

Support Document for the Application for an Exempted Fishing Permit to Test a Salmon Excluder Device for Pollock Trawls

Introduction

Chinook salmon *Oncorhynchus tshawytscha* and chum salmon *O. keta* are caught incidentally in Alaska groundfish fisheries, primarily in the walleye pollock *Theragra chalcogramma* trawl fishery. From 1990-2002, an average of 37,795 Chinook salmon and 69,680 other salmon species (> 95% are chum salmon) were incidentally caught annually in Bering Sea and Aleutian Islands groundfish trawl fisheries (Table 1). Bycatch is primarily juvenile salmon that are one or two years away from returning to the river of origin as adults.

BYCATCH OF PACIFIC SALMON IN ALASKA GROUND FISH TRAWL FISHERIES

Bering Sea and Aleutian Islands Area

Year	Numbers of Fish	
	Chinook	Chum
1990	14,085	16,202
1991	48,873	29,706
1992	41,955	40,090
1993	45,964	242,895
1994	44,380	95,978
1995	23,079	20,901
1996	63,205	77,771
1997	50,218	67,349
1998	58,966	69,237
1999	14,586	47,204
2000	8,219	59,306
2001	40,303	60,460
2002	37,507	78,739
Average	37,795	69,680

Source: NMFS Alaska Region website

Pacific salmon support large commercial, recreational, and subsistence fisheries throughout Alaska. Over the last four years, Chinook and chum salmon runs in western Alaska have been at relatively low levels compared to runs observed over the last 20 years. Although these reduced salmon runs appear to be attributable to changes in ocean conditions (Hare and Francis 1995; Kruse 1998), considerable public concern has been raised as to the effect of low salmon returns on fishery dependent communities in western Alaska. Responding to the crisis in the salmon industry, the Governor of Alaska has declared a state emergency on several occasions over the last four years. In response to the Governor's concerns, the North Pacific Fishery Management Council (NPFMC) has

reviewed on several occasions the bycatch management measures in place to reduce salmon bycatch to the extent practicable, as required by the Sustainable Fisheries Act of 1996.

In 2002, the North Pacific Fishery Management Council reviewed a retrospective analysis of salmon bycatch trends and estimated effects of Alaska groundfish trawl fisheries on salmon returns in Alaska (Witherell et al 2002). This evaluation of the possible bycatch effects concluded that bycatch in groundfish fisheries reduced western Alaska Chinook salmon runs by less than 2.7%. Estimated effects were derived by evaluating numbers of bycaught salmon at age and factoring effects of natural mortality (that would have been expected to occur). Salmon taken incidentally in these fisheries are known to originate from Alaska and Pacific northwest runs, as well as Asia and Russia. While this is clearly a small percentage effect on fish bound for Alaskan river systems, the effect is nonetheless considered to be slightly greater than the estimated effect of Alaskan groundfish fisheries on other prohibited species in federal waters fisheries off Alaska, such species as Pacific halibut and several species of king and tanner crabs (Witherell et al. 2002)

Existing Fishery Management Bycatch Reduction Measures

Salmon are listed as a prohibited species in the groundfish fishery management plans, meaning that they cannot be retained and sold. Regulations implemented in 1994 prohibited the discard of salmon taken as bycatch in BSAI groundfish trawl fisheries until the number of salmon has been determined by a NMFS certified observer. Subsequent regulations allowed for voluntary retention and processing of salmon for donation to foodbanks.

Bycatch of Chinook salmon in Alaska groundfish fisheries is generally higher in the winter and chum salmon bycatch is higher in the summer although this trend is not without exceptions. Based on this seasonal pattern, the North Pacific Fishery Management Council has adopted extensive seasonal cap and closure measures to control bycatch of salmon in trawl fisheries (Witherell and Pautzke 1997). Regulations establish closures for several areas with historically high bycatch of salmon if the seasonal cap (number) of salmon is taken as bycatch. Beginning in 1994, the Chum Salmon Savings Area has been closed to all trawling from August 1 through August 31. Additionally, the area re-closes after August 31 if a bycatch threshold limit of 42,000 chum salmon is caught incidentally in the southeastern part of the Bering Sea between August 15 to October 14.

