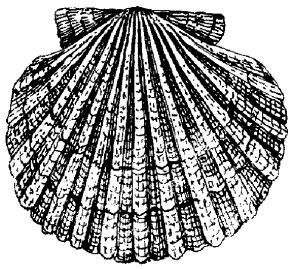
Initial Review Draft

ENVIRONMENTAL ASSESSMENT
for proposed amendment

TO THE FISHERY MANAGEMENT PLAN FOR THE SCALLOP FISHERY OFF ALASKA

to comply with Annual Catch Limit requirements



Abstract: This environmental assessment analyses a range of alternatives to implement Annual Catch Limits (ACLs) in the Alaskan Scallop Fishery to meet regulatory requirements. Four alternatives are examined: Alternative 1: Status Quo, Alternative 2: Set ACL equal to the upper end of the Guideline Harvest Ranges (GHRs) ; Alternative 3: Set ACL equal to 90% of the upper end of the GHR and Alternative 4: Set ACL equal to 75% of the upper end of the GHR. For alternatives 2-4 two options are considered for each, establishing a statewide ACL and establishing ACLs by region. Three additional options are included for the treatment of non-target scallop stocks. These include: option 1: remove non-target stocks from the FMP; option 2: move non-target scallop stocks to an ecosystem component category under the FMP (and do not establish ACLs for these stocks); and option 3: Set ACLs for non-target scallop stocks. The impacts of the alternatives upon scallop resources, fishery participants, habitat, marine mammals, and other groundfish resources are discussed in the analysis.

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May 2010

Executive Summary

The Fishery Management Plan (FMP) for Alaskan Scallops governs scallop fisheries in federal waters off the State of Alaska. The FMP management unit is the U.S. exclusive economic zone (EEZ) of the Bering Sea, Aleutian Islands, and the Gulf of Alaska, and includes weathervane scallops and other scallop species not currently exploited.

There are five alternatives for setting annual catch limits (ACLs) and three options for treatment of non-target stocks contained in this analysis. The proposed action is to establish ACLs to meet the requirements of the revised Magnuson Stevens Fishery Conservation and Management Act (MSA). These ACLs are to be established based upon acceptable biological catch (ABC) control rules which account for the uncertainty in the overfishing limit (OFL) point estimate. To meet the ACL requirements, ABCs will be established under the Scallop FMP such that ACL = ABC and the guideline harvest levels (GHLs) must be established sufficiently low so as not to exceed the ACL. Determinations of GHLs are delegated to the State following the criteria in the FMP.

This action must be implemented prior to the start of the 2011 fishing year on July 1, 2011. Management actions for the Alaskan scallop fisheries must comply with applicable Federal laws and regulations.

This environmental assessment analyzes a range of alternatives to implement Annual Catch Limits (ACLs) in the Alaskan Scallop Fishery to meet regulatory requirements. Five alternatives are examined: Alternative 1: Status Quo; Alternative 2: Set ACL equal to the upper end of the Guideline Harvest Ranges (GHRs) plus estimated discard mortality; Alternative 3: Set ACL equal to 90% of the upper end of the GHR plus estimate discard mortality; Alternative 4: Set ACL equal to 75% of the upper end of the GHR plus estimated discard mortality. For Alternatives 2–4, the OFL was redefined to include estimates of discard mortality in the directed scallop fishery, the groundfish fisheries, and agency surveys. Alternatives 2–5 also include two options: establishing a statewide ACL and establishing ACLs by region. Three additional options are considered for the treatment of non-target scallop stocks. These include: option 1 – remove non-target stocks from the FMP; option 2 – move non-target scallop stocks to an ecosystem component category under the FMP (and do not establish ACLs for these stocks); and option 3 - Set ACLs for non-target scallop stocks.

The impacts of the alternatives upon scallop resources, fishery participants, habitat, marine mammals, and other groundfish resources are discussed in the analysis. Based on historical catch patterns, Alternatives 2 through 4 are unlikely to constrain the fishery when ACLs are applied statewide, but may constrain the fishery in some regions at times of high scallop abundance when region-specific ACLs are applied. To determine the relative risk of overfishing by each of the alternatives, a probability approach was employed to estimate the relative risk of exceeding the OFL under each of alternatives 2-4. This approach also considers additional, unmeasured scientific uncertainty and its relative impact on the perceived overfishing.

The requirement to account for all removals necessitates taking into account the scallop discard mortality in directed and non-directed fisheries. The combination of progressively more conservative ACLs (moving from Alternative 2 to Alternative 4), combined with providing a sufficient buffer to allow for incidental catch not to exceed the ACL, would provide additional conservation against overfishing for the scallop resource but has greater potential to constrain the scallop fishery. Alternatives 3 and 4 provide for additional conservatism by further buffering against the uncertainty in the estimation of the OFL. Alternative 5 incorporates both quantitative and qualitative measures of uncertainty in providing a buffer between the OFL and the ACL, with greater uncertainty resulting in a larger buffer. None of the alternatives are likely to impact other groundfish resources, habitat, or prohibited species.

Table of Contents

Table of Tables

Table of Figures

Chapter 1 Purpose and Need

1.1 Introduction

The Fishery Management Plan (FMP) for Alaskan Scallops governs scallop fisheries in federal waters off the State of Alaska. The FMP management unit is the U.S. exclusive economic zone (EEZ) of the Bering Sea, Aleutian Islands (BSAI), and the Gulf of Alaska (GOA), and includes weathervane scallops (*Patinopecten caurinus*) and other scallop species (family Pectinidae) not currently exploited. The GOA is defined as the U.S. EEZ of the North Pacific Ocean, exclusive of the Bering Sea, between the eastern Aleutian Islands at 170º 00' W longitude and Dixon Entrance at 132º 40' W longitude. The BSAI is defined as the U.S. EEZ south of the Bering Strait to the Alaska Peninsula and Aleutian Islands and extending south of the Aleutian Islands west of 170º 00' W longitude.

The FMP establishes a State/Federal cooperative management regime that delegates scallop fisheries management to the State of Alaska (State) with Federal oversight. Management measures in the FMP fall into two categories: Category 1 measures are those delegated to the State for implementation, while Category 2 measures are limited access management measures and all Federal requirements, which are fixed in the FMP, implemented by Federal regulation, and require an FMP amendment to change. Category 1 and 2 measures are listed in Table 1-1. State regulations are subject to the provisions of the FMP, including its goals and objectives, the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and other applicable Federal laws. This action described in this analysis is a federal measure and thus will fall under Category 2, although it may have implications for certain Category 1 measures.

Table 1-1 Management measures in FMP.

CATEGORY 1 (Delegated to the State)	CATEGORY 2 (Fixed in FMP, Implemented by Federal Regulation)
Guideline Harvest Levels	License limitation program
Registration Areas, Districts, Subdistricts and Sections	Optimum Yield specification
Gear Limitations	Overfishing specification
Crew and Efficiency Limits	EFH/HAPC designation
Fishing Seasons	
Observer Requirements	
Prohibited Species and Bycatch Limits	
Recordkeeping and Reporting Requirements	
In-season Adjustments	
Closed Areas	
Other	

This analysis contains five alternatives for setting annual catch limits (ACLs) and three options for treatment of non-target scallop stocks. The proposed action is to amend the FMP to specify the method by which the Council will establish ACLs to meet the requirements of the 2006 revision of the MSA. These ACLs are to be established based upon acceptable biological catch (ABC) control rules which account for the uncertainty in the overfishing limit (OFL) point estimate. To meet the ACL requirements, ABCs will be established under the Scallop FMP such that ACL = ABC and the guideline harvest levels (GHLs) must be established sufficiently below the ABC so as not to exceed the ACL. Determinations of GHLs are delegated to the State following the criteria in the FMP.

This action must be implemented prior to the July 1, 2011 start of the 2011 fishing year. Management actions for the Alaskan scallop fisheries must comply with applicable Federal laws and regulations. Although several laws and regulations guide this action, the principal laws and regulations that govern this action are the MSA and the National Environmental Policy Act (NEPA). None of the alternatives require implementing regulations and, therefore, the Regulatory Flexibility Act does not apply and review under Executive Order 12866 is not required.

1.2 Purpose and Need

The purpose of the proposed action is to reduce the risk of overfishing and maintain healthy scallop stocks that will provide optimum yield over the long-term, in compliance with the Magnuson-Stevens Act and the national standard guidelines.

The Council approved the following problem statement for this analysis in October 2009.

On January 16, 2009, NMFS issued final guidelines for National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act (MSA). They provide guidance on how to comply with new annual catch limit (ACL) and accountability measure (AM) requirements for ending overfishing of fisheries managed by federal fishery management plans. Annual catch limits are amounts of fish allowed to be caught in a year. A legal review of the Alaskan Scallop FMP found there were inadequacies in the FMP texts that need to be addressed. Several work groups (e.g., ABC/ACT Control Rules, Vulnerability Evaluations) have been created to produce reports on how to carry out the more technical components of the NS 1 guidelines. Statutory deadlines require compliance with the MSA by the start of the 2011 fisheries although these reports have not been finalized.

This action is necessary to facilitate compliance with requirements of the MSA to end and prevent overfishing, rebuild overfished stocks and achieve optimum yield.

A more focussed ACL problem statement may be developed by the Council at initial review given that the development of alternatives has progressed much further than when the Council first drafted its problem statement.

1.3 Magnuson-Stevens Act and National Standard Guidelines

The Magnuson-Stevens Act sets forth ten national standards for fishery conservation and management. National Standard 1 states that "Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield (OY) from each fishery for the U.S. fishing industry." The specification of OY and the conservation and management measures to achieve it must prevent overfishing. NMFS published national standard guidelines (50 CFR sections 600.310 – 600.355) to provide comprehensive guidance for the development of FMPs and FMP amendments that comply with the Magnuson-Stevens Act national standards.

The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (MSRA, Public Law 109-479) includes provisions intended to prevent overfishing by requiring that: FMPs establish a mechanism for specifying ACLs in the plan (including a multiyear plan); implementing regulations, or annual specifications, at a level such that overfishing does not occur in the fishery; and including measures to ensure accountability (AMs). ACLs and AMs are required by fishing year 2010 if overfishing is occurring in a fishery, and they are required for all other fisheries by fishing year 2011. Since overfishing is not occurring for any scallop stock, scallop fisheries must have ACL and AM mechanisms by the 2011/2012 scallop fishing year. The MSRA includes a requirement for the SSC to

recommend ABC levels to the Council, and provides that ACLs may not exceed the fishing levels recommended by the SSC.

On January 16, 2009, NMFS published a final rule to amend the National Standard 1 guidelines to provide guidance on how to comply with the new ACL and AM requirements intended to end overfishing of fisheries managed under fishery management plans (74 FR 3178; 50 CFR 600.310). The guidelines clarify the relationship between ACLs, ABCs, OFLs, maximum sustainable yield (MSY), OY, and other applicable reference points. The proposed actions were developed according to these amended guidelines.

1.4 Other Applicable Law

Several state regulations may be pertinent to some of the options under consideration for non-target species in this analysis. In particular, regulation 5 AAC 39.210 Management Plan for High Impact Emerging Fisheries guides State actions in the event that a fishery under State management develops beyond a low sporadic level. In addition, 5 AAC 38.076 Alaska Scallop Fishery Management Plan provides fishery regulations for targeting both weathervane and other scallop species; regulations include registration areas, legal gear, and observer and reporting requirements. Finally, regulation 5 AAC 38.010 Application of Regulations clarifies that regulations which apply to a State registration area also apply to waters of the adjacent EEZ.

Chapter 2 Description of Alternatives

This section contains an overview of the four alternatives considered for analysis as well as those that were initially considered, but, for the reasons described in section 2.2, were not carried forward for analysis.

2.1 Alternatives

Four alternatives with associated options for spatial management for weathervane scallops are considered in this analysis. A comparison of the ACLs for the different alternatives is contained in Table 2-1. Consideration of the options for management of the non-target scallop stocks is contained in Section 2.1.4. One of the non-target stock options must be selected in conjunction with one of the alternatives (and spatial option) for ACLs for the weathervane scallop stock.

2.1.1 Alternative 1: Status quo (No Action alternative)

Alternative 1 is the no action alternative. This alternative would retain the current management as specified in the FMP for establishment of federal overfishing limits on a statewide basis and guideline harvest ranges (GHRs) and guideline harvest levels (GHLs) by registration area. Note that this alternative is considered for comparative purposes against other alternatives in this analysis but, per revised federal guidelines as specified in Chapter 1, would not meet all applicable legal requirements.

Under the FMP, overfishing is defined as a level of fishing mortality that jeopardizes the long-term capacity of a stock or stock complex to produce MSY on a continuing basis. The MSY is defined as the largest long-term average catch that can be taken from a stock under prevailing ecological and environmental conditions. The long-term average stock size obtained by fishing year after year at this rate under average recruitment may be a reasonable proxy for the MSY stock size, and the long-term average catch so obtained may be a reasonable proxy for MSY. Amendment 6 to the scallop FMP established MSY for weathervane scallops at 1.24 million pounds (lbs) of shucked meats based on the average catch from 1990 to 1997, excluding 1995 when the fishery was closed most of the year. Optimum Yield (OY) was defined as 0–1.24 million lbs, and the overfishing control rule was defined as a fishing rate in excess of the natural mortality rate, which has been estimated as $F_{overfishing} = M = 0.13$ (12% per year) statewide (NPFMC 2010b). Currently, abundance is estimated for only two of the nine registration areas and a determination of MSST cannot be made for the stock statewide.

The MSY for weathervane scallops is 1.24 million lbs (562.46 metric tons) of shucked adductor muscles, or meats; MSY was estimated as the average catch from 1990 to 1997, excluding 1995. The period of 1990–1997 reflects prevailing ecological conditions. The fishery was fully capitalized during this time period, and all areas of the state where scallops could be harvested were being exploited. Prior to that period, vessels moved into and out of the scallop fishery, partly due to economic opportunities in other fisheries (Shirley and Kruse 1995). However, since 1993, the fishery has been somewhat limited by crab bycatch limits, closure areas, and season length. As a consequence, a stable period during the history of this fishery does not exist.

2.1.2 Alternatives 2–-4: Establish ABC control rules using fixed buffers for the scallop stocks

The intent of the ABC control rule is to account for scientific uncertainty in the calculation of the OFL. This parameter was previously viewed as the sum of the upper ends of the ADF&G regulatory GHRs. However, because the OFL should ideally consider all sources of fishing mortality, the OFL was

redefined for Alternatives 2–4 (and Alternative 5) to be the sum of the upper ends of the ADF&G regulatory GHRs plus the estimated discard mortalities in the directed scallop fishery, the groundfish fishery, and agency surveys. There are many sources of scientific uncertainty in an estimated OFL, some of which can be readily quantified based on the data collected from a fishery through the use of assessments and other methods of data analysis, while other sources cannot. For the Alaskan scallop stock, most sources of uncertainty are not directly quantifiable at this time. The ABC control rules for Alternatives 2–4 are formulated based on fixed buffers which would account for this unquantifiable uncertainty in the OFL (MSY) estimation. A range of buffer values from 0–25% of the OFL are considered here. Options beneath each alternative consider spatial management of the ACL, either statewide or regionally. Here, regions under each alternative and option are the State management regions as shown in Table 2-1 and Figure 2-1. For reasons explained in Section 2.2, management by individual registration areas, rather than by regions, was not considered at this time.

The Scallop SAFE report (NPFMC 2010b) provides an overview of information available for assessment and management of scallop stocks within the three management regions shown in Figure 2-1. Information on management by region is summarized below (from NPFMC 2010b):

Region 1 (Southeast Alaska): No regular assessment surveys are conducted in the Southeast Alaska Region. Management of the fishery relies solely on fishery-dependent data. Separate GHLs are assigned for Area D and District 16, both of which fall into Scallop Registration Area D (Yakutat). Southeast shellfish management staff meets annually with the scallop biometrician to review analysis of the most recent scallop observer data. Data considered when adjusting GHLs include: total harvest and CPUE for the entire registration area; total harvest and CPUE by scallop bed; daily CPUE versus cumulative catch in each bed where effort occurred; shell height histograms for Area D and District 16; and Tanner crab bycatch for the entire registration area. The GHLs are set prior to each fishing season based on these data. There are no crab bycatch limits in Scallop Registration Area D.

Region 2 (Central Region): ADF&G conducts biennial dredge surveys in the Kamishak District of the Cook Inlet Registration Area and near Kayak Island in the Prince William Sound Registration Area. Data from these surveys are used to set GHLs. In the Kamishak District fishery, vessels are limited to a single 6-ft dredge, and observer requirements may be waived at the discretion of ADF&G, although ADF&G staff are regularly deployed as observers when fishing occurs.

Region 4 (Westward Region)**:** Regular scallop stock assessment surveys are not conducted in the Westward Region. GHLs are set after review of observer data collected during recent seasons. For some areas, GHLs are set by statistical area to distribute effort and reduce the likelihood of localized depletion. Management staff also set CPUE benchmarks for some areas prior to the season, and if CPUE falls below the benchmark level during fishing, management staff meet to review in-season observer data and the fishery may be closed or be allowed to continue. In all areas, crab bycatch and CPUE are closely monitored during the season, and scallop fishing in an area may be closed due to high crab bycatch or poor fishery performance.

For the purpose of scallop management under regional ACLs, two tiers may be considered based on the relative information available.

Tier 1: Survey information available and some estimation of biomass by region is possible. Commercial fishery-dependent data available for PWS (100% observer coverage); Observer coverage in Cook Inlet may be waived at the discretion of ADF&G.

Tier 2: Commercial fishery-dependant data only (100% observer coverage).

For both tiers, ADF&G manages the fishery by registration areas and districts for GHRs, which are hard caps established in State of Alaska regulations for each registration area and not to be exceeded. Guideline harvest limits (GHLs) are pre-season targets set for each fishing area (registration area, district, or statistical area) prior to each season. Total harvest for each fishing area during a given season will typically be near or below, but may exceed, the GHL. Catch data are relayed by radio from the onboard observers or the vessel operator thrice weekly, or more often as required by the ADF&G manager. Fishing may be closed in any area before the GHL is reached due to concerns about localized depletion, trends in CPUE, or bycatch rates.

