ISSN: 0579-3920

INTERNATIONAL PACIFIC HALIBUT COMMISSION

ESTABLISHED BY A CONVENTION BETWEEN
CANADA AND THE UNITED STATES OF AMERICA

Technical Report No. 57

Report of the 2010 Halibut Bycatch Work Group

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SEATTLE, WASHINGTON
2012

The International Pacific Halibut Commission has three publications: Annual Reports (U.S. 0074-7238), Scientific Reports, and Technical Reports (U.S. ISSN 0579-3920). Until 1969, only one series was published (U.S. ISSN 0074-7426). The numbering of the original series has been continued with the Scientific Reports.

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Contents

List of Abbreviations

ADF&G	Alaska Department of Fish and Game	IFQ	Individual Fishing Quota
AFA	American Fisheries Act	IBQ	Individual Bycatch Quota
APA	Administrative Procedure Act	IFMP	Integrated Fisheries Management Plan
BRD	Bycatch Reduction Device	ITQ	Individual Transferable Quota
BREP	Bycatch Reduction Engineering Program	IPHC	International Pacific Halibut Commission
BSAI	Bering Sea/Aleutian Islands region	IVCP	Individual Vessel Checklist Program
CAS	Catch Accounting System (AK)	LAPP	Limited Access Privilege Program
CDQ	Community Development Quota	LOA	Length overall
CGIP	Commercial Groundfish Integration Plan	MSA	Magnuson-Stevens Fishery Conservation and Management Act
CGIPP	Commercial Groundfish Integration Pilot Program	mt	metric tons
CIC	Commercial Industry Caucus	NMFS	National Marine Fisheries Service
CL	Catch Limit	NOAA	National Oceanic and Atmospheric Administration
CP	Catcher/Processor	NPFMC	North Pacific Fishery Management Council
CSP	Catch Share Program	NPGOP	North Pacific Groundfish Observer Program
CV	Catcher Vessel	NWFSC	Northwest Fisheries Science Center
DFO	Fisheries and Oceans Canada	ODFW	Oregon Department of Fish and Wildlife
DMP	Dockside Monitoring Program	OY	Optimal Yield
DMR	Discard Mortality Rate	PFMC	Pacific Fishery Management Council
EM	Electronic Monitoring	PSC	Prohibited Species Catch
FFP	Federal Fishing Permit	QSVN	Quota Status Verification Number
FLCC	Freezer Longline Coalition Cooperative	RCA	Rockfish Conservation Area
FMP	Fishery Management Plan	RPP	Rockfish Pilot Program
fms	fathoms	SSC	Scientific and Statistical Committee
ft	Feet	TAC	Total Allowable Catch
GOA	Gulf of Alaska region	TIQ	Trawl Individual Quota
GTAC	Groundfish Trawl Advisory Committee	VBA	Vessel Bycatch Accountability
H&L	Hook and Line	VF	Video footage
HBWG	Halibut Bycatch Work Group	WCGOP	West Coast Groundfish Observer Program
HMAP	Halibut Mortality Avoidance Program	WDFW	Washington Department of Fish and Wildlife

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PREFACE

This report was prepared under authority of a directive by the International Pacific Halibut Commission adopted at the 2010 Annual Meeting. The directive sought an update on the goals laid out by the first Halibut Bycatch Work Group (HBWG) in 1991, an examination of the methods and programs employed by the agencies of the contracting parties to reduce halibut bycatch in fisheries targeting other species, and an examination of how bycatch is accounted for in the Commission's harvest policy. At its retreat in September 2010, the Commission decided to drop the latter task from the HBWG after determining that other approaches would be more appropriate to examining that question. The Commission received a report on the preliminary findings during the 2011 Annual Meeting, and requested that discussion of planned changes to management programs affecting bycatch be added to the report. This report was finalized following the Commission's September 2011 retreat.

NOTE TO THE READER

All weights presented and discussed in this report are either in (1) pounds, net weight (eviscerated, head off) or (2) metric round weight (uneviscerated, head-on). Pacific halibut harvests have been reported in pounds net weight since the beginning of the commercial fishery and those involved with the industry are accustomed to halibut weights reported in this form. However, it is recognized that the standard in many other fisheries is to report weights in "round" units. Additionally, most groundfish fishery management is specified in metric units, and this form is presented where it is the management standard or convention for that fishery. To assist the reader, the round weight equivalent can be calculated by dividing the net weight by a factor of 0.75.

Report of the 2010 Halibut Bycatch Work Group

Co-Chaired by T. Karim and D. Mecum

Objectives

At its 2010 Annual Meeting, the International Pacific Halibut Commission (IPHC, or Commission) decided to reconstitute the bilateral Halibut Bycatch Work Group (hereafter HBWG I) originally formed in 1991 to address several bycatch issues significant at that time. This 2010 Halibut Bycatch Work Group (hereafter HBWG II) was formed to review progress since 1991 and examine current bycatch issues.

In recent years, several issues have served to increase the need for greater understanding of the impacts of halibut bycatch, including the decline in halibut exploitable biomass, changes in observed size at age, and new information on migration by juvenile and adult halibut coming from a 2003-2004 tagging study (Webster and Clark 2007, Hare 2011). In addition, concerns about the adequacy of monitoring and the accuracy of estimates of bycatch provided to IPHC by domestic agencies have been raised. Thus, at its 2010 Annual Meeting, the Commission decided to form HBWG II, with the goal of reviewing progress on bycatch control since 1991, reviewing bycatch monitoring programs, and examining how bycatch mortality is accounted for within the IPHC harvest policy[1].

HBWG II met in Seattle, WA on August 11 and held conference calls on September 27 and December 1 and 20, 2010 as it worked to meet its charge. Additionally, staffs of the U.S. National Marine Fisheries Service (NMFS), IPHC, and Fisheries and Oceans Canada (DFO) produced and reviewed numerous documents and analyses in support of HBWG II deliberation. This report presents the results of those deliberations.

Background information

Bycatch has long been a subject of much research and discussion by the Commission in its management of the resource and fishery (Bell 1955, Hoag and French 1976). Sullivan et al. (1994) examined the impacts of groundfish fisheries on the directed setline fisheries in other areas, demonstrating the significant effects on yield and reproductive potential. The effect of bycatch in groundfish fisheries off Alaska on the directed halibut fishery in Canadian waters led to an impasse during the Commission's approval of catch limits for the 1991 halibut fishery at that year's Annual Meeting. The ensuing discussions led to a resolution in which the Commission formed HBWG I and charged it with the following tasks:

1. Review of management measures being implemented in each country to control and reduce bycatch, and to advise the Commission on their adequacy;
2. Recommend additional measures that could be implemented to reduce bycatch; and
3. Determine appropriate target levels for bycatch reduction.

HBWG I met six times during February-June 1991 to discuss these issues. A special meeting of the Commission took place in July 1991 to receive and review the report of HBWG

[1] The last task was subsequently removed from the HBWG's assignment by the Commission.

I (Salveson et al. 1992). The report contained several recommended actions for Canada and the United States to reduce incidental mortality of halibut in non-target fisheries. The IPHC adopted the following recommendations and transmitted them to the member governments for action:

U.S. Fisheries

1. Bring all groundfish fisheries off Alaska under existing caps in 1992 and ensure that all fisheries adhere to specified bycatch controls.
2. Support development and expansion of incentive programs in 1992.
3. Promote a downwards ratcheting of caps starting in 1993 at 10 percent per year based on a rate or vessel quota incentive program. The goal would be to reduce mortality as far as possible over time consistent with the need to harvest the groundfish resources. The foreign fishery levels achieved in the mid-1980s shall provide an initial yardstick for monitoring success.
4. Measures to address the estimation and control of bycatch off the Washington-Oregon coast should be developed, but as of this time, no data exist on which to base bycatch management measures. We therefore recommend that the IPHC develop procedures for estimation of bycatch in this area, using the best available information, and incorporate these estimates into yield estimation.
5. Pending analysis of the 1990 observer data, incorporate revised mortality assumptions, rather than total bycatch amounts, for the Bering Sea/Aleutian Islands (BSAI) trawl fisheries in the IPHC staff procedure used to develop annual setline catch quotas.

Canadian Fisheries

1. The HBWG I recommends that the Canadian observer program be expanded to cover all bottom-trawl fisheries and that DFO undertake research to examine the viability of trawl caught halibut in Canadian waters. Further, that the results of the observer program, and relevant U.S. experience, be used to develop and implement a bycatch control and reduction program for Canadian waters.

General

1. Continue the HBWG I and develop a schedule, with review and check points, to track progress of the issues and solutions. The progress would then be reported to the Commission during its “interim” and “annual” meetings.
2. Support the research recommendations of the HBWG I.
3. Recognizing the uncertainties associated with present bycatch compensation procedures, the HBWG I recommends that the IPHC continue its research into the adequacy of present procedures and develop alternative methodology where necessary.

Halibut bycatch and the associated impacts have continued to be a topic of considerable focus by the Commission and the fishing industry in the intervening years. Since 1991, new programs for managing groundfish fisheries have been introduced by both countries. Advances in gear technology and monitoring have also occurred. Some of these changes are a result of the 1991 goals, but others are not. Thus, at its 2010 Annual Meeting, the Commission reconstituted HBWG II and assigned it three tasks:

1. Review progress on reduction of halibut bycatch mortality;
2. Review target levels for reduction identified by the HBWG I report in 1991; and
3. Examine how best to incorporate halibut bycatch mortality into halibut assessment and management.

The third HBWG II task was later dropped by the Commission.

Management and monitoring practices implemented to reduce halibut bycatch

U.S. West Coast

Halibut allocation, whether for harvest by directed fisheries or bycatch in groundfish fisheries, has been a highly contentious issue within the Pacific Fishery Management Council (PFMC) process. Halibut bycatch has typically been managed and measured in conjunction with groundfish bycatch. The PFMC has employed the following management measures: 1) an allowance for the retention of a limited amount of halibut caught incidentally in the sablefish H&L fishery north of Point Chehalis, Washington (46°53'18" N. latitude) and also in the salmon troll fishery, through the PFMC's Catch Sharing Plan; and 2) trip limits to control the harvest of targeted groundfish species which have attendant halibut bycatch.

Prior to the implementation of the West Coast Groundfish Observer Program (WCGOP), which is administered by the National Marine Fisheries Service Northwest Fisheries Science Center (NWFSC), halibut bycatch estimates were fairly uncertain. Since the observer program began in 2001, coverage has increased in terms of higher sampling rates and the scope of fisheries covered and, as a result, halibut bycatch estimates have become increasingly robust. With the implementation of the trawl catch share program, i.e., the individual quota program for the groundfish fishery, in 2011, at-sea observer coverage has increased to 100%, providing even greater certainty relative to halibut bycatch estimates in the trawl fishery.

Management practices implemented to reduce halibut bycatch

Halibut catch sharing plan and incidental fisheries

In 1988, PFMC adopted its first annual Pacific Halibut Catch Sharing Plan. Allocations through this plan were to four fishery groups: tribal fishery, non-tribal commercial fishery, Washington sport fishery, and Oregon/California sport fishery. At that time, PFMC chose to allocate the non-tribal halibut quota for Washington for the primary benefit of the recreational fishery. As a consequence, the directed commercial fishery was restricted to the area south of Point Chehalis, Washington, which is at the southern tip of the mouth of Grays Harbor.

In 1995, the non-tribal commercial fishery allocation was divided into two components: the directed fishery south of Point Chehalis, and the incidental landing allowance in the salmon troll fishery. In the late 1990s, PFMC developed alternatives for establishing the primary sablefish fishery using a tiered limit system. The final plan for the tiered limit system and permit stacking provisions was adopted by PFMC in November 2000.

There were some fishers who believed that the initial halibut allocation was unfair to those who had traditionally fished for halibut commercially off northern Washington, either as part of a targeted fishery or through the retention of incidental catch when targeting sablefish, which tend to intermingle with halibut. However, at the time the Catch Sharing Plan was first adopted, the catch limit (CL) for IPHC Area 2A (Fig. 1) had been about 500,000 pounds and it was

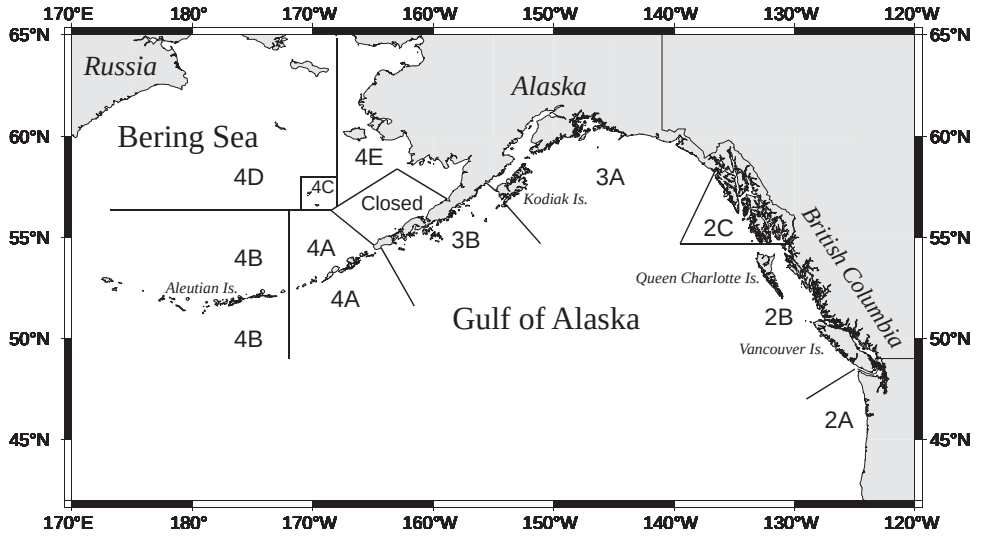

Figure 1. 2010 IPHC regulatory areas.

acknowledged that, with a growing recreational fishery, it would be difficult to accommodate both sport and commercial fisheries. The Area 2A CL remained fairly steady at about 450,000-650,000 pounds for ten years until 1998, when it was increased to 820,000 pounds. With this higher CL, some fishers thought that a Washington sport and an incidental commercial fishery could both be accommodated.

This issue was addressed in November 2000 at the same PFMC meeting where the Washington Department of Fish and Wildlife (WDFW) recommended that, in years of higher halibut abundance, the Washington recreational allocation would be modified to accommodate landings of incidental catches in the directed sablefish fishery north of Point Chehalis. Specifically, in years when the Area 2A CL is greater than 900,000 pounds, the primary directed sablefish fishery north of Point Chehalis was to be allocated the Washington sport allocation that is in excess of 214,110 pounds, as long as a minimum of 10,000 pounds was available (i.e., at least 224,110 pounds is allocated to the Washington sport fishery). This change to the Catch Sharing Plan was adopted by PFMC and became effective in 2001.

In 2002, the Area 2A CL increased to 1.31 million pounds, making almost 90,000 pounds available for the incidental sablefish fishery. WDFW met with representatives from the primary sablefish fishery and the recreational fishery and developed a compromise whereby the allocation would still occur in years of higher halibut abundance, but the amount of the allocation to the incidental sablefish fishery would be capped at 70,000 pounds. Any amount above 70,000 pounds would be transferred back to the Washington sport fishery. This was agreeable to all, including the primary sablefish fishermen, who indicated that given the trend in the sablefish stock and the landing ratio restriction, 70,000 pounds would likely accommodate most of their incidental catch.

From 2001 through 2009, participants in the primary sablefish fishery were allowed to retain incidental catches of halibut because the CL in Area 2A was above 900,000 pounds in those years. However, in 2010, the CL decreased to 810,000 pounds, so there was no allocation made to accommodate incidental catches in the sablefish fishery. The sablefish fishery typically extends from April 1 through October 31 with associated halibut landings allowed beginning in May. Fishers are subject either to trip limits or to a landing ratio of halibut to sablefish (by weight), with up to two additional halibut per fishing trip to provide some flexibility in complying with the regulation. The landing ratio or trip limit is adopted annually through the PFMC process in

April. The ratio applied from 2004 to 2008, and was set at 100 pounds of halibut per 1,000 pounds of sablefish. In 2009, a limit of 100 pounds of halibut per trip was adopted because the CL of 950,000 pounds resulted in a low incidental allowance of 11,895 pounds for the sablefish fishery.

The salmon troll fishery begins in May; a second opening may occur in July if sufficient salmon quota remains. Fishers are also subject to a landing ratio of halibut to Chinook salmon (by number of fish) with up to one additional halibut (again, to provide flexibility in complying with the regulation), and an overall trip limit of halibut. Since 2000, the landing ratio has been one halibut for every three Chinook salmon, with an overall trip limit of 35 halibut. Exceptions occurred in 2008 and 2009, when the landing ratio was set at one halibut for every two Chinook salmon while the overall trip limit remained unchanged.

Groundfish bycatch management

In 1999, PFMC embarked upon a two-year facilitated strategic planning process for the West Coast groundfish fishery. Overcapitalization of the groundfish fisheries was readily acknowledged, and PFMC determined that a 50% reduction in harvest capacity in each sector was needed for long-term resource and economic sustainability. The plan recommended management and harvest policies to reduce capacity and a precautionary approach to protect weak stocks, and the exploration of incentives to encourage fishermen to avoid known areas of high bycatch, or employ gear which had low bycatch capture properties. One of the primary recommendations of the plan was to immediately implement an at-sea groundfish observer program to quantify total groundfish catch and mortality.

In May 2001, the National Marine Fisheries Service (NMFS) established the WCGOP with the goal of improving estimates of total catch and discard. Observers were stationed in ports from Bellingham, Washington to Santa Barbara, California. Initial coverage goals were 10% of vessel trips; over time, this coverage level has increased to 20% to 30%. All vessels, regardless of size, are subject to mandatory coverage and vessel selection occurs randomly across six bimonthly periods each year. Annual reports for halibut bycatch are provided to PFMC in September of each year and forwarded to IPHC for consideration; annual reports for all other groundfish bycatch are posted on the NWFSC website.

In 2005, PFMC adopted Amendment 18 to the West Coast Groundfish Fishery Management Plan. Amendment 18 described the PFMC's strategy relative to bycatch management as: 1) gather data through a standardized total catch reporting methodology (i.e., WCGOP); 2) use federal/state/tribal agency partners to assess these data through bycatch models that estimate when, where, and with which gear types bycatch of varying species occurs; and 3) develop management measures that minimize bycatch and bycatch mortality to the extent practicable.

In general, PFMC uses catch restrictions to constrain the catch of more abundant targeted stocks that co-mingle with other stocks such as overfished species, in times and areas where higher abundance of such species are expected to occur or when and where overfished species are most vulnerable to a particular gear type or fishery. These time and area restrictions were established and implemented for overfished species protection, but some of them have likely reduced halibut bycatch as well. For example, trawl Rockfish Conservation Areas (RCAs) off Washington and Oregon extend from 75 fms to about 200 fms throughout the year, with an additional area closure from the shore to 200 fms north of Cape Alava (48°10' N. latitude), Washington. This has likely reduced halibut bycatch significantly as the area north of Cape Alava is an area of high halibut abundance. Conversely, the commercial H&L RCA extends from the shore to 100 fms year-round off Washington and Oregon, which may provide halibut protection in the nearshore areas.