From 1996 through 1999, regulations were in place to prohibit trawling in the Chinook Salmon Savings Areas through April 15 if and when a bycatch limit of 48,000 Chinook salmon was attained in the BSAI trawl fisheries. More than 48,000 Chinook salmon were taken as bycatch annually from 1996 through 1998, but closures were not triggered because bycatch limits were not exceeded before April 15.

In 2000, new regulations to reduce Chinook salmon bycatch in BSAI trawl fisheries were implemented (NPFMC 1999). The regulations incrementally reduced the bycatch limit

for the pollock fishery from 48,000 to 29,000 Chinook salmon over a 4-year period and implemented year-round accounting of Chinook salmon bycatch in the pollock fishery. Additionally, the boundaries of the Chinook Salmon Savings Areas were modified. Under these modifications, in the event the limit is triggered before April 15, the Chinook Salmon Savings Area closes immediately. The closure would be removed on April 16, but would be reinitiated September 1 and continue through the end of the year. If the limit were reached after April 15, but before September 1, then the areas would close on September 1. If the limit were reached after September 1, the areas would close immediately through the end of the year. The bycatch limit for the 2002 BSAI walleye pollock fisheries was 33,000 Chinook salmon.

In February 2002, the North Pacific Council initiated a process to consider salmon bycatch control measures for GOA groundfish trawl fisheries. These measures may include bycatch limits that when attained, would trigger closures in areas with the historically highest bycatch rates.

Fishing Industry Initiatives To Control And Reduce Salmon Bycatch In Groundfish Fisheries

Over the last ten years, the pollock industry has developed voluntary controls on bycatch of salmon and initiatives to collect and analyze samples for genetic analysis to improve information on country of origin. Efforts have also been undertaken to evaluate temperature and other environmental data collected routinely by industry for information on how these variables are associated with salmon bycatch.

Starting in the early 1990s, several programs employing location-specific bycatch avoidance data exchanges between fishermen were implemented by the pollock industry. These programs utilize fishery observer data on a fast-turn-around basis so fishermen can more effectively avoid bycatch “hotspot” locations. These early efforts were formally adopted into agreements between pollock fishing cooperatives that were established through the American Fisheries Act of 1998. The individual incentives and accountability through internal private contracts within pollock fishing cooperatives established under the American Fisheries Act have increased the effectiveness of industry bycatch management systems.

Industry efforts to control and reduce salmon bycatch have resulted in tangible improvements in fishery performance. The nature of the bycatch problem with salmon, however, is exceedingly complex and inherently difficult due to the unpredictable nature of salmon locations and movements. From a practical perspective, the pollock industry believes that one of the biggest problems with salmon avoidance is that hotspots are often transitory. By the time such concentrations are identified, a relatively large number of salmon may have already been taken and salmon may have already moved to other locations. Overall, hotspot avoidance and other approaches have provided some success but these efforts can only achieve success to the degree that salmon movements (and hence bycatch) follow some sort of predictable pattern.

The challenges of salmon bycatch avoidance itself, particularly in the context of the restrictive bycatch management measures in place in the Bering Sea/ Aleutian Islands groundfish management plan create a significant problem for the pollock industry. This situation will undoubtedly be even more acute if salmon populations increase or environmental conditions change in the future to increase the overlap of Chinook and chum salmon feeding and migration routes with fishing grounds used for pollock fishing. The potential effects of existing management controls on salmon bycatch can be seen in the fact that the analysis prepared in support of the decision to reduce the Chinook bycatch cap determined that had the cap of 36,000 salmon (an amount far in excess of what the cap will be once the phased-in reduction to 29,000 is complete) been in place during the 1994-1997 period, such a cap would have been triggered three of the four years for which data were available. This would have been expected to reduce the pollock catch in those years by 7-28% (NPFMC 1999).

One further complication is that salmon avoidance is not the only constraint facing the pollock industry. The decision of where to fish is affected by other constraints. An important constraint on where pollock vessels might fish in order to avoid salmon are regulations governing pollock removals and fishing locations so as to minimize potential competition with Steller sea lions. To avoid harvesting more than the allowable amount of pollock in sea lion critical habitat, fishermen often must select fishing areas that are outside of sea lion critical habitat even when salmon bycatch was relatively low in those sea lion protection zones. In some cases, this tradeoff can mean higher incidental catch rates of salmon.