2.1.2.1 Alternative 2: ABC control rule = GHR

Alternative 2 establishes an ABC control rule such that the ABC is established annually at a level equal to the sum of the upper ends of the GHRs and estimated discard mortalities in fisheries and agency surveys. ACL(s) will be set equal to the ABC(s). There are two options considered under this alternative for specifying ACLs: statewide (Alternative 2a) and by region (Alternative 2b).

Alternative 2a: Statewide ACL
Here the ABC and ACL would both be established as the sum of the upper ends of the GHRs and discard mortalities for all regions.

Alternative 2b: Regional
Here an ABC and ACL would both be established for each region as the sums of the upper ends of the GHRs and discard mortalities for each individual region.

2.1.2.2 Alternative 3: ABC control rule = 90% of GHR

Alternative 3 establishes an ABC control rule such that ABC is established annually at a level equal to 90% of the sum of the upper ends of the GHRs and the estimated discard mortalities in fisheries and agency surveys. This percentage deduction from the upper end of the GHR accounts for additional uncertainty in the estimate of the OFL. ACL(s) will be set equal to the ABC(s). There are two options considered under this alternative for specifying ACLs: statewide (Alternative 3a) and by region (Alternative 3b).

Alternative 3a: Statewide
Here the ACL and ABC would both be established as 90% of the sum of the upper ends of the GHRs and discard mortalities for all regions.

Alternative 3b: Regional
Here an ACL and ABC would both be established for each region at 90% of the sums of the upper ends of the GHRs and discard mortalities for each individual region.

2.1.2.3 Alternative 4: ABC control rule = 75% of GHR

Alternative 4 establishes an ABC control rule such that ABC is established annually at a level equal to 75% of the OFL, defined as the sum of the upper end of the GHRs and estimated discard mortalities in fisheries and agency surveys. This percentage deduction from the upper end of the GHR further accounts for additional uncertainty in the estimate of the OFL. ACL(s) will be set equal to the ABC(s). There are two options considered under this alternative for specifying ACLs: statewide (Alternative 4a) and by region (Alternative 4b).

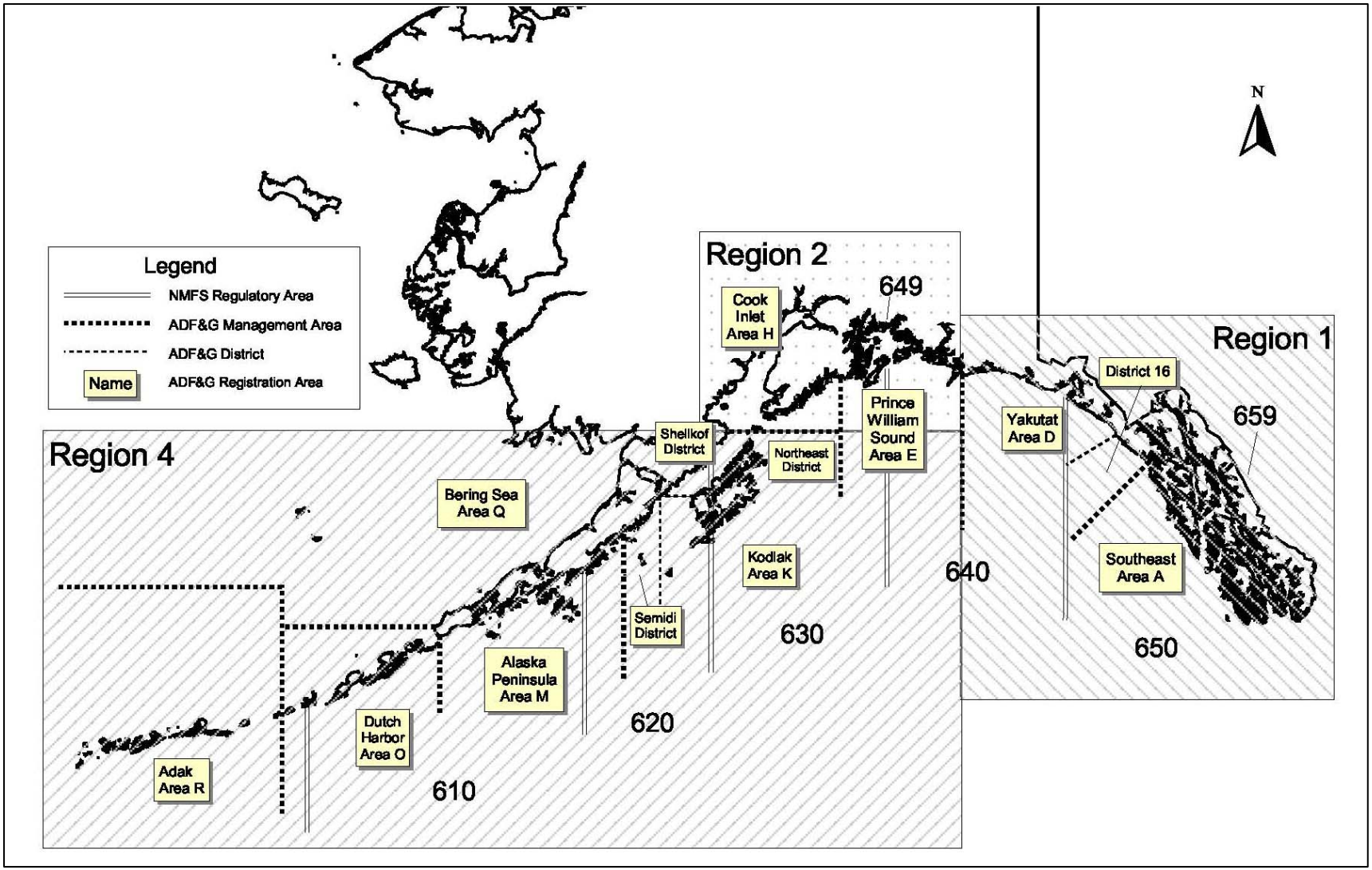

Figure 2-1 Location of ADF&G registration areas in relation to ADF&G regions (shown as patterned rectangles) and NMFS regulatory areas (shown as 3-digit numbers for the Gulf of Alaska).

Table 2-1 Alternatives 1-4 under consideration in this analysis and associated ACLs statewide and by region.

	ADF&G Region	Alternative 1 Upper end of GHR (no ACL)	Alternative 2a ACL = 100% GHR SW	Alternative 2b ACL = 100% Region GHR	Alternative 3a ACL = 90% GHR SW	Alternative 3b ACL = 90% Region GHR	Alternative 4a ACL = 75% GHR SW	Alternative 4b ACL = 75% Region GHR
Yakutat	1	250,000		261,870		235,680		205,730
District 16	1	35,000		36,660		33,000		28,800
Region 1 Total		**285,000**		**298,530**		**268,680**		**234,530**
PWS	2	50,000		51,280		46,160		39,450
Cook Inlet	2	20,000		20,510		18,460		15,780
Region 2 Total		**70,000**		**71,790**		**64,620**		**55,230**
Kodiak	4	300,000		309,750		278,770		239,860
Alaska Pen.	4	100,000		103,250		92,920		79,950
Dutch Harbor	4	110,000		113,570		102,220		87,950
Adak	4	75,000		77,440		69,690		59,970
Bering Sea	4	300,000		309,750		278,770		239,860
Region 4 total		**885,000**		**913,760**		**822,370**		**707,590**
Statewide		**1,240,000**	**1,284,080**		**1,155,670**		**997,350**	

All alternatives are in meat weights (lbs); "GHR" = Guideline Harvest Range; "SW' = Statewide.

Alternative 4a: Statewide
Here the ACL and ABC would both be established as 75% of the sum of the upper ends of the GHRs and discard mortalities for all regions.

Alternative 4b: Regional
Here an ACL and ABC would both be established for each region at 75% of the sum of the upper end of the GHR and discard mortalities for each individual region.

2.1.3 Accountability Measures

As noted in Section 1.3 accountability measures (AMs) are also a required provision of the MSRA in conjunction with provisions for ACL requirements. The intent of the AMs is to further protect a stock from overfishing by providing for a transparent response mechanism in the event that the established ACLs are exceeded. Several preliminary discussions have occurred on appropriate AMs for a delegated management situation, such as with the Scallop FMP. These ideas include:

1. Defer AMs to the State with Federal oversight through the annual SAFE report as to whether the ACLs were exceeded, and, if so, what action was taken by the State;
2. Consider a layered AM approach with specific State AMs that would be instituted initially upon an ACL being exceeded; with Federal AMs in place should the State measures not prove to be effective;
3. Consider a performance standard over a period of years (e.g., "If ACLs are exceeded more than once over a five year time frame, then…") which would outline a process whereby the system of ACLs and AMs could be revisited.

In considering the first option, ADF&G has responsibility for setting the annual GHLs (Table 1-1). In the event of exceeding the ACL, ADF&G would have the appropriate information to take corrective measures, under oversight of the Council through the annual SAFE report, when setting subsequent GHLs. The second option involving a layered approach may be overly complex, particularly if the GHL is ultimately set by ADF&G based on recent fishery performance, and if the ACL is exceeded statewide or in a particular region, ADF&G would presumably take corrective measures when setting the subsequent GHL (as is presented in the first option). The third option, establishing a performance standard over a series of years, would provide less protection to the scallop resource than the first option in which the accountability measures are implemented as needed on an annual basis with an annual review through the SAFE report.

2.1.4 Options for non-target stocks (applies to all)

"Target stocks" are scallop stocks that are retained for sale or personal use, including "economic discards" as defined under Magnuson-Stevens Act section 3(9). "Non-target stocks," including "non-target species," are fish caught incidentally during the pursuit of target stocks in a fishery, including "regulatory discards" as defined under Magnuson-Stevens Act section 3(38). Non-target stocks may or may not be retained for sale or personal use. Non-target species, if included in a fishery, should be identified at the stock level.

These options deal with the treatment of non-target scallop stocks under the FMP. One of the three options below must be selected for management of the non-target stocks. Although the weathervane scallop has comprised the primary scallop fishery off Alaska, other species of scallop are contained under the FMP and sporadic efforts have been made to harvest the pink scallop (*Chlamys rubida*), arctic pink scallop (*C. pseudoislandica*), and spiny scallop (*C. hastata*) (Kruse 1994). A total of approximately 124,000 lbs of meats of *Chlamys* sp. harvested along the Aleutian Islands between 1991 and 1992 comprise the sole records of non-weathervane scallop landings in the ADF&G fish ticket database (C. Russ, ADF&G, Homer, pers. comm.). In addition, the rock scallop (*Crassadoma gigantea*) is harvested

by divers for personal use in nearshore waters of Southeast Alaska, and continuing investigations have examined aquaculture techniques for rock scallop (Agosti 2001; J. Hetrick, Alutiiq Pride Shellfish Hatchery, Seward, pers. comm.).

2.1.4.1 Option 1: Remove from FMP

This option would remove scallop species, excluding weathervane scallop, from the scallop FMP. Once removed, management authority for these removed species would default to the State of Alaska. The State of Alaska would regulate fishing for these species by vessels registered under State law. This action would allow the State to implement more responsive, regionally based, management of these species than is currently possible under the FMP. The intended effect of this action would be to repeal duplicative Federal regulations, provide for more responsive State management, and prevent localized overfishing of non-target scallop species occurring predominantly in nearshore waters.

2.1.4.2 Option 2: Move to Ecosystem component

This option would move non-target scallop stocks to an ecosystem component under the FMP for which ACLs are not established. Under the ecosystem component, targeting of these species would not be possible without moving them "into the fishery" and establishing ACLs for these stocks. While these stocks are currently not targeted commercially, moving them to the ecosystem component would be intended to discourage uncontrolled fishing on these species without applicable management measures in place should they become economically viable in the future. There is currently is a low-level personal use/subsistence fisheries for some of these species.

Some non-target species may be identified in an FMP as ecosystem component (EC) species or stocks. "Ecosystem component (EC) species" generally are not retained for any purpose, although *de minimis* amounts might occasionally be retained.

To be considered for possible EC classification, species should, among other considerations, conform to the following criteria; conversely, failure to satisfy these criteria could eliminate some groups from further consideration as EC stocks.

- Be a non-target species or non-target stock;
- Not be determined to be subject to overfishing, approaching overfished, or overfished;
- Not be likely to become subject to overfishing or overfished in the absence of conservation and management measures; and
- Not generally be retained for sale or personal use.

The EC species may be identified at the species or stock level, and may be grouped into complexes. Determination of conformity to the above criteria may require more in-depth analysis, with contributions by ADF&G and NMFS, than is provided in this document. In addition, a periodic assessment of these non-target stocks would be beneficial. The EC species may be included in an FMP or FMP amendment for any of the following reasons:

> "…for data collection purposes; for ecosystem considerations related to specification of OY for the associated fishery; as considerations in the development of conservation and management measures for the associated fishery; and/or to address other ecosystem issues. While EC species are not considered to be "in the fishery," a Council should consider measures for the fishery to minimize bycatch and bycatch mortality of EC species consistent with National Standard 9, and to protect their associated role in the ecosystem. EC species do not require specification of reference points but should be monitored on a regular basis, to the extent practicable, to

determine changes in their status or their vulnerability to the fishery. If necessary, they should be reclassified as in the fishery."

Beyond identifying the stocks in the fishery, a Council may, but is not required to, include EC species in an FMP. Such species could include non-target fish species that are not considered part of the fishery, but are species with which the fishery may occasionally interact (i.e., catch) (see § 600.310(d)(5). As a default, all stocks in an FMP are considered to be "in the fishery" unless otherwise classified through an FMP amendment (see § 600.310(d)).

Thus, identification of EC species must occur through an FMP amendment (see § 600.310(d)). Such species are appropriate to consider when addressing specification of OY and conservation and management measures for the fishery (see MSA sections 3(33) (referring to taking into account the marine ecosystems in OY definition), and 3(5) (referring to avoiding irreversible or long-term effects on fishery resources and the marine environment and ensuring multiplicity of options)). Because EC species are not considered to be in the fishery, specification of reference points and ACLs are not required.

2.1.4.3 Option 3: Set ACL for those stocks

This option would set ACLs for the non-target species *Chlamys* sp. and rock scallops. Currently there is little stock assessment and fishery performance data on which to base the ACLs. Thus, determination of ACLs would rely primarily on the limited data available from ADF&G and NMFS trawl surveys. Species identification for non-target scallops can be highly uncertain (e.g., non-weathervane scallop were often recorded simply as *Chlamys*), particularly for ADF&G and older NMFS survey data. Thus, for purposes of this preliminary analysis, non-target scallop species were pooled into a non-target group rather than at the species level. Although area-swept estimates from the trawl survey data may be extrapolated to population estimates, the available data is fairly sparse and extrapolation was beyond the scope of our analysis. Therefore, available survey catch data are summarized at both the statewide and the regional levels.

In order to establish an aggregate ACL for the non-target species, it is first necessary to establish an OFL for the non-target species. An ACL could then be established as a fixed proportion of the OFL similar to the options considered under Alternatives 2-4. Three approaches could be considered for establishing an OFL for these aggregate non-target scallop stocks.

1. Extrapolate area-swept estimates from agency surveys to population estimates, and set the ABC as some fixed proportion of the average annual population estimate. This approach would require spatial analysis of the survey data to provide for some averaging approach between surveys occurring in the same geographic location (e.g., there is likely some spatial overlap between the NMFS and ADF&G surveys in Region 4). This approach is complicated because survey catchability is unknown for non-target species, but likely differs between the ADF&G and NMFS survey gears.

2. Set the OFL as fixed portion of the average annual catch. Given that the only documented harvest of non-target species was 124,000 lbs of meats in 1992 and 1992, this approach would reply on an average annual catch of 62,000 lbs of meats. However, there is high uncertainty in this estimate since it is based on only two years of data and localized catch locations.

3. Set a non-target OFL in relationship to estimated discard mortality needs. This approach relies on agency survey data and could include discard information from the groundfish fisheries. Because groundfish fishery discards are presently pooled into a "bivalve" category, this approach would overestimate historical discards. A problem with setting the OFL according to historical discard

mortality is the uncertainty in how well the historical data represent the trends and spatial distribution of the non-target species. For example, the groundfish fishery data on bivalve discards exists only since 2003. An increase in stock abundance of non-target species would likely increase discard mortality in agency surveys and various fisheries, perhaps resulting in the OFL being exceeded at a time when stock abundance is high.

2.1.5 ABC recommendation annually by SSC

Included under all alternatives (with the exception of status quo) will be a review of ACLs annually by the SSC (in April) with a resulting recommendation for the upcoming fishing year. The SSC annually reviews the status of statewide scallop stocks at the April SSC meeting. In conjunction with amending the FMP to annually establish ACLs for scallop stocks by one of the alternatives as listed above, the SSC will annually recommend an ABC (and thus an ACL) to the Council for scallop stocks. This will not change the timing of scallop management and annual establishment of GHLs by the State. The GHL(s) must be established at or below the annual ACL, with sufficient buffer below the ACL(s) to allow for any incidental catch of scallops in either directed or non-directed fisheries.

2.2 Alternatives considered and not carried forward for analysis

In the development of this analysis, several alternatives were considered but not carried forward due to a lack of available information upon which to base ACLs. In addition to the constant buffer approach in the alternatives for analysis, two measures were recommended during the NPFMC's ACL workshop in May 2009 (NPFMC 2009c). These were to re-estimate MSY based upon the older catch history time frame and to estimate scallop density in unfished areas using trawl survey and other scallop survey information.