Specific to the trawl fishery, the groundfish individual quota program includes, among other things, individual bycatch quotas (IBQs) for halibut. The maximum limit on trawl bycatch set by PFMC represents a reduction of more than 50% from historical trawl bycatch levels. Therefore,

the individual IBQ amounts are relatively low and acquiring additional halibut IBQ is likely expensive; these factors provide an incentive for trawl fishermen to change their fishing behavior to reduce bycatch and halibut bycatch mortality.

West Coast groundfish observer program

The trawl individual quota program has been in place since January 11, 2011, and includes 100% at-sea observer coverage for all catcher vessels and at-sea processors. In addition, shoreside deliveries are all observed by compliance monitors. The WCGOP provides at-sea observations to estimate total catch mortality, including halibut bycatch. The coverage level by gear type and fishery ranges from 100% for the groundfish trawl and 100% for the at-sea whiting fishery (motherships and catcher-processors), to 20-30% for fixed gear (H&L and pot fisheries). Observer coverage is mandatory regardless of vessel length. Because observers cover a fraction of the fixed gear groundfish fleet, their observations must be expanded using statistical methods in order to estimate total catch. For some smaller sectors, there may little or no direct observation or reporting of bycatch or coverage; in such cases, average bycatch rates developed from observations of similar gear types may be used to estimate bycatch. A description of the Pacific halibut sampling protocols currently used by WCGOP and changes implemented for the West Coast trawl individual quota program are provided in the appendix.

Electronic monitoring and logbooks

PFMC has considered the use of electronic monitoring (EM) methods and implemented a pilot program with the midwater trawl whiting fleet, which has a maximized retention component. Electronic monitoring could be useful in determining bycatch of some species, but not those that tend to look alike, e.g., certain overfished rockfish. Currently, PFMC has decided to not use video cameras in place of human observers, but will continue to explore the feasibility of electronic monitoring techniques for potential future application.

Regarding logbooks, a mandatory paper logbook system is in place with a high degree of compliance, but bycatch is typically not recorded. An electronic logbook system may be developed and implemented in the future.

British Columbia

Management practices implemented to reduce halibut bycatch

The commercial groundfish fishery consists of seven fisheries: lingcod, dogfish, rockfish outside, rockfish inside, halibut, sablefish, and groundfish trawl. These fisheries are managed through a system of total allowable catches (TACs), individual transferable quotas (ITQs), caps, and restrictions, and include multiple license categories, harvesting more than 20 different species. Historically management had been species-specific and monitoring was limited. The H&L (H&L) and trap fisheries were required to have approximately 10% to 15% of the vessels in the fishery use at-sea monitoring, either through an on-board observer or EM. The complexity of differently regulated single-species fisheries combined with the lack of accurate reporting of catches and releases led to significant conservation concerns, particularly concerning the discard of bycatch. The practice of releasing fish at sea occurred because fleets were unable to restrict their harvest to their target species and the conditions of license did not permit retention of the incidental catch. As such, harvesters were required to release most of their incidental catches. Harvesters had no incentive to accurately report their catch and the mortality associated with discarding, which was not fully monitored, raised conservation issues. To address these growing management problems, in 2003 DFO established the following principles to guide the development of a new management plan for groundfish:

1. All groundfish catch must be accounted for;
2. Catches are managed according to established groundfish management areas;
3. Harvesters are individually accountable for their catch;
4. New monitoring standards will be established and implemented; and,
5. Species and stocks of concern will be closely examined and actions such as reduction of TACs and other catch limits will be considered and implemented to be consistent with the Precautionary Approach.

Stakeholders were advised that these five guiding principles must be met for the management of the commercial groundfish fisheries. Stakeholders were encouraged to develop a management proposal to address these principles by 2006 or alternatively, DFO would implement its own plan. In 2006, the Commercial Groundfish Integration Pilot Program (CGIPP), developed by the guidance of the Commercial Industry Caucus (CIC) stakeholder group, was introduced to address these principles. The Commercial Groundfish Integration Program (CGIP) was completed and made permanent in 2010. There are six critical components to the CGIP:

1. The implementation of ITQs;
2. The ability to retain other species that were previously identified as bycatch and discarded;
3. Individual vessel accountability;
4. Quota transferability between fisheries;
5. New stock management areas, consistent between fisheries; and
6. Improved catch monitoring.

Each is described in more detail below, with the exception of catch monitoring, which is discussed in a later section.

Establishment of individual transferable quotas (ITQ) for all groundfish fisheries

Rather than "racing for fish," harvesters are allocated a share of the TAC to be harvested during a predefined season. Known as Individual Transferable Quotas (ITQ), these shares allow a harvester to maximize value and fishing safety by choosing when to fish, e.g., during optimal weather and market conditions). Moreover, to maximize value of their ITQ asset, harvesters now have an incentive to improve the health of the resource.

The three fisheries not previously managed using ITQs (rockfish, lingcod, and dogfish) had ITQs introduced in 2006 for both directed and most non-directed catch. Generally speaking, ITQs were only allocated to a license for the target species, e.g., halibut quota allocated to a halibut license, so if harvesters were to be accountable for all their catch, ITQs for target and non-target species must be transferable between all license types. The trading of quota operated under the principle of willing buyer/willing seller. In addition to the trading of ITQs, effort controls, such as trip limits, were established for both quota and non-quota species (not all groundfish species have a TAC) and continue to be used.

Ability to retain other species

As described above, harvesters are held accountable for all their catch under the CGIP. Previously, the conditions of license would not permit the retention of incidental catches, but under the CGIP harvesters are permitted to retain other groundfish species within monthly and annual limits. Table 1 lists the species each groundfish fishery is now permitted to retain.

Table 1. Summary of management techniques under the Commercial Groundfish Integration Program (CGIP).

	Management techniques by species group		
Fishery	**Directed species**	**Rockfish**	**Other groundfish**
Halibut	ITQs	Trip limits and annual vessel caps	Trip limits and annual vessel caps for sablefish, lingcod, and dogfish
Sablefish	ITQs	Trip limits and annual vessel caps	Trip limits and annual vessel caps for halibut, lingcod, and dogfish
Rockfish Outside	ITQs	n/a	Trip limits and annual vessel caps for sablefish, halibut, lingcod, and dogfish
Rockfish Inside	ITQs	n/a	Trip limits and annual vessel caps for sablefish, halibut, lingcod, and dogfish
Lingcod	ITQs	Trip limits and annual vessel caps	Trip limits and annual vessel caps for sablefish, halibut, and dogfish
Dogfish	ITQs	Trip limits and annual vessel caps	Trip limits and annual vessel caps for sablefish, lingcod, and halibut

The rationale for imposing limits on the amount of incidental catches by each fishery was Principle 9 in the original CIC proposal, which called for fishing fleets to protect the autonomy of their directed fishery (DMC, 2005). Essentially, each fishing fleet did not want others "targeting" fish considered incidental to their fishery. Limits were placed to require harvesters to be accountable for their incidental catch while participating in their directed fisheries. Each of the non-directed species noted above, i.e., rockfish, sablefish, lingcod, and dogfish, are managed using ITQs. The trip limits and annual vessel caps for these non-directed species require the acquisition of quota as well.

Individual vessel accountability

Harvesters are required to acquire quota to cover the mortality for all catches, including those fish released at sea while fishing. Harvesters not acquiring quota or fishing within the prescribed limits outlined within the Integrated Fisheries Management Plan (IFMP) are unable to continue fishing. While variables such as gear types and the times and locations of fishing trips affect the amount of incidental catch intercepted, it is possible for a harvester to plan his/her fishery in such a way as to be able to expect and account for a specified amount of incidental catch. Due to their high mortality rate, all rockfish caught while fishing must be retained; for all other species, a harvester can choose to either retain or release legal size fish. If released, the harvester is responsible for the mortality associated with releasing that fish, which varies by species and gear type. A harvester's behavior is the most significant factor in his ability to access quota for incidental catch.

Quota transferability between all groundfish fisheries

To enable harvesters to account for all groundfish catch mortality, including fish released at sea, quotas need to be transferable between fisheries, i.e., different license types. Reallocation

of quotas between fisheries is only temporary (for the duration of one season), and limits have been placed on how much quota a license can acquire. These limits are in place in part due to the autonomy of the sector, but also to keep incidental species quotas available and ensure that harvesters fish selectively.

For example, the 2010 commercial halibut catch limit (not including a "carryover" of some uncaught quota from the previous season) was 6,598,560 pounds. A portion of the TAC is made available to each of the other sectors at the beginning of the season to allow harvesters to be individually responsible for their halibut catch, irrespective of the fishery in which it is caught. Table 2 provides the breakdown of the halibut catch limit that was acquired by each of the other commercial groundfish fishing sectors during the 2010 fishing season, which also includes carryovers form 2009.

Table 2. Approximate total of acquired halibut quota by the hook and line sectors during the 2010 fishing season (pounds).

Sector	Acquired Halibut Quota (lbs)
Halibut	6,194,466
Sablefish	84,854
Rockfish Inside	661
Rockfish Outside	179,216
Lingcod	7,015
Dogfish	137,611
Total	**6,603,823**

Quota transfers are managed through a system of quota caps which place restrictions on the amount and method with which ITQ can be transferred. When a license's catch exceeds its ITQ holdings, this is known as "overage". Overage is permitted, but only to a certain extent. If the amount of overage exceeds a defined amount, then this is "excess overage". Excess overage occurs when a license exceeds its total species ITQ holdings by more than 30% (or 10% in the case of rockfish inside licenses and 10% of verified remaining quota for halibut licenses) or 100 pounds (400 pounds for halibut licenses), whichever amount is greater. When a vessel is in excess overage, it is restricted from fishing for the remainder of the year, or until sufficient ITQ has been reallocated to cover any overages. If at the end of the season, a license has uncaught ITQ remaining, it may carryover a portion of this ITQ over into the next season and have the amount added to its total ITQ holdings.

In addition, individual fleets have developed annual vessel caps that provide sufficient incidental catch to pursue the target fishery, but will not allow for the accumulation of large amounts of incidental quota on any one license. Table 3 shows the various license caps in place, as they pertain to halibut.

Consistent management areas

One of DFO's guiding principles included the establishment of common management areas. Prior to the CGIP, there were varying management areas for different fisheries and for different species. Common management areas allow DFO to manage stocks by area, which will improve stock assessment for groundfish species. Lastly, common management areas are especially critical when all species quotas are transferable between fisheries.

Table 3. 2010/2011 hook and line halibut quota caps implemented by DFO.

License	Caps
Lingcod Schedule II	Quota Holdings Cap: A license's halibut quota may not exceed 15% of the license's lingcod quota.
Dogfish Schedule II	Quota Holdings Cap: A license's halibut quota may not exceed 5.8% of the license's dogfish quota.
	Quota Landings Cap: A license may land 23,000 pounds of halibut if less than 200,000 pounds of dogfish have been landed; 46,000 pounds of halibut if less than 400,000 pounds of dogfish have been landed.
	Trip Limits: Halibut landings may not exceed 30% of dogfish landed per trip during March 6-June 15 & Sept 15-Nov 15; landings may not exceed 20% of dogfish landed per trip during June 16-Sept 14 & Nov 15-Feb 20.
Rockfish Inside (ZNI)	License Species Cap: Temporary reallocations of up to 3,500 pounds of halibut are allowed.
	Trip Limits: Limit of 800 pounds of halibut per trip.
Rockfish Outside (ZNO)	Quota Landings Cap: A license may land 7,500 pounds of halibut if less than 20,000 pounds of rockfish have been landed; 10,000 pounds of halibut if 20,000-40,000 pounds of rockfish have been landed; 15,000 pounds of halibut if 40,000-60,000 pounds of rockfish have been landed; 20,000 pounds of halibut if more than 60,000 pounds of rockfish have been landed.
Sablefish (K)	License Species Cap: Temporary reallocations of up to 65,466 pounds of halibut are allowed.
	Trip Limits: Landings (fresh, dressed head-off weight) may not exceed 15% of sablefish (round weight) landed per trip.

Halibut bycatch management in the trawl sector

The trawl industry has implemented a number of measures over the past 15 years to reduce halibut bycatch. In 1995, the DFO created a three year plan to reduce halibut bycatch within the fishery. In 1995, a Pacific halibut bycatch mortality cap of 600,000 pounds was introduced for the Hecate Strait Area, which was then extended in 1996 to include the west coast of Vancouver Island, with an additional 380,000 pounds. The Hecate Strait mortality cap was monitored on a quarterly basis; halibut mortality was calculated by applying a mortality incidence rate to any landed halibut. This method had been used in previous years to estimate halibut bycatch mortality. By September, estimates showed that the cap had been exceeded in Hecate Strait. As a consequence, a full review was carried out on all groundfish catches, especially those with a set TAC, which revealed that most TACs had also been reached or exceeded. All of Area 2B was closed to the trawl fishery on October 1, 1995.

Fisheries and Oceans Canada held a series of meetings with the Groundfish Trawl Advisory Committee (GTAC) to initialize the development of a management plan that would allow year-round fishing, but would also ensure the conservation of groundfish species. By February 1996, the management plan was finalized. As a result of this plan, a number of monitoring measures were implemented. These included 100% at-sea monitoring through on-board observers, continued dockside monitoring, and individual vessel bycatch limits for halibut. The objectives of this plan were to:

1. Provide more reliable information on removals;
2. Reduce the quantity of fish discarded and wasted;
3. Minimize incidental catches of non-target species, i.e., halibut & sablefish;
4. Promote "cleaner" fishing practices;
5. Allow a year-round fishery; and
6. Individual accountability.

In 1997, implementation of commercial ITQs in the groundfish trawl fishery was introduced, as well as the final expansion of the halibut bycatch mortality cap to include the entire B.C. coast. The groundfish trawl fishery continues to operate under the coastwide bycatch mortality cap, which is 454 mt, or 1,000,000 pounds. The bycatch mortality cap is not part of the commercial TAC, and is not transferable to other groundfish fisheries where halibut can be retained.

The current management of trawl halibut bycatch is described under the Halibut Bycatch Management Plan, which is outlined in the groundfish IFMP. Under this plan, halibut bycatch is reduced through a series of caps, bycatch ITQs, and overage and underage carryovers, as follows:

1. Halibut Prohibition: Halibut caught while fishing under the authority of a groundfish trawl license cannot be retained and must be returned to the water as quickly as possible.
2. Halibut Mortality Fleet Cap: For the 2010/2011 season, the halibut bycatch mortality cap for the trawl fleet is approximately 454 mt, or 1,000,000 pounds. All estimated halibut bycatch mortality will be deducted from a vessel's individual cap.
3. Halibut Species Mortality Cap: No trawl license can permanently hold more than 4% of the total halibut bycatch mortality cap for the trawl fleet. No license can temporarily hold more than 8% of the halibut bycatch mortality cap for the trawl fleet.
4. Halibut Bycatch Reallocation: Uncaught halibut bycatch mortality ITQ can be reallocated, subject to rules stated above. Halibut bycatch ITQ is not considered part of the groundfish trawl vessel's groundfish ITQ holdings for holdings cap calculations/ limits.
5. Halibut Bycatch Quota Overage: Halibut catch in excess of a vessel's individual halibut bycatch cap will result in the vessel being restricted to mid-water species coast-wide for the remainder of the year, or until additional halibut bycatch cap is reallocated on the license.
    a. Halibut overages in the current year will be deducted from the groundfish trawl license's halibut bycatch mortality cap allocation the following year.
6. Halibut Bycatch Underage: A trawl license can carry forward up to 15% of its halibut bycatch mortality holdings that are uncaught into the next season.

Monitoring practices implemented to reduce halibut bycatch

Timely and accurate information on harvesting practices, catch composition, and location is essential to assess the status of fish stocks and ensure the conservation and long-term sustainability of fish resources. While the previous dockside monitoring program (DMP) allowed for all landed catch to be verified, at-sea monitoring is also essential for incidental catch, which is catch which may not be landed and for which DFO would otherwise have little or no fishery data. As such, in 2006, with the CGIP, DFO commenced a new standard for all commercial groundfish fisheries of 100% at-sea monitoring[2]. This was in addition to the already existing 100% DMP requirement.

[2] One hundred percent at-sea monitoring for the groundfish trawl fishery commenced in 1996.

Monitoring program within the H&L and trap fisheries

Although a limited monitoring program existed for the H&L fisheries since 1991, additional monitoring practices to reduce bycatch and the associated mortality were introduced in 2006. The current comprehensive H&L monitoring program includes:

1. Hail-out and hail-in;
2. 100% at-sea monitoring; either through an onboard observer or electronic monitoring (EM) system;
3. Logbooks;
4. Dockside Monitoring Program (DMP);); and
5. Audit process.

Prior to leaving port, each vessel must hail out to a service provider and declare the fishery in which it intends to participate. Vessels must have quota for their target species prior to hailing out. Once a fishing trip has commenced, vessels are required to have 100% at-sea monitoring, which is comprised of either an onboard observer or an EM system. Both the observer and the EM system record information on latitude and longitude, date, haul start and end times, fishing depths, and retained and released species. If a vessel is equipped with an electronic monitoring system, there are requirements that must be met: the system must be fully operational for the entire duration of the trip, the system must remain on at all times, and the cameras must have a clear view of the fishing area at all times. If these requirements are not met, the vessel may be required to carry an onboard observer on subsequent fishing trips. While fishing, all releases must take place within view of the camera equipment. While releasing any sub-legal sized halibut, a measurement grid may be used to provide proof that the fish is indeed sub-legal. If the grid is not used during the release, the halibut will be considered legal size and the corresponding mortality rate will be applied. The license holder is responsible for acquiring quota to cover all mortality. All halibut that are caught, whether retained or released, must be accurately recorded by piece and estimated weight in the fishing log. Fishing logs must also record the date, time, and location of each fishing event.

Before completion of the trip, the vessel must hail in. A dockside observer will meet the vessel at the dock; landing cannot begin until the observer is present. The observer will separate, count by piece, and weigh all retained species of fish using the dockside weight verification system. All fish landed are verified and recorded in the Groundfish Validation Log, and halibut data are converted to a net dressed, head-off weight. Retained halibut are tagged and recorded by the observer. Once the validation is complete, the observer will compare the weight of all validated fish to the license's remaining ITQ. If the vessel is deemed not to be in excess overage of any species of fish, the observer will provide the vessel with a Quota Status Verification Number (QSVN), which will be required during the vessels next hail-out. If the vessel is in excess overage, it will not be permitted to fish again (no QSVN issued) until sufficient quota is reallocated to cover the overage.