The Need For An Alternative Approach To Salmon Bycatch Reduction

Over the years since seasonal bycatch caps have been in place, pollock fishermen have incurred substantial costs to control salmon bycatch. The industry believes that the cost of these salmon avoidance measures is high under the current set of seasonal bycatch caps. Costs could increase further as the phased-in reduction of Chinook salmon bycatch are implemented or as a result of potential additional measures to protect sea lions.

Costs associated with salmon avoidance go beyond the simple time and fuel costs incurred by moving vessels to alternative fishing areas. At times, pollock catch rate and/or the abundance of fish in optimal size ranges is highest in areas where salmon are concentrated. The costs of not being able to conduct fishing in those areas often exceed the costs of moving to alternative fishing areas according to industry sources.

This discussion of costs of existing methods to control salmon bycatch illustrates the potential value of a bycatch reduction device (BRD) to the pollock fishing industry. If a BRD is successful at reducing salmon bycatch with relatively low escapement of pollock, such a device would allow pollock fishermen to avoid or reduce the costs of moving and searching for an alternate fishing location or sacrificing good fishing conditions. An effective BRD might not only reduce such costs but could actually increase product quality and per unit revenues in conditions where the most valuable pollock are located in areas where salmon are relatively concentrated. If the performance of the device proved

to be exceptional, then the effects of the salmon bycatch control measures, both the fishery management controls and the industry controls, might be avoided entirely.

Benefits to consumers and the country overall from the pollock fishery could also increase under the expectation that the benefits of efficiency gains and increased product quality would accrue to consumers and the nation. Additionally, although the estimated environmental effect of salmon bycatch on salmon runs in Alaska are thought to be minimal, the reduction in these effects would create some expected benefits for commercial and recreational fishermen, Alaskan natives and tribal values associated with salmon, and salmon management and conservation goals. In years where salmon returns are relatively low, the reduction in bycatch effects on salmon runs, however minimal those effects might be, would be avoided to the timely benefit of those runs.

These environmental benefits are based on the assumption of minimal injury to salmon utilizing the escapement device. Any evaluation of the performance of salmon bycatch reduction device and its costs and benefits would clearly need to explicitly evaluate the question of long term survival in order to assess actual benefit/cost tradeoffs. The expectation of benefits from a BRD also assumes that changes in fishing behavior as a result of widespread the use of the device would not increase some other potential environmental costs associated with the fishery.

Purpose And Need For An Experimental Fishing Permit To Develop A Salmon BRD Device And Evaluate Its Performance

Trawl skippers have informally developed and tested excluder devices for bottom trawls for many years. To the best of our knowledge, however, little or no informal effort has been focused on designing a salmon excluder device for pelagic trawls used in the BS/AI pollock fishery. One explanation for this is that up until recently, the industry did not have access to the technical expertise and equipment to capture video images *in situ* where low-light conditions make this difficult.

Design of BRDs necessitates information on fish behavior in response to different stimuli such as the change in water pressure and direction associated with a bycatch reduction device. Development of a salmon BRD for pollock nets would require observation of how salmon behave in a pelagic pollock net relative to pollock, and lacking this, development of concepts for excluders would likely not be productive. Observation of differences in location, swimming ability, or response to stimuli have been critical to the development of effective BRDs (Glass and Wardle 1995).

In the context of the costs of salmon avoidance with available tools, there appears to be large potential benefit from an effective salmon BRD for the BS/AI pollock fishery. Given the information obtained from some preliminary video footage of chum salmon behavior in a pelagic pollock trawl, we believe there are promising behavioral difference between the target species and salmon that will allow for the development of an effective BRD (Dr. Craig Rose, Alaska Fisheries Science Center, personal communication). The question now is how to proceed most efficaciously with development of such a device.

Experience with development of BRDs for the Alaska trawl fisheries has shown that exempted fishing permits are an effective way to develop bycatch reduction gear. That experience has underscored the value of systematic testing under a rigorous experimental design. In the experience of the fishing industry, informal efforts to test net modifications in an *ad hoc* manner are not often productive because a fishermen working independently typically does not subject his modification ideas to systematic testing. While fishermen often possess a strong grasp of technical aspects of fishing gear in combination with outstanding ingenuity for adaptation, the coordinated and systematic approach of testing gear modifications through an EFP collaboration of science and industry is a more productive way to develop BRDs.