The current proxy MSY is based on historical average catch by ADF&G registration area, but excluding years of fishery development, considered to over-estimate productivity, and also years when catches were extremely low, considered to under-estimate productivity (Kruse 1994; NPFMC 2006). If an older estimate of average catch were considered, it would include years when the fishery was developing, which could over-estimate productivity. Based on more recent information, including fishery performance, observer sample, and survey data, GHLs implemented by the state have resulted in catches substantially less than the proxy MSY, suggesting that the existing proxy MSY may be overly optimistic under current environmental conditions. Tools such as the video imaging system currently being developed to provide distribution and density data (Rosenkranz et al. 2008) or development of age-structured models (Bechtol 2000) would improve our understanding of weathervane scallop stocks and allow the proxy MSY to be better evaluated. However, a formal re-evaluation of the current proxy MSY is not realistic at this time due to a lack of sufficient new information.

Extrapolation of scallop density estimates into other areas based on NMFS trawl survey data would also be problematic due to two primary factors. First, because weathervane scallops tend to occur at, or slightly imbedded in, a sand, silt, and/or clay substrates (Turk 2000), survey bottom trawls tend to "ride" over most scallops, making the trawl an inefficient sampling tool. Second, the high density scallop beds exhibit patchy distributions such that coarse extrapolation of scallop densities may provide unrealistic expectations with high uncertainty in potential scallop yield. Dredge surveys are currently used in the Central Region (Region 2) to set GHLs for Kayak Island (Area E) and Cook Inlet (Area H; NPFMC 2010b). In all other areas, the scallop observer program provides the primary data for setting GHLs. These data consist of a time series of scallop harvest and fishing effort, including catch per unit effort (CPUE), fishing locations, size structure of the catch, discard of scallops, and crab bycatch. A towed imaging system to survey scallop beds is currently being developed by ADF&G with (Rosenkranz et al. 2008). At present, extension of the dredge survey to other areas is not feasible due to survey costs, and

the towed imaging system is still under development. Thus, expansion of scallop density estimates into all areas was not carried forward at this time.

In addition, analysis to a finer spatial scale of resolution was considered but not carried forward for several reasons. First, fishery prosecution at the registration area scale has been highly variable over time in many of the areas in response to fluctuations in stock status, fleet dynamics, and closure of some historical fishing areas to provide greater protection to benthic species (e.g., crabs) and their habitat. This variability makes it difficult to characterize patterns for some of the registration areas. Second, the scallop fleet tends to operate as a statewide fleet, moving on relatively short notice among regions or registration areas in response to market conditions, other vessels, catch rates, and other factors. Third, preliminary genetic analysis suggests that little genetic variability exists among scallop aggregations located in areas from the Gulf of Alaska to the Bering Sea (Gaffney et al. under review.). Thus, annual catch limits at scales larger than registration area may be justified.

Finally, an alternative that lumps non-target scallop species into a scallop complex was considered but not carried forward. Because we currently lack sufficient data to assess non-target species (see section 4.6), management of a scallop complex would rely on the weathervane scallop abundance. Under such a scenario, a rapid increase in harvests of non-target species would not automatically trigger management controls of the "scallop complex," potentially putting the non-target species at risk.

Chapter 3 Methodology

Management of weathervane scallops by ADF&G occurs on scales ranging from registration area to individual documented beds (e.g., the east and west beds around Kayak Island). Within the spatial scale of the management unit, ADF&G applies a guideline harvest level (GHL), representing an acceptable fishery harvest removal based on fishery expectations derived from both short- and long-term fishery performance and assessment data. The GHL may not exceed the guideline harvest range (GHR); GHRs are hard caps established in State of Alaska regulation for each registration area and are not to be exceeded. The currency used for management of weathervane scallop fisheries off Alaska is lbs of shucked scallop meats. Amendment 6 to the FMP established an overfishing level for weathervane scallops as a fishing rate ($F_{overfishing}$) in excess of the natural mortality rate M = 0.13 (NPFMC 2006). An Optimum Yield range was specified as 0-1.24 million lbs of shucked scallop meats statewide. The upper bound of this range was established as the proxy MSY for weathervane scallops, and as noted previously, is based on the average catch from 1990-1997 (excluding 1995).

This analysis of proposed alternatives relies heavily on data available in NPFMC documents (NPFMC 2006, 20010b) and data provided by various staff from NMFS or ADF&G. For this analysis, we examined ACL alternatives based on the upper ends of the GHRs as defined under Chapter 38 Miscellaneous Shellfish Fisheries in State regulation. The analysis was restricted to the ADF&G regions where commercial scallop fishing occurs: Region 1 includes the Southeast Alaska and Yakutat Areas; Region 2 includes the Prince William Sound and Cook Inlet Areas; and Region 4 includes the Westward Area (Figure 2-1). For the analysis, we evaluated harvests and discards for the years 1990–2008, particularly focusing on the years 1998–2008 as representing fishery and survey data following implementation of the 1.24 million lb MSY (Table **3-1**).

Under Alternative 1, Status Quo, the ACL was set equal to statewide sum of the upper ends of the Registration Area GHRs, or 1.24 million lbs (562.4 mt) of meats, applied statewide to federal waters off the coast of Alaska. In examining Alternatives 2–4, the ACL is defined as a fixed percentage (100, 90, or 75%) of the OFL. For Alternative 5, the ACL is estimated using the P* approach. Because the OFL should ideally consider all sources of fishing mortality, the OFL under Alternatives 2–5 was redefined to be the sums of the upper ends of the GHRs plus estimated discard mortalities in the directed scallop fishery, the groundfish fishery, and agency surveys. The ACL alternatives based on the GHRs plus discards were evaluated at both the statewide level and by ADF&G region. For evaluation at the regional level, the upper ends of the registration area GHRs and discards were pooled within ADF&G management region.

3.1 Scallop discard estimation and associated mortality

Discards of scallops and corresponding discard mortality, in the directed scallop fisheries is currently taken into consideration by ADF&G fishery managers when setting a GHL, the pre-season harvest target, but is not deducted from the GHL. Discard mortality also occurs in non-scallop fisheries and in agency surveys. To better understand the impacts of the alternatives on total scallop mortality and potential management implications, the maximum GHL was calculated as the deduction of an estimate of total discard mortality from the ACL derived under each alternative. Evaluation of the impact of Alternative 1 (status quo) includes no accounting for scallop discards in either directed scallop fisheries or non-scallop fisheries. Analyses of Alternatives 2–5 incorporate estimates of incidental scallop discard mortality; mortality sources considered included directed scallop fisheries, federal groundfish fisheries, and agency surveys. Data on estimated scallop bycatch in other non-scallop EEZ fisheries (e.g., crab fisheries) is either not available or is believed to be negligible. For Alternatives 2–5, discard mortality was evaluated at both the statewide and regional levels.

Table 3-1 Annual weathervane scallop harvests and percentages of the upper end of the regulatory GHRs by ADF&G region for the 1998/99 to 2008/09 fishing seasons.

	Region			
Year	1	2[a]	4	Statewide
	Annual harvest (lbs of shucked meats)			
1998/99	275,831	19,650	508,117	803,598
1999/00	284,305	40,725	512,941	837,971
2000/01	226,603	50,782	473,232	750,617
2001/02	124,198	30,090	398,453	552,741
2002/03	126,403	24,232	358,820	509,455
2003/04	161,990	19,980	302,566	484,536
2004/05	111,380	55,437	264,777	431,594
2005/06	213,001	49,205	263,151	525,357
2006/07	164,395	36,990	286,088	487,473
2007/08	126,140	37,105	295,068	458,313
2008/09	171,275	20,040	151,119	342,434
Mean	180,502	34,931	346,757	562,190
CV (%)	34.0	37.7	33.2	28.8
MSY	285,000	70,000	885,000	1,240,000
	Annual harvest percentage of the upper end of the GHR			
1998/99	96.8	28.1	57.4	64.8
1999/00	99.8	58.2	58.0	67.6
2000/01	79.5	72.5	53.5	60.5
2001/02	43.6	43.0	45.0	44.6
2002/03	44.4	34.6	40.5	41.1
2003/04	56.8	28.5	34.2	39.1
2004/05	39.1	79.2	29.9	34.8
2005/06	74.7	70.3	29.7	42.4
2006/07	57.7	52.8	32.3	39.3
2007/08	44.3	53.0	33.3	37.0
2008/09	60.1	28.6	17.1	27.6
Mean % of MSY	63.3	49.9	39.2	45.3
CV (%)	34.0	37.7	33.2	28.8

[a] Due to confidentiality resulting from low fishing effort, Region 2 data includes Cook Inlet catches only in the 1999/00, 2000/01, 2002/03 and 2004/05 seasons.
Sources: G. Rosenkranz, ADF&G, Kodiak, pers. comm.; NPFMC 2010b

Weathervane scallops may be discarded rather than shucked due to market considerations, such as meat color or small scallop size (the minimum dredge ring size is currently 4 inches [101.6 mm]), or due to excessive mechanical damage to the scallop from the capture process. Discarded scallops may suffer mortality on deck due to mechanical damage or physiological stress such as temperature change or desiccation, or suffer post-discard mortality due to physiological stress or increased predation from shell damage or an inability to swim. On deck mortality from mechanical damage may be less for smaller scallops (J. Stone, pers. comm.), although no formal studies have been conducted off Alaska. For Atlantic scallops (*Placopecten magellanicus*), Murawski and Serchuk (1989) estimated about 90% of

tagged scallops were alive several days after being returned to the water. Total discard mortality of Atlantic scallops remains uncertain, but is estimated as 20% from the combined on-deck (10%) and post-release (10%) mortality (NEFSC 2007). In the absence of additional information, we applied a 20% mortality to discards from the directed scallop fishery off Alaska.

Scallop discards in the directed scallop fisheries off Alaska were generally estimated by scallop observer program samples during the fishing seasons 1998/1999 to 2008/2009 (Table 3-2). Due to a more limited and sporadic fishing effort among years, estimated discards in the Cook Inlet scallop fishery only included data for the 1999/2000 to 2005/06 seasons (Table 3-2). Because of harvest confidentiality due to a small number of permit holders in many fishing seasons, Cook Inlet discard data were not available as annual estimates but were obtained as an aggregate total (2,327.5 lbs of meats) among the seven seasons. No bycatch data were available for Cook Inlet fisheries following the 2005/2006 season. Thus, the average Region 2 bycatch estimates were calculated as the annual average for the Prince William Sound fishery combined with the average for the Cook Inlet fishery for years in which data were available.

Because the observer estimates were initially calculated as round weight (except data on meat weights were used in Cook Inlet), discard estimates were converted to shucked scallop meat weights to provide consistency with the currency used for management. Scallop meats represent approximately 8-12% of the round weight depending on area and season (Barnhart and Rosenkranz 2003), so a median meat recovery of 10% was used to convert scallop discard estimates to meat equivalents for this ACL analysis. Estimated scallop discards in the directed scallop fisheries were summarized by region and statewide. Annual statewide discards in the scallop fisheries ranged from 75,715 lbs of meats in 2008/09 to 123,938 lbs in 2007/08 (Table 3-2). Mean annual scallop discards in the directed scallop fisheries totalled 97,803 lbs (CV = 5%) of meats statewide for the 1998/1999 to 2008/2009 fishing seasons. Within regions, annual discards generally exhibited moderate interannual variability with CVs of 9% in Regions 1 and 4 and 21% in Region 2. The largest component of the annual discards, 50,815 lbs of meats (52% of the statewide total), occurred in Region 4, followed by 42,830 lbs (44% of total) in Region 1, and 4,158 lbs (4% of total) in Region 2. Using a 20% discard mortality rate to extrapolate to discard mortality in the directed scallop fisheries resulted in annual estimates of 8,566 lbs of meats in Region 1, 832 lbs in Region 2, and 10,163 lbs in Region 4, totalling to 19,561 lbs of meats statewide (Table 3-2).

Discard mortality also occurs in non-scallop fisheries, but estimates have even greater uncertainty due to a lack of studies in on-deck and delayed mortality in non-scallop fisheries, the lack of historical data, and limits of the current scallop identification protocol. Bycatch estimates, derived from the groundfish observer program and extrapolated to the groundfish fleet level, were obtained from the NMFS Alaska Regional Office as summarized by discarded whole weight (mt) by NMFS regulatory area for the years 2003–2009 (J. Gasper and G. Harrington, NMFS, Juneau, pers. comm.). No data are currently available for years prior to 2003. Under the current groundfish observer reporting system, all bivalves (e.g., clams, mussels, scallops) are categorized as class Pelecypoda, with no further taxonomic break-down. In the absence of more comprehensive data, we treated the Pelecypoda estimate as total scallop bycatch. Because these bycatch values overestimate, by an undetermined amount, the true scallop bycatch in the groundfish fisheries, the estimates are assumed to be conservative. We used a meat recovery of 10% to convert scallop bycatch estimates from the round weight reported by the groundfish observer program to the meat weights currency applied in the scallop fishery. Finally, in the absence of additional information, we applied a discard mortality rate of 20%, similar to that for discards in the directed scallop fishery (see above). The 20% mortality assumption may overestimate true scallop discard mortality, but provides a reasonable approach given the available data.

Table 3-2 Estimated scallop discards (lbs of meats) in directed scallop fisheries by ADF&G management region for the 1998/1999 to 2008/2009 fishing seasons.

	ADF&G Region			
	1	2[a]	4	Total
Seasons	Estimate meat weight (lbs)			
1998/99	29,680	1,279	60,743	91,701
1999/00	59,089	1,850	53,536	114,475
2000/01	64,020	1,383	34,457	99,860
2001/02	32,118	2,382	42,456	76,956
2002/03	37,309	756	71,844	109,910
2003/04	39,864	4,996	54,857	99,717
2004/05	23,781	8,279	70,194	102,255
2005/06	43,183	6,409	39,964	89,556
2006/07	40,842	3,810	43,440	88,092
2007/08	52,610	7,965	63,364	123,938
2008/09	48,636	2,966	24,112	75,715
Total	471,132	44,404	558,965	1,074,501
Average	42,830	4,158	50,815	97,803
Standard Dev.	12,396	2,713	15,232	15,020
Standard Error	3,738	818	4,593	4,529
CV (%)	8.7	19.7	9.0	4.6
	Average annual discard mortality[b]			
	8,566	832	10,163	19,561

[a] Confidential data for Cook Inlet is included in Region 2 total and average, but excluded from annual estimates.
[b] Discard mortality was assumed to be 20%.
Sources: G. Rosenkranz, ADF&G, Kodiak, pers. comm.; C. Trowbridge, ADF&G, Homer, pers. comm.

In the GOA, annual scallop bycatch in the federal groundfish fisheries has ranged from 392 lbs of meats in 2004 to 1,479 lbs in 2007 (mean = 985, CV = 17%; Table 3-3). Annual bycatch has generally increased during the years 2003–2009. During these years, Regulatory Area 630 accounted for 62% (annual mean of 607 lbs of meats) of the GOA scallop bycatch. Annual scallop bycatch in the federal groundfish fisheries of the BSAI was highest in 2003 (5,776 lbs of meats), declined to a low of 1,163 lbs in 2007, and increased in 2008 and 2009 (Table 3-3). Mean bycatch among years was 2,924 lbs of meats (CV = 21%). Regulatory Area 509 accounted for 49% (annual mean of 1,439 lbs of meats) of the BSAI scallop bycatch. Statewide scallop bycatch averaged 3,909 lbs of meats annually (CV = 12%), ranging from 2,643 lbs in 2007 to 6,247 lbs in 2003. The BSAI generated the largest component of the statewide scallop bycatch (75% of statewide total) in all years except 2007. Mortality extrapolated from the groundfish fisheries under a 20% discard mortality rate averaged 782 lbs of meats annually (Table 3-3), comprised of 3 lbs from Region 1, 2 lbs from Region 2 and 777 lbs from Region 4.

Table 3-3 Bivalve bycatch (lbs of shucked meats) estimated by the groundfish observer program.

Regulatory Area	Year							Mean	C.V. (%)
	2003	2004	2005	2006	2007	2008	2009		
Gulf of Alaska									
610	41.8	53.8	149.8	93.8	55.4	58.4	537.8	141.5	47.7
620	135.2	140.8	155.6	441.6	191.2	203.0	204.1	210.2	19.1
630	293.6	196.9	904.4	605.1	1,232.0	503.4	514.9	607.2	22.2
640	0.1	0.0	0.0	0.3	0.2	10.7	87.8	14.1	87.5
649	0.0	0.0	0.0	0.0	0.1	0.7	22.5	3.3	96.0
650	0.3	0.1	0.0	0.0	0.0	0.0	24.4	3.5	98.4
659	0.4	0.0	0.0	0.2	0.4	7.9	23.0	4.6	71.4
Total	471.4	391.6	1,209.8	1,140.9	1,479.2	784.0	1,414.5	984.5	16.9
Bering Sea/Aleutian Islands									
508	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	98.2
509	1,495.9	2,591.5	872.4	858.3	352.5	1,960.3	1,944.7	1,439.4	20.6
512	1.4	0.0	0.0	0.0	0.0	0.4	0.0	0.3	72.7
513	274.1	221.1	178.8	44.4	37.3	145.6	32.4	133.4	27.6
514	53.9	70.5	48.1	65.9	101.5	11.8	38.8	55.8	19.0
516	2.2	3.0	1.7	1.1	0.0	0.6	4.7	1.9	31.6
517	587.9	931.3	470.4	184.4	73.8	556.2	248.8	436.1	25.4
518	1.0	1.1	1.4	1.3	0.4	3.5	3.4	1.7	26.4
519	65.4	95.9	28.8	17.7	11.6	18.2	10.7	35.5	34.7
521	69.0	75.3	19.3	25.9	70.6	24.8	146.2	61.6	27.3
523	0.7	1.4	1.1	0.1	1.9	0.0	3.4	1.2	36.3
524	1.7	25.1	102.8	30.9	24.9	62.9	20.0	38.3	33.3
541	1,364.0	282.9	36.8	486.1	461.6	159.1	99.9	412.9	41.5
542	1,858.8	57.2	84.3	97.4	23.8	10.0	6.0	305.4	84.9
543	0.3	0.0	0.0	0.0	3.5	0.2	1.3	0.8	64.0
Total	5,776.1	4,356.6	1,845.9	1,813.4	1,163.4	2,953.6	2,560.3	2,924.2	21.0
Statewide									
Total	6,247.4	4,748.2	3,055.7	2,954.4	2,642.6	3,737.6	3,974.8	3,908.7	12.1
Annual average discard mortality [a]									
	1249.5	949.6	611.1	590.9	528.5	747.5	795.0	781.7	12.1

[a] Discard mortality was assumed to be 20%

Source: J. Gasper and G. Harrington, NMFS, Juneau, pers. comm.