The catch monitoring program requires all vessels fishing within the H&L and trap fisheries to have at-sea monitoring either via onboard observers or EM. EM technology incorporates a system of onboard cameras integrated with GPS and other onboard electronic sensors. Harvesters are required to record all retained and released catch by piece and by location within their logbooks. Ten percent of the camera footage is viewed to check the accuracy of the harvester's logbook. The data collected by the DMP, which verifies only catch that is retained and landed, is also used to audit the logbook. If a logbook is found not to accurately represent actual catch seen on the video footage or by the DMP, 100% of the camera footage is reviewed at the individual

harvester's expense. If it is found that a vessel's logbook consistently does not match with the camera footage, the vessel will be required to take an onboard observer on future trips.

An audit is performed after each fishing trip has been completed and validated. The purpose of the audit is to verify the accuracy of the logbook; the observed catches and releases from the electronic footage are compared to the logbook records, and a trip score is assigned based on the accuracy of the logbook. The service provider for groundfish monitoring randomly selects and reviews electronic video footage for 10% of the sets from each trip. If the score is below an acceptable threshold, it may result in further action being taken, e.g., being required to take an at-sea observer or 100% video footage review, both at the expense of the harvester. If the logbook matches the video footage within an acceptable range, the logbook becomes the official record of all species caught, both retained and released, for the trip.

Monitoring program within the groundfish trawl fisheries

Some monitoring practices in the trawl sector had already been established prior to the CGIP. The 100% Dockside Monitoring Program was made mandatory in 1994, and 100% at-sea observer coverage was implemented in 1996. The monitoring practices employed by the trawl industry include:

1. Hail-in and hail-out;
2. Log books;
3. 100% at-sea monitoring; either through an onboard observer or EM, depending on the license category;
4. Dockside Monitoring Program; and,
5. Audit process.

Prior to the beginning of a trip, a trawl vessel must hail out and inform the service provider of its intentions. During the trip, all vessels are required to have 100% at-sea monitoring. Within the trawl fishery, there are two different categories of trawl license, classified as either Option A or Option B. Option A and B differ slightly in regards to at-sea monitoring:

1. Option A: These vessels are permitted to mid-water trawl coastwide, and bottom trawl in all waters excluding the Strait of Georgia. These vessels are subject to 100% at-sea observer coverage.
2. Option B: These vessels are permitted to fish by bottom trawl only within the Strait of Georgia. These vessels employ 100% electronic monitoring.

If a halibut is caught while trawling, the observer will assess the condition of the halibut before it is released back into the water. The observer will examine several features of the halibut, such as operculum movement, color of the gills, and liveliness. The observer will then assign a corresponding mortality rate that has been established by the IPHC, and will record the mortality in the observer logbook. The observer logbook also records information on latitude and longitude, haul start and finish time, date, start and end depths, area, target species, catch, and other important features. The vessel master must also maintain a logbook. For those vessels that use EM (Option B vessels), the same conditions for EM apply as in the H&L industry: the camera equipment must be fully functional for the entire duration of the trip, the system must remain on at all times, and it must have a clear view of the fishing area at all times.

Prior to landing, a vessel must hail in and inform the service provider of its intentions to dock. A dockside observer will meet the vessel at the dock; landing cannot begin until the observer

is present. The observer will piece count and weigh all retained fish, confirming that no halibut have been retained. After validation by the DMP has occurred, the groundfish monitoring service provider finalizes the catch record. At-sea observer data undergo a complex audit process, with a series of checks, to ensure that the data are valid. DMP data are then correlated with the observer data, and catch is then assigned to the appropriate management area and vessel. The finalized information is then forwarded to the vessel master as a Quota Status Report (QSR) within 48 hours of offload completion. Option B vessels also undergo an audit process. The groundfish monitoring service provider reviews 100% of the video footage to identify any at-sea releases. If any halibut is retained by a trawl vessel, a compliance report will be filled out and will be followed up by Conservation and Protection (C&P). If necessary, certain enforcement measures can be taken depending on the severity of the infraction. These can range from sending a letter to the fisher to imposing fines or pursuing legal action.

Alaska

Management practices implemented to reduce halibut bycatch

The North Pacific Fishery Management Council (NPFMC) manages commercial fisheries for groundfish, crab, scallop, and salmon in separate Fishery Management Plans (FMPs) under the authority of the Magnuson-Stevens Fishery Conservation and Management Act (MSA). NPFMC recommendations are approved, partially approved, or rejected by NMFS, acting on behalf of the Secretary of Commerce, under the authority of the MSA.

The Gulf of Alaska (GOA) Groundfish FMP became effective on December 11, 1978, and the Bering Sea and Aleutian Islands (BSAI) Groundfish FMP became effective on January 1, 1982. The initial GOA FMP contained halibut bycatch limits for the fully domestic fishery, whereas the BSAI FMP did not. Generally, the GOA groundfish regulatory areas overlap IPHC Regulatory Areas 2C, 3A, and 3B; the Bering Sea Aleutian Island (BSAI) groundfish regulatory areas overlap IPHC Regulatory Area 4. The NPFMC manages Pacific halibut allocations in federal regulations under separate authority of the North Pacific Halibut Act.

NPFMC is guided by ten national standards[3]. The NPFMC often must balance competing standards in developing its fishery management policies. In managing North Pacific groundfish fisheries to achieve their optimal yields, the NPFMC also strives to minimize bycatch, and the mortality associated with such bycatch. The NPFMC designated several fully utilized species, including Pacific halibut, as prohibited species upon implementation of its two groundfish FMPs over 30 years ago. Each groundfish FMP has been amended several times since implementation, with several of the amendments containing provisions regarding halibut bycatch limits. This section provides an overview of these bycatch reduction measures.

Halibut setline fishery

The NPFMC allocates Pacific halibut in Areas 2C, 3A, 3B, and 4A through 4E based on catch limits set by IPHC. The Pacific halibut setline fishery was one of the first fully domestic fisheries to become established off Alaska. By 1990, the halibut and sablefish H&L fisheries were exhibiting significant problems created by open access derby-style fisheries. With the constant influx of new entrants into the fishery, the fishing seasons had been reduced to several short seasons each year, with halibut seasons lasting only a day or two in some areas. The short seasons created a number of problems, including allocation conflicts, gear conflicts, fish loss from lost gear, increased bycatch and discard mortality, excess harvesting capacity, decreased product wholesomeness, safety concerns, and economic instability in the fisheries and fishing communities.

[3] http://www.fakr.noaa.gov/npfmc/PDFdocuments/halibut/MSANationalStandards.pdf

The NPFMC adopted individual fishing quota (IFQ) programs in 1992 for the Pacific halibut and sablefish fixed gear fisheries, which were implemented in 1995. The programs assign the privilege of harvesting a percentage of the sablefish and halibut quotas to specific individuals with a history of harvest in the fisheries. The fishing privileges assigned to each person are proportional to their fixed gear halibut and sablefish landings during the qualifying period and are represented as quota shares (QS). Only persons holding QS are allowed to make fixed gear landings of halibut and sablefish in the regulatory areas identified on the permits.

The effect of the two IFQ programs was an immediate reduction in halibut bycatch allowances of 400 mt, or 661,500 pounds, each year. Instead of being caught and potentially discarded, these catches are retained using IFQs.

Commercial groundfish fisheries

As domestic groundfish fisheries developed and foreign fishing was phased out in the 1980s, federal regulations were implemented to limit bycatch of halibut to minimize impacts on the domestic halibut fisheries. Interception of juvenile halibut (~30 cm and greater) often occurs in trawl fisheries targeting other groundfish species (such as rock sole, pollock, yellowfin sole, and Pacific cod). Incidental catch of halibut also occurs in groundfish H&L and pot fisheries. Regulations require that all halibut caught incidentally must be discarded, regardless of whether the fish is alive or dead.

The NPFMC recommends annual catch limits and allocations for commercial groundfish fisheries for 133 species managed under 22 management categories in the BSAI and 121 species and 25 categories in the GOA. Commercial groundfish quotas in the BSAI are capped by law at 2 million mt. Commercial groundfish quotas in the GOA are set at about 300,000 mt (660 million pounds) each year, and are not capped. Flatfish quotas are set well below the acceptable biological levels (ABCs) due to the BSAI OY cap and halibut bycatch constraints in both areas.

Control of domestic bycatch of halibut

Regulations to control halibut bycatch in domestic groundfish fisheries were implemented initially as part of the GOA groundfish FMP in 1978 and the BSAI groundfish FMP in 1982. These regulations reflected some of the time-area closures in effect for foreign trawl operations. The GOA fisheries were also monitored under halibut bycatch limits. Restrictions on domestic operations were relaxed and revised as the domestic groundfish fishery developed, consistent with the desire to enhance development of this fishery. Beginning in 1985, annual halibut prohibited species catch (PSC) limits were implemented for the groundfish trawl fisheries, attainment of which triggered closures to bottom trawl gear. In 1990, regulatory authority was also implemented to limit halibut bycatch in GOA fixed-gear fisheries. Seasonal allocations of halibut PSC limits are also authorized. Their attainment closes the GOA to further fishing with the applicable gear type for the remainder of the season. While the groundfish FMPs allow the NPFMC to set the season start dates to accommodate fishery interests, it has relied on the seasonal apportionments of halibut PSC limits to take advantage of seasonal differences in halibut and some groundfish fishery species distributions.

Other measures that have reduced halibut bycatch include seasonal and area allocations of groundfish quotas for selected target species, seasonal and year--round area closures, gear restrictions, careful release requirements, public reporting of individual bycatch rates, and gear modifications. Gear restrictions are specified to reduce bycatch or bycatch mortality of halibut. Restrictions include: (a) requiring biodegradable panels on groundfish pots; (b) requiring halibut exclusion devices on groundfish pots; and (c) revised specifications for pelagic trawl gear that constrain the pelagic trawl fisheries for groundfish to a trawl gear configuration designed to enhance escapement of halibut.

Prohibited Species Catch limits

Fisheries targeting groundfish off Alaska incidentally catch non-groundfish species, some of which are themselves the objects of valuable targeted fisheries. These species include Pacific halibut, Chinook and "other" salmon, several crab species, and herring. Provisions to prohibit the retention of these species by foreign fleets were incorporated by the NPFMC into early FMPs for GOA and BSAI groundfish, hence the expression "prohibited species."

Bycatch limits, referred to in the FMPs and federal regulations as Prohibited Species Catch or PSC limits, have been used to control the bycatch of halibut in the groundfish fisheries off Alaska since the initial groundfish FMPs were developed. PSC limits are intended to optimize total groundfish harvest under specified PSC limits, taking into consideration the anticipated amounts of incidental halibut catch in each directed fishery. They are apportioned by target fishery, gear type, and season. Essentially, these bycatch limits direct fisheries, by area or time, to regions where the highest volume or highest value target species may be harvested with minimal halibut bycatch. Directed fishing for that species must stop when seasonal PSC limits are reached and the groundfish species may not be retained incidentally in other directed fisheries. All other users and gear remain unaffected. Reaching a PSC limit results in closure of an area or a groundfish directed fishery, even if some of the groundfish (particularly flatfish) TAC for that fishery remains unharvested.

Federal regulations also establish allocations of the BSAI halibut PSC limit between the community development quota (CDQ) and non-CDQ fisheries, as well as a process for apportioning those limits among the non-CDQ fisheries. The BSAI halibut PSC limit is set in regulation and the GOA halibut PSC limit is set annually through the groundfish harvest specifications process; neither is tied to halibut abundance.

Halibut PSC limits in the GOA totaled 2,300 mt in 2010. The total is allocated as follows: 2,000 mt (i.e., 3.3 million pounds) to trawl gear, and 300 mt (i.e., 0.5 million pounds) to fixed gear. The PSC limit for the groundfish trawl fishery bycatch was implemented in 1985; the limit for the fixed gear fishery was implemented in 1990. The NPFMC originally set the fixed gear fishery PSC limit at 750 mt (i.e., 1.2 million pounds), but was reduced with the implementation of the halibut and sablefish IFQ program in 1995.

Halibut PSC limits in the BSAI total 4,526 mt and are set in regulation. Specific PSC limits by gear are 3,626 mt (or roughly 6.0 million lbs) to trawl gear and 900 mt (or roughly 1.5 million lbs) to fixed gear. In 1999, the trawl PSC limit was reduced by 100 mt (or roughly 165,000 lbs), when the NPFMC adopted a requirement that only pelagic trawls can be used in the BSAI pollock fishery. Beginning in 2008, a subsequent program resulted in further reductions to the amount of the PSC limit actually allocated to certain trawl fisheries. Although the total trawl gear PSC limit remained at 3,626 mt, the annual amount assigned to the trawl fisheries was incrementally reduced during 2008-2012 to reach a final amount of 3,475 mt by 2012, for a savings in halibut mortality of 150 mt (i.e., approximately 250,000 pounds).

Groundfish pot gear is exempted from halibut bycatch restrictions because: (l) halibut discard mortality rate and total mortality associated with this gear type is relatively low; and (2) existing pot gear restrictions are intended to further reduce halibut bycatch mortality. Halibut PSC limits are for dead fish only. Most halibut taken as bycatch are juveniles, so the loss is viewed not just as immediate tonnage, but also as fish that would have grown larger and recruited into the directed halibut fisheries.

A PSC limit in a fishery is essentially a common property quota[4]. Although the purpose is to limit bycatch mortality, the effect of the cap is to create a quota that accommodates unavoidable incidental catches, but strictly forbids the retention of halibut bycatch by the participants in the

[4] This section was adapted from NMFS (2008).

target fishery. Access to a PSC limit is highly competitive. The PSC limit for a fishery can become an effective limit on the target fishery, preventing the TAC from being completely harvested. This situation sets up "perverse" economic incentives that encourage individual vessels to "race" to catch their intended target species before the fishery's collective PSC limit is taken and the fishery closed. This race results in excessively rapid catch of bycatch and the early closure that participants fear. PSC limits quickly lead to numerous and expensive groundfish fishing closures. These closures had significant economic impacts on joint venture and domestic flatfish fisheries in the BSAI, domestic pollock and Pacific cod fisheries in the BSAI, and domestic H&L and non-pelagic trawl fisheries in the GOA. Closure of these fisheries has resulted in an economic loss estimated to be in the tens of millions of dollars in groundfish fishing revenues, based on the amount of groundfish TAC that remained unutilized.

The "race for the fish," and attendant high PSC rates, occur because the competition created by PSC limits do not encourage individual fishing operations to take full account of their actions when they make fishing decisions (a "common property externality"). An operation that fishes with high rates of associated bycatch ("dirty" fishing), seeking only to maximize its target catch rate, obtains a benefit that accrued to it alone: a larger share of the total groundfish catch (i.e., increased catch-per-unit-effort (CPUE), lower cost-per-unit-catch). But the operation does so by hastening the closure of the groundfish fishery. If the closure came before the target groundfish TAC was fully caught, society incurs a cost associated with the value of the foregone groundfish (unharvested TAC). The operation that was fishing dirty would bear some small share of this cost, but much of it would be distributed across other operations in the fishery. However, the dirty operation realizes a direct economic benefit from its actions and offsets its share of this cost through its higher CPUE as compared to clean fishermen in the fleet. By shifting a large part of its "net" bycatch costs to other operations, a dirty operation has no incentive to control PSC rates.

If all the operations in a targeted groundfish fishery controlled their bycatch, the fishery could operate longer and produce larger volumes of fish for the participants. However, an operator that chose not to control bycatch while all others did, would be able to "free ride" on the efforts of those fishermen that incurred the cost of bycatch controls. This creates a perverse incentive structure that effectively subverts bycatch reduction efforts by any single operation. Without appropriate incentives for an individual operation, a group of fishermen will fail to take actions that would have positive net benefits for them as a group.

To directly limit the bycatch of prohibited species, the NPFMC and NMFS have supported numerous actions to establish bycatch protection areas, encourage bycatch reduction, and improve the selectivity of fishing gear:

1. Amendments 12a and 18 (54 *FR* 19199) introduced PSC limits into groundfish management in the BSAI and GOA Groundfish FMPs, respectively. PSC limits were established and apportioned among fisheries based on gear or target species. Once a fishery had taken its PSC limit for a given species, directed fishing for the target species was closed. The program was introduced for part of 1989 and all of 1990.
2. Amendments 16 and 21 to the BSAI and GOA Groundfish FMPs, respectively, (56 FR 2700) would have created incentives for individual fishing operations to control their PSC rates. The incentive program was referred to as the "penalty box" program; it would have required vessels operating in a fishery to "maintain a four-week average bycatch rate less than twice the concurrent fleet average in each of the fisheries and for each of three bycatch species. Failure of a vessel to meet such bycatch rate standards would result in a suspension of the vessel from the Alaskan groundfish fishery (placement in the penalty box) for a period ranging from five days to six weeks." The Secretary of Commerce did not approve the penalty box program because of legal considerations;

however, he did approve other measures, including a trawl prohibition at all times within the Pribilof Islands Habitat Conservation Area to eliminate trawl activities in areas of importance to blue king crab and Korean hair crab stocks, so that the stocks could rebuild, and to reduce bycatch of juvenile halibut and crab, and mitigate unobserved mortality or habitat modification that occurred due to trawling.

3. Regulatory amendments (56 FR 21619) implemented a vessel incentive program (VIP) in the BSAI and GOA to replace its rejected penalty box program.
4. Amendments 19/24 to the BSAI and GOA Groundfish FMPs (57 FR 43926) accomplished three objectives: 1) reduced the 1992 halibut PSC limit established for BSAI trawl gear from 5,333 mt to 5,033 mt, but retained the primary halibut PSC limit at 4,400 mt; 2) established a 750 mt PSC limit for BSAI fixed gear in 1992; and 3) established FMP authority to develop and implement regulatory amendments that allow for time/area closures to reduce prohibited species bycatch rates (revised "hotspot authority"). A number of regulatory amendments were adopted:
    a. Revised BSAI fishery definitions for purposes of monitoring fishery specific bycatch allowances and assigning vessels to fisheries for purposes of the VIP;
    b. Revised management of BSAI trawl fishery categories for bycatch accounting;
    c. Expanded VIP to address halibut bycatch rates in all trawl fisheries;
    d. Delayed the season opening date of the BSAI and GOA groundfish trawl fisheries to January 20 of each fishing year to reduce salmon and halibut bycatch rates;
    e. Further delayed the season opening date of the GOA trawl rockfish fishery to the Monday closest to July 1 to reduce halibut and Chinook salmon bycatch rates; and
5. Changed directed fishing standards to further limit halibut bycatch associated with bottom trawl fisheries.
6. BSAI Groundfish FMP Amendment 50 (63 FR 32144; 66 FR 53122): Donation program of incidentally caught halibut to food banks was implemented in 1998. Since then approximately 614,500 meal portions have been provided.
7. GOA Groundfish FMP Amendment 59 (65 FR 30559; 65 FR 67305; 66 FR 8372): Prohibited fishing in important fish habitat areas.
8. GOA Groundfish FMP Amendment 60 (67 FR 34424; 67 FR 70859): Prohibited the use of trawl gear in Cook Inlet.
9. GOA Groundfish FMP Amendment 68 (71 FR 27984; 71 FR 67210): Central GOA Rockfish Pilot Program implemented a 5-year catch share program (CSP) in 2007 for several rockfish species, sablefish, and Pacific cod to mid-sized trawl and fixed gear vessels with shore-based and at-sea fleets that form cooperatives; it further divided allocations to catcher vessel (CV) and catcher/processor (CP) sectors. Catcher vessel incidental catch and discards of halibut has been reduced substantially.
10. BSAI Groundfish FMP Amendment 79 (71 FR 17362): Established a minimum groundfish retention standard and required all non-American Fisheries Act (AFA) trawl vessels greater than or equal to 125 ft in length overall (LOA) to use flow scales and carry two observers.
11. BSAI Groundfish FMP Amendment 80 (72 FR 21198; 72 FR 30052): Allocated specified target species and PSC limits to non-AFA catcher trawl processors and facilitated the formation of fishery cooperatives.
12. GOA Groundfish FMP Amendment 88 would allocate permanent catch shares to Amendment 68 cooperatives. It would reduce the GOA halibut PSC limit by 27.4

mt, or 60,000 lb. To create an incentive for further halibut mortality reductions, 55% of any cooperative's unused halibut allowance would be available for use in the fifth season trawl fisheries. The remaining halibut allowance would remain unused for that fishing year.

