas of reduced fishing coincide with areas important for foraging and breeding seabirds, then Alternative 6 may be useful in reducing the potential for seabird/fishery interactions. Conversely, if these restricted areas cause fishing effort to be concentrated in areas used by seabirds, then Alternative 6 may increase the potential for seabird/fishery interactions. However, the added implementation of groundfish quotas would likely result in a smaller fleet and more cautious fishing strategies. Therefore, Alternative 6 is predicted to result in reduced seabird/fishery interactions compared to Alternatives 1, 2, and 3 and similar to Alternative 5. As more information is gathered on seabird interactions with the groundfish fleet, marine protected areas may be modified to reduce interactions with seabirds.

Alternative 7 would establish sector allocations and continue the use of trip limits, but with additional restrictions on the amount of groundfish catch that can occur. The objectives of Alternative 7 are to reward those sectors achieving low groundfish bycatch rates or amounts, and to provide incentives for individual vessels to reduce their bycatch. Vessels that opt to voluntarily pay the costs of observer coverage would receive vessel catch limits of overfished species, larger trip limits of other species, and be exempted from certain sector restrictions. The effects on seabird/ fishery interactions due to these restrictions are difficult to predict; however, it is likely that they would be similar to those under Alternatives 4 and 5.

As more information about the spatial and temporal overlap of groundfish fisheries and seabird populations along the Pacific Coast is gathered, a more comprehensive understanding of seabird/fishery interactions is possible. If it is found that mitigating the effects of the Pacific Coast groundfish fishery on seabirds is necessary, additional management measures, such as seabird deterrents (i.e., streamer lines), discharging offal opposite the hauling station, and reducing fishing activity in areas and/or during seasons important for seabird breeding and/or foraging, may be required under any of the alternatives.

#### *4.3.3.3 Impacts on Marine Mammals*

The marine mammal species accounts presented here are taken primarily from the most recent Stock Assessment Reports (Carretta *et al.* 2001) prepared by NMFS as required by the Marine Mammal Protection Act (MMPA).

Table 4.3.17. Marine mammal species that occur off the West Coast that are, or could be, of concern with respect to potential interactions with groundfish fisheries.

| | Scientific Name | ESA Status |
|---|---|---|
| **Pinnipeds** | | |
| California sea lion | *Zalophus californianus* | |
| Pacific harbor seal | *Phoca vitulina richardsi* | |
| Northern elephant seal | *Mirounga angustirostris* | |
| Guadalupe fur seal | *Arctocephalus townsendi* | T |
| Northern fur seal | *Callorhinus ursinus* | |
| Northern or Steller sea lion | *Eumetopias jubatus* | T |
| **Sea otters** | | |
| Southern | *Enhydra lutris nereis* | T |
| Washington | *Enhydra lutris kenyoni* | |
| **Cetaceans** | | |
| Minke whale | *Balaenoptera acutorostrata* | |
| Short-finned pilot whale | *Globicephala macrorhyncus* | |
| Gray Whale | *Eschrichtius robustus* | |
| Harbor porpoise | *Phocoena phocoena* | |
| Dall's porpoise | *Phocoenoides dalli* | |
| Pacific white-sided dolphin | *Lagenorhynchus obliquidens* | |
| Short-beaked common dolphin | *Delphinus delphis* | |
| Long-beaked common dolphin | *Delphinus capensis* | |

The groundfish fisheries have been determined not to jeopardize any marine mammal species. None of the alternatives under consideration is expected to significantly impact any marine mammal.

Table 4.3.18. Cetaceans that are present but not likely to interact with groundfish fisheries or that have not been documented having had interactions in observed groundfish fisheries.

| | Scientific name | ESA Status |
|---|---|---|
| Bottlenose dolphin | *Tursiops truncatus* | |
| Striped Dolphin | *Stenella coeruleoalba* | |
| Sei whale | *Balaenoptera borealis* | E |
| Blue whale | *Balaenoptera musculus* | E |
| Fin whale | *Balaenoptera physalus* | E |
| Sperm whale | *Physeter macrocephalus* | E |
| Humpback whale | *Megaptera novaeangliae* | E |
| Bryde's whale | *Balaenoptera edeni* | |
| Sei whale | *Balaenoptera* | E |
| Killer whale | *Orcinus orca* | |
| Baird's beaked whale | *Berardius bairdii* | |
| Cuvier's beaked whale | *Ziphius cavirostris* | |
| Pygmy sperm whale | *Kogia breviceps* | |
| Risso's dolphin | *Grampus griseus* | |
| Striped dolphin | *Stenella coeruleoalba* | |
| Northern right-whale dolphin | *Lissodelphis borealis* | |

**California Sea Lion** - Incidental mortalities of California sea lions have been documented in set and drift gillnet fisheries (Carretta *et al.* 2001; Hanan *et al.* 1993). Skippers logs and at-sea observations have shown that California sea lions have been incidentally killed in Washington, Oregon, and California groundfish trawls and during Washington, Oregon, and California commercial passenger fishing vessel fishing activities (Carretta *et al.* 2001). Total human-caused mortality (1,352 sea lions) is less than the 6,591 sea lions allowed under the Potential Biological Removal formula (Carretta et al. 2001).