Scallop discard mortality in several agency surveys was also examined. For example, ADF&G uses an 8-foot New Bedford style scallop dredge to conduct scallop surveys in Areas E and H of Region 2 (Bechtol 2003; Bechtol et al. 2009). In addition, ADF&G conducts multi-species surveys using a 400 Eastern bottom trawl in Region 2 (Registration areas E and H) and in Region 4 (Registration areas K, M, and O; Bechtol 2005; Spalinger 2009; M. Stichert, ADF&G, Kodiak, pers. comm.; M. Spahn, ADF&G, Homer, pers. comm..). For waters of the Gulf of Alaska and Bering Sea, NMFS conducts multi-species surveys with a standard 83-112 Eastern bottom trawl (von Szalay 2008; Lauth 2010; R. Foy, NMFS, Kodiak, pers. comm.). Because our intent was to estimate actual discard mortality, data from these surveys were

obtained as unscaled survey catches, (i.e., the actual catches, before standardizing for tow length or extrapolation to area swept estimates), then summarized by both region and statewide. Similar to the above discard calculations, we applied a meat recovery rate of 10% to convert to meat weights from survey round weight, and then a discard mortality rate of 20% (Table 3-4).

Due to survey timing, the NMFS trawl survey primarily caught scallops on odd-numbered years, largely reflecting survey location, such as the NMFS biennial survey of the GOA (von Szalay 2008). Estimates of discard mortality in weathervane scallops by agency surveys was relatively minor during 1998-2008, averaging 259 lbs (CV=7.6%) of meats statewide, comprised of 0.1 lbs (<1% of total) from Region 1, 130 lbs (50.3% of total) from Region 2, and 129 lbs (49.6% of total) from Region 4 (Table 3-4). The ADF&G trawl surveys generated the largest component (148 lbs of meats) of the discard mortality, followed by the ADF&G dredge survey (110 lbs), and the NMFS trawl survey (2 lbs).

Our analysis did not examine incidental mortality incurred as a result of contact with fishing or survey gear or sediment disturbance, but in cases where scallop are not captured by the gear. Such mortality could involve mechanical damage from contact with the gear or being buried due to sediment redistribution by the gear. Calculation of incidental mortality in Atlantic scallops relies on estimation of gear efficiency, or the probability that a scallop in the path of the gear is captured, and the mortality rate for scallops in the path of the gear (NEFSC 2007). Due to the difficulty in estimating these parameters, we did not incorporate incidental mortality into this analysis.

3.2 Discard mortality allocation among regions

Although weathervane scallops are found broadly throughout the subtidal marine environment, the occurrence of beds with high densities of scallops is relatively limited. In addition, the spatial distribution of the scallop fishery is substantially less than the distribution of the groundfish fishery. Therefore, our analysis of Alternatives 2–5 applied two approaches for incorporating discard mortality. For alternatives considering ACLs at the statewide level, scallop bycatch was pooled across all NMFS regulatory areas. This approach considers that, although scallops are managed on relatively discrete scales, the FMP examines scallops across all of Alaska. Therefore, available data on scallop discard mortality in all federal groundfish fisheries and agency surveys, even in areas without active scallop fisheries or documented beds, was deducted from the statewide ACL. For alternatives considering ACLs at the regional level, scallop discard mortality in agency surveys was assigned to the corresponding ADF&G region based on tow location. However, bivalve bycatch from the federal groundfish fisheries, initially designated only to NMFS regulatory area, was apportioned to the ADF&G regional management areas based on the distribution of the primary scallop beds within the NMFS regulatory areas. In cases where the groundfish catch accounting system allocated scallop bycatch to areas where no scallop fishing occurred, the estimated bycatch was assigned to the encompassing or nearest ADF&G region. For example, although no commercial fishing for weathervane scallops occurs in NMFS Regulatory Area 659, the catch accounting system assigns scallop bycatch to NMFS Regulatory Area 659; therefore, we allocated the Area 659 bycatch to ADF&G Region 1. Allocation of bycatch among ADF&G regions during recent years is shown in Table 3-5. Based on this allocation, the bycatch within a region was assumed to have a 20% discard mortality and converted to meat equivalents by assuming a 10% meat recovery. The ratio of the meat discard mortality compared to the pounds of meats retained by the directed scallop fishery was converted to a discard mortality rate for the directed scallop fishery, the groundfish fishery, and agency surveys within each ADF&G region (Table 3-6).

Table 3-4 Annual (A) biomass and estimated discard mortality (lbs of meats) of weathervane scallops and (B) biomass (whole lbs) of non-target scallops captured in ADF&G and NMFS surveys within ADF&G management region during 1998-2008.

	Region 1		Region 2				Region 4		
Year	NMFS Trawl	Region Total	ADF&G Dredge	ADF&G Trawl	NMFS Trawl	Region Total	ADF&G Trawl	NMFS Trawl	Region Total
A. Weathervane scallops									
			Survey catch (lbs of meats)[a]						
1998			535	39		574	533		533
1999	<1	<1	623	222	2	847	574	1	575
2000			705	60		764	517		517
2001	0	0	742	339	0	1,081	536	13	548
2002			236	87		322	407		407
2003	<1	<1	552	117	<1	669	580	11	591
2004			975	52		1,027	732		732
2005	1	1	335	102	1	437	619	3	622
2006			590	42		632	997		997
2007	1	1	411	56	<1	467	927	6	933
2008			337	13		350	610		610
Mean	0.5	0.5	549.1	102.5	0.6	651.8	639.2	6.9	642.3
CV (%)	37.4	37.4	12.4	29.2	51.3	12.5	8.7	32.7	7.6
			Estimated weathervane scallop discard mortality (lbs of meats)[b]						
Mean	0.1	0.1	109.8	20.5	0.1	130.4	127.8	1.4	128.5
B. Non-target scallop species									
			Survey Catch (whole lbs)						
1998			NA	46		46	75		75
1999	1	1		6	10	15	68	36	105
2000				33		33	109		109
2001	0	0		53	2	55	23	32	55
2002				15		15	19		19
2003	2	2		12	2	13	33	96	129
2004				38		38	11		11
2005	3	3		10	3	14	3	111	114
2006				18		18	20		20
2007	0	0		7	2	9	15	77	92
2008				<1		<1	8		8
Total	5	5		238	18	257	384	352	736
Mean	1.0	1.0		21.7	3.7	23.3	34.9	70.3	66.9
CV (%)	55.1	55.1		24.9	43.0	22.2	29.3	22.4	20.8

[a] Meat weight based on a median meat recovery of 10% statewide.
[b] Discard mortality assumes a 20% mortality on scallops that were captured, but nor retained.

Table 3-5 TheADF&G registration area in relation to the corresponding ADF&G Region, estimated annual discard mortality (lbs of shucked meats) in the directed scallop fisheries, federal groundfish fisheries, and agency surveys, and the total estimated scallop bycatch during 1998/98–2008/09.

			Groundfish fishery discards			
ADF&G Registration Area	ADF&G Region	Directed fishery discards (lbs)	Allocated Regulatory Area [a]	Bycatch fishing mortality (lbs)	Agency survey mortality (lbs)	Total annual discard mortality (lbs)
Yakutat	1		650, 659 and half of 640	3		
District 16	1		Pooled with Yakutat	With above		
Region 1 Total	1	8,566		3	<1	8,569
PWS	2	765	Half of 640 and 649	2		
Cook Inlet	2	67	0	With above		
		832		2	130	964
Kodiak	4		630 and half of 620	142		
Alaska Pen.	4		Half of 620 and half of 610	35		
Dutch Harbor	4		Half of 610	14		
Adak	4		541	83		
Bering Sea	4		BSAI excluding 541	502		
		10,163		777	128	11,068
Total		19,561	Statewide	782	259	20,602

[a] Shows the NMFS Regulatory area to which groundfish fishery bycatch was allocated. Totals may differ due to rounding.

Table 3-6 Retained catch (lbs of meats) and estimated additional discard mortality in the scallop fishery, the groundfish fishery, and agency surveys as a percentage of the retained catch.

		Discard mortality as percentage of retained catch			
Season	Retained Catch	Scallop Fishery	Groundfish Fishery	Agency Surveys	Total
		Region 1			
1998/99	275,831	2.15			
1999/00	284,305	4.16		<0.01	
2000/01	226,603	5.65			
2001/02	124,198	5.17		0.00	
2002/03	126,403	5.90	<0.01		
2003/04	161,990	4.92	<0.01	<0.01	
2004/05	111,380	4.27	<0.01		
2005/06	213,001	4.05	<0.01	<0.01	
2006/07	164,395	4.97	<0.01		
2007/08	126,140	8.34	<0.01	<0.01	
2008/09	171,275	5.68	0.01		
Mean	180,502	4.75	<0.01	<0.01	4.75
CV (%)	10.2	9.7	67.2	137.6	
		Region 2			
1998/99	19,650	1.30		0.58	
1999/00	40,725	0.91		0.42	
2000/01	50,782	0.54		0.30	
2001/02	30,090	1.58		0.72	
2002/03	24,232	0.62	<0.01	0.27	
2003/04	19,980	5.00	<0.01	0.67	
2004/05	55,437	2.99	<0.01	0.37	
2005/06	49,205	2.61	<0.01	0.18	
2006/07	36,990	2.06	<0.01	0.34	
2007/08	37,105	4.29	<0.01	0.25	
2008/09	20,040	2.96	0.07	0.35	
Mean	34,931	2.19	0.01	0.37	2.57
CV (%)	11.4	20.36	156.8	14.3	
		Region 4			
1998/99	508,117	2.39		0.02	
1999/00	512,941	2.09		0.02	
2000/01	473,232	1.46		0.02	
2001/02	398,453	2.13		0.03	
2002/03	358,820	4.00	0.35	0.02	
2003/04	302,566	3.63	0.31	0.04	
2004/05	264,777	5.30	0.23	0.06	
2005/06	263,151	3.04	0.22	0.05	
2006/07	286,088	3.04	0.18	0.07	
2007/08	295,068	4.29	0.25	0.06	
2008/09	151,119	3.19	0.51	0.08	
Mean	346,757	2.93	0.28	0.04	3.25
CV (%)	10.0	11.5	14.5	17.7	

3.3 Adjustment of the OFL

To redefine the OFL in terms of total scallop mortality, it was necessary to increase the proxy MSY value of 1.24 million lbs of shucked meats by an amount equivalent to estimates of the additional fishing mortality during the 1990–1997 period (excluding 1995) on which the proxy MSY is based. Specifically, discard mortality at that time occurred in the scallop fishery, the groundfish fishery, and agency surveys, at a minimum. However, little discard data is available for the period of interest. Therefore, the mean of annual discard mortality rates was estimated for each of the above discard sources for years in which data was available (Table 3-6), and the sum of the means was used to scale and redefine the proxy MSY. In estimating the means, we note that "year" as defined in the available data was often inconsistent. For example, scallop seasons were defined according to calendar year prior to 1994, but spanned portions of two calendar years thereafter. Groundfish fishery data and agency surveys are defined according to calendar year. For simplicity, we assigned the groundfish and survey data to the first year in a scallop season spanning portion of two calendar years. Thus, bycatch in the 1998 groundfish fisheries was allocated to the 1998/99 scallop season. Although this approach may shift some of the effect of a large scallop recruit cohort, it was assumed that any errors are approximately normally distributed, particularly given individual growth differences that result in a given recruit class becoming fully selected over a series of years by a particular fishery/survey gear.

For the scallop fishery, statewide discard mortality comprised an additional 3.6% of the annual retained catch. This mortality was derived from on-board observer data during the 1998/99 to 2008/09 fishing seasons and based on a meat recovery equivalent of 10% of the whole weight and an assumed discard mortality rate of 20%. We note that within this period, the discard mortality rate was 1.7% higher beginning with the 2002/03 season compared to the preceding years. This increase may be an effect of formation of the fishery cooperatives which allowed the fleet to be more selective in which scallops are retained compared to the pre-cooperative years (J. Stone, pers. comm.). The implication is that the scallop discard mortality rate may have been slightly lower during the years on which the proxy MSY is based, but there is insufficient data to confirm this. For the groundfish fishery, an additional discard mortality of 0.2% (CV = 12%) of the annual retained scallop catch was derived using data from the 2002/03 to 2008/09 fishing seasons. As mentioned previously, this rate applies to bivalves, used as a proxy for weathervane scallops. It is anticipated that historical groundfish discards may have been substantially greater than in recent years due to several factors. First, changes in gear technology, such as roller gear designed to keep the footrope of a bottom trawl slightly off the bottom, likely reduce scallop bycatch. Second, the spatial distribution of groundfish fishing effort has become more constrained in an effort to protect critical habitat for various species. Third, the development of various fishery rationalization or quota-share programs, particularly in the eastern Bering Sea, has generally reduced both the number of vessels fishing and the "race for fish," generally allowing greater fishing effort to be replaced by more efficient effort in targeting a particular groundfish species. Agency survey data, derived from the 1998–2008 calendar years, generated an additional discard mortality of <0.1% (CV = 12%) of the retained catch. This mean is averaged across surveys that may occur annually or biennially in different areas, but likely represents long-term annual discard mortality. With the additional discard mortality totalling to 3.6% of the retained catch, the OFL is redefined to equal 1.28 million lbs of scallop meats, including all sources of fishing and survey mortality.

A similar approach, applying the data available for the same time periods as were used above, was used to estimate discard mortality within regions (Table 3-5 and Table 3-6). Within Region 1, additional discard mortality averaged 4.75% of the annual retained catch. This additional discard mortality resulted primarily from the directed scallop fishery with <0.01% in both the groundfish fishery and agency surveys. For consideration of alternatives that establish ACLs at the regional level, the revised proxy MSY for Region 1 becomes 298,532 lbs of meats. Additional discard mortality within Region 2 averaged 2.57% of the annual retained catch, comprised of 2.19% in the scallop fishery, 0.01% in the groundfish

fishery, and 0.37% in agency surveys. With the additional mortality, the revised proxy MSY for Region 2 became 71,798 lbs of meats. For Region 4, the additional discard mortality averaged 3.25% of the annual retained catch for the year examined, comprised of 2.93% in the scallop fishery, 0.28% in the groundfish fishery, and 0.04% in agency surveys. The proxy MSY for Region 4 increased to 913,759 lbs of meats.

For the purpose of this analysis, it was assumed that the ACL available under each alternative is allocated to either retained catch or discard mortality, represented by a discard mortality rate, such that:

$$ACL = C(1 + D) \quad (1)$$

where C is retained catch and D is the discard mortality rate expressed as a mean percentage of the retained catch. Although the directed fishery has been constrained in recent years to levels substantially below the upper ends of the GHRs established in ADF&G regulation, for this analysis we also assumed that the retained catch is harvested up to the amount estimated by rearranging the above to give:

$$C = \frac{ACL}{1 + D}. \quad (2)$$

However, annual determination of catch and pre-season estimates of discard mortality within the ACL will continue to be the responsibility of ADF&G management staff.

3.4 Analysis of fixed buffers

To evaluate the potential effects of adoption of the fixed buffers contained in Alternatives 2-4, we applied a potential constant buffer (multiplier) to the revised OFL to give the corresponding ACL using:

$$ABC = B_f OFL \quad (3)$$

where B_f is the fixed multiplier. Retained catch was then calculated from Equation 2, and discard mortality estimated as the difference between the ACL and retained catch. For the purpose of this analysis, the GHL was assumed to be the smaller of either the upper end of the GHR allowable in State regulation or the retained catch apportionment of the ACL.

For Alternative 2a, a statewide ACL was set equal to the statewide revised OFL of 1.28 million lbs (582.5 mt) of shucked meats (Table 2-1). The maximum allowable GHL (i.e., retained catch) was estimated based on the statewide discard mortality rate of 3.6% among the directed scallop fishery, groundfish fisheries, and agency surveys. Alternative 2b sets regional ACLs equal to the sums of the regional GHR upper bounds, plus estimated historical discard mortalities, resulting in ACLs of 298,530 lbs (135.4 mt) of shucked meats for Region 1, 71,790 lbs (32.6 mt) for Region 2, and 913,760 lbs (414.5 mt) for Region 4 (Table 2-1).

Alternatives 3a and 3b incorporate greater uncertainty into the estimate by establishing the upper bound of the harvest range at 90% of the redefined OFL values, calculated as the sums of the GHRs established in ADF&G regulation, plus the sums of the estimated discard mortalities in the years used to establish the proxy MSY. Two options were considered under this alternative (Table 2-1): Alternative 3a estimates the scallop ACL at the statewide level and results in a statewide ACL of 1,155,670 lbs (524.2 mt) of meats; Alternative 3b estimates scallop ACLs at the ADF&G regional level and results in ACLs of 268,280 lbs (121.9 mt) lbs for Region 1, 64,620 lbs (29.3 mt) for Region 2, and 822,370 lbs (373.0 mt) for Region 4.

Alternatives 4a and 4b are similar to Alternatives 3a and 3b but incorporate even greater uncertainty into the estimate by establishing the upper bound of the harvest range at 75% of the sum of the revised OFL. Two options were considered under this alternative (Table 2-1): Alternative 4a estimates the scallop ACL at the statewide level and results in a statewide ACL of 997,350 lbs (452.4 mt) of meats; Alternative 4b estimates scallop ACLs at the ADF&G regional level and results in ACLs of 234,530 lbs (106.4 mt) for Region 1, 55,230 lbs (25.1 mt) for Region 2, and 707,590 lbs (321.0 mt) for Region 4.