13. Issuance of an exempted fishing permit to test a new device designed to reduce halibut bycatch in trawl gear.
14. Use and research of halibut excluder devices in the trawl fishery.
15. Installation of vessel monitoring systems to assist enforcement of numerous regulatory measures.
16. Voluntary industry bycatch control measures, e.g., contracting Sea State, Inc., to enable the rapid sharing of information.

In April 2011 the NPFMC adopted a range of alternatives (0, 5, 10, or 15%) to reduce the 2,000 mt halibut trawl PSC limit and/or the 300 mt halibut H&L PSC limit. The intent is for the reduction to be selected in June 2012 and implemented in 2013. The NPFMC intends to consider reductions to the halibut PSC limits in the BSAI in the future. There is an overall cap of 3,675 mt of which 3,526 mt is apportioned for the trawl fishery and 900 mt for the H&L fishery.

Other management attempts to control halibut bycatch in the late 1980s and 1990s

Secretarial disapproval of the penalty box program of FMP Amendments 16/21 (see above) caused NMFS to review the timeliness and availability of observer data. NMFS determined that substantial revisions were often made to observer information following observer debriefing and data becoming finalized. In some instances, final data might not have been available for up to six months after a given fishing week. Because enforcement of the penalty box program could only be based upon corrected data, in-season action against vessels that failed to meet acceptable bycatch rate standards could not be taken (NMFS 1990). The penalty box program also failed to conform to requirements of other applicable law, including the Administrative Procedure Act (APA), which requires that regulations be reasonable and effective. The observer data were thus determined to be insufficient to determine whether variability of bycatch rates allowed the use of four-week fleet averages as a basis for legally acceptable standards (NMFS 1990).

Following the rejection of the penalty box program, the NPFMC adopted the VIP in November 1990 (Table 4); the interim final rule implementing the program was issued on May 10, 1991 (56 *FR* 21619). The VIP bycatch rate standards applied only to the non-pelagic pollock fishery because halibut bycatch rates were considered low in the pelagic pollock fishery. To avoid excessive bycatch rates, non-pelagic pollock trawl fishermen reconfigured their nets as pelagic gear, and continued to fish the gear on the bottom. In June 1992, the NPFMC and NMFS addressed this problem through an emergency rule that applied VIP requirements to the pelagic pollock fishery. The final rule became effective in 1993 and extended the VIP to all trawl fisheries in the GOA and BSAI. The NPFMC viewed the extension of the VIP "as a means of decreasing the inequities between vessels in different fisheries which contributed to the same halibut bycatch allowances." It also tightened the regulation to prevent vessels from manipulating fishing targets in order to be excluded from the VIP. In its final form, the VIP applied to two GOA fisheries (midwater pollock and other trawl) and four BSAI fisheries (midwater pollock, yellowfin sole, bottom pollock, and other trawl).

The VIP required applicable vessels to maintain halibut bycatch rates below fishery specific standards. NMFS published the bycatch rate standards twice a year. Observer data on the catch composition of harvests in subject fisheries would be statistically analyzed; vessels that exceeded the published standards were subject to prosecution. As a practical matter, only groundfish trawl

Table 4. Vessel Incentive Program (VIP) chronology.

Date		Action
1990	Jan	Implementation of required Observer Program
1991	May	Interim final rule published in *Federal Register* on May 10, effective on May 6 First violation that will be prosecuted occurs
	Jun-Jul	Second and third violations that will be prosecuted occur
	Sep	Fourth violation that will be prosecuted occurs
1992	Sept	Final rule published that expands VIP to include halibut bycatch in all trawl fisheries
1993	May	Fifth and last violation that will be prosecuted occurs
1999		Last warning letter sent out in Fall
2003	June	VIP bycatch rate standards for second half of 2003 are not published; NPFMC votes to consider repeal of the VIP during its October meeting
	Oct	NPFMC approves alternatives outlined in the NMFS discussion paper about VIP
	Dec	NPFMC reiterates its approval of the alternatives outlined in the NMFS VIP discussion paper
2006	Oct	NPFMC performs initial review of the Environmental Assessment/ Regulatory Impact Review/Initial Regulatory Flexibility Analysis and releases it for public review.
	Dec	NPFMC takes final action, adopting Alternative 3, Option 2.

vessels carrying observers were subject to the VIP. Enforcement actions could be taken if a vessel's bycatch rate for a fishing month exceeded the standard established for that fishery. The VIP imposed potential costs on fishermen with high observed prohibited species bycatch rates. This created an incentive for fishermen to reduce these observed rates by changing the patterns of their fishing behavior or by manipulating the observer reported rates. The incidence of these illegal actions was unknown, but may have been serious.

Effective enforcement of the VIP imposed significant costs on NMFS. Furthermore, the establishment of a fishery cooperative in 2000 and the stringent catch monitoring provisions implemented by NMFS to monitor cooperative-specific allocations of groundfish and prohibited species, including halibut and red king crab, created other means to reduce bycatch. Fishery cooperatives are allocated a specified amount of bycatch which is further assigned to cooperative members through internal agreements. This creates incentives and capabilities for cooperatives to control individual operation bycatch rates to better maximize the value of the cooperative's bycatch allocation than occurred under the VIP.

Prior to 2003, publication of the bi-annual bycatch rate standards was expedited to the final rule by using the "good cause" exemption in the APA. The good cause waiver allows an agency to forgo publication in the *Federal Register* for a 30-day public comment period before a rule is promulgated. This waiver can only be used if notification and public comment "are impracticable, unnecessary, or contrary to the public interest." In spring 2003, NMFS concurred with National Oceanic and Atmospheric Administration (NOAA) General Counsel that the rationale on which a good cause waiver of prior notice and opportunity to comment had been based did not constitute

adequate justification for such a waiver. Without use of the waiver, NMFS could not publish bycatch rate standards for the second half of 2003, because of the time and resources needed for notice, public comment, and analysis. VIP bycatch rate standards have not been published since the first half of 2003.

With this record, the NPFMC initiated an amendment in 2003 to repeal the VIP given concerns about its effectiveness, its potential to absorb resources that could be utilized by other, more important management and enforcement functions, the incentive created for pre-sorting of bycatch, and developments in other bycatch reduction programs that had occurred since 1991. NPFMC approved withdrawal of the VIP in 2006, and it was withdrawn from federal regulations in 2008 (73 *FR* 12898).

Other programs considered but not adopted by the NPFMC

Halibut Mortality Avoidance Program (HMAP)

Between 1998 and 2002, the NPFMC considered a system to reduce halibut bycatch mortality by allowing deck sorting of halibut under a controlled and verifiable protocol. Trawlers would limit the length of their tows and carefully remove halibut from the catch as soon as the net was on board. Observers would count and measure halibut before releasing them. Deck sorting was proposed to lower halibut mortality and provide more accurate estimates of halibut bycatch. Several studies were conducted by NMFS and industry partners under experimental fishing permits. In 2002, the NPFMC's Scientific and Statistical Committee (SSC) concluded, based on a contracted NPFMC analysis, that the HMAP proposal was not feasible under existing levels of observer coverage. The HMAP proposal required that observers monitor the on-deck sorting of halibut bycatch for each haul. This would have greatly increased the complexity and amount of the observer's workload, placing halibut mortality assessment as the highest priority for observer activity, requiring that observers work in a potentially unsafe environment, and increasing the potential for conflict between observers and vessel crew. The HMAP proposal could not be implemented without increasing the number of observers on participating vessels.

Vessel Bycatch Accountability (VBA)

In the late 1990s, the NPFMC tasked a committee with developing a pilot program for Vessel Bycatch Accountability, along with a HMAP pilot program, and developing options for setting PSC limits for cooperatives in non-pollock fisheries, as part of the American Fisheries Act amendment measures. Ultimately, the VBA initiative was subsumed in the development of several CSPs (as noted below).

Individual Vessel Checklist Program (IVCP)

In the late 1990s, the NPFMC also tasked its bycatch committee with investigating vessel-based bycatch reduction programs, along with HMAP, VBA, and other PSC limit reduction programs. Ultimately, elements of IVCP were examined for incorporation into CSPs, where applicable, to improve monitoring and reduce bycatch.

Voluntary industry efforts

Several fishery participants have voluntarily modified their gear or fishing behavior to reduce halibut bycatch in order to increase their target fishery catches. Evaluations of these efforts are summarized below for the Pacific cod H&L and the flatfish trawl fisheries.

Hot-spot analysis

Since 1995, the Bering Sea flatfish and cod fisheries have reduced halibut bycatch rates through the use of the Sea State data-sharing program. Under this system, individual vessel operators share bycatch rate information with a coordinator, who redistributes summarized data

back to the entire group. The summaries are provided on charts which depict daily bycatch rates and "hotspots". The small number of participants (~25) and the transparency of vessel-specific bycatch performance allow the group to function reasonably well with only informal agreements among fishermen. The program works best with a limited number of entrants. Success in bycatch avoidance is reduced in larger groups, when peer pressure becomes less effective, as participants begin to doubt that the savings in terms of additional fishing opportunity from bycatch savings will accrue to the ones who incurred the sacrifices. This is a classic case where the lack of assigned rights to catch and bycatch tends to allow individual profit maximization incentives to prevail even when such behavior decreases total yields and overall revenue.

A critical factor in the success of bycatch management in the Bering Sea flatfish fisheries which does not exist in the GOA is the relatively predictable and consistent spatial patterns in bycatch locations that emerge within seasons and annually. A voluntary hot-spot program works in the Bering Sea because there are reasonable alternative areas for fishermen to relocate fishing effort to reduce bycatch while achieving acceptable target catch rates. Consequently, fishermen are rarely faced with "no win" situations wherein, to achieve lower bycatch rates, they must necessarily accept lower target catch rates.

GOA Pacific cod H&L fishery

In 2006, the Freezer Longline Coalition organized a voluntary cooperative for its vessels operating in the GOA. Internal negotiations within the Freezer Longline Coalition Cooperative (FLCC) resulted in a small number of participating vessels and an agreement on the share of the GOA halibut H&L PSC limit each boat would be provided. The portion of the overall GOA fixed gear PSC limit assigned to the FLCC vessels was determined by subtracting the estimated halibut bycatch needs of the shoreside H&L sector from the amount of the fixed gear PSC limit available prior to the fishery.

The FLCC contracted with a private company to monitor trends in real-time target catch (usually cod) and halibut bycatch in the GOA H&L sector. Initially with Fisheries Information Service (FIS) and currently with Sea State, Inc., a secondary task for the contractor is to collect and analyze halibut release viability data. All federally permitted freezer longliners participate in the monitoring program. Sea State downloads observer information on daily catch and bycatch rates from NMFS. Detailed information about vessel-specific totals (and halibut PSC limit remainders) to date, bycatch rates (ratio of halibut to cod), estimates of end date based on recent catches, and a graphic depiction of the progression of halibut catch toward the vessel limit is sent to the participating vessels and/or vessel managers on a daily basis. Information is provided weekly to the entire fleet and NMFS in-season managers.

The efforts of the FLCC to assign direct responsibility for halibut bycatch reduction to individual vessels have resulted in a reduced halibut discard mortality rate (DMR) in the Pacific cod H&L fishery from 13% to 11% for 2010-2012. Figure 2 shows the difference in assumed rates vs. actual rates achieved by the FLCC. Additional background on bycatch avoidance practices by the freezer longline fleet can be found in Smoker (1996).

Halibut excluders

The potential reduction of halibut PSC limits has created incentives for industry to investigate the use of halibut excluders and methods to reduce halibut mortality rates through improved handling procedures. Commercial trawl industry representatives have worked to develop bycatch excluders for use in trawl fisheries for flatfish and Pacific cod in the BSAI and GOA. The potential for halibut excluders is particularly important for the Pacific cod fishery. According to fishermen, regulations protecting Steller sea lions have forced fishery effort towards cod into summer and early autumn, when halibut bycatch rates are high (Gauvin 2008).

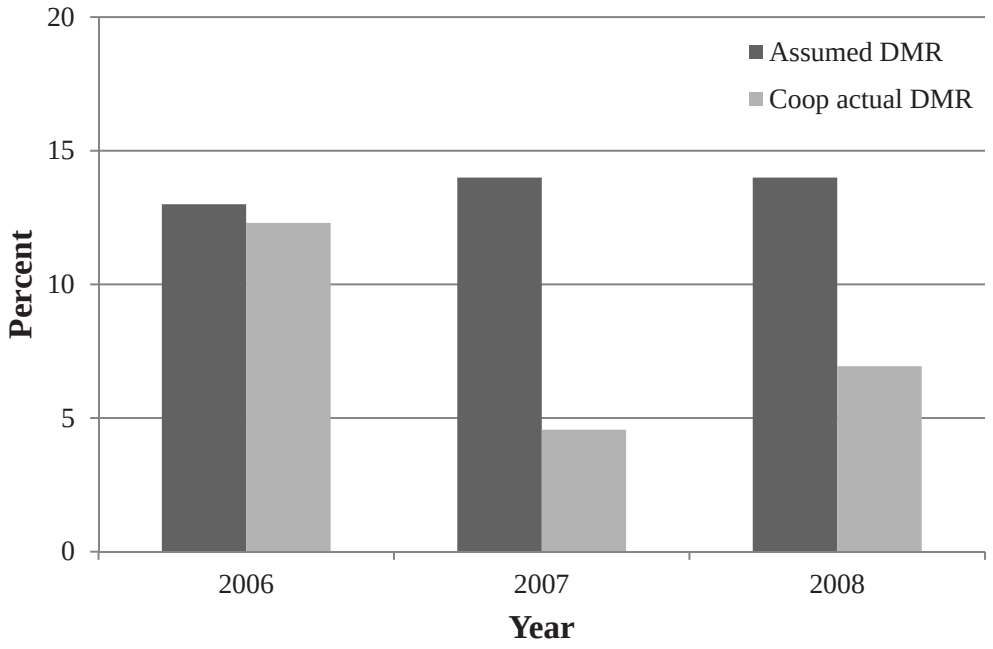

Figure 2. Halibut mortality data for the 2006-2008 GOA hook-and-line cooperative fisheries. Source: Smoker (1996).

Several halibut excluder devices have been developed for trawl fisheries for flatfish and Pacific cod trawl fisheries in the BSAI and GOA. Rose and Gauvin (2000) and Gauvin and Rose (2000) reported on a rigid grate system and escape panel, which are installed ahead of the trawl codend to avoid catching halibut. In test trials in the GOA deepwater flatfish fishery, halibut and deepwater flatfish were concentrated in overlapping areas and the exclusion of halibut could dramatically increase harvest of the target species. Also, the halibut caught in this fishery tend to be large, creating more potential for size selectivity in lowering halibut catches and minimizing loss of target species catch. The test gear excluded 94% of the halibut while releasing 38% of the target flatfish. Results of simulations of its use in the flatfish fishery estimated that fleet-wide use of the grate would result in a 171% increase in the duration of the fishery, a 61% increase in target flatfish catch, and a 71% reduction in overall halibut bycatch. Other simulations demonstrated that a high incentive for individual non-compliance remains without a rationalized fishery.

Gauvin (2004) studied the tradeoffs of target catch rates (flatfish) and halibut bycatch in Central GOA trawl fisheries. The potential for gear modifications to reduce halibut bycatch rates while increasing utilization of GOA flatfish resources were examined. Results from the study concluded that there are differences in the usage ratios of target catch to halibut for different GOA fishing areas and within different target fisheries. These differences were seasonal, with the relative strength and repeatability of between-area and within-season patterns being an unresolved question for improving the efficiency of flatfish yields against PSC usage. Gauvin (2004) drew some general observations from comparison with the BSAI flatfish trawl fleet:

1. The GOA flatfish fishery faces greater challenges in terms of finding areas where tradeoffs between target and bycatch rates can be achieved. This observation is based primarily on

the relative degree of consistency and predictability of target catch and halibut bycatch rates by area for the flatfish fisheries of the Bering Sea relative to the Central GOA.

2. Catch and bycatch trends in the Bering Sea flatfish fishery appear less variable, both in range of target species catch rates and in halibut bycatch rates, seasonally as well as annually, at the core fishing locations.
3. The Pacific cod trawl fishery in the GOA and Bering Sea are similar in several respects. For instance, trawl cod fisheries in both regions appear to have relatively similar catch and bycatch rates. Additionally, they both have a few core areas that tend to offer clearly better tradeoffs of catch rates and halibut bycatch usage. However, the GOA cod fishery had fishing areas with a variety of rates for cod catch and halibut bycatch spread over a larger number of relatively small and discrete locations. This is not the case for the Bering Sea, where cod fishing tends to occur in three basic locations: Unimak Pass, the Slime Bank, and an area south and west of the Pribilof Islands. The differences in the cod catch rates and halibut bycatch rates between these areas are relatively small and generally predictable.

Halibut excluder devices tested in the BSAI and GOA for the flatfish and cod fisheries were reviewed by Gauvin (2004). The review concluded that the use of "soft" halibut excluders on shoreside trawlers could increase utilization under a CSP, with potential for increases in flatfish yields as halibut bycatch rates declined. Remaining selectivity and usage issues could be ameliorated with additional field testing for some species; however, fisheries for arrowtooth flounder and flathead sole continue to appear problematic for halibut bycatch reduction due to similar average size of arrowtooth flounder, flathead sole, and halibut. Limited success at creating the desired selectivity was achieved with the use of spreading bars with webbing or soft-panel excluders. More recent work reconsidering some of the previous HMAP type approaches demonstrated that mortality could be reduced, but there was a high labor cost.