Exempted Fishing Permits (EFPs) offer advantages given the relatively high cost of research charters on the scale of vessels primarily used in the BS/AI pollock fishery. Because harvest limits are typically set below the allowable biological limits (referred to as ABC) in the federal fisheries off Alaska, additional fishing opportunities can be used to help fund research and development costs of conservation engineering without biological effects on stocks. In addition, there are benefits to evaluating gear modifications under the most realistic fishing scale and conditions. In our experience, research charters can be a difficult and potentially very expensive and possibly less effective way to recreate actual fishing conditions compared to an EFP test. For these reasons, an EFP is the best model for developing a salmon excluder.

Evolution Of The Concept Of A Salmon Excluder Device For The Pollock Fishery

The first step in the development of prototype salmon bycatch reduction devices has been to tap into the fishing industry's ideas on how such an excluder might function. A meeting that attempted to accomplish this goal was held by the United Catcher Boat Association (UCB) in the spring of 2002. The product of the meeting, however, was strong support for the development of an excluder device but none of the participants had any existing designs for such an excluder.

Following that meeting, Dr. Rose of the AFSC carried out a research charter on a pollock vessel in the summer of 2002 to deploy low light camera equipment and a new technology called "acoustic video" to obtain images of how salmon and pollock behave in the portion of a trawl net called the tapered intermediate. Dr. Rose was also able to perform some basic net modifications (cutting an escapement portal) to get some idea of how salmon react to such an escapement opportunity. This preliminary work suggests that, as would be expected, salmon are stronger swimmers compared to pollock. In addition, it appears that salmon may prefer to swim in the upper (furthest from the seafloor) portion of the trawl intermediate.

Dr. Rose's video and digital footage from his charter last summer are currently under review by trawl skippers and gear manufacturers. While still preliminary, some concrete ideas for excluder designs have emerged (John Gruver, Catcher Vessel Inter-cooperative Manager, personal communication). A depiction of a potential prototype devices is seen in Figure 1 below. The device depicted in the drawing is based upon a funnel of smaller

mesh webbing placed within the mid-section portion of the trawl. The funnel would attempt to create an eddy in the water flow at the aft section of the device where escapement portals would be used to provide salmon an egress opportunity (here shown with a recapture device attached).

INSERT DRAWING as Figure 1 (sent by fax)

This application is for an EFP seeks an allowance of pollock and bycatch species to test the most promising prototype salmon excluder that is developed through a set of steps outlined in this EFP application. An iterative development process with research charters leading into a formal EFP test has been followed previously in 2000-2001 for the successful development of a halibut excluder for Pacific cod trawls (Rose 2001). In that earlier process, industry had some conceptual expectations for what a halibut excluder for cod trawls would require in order to allow halibut to escape without compromising cod catch rates but no one had a clear design idea at the outset. In the case of this EFP application, the video footage may provide a better starting point by providing information about the behavioral differences between target and bycatch species than was available for the cod excluder EFP project in 2000-2001.

Application For An Exempted Fishing Permit: Statement Of Purpose

The objective of the project is to develop a salmon excluder for the BS/AI pollock fishery that allows escapement of a significant proportion of salmon that are herded into the net without significant reduction in catch rate of pollock. The use of “significant” in this statement is to illustrate the inherent tradeoff: for practicability reasons, the rate of reduction in salmon catch has to be balanced against the any reduction in the rate of pollock catch. Likewise, the overall ability to determine the benefits of the device requires information on the survival of salmon. Therefore, an explicit objective of this work is to evaluate the expected mortality rate of salmon utilizing the device. The specific purpose of the EFP portion of this overall project is to perform a scientifically sound evaluation under actual commercial fishing conditions of the proto-type BRD developed for the test.

Attributes of a successful salmon excluder are:

- 1) Effective performance in terms of reduction in salmon bycatch and minimization of the loss of pollock
- 2) Avoidance of injury to salmon escaping the trawl
- 2) Resistance to failures, break downs, and clogging
- 3) Ease of removal and re-installation in cases where salmon bycatch in not problematic and attendant loss of target catch would not justify continued use of the device
- 4) Durability and ease of storage on deck
- 5) Construction from affordable materials that are readily available.

These criteria collectively describe the desired end product of the process of development of a salmon BRD. As is described below, the EFP plays an important role in the determination of the effectiveness of the device to exclude salmon with minimal mortality, retain pollock catches, and function reasonably and practically.