3.5 The P* method and additional uncertainty

The implications of using a fixed buffer between the OFL and the ABC were also examined using the P* method (Caddy and McGarvey 1996; Prager *et al*. 2003; Shertzer *et al*. 2008; Hanselman 2009; NPFMC 2010a), in which P*represents the probability that the ABC exceeds the true OFL. Thus, a lower P* value implies a lower probability that the ABC exceeds the true OFL (i.e., the probability of the stock being overfished is less). Values of P* may be calculated from a *t*-distribution that depends on the size of the fixed buffer and the estimated scientific uncertainty associated with a stock.

While the intent of the ABC control rule is to account for scientific uncertainty in the estimation of the OFL, a variety of sources can introduce scientific uncertainty. Some uncertainty may be characterized as "within" by being quantified within an assessment model. To generate a distribution for the OFL, we used the standard error of the annual total scallop mortality for 1990–1997 (excluding 1995), the years on which the proxy MSY is based. However, "additional" uncertainty exists that cannot be quantified within the existing stock assessment, such as the extent to which discard mortality rates estimated for recent years represent the true rates during the years used to define the OFL. To accommodate this unquantified uncertainty, an additional variance term, σ_a, is added to the within uncertainty. For this deterministic analysis in which the OFL for weathervane scallops is based on historical catch levels, the probability of the stock being overfish was calculated through the t-distribution as:

$$t_{(P^*, n-1\,df)} = \frac{\bar{x}\left(1 - B_f\right)}{\sqrt{s_{\bar{x}}^2 + (\sigma_a \bar{x})^2}} \qquad (4)$$

where t is the probability based on a *t*-distribution with the P* probability and 6 degrees of freedom, $\bar{x}$ is the revised proxy MSY, $s_{\bar{x}}$ is the standard error of the annual total mortality in the years producing the revised proxy MSY, and σ_a is additional uncertainty. In the case where no additional uncertainty is assumed, $\sigma_a = 0.0$. For this analysis, P* values were calculated at both the statewide and regional scales for the multiplier values of 1.0, 0.90, and 0.75, representing Alternatives 2, 3, 4, respectively, but also with values of additional uncertainty, σ_a , of 0.0 (no additional uncertainty), 0.2, 0.3, 0.4, and 0.5 (Table 3-7).

3.6 Data to evaluate non-target scallop stocks

To examine potential impacts of the non-target options, data on capture of non-target scallop species was derived from ADF&G and NMFS trawl surveys for the years 1998–2008 (M. Stichert, ADF&G, Kodiak; M. Spahn, ADF&G, Homer; and R. Foy, NMFS, Kodiak, all pers. comm.). Trawl surveys are conducted in Region 1 only by NMFS and in Regions 2 and 4 by both ADF&G and NMFS. Among all ADF&G surveys, all non-target scallops were recorded as *Chlamys* sp. Although data extrapolated to area-swept estimates were not available for the ADF&G surveys, and these trawl surveys are not designed to assess non-target scallop species, surveys catches of non-target scallops were relatively minor (Table 3-4). Data on non-target species was summarized according to whole weight (lbs). In Region 1, catches of non-target scallops by the NMFS survey in odd-numbered years from 1999 to 2007 averaged 1 lb annually.

For Region 2, ADF&G catches among either annual trawl surveys averaged 22 lbs (whole weight; CV = 84%) annually, ranging from <1 to 53 lbs, whereas NMFS surveys caught an average of 4 lbs annually. For Region 4, annual catch of *Chlamys* among ADF&G trawl surveys ranged from 3 to 109 lbs, averaging 35 lbs (CV = 97%), whereas NMFS survey catches averaged 70 lbs (CV = 50%) annually.

Table 3-7 Estimates of P* for multiplier of B_f = 1.0, 0.90, and 0.75 and additional uncertainty of σ_a = 0.0 (no additional uncertainty), 0.2, 0.3, 0.4, and 0.5 at the statewide and regional levels with the revised proxy OFL of 1.28 million lbs of meats.

	σ_a=0.0	σ_a =0.2	σ_a =0.3	σ_a =0.4	σ_a =0.5
B_f			Statewide P*		
1.00	0.500	0.500	0.500	0.500	0.500
0.90	0.285	0.357	0.390	0.413	0.428
0.75	0.091	0.187	0.247	0.292	0.326
B_f			Region 1 P*		
1.00	0.500	0.500	0.500	0.500	0.500
0.90	0.345	0.380	0.401	0.419	0.431
0.75	0.168	0.226	0.269	0.305	0.334
B_f			Region 2 P*		
1.00	0.500	0.500	0.500	0.500	0.500
0.90	0.418	0.424	0.431	0.438	0.444
0.75	0.304	0.318	0.333	0.348	0.363
B_f			Region 4 P*		
1.00	0.500	0.500	0.500	0.500	0.500
0.90	0.252	0.348	0.387	0.411	0.427
0.75	0.063	0.173	0.240	0.289	0.324

Chapter 4 Impacts of Alternatives

4.1 Alternative 1 (status quo)

Under this alternative no change would be made to the current management to implement ACLs. Scallop catch would continue to be constrained by the statewide OFL and regional GHLs and GHRs as described below. Additionally, under Alternative 1 there would be no change to the management of non-target scallop species.

Commercial fishing for scallops under the State of Alaska Scallop Fishery Management Plan occurs in 9 scallop registration areas (Figure 4-1; NPFMC 2010b). These registration areas include the Southeastern Alaska (Area A); Yakutat (Area D and District 16); Prince William Sound (Area E); Cook Inlet (Area H); Kodiak (Area K), which is subdivided into the Northeast, Shelikof and Semidi Districts; Alaska Peninsula (Area M); Dutch Harbor (Area O); Bering Sea (Area Q); and Adak (Area R). Scallop seasons have never been opened in Area A, and effort occurred in Area R only during 1995.

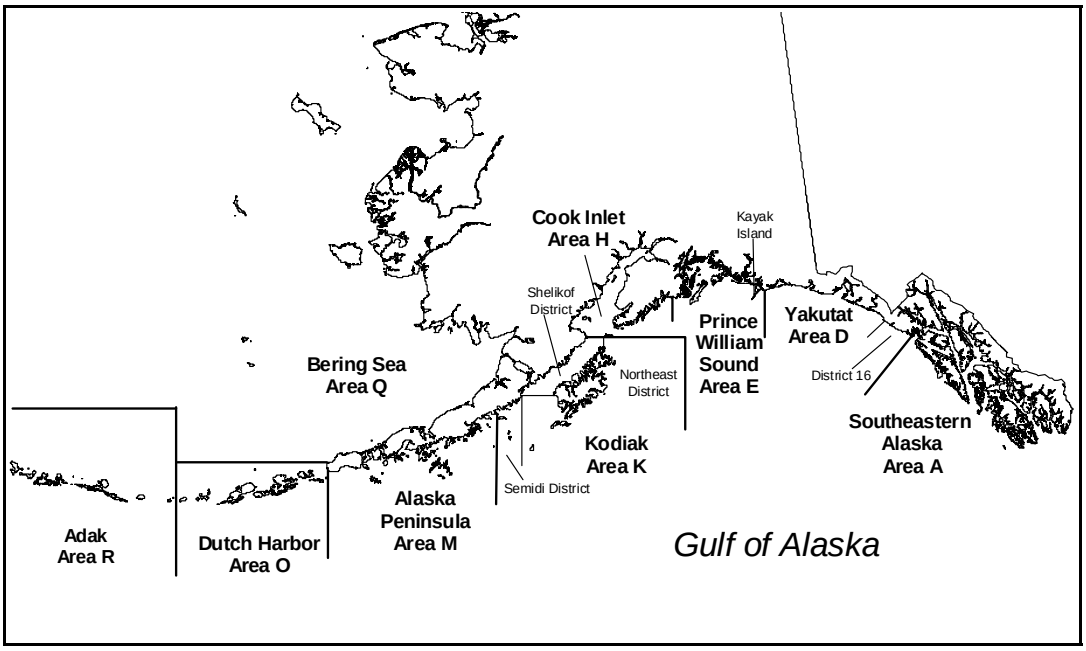

Figure 4-1 Alaska weathervane scallop fishing registration areas (from NPFMC 2010b).

The fishery is managed by ADF&G within registration areas and districts. For each registration area, State of Alaska regulations establish a guideline harvest range (GHR), the upper end which represents a hard cap that is not to be exceeded. Prior to each season, ADF&G sets guideline harvest limits (GHLs) as pre-season targets for each fishing area (registration area, district, or statistical area). These pre-season targets are typically based on historical fishery performance combined with recent stock status information such as survey data and/or size and age composition data (NPFMC 2010b). Specifying harvest levels in terms of ranges allows the State to make in-season management adjustments to harvest areas or allowances based on observer data and concerns about fishery performance, bycatch rates, or localized depletion (NPFMC 2006).

The State of Alaska first established regulatory GHRs for traditional scallop fishing areas in 1993 under the Interim Management Plan for Commercial Scallop Fisheries in Alaska. Regulatory GHRs (set as

shucked meats) were 0–250,000 lbs for Yakutat, 0–50,000 lbs for Prince William Sound, 0–20,000 lbs for the Kamishak District of Cook Inlet, 0–400,000 lbs for Kodiak, and 0–170,000 lbs for Dutch Harbor. These GHRs were determined by averaging historic catches from 1969 to 1992 excluding years when either no fishing or a "fishing-up effect" occurred (Barnhart 2003).

Prior to the 1996 re-opening of the weathervane scallop fishery, the State of Alaska set the following GHRs for non-traditional registration areas: 0–200,000 lbs for the Alaska Peninsula, 0–600,000 lbs for the Bering Sea, 0–35,000 lbs for District 16, and 0–75,000 lbs for Adak. The upper limits from traditional and non-traditional areas totalled 1.8 million lbs, which was defined as maximum sustainable yield (MSY) in Amendment 1 to the federal FMP (Table 4-1).

In 1998, the Scallop Plan Team recommended a more conservative definition of MSY (Table 4-1). Based on average landings from 1990 to 1997, excluding 1995 when the fishery was closed most of the year, MSY was subsequently established in Amendment 6 of the FMP at 1.24 million lbs, with optimum yield (OY) defined as the range 0–1.24 million pounds. To accommodate the new definition, the State of Alaska reduced regulatory GHR ceilings to 300,000 lbs for Kodiak, 110,000 lbs for Dutch Harbor, 100,000 lbs for the Alaska Peninsula, and 300,000 lbs for the Bering Sea. Thus, MSY and the State regulatory GHR ceiling are both 1.24 million lbs.

Table 4-1 Alaska weathervane scallop harvest, Maximum Sustainable Yield, and percentage of the MSY harvested during the 1993/94–2007/08 seasons.

Season	Harvest (lbs meat)	MSY	% MSY
1993/94	984,583	1,800,000	55
1994/95	1,240,775	1,800,000	69
1995/96	410,743	1,800,000	23
1996/97	732,424	1,800,000	41
1997/98	818,913	1,800,000	45
1998/99	822,096	1,240,000	66
1999/2000	837,971	1,240,000	68
2000/01	750,617	1,240,000	61
2001/02	572,838	1,240,000	46
2002/03	509,455	1,240,000	41
2003/04	492,000	1,240,000	40
2004/05	425,477	1,240,000	34
2005/06	525,357	1,240,000	42
2006/07	487,473	1,240,000	39
2007/08	458,313	1,240,000	37
2008/09	342,434	1,240,000	28

Under the current management strategy, a proxy MSY level is established as the sum of the upper end of the GHRs listed in ADF&G regulation. The GHRs are specified both at the registration area and statewide (Table 4-2), with a statewide GHR of 1.24 million lbs established as the sum of the upper ends of the GHRs across registration areas. In-season management by ADF&G targets a GHL at the scale of registration area or statistical reporting area, taking into consideration aspects such as fishery performance, stock status, stock age composition, etc. Under the status quo management, the maximum GHL is the proxy MSY level of 1.24 million lbs of meats. The fishery is managed conservatively with harvest levels well below the proxy MSY, and since the proxy MSY levels were updated in 1996, annual catches have averaged from 28 to 66% of the statewide MSY (Table 4-1; NPFMC 2010b). However, the status quo approach under Alternative 1 does not explicitly incorporate bycatch needs into the management process and, thus, fails to comply with the ACL standards. In addition, abundance is currently estimated for only two of the nine registration areas and a determination of MSST cannot be made at this time on the statewide stock. Although the fishery is managed conservatively for harvests well below proxy MSY levels, the lack of comprehensive stock abundance and biomass information creates an indeterminate risk of overfishing.

4.2 Alternatives 2–4

As discussed in Section 2.1.2, Alternatives 2–4 all employ fixed buffer values, ranging from 0–25%, to establish the ABC control rule as a fraction of the OFL. In addition, the OFL has been revised to include estimates of discard mortality. Two main aspects differentiate among the alternatives: (1) the size of the buffer under consideration (0, 10%, or 25%); and (2) the spatial scale at which the ACL is specified (statewide or regionally). The appropriate size of the buffer relies primarily on the uncertainty surrounding the MSY determination. A secondary component involves the uncertainty around two factors: (1) estimation of discard mortality from all sources; and (2) management implementation.

This analysis examines discard mortality based on an annual average of the available data on scallops captured, but not retained, by a variety of fisheries and agency surveys. Thus, years of both higher and lower discards have occurred. Directed fishery harvests in recent years have been substantially below the regulatory allowable maximum, represented by the upper end of the statewide GHR (Table **3-1**). However, in the event of increased stock abundances, total scallop mortality will likely increase as the management target is increased to accommodate the increased stock abundance. Increased abundance will also increase the discards from all other sources of discard mortality. In-season estimation of discard mortality will be a critical aspect to prevention of exceeding the ACL annually (and avoiding the need to implement AMs). For purposes of this preliminary analysis, ACLs were apportioned to retained catch and discard mortality according to the discussion laid out in Chapter 3 (Table 4-2). In order to look at relative fishery constraints, the retained catch was compared to the GHR to determine the "maximum GHL" as an estimate of the maximum retained harvest by region. However, the annual GHL would ultimately be determined by the State, within the constraints of the ACL and the GHRs listed in State regulation.

With respect to management implementation, while this is a consideration in maintaining harvests below the ACL (i.e., not necessarily in the specification of the ACL), it affects our ability to estimate impacts, particularly in conjunction with the assumptions and uncertainty in the discard estimates. The precision in which managers achieve the target harvest level may become increasingly important as harvest targets, and corresponding discard mortality, approaches the ACL. To gain perspective on management implementation, we also examined the actual harvest level as a percentage of the target GHL. Because several factors can affect a GHL not being achieved (e.g., no or reduced fleet effort due to poor weather), the more important aspect from the stock perspective is that the GHL in not exceeded. Among years and registration areas, management implementation in the scallop fishery kept harvests at or near the GHL

Table 4-2 Effects of alternatives on ACLs, discard mortality, and maximum GHLs, all measured in lbs of shucked meats, for the weathervane scallop fishery, and the corresponding probability, P*, that the ACL exceeds the true MSY.

Alternative	ABC Control Rule	Spatial Scale	ACL	Discard mortality[a]	Maximum GHL[b]	P*
1 – Status quo	ABC = GHR	Statewide	1,240,000	NA	1,240,000	NA
2a ACL = sum of upper end of regional GHRs	ABC = GHR	Statewide	1,284,089	44,089	1,240,000	0.500
2b By region, ACL = upper end of GHR	ABC = GHR	Region 1	298,532	13,532	285,000	0.500
		Region 2	71,798	1,798	70,000	0.500
		Region 4	913,759	28,759	885,000	0.500
3a ACL = 90% of sum of upper end of regional GHRs	ABC = 90% of GHR	Statewide	1,155,680	39,680	1,116,000	0.285
3b By region, ACL = 90% upper end of GHR	ABC = 90% of GHR	Region 1	268,678	12,178	256,500	0.345
		Region 2	64,619	1,619	63,000	0.418
		Region 4	822,383	25,883	796,500	0.252
4a ACL = 75% of sum of upper end of regional GHRs	ABC = 75% of GHR	Statewide	963,067	33,067	930,000	0.091
4b By region, ACL = 75% of upper end of GHR	ABC = 75% of GHR	Region 1	223,899	10,149	213,750	0.168
		Region 2	53,849	1,349	52,500	0.304
		Region 4	685,319	21,569	663,750	0.063

[a] Discard mortality was calculated as the sum of estimated scallop discards in the direct scallop fishery, bivalve bycatch in the federal groundfish fisheries as a proxy for weathervane scallop discards, and catch in agency surveys, and assuming a 20% discard mortality rate in (see text for description).
[b] The maximum GHL is the ACL minus the discard mortality.

(Table 4-3). Among registration areas, the GHL was exceeded from 0 to 56% of the time. However, in all cases of overages, the GHL was exceeded by a maximum of 5%.

The second factor differentiating the alternatives is the appropriate spatial scale for ACL management in order to best provide protection against overfishing. In-season management for the GHL is currently implemented at the registration area, or on finer scales, such as specific beds, based on pre-fishery and in-season perceptions of stock status. These perceptions often are based on historical fishery performance measures such as CPUE or size and age composition data that may suggest different production from fishing areas at different spatial scales. Although growth rates of weathervane scallops appear to increase moving from east to west in the Gulf of Alaska (Ignell and Haynes 2000; Kruse et al. 2000), it is unclear whether these differences are driven by genetics or environmental conditions. Strong genetic differences would suggest scallops are self-recruiting. However, a recent study used four classes of molecular markers to examined genetic variability in weathervane scallops from eight locations in the Gulf of Alaska and the Bering Sea (Gaffney et al. under review). Results indicate virtually no population structure across the spatial distributions sampled and high gene flow is proposed as a causative mechanism. However, the authors suggest a cautionary approach in warranted because geographically separated scallop "populations" may still be ecologically independent. The use of the State of Alaska's management regions, which roughly coincide with putative larval drift zones, is offered as a reasonable approach for sustainable harvest management.