The trawl industry has also conducted research into a halibut excluder for the Pacific cod trawl fishery, based on the excluder designed for the flatfish fishery (Gauvin 2008). The square openings were replaced with circular openings. This configuration was effective for large halibut, but it was necessary to add new components to exclude small halibut and skates. The main challenge in applying the flatfish excluder device to cod fisheries was that cod are much more similar in size and swimming ability to halibut than are sole. Thus, a square hole or mesh large enough to allow all cod to pass would only exclude the very largest halibut. The different body shapes of these fish were considered a characteristic that could be exploited for separation. Excluders were constructed with rigid circular holes in the selection panels because rigid circular holes, sized for the largest cod, had the best chance of excluding smaller halibut. In tests conducted in the Gulf of Alaska, 80% of the halibut were released while retaining an average of 85% of the cod.

Monitoring practices implemented to reduce halibut bycatch

Catch Accounting System

Halibut bycatch estimation methods used in the Alaska Region Catch Accounting System (CAS) were designed to provide in-season point estimates of catch that enable managers to monitor and manage fisheries within prescribed limits. For example, in-season managers need to estimate and monitor halibut bycatch in multiple management scenarios, including PSC limits that are part of CSPs (e.g., Amendment 80 and CDQ cooperatives; industry-formed cooperatives) and halibut PSC limits which are assigned to an open access fishery that is specific to species, gear, and processing modes. Estimation methods were developed to balance the near real-time requirements of in-season management while being specific to fishery-associated PSC limits.

The CAS database is designed such that bycatch mortality estimates are summed to an account that reflects groundfish fisheries with in-season monitoring of halibut bycatch mortality. These accounts are often specific to attributes such as target species, season, management program, gear, and reporting area. The CAS uses complex algorithms with associated data assumptions that cannot be captured in a brief overview. Readers are directed to Cahalan et al. (2010a) for a comprehensive description of bycatch mortality estimation methods and reporting tools used in CAS.

Halibut discard mortality rates (DMRs) are applied to the total estimated halibut discard for a gear type, FMP area (GOA or BSAI), fishery, and year. DMRs are derived from the estimated condition of halibut sampled by observers (Williams 2010a). DMRs are determined periodically by IPHC and are specific to the condition of the halibut. The pre-determined mortality rates are applied to the subsequent fishery regardless of actual fleet performance. Improved performance would lower future rates; conversely, poor handling results in higher DMRs in subsequent years.

As described above, groundfish catch information used for halibut bycatch estimation is often based on industry-based reporting. Vessels in federal or state fisheries report groundfish landing and production through a web-based interface known as eLandings. In 2005, NMFS, IPHC, and the Alaska Department of Fish and Game (ADF&G) implemented eLandings to reduce reporting redundancy and consolidate industry-reported fishery landing information. There is also a stand-alone application available for the vessels fishing and processing catch at sea (the at-sea fleet). The at-sea fleet submits eLandings files via email. Each industry report submitted via eLandings undergoes error checking by NMFS. Data are then stored in a database and made available to the three collaborating agencies.

There are two basic eLandings report types used for catch estimation: production reports and landing reports.

1. At-sea production reports are mandatory for CPs and motherships that are issued a Federal Fishing Permit (FFP). At-sea production reports include information about the gear type used, area fished, and product weights (post-processed) by species. Since 2009, the at-sea fishing fleet has submitted these reports daily. Prior to 2009, these reports were submitted weekly. Shore-based plants also complete production reports, but these are not discussed since they are not used for halibut PSC estimation.
2. Landing reports are required when a CV makes a delivery to a shoreside plant or a mothership. Upon making a landing, a representative of the shoreside plant or mothership submits the landing report into eLandings and a paper "fish ticket" is printed for both the processor and the CV representative to sign. The collection period for a landing report is a trip for shoreside processors and a day for each CV that delivers to a mothership. A trip for CVs delivering to a shoreside processor is defined as the time period between when fishing gear is first deployed and the day the vessel offloads groundfish (50 CFR 679.2). Landing reports are mandatory for all processors required to have a Federal processing permit, including motherships who receive groundfish from federally permitted CVs.

North Pacific Groundfish Observer Program

The Fisheries Monitoring Division of the Alaska Fisheries Science Center operates the North Pacific Groundfish Observer Program (NPGOP, or Observer Program). The current program generally covers groundfish vessels greater than 60 ft LOA and governed by the provisions of a FFP. The amount of observer coverage described in regulation is broadly divided into three categories: (1) vessels less than 60 ft are not required to carry observers; (2) vessels between 60 and 125 ft LOA are required to carry observers 30% of their fishing days in a calendar quarter; and (3) vessels greater than 125 ft must have all fishing days observed. Vessels between 60 and

125 ft make up the majority of vessels fishing groundfish in the GOA and out of ports other than Dutch Harbor and Akutan in the BSAI. Regardless of length, vessels that are associated with CSPs, such as Amendment 80, AFA, and the Rockfish Program (RP), are required to carry an observer whenever the vessel is fishing. Many of the larger processing vessels now carry two observers at all times to ensure round-the-clock observation.

Observer information represents the only at-sea discard information available to estimate mortality of halibut in Alaska groundfish fisheries and is central to understanding catch activity in waters off Alaska. Observer data from observed vessels are assumed to be representative of the activity of all vessels (observed and unobserved), and are used to estimate total incidental catch of prohibited species (halibut) for the entire fishery. In addition, observers collect lengths and gather halibut viability and injury data, which are used to assess halibut mortality estimates for groundfish fisheries. Further, observer information is used extensively in management analysis, halibut stock assessment, and in-season forecasting of PSC limits.

In 2010, the NPFMC adopted a plan to restructure the observer program and its coverage requirements for vessels and processors that require less than 100% observer coverage, including previously uncovered sectors such as the commercial halibut sector and <60 ft LOA groundfish sector. In the restructured plan, NMFS would contract directly with observer companies to provide observers. NMFS would deploy observers across prescribed fisheries according to predetermined deployment plan, and industry would pay a fee equal to 1.25% of the ex-vessel value of the landings included under the program. NMFS would have the flexibility to deploy observers in response to fishery management needs. The restructured plan's deployment strategy would also reduce the coverage bias inherent in the existing program. No observer coverage is planned for vessels <40 ft LOA in the first year(s) of the program. Additionally, coverage requirements will remain unchanged for those groundfish fishery sectors which are currently required to carry two observers. Specific proposed coverage requirements can be found in 77 FR 23326. The new program is expected to be implemented in 2013.

Logbook program

While not used for bycatch estimation, the NMFS logbook program has been in place since 1991 and has largely been used for enforcement purposes. Paper logbooks are required to be completed and submitted for federally permitted vessels over 60 feet in length that are fishing for groundfish, and for vessels fishing IFQ halibut that are 26 feet and over. Catcher vessels and CPs that participate in both the groundfish fishery and sablefish or halibut IFQ fishery during the same fishing year are allowed to submit a single combined NMFS/IPHC logbook. Haul-specific information, including date and time, location, vessel estimates of total catch and species-specific catch, fishing gear, fishing depth, and at-sea discards are recorded in the logbook. These data are not available electronically and are not used in catch estimation. They are used in halibut stock assessment, however.

A small number of vessels are currently participating in an electronic logbook program. This program was implemented in 2003 and involves 12 voluntary participants. Expansion of electronic logbooks would provide haul-specific effort information on unobserved vessels and the information could be useful for halibut discard estimation or observer deployment processes in the future.

Electronic monitoring (EM)

NMFS and industry have been working together to evaluate the potential for video monitoring to augment observer information (Bonney and McGauley 2008, Bonney et al. 2009, Cahalan et al. 2010b, Kinsolving 2006). In 2008, NMFS, the North Pacific Research Board, and the NPFMC conducted a workshop to assess the state of EM technology across the nation and internationally (NPFMC 2008). One session discussed past pilot studies conducted in the U.S. and Canada. Other sessions included industry perspectives, legal/ management/enforcement

concerns, and research/development advancements. The workshop concluded with a synthesis of the discussions of the workshop. The major outcomes of the workshop were that EM may have potential in the North Pacific, but the applicability depends on the specific objectives of the program that must be monitored and potential directions for further investigation of EM.

Most EM work in Alaska to date has been focused on compliance monitoring, with some tests of EM efficacy for fisheries management. Currently, EM has limited potential as a biological data collection tool. EM will likely not be able to collect age or sex information, but as the technology advances, may be able to provide species and length information. Video has been implemented through regulations in two programs: as a tool to monitor pre-sorting in the Amendment 80 program and to monitor Chinook salmon bycatch under Amendment 91.

Summary of evaluations of current management practices and accuracy of data collected from monitoring programs

U.S. West Coast

Summary of evaluations of current management practices

The PFMC completes a biennial management process every even-numbered year for the following two years (e.g., measures adopted in 2010 will apply to 2011 and 2012). Through this comprehensive process, new stock assessments are completed and independently reviewed, and management practices, monitoring and sampling programs, and bycatch modeling techniques are evaluated by the PFMC's Groundfish Management Team. In addition, the PFMC receives annual reports from the NMFS Northwest Fisheries Science Center on the halibut bycatch estimates in the trawl and fixed-gear fisheries. These reports are reviewed by the PFMC's Scientific and Statistical Committee (SSC) in September of each year. The Final Environmental Impact Statements for the biennial management process, annual halibut bycatch estimate reports, and the SSC's comments are posted on the PFMC website (www.pcouncil.org).

Additional reports produced by the PFMC and others to evaluate current management practices and/or data collected through monitoring programs can be found in Sampson and Crone (1997), PFMC (2000), Harms and Sylvia (2001), NMFS (2003), NMFS (2004a) and (2004b), PFMC and NMFS (2005), Punt et al. (2008), PFMC and NMFS (2010), and Heery et. al (2010).

British Columbia

Summary of evaluations of current management practices

Prior to the introduction of ITQs, TACs in the many British Columbia groundfish fisheries were often exceeded. For example, in the 1980s, catch limits for the Area 2B halibut fishery were exceeded in eight out of ten years (Casey et al. 1995). Following the implementation of ITQs in the halibut fishery in 1991, the TAC has never been exceeded in the commercial fishery. In addition, since the CGIP began in 2006, all rockfish catches have been below the set TAC (DFO 2009). The same can also be seen for other groundfish species; DFO year-end summary reports show that the total quota for any groundfish species has not been exceeded since the CGIP was implemented (Mawani 2009). Table 5 shows that for the 2008/09 and 2009/10 fishing seasons, the total halibut catch did not exceed the total amount of quota. This also includes the mortality associated with released legal size fish.

Since the implementation of ITQs, there has been a marked difference in the levels of catch and bycatch. Prior to ITQs, the "derby" style fishery resulted in "…excessive fishing capacity, very short seasons, unsafe fishing operations, large quantities of bycatch being wasted…" (E.B. Economics 1992). When ITQs were introduced into the halibut fishery in 1991, the fishing season was extended from 10 days in 1989 (the catch limit was exceeded by 95 mt that year)

Table 5. Halibut quota and catch in pounds for the hook and line sector in 2008/09 to 2009/10.

Sector	Halibut	Sablefish	Rockfish Inside	Rockfish Outside	Ling cod	Spiny Dogfish	Total
2008/09							
Total Quota	7,744,715	41,211	655	152,051	15,567	225,992	8,180,191
YTD Catch	7,253,422	45,017	651	118,484	12,427	219,791	7,649,792
						Percent of total quota:	**93.52**
2009/10							
Total Quota	6,318,373	48,103	427	143,665	11,528	207,800	6,729,896
YTD Catch	6,121,372	72,164	483	138,975	10,890	203,487	6,547,371
						Percent of total quota:	**97.29**

to 250 days (Mawani 2009). The benefits of ITQs extend across both the H&L fishery and the trawl fishery. In regards to the trawl fishery, Grafton et al. (2005) states that "… changed fishing practices in response to economic incentives have also reduced the annual bycatch mortality for halibut to about 15% of its previous level, dropping from around 900 mt to a little over 100 mt since the introduction of ITQs." Figure 3 shows the estimates of halibut bycatch mortality from the British Columbia bottom trawl fishery. It can be seen that bycatch mortality were generally increasing through the late 1980s, with a peak occurring in 1991. After 1991, there is a decrease in halibut bycatch mortality, with the most dramatic decrease occurring from 1995 (1,522,000 pounds) to 1996 (299,000 pounds). Bycatch mortality has remained fairly consistent since 1996.

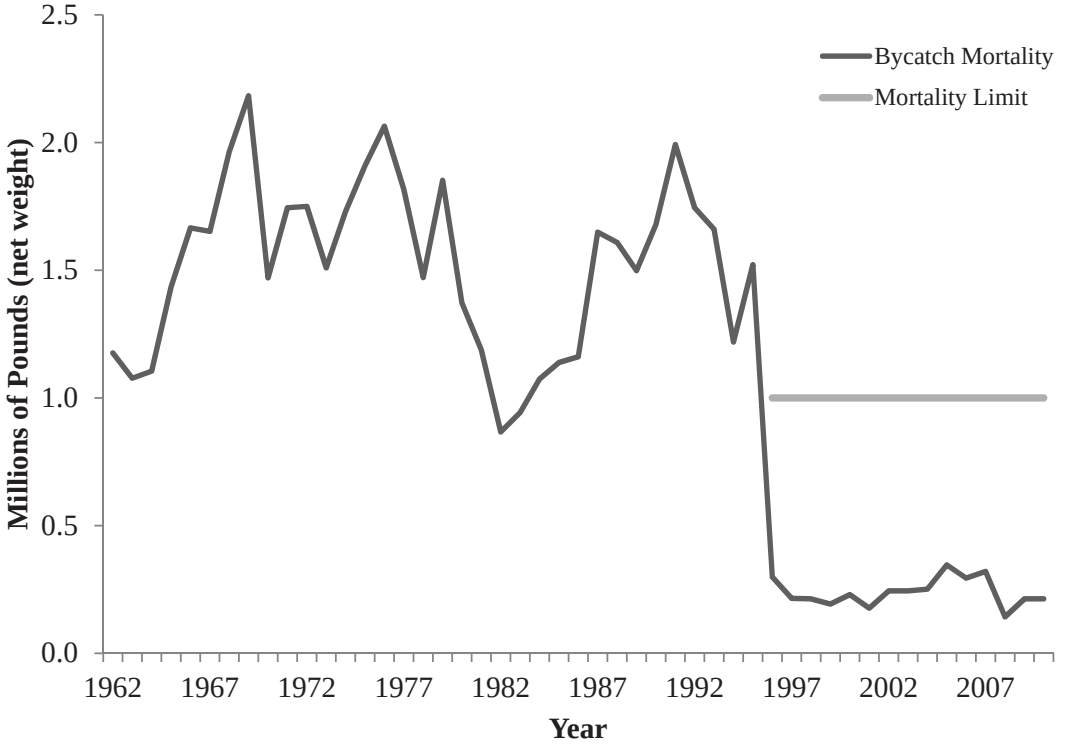

Figure 3. Estimates (thousands of pounds, net weight) of bycatch mortality of Pacific halibut from the British Columbia (Area 2B) bottom trawl fishery for 1962 through 2010. Source: Williams 2011.

The dramatic decrease in bycatch demonstrates the effect of the introduction of ITQs within the trawl fisheries. In 1996, individual vessel bycatch limits for trawl vessels were implemented, which then became halibut bycatch ITQs. The introduction of individual halibut bycatch quotas within the trawl fleet required individual harvesters to account for their bycatch and significant reductions in trawl bycatch mortality were realized.

Summary of the Accuracy of Data Collected from Monitoring Programs

Before 2006, the H&L industry required only 10-15% of the vessels to use at-sea monitoring. Under the conditions of license, directed fisheries for sablefish, rockfish, dogfish, and lingcod were unable to retain halibut (Mawani 2009). Scientific reviews proposed that the low level of observer coverage rendered catch estimates inaccurate, and that the data should not be used for management (Mawani 2009). A Canadian Science Advisory Secretariat report by Haigh et al. (2002) suggested, "… [fisher logs] record the most detailed information on catch composition. However, for a variety of reasons – no estimates of discards, incompleteness, and unavailability to DFO – they are not sufficient to determine total removals. This suggests that observer coverage is needed. Implementing 100% observer coverage is the most direct solution." This paper further goes on to state that "…it is suspected that fishermen change their discard behavior when an observer is onboard. If this is the case then observer records accurately reflect the altered discard behavior. However, the systematic discard behavior remains unknown. Under 100% coverage, the observed discard rate becomes the true discard rate." The paper also attempted to estimate total catch using three different statistical methods and extrapolated information from partial at-sea observations, but found biases that made the estimates unreliable. Another such study concluded that improved catch accountability in fisheries could be achieved through an integrated observer and EM monitoring program, by providing higher fleet coverage and more randomly distributed fleet sampling (McElderry et al. 2003).

Electronic monitoring has been shown to be an effective method of observation, but without any enforcement, such as an audit process, it would not be able to provide accurate catch numbers. The electronic footage captures any discarding that occurs while fishing, but there is still a possibility that fishers may discard before unloading at the dock. When combined, the Dockside Monitoring Program (DMP) and the video audit are effective tools to ensure that no illegal discarding has occurred. A study performed by Stanley et al. (2009) shows that the DMP results and reviewed EM footage generally match the total fisher log counts for yelloweye rockfish. Furthermore, most fishers receive a passing score in the DMP and fishing log validation. An evaluation of the CGIP done by DFO in 2009 states that "…concerns [regarding cheating] can be abated by measures within the monitoring program. It is perceived that harvesters would be unlikely to bias their logbooks or DMP records for fear of increasing the likelihood of failing the audit checks, which would incur the cost of 100% video footage (VF) review and/or an on-board observer…consistency between VF-estimates, the fisher log and DMP-estimates indicate that there is negligible unreported discarding or dumping."

Studies have been completed to examine the accuracy of data collected from monitoring programs. A study by Stanley et al. (2009) examined the accuracy of yelloweye rockfish catch estimates in the CGIPP. In this study, EM video footage was used as an independent and unbiased estimate of total catch. The catch estimates from this footage were compared to results from the DMP and records in the fisher log. Stanley et al. (2009) noted "…the mean estimates [from video footage] closely match the official estimates provided as the sum of the fisher logs or DMP at the region and coastwide levels and even provide reasonable matches for the individual sector estimates. The match of the piece counts indicates that the total weights reported in the DMP accurately reflect the actual total catch of yelloweye rockfish in the regions for these sectors." The results of this comparison can be seen in Table 6. In some cases, such as within the halibut and spiny dogfish sectors, the video footage estimates for yelloweye rockfish were found to be

lower than the DMP totals; however, since the official estimates were higher, there was no risk posed to conservation. It is also noted that "All of the official yelloweye rockfish estimates fall well within the 95% confidence limits of the VF estimates" (Stanley et al. 2009). Stanley et al. (2009) concludes that the CGIP catch monitoring program provides accurate total catch estimates of yelloweye rockfish in British Columbia.

Table 6. Comparison of yelloweye rockfish piece counts from video footage (VF) review, fisher logs, and the Dockside Monitoring Program (DMP) for each groundfish license sector along the coast of British Columbia, fishing year 2008/09. From Stanley et al. (2009).