**Harbor Seal** - Combining mortality estimates from California set net, northern Washington marine set gillnet, and groundfish trawl results in an estimated mean mortality rate in observed groundfish fisheries of 667 harbor seals per year along Washington, Oregon, and California (Carretta et al. 2001).

**Northern Elephant Seal** - There are no recent estimated incidental kills of Northern elephant seals in groundfish fisheries along Washington, Oregon, and California, however they have been caught in setnet fisheries (Carretta et al. 2001).

**Guadalupe Fur Seal** - There have been no U.S. reports of mortalities or injuries for Guadalupe fur seals (Cameron and Forney 1999; Julian 1997; Julian and

Beeson 1998), although there have been reports of stranded animals with net abrasions and imbedded fish hooks (Hanni et al. 1997).

**Northern Fur Seal** - There were no reported mortalities of northern fur seals in any observed fishery along the West Coast of the continental U.S. during the period 1994-1998 (Carretta *et al.* 2001), although there were incidental mortalities in trawl and gillnet fisheries off Alaska (Angliss and Lodge 2002).

**Eastern Stock Steller Sea Lion** - These have been observed taken incidentally in WA/OR/CA groundfish trawls and marine set gillnet fisheries (Angliss and Lodge 2002). Total estimated mortalities of this stock (44) is less than the 1,396 Steller sea lions allowed under the Potential Biological Removal formula (Angliss and Lodge 2002).

**Southern Sea Otter** - During the 1970s and 1980s considerable numbers of sea otters were observed caught in gill and trammel entangling nets in central California. During 1982 to 1984, an average of 80 sea otters were estimated to have drowned in gill and trammel nets (Wendell *et al.* 1986). This was projected as a significant source of mortality for the stock until gill nets were prohibited within their feeding range. More recent mortality data (Pattison *et al.* 1997) suggest similar patterns during a period of increasing trap and pot fishing for groundfish and crabs (Estes *et al.* In Press). This elevated mortality appears to be the main reason for both sluggish population growth and periods of decline in the California sea otter population (Estes *et al.* In Press).

**Sea Otter (Washington Stock)** - Gillnet and trammel net entanglements were a significant source of mortality for southern sea otters (Wendell *et al.* 1986) and some sea otters were taken incidentally in setnets off Washington (Kajimura 1990). Evidence from California and Alaska suggests that incidental take of sea otter in crab pots and tribal set-net fisheries may also occur. Sea otters are also quite vulnerable to oil spills due to oiled fur interfering with thermoregulation, ingested oil disintegrating the intestinal track, and inhaled fumes eroding the lungs (Richardson and Allen 2000).

**Harbor porpoise** - Harbor porpoise are very susceptible to incidental capture and mortalities in setnet fisheries (Julian and Beeson 1998). Off Oregon and Washington, fishery mortalities of harbor porpoise have been recorded in the northern Washington marine set and drift gillnet fisheries (Carretta *et al.* 2001). However, these fisheries have largely been eliminated.

**Dall's porpoise** - Observers document that Dall's porpoise have been caught in the California, Oregon and Washington domestic groundfish trawl fisheries (Perez and Loughlin 1991) but the estimated annual take is less than two porpoise per year.

**White-sided Dolphin** - Observers have documented mortalities in the California, Oregon, and Washington groundfish trawl fisheries for whiting (Perez and Loughlin 1991). The total estimated kill of white-sided dolphins in these fisheries averages less than one dolphin per year (Carretta *et al.* 2001).

**Risso's Dolphin** - There have been no recent Risso's dolphin moralities in West Coast groundfish fisheries (Carretta *et al.* 2001), although Reeves *et al*.(2002) report that Risso's are a bycatch in some longline and trawl fisheries.

**Common Dolphin** - Common dolphin mortality has been estimated for set gillnets in California (Julian and Beeson 1998); however, the two species (short-beaked and long-beaked) were not reported separately. Reeves *et al*.(2002) relate that short-beaked common dolphins are also a bycatch in some trawl fisheries.

**Short-finned Pilot Whale** - Total human-caused mortality (3) of this species is less than the 6 short-finned pilot whales allowed under the Potential Biological Removal formula (Carretta *et al.* 2001).