4.3 Alternative 2: ABC Control Rule = GHR

4.3.1.1 Alternative 2a: Statewide ACL = Sum of upper ends of GHRs

Alternative 2a would establish a statewide ACL based on the upper end of the statewide GHR defined in ADF&G regulation for the commercial scallop fishery and additional discard mortality at the time the statewide GHR was established as the proxy MSY. Under the current management strategy, a proxy MSY level is established in ADF&G regulation as the upper end of the GHR. The GHR is specified both at the registration area and statewide, with a statewide GHR of 1.24 million lbs (562.5 mt) of meats established as the sum of the upper ends of the GHRs across registration areas (Table 4-1). However, this proxy MSY fails to account for discard mortality from various fisheries and surveys. Inclusion of estimated discard mortality in the scallop and groundfish fisheries and in agency surveys increases the proxy MSY to 1.29 million lbs (583.8 mt). Although current discard mortality rates would result in discard mortality of 44,089 lbs, reducing the maximum statewide GHL to the ADF&G regulatory maximum of 1.24 million lbs (Table 4-2). Given the historical ADF&G management performance yielding annual harvests ranging from 28 to 68% of historical proxy MSY (Table 4-3), adoption of this alternative is not expected to significantly affect ADF&G in-season management strategies. However, statewide bycatch needs as applied in this analysis are estimated with some uncertainty due to the current pooling of scallops into a bivalve category for the groundfish fisheries and the potential for future changes in scallop bycatch among fisheries.

The use of Equation 4 to examine Alternative 2a, which specifies a multiplier of B_f=1.00, indicates P*=0.500, which is to say that there is an equal probability that the ABC will be above or below the true MSY (Table 3-7). This result is based on available data and the assumption that uncertainty in the estimation of the proxy MSY is adequately represented by the variability in the annual catch and discard data used to estimate the proxy MSY. This result is expected given that the revised proxy MSY is based on the annual average of estimated retained plus discard scallop mortality during 1990-1997 (excluding 1995), and the ABC is set equal to the proxy MSY. Assumption of additional uncertainty for a fixed multiplier of B_f=1.00 for an assumed proxy MSY of 1.28 million lbs of meats has little effect on P* (i.e., the probability of the ABC exceeding the OFL).

Table 4-3 Percentage of the annual GHL harvested in a season and ADF&G registration area during 1998/99–2007/08.[a]

Season	Yakutat	Yakutat District 16	Prince William Sound	Cook Inlet	Kodiak Northeast District	Kodiak Shelikof District	Alaska Peninsula	Bering Sea	Dutch Harbor
	Percentage of the registration area GHL that was harvested								
1998/99	97.2	97.6	98.3		100.0		31.6	24.2	42.2
1999/00	99.9	98.9	102.1	101.6	100.0	104.4	37.8	41.2	5.9
2000/01	78.3	88.3	100.9	102.6	100.0	100.0	23.2	102.8	
2001/02	51.9	58.3	100.3		100.0	98.4		70.4	
2002/03	61.4	10.5	78.2	43.0	100.0	100.3		87.8	60.0
2003/04	80.5	3.1	99.9		100.0	100.0	0.0	40.6	
2004/05	43.5	69.8	98.6	30.6	100.0	97.0	0.0	9.6	
2005/06	99.7	39.0	98.4		100.0	100.0	0.0	46.4	
2006/07	100.6	64.0	100.0		100.0	101.6	0.6	96.5	
2007/08	84.0	0.9	100.3		100.0	100.0	0.0	100.0	
Average	79.7	53.0	97.7	69.4	100.0	100.2	11.7	62.0	36.0
CV (%)	26.4	71.6	7.1	54.8	0.0	2.0	140.6	54.7	76.6
	Percentage of the years in which the GHL was exceeded								
	10.0	0.0	40.0	50.0	0.0	55.6	0.0	10.0	0.0

[a] GHL = Guideline Harvest Level. Missing data may indicate the area was closed, the registration area GHL was not established (Shelikof in 1998/99), or the data were confidential.

This alternative would benefit the weathervane scallop stock compared to status quo because: (1) an estimate of total fishing mortality would now be included in estimation of the OFL; and (2) anticipated discard mortality would need to be explicitly considered when setting the annual fishery GHL. Because the scallop fishery is currently managed for a statewide harvest that is substantially less than the upper end of the statewide GHR, the current discard mortality of 20,601 lbs of meats is substantially less than that applied in Alternative 2a, thus providing a buffer between the maximum GHL and the ACL (Table 3-4). But potential future increases in total stock abundance would likely result in increases to both the annual GHL and to the scallop discard mortality in the direct scallop fishery, non-scallop fisheries, and agency surveys. Our analysis used average estimates for the 1998/99 to 2008/09 fishing seasons to represent annual discard mortality. Given the uncertainty in preseason estimates of discard mortality, underestimation of mortality in years with harvest levels approaching the upper end of the statewide GHR could result in the statewide OFL being exceeded. To some extent, unanticipated discard mortality or catch overages in some registration areas could be remedied by in-season management adjustments to restrict the directed scallop fishery in alternative registration areas. However, the potential for management implementation error is high given the potential for time lags in data from various fisheries and agency surveys. We also note that there is currently no mechanism to address increased discard mortalities in non-scallop fisheries other than to reduce directed scallop fishery harvests.

4.3.2 Alternative 2b: Regional ACLs = upper end of regional GHR

Alternative 2b would establish regional ACLs as the sums of the upper ends of the GHRs defined in ADF&G regulation for commercial scallop fishery registration areas, plus estimated fishery and survey discard mortalities during the time period on which the OFL is based. Under the current management strategy, proxy MSY levels, based on the upper ends of the registration area GHRs for each ADF&G registration area, total to 285,000 lbs (129.3 mt) of meats for Region 1, 70,000 lbs (31.8 mt) for Region 2, and 885,000 lbs (401.4 mt) for Region 4. But these sums do not include estimated discard mortality during the 1990–1997 years (excluding 1995) on which the OFL is based. Redefining the upper ends of the regional GHRs to account for historical discard mortality increases the regional OFLs to 229,330 lbs (135.8 mt) of meats for Region 1, 71,782 lbs (32.6 mt) for Region 2, and 915,786 lbs (415.4 mt) for Region 4(Table 4-2). Applying the discard mortality rates by region results in estimated discard mortalities of 13,532 lbs of meats for Region 1, 1,798 lbs for Region 2, and 28,759 lbs for Region 4. In contrast, current discard mortality is estimated to be 8,569 lbs of meats in Region 1, 964 lbs in Region 2, and 11,068 lbs in Region 4, although annual fishery harvests are substantially less than the maximum allowed as sums of the upper ends of the regional GHRs (Table 3-4). Based on ADF&G management performance following the 2001 implementation of the License Limitation Program (LLP; NPFMC 2006), annual harvests have comprised a maximum of 74.7, 79.2, and 40.5% of the regional GHRs for Regions 1, 2, and 4, respectively (Table **3-1**). Thus, adoption of this alternative is not expected to significantly affect ADF&G in-season management strategies. However, regional discard mortalities as applied in this analysis are estimated with some uncertainty due to the current pooling of scallops into a bivalve category for the groundfish fisheries and the potential for future changes in scallop bycatch among fisheries. Given interregional variability in benthic species composition (e.g., mussels may predominate as bivalves in some areas and scallops predominate in other areas), uncertainty is likely exacerbated when estimating bycatch needs at the regional level.

The use of Equation 4 through Alternative 2b, which specifies a multiplier of B_f=1.00 for the regional ABCs, results in an estimated P*= 0.500 for each of Region 1, Region 2, and Region 4 (Table 3-7). Similar to aspects of Alternative 2a, this result from setting the regional ABCs equal to revised proxy MSY for each region, with the regional proxy MSYs based on the annual average of estimated retained plus discard scallop mortalities during 1990-1997 (excluding 1995). Assumption of additional uncertainty for a fixed multiplier of B_f=1.00 for an assumed proxy MSY of 1.28 million lbs of meats had little effect on P* (i.e., the probability of the ABC exceeding the OFL).

Alternative 2b shares some of the benefits as alternative 2a in providing additional protection from overfishing in comparison with status quo, in that estimated discard mortality needs to be explicitly considered when establishing regional GHL levels. However, the potential problem with underestimation of scallop discard mortality is increased because of the smaller spatial scale of in-season management. For example, if ADF&G sets the GHL as the maximum allowable after deducting anticipated discard mortality, but actual discard mortality exceeds preseason estimates, the regional ACL could be exceeded if the fishery takes its full allocation. There is some potential for in-season management adjustments if other registration areas exist within the region and the directed scallop fisheries can be constrained in those alternate registration areas. Thus, the potential for management error implementation is greater than for Alternative 2b compared to 2a.

4.4 Alternative 3: ABC Control Rule = 90% of GHR

4.4.1 Alternative 3a: Statewide ACL = 90% of sum of upper ends of GHRs

Alternative 3a would establish a statewide ACL as 90% of the sum of the upper ends of the GHRs defined in ADF&G regulation for commercial scallop fishery registration areas, plus anticipated discard mortality based on rates observed in recent years but applied to retained catch in the years 1990–1997 (excluding 1995) when the proxy MSY was defined. Applying a Control Rule of 90% of the maximum GHR would result in a statewide ACL of 1,155,680 lbs (524.2 mt) of meats. Apportioning this ACL results in a discard mortality of 39,680 lbs (18.0 mt) of meats and a retained catch of 1,116,000 lbs (506.2 mt) (Table 4-2). Given the historical ADF&G management performance yielding annual harvests ranging from 28 to 68% of the statewide proxy MSY, adoption of this alternative is not expected to significantly affect ADF&G in-season management strategies (Table 4-3). However, statewide bycatch needs as applied in this analysis are estimated with some uncertainty due to the current pooling of scallops into a bivalve category for the groundfish fisheries and the potential for future changes in scallop bycatch among fisheries.

The use of Equation 4 to examine Alternative 3a, which specifies a multiplier of B_f=0.90, indicates a statewide P* value of 0.285, the probability that the ABC will exceed the true MSY given the available data and the assumption that variability is represented in the annual catch (Table 3-7). However, incorporation of additional uncertainty increases the P* value, although not to the level of assuming B_f=1.00.

Thus, by providing a 10% buffer between the proxy MSY and the ACL, Alternative 3a gives greater protection to the weathervane scallop resource, particularly at times when stock abundance, and the corresponding discard mortality, is high, and GHLs for the registration areas are close to the maximum allowable. Because this is a statewide ACL, similar to Alternative 2a, unanticipated overages in either the directed fishery harvests or discard mortality may be accommodated through in-season management adjustments which curtail directed scallop fishing in other registration areas. At this time, there is no measure which constrains fishing in non-scallop fisheries to reduce weathervane scallop discard mortality. However, actual discard mortality would need to substantially exceed preseason estimates, and all fishery harvests among all registration areas would need to be at or near the maximum GHL to exceed the buffered proxy MSY.

4.4.2 Alternative 3b: Regional ACLs = 90% of upper ends of regional GHRs

Alternative 3b would establish regional ACLs based on 90% of the sums of the upper ends of the GHRs defined in ADF&G regulation for commercial scallop fishery registration areas plus the estimated discard mortality from the scallop and groundfish fisheries and agency surveys. The current management

strategy establishes a proxy MSY level as the sums of the upper ends of the GHRs, with a statewide GHR of 1.24 million lbs (562.5 mt) of meats across ADF&G registration areas (Table 4-1). This alternative would increase the proxy MSY to levels similar to Alternative 2b to account for estimated discard mortality. But under an ABC control Rule of 90%, Alternative 3b would establish regional ACLs of 268,678 lbs (121.8 mt) of meats for Region 1, 64,619 lbs (29.3 mt) for Region 2, and 822,383 lbs (373.0 mt) for Region 4 (Table 4-2). Estimated discard mortalities under these ACLs would be 12,178 lbs, 1,619 lbs and 25,883 lbs of meats for ADF&G Region 1, Region 2, and Region 4, respectively, with corresponding maximum allowable retained catches of 256,500 lbs in Region 1, 63,000 lbs in Region 2, and 796, 500 lbs in Region 4. Historical fisheries harvested a much higher proportion of the regional GHRs (e.g., 99.8% of the Region 1 GHR in the 1999/00 season, but annual harvests have comprised a maximum of 74.7, 79.2, and 40.5% of the regional GHRs for Regions 1, 2, and 4, respectively, following the 2001 implementation of the LLP (Table 4-3). From a historical perspective, this alternative would have been constraining during the 1998/99 and 1999/2000 seasons in Region 1, but is less likely to be so under more recent stock abundance levels and management practices. Nonetheless, regional bycatch needs as applied in this analysis are estimated with some uncertainty due to the current pooling of scallops into a bivalve category for the groundfish fisheries and the potential for future changes in scallop bycatch among fisheries. In addition, both annual GHLs and anticipated bycatch needs will depend on which scallop beds are targeted because a given bed may not open every year. Therefore, a more conservative approach may be needed by ADF&G managers when setting GHLs for individual registration areas.

Alternative 3b specifies a multiplier of B_f=0.90 for the proxy MSY within each region, and results in an estimated P*= 0.345 for Region 1, 0.418 for Region 2, and 0.252 for Region 4 (Table 3-7). The rank differences in the P* values among regions reflects the relative differences in interannual variability of average catches over the years in which the proxy MSY values are based. It is also apparent that P* values, representing the probability that the ABC will exceed the true MSY, increase as greater uncertainty is considered in the estimation of the proxy MSY. The relative differences in regional P* values are less pronounced with reduced (i.e., smaller σ_a values), compared to greater, uncertainty.

This alternative improves protection to the scallop resource over status quo (and Alternatives 2a and 2b) by providing a 10% buffer between the revised proxy MSY and the ACL. This protection is likely to be greatest when stock abundance, and the corresponding discard mortality, is high, and GHLs for the registration areas are close to the maximum allowable. Similar to Alternative 2b, there is greater potential for unanticipated catches and/or discards to result in a regional ACL being exceeded compared to a statewide ACL, as in Alternative 3a, because there is less opportunity to make in-season management adjustments by constraining fishing in alternate registration areas within a regional management area. We also note that there is currently no mechanism to address increased discard mortalities in non-scallop fisheries other than to reduce directed scallop fishery harvests.

4.5 Alternative 4: ABC Control Rule = 75% of GHR

4.5.1 Alternative 4a: Statewide ACL = 75% of sum of upper ends of GHRs

Alternative 4a would establish a statewide ACL as 75% of the sum of the upper ends of the GHRs defined in ADF&G regulation for commercial scallop fishery registration areas plus estimated discard mortalities in the scallop and groundfish fisheries and agency surveys. Under the current management strategy, a proxy MSY level based on the upper ends of the GHRs totals to a statewide GHR of 1.24 million lbs (562.5 mt) of meats (Table 4-1). Redefining the OFL to include all fishing mortality, and applying a Control Rule of 75% of the OFL results in a statewide ACL of 963,067 lbs (436.8 mt) of meats (Table 4-2). The estimated discard mortality becomes 33,067 lbs, with a retained catch of 930,000 lbs. Historical ADF&G management performance produced annual harvests ranging from 28 to 68% of the

statewide proxy MSY; harvests have comprised <50% of the proxy MSY since the 2001 LLP implementation for weathervane scallops (Table 4-3; NPFMC 2006). Thus, adoption of this alternative is anticipated to retain a buffer of at least 20% of the proxy MSY between the ACL and the ADF&G management target, after estimated discard mortality is accounted for. This alternative is not likely to significantly affect ADF&G in-season management strategies, particularly based on harvest targets in recent years, and provided that neither bycatch needs increase dramatically nor estimated MSY decreases dramatically based on future analysis. However, statewide bycatch needs as applied in this analysis are estimated with some uncertainty due to the current pooling of scallops into a bivalve category for the groundfish fisheries and the potential for future changes in scallop bycatch among fisheries.

The use of Equation 4 to examine Alternative 4a, which specifies a multiplier of B_f=0.75, indicates a statewide P* value of 0.091, thus, a relatively low probability that the ABC will exceed the true MSY given the available data and the assumption that variability is represented in the annual catch (Table 3-7). However, incorporation of additional uncertainty increases the P* value, and σ_a values of 0.4 or 0.5 result in P* values exceeding that under a fixed multiplier of B_f=0.90 with no additional uncertainty.

By increasing the buffer between the upper end of the regional GHR and the regional ACL to 25%, this alternative further increases the protection from overfishing provided to the resource in comparison to Alternatives 3a or 3b. Given the history of management implementation, the 25% buffer substantially exceeds the maximum GHL overage of 5% since the 1998/99 season (Table 4-3). However, in the event of unanticipated overages in either the directed fishery harvests or discard mortality, this alternative with a statewide ACL, similar to Alternative 2a, allows for in-season management adjustments which curtail fishing in other registration areas. In addition, Table 3-7 shows that high values of assumed additional uncertainty result in P* values that exceed the P* value with a fixed multiplier of 0.90 and no additional uncertainty. But, the actual discard mortality based on the 25% buffer in this alternative would need to substantially exceed preseason estimates, and all fishery harvests among all registration areas would need to be at or near the maximum GHL to exceed the buffered proxy MSY. We note that there is currently no mechanism to address increased discard mortalities in non-scallop fisheries other than to reduce directed scallop fishery harvests.