	Total piece count by source		
Sector and Region	**VF**	**Fisher Logs**	**DMP**
Pacific halibut (outside)	34,547	39,880	39,988
Pacific halibut/sablefish (outside)	11,144	10,411	10,128
Lingcod (outside)	2,310	2,008	2,056
Rockfish (inside)	536	554	519
Rockfish (outside)	16,991	14,159	14,063
Sablefish (outside)	359	292	304
Spiny dogfish (inside)	1,282	1,581	1,563
Spiny dogfish (outside)	4,496	3,499	3,531
Outside total	69,847	70,249	70,070
Inside total	1,819	2,135	2,082
Coastwide	71,666	72,384	72,152

The reliability of at-sea observer release reports with the groundfish trawl fishery has also been examined by Grinnell (2010). The study compared releases reported by at-sea observers to the predicted number of releases of sablefish and halibut. The predicted releases incorporated social, economic, and environmental predictors. The study examined many different factors that influence observer reports, and the reliability of the information. One of the variables measured was "observer-skipper familiarity", a social predictor that measured the number of events that a skipper and observer have in common. The study noted that although observers will report higher halibut mortality as the number of fishing events with a particular skipper increases observers do not show preferential treatment to skippers they are more familiar with. Grinnell also noted that "Observer experience has an important effect on release rates, and indicates that experienced observers report less released fish than new observers." In general, it was seen that new observers reported a higher proportion of dead released halibut then those with more experience; however, Grinnell's calculations show that for halibut from 1997 to 2006, the 90th percentile range for misreported weight overlaps zero, indicating that yearly misreported weights are not statistically different from zero. The study concludes that misreported weights are negligible, and that there are no strong reasons to suspect release data reported by observers are unreliable.

Alaska

Summary of evaluations of current management practices

Catch Share Programs (CSP)

A number of CSPs that include bycatch reduction elements have been implemented in Alaska federal fisheries. CSPs allow vessel operators to make operational choices to reduce discards of fish due to longer fishing periods and economically efficient use of vessel capacity.

The harvest privileges afforded by a CSP allow vessel operators to slow the pace of fishing and to fish in a less wasteful manner. For example, catch shares have encouraged operators to use modified gear to reduce bycatch, coordinate with other vessel operators to avoid areas of high bycatch, and investigate handling methods to reduce discard mortality.

Individual Fishing Quota Program (Amendments 15/20 to the BSAI/GOA FMPs)

An Individual Fishing Quota Program was implemented for the Pacific halibut (via regulatory amendment) and sablefish fixed-gear fisheries in the federal waters of the BSAI and GOA in 1995. Bycatch reduction was inherent in the program, due to the close interaction between sablefish and halibut fisheries. Much of the H&L bycatch of halibut occurred in the sablefish fisheries, and many fishermen fish for both (and received IFQ for both). To the extent sablefish fishermen hold halibut IFQ, this halibut is now retained and counted against the target quotas, as opposed to being caught as bycatch and discarded (regulations previously required it to be discarded). Implementation of the IFQ Program resulted in an immediate reduction of the GOA halibut PSC limit apportionment to the H&L sector from 750 mt to 300 mt in the annual specifications process for 1995 and thereafter (Pautzke and Oliver 1997).

Central GOA Rockfish Program (Amendments 68 and 88 to the GOA FMP)

The Central GOA Rockfish Pilot Program (RPP) was implemented in 2007 and was reauthorized in 2011 as the Central GOA Rockfish Program (Amendment 88 to the GOA FMP). The program enhances resource conservation and improves economic efficiency for participating harvesters and processors. Allocations of the primary rockfish species (Pacific Ocean perch, northern rockfish, and pelagic shelf rockfish) and important incidental catch species (sablefish, Pacific cod, shortraker, rougheye, and thornyhead rockfishes) are divided between the catcher vessel sector and the catcher processor sector. Each sector is also assigned a halibut limit based on historic catch of halibut in the target rockfish fisheries. Participants in each sector can either fish as part of a cooperative or in a competitive, limited-access fishery.

The annual halibut catch and mortality in the Central GOA rockfish fishery has declined since the implementation of the pilot program (Table 7). This reduction in halibut mortality (particularly in the CV sector) likely arises from several factors. First, vessels have exclusive allocations, allowing them to move from areas of high halibut catch without risking loss of catch of the primary rockfish. Second, exclusive allocations also increase the incentive for participants to communicate with each other concerning catch rates, improving information concerning areas of high halibut incidental catch in the fleet, and preventing repeated high halibut mortality among vessels exploring fishing grounds. Third, several vessels have begun employing new pelagic gear that limits bottom contact and halibut incidental catch. These gear changes are apparent when comparing the percentage of catch using pelagic trawl gear and non-pelagic gear in the first two years of the program with catch by those gear types in the preceding years. In the second year of the program, over 40% of primary rockfish catch was with pelagic trawl, in comparison to less than 25% in 2006 and 6% or less in the preceding years. In the second year of the program, nearly 85% of the catcher vessel fleet used pelagic gear for some of its catch, in comparison to slightly more than half of that fleet in 2006 and less than 20% in the preceding years. Participants in the program report that a primary motivation for these changes in gear types is constraining halibut allocations, which could jeopardize cooperative catches in the event that halibut bycatch exceeds allocations.

Previously, attainment of the halibut PSC limit prior to catch of the rockfish TAC resulted in early closures of the rockfish season until the September apportionment of catch was newly available. Since implementation, cooperatives receive exclusive allocations of halibut PSC limits from the third quarter deep water complex apportionment that constrain their fishing activity. Participants in the limited access fishery (who elected not to join a cooperative) are subject to the same limitation as participants in the rockfish fisheries prior to the pilot program.

Table 7. Halibut mortality of vessels in the Central Gulf of Alaska rockfish pilot program (2007 and 2008).

Year	Fishery	No. of Vessels	Halibut mortality (lbs)[b]	Catch of primary rockfish (mt)	Pounds of halibut mortality per mt of primary rockfish catch	Allocation including transfer of halibut PSC (lbs)	Unused allocation (pounds)
2007	Catcher processor limited access	3	26,312.8	2,063.3	12.8	NA	NA
	Catcher processor cooperative[a]	1	16,623.3	1,933.1	8.6	77,760.7	61,137.3
	Catcher vessel cooperative	25	32,710.1	7,746.0	4.2	309,816.8	277,106.7
	Total	**29**	**75,646.3**	**11,742.4**	**6.4**	**387,577[c]**	**338,244[d]**
2008	Catcher processor limited access	4	47,624.4	2,892.1	16.5	NA	NA
	Catcher processor cooperative[a]	2	19,332.0	1,836.4	10.5	44,092.0	24,760.0
	Catcher vessel cooperative	23	60,622.0	7,446.7	8.1	331,906.9	271,284.9
	Total	**29**	**127,578.4**	**12,175.2**	**10.5**	**375,998.9[c]**	**296,044.9[d]**

Source: NMFS Catch Accounting Data

[a]Data are not confidential because of disclosure in cooperative reports.

[b]Includes all halibut mortality under the primary program, i.e., excludes entry level fishery.

[c]Includes allocation to catcher processor cooperative that did not fish. No allocation is made to the limited access fishery.

[d]Includes all allocations and only catches by vessels subject to those allocations.

In other words, if the third season halibut PSC limit apportionment is fully used prior to harvest of the applicable limited access rockfish TAC, that fishery will be closed until the next season's apportionment becomes available in September.

The incentive for halibut mortality reductions is increased by the rollover of saved halibut mortality to other fisheries late in the year, allowing the trawl sector as a whole (including vessels that did not qualify for the RPP) to benefit from these halibut mortality reductions. As seen in the three years of the pilot program, any unused portion of the cooperative's halibut PSC limit which has not been used by a cooperative before November 15 or after a declaration to terminate fishing by the cooperative, will be added to the last seasonal apportionment for trawl gear during the current fishing year. A total of 128 mt of unused rockfish cooperative halibut PSC was reallocated to trawl gear in November 2007; 135 mt was reallocated in November 2008, and 139 mt was reallocated in November 2009. In all three years, the reallocation of the unused portion of a PSC limit from the rockfish pilot program to the GOA trawl fisheries allowed the trawl GOA groundfish fisheries to remain open until December 31. The GOA trawl fisheries used 97%, 98%, and 91% of their halibut allocation in 2007, 2008, and 2009, respectively. In the five years previous to implementation of the RPP, the trawl GOA groundfish fisheries were closed to directed fishing prior to the end of the season so as not to exceed the halibut PSC limit. In two of those years, 2004 and 2005, the trawl GOA groundfish fishery was closed to direct fishing on October 1.

Under revisions to the renewed program, the program's halibut PSC limit will be reduced to 87.5% of the annual average usage of halibut in the target fishery during the qualifying period by both sectors. The remaining 12.5% would remain unavailable for use in any fishery, a reduction of 27.4 mt (45,000 lb net weight). In addition, 55% of any cooperative's unused halibut allowance would be available for use in the fifth season trawl fisheries, as an added incentive in target groundfish fisheries, with the remainder unallocated.

Amendment 80 to the BSAI Groundfish FMP

Amendment 80 established a limited access privilege program (LAPP) in 2008 for the BSAI trawl catcher processor sector that is not included in the American Fisheries Act, i.e., the "non-AFA" sector. Previously, halibut PSC limits were allocated by target fishery and shared among all trawl vessels, resulting in a race to harvest target species before a PSC limit allocation was reached. This resulted in trawl fisheries being prematurely closed due to halibut PSC limit constraints. Vessels participating in the Amendment 80 cooperative have successfully harvested target species quotas and maintained halibut catch below halibut PSC allocation.

Amendment 80 provides specific groundfish and PSC allocations to the non-AFA trawl CP sector and allows the formation of cooperatives. A key feature of the program was to reduce the amount of halibut bycatch mortality that may be taken while non-AFA trawl CPs are harvesting groundfish in the BSAI. Because vessel operators in cooperatives are better able to target catch and can engage in voluntary agreements to avoid areas with higher bycatch, the NPFMC recommended an overall reduction in the amount of halibut and crab PSC limit that may be used by the non-AFA trawl catcher/processor sector. In addition, the halibut PSC limit for the Amendment 80 cooperative sector is reduced by 50 mt annually from a high of 2,535 mt in 2008 to a final amount of 2,325 mt in 2012. The halibut PSC allocation for the trawl limited access group is fixed at 875 mt. Further, Amendment 80 vessels are limited in the amount of halibut bycatch they may catch in the GOA, but it is not an allocation. Abbot and Wilen (2010) provides an assessment of the Sea State program for fishing that occurred prior to Amendment 80, suggesting efforts to reduce bycatch failed due to counterproductive incentives that have since been removed with the implementation of Amendment 80.

Bering Sea/Aleutian Islands Pacific Cod Allocations (Amendment 85 to the BSAI FMP)

Federal regulations established a 3,400 mt PSC limit in the non-CDQ BSAI trawl fisheries. In the annual harvest specifications process, NMFS apportioned this amount among specific trawl fisheries, i.e., yellowfin sole, Pacific cod, and rock sole/other flatfish/flathead sole. For some of these fisheries, the allocation was further apportioned by season. At the beginning of the fishing year, the Pacific cod fishery was provided a greater PSC limit than was needed to support directed fishing, so NMFS transferred small amounts of the Pacific cod fishery PSC limit to the flatfish fisheries throughout the season as needed. Despite this reapportionment, some trawl vessels raced to harvest as much of the TAC as possible before the PSC limit to the overall trawl sector was fully utilized. Typically, once the PSC limit or TAC has been taken, the directed fishery would be closed. NMFS worked with industry to ensure that other fisheries were not constrained by PSC limits (while keeping total halibut mortality under the overall trawl PSC limit) by moving PSC among fisheries in-season to cover potential shortfalls. This flexibility to move PSC allowances between fisheries with a general consent from industry is critical since no formal regulation defined this management practice.

The BSAI halibut PSC limit for trawl gear in the non-CDQ fisheries is apportioned in the annual harvest specifications process among the following four fisheries: (1) Pacific cod, (2) yellowfin sole, (3) rock sole/other flatfish/flathead sole, and (4) pollock/Atka mackerel/other fisheries. Beginning in 2008, under Amendment 85, BSAI Pacific cod allocations and seasonal apportionments were revised for the following gear sectors: H&L (CP & CV); pot (CP & CV); jig; <60 feet H&L/pot; trawl CV; non-AFA trawl CP; AFA trawl CP; and CDQ sector. The objective was to change allocations to better reflect actual historical use of the resource (i.e., account for roll-overs), with consideration for social and community factors.

Amendment 85 further apportioned the Pacific cod trawl fishery halibut PSC limits among the trawl sectors and between two H&L sectors. Pot and jig sectors currently are exempt from PSC limits due to very low bycatch rates in these sectors. Generally, about 1,400 mt of halibut bycatch mortality is apportioned to the BSAI Pacific cod trawl fishery, but this amount and actual use can vary annually. The annual halibut PSC limit specified for this fishery category is divided among the trawl sectors as follows: 70.7% for trawl CVs; 4.4% for AFA trawl CPs; and 24.9% for non-AFA trawl CPs. Because the AFA and non-AFA trawl CVs share a Pacific cod allocation, this sector receives combined halibut PSC limits. Halibut bycatch mortality is attributed to a fishery based upon the target fishery.

Gulf of Alaska Pacific cod allocations

From 1999 to 2006, the NPFMC developed several approaches to rationalize the derby style GOA groundfish fisheries to address concerns regarding social and economic impacts of regulations on harvesters, processors, crew, and communities that depend on these fisheries. In December 2006, however, the NPFMC developed an alternate, more discrete approach to allocate the Pacific cod resource to the various gear sectors and limit future entry to the groundfish fisheries by extinguishing latent Limited License Program licenses.

The competition among sectors in the Pacific cod fishery may have contributed to higher rates of halibut bycatch and discards, and out-of-season incidental catch of Pacific cod. Participants in the fisheries who have made long-term investments and are dependent on the fisheries faced uncertainty as a result of the competition for catch share history as the NPFMC developed alternatives to rationalize the fishery.

In December 2009, the NPFMC apportioned the GOA H&L halibut PSC limit to the CP and CV sectors in proportion to the total Western GOA and Central GOA Pacific cod allocations to each sector. No later than November 1, the portion of the PSC limit projected by NMFS to not be used by one of the H&L sectors during the remainder of the year would be made available to the other sector. The apportionment of halibut bycatch will be proportional to the Pacific cod

area apportionment determined during the TAC setting process. The NPFMC did not reduce the PSC limit to this fishery.

Summary of the accuracy of data collected from monitoring programs

The current catch estimation methodology employed by NMFS in the CAS and Observer Program constitutes the best available science for data collection. Observers are currently the only reliable method through which bycatch data can be collected in the North Pacific groundfish fisheries.

Past analytical examinations of the Observer Program have discussed sampling protocols, bias, estimate expansion, and the statistical properties of estimates (e.g., Jensen et al. 2000; Miller 2005; Miller and Skalski 2006a, 2006b; Miller et al. 2007; MRAG Americas, Inc. 2000, 2002; Volstad et al. 1997, 2006; Pennington 1996; Pennington and Volstad 1994). These recommendations are considered when adjustments are made to the methods used by observers to collect catch and biological data. Redesigned data collections were implemented by the Observer Program in 2008 and include recording sample-specific data in lieu of pooled information, increased use of systematic sampling over simple random and opportunistic sampling, and decreased reliance on observer computations. In addition, studies suggest the risk of bias in the data would be reduced by changing from the current system, in which 30% coverage vessels can choose when and where to take observers, to a restructured observer deployment program in which NMFS is responsible for distributing observers among vessels using statistically robust methods.

At its October 2010 meeting, the NPFMC recommended restructuring the Observer Program so that NMFS could address issues of bias and other issues in the current deployment model (NPFMC 2010a). This flexibility would enable NMFS to explore and develop alternative observer sampling designs (including sample size analyses and optimization) and estimators of catch. The proposed new methods that incorporate random selection would also likely reduce bias introduced through an observer deployment effect as has been shown elsewhere (Benoit and Allard, 2009). Further, randomization of trip selection in the portion of the groundfish fleet that is not subject to full coverage will increase the statistical credibility of the catch estimates used to regulate the fisheries, and may decrease the bias that arises from non-representative spatial and temporal distribution of observed catch (relative to total catch; NMFS 2010a).

The ability for NMFS to assess the statistical reliability of CAS is hampered by the current non-random placement of observers on vessels less than 125 feet, unknown consequences of post-stratification of observer information in CAS, and unknown bias associated with imputation methods (Cahalan et al. 2010a). The restructured Observer Program will greatly enhance NMFS' ability to assess uncertainty associated with halibut bycatch estimates. In addition, NMFS and the Pacific State Marine Fisheries Commission are currently working to evaluate procedures used to estimate total catch and discard from Alaska's groundfish fisheries. Recently, an evaluation of the imputation methodology (Mondragon et al. 2010) and spatial analysis (Gasper et al. 2010) were prepared. The continued evaluation is expected to assess alternative estimators of total catch and bycatch as well as develop and incorporate statistically valid variance estimates.

Finally, evaluations of sampling methods used by the Observer Program to estimate catch have been conducted. These studies range from evaluations of sampling tools used such as motion compensated flow scales (Dorn et al. 1999), evaluation of haul weight estimation (e.g., Dorn et al. 1995, 1997), and evaluation of observer coverage levels (e.g., NPFMC 2010a). These studies, as well as those mentioned in preceding paragraphs, informed the development of current and future sampling protocols and provide information on the reliability of historic sampling methodology used by the Observer Program.

Summary of best management and monitoring practices

U.S. West Coast

As mentioned above, the PFMC's strategy relative to bycatch management is to gather data through a standardized total catch reporting methodology, use federal/state/tribal agency partners to assess these data through bycatch models, and develop and implement management measures that minimize bycatch, such as catch limits for target species and time and area closures. These management and monitoring practices have largely been successful, and the PFMC recognizes and supports the improved management and monitoring practices associated with its recently implemented trawl individual quota program, which includes bycatch limits and 100% observer coverage.

British Columbia

Individual accountability—A key ingredient

A key premise of the CGIP is the requirement for individual accountability for all catch. This guiding principle was the precursor to each of the management techniques that followed. The complexities of multi-species fisheries require a holistic approach to fisheries management. To achieve individual accountability in multi-species fisheries, accurate and defensible catch information must be obtained and a mechanism for harvesters to account for this catch must be provided. As such, a management system in a multi-species fishery such as the B.C. groundfish fishery, which requires individual accountability for all catch, benefits from the implementation of ITQs, transferability amongst and between license categories, and comprehensive at-sea and dockside monitoring. Each of these management techniques works in combination to achieve the principle of individual accountability. Individual accountability is a key ingredient for sustainable fisheries. Scott Wallace, a sustainable fisheries analyst for the David Suzuki Foundation, believes "the principles of full catch accountability and defensible catch limits are a prerequisite for any sustainable multi-species fishery" (S. Wallace, personal communication, February 2009). As such, multi-species fisheries aspiring to achieve "sustainability" status should consider including individual catch accountability as a founding principle.