**Eastern Pacific Gray Whale** - These have been an incidental catch in set net fisheries, but there have been no recent takes in groundfish fisheries (Angliss and Lodge 2002).

**Minke Whale** Minke whales have occasionally been caught in coastal gillnets off California (Hanan *et al.* 1993), in salmon drift gillnet in Puget Sound, Washington, and in drift gillnets off California and Oregon (Carretta *et al.* 2001). There have been no recent takes in groundfish fisheries off California , Oregon, or Washington (Carretta *et al.* 2001).

**Sperm Whale** - There are no recent observations of sperm whale incidental catches in West Coast groundfish fisheries.

**Humpback, Blue, Fin, and Sei Whales** - There are no recent observations of incidental catches of these species in West Coast groundfish fisheries.

**Killer Whale** - The only incidental take recorded by groundfish fishery observers was in the Bering Sea/Aleutian Islands (BSAI) groundfish trawl (Carretta *et al.* 2001). There are also reports of interactions between killer whales and longline vessels (Perez and Loughlin 1991). (Longline fishers in the Aleutian Islands reported several cases where orcas removed sablefish from longlines as the gear was retrieved.) There are no other reports of killer whale takes in West Coast groundfish fisheries (Carretta *et al.* 2001).

**California Coastal Bottlenose Dolphin** - Due to its exclusive use of coastal habitats, this bottlenose dolphin population is susceptible to fishery-related mortality in coastal set net fisheries. However, from 1991-94 observers saw no bottlenose dolphins taken in this fishery, and in 1994 the state of California

banned coastal set gillnet fishing within 3 nm of the southern California coast. In central California, set gillnets have been restricted to waters deeper than 30 fathoms (56 m) since 1991 in all areas except between Point Sal and Point Arguello. These closures greatly reduced the potential for mortality of coastal bottlenose dolphins in the California set gillnet fishery.

#### *4.3.3.4 Impacts on Sea Turtles*

The sea turtle species accounts are taken from the species accounts of the Environmental Assessment for the issuance of a marine mammal permit to the California/Oregon drift gillnet fishery (NMFS 2001a).

Table 4.3.19. Sea turtle species occurring off the West Coast that are or could be of concern with respect to potential interactions with groundfish fisheries.

| | Scientific Name | ESA Status |
|---|---|---|
| Loggerhead | *Caretta caretta* | T |
| Green | *Chelonia mydas* | T |
| Leatherback | *Dermochelys coriacea* | E |
| Olive (Pacific) ridley | *Lepidochelys olivacea* | T |

Numerous human-induced factors have adversely affected sea turtle populations in the North Pacific and resulted in their threatened or endangered status (Eckert 1993; Wetherall *et al.* 1993). Documented incidental capture and mortality by purse seines, gillnets, trawls, longline fisheries, and other types of fishing gear adversely affect sea turtles, however the relative effect of each of these sources of impact on sea turtles is difficult to assess (NMFS and USFWS 1998a; 1998b; 1998c; 1998d). Each of the sea turtle species that might interact with groundfish fisheries are listed. Little data are available estimating total annual mortalities except in the drift gillnet fishery, which is not part of the groundfish FMP. None of the alternatives is expected to result in any impacts on these species.

**Loggerhead** - The primary fishery threats to the loggerheads in the Pacific are pelagic longline and gillnet fisheries (NMFS and USFWS 1998c). These gears are not used for taking groundfish.

**Leatherback** - Primary threats to leatherbacks in the Pacific are the killing of nesting females and eggs at nesting beaches and incidental take in coastal and high seas fisheries (NMFS and USFWS 1998b). Groundfish fishing operations are not known to affect this species.

**Olive Ridley** - Occasionally these turtles are found entangled in scraps of net or other floating debris. Although they are generally thought to be surface feeders,

olive ridleys have been caught in trawls at depths of 80-110 meters (NMFS and USFWS 1998d).

### 4.3.4 Miscellaneous Species

Miscellaneous species include sea urchins, starfish, corals, octopuses, various crustaceans and finfish. Little information is available about these species and the amount of interaction with groundfish fishing and fishing gears. Alternatives 4-7 would be expected to result in reduced groundfish fishing, especially on-bottom fishing, and thus would reduce bycatch of benthic species. The establishment of long-term no-take reserves by Alternative 6 would likely provide the greatest protection to benthic animals within the reserve boundaries. Outside marine reserve boundaries, fishing could intensify. Requirements to use only certified gears may reduce the potential for increased impacts in such areas. Although there is no way to anticipate the effects of the various alternatives, no significant effects are expected. Further detailed environmental analysis would be necessary before any regulations were promulgated.