4.5.2 Alternative 4b: Regional ACLs = 75% of upper ends of regional GHRs

Alternative 4b would establish regional ACLs based on 75% of the sums of the upper ends of the GHRs defined in ADF&G regulation for commercial scallop fishery registration areas plus estimated discard mortalities in the directed scallop fishery, the groundfish fisheries, and agency surveys. Under the current management strategy, proxy MSY levels, based on the upper ends of the registration area GHRs for each ADF&G registration area, total to 285,000 lbs (129.3 mt) of meats for Region 1, 70,000 lbs (31.8 mt) for Region 2, and 885,000 lbs (401.4 mt) for Region 4 (Table 4-2). The ABC control rule of 75% of the sums of the GHRs and the discard mortalities under this alternative would reduce the ACLs to 223,899 lbs (101.6 mt) of meats for Region 1, 53,849 lbs (24.4 mt) for Region 2, and 685,319 lbs (310.9 mt) for Region 4. Estimated discard mortalities under these ACLs would be 10,149 lbs of meats in Region 1, 1,349 lbs in Region 2, and 21,569 lbs in Region 4, with resulting maximum GHLs of 213,750 lbs in Region 1, 52,500 lbs in Region 2, and 663,750 lbs in Region 4. Although these maximum GHLs are smaller than the upper ends of the GHRs as specified in State regulation, ADF&G management in recent years has targeted GHLs smaller than the regulatory maximum (Table 4-3). This alternative would still have constrained the fishery if implemented in the late 1990s to early 2000s in Regions 1 and in 2004/05 in Region 2 (Table **3-1**). Based on ADF&G management performance following the 2001 implementation of the LLP, annual harvests as a proportion of the regional GHRs have ranged from 39.1 to 74.7% (mean = 53.9%, CV = 22.7%) for Region 1, from 28.5 to 79.2% (mean = 49.6, CV = 40.6%) in Region 2, and from 17.1 to 40.5% (mean = 31.0, CV = 23%) in Region 4 (Table 4-3). Depending on the stock assessment and anticipated bycatch needs in any given year, adoption of this alternative has the

potential to constrain directed scallop fishing in Regions 1 and 2, but would likely retain an adequate buffer between the ACL and the ADF&G management target to accommodate discard mortality needs in Region 4. However, regional bycatch needs as applied in this analysis are estimated with some uncertainty due to the current pooling of scallops into a bivalve category for the groundfish fisheries and the potential for future changes in scallop bycatch among fisheries. Given interregional variability in benthic species composition (e.g., mussels may predominate as bivalves in some areas while scallops predominate in other areas), uncertainty is likely exacerbated when estimating bycatch needs at the regional level.

Alternative 4b specifies a multiplier of B_f=0.75; through Equation 4, estimated P* values of 0.168 for Region 1, 0.304 for Region 2, and 0.063 for Region 4 (Table 4-2). The rank differences in the P* values among regions reflects the relative differences in interannual variability of average catches over the years in which the proxy MSY values are based. As in other alternatives with B_f<0.75, P* increases with greater assumed additional uncertainty, particularly in Region 4 for which the P* values under σ_a of 0.4 or 0.5 exceeds that under a fixed multiplier of B_f=0.90 with no additional uncertainty (Table 3-7).

We note that the Region 2 stocks have relatively low GHR caps and relatively high variability in fishery performance compared to other regions. The reasons for these differences are unknown, but several aspects are suspected. For the Prince William Sound scallop beds, fishing in 1995 by an unregistered vessel substantially exceeded the upper end of the Registration Area GHR, possibly reducing stock productivity (Barnhart et al. 2008). In the case of the Cook Inlet scallop beds, the beds, and corresponding biomasses, are relatively small with high interannual variability (Trowbridge and Goldman 2006), possibly suggesting relatively low resilience compared to other scallop beds. Thus, a slightly more conservative approach may be warranted for these areas.

This alternative, similar to Alternative 4b, provides greater protection to the weathervane scallop population relative to Alternatives 1-3. Although fisheries in some regions and years may have been constrained had the average discard mortality been considered under a 25% Control Rule, we note that management implementation has been relatively precise in all regions (Table 4-3). Thus, with preseason incorporation of anticipated discard mortality into the management process, it is unlikely that scallop mortality would have approached the ACL. However, the previous notes about the reduced flexibility of in-season management adjustments under regional compared to statewide ACLs still apply under this alternative. We also note that there is no measure at this time that would constrain fishing in non-scallop fisheries to reduce weathervane scallop discard mortality.

4.6 Options for non-target species

No commercial harvests have been documented for scallop species other than weathervane scallop since at least 1992 (C. Russ, ADF&G, Homer, pers. comm.). Major fishery development is not anticipated for these non-target scallop fisheries, but market potential does exist for both pink and rock scallops. The spatial distribution of these non-target species is not well defined, although these species currently comprise a relatively minor component of catches in both NMFS and ADF&G surveys. In addition, limited non-commercial harvests of *Chlamys* sp. and rock scallops currently occur within waters of state jurisdiction. The following impacts may be anticipated of the options considered (described in Section 2.1.4) for management of scallop species other than weathervane scallop.

4.6.1 Remove from FMP

This option would limit the Scallop FMP to weathervane scallops by removing non-weathervane species from the FMP. The State currently has management authority for non-target species in State waters. If non-target species are removed from the FMP, management authority for these removed species in all

waters off Alaska, including federal waters, will default to the State of Alaska. The State of Alaska would then regulate fishing under State law for these species external to the federal council process. Adoption of this option would allow the State to implement more responsive, regionally based, management of these species than is currently possible under the FMP.

The actions that would be required for fishery development under this option are, to some extent, currently implemented by ADF&G. Individuals interested in harvesting non-target scallops are required to obtain an ADF&G Commissioner's Permit, and ADF&G staff consider various management aspects including, but not limited to, legal gear, harvest area, harvest limits, bycatch considerations, and observer and reporting requirements. If a fishery harvest were allowed, ADF&G would implement in-season management measures as needed to achieve the fishery guidelines. In the event of rapid fishery development for non-target scallop species, the State would implement the High Impact Emerging Fishery Policy to constrain fishery development until additional management measures are developed. As understanding of the fishery potential increases, the Alaska Board of Fisheries would develop a more refined management plan.

The intended effect of removal from the FMP would be to ease the burden of Federal oversight through the Council process for what would likely be a relatively small fishery, provide for more responsive State management, and prevent localized overfishing of non-target scallop species. This option would require an FMP amendment.

4.6.2 Move to Ecosystem Component

This option would transfer scallop species other than weathervane scallops into an Ecosystem Component category of the FMP. This action would retain oversight of non-target scallops by the Council, and require monitoring, to the extent practicable, of the scallop species exclusive of weathervane scallops. Monitoring would likely include compilation of historical and future data from sources such as State and Federal surveys and incidental bycatch in other fisheries, with a periodic status report summarizing landings and biomass data provided through SAFE reports. There is currently little information available on these non-target species and their role in the ecosystem as a benthic, filter feeder is unknown, as is their potential as an ecosystem indicator. One criterion that should be met for EC classification (see section 2.1.4.2) is that non-target species "Not generally be retained for sale or personal use." At present, some non-commercial harvests of non-target species (e.g., harvests by scuba divers) occur, although the extent of these removals is not well quantified.

No additional catch restrictions would be enacted (e.g. prohibited bycatch of these species in other fisheries) if non-target species are transferred to an EC classification. However, this option would require an FMP amendment. If there was a future interest in fishery development, these species would need to be moved back "into the fishery" through an FMP amendment, and ACLs would need to be established annually, as in Section 4.6.3.

4.6.3 Set ACLs for those stocks

Establishment of ACLs for non-target scallop species would potentially provide increased protection against fisheries impacts. However, the data available to establish ACLs is limited. Establishment of ACLs will require stock assessment or fishery performance data for non-target species as either a group or broken out by individual species. Reported commercial harvests for *Chlamys* sp. are limited to approximately 124,000 lbs of meats harvested along the Aleutian Islands between 1991 and 1992 (C. Russ, ADF&G, Homer, pers. comm.). The rock scallop is harvested by divers for personal use in nearshore waters of Southeast Alaska, but commercial harvests have not been recorded.

Documentation of any scallop species by federal groundfish observers has been limited, with at-sea observations pooled into a "bivalve" category that averaged 39,087 lbs (whole weight; 17.7 mt) annually across all Alaska groundfish fisheries (Table 3-3). Delineating this bivalve catch into more refined species groups, including non-target scallop species, is not possible at this time. The NMFS and ADF&G bottom trawl surveys have also produced some data on the abundance and distribution of non-target scallop species, although species identification has been inconsistent over time; most of the non-target species encountered by these survey platforms are likely *Chlamys* sp. In addition, samples sizes on which to establish ACLs for non-target species is sparse, represented by an annual average survey catch of 1 lb from Region 1, 23 lbs from Region 2, and 67 lbs from Region 4 for a statewide total of 91 lbs annually among all ADF&G and NMFS trawl survey platforms since 1998 (Table 3-4).

In the event that this option is selected by the Council, it is expected that development of ACLs in anticipation of a potential fishery will involve a concerted effort by both ADF&G and NMFS staff for data compilation, analysis, and technical review, as well as periodic updates of data and analysis. Although both state and federal waters contribute to the greater population, the species composition and spatial distribution remains largely unknown. In addition to the Council process to develop ACLS, determination of the TAC/GHL would involve virtually all of the management measures identified under Option 1 as being implemented by ADF&G. In essence, measures to be developed by the State of Alaska would include, but not limited to, legal gear, harvest area, harvest limits, bycatch considerations, and in-season management measures such as observer and reporting requirements. In the event of rapid fishery development for non-target scallop species, the State would implement the High Impact Emerging Fishery Policy to constrain fishery development until additional management measures are developed. As understanding of the fishery potential increases, the Alaska Board of Fisheries would develop a more refined management plan.

Three proposed approaches to establish an OFL for non-target stocks in aggregate are provided in Section 2.1.4.3.

4.7 Economic Impacts

4.7.1 Direct effects

This section provides preliminary analysis of the potential economic direct effects that the ACL alternatives may have on the scallop fishery. This analysis compares the ACL levels, as a percent of the upper range of the GHR levels, with the percent that harvest has represented of the upper range of the GHR by region and statewide from the 1998/99 season through the 2008/09 season. The information contained in this section comes from Table 3-6 as well as from economic price and revenue data contained in the 2010 Scallop SAFE report (NPFMC 2010b). This retrospective analysis shows what would have occurred, in terms of forgone revenue, had the ACL levels been in place during this time frame.

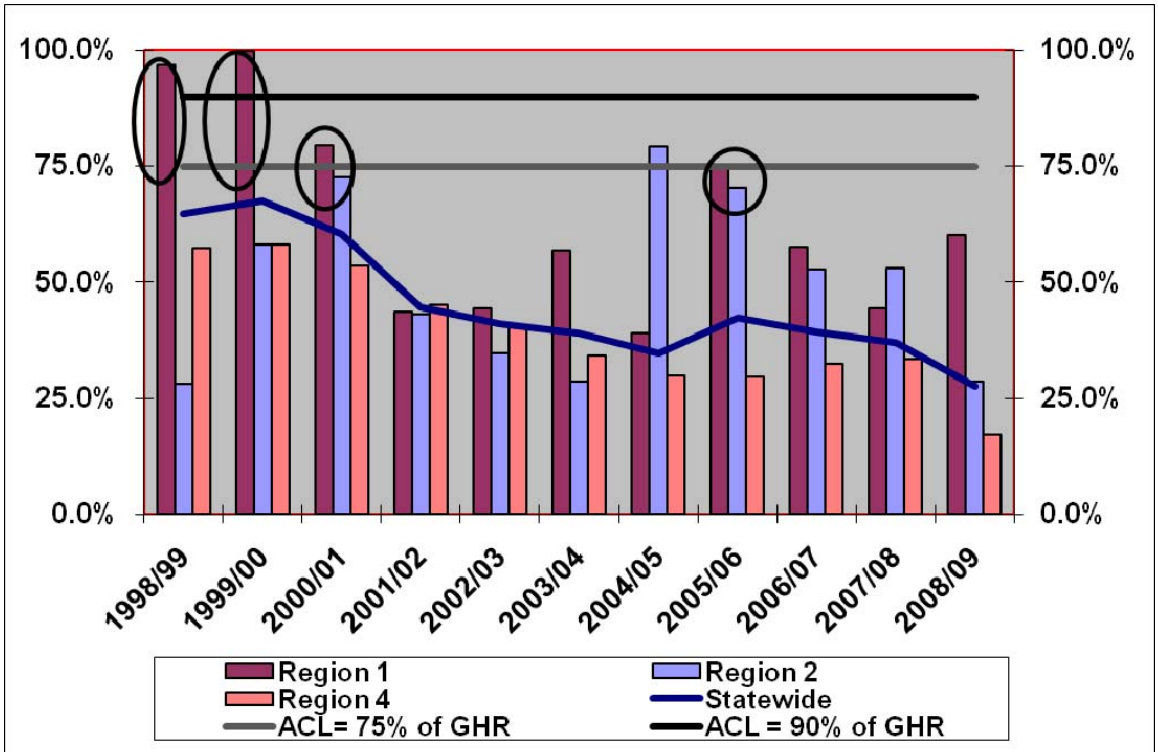

Figure 4-2 Scallop harvests by region and statewide as a percent of the upper end of the GHR, compared to ACL levels.

Figure 4-2 provides an historical overview that identifies seasons when the scallop harvests, statewide and by region, would have exceeded the ACL levels of 75% and 90% of the upper ends of the GHR. This figure makes it clear that were the ACL set at a statewide level there would historically have been no impact because the statewide harvests, since inception of the current MSY of 1.24 million pounds, have always been below both the 75% and 90% levels of the GHR. This figure does; however, point out that were the ACL set regionally at 75% of GHR, the ACL would historically have been exceeded, or nearly so, for Region 1 in each of the seasons of 1998/99, 1999/00, 2000/01, and 2005/06 (each instance is circled). This is also true for Region 2 in 2000/01 and 2004/05. An ACL set at 90% of the GHR would have been exceeded in 1998/99, 1999/00 in Region1. In contrast, Region 4 harvests have not historically exceeded 60% of the upper end of the regional GHR and would not have been affected by ACLs set at either the 75% or 90% of GHR level.

It is possible to quantify the impacts shown in this retrospective analysis by simply subtracting the ACL percentage of the upper range of the GHR, either 75% or 90%, from the percentage that each annual harvest quantity is of the upper end of the GHR. This yields a retrospective percent of harvest, and thereby revenue, that would have been forgone were the ACL rule in place. These percentages can then be multiplied by real (inflation adjusted) annual average scallop prices in order to estimate forgone revenue. Scallop prices along with overall revenue estimates by region and statewide and are presented in Table 4-4.

Table 4-4 Alaska scallop first wholesale value per pound with total revenue (in dollars) by region and season.

Year	Real Price ($/lb.)	Value of Annual harvest			
		Region			
		1	2[a]	4	Statewide
1998/99	$7.94	$2,190,098	$156,021	$4,034,449	$6,380,568
1999/00	$7.63	$2,169,247	$310,732	$3,913,740	$6,393,719
2000/01	$6.60	$1,495,580	$335,161	$3,123,331	$4,954,072
2001/02	$6.14	$762,576	$184,753	$2,446,501	$3,393,830
2002/03	$6.04	$763,474	$146,361	$2,167,273	$3,077,108
2003/04	$5.88	$952,501	$117,482	$1,779,088	$2,849,072
2004/05	$6.00	$668,280	$332,622	$1,588,662	$2,589,564
2005/06	$8.03	$1,710,398	$395,116	$2,113,103	$4,218,617
2006/07	$8.10	$1,331,600	$299,619	$2,317,313	$3,948,531
2007/08	$5.98	$754,317	$221,888	$1,764,507	$2,740,712
2008/09	$6.34	$1,085,884	$127,054	$958,094	$2,171,032

Alternative 2a would set a statewide ACL as the sum of the upper end of the GHRs among regions. As shown in both Figure 4-2 and previously in Table 4-1, this alternative would historically have had no direct effects because the statewide harvest has not exceeded 70% of the upper range of the GHR and has been considerably lower than that percentage in recent years.

Alternative 2b would set the regional ACLs as the upper end of the GHRs in each individual region. As shown in both Figure 4-2 and previously in Table 3-6, this alternative would historically have had no direct effects because regional harvests have not exceeded the upper range of the GHR in recent years, although Region 1 harvests were within two tenths of a percentage point of achieving the upper range of the GHR in the 1999/00 season.

Alternative 3a would establish a statewide ACL that would be 90% of the sum of the upper end of the regional GHRs. As shown in Table 4-5, a statewide ACL set at 90% of the upper end of the statewide GHR would not have resulted in forgone revenue in any of the seasons since 1998/99, when the 1.24 million pound MSY was first implemented. A review of Table 4-1 and Figure 4-2 shows that the greatest statewide harvest, as a percentage of GHR, occurred in 1999/00 at 67.6% of the upper end of the statewide GHR and has trended downward in recent years.

Alternative 3b would set regional ACLs at 90% of the upper end of the GHR in each individual region. As shown in Table 4-5, Region 1 would historically have had forgone harvest and revenue of 6.8% and 9.8% in 1998/99 and 199/00 respectively. This translates into $148,927 and $212,586 of forgone revenue in 1998/99 and 199/00 respectively. The other regions would historically not have been affected by this alternative.

Table 4-5 Percent of harvest and revenue (upper) that would historically have been forgone under ACL=90% of GHR along with estimated historic forgone revenue (dollars, lower)

Year	Percent of harvest forgone with ACL=90% of GHR			
	Region 1	Region 2	Region 4	Statewide
1998/99	6.8	0	0	0
1999/00	9.8	0	0	0
2000/01	0	0	0	0
2001/02	0	0	0	0
2002/03	0	0	0	0
2003/04	0	0	0	0
2004/05	0	0	0	0
2005/06	0	0	0	0
2006/07	0	0	0	0
2007/08	0	0	0	0
2008/09	0	0	0	0
Year	Forgone Revenue with ACL=90% of GHR			
1998/99	$148,927	$0	$0	$0
1999/00	$212,586	$0	$0	$0
2000/01	$0	$0	$0	$0
2001/02	$0	$0	$0	$0
2002/03	$0	$0	$0	$0
2003/04	$0	$0	$0	$0
2004/05	$0	$0	$0	$0
2005/06	$0	$0	$0	$0
2006/07	$0	$0	$0	$0
2007/08	$0	$0	$0	$0
2008/09	$0	$0	$0	$0

Alternative 4a would establish a statewide ACL that would be 75% of the sum of the upper end of the regional GHRs. As shown in Table 4-6, a statewide ACL set at 75% of the upper end of the statewide GHR would not have resulted in forgone revenue in any of the seasons since 1998/99, when the 1.24 million pound MSY was first implemented. A review of Table 4-1 and Figure 4-2, shows that the greatest statewide harvest, as a percentage of GHR, occurred in 1999/00 at 67.6% of the upper end of the statewide GHR and has trended downward in recent years.