Ecosystem-based approach to management and stakeholder involvement

An ecosystem approach requires fisheries management to take into consideration impacts on incidental catches, benthic habitat, and the larger ecosystem in which species reside. This ecosystem-based approach requires significant changes to the more traditional fisheries management techniques, which in turn requires active stakeholder participation in the development of an effective and efficient management regime.

The objectives put forward by DFO in 2003 could not have been achieved without affecting industry participants and, therefore, required the active involvement of industry in a meaningful manner. Fisheries wishing to move in the direction of an ecosystem-based approach to management must acknowledge that the approach extends beyond merely management changes to also include a strong co-management arrangement.

In 2003, DFO gave clear directions to industry regarding conservation concerns and what the minimal requirements were for the future. DFO then empowered stakeholders with the ability to develop their own solutions for consideration by the Minister of Fisheries and Oceans. The Minister still has the ultimate decision-making authority, but industry also has a meaningful role in the decision-making process. Of equal significance is that the Minister accepted industry's solutions in 2006 and continues to consider industry solutions on an ongoing basis as the program is modified in-season and over the longer term.

Despite the fact that prior to the CGIP there was a long history of industry groups not cooperating with each other and trying to convince DFO that their ideas were of greater merit

than those of competing industry groups, it was in the best interest of industry participants to collaborate and develop a plan that met their needs while satisfying the requirements of DFO. Moreover, the consensus process that was used by the advisory board now requires industry groups to convince each other or compromise if they want to affect change. With a significant stake in the design of the plan, industry had a greater incentive to collaborate to make it work. This process also helped to gain industry acceptance of the management changes. The development of co-management arrangements should include clear objectives, expectations, and true empowerment of the body to develop initial as well as ongoing recommendations for consideration.

Catch monitoring

Without adequate catch monitoring, an effective fisheries management plan to reduce incidental harvest of species is impossible. Individual accountability must be accompanied by 100% at-sea monitoring, otherwise the incentive to cheat the system will always exist and the individual incentive to report accurately will be diminished. Knowing that each harvester is equally monitored and the ability to cheat the system is eliminated, harvesters are provided with an incentive to fish more responsibly and are better able to take ownership of their fishing practices. As discussed in the monitoring section of this paper, data derived from management programs with at-sea monitoring below 100% should not be used to make management decisions. The data do not accurately reflect true removals and as such, do not allow a government agency to confidently state that current harvest levels are within sustainable limits. DFO's experience has shown that the only effective catch monitoring program is one that requires 100% at-sea monitoring either using electronic monitoring and an accompanying audit program or on-board observers.

Alaska

Catch accounting and monitoring

Accurate and timely estimates of bycatch in the groundfish fisheries have required implementation of a combination of robust monitoring tools, including high levels of observer coverage, technology (e.g., flow scales, vessel monitoring systems), regulations designed to improve catch estimates (e.g., observer station requirements and prohibition of pre-sorting of catch), and electronically reported industry data.

Catch share programs

Catch share programs have been used in U.S. federal fisheries since 1990 and now include 14 different programs managed by six different Councils, from Alaska to Florida (NOAA 2010). Catch share is a general term for fishery management strategies that allocate a specific portion of the total allowable fishery catch to individuals, cooperatives, communities, or other entities. Catch share programs are an important component of NOAA's comprehensive national ocean policy (NOAA 2010). This policy encourages well-designed CSPs to help maintain fisheries, while recognizing they may not be the best management option for every fishery or sector. Care must be exercised in the design and monitoring phases to ensure that discards are adequately monitored and that the program components are appropriate for the fishery.

The BSAI Amendment 80 and GOA Amendments 68 and 88 rockfish CSPs have both demonstrated a reduction in halibut discards since their inception. Cooperatives formed under these programs have experienced decreased discards as fishermen are able to become more selective and redirect their effort away from areas of bycatch to avoid prohibited and non-target species. Further, these programs both resulted in increased monitoring requirements to facilitate accurate and timely accounting for enforcement and quota monitoring. Catch and bycatch monitoring issues have been addressed through high levels of observer coverage (all

trips observed), technology (e.g., flow scales), sampling protocol, and regulations designed to improve estimates (e.g., observer station requirements and prohibition on pre-sorting of catch).

Gear modifications

The NPFMC and NMFS, through industry partnerships, have pursued methods of reducing halibut bycatch using gear modifications. These efforts are consistent with the NMFS policy directive (January 11, 2008) that established the Bycatch Reduction Engineering Program (BREP). The mission of the BREP is to develop technological solutions and investigate changes in fishing practices designed to minimize bycatch and mortality (including post-release injury and mortality).

In 2009, BREP funded research through the Alaska Fishery Science Center to work with the Bering Sea bottom trawl fleet to develop and improve devices for trawl selectivity. This funding built upon previous partnerships between industry, NPFMC, and NMFS to develop gear that excludes Pacific halibut (Gauvin 2008). The project's primary fieldwork tested flexible grid excluders just ahead of trawl codends in the Bering Sea flathead sole fishery. The most effective of these designs excluded approximately 65% of the halibut with a loss of 20% of the target flatfish (NOAA 2009).

Ongoing research activity continues to develop and improve bycatch reduction devices (BRDs), which improves the selectivity of trawls in Alaska's groundfish fisheries and facilitates BRD application in the fishery. The long-term goal is to create a diverse and flexible toolbox of devices and make the fleet familiar with their applicability to a range of bycatch situations. The greatest advance in 2008 was a greatly increased routine use of these BRDs, motivated by management changes and fleet cooperation (NOAA 2009).

Careful handling of halibut

Crucifiers, or hook strippers, speed up the process of removing hooks by stopping the fish while allowing the H&L gear to proceed, thereby tearing the hook out of the fish's mouth. Crucifiers are mounted near the roller on H&L vessels and consist of a pair of parallel bars spaced just far enough apart to allow gangions and hooks to pass, but not hooked fish. This technique increases mortality of undersized fish compared to careful release techniques. Increasing the mortality has the effect of decreasing the commercial catch limits. Circle hooks have greatly increased the efficiency of longlining and shift the selectivity towards legal sized fish (Crutchfield and Zellner 2003).

Hook strippers were illegal aboard halibut vessels prior to the implementation of the IFQ program in 1995. Their use was reinstated after the NPFMC adopted the IFQ program for halibut. At that time, the focus of the regulations shifted from prohibiting the gear to prohibiting the effects of the gear, i.e., damaging jaws. The use of hook strippers started on the bigger vessels fishing sablefish, as they were very handy for the close-spaced gear commonly used in that fishery. In the preparatory work for implementing the IFQ program, a multiagency group that worked on harmonizing the regulations for halibut and sablefish resolved the inconsistency by recommending that IPHC drop the prohibition and instead prohibit the injuries caused by hook strippers. Currently, the North Pacific H&L fisheries have specific careful release handling techniques for Pacific halibut that are defined in regulation (CFR 679.7):

(1) All halibut that are caught and are not retained shall be immediately released outboard of the roller and returned to the sea with a minimum of injury by
- *(a) hook straightening;*
- *(b) cutting the gangion near the hook; or*
- *(c) carefully removing the hook by twisting it from the halibut with a gaff.*

(2) Except that paragraph (1) shall not prohibit the possession of halibut on board a vessel that has been brought aboard to be measured to determine if the minimum size limit of the halibut is met and, if sublegal-sized, is promptly returned to the sea with a minimum of injury.

Summary of planned changes to management and monitoring practices

U.S. West Coast

In 2010, the PFMC adopted Amendments 20 and 21, which established a trawl individual quota (TIQ) program and set allocations for most target species and some overfished rockfish species between the trawl and non-trawl fishing sectors. The TIQ program began in January 2011, and includes individual bycatch quotas for halibut.

The trawl sector is held to an overall annual quota of 15% of the Area 2A Total Catch Exploitation Yield (TCEY) as identified in the most recent stock assessment, up to a maximum limit of 130,000 pounds (legal-sized or O32, dressed weight) for the first four years of the program (2011-2014). Beginning in 2015, this maximum limit will be reduced to 100,000 pounds (legal-sized or O32, dressed weight). The TCEY percentage can be adjusted through the PFMC's biennial management process, but the overall maximum limit can only be changed through a fishery management plan amendment process. A portion of the trawl quota is set aside to cover catches occurring in the at-sea midwater trawl whiting (hake) fishery, and the bottom trawl fishery occurring south of Cape Mendocino, California (40°10' N. latitude). The remaining trawl quota is allocated to individuals. The fishery has 100% at-sea observer coverage, and 100% dockside monitoring. Observers record the number and length of halibut, and note disposition of released halibut to determine discard mortality on an individual basis. The mortality of all halibut, regardless of size, counts against the individual's bycatch quota.

British Columbia

The current management and monitoring programs within British Columbia are reviewed annually through the Integrated Fisheries Management Plan. Recommended changes put forward by stakeholders or other interested parties are discussed through the advisory process, and if changes are made they are included in the IFMP for the following year. This process allows for an adaptive management approach to fisheries management and is consistent with Canada's Sustainable Fisheries Framework. Given the comprehensive nature of the CGIP, including the monitoring programs in the groundfish trawl and H&L fisheries, additional significant management and monitoring changes are not anticipated.

Alaska

Restructuring of the North Pacific Groundfish Observer Program

The current levels of observer coverage for vessels in the federal groundfish observer program in Alaska are structured by vessel size. As such, groundfish vessels less than 60 feet length overall (LOA) are not required to carry observers; vessels 60–125 feet LOA are required to carry and pay for their own observers for 30% of their fishing days, regardless of gear type or target fishery; and vessels greater than 125 feet LOA are required to carry observers 100% of the time. Vessels in the 30% coverage category select when to carry observers and are constrained in this self-selection by regulatory requirements for quarterly coverage levels. The two size categories with less than 100% observer coverage comprise the majority of vessels fishing in the GOA and out of ports other than Dutch Harbor and Akutan in the BSAI.

Observers estimate total catch for a portion of hauls or sets, and sample hauls or sets for species composition, including prohibited species. These data are extrapolated in the CAS to make estimates of total halibut bycatch on both observed and unobserved vessels. Observer data are assumed to be representative of the activity of all vessels and are used to estimate total halibut bycatch. The ratio estimator is derived from a set of covariates that match both observer and groundfish landing/production information. A detailed description of this process is presented in Cahalan et al. (2010a).

Regulations governing observer deployment (in particular, observer coverage requirements) introduce the potential for bias in observer data by using a non-random deployment model that may facilitate non-representative fishing. Given the use of observer data in CAS, and the subsequent use of CAS estimation in stock assessments and quota management, this issue can undermine the data used to manage halibut bycatch (among other species) in the North Pacific groundfish fisheries. In response to these issues, the NPFMC took action at its October 2010 meeting to restructure the observer program to address multiple issues, including bias (NPFMC 2010a). The preferred alternative provides NMFS with flexibility to place observers onboard vessels using accepted statistical practices so that coverage gaps and vessel-trip selection bias is addressed.

The preferred alternative is likely to influence estimation primarily in sectors currently with 30% or less coverage. Past analytical examinations of the NPGOP have dealt with such issues as sampling protocols, reducing bias, estimate expansion, and the statistical properties of estimates (e.g., Jensen et al. 2000, Volstad et al. 1997, Pennington 1996, Pennington and Volstad 1994). These and other studies suggest bias is likely to be reduced by changing from the current system, in which 30% coverage vessels can choose when and where to take observers, to a new system in which NMFS is responsible for distributing observers among vessels using statistically robust methods. Restructuring will also allow NMFS to place observers on halibut IFQ vessels, which were previously unobserved. This will provide information on bycatch that can be used to augment the current IFQ logbook program.

Areas for improvement and recommendations

U.S. West Coast

One major area of concern for the PFMC over the years has been the management of bycatch, particularly for overfished, non-target species. The PFMC has been focused on minimizing bycatch through the use of trip limits and time/area restrictions, and also developing rebuilding plans for overfished rockfish. Prior to 2011, when the trawl fisheries were managed as open access, total catch accounting for target species and bycatch had been difficult to achieve due to a limited amount of monitoring at-sea. However, with the PFMC's trawl IQ program, which includes 100% at-sea observer coverage, there is individual accountability for catch, including overfished species and halibut. Total catch is estimated substantially better than before, and bycatch reduction is being achieved through setting lower catch levels for the IFQ program. The PFMC has achieved much needed improvement in its fisheries through the IQ program. Further improvement is anticipated, as stakeholders become experienced at operating within the parameters of the IQ program.

British Columbia

The CGIP continues to be improved with input from stakeholders to improve its accuracy and efficiency while maintaining adherence to its founding principles. The CGIP is the first step in a more ecosystem-based approach to groundfish fisheries management with respect to the impact on incidental catches, but more work is required to address the other aspects of ecosystem-based management. Government and industry will continue to collaborate to meet DFO's objectives for ecosystem-based management.

Alaska

Estimation and management have improved greatly since halibut PSC limits were initially established. These improvements have built upon support from the NPFMC and industry in reducing halibut bycatch mortality. Work continues on the part of the NPFMC, industry, and NMFS to improve estimation and reduce bycatch in the groundfish fisheries. Areas of focus include:

1. Providing statistically robust estimates of halibut PSC through a new observer deployment model that allows NMFS to deploy observers. The regulations and detailed deployment are currently in development.
2. The NMFS Alaska Regional Office continues work on evaluating and improving estimation methods, evaluating the quality of data, and ensuring data is available to managers and researchers.
3. Assessing the feasibility of electronic monitoring (EM) to augment observer information is an important area of research. The 2006 reauthorization of the MSA included changes to Section 313(b)(2), allowing for fees collected under this section to be used for EM systems. This language appears to anticipate the future potential of electronic monitoring technologies as part of a comprehensive monitoring plan in the North Pacific.
4. Continued work by NMFS, NPFMC, and industry to develop innovative methods to reduce bycatch through gear modification and careful handling of halibut. Through the use of Exempted Fishing Permits, the trawl industry in particular has been active with the development and testing of trawl modifications and evaluating handling mortality of Pacific halibut.
5. Proposed reductions to GOA groundfish fishery halibut PSC limits. Since December 2009, the NPFMC has reviewed several discussion papers to scope the need to reduce halibut PSC and potential management solutions in the GOA and the BSAI. In April 2011, the NPFMC proposed alternatives for analysis to reduce GOA halibut PSC limits. Any adopted reductions are intended to be in place in 2013. Specific reductions for analysis are 5, 10, or 15% for trawl and fixed gear fisheries. In addition, suboptions include (a) applying a trawl reduction to a specific time period during the year, and (b) revising the manner in which the reductions in trawl PSC limits are applied to certain trawl fishery sectors.
6. The NPFMC has not set a timeline for revising BSAI halibut PSC limits but has stated its intent to scope the issue.

Summary

Progress on 1992 objectives

HBWG II was reconvened in 2010 by the Commission to review the progress by the contracting parties towards the 1992 objectives for improving and expanding bycatch control measures. In addition, the Commission requested that the national bycatch monitoring programs be reviewed to evaluate the reliability of bycatch estimates.

The HBWG II noted that much progress has been made towards the 1992 objectives in all jurisdictions.

Formal estimation of bycatch mortality in the U.S. West Coast trawl fishery began in 1998, initially by IPHC and subsequently by NMFS. Estimations have evolved from being based on research fishing catch rates to being derived from observer data beginning in 2003. The adoption of a multi-species individual quota program for the bottom trawl fishery in 2011 included an individual vessel bycatch quota program for halibut bycatch and 100% fishery monitoring.

The initial allocation started at levels of less than 50% of the previous year, representing an improvement in halibut bycatch monitoring and management. The closure of some areas to commercial fishing for the protection of certain overfished species has also likely reduced halibut bycatch as well.

Objectives for Canadian fisheries sought to increase monitoring, examine survival rates, and implement control and reduction measures. Management and reduction of halibut bycatch in Canadian fisheries has been achieved by the implementation of several programs. A substantial reduction was achieved with the introduction in 1997 of a multi-species individual transferable quota program for the bottom trawl fishery. The program also included a requirement for 100% observer monitoring; electronic monitoring was added later. More recently, the addition of the CGIP in 2006, which expanded the ITQ program to include all groundfish fisheries and gears, served to increase the monitoring of total removals of managed species. Estimates of halibut bycatch mortality are now based on data collected by fishery observers, instead of assumed discard mortality rates as had been the case previously. These programs have served to improve the accuracy of the estimates of bycatch, and to substantially reduce the number killed.

Objectives for U.S. groundfish fisheries off Alaska looked to expand halibut bycatch management to a fuller, comprehensive approach. Reductions to bycatch were also recommended through a series of 10% annual reductions of the limits, although no specific target was noted. It was also recommended to revise the accounting of bycatch from BSAI trawl fisheries to mortality amounts based on current observer data. Major progress has been made on most, but not all of these, however. In 1992, BSAI FMP Amendment 19 and GOA FMP Amendment 24 introduced several management additions and changes, which included a PSC limit for fixed gear fisheries, an expansion of the Vessel Incentive Program, and provided authority to enact seasonal and area closures to reduce bycatch rates. BSAI Amendment 19 also reduced the trawl fishery PSC limit from 5,333 mt to 5,033 mt, however the limit was not revised to mortality until 1993, when an equivalent PSC limit of 3,775 mt of mortality was adopted. Subsequent action in 1999 reduced the BSAI trawl fishery PSC limit 3,675 mt, when only pelagic trawls were allowed in the pollock fishery. While other regulations were adopted that had some indirect or minor effect on halibut bycatch, the most significant were those that allowed for the formation of fishery cooperatives (BSAI Amendment 80; GOA Amendments 68 and 88). The BSAI amendment also reduced the amount of the PSC limit allocated to the trawl fishery, to 3,475 mt by 2012. Although the PSC limit was not reduced by this latest action, the 300 mt which has been not been allocated by the two actions reflects a 7.9% reduction. The other primary management tool identified by the 1992 objectives was the VIP, but it proved to be of questionable effectiveness and costly to NMFS. Following a review, the program was repealed by the NPFMC in 2006 and removed from regulation in 2008.

Bycatch monitoring programs and bycatch estimates

Since 2003, U.S. West Coast groundfish fisheries have been monitored by an at-sea observer program. Coverage levels ranged from 20-30% for bottom trawl, H&L, and pot fisheries, and 100% for the at-sea whiting fishery. Although coverage was mandatory regardless of vessel length, in practice, actual coverage levels were very sparse for some sectors, and average bycatch rates were determined from comparable fisheries to estimate total halibut bycatch. Consequently, bycatch estimates were probably not biased, but levels of variance were unknown. Regular reports prepared by NMFS were reviewed by the PFMC and its advisory bodies. Additional independent evaluations of data collected by monitoring programs were also conducted. Beginning in 2011, observer coverage jumped to 100% in support of the multi-species groundfish trawl fishery IQ program. Accuracy of bycatch estimates is expected to be much greater as a consequence, as all halibut brought on board will be available for sampling to ensure proper accounting.