Alternative 4b would set regional ACLs at 75% of the upper end of the GHR in each individual region. As shown inTable 4-6, Region 1 would historically have had forgone harvest and revenue of 21.8%, 24.8%, and 4.5% in 1998/99, 1999/00, and 2000/01 respectively. This translates into $477,441, $537,973, and $67,301 of forgone revenue in 1998/99, 1999/00, and 2000/01 respectively. In addition, Region 2 would have had forgone harvest and revenue of 4.2%, or $13,970, in the 2004/05 season. Region 4 would historically not have been affected by this alternative.

Table 4-6 Percent of harvest and revenue (upper) that would historically have been forgone under ACL=75% of GHR along with estimated historic forgone revenue (dollars, lower)

Year	Percent of harvest forgone with ACL=75% of GHR			
	Region 1	Region 2	Region 4	Statewide
1998/99	21.8	0	0	0
1999/00	24.8	0	0	0
2000/01	4.5	0	0	0
2001/02	0	0	0	0
2002/03	0	0	0	0
2003/04	0	0	0	0
2004/05	0	4.2	0	0
2005/06	0	0	0	0
2006/07	0	0	0	0
2007/08	0	0	0	0
2008/09	0	0	0	0
Year	Forgone Revenue with ACL=75% of GHR			
1998/99	$477,441	$0	$0	$0
1999/00	$537,973	$0	$0	$0
2000/01	$67,301	$0	$0	$0
2001/02	$0	$0	$0	$0
2002/03	$0	$0	$0	$0
2003/04	$0	$0	$0	$0
2004/05	$0	$13,970	$0	$0
2005/06	$0	$0	$0	$0
2006/07	$0	$0	$0	$0
2007/08	$0	$0	$0	$0
2008/09	$0	$0	$0	$0

4.7.2 The Economic Benefits of ACL Management

Annual Catch Limits are intended to reduce the probability that overfishing could occur, and thereby improve the likelihood that Optimum Yield (OY) is achieved for the fishery as a whole. The achievement of OY is a major tenant of fisheries management under the national standards prescribed in the Magnuson-Stevens Act.

For fish stocks that are not undergoing overfishing, such as Alaska scallop stocks, ACL requirements still might require catch targets slightly less than current catch quotas if there is a demonstrated risk of overfishing. In general, management via ACLs should contribute to the conservation of stocks through more rapid rebuilding of overfished stocks and preventing overfishing, even in stocks not presently overfished.

Alaska Scallops are presently being harvested at levels that are considerably below the MSY for this fishery (Table 4-1). Historically, the fishery has not exceeded 70% of statewide MSY. This is largely due to conservative management by ADF&G, which sets GHLs that are below the upper end of the GHR range. Further, the fishery has 100% observer coverage, although coverage may be waived in the Cook Inlet area at the discretion of ADF&G staff. Thus, management of the fishery, via closures, is quite timely and results in catch that does not generally exceed the GHLs, which are set below the upper end of the GHRs (Table 4-3).

Chapter 5 Other Marine Resources and Habitat

Bycatch in the scallop fishery includes prohibited species, other commercially important species of fish and invertebrates, miscellaneous non-commercial species, and natural and man-made debris (e.g., Barnhart and Rosenkranz 2003). Prohibited species include king crab (*Paralithodes camtschaticus*), Tanner crab (*Chionoecetes bairdi*), snow crab (*C. opilio*), Dungeness crab (*Cancer magister*), and Pacific halibut (*Hippoglossus stenolepis*). Although a variety of marine vertebrates, invertebrates, and debris are caught incidentally in the scallop fishery dredges, weathervane scallops comprise the bulk of haul composition samples. During the 2000/01–2007/08 seasons, the most common items, by percent weight, have been weathervane scallops (84%), twenty-arm sea stars *Pycnopidia helianthoides* (4%), natural debris such as kelp and wood (3%), and assorted skate species (2%) (NPFMC 2010b). Gorgonian (hard) corals are infrequently encountered in observer samples; corals were observed in only 11 of 15,836 sampled tows.

5.1 Impacts of Alternatives on Groundfish Stocks and Fisheries

Pacific cod has typically comprised <0.5% of scallop fisheries catch biomass (e.g., Rosenkranz and Burt 2009). Because a single Pacific cod weighs substantially more than a single scallop, on average, observer estimates of Pacific cod bycatch by weight represent relatively few individual Pacific cod compared to weathervane scallops. Under current scallop fishery in-season management strategies in which ADF&G targets a GHL that is typically well below any of the proposed alternative ACLs, adoption of any of the proposed alternatives is not expected to substantially affect the Pacific cod fisheries. Although the potential exists for shifts in a species spatial distribution due to aspects such as global warming or changes in inter-specific competition (e.g., Perry et al. 2005), it is still unlikely that Pacific cod would develop substantial spatial overlap with weathervane scallops given different habitat preferences.

The scallop fishery bycatch extrapolation of observer samples in the NMFS catch accounting program indicates bycatch of bivalves, including scallops, in the Pacific cod fishery (J. Gasper, NMFS, Juneau, pers. comm.). This is based on the occurrence of bivalves observed on top of retrieved pots, clamped onto retrieved longlines, or in the dump of a trawl tow. Under the current management approach and proposed ACL alternatives, estimates of the anticipated bycatch of weathervane scallops in the Pacific cod fisheries are deducted from the scallop fishery ABC(s) under the ABC control rule applicable for the alternative considered. Although this essentially redistributes the burden for scallop bycatch in the Pacific cod fisheries to the scallop fisheries, the bycatch redistribution is not limiting to the scallop fishery based on the current approach to specifying ABC and the available data for scallop bycatch in the Pacific cod fishery.

Skates have become a species of concern due to life history characteristics and an uncertainty in the catch composition (Ormseth and Matta 2009). Skates comprise ~2% of historical catch biomass in observed scallop tows (Barnhart and Rosenkranz 2003). Flounder and sole in aggregate typically comprise < 1.5% of scallop fishery catch biomass, but may approach 5% along the Alaska Peninsula. Other groundfish species typically comprise smaller components of the scallop bycatch. Based on the proportionally smaller body size of scallops compared to most groundfish species, these bycatch values represent a relatively small number of individual groundfish. Under current scallop fishery in-season management strategies in which ADF&G targets a GHL that is typically well below any of the proposed alternative ACLs, adoption of any of the proposed alternatives is not expected to substantially affect any of the groundfish fisheries. However, shifts in species distribution due to factors such as climate change or inter-specific competition may increase scallop fishery bycatch of any groundfish resource. Similarly,

such shifts may increase scallop bycatch in particular groundfish fisheries. These potential changes would need to be addressed as they occur.

5.2 Impacts on marine mammals

Within the EEZ off Alaska, the scallop fishery is classified as a Category III fishery under the Marine Mammal Protection Act because it has annual mortality and serious injury of a marine mammal stock of less than 1% of that stock's potential biological removal. A fishery that interacts only with non-strategic stocks and whose level of take has insignificant impact on the stocks is placed in Category III. An observer program is in place for the scallop fisheries off Alaska. No takes of marine mammals in the scallop fishery off Alaska recorded in the ADF&G Observer database during 1996–2008. However, anecdotal information suggests a small pinniped was captured in a scallop dredge fished off Yakutat in 2009 (R. Burt, ADF&G, Kodiak, pers. comm.). Although the condition (i.e., alive or dead) of the pinniped prior to capture in the dredge was not determined, the likelihood of a live marine mammal being captured in a scallop dredge remains extremely low.

5.3 Impacts on other benthic organisms

Because the scallop fishery off Alaska has 100% observer coverage (although coverage may be reduced at the discretion of ADF&G management staff in the Cook Inlet region; Trowbridge and Goldman 2006; NPFMC 2010b), bycatch data on non-target species in the fishery is well documented. This includes prohibited species (e.g., crab and halibut), other commercially important fish and invertebrate species, miscellaneous non-commercial species, and natural and man-made debris. Annual ADF&G reports document catch composition data from observer sampling (Rosenkranz and Burt 2009).

Crab mortality in the scallop fisheries likely varies spatially and by fishing practices and benthic substrate. Hennick (1973) estimated about 30% of Tanner crabs and 42% of the red king crabs caught in scallop dredges in the Gulf of Alaska fishery were killed or injured. Hammerstrom and Merrit (1985) estimated an 8% mortality to Tanner crab in Cook Inlet scallop fishery, whereas Kaiser (1986) estimated mortality rates of 19% for Tanner crab and 48% for red king crab bycatch off Kodiak Island. Based on observer data collected in 1993, Urban et al. (1994) reported 13–35% of the Tanner crab caught by scallop dredges were dead or moribund, with the highest mortalities for small (<40 mm carapace width, CW) and large (>120 mm CW) crabs. Delayed mortality in discarded Tanner crab has not estimated. Compared to the Gulf of Alaska, crab mortality appears to be lower in the Bering Sea scallop fisheries with observer-documented mortalities of 10% for red king crab, 11% for Tanner crab, and 19% for snow crab (Barnhart et al. 1996). As in the Gulf of Alaska, mortality appeared to be related to size, with larger and smaller crabs having higher mortality rates (Barnhart et al. 1996). These mortality rates are substantially less than the 80% discard mortality assumed for crab species caught by bottom trawls fisheries in the Bering Sea (NPFMC 2010a).

Following the 2001 implementation of fishery cooperatives in the scallop fishery, incidental catch in the scallop fishery dropped by 39%, including catch and discard reductions of 51% for brittle stars and sea baskets, 1% for prohibited species, 12% for other commercial species, 56% for kelps and rocks, and 52% for miscellaneous starfish species (Northern Economics 2003). The decline in kelp and rocks is noteworthy in that these make up important habitat components of the ecosystem; thus, this decline may indicate reduced stress upon the habitat as a result of revised fishing practices following the formation of cooperatives.

Crab Bycatch Limits (CBLs) are used to monitor and regulate crab bycatch in the scallop fishery based on localized crab stock abundance (Table 5-1). Annual CBLs are established by ADF&G by region before

the scallop season, and bycatch is monitored in-season through observer reports. Scallop fishery closures due to CBLs attainment have decreased in recent years, partly due to decreased crab abundance (Barnhart and Rosenkranz 2003), and also due to industry encouragement to avoid high bycatch areas. Bycatch may affect harvest and CPUE in the Bering Sea scallop fishery as vessel operators cease fishing when bycatch rates exceed benchmarks. Although bycatch caps, expressed as crab abundance, include all sizes of crabs caught in the scallop fishery (Barnhart 2003), prohibited species caps are based on total abundance irrespective of crab size. Thus, a juvenile crab accrues to the PSC limit the same as an adult crab. However, in areas where CBLS area linked to crab stock abundance, reduction in the abundance of a crab stock results in a corresponding reduction in the CBL, thus providing increased protection to the crab stock. The Scallop SAFE report annually reports crab bycatch in the Alaskan scallop fishery (NPFMC 2010b).

None of the alternatives are expected to jeopardize the long-term productivity of crab or other benthic organisms.

Table 5-1 Statewide crab bycatch limits in percentage of crab abundance estimates (where available) or number of crabs.

Area/District	Red King Crab[a]	*C. bairdi*[a]	*C. opilio*[b]
Yakutat District 16	NE	NE	NA
Yakutat Area D	NE	NE	NA
Prince William Sound	NE	0.5%	NA
Cook Inlet Kamishak District	60 crab[c]	0.5%	NA
Kodiak Northeast District	0.5% or 1.0%	0.5% or 1.0%	NA
Kodiak Shelikof District	0.5% or 1.0%	0.5% or 1.0%	NA
Kodiak Semidi District	NE	NE	NA
Alaska Peninsula	0.5% or 1.0%	0.5% or 1.0%	NA
Bering Sea	500 crab[c]	3 tier approach	3 tier approach
Dutch Harbor	0.5% or 1.0%	0.5% or 1.0%	NA
Adak[d]	50	10,000 crab[c]	NA

[a] NE = Not established.
[b] NA = Not applicable.
[c] Fixed CBL.
[d] Bycatch limit established to provide scallop fleet opportunity for exploratory fishing while protecting crab resources.

5.4 Impacts on Benthic Habitat

Two broad categories of habitat impacts may result from scallop dredge fisheries: habitat alteration and gear-induced damage and mortality (Grant 2000). Scallop dredging may alter habitat through unobserved mortality to marine organisms, discard mortality, and modification of benthic sediments and community structure. Dredging resuspends fine sediments, buries gravel below the surface, and overturns large rocks that are embedded in the substrate (NEFMC 1982, Caddy 1973). Dredging also dislodges buried shell material, buries gravel under resuspended sand, and overturns larger rocks with an appreciable roughening of the sediment surface (Caddy 1968).

For some scallop species, dredges have been shown to adversely affect substrate required for settlement of young to the bottom (Fonseca et al. 1984; Orensanz 1986). An investigation of sediment impacts from a New Bedford scallop dredge found that vertical redistribution of bottom sediments had greater implications than the horizontal translocation associated with scraping and plowing the bottom (Mayer et al. 1991). The scallop dredge tended to bury organic matter below the surface, causing a shift in sediment metabolism away from aerobic respiration that occurs at the sediment surface. Dredge marks on the sea floor tend to be short-lived in areas of strong bottom currents, but may persist in low energy environments (Messieh et al. 1991).

Bycatch data from the Scallop Observer Program indicates that habitat forming organisms (e.g. Gorgonian hard corals) are infrequently encountered in scallop fishery catch. Since 1996, corals have only been encountered in 11 of the 15,836 tows sampled for catch composition and bycatch (Barnhart and Rosenkranz 2003). Natural debris, such as kelp and wood, comprised approximately 5% of the total percent weight sampled for the same time period. As previously expressed, the bycatch of kelp and rocks declined 56% after scallop fishery cooperatives were implemented in 2001(Northern Economics 2003). Although this may indicate reduced stress upon the habitat due to changes in fishing practices following the formation of cooperatives, a specific study to assess changes to fishing practices has not been conducted.

The Alaska weathervane scallop fishery occurs in continental shelf waters at 40–150 m depths in three main areas: the eastern Gulf of Alaska between Prince William Sound and Cape Spencer, around Kodiak Island, and in the eastern Bering Sea (Turk 2000; Figure 4-1). Because the fishery footprint is confined to these areas, and many areas of similar habitat are closed to scallop dredging, the effects of these alternatives on the GOA and Bering Sea ecosystems are likely to be minor (NPFMC 2010b). The habitat impacts of the scallop fishery are not anticipated to change under the proposed alternatives because the alternatives do not increase the amount of scallops harvested or change the location or timing of the fishery. In the event that discard mortality become limiting to the scallop fishery, habitat impacts may decrease.

Chapter 6 Cumulative Effects

Analysis of the potential cumulative effects of a proposed action and its alternatives is a requirement of NEPA. Cumulative effects are those combined effects on the quality of the human environment that result from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions, regardless of what Federal or non-Federal agency or person undertakes such other actions (40 CFR 1508.7, 1508.25(a), and 1508.25(c)). Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time. The concept behind cumulative effects analysis is to capture the total effects of many actions over time that would be missed by evaluating each action individually. At the same time, the CEQ guidelines recognize that it is not practical to analyze the cumulative effects of an action on the universe, but to focus on those effects that are truly meaningful.

In this EA, relevant past and present actions are identified and integrated into the impacts analysis in Chapter 4. This section provides a summary description of the reasonably foreseeable future actions that may affect scallops and that also may be affected by the alternatives in this analysis. Consideration of future actions provides the reader with an understanding of the changes in the impacts of the alternatives on each resource component when we take into account the reasonable foreseeable future actions. The "action area" for scallop management includes the federal waters of the Gulf of Alaska and Bering Sea. The time frame for future actions is ten years.

CEQ regulations require a consideration of actions, whether taken by a government or by private persons, which are reasonably foreseeable. This is interpreted as indicating actions that are more than merely possible or speculative. Actions have been considered reasonably foreseeable if some concrete step has been taken toward implementation, such as a Council recommendation or the publication of a proposed rule. Actions simply "under consideration" have not generally been included because they may change substantially or may not be adopted, and so cannot be reasonably described, predicted, or foreseen.

Future actions that may affect the scallop fishery, the bycatch in that fishery, and the impacts of the scallop fishery on the resources components analyzed in this EA have been grouped in the following four categories:

- Ecosystem-sensitive management
- Traditional management tools
- Actions by other Federal, State, and international agencies
- Private actions

Table 6-1 summarizes the reasonably foreseeable "actions" identified in this analysis that are likely to have an impact on a resource component within the action area and timeframe. Identification of actions likely to impact a resource component, or change the impacts of any of the alternatives, within this action's area and time frame will allow decision makers and the public to make a reasoned choice among alternatives. Actions are understood to be human actions (e.g., a proposed rule to designate northern right whale critical habitat in the Pacific Ocean), as distinguished from natural events (e.g., an ecological regime shift). Natural events are included in this analysis for informational purposes.

Table 6-1 Reasonably foreseeable future actions and natural events

Ecosystem-sensitive management	• Increasing habitat protection • Actions to minimize bycatch
Traditional management tools	• Continuation of License Limitation Program
Other Federal, State, and international agencies	• State management of scallop fisheries
Private actions	• Commercial scallop fishing • Increasing levels of economic activity in Alaska's waters and coastal zone
Natural events	• Ocean acidification

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