Monitoring of B.C. fisheries is very comprehensive. The goals of reduced discard and waste, improved information on removals, cleaner fishing, and individual accountability required a much higher level of monitoring than had previously been required. Introduction of the trawl ITQ program in the 1990s was accompanied by a 100% observer coverage requirement. This high level of monitoring was continued with the broader 2006 ITQ program for all groundfish fisheries, and it has enabled better accounting of removals, including halibut bycatch from all sources. Additional reporting and transferability programs have led to reduced halibut bycatch and improved tracking of what is taken. Consequently, halibut bycatch estimates for the B.C. bottom trawl fishery are extremely accurate.

Bycatch monitoring in federal fisheries off Alaska is accomplished primarily by the North Pacific Groundfish Observer Program using human observers. The current program is based on coverage requirements developed in the early 1990s by the NPFMC. Observer sampling protocols have been evaluated in several studies. These have led to redesigns of sampling plans and collections protocols. Additionally, more recent studies have suggested the potential for bias in the data could be reduced with fundamental changes in observer deployment. In late 2010, the NPFMC adopted structural changes to the deployment plan to address this issue, as well as other operational changes to the program. Although not expected to be implemented until 2013, the deployment changes should provide NMFS with the ability to evaluate the statistical reliability of the CAS, including being able to assess the uncertainty of the estimates of bycatch. The proposed changes also provide monitoring for fisheries previously unobserved, which will improve knowledge about the overall level of halibut bycatch.

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Appendix

Part I. Summary of monitoring programs for 2009.

Part II. Pacific halibut sampling protocols currently used by WCGOP and changes implemented for the West Coast trawl individual quota program.

Part III. Estimates (thousands of pounds, net weight and metric tons, round weight) of bycatch mortality of Pacific halibut (*Hippoglossus stenolepis*) from all sources by IPHC regulatory area for 1962 through 2010.

Part I. Summary of monitoring programs in 2009.

A. IPHC Area 2A

Fishery	Vessel length class	Halibut bycatch estimate (lbs)[1]	Source of bycatch estimate	Total number of trips	Number of trips observed	Total number of tows	Number of tows observed
Bottom trawl groundfish	N/A	553,355	At-sea observer and logbook	N/A	692	85,047 (tow hrs)	19,542 tow hrs (23%)
Limited entry fixed gear sablefish primary	N/A	109,490	At-sea observer	N/A	74	N/A	354 sets (8.7%)
Limited entry fixed gear sablefish non-primary	N/A	83	At-sea observer	N/A	138	N/A	271 sets
Open access fixed gear	N/A	14,115	At-sea observer	N/A	98	N/A	146 sets
Nearshore fixed gear	N/A	2,862	At-sea observer	N/A	N/A	N/A	219 sets (6.2% of target species landed) in OR; 122 sets (2.6% of target species landed) in CA
Pink shrimp trawl	N/A	0	At-sea observer	N/A	N/A	N/A	695 (6% of landings)
California halibut trawl	N/A	0	At-sea observer	N/A	N/A	N/A	29 (6%) limited entry; 30 (0.7% of landings) open access

Part I. Summary of monitoring programs for 2009 (cont'd).

B. IPHC Area 2B

Fishery	Vessel length class	Halibut bycatch estimate (lbs)[1]	Source of by-catch estimate	Total number of trips[5]	Number of trips observed[5]	Total number of tows[5]	Number of fishing events observed
Halibut	N/A	Directed catch: 6,121,372 ± 0	At-sea observer/ EM, DMP, Log-book	496	496	7,977	100% are observed w/ EM or observer, 10% are audited if EM used
Sablefish	N/A	72,164 ± 0	At-sea observer/ EM, DMP, Log-book	52	52	6,106	100% are observed w/ EM or observer, 10% are audited if EM used
Halibut & Sablefish	N/A	Reported in "Halibut" and "Sablefish" fisheries	At-sea observer/ EM, DMP, Log-book	80	80	2,065	100% are observed w/ EM or observer, 10% are audited if EM used
Rockfish Inside	N/A	483 ± 0	At-sea observer/ EM, DMP, Log-book	60	60	782	100% are observed w/ EM or observer, 10% are audited if EM used
Rockfish Outside	N/A	138,975 ± 0	At-sea observer/ EM, DMP, Log-book	246	246	3,838	100% are observed w/ EM or observer, 10% are audited if EM used
Lingcod	N/A	10,890 ± 0	At-sea observer/ EM, DMP, Log-book	190	190	2,353	100% are observed w/ EM or observer, 10% are audited if EM used
Dogfish	N/A	203,487 ± 0	At-sea observer/ EM, DMP, Log-book	212	212	3,346	100% are observed w/ EM or observer, 10% are audited if EM used
Trawl	N/A	278,069 ± 0	At-sea observer/ EM, DMP, Log-book	1,586	1,586	15,827	100% are observed

Part I. Summary of monitoring programs for 2009 (cont'd).

C. IPHC Areas 2C, 3A and 3B

Fishery[2]	Vessel length class	Halibut bycatch estimate (lb)[1]	Source of by-catch estimate	Total number of trips[3]	Number of trips observed	Total num-ber of tows	Number of tows observed
Trawl CP Pacific cod	NA	56,960	CAS	7	7	NA	NA
Trawl CP Rockfish	NA	135,658	CAS	41	41	NA	NA
Trawl CP other	NA	849,396	CAS	70	59	NA	NA
Trawl CV Pollock	NA	82,967	CAS	450	254	NA	NA
Trawl CV Pacific cod	NA	579,762	CAS	267	100	NA	NA
Trawl CV Rockfish	NA	24,395	CAS	113	101	NA	NA
Trawl CV other	NA	2,301,846	CAS	509	342	NA	NA
GOA pot and jig[4]	NA	15,048	CAS	1,472	29	NA	NA
GOA non-IFQ H&L	NA	626,447	CAS	789	163	NA	NA

Part I. Summary of monitoring programs for 2009 (cont'd).

D. IPHC Area 4

Fishery[2]	Vessel length class	Halibut bycatch estimate (lb)[1]	Source of bycatch estimate	Total number of trips[3]	Number of trips observed	Total number of tows	Number of tows observed
Trawl CP/M pollock	NA	727,292	CAS	312	312	NA	NA
Trawl CP/M Pacific cod	NA	180,426	CAS	33	32	NA	NA
Trawl CP/M Atka mackerel	NA	158,565	CAS	112	112	NA	NA
Trawl CP other	NA	4,620,129	CAS	582	582	NA	NA
Trawl CV pollock	NA	284,553	CAS	1,450	1,430	NA	NA
Trawl CV Pacific cod	NA	389,081	CAS	361	323	NA	NA
Trawl CV other	NA	4,344	CAS	9	9	NA	NA
BSAI Pot and jig gear[4]	NA	3,603	CAS	1,034	114	NA	NA
BSAI non-IFQ H&L	NA	1,533,904	CAS	1,090	871	NA	NA

[1] Bycatch estimates include both the total caught and released mortality.

[2] Fishery definitions can be ambiguous due to difficulty in determining a target species in multi-species fisheries. For example, Pacific cod may be retained in the "other trawl target", which in the GOA is primarily composed of deep and shallow water flatfish "fisheries." Estimates were made based on the predominant species in the catch.

[3] A trip is defined for catcher processors (CPs) as a week (Sunday-Saturday) and for catcher vessels (CVs) as the time period between when fishing started and landing.

[4] Trip total is the sum of jig and pot gear trips. Halibut bycatch is not estimated for jig gear due to lack of observer coverage.

[5] For 2009/10 fishing season, from February 21, 2009 to February 20, 2010.

Part II. Pacific halibut sampling protocols currently used by West Coast Groundfish Observer Program and changes implemented for the West Coast Trawl Individual Quota Program.

This information has been supplied to Washington Department of Fish and Wildlife by the Northwest Fisheries Science Center for use in understanding how Pacific halibut are sampled by the West Coast Groundfish Observer Program. Any questions should be directed to Janell Majewski, Northwest Fisheries Science Center, at (206) 860-3293.

TRAWL VESSELS

2001 – 2010 Pacific Halibut Sampling Protocols On Trawl Vessels

Observers visually estimate the length of each halibut in their sample in 10 centimeter blocks (55-64, 65-74, etc.). That length is converted to pounds using the length/weight conversion table created by the International Pacific Halibut Commission (IPHC). Observers also take a random subsample of five (5) individuals for biological sampling. Biological sampling includes measuring and assessing the condition of the halibut based on criteria developed by the IPHC.

2011 Pacific Halibut Sampling Protocols On Non-IFQ Trawl Vessels

Observers will use the same methodology described above.

2011 Pacific Halibut Sampling Protocols On IFQ Trawl Vessels

Observers will count every halibut in a trawl haul. Depending on quantity of halibut in the haul, observers will either biologically sample all halibut or take a random subsample. Biological sampling will include measuring and assessing the condition of the halibut based on criteria developed by the IPHC.

The biological data will be used to determine the total weight of halibut and the estimated Pacific halibut mortality in the haul.

HOOK-AND-LINE VESSELS

2001 – 2010 Pacific Halibut Sampling Protocols On Hook-And-Line Vessels

When a Pacific halibut is caught while a set is being sampled, the observer visually estimates its length in 10 centimeter blocks (55-64, 65-74, etc). That length is converted to pounds using the length/weight conversion table created by the International Pacific Halibut Commission (IPHC).

No viabilities are taken from Pacific halibut on H&L vessels as the normal handling of the crew is to release the fish without bringing them on board.

2011 Pacific Halibut Sampling Protocols On IFQ Hook-And-Line Vessels

Observers will use the same methodology described above.

2011 Pacific Halibut Sampling Protocols On Non-IFQ Hook-And-Line Vessels

When a Pacific halibut is caught while a set is being sampled, the observer visually estimates its length in 10 centimeter blocks (55-64, 65-74, etc). That length is converted to pounds using the length/weight conversion table created by the International Pacific Halibut Commission (IPHC).

Observers also take a random subsample of five (5) individuals for biological sampling. Biological sampling includes measuring and assessing the condition of the halibut based on criteria developed by the IPHC.

POT VESSELS

2001 – 2010 Pacific Halibut Sampling Protocols On Pot Vessels

When a Pacific halibut is caught while a set is being sampled, the observer visually estimates its length in 10 centimeter blocks (55-64, 65-74, etc.). That length is converted to pounds using a length/weight conversion table created by the International Pacific Halibut Commission (IPHC).

Only a few biological samples have been taken from Pacific halibut on pot vessels primarily due to the low number of pot vessels that operate on the west coast and the low number of halibut caught by pot vessels.

Pacific Halibut Sampling Protocols On IFQ Pot Vessels

Observers will count every halibut in a sampled pot. Depending on quantity of halibut in the haul, observers will either biologically sample all halibut or take a random subsample. Biological sampling will include measuring and assessing the condition of the halibut based on criteria developed by the IPHC.

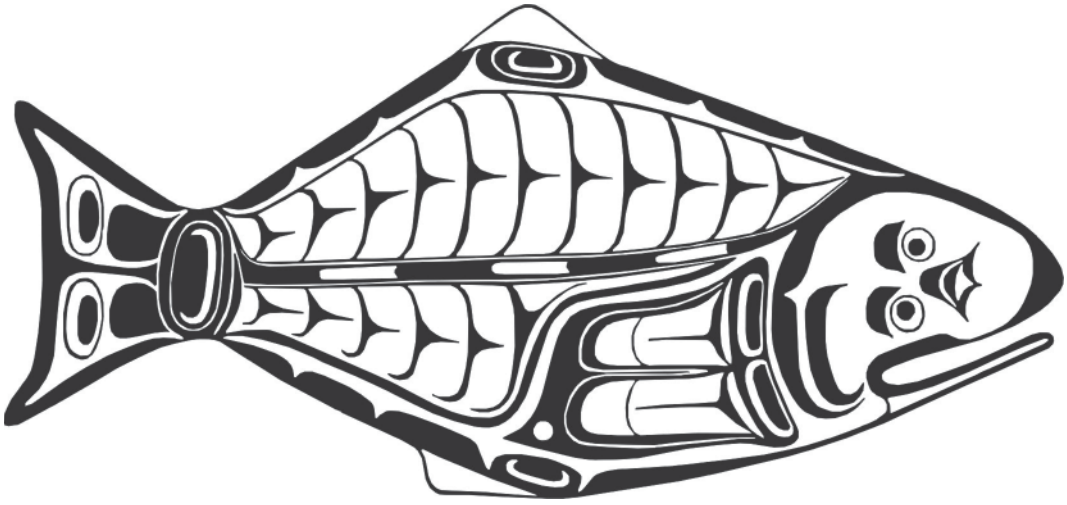
The biological data will be used to determine the total weight of halibut and the estimated Pacific halibut mortality in the haul.

Part III. Estimates (thousands of pounds, net weight and metric tons, round weight) of bycatch mortality of Pacific halibut (*Hippoglossus stenolepis*) from all sources by IPHC regulatory area for 1962 through 2010. Estimates for 2010 are preliminary and subject to change as new information becomes available. Source: Williams (2011).

	Thousands of pounds, net weight							*Metric tons, round weight*						
Year	Area 2A	Area 2B	Area 2C	Area 3A	Area 3B	Area 4	Total	Area 2A	Area 2B	Area 2C	Area 3A	Area 3B	Area 4	Total
1962	-	1,176	207	1,919	1,164	4,143	8,609	-	709	125	1,157	702	2,499	5,192
1963	-	1,077	206	3,314	2,788	2,038	9,423	-	649	124	1,999	1,682	1,229	5,683
1964	-	1,105	205	9,370	2,269	2,965	15,914	-	667	124	5,652	1,369	1,788	9,599
1965	-	1,435	205	6,097	10,442	3,182	21,361	-	866	124	3,678	6,298	1,919	12,884
1966	-	1,666	213	4,513	7,982	3,400	17,774	-	1,005	128	2,722	4,815	2,051	10,721
1967	-	1,652	439	4,633	4,895	4,718	16,337	-	996	265	2,795	2,953	2,846	9,854
1968	-	1,963	515	5,476	1,577	5,685	15,216	-	1,184	311	3,303	951	3,429	9,178
1969	-	2,183	468	3,806	1,174	7,599	15,230	-	1,317	282	2,296	708	4,584	9,186
1970	-	1,470	562	3,389	2,841	8,028	16,290	-	886	339	2,044	1,714	4,842	9,825
1971	-	1,745	539	2,974	1,367	13,095	19,720	-	1,052	325	1,794	825	7,899	11,894
1972	-	1,750	756	5,406	1,693	9,675	19,280	-	1,056	456	3,261	1,021	5,836	11,629
1973	-	1,509	848	4,452	2,695	8,029	17,533	-	910	511	2,685	1,626	4,843	10,575
1974	477	1,729	532	5,247	3,420	7,620	19,025	288	1,043	321	3,165	2,063	4,596	11,475
1975	477	1,909	639	3,158	2,073	3,650	11,906	288	1,151	385	1,905	1,250	2,202	7,181
1976	477	2,064	708	3,495	2,443	4,564	13,751	288	1,245	427	2,108	1,474	2,753	8,294
1977	477	1,817	580	4,094	1,894	2,914	11,776	288	1,096	350	2,469	1,142	1,758	7,103
1978	477	1,471	377	3,055	1,840	5,023	12,242	288	887	227	1,843	1,110	3,029	7,384
1979	476	1,852	821	5,780	935	5,419	15,282	287	1,117	495	3,486	564	3,269	9,218
1980	476	1,372	520	5,852	1,246	9,235	18,702	287	828	314	3,530	752	5,570	11,280
1981	475	1,188	507	4,720	1,563	6,408	14,859	287	716	306	2,847	942	3,865	8,963
1982	475	867	302	3,797	2,175	4,756	12,373	287	523	182	2,290	1,312	2,869	7,463
1983	476	943	304	2,957	1,935	4,269	10,883	287	568	183	1,784	1,167	2,575	6,564
1984	475	1,074	302	2,140	1,507	4,692	10,189	287	648	182	1,290	909	2,830	6,146
1985	475	1,139	301	1,001	577	4,207	7,700	287	687	182	604	348	2,538	4,644

Part III. continued

1986	476	1,161	303	836	410	5,576	8,762	287	700	183	504	247	3,363	5,285
1987	476	1,649	303	2,240	873	5,738	11,279	287	995	183	1,351	527	3,461	6,803
1988	477	1,609	303	3,365	50	8,858	14,662	288	971	183	2,030	30	5,343	8,844
1989	477	1,498	303	3,267	818	7,282	13,646	288	904	183	1,971	494	4,393	8,231
1990	408	1,679	856	4,114	2,045	8,580	17,682	246	1,013	516	2,481	1,233	5,175	10,665
1991	408	1,992	733	4,843	1,671	10,022	19,669	246	1,202	442	2,921	1,008	6,045	11,864
1992	444	1,745	736	4,668	1,982	10,718	20,293	268	1,053	444	2,816	1,195	6,465	12,240
1993	444	1,661	742	4,291	1,062	7,764	15,964	268	1,002	448	2,588	641	4,683	9,629
1994	444	1,219	528	3,907	1,387	9,466	16,951	268	735	318	2,357	837	5,710	10,224
1995	614	1,522	348	2,963	1,760	8,726	15,933	370	918	210	1,787	1,062	5,263	9,610
1996	614	299	345	2,743	1,957	8,507	14,465	370	180	208	1,655	1,180	5,131	8,725
1997	614	215	397	2,965	1,443	7,880	13,514	370	130	239	1,788	870	4,753	8,151
1998	1,082	213	361	2,662	1,389	7,725	13,432	653	128	218	1,606	838	4,660	8,102
1999	987	193	358	2,885	1,737	7,684	13,844	595	116	216	1,740	1,048	4,635	8,350
2000	822	230	395	2,892	1,510	7,441	13,290	496	139	238	1,744	911	4,488	8,016
2001	837	177	341	3,009	1,675	7,120	13,159	505	107	206	1,815	1,010	4,295	7,937
2002	635	244	340	2,194	1,924	7,273	12,610	383	147	205	1,323	1,161	4,387	7,606
2003	260	244	341	3,180	1,734	6,822	12,581	157	147	206	1,918	1,046	4,115	7,589
2004	286	251	362	3,671	1,274	6,735	12,579	173	151	218	2,214	768	4,062	7,587
2005	537	346	340	3,220	1,126	7,692	13,261	324	209	205	1,942	679	4,640	7,999
2006	578	294	341	2,975	1,400	7,491	13,079	349	177	206	1,794	844	4,518	7,889
2007	387	320	342	2,843	1,115	7,262	12,269	233	193	206	1,715	673	4,380	7,400
2008	422	143	346	3,066	1,353	6,555	11,885	255	86	209	1,849	816	3,954	7,169
2009	509	213	344	2,722	1,294	6,297	11,378	307	128	207	1,642	780	3,798	6,863
2010	509	213	341	2,663	1,226	5,591	10,543	307	128	206	1,606	740	3,372	6,359



Halibut Crest - adapted from designs used by Tlingit, Tsimshian and Haida Indians