Description Of Work:

A meeting with trawl skippers and gear manufacturers was conducted in the spring of 2002 to discuss the possibility of developing a salmon excluder and get fishermen's ideas on how such a device might operate. Additional industry meetings will be held in March and April of 2003 to get additional information and design ideas from skippers based on their review of Dr. Rose's video work. The designs generated from the input above will be used to develop several prototype models of excluders.

During the same period, the EFP applicant, in conjunction with the NMFS RACE division, will develop materials for and eventually conduct an RFP process to seek applications for a vessel to conduct the EFP work. The RFP process (described in detail below) will be used to set out the responsibilities of the applicant vessel owners to build the excluder prototype devices as per the designs and conduct the testing under the prescribed experimental design. Applicants for the field work must make a commitment to carry out both stages of the field tests, one this fall on chum salmon and one next spring targeting escapement of Chinook salmon

Application materials developed for the RFP process will describe such things as the amount of target catch available to the successful applicant for each stage of the field work, the responsibilities of the applicant to provide facilities and materials for the EFP work, and the terms under which the test will be cancelled or postponed if unanticipated and unmanageable circumstances arise, the physical and staffing requirements of the vessel used for the test, and other information critical to the EFP test.

For the summer of 2003, Dr. Rose has scheduled another research charter to pre-test the designs for a chum salmon excluder (that are developed from the second set of meetings with pollock fishermen) just prior to the chum salmon portion of the EFP work. That charter work will be used to determine which proto-type device appears to produce the highest reduction in salmon and retention of pollock catch. Approximate measurement of deployment and performance of the prototype devices in the NMFS research charter this summer will be through video observation only.

The first stage of EFP field test work on chum salmon is planned for the early fall of 2003. The vessel selected for the work will pick up the materials and project personnel (EFP applicant, Dr. Rose, NMFS-certified fishery observers) in Dutch Harbor and conduct the field work.

The measurement of the effect of the device on salmon and pollock catch will be done through a recapture cod end where salmon numbers in the regular cod end and the recapture cod end can be compared and pollock catch by weight in recapture and regular cod end can be evaluated for each EFP tow (see Experimental Design below).

Following the completion of the tasks outlined above, including the completion of the field work on chum salmon and analysis of the performance of the chum salmon excluder, skippers and gear designers will once again be invited to submit designs and ideas for adapting the excluder to work for Chinook salmon escapement for a second field test that will occur during the winter/spring pollock season. Chinook bycatch has traditionally been problematic in the winter/spring fishery, where fishing and environmental conditions are somewhat different. Differences in swimming ability or response to the excluder between chum and Chinook salmon may also require modification of the excluder to maximize its performance for Chinook escapement adaptation. This second interface with industry to get ideas for adaptation of the BRD device will occur during the late fall and early winter of 2003.

Following this developmental work, the vessel used for the chum salmon work will once again be used for EFP field work, but this later test will evaluate ability of the modified device to release Chinook salmon while retaining target catches of pollock. This Chinook salmon escapement test may be preceded by a second research charter if modifications to the excluder design to allow Chinook escapement are sufficiently large to merit a pre-test. There is currently no confirmed funding for this second NMFS charter to pre-test design modifications next spring, but such funding is currently being sought by Dr. Rose and the pollock industry.

Itemized Tasks And Schedule:

- 1) Meetings with skippers, gear manufacturers, Dr. Rose to develop concepts for excluder devices (January- April, 2003)
- 2) NMFS review of EFP application (February-April, 2003)
- 3) Preparation of materials for RFP process for chum salmon test
- 4) Meetings with skippers returning from 2003 A season and review ideas and designs for excluders
- 5) Administration and coordination of RFP process to select a vessel for the EFP field work (following EFP approval starting in May or June of 2003)
- 6) Assist Dr. Rose's preparation for pre-test charters this summer (starting in April or May, 2003)
- 7) Field work for pre-test of device under NMFS research charter in Puget Sound (June, 2003)
- 8) Field work for NMFS research charter in Bering Sea to pre-test designs for chum salmon excluder prior to EFP test
- 9) Field work for EFP test in Bering Sea (September, 2003)
- 10) Data entry and analysis for EFP test (September-October, 2003)
- 11) Preparation of report on performance of chum salmon excluder (November 2003)
- 12) Meetings with industry on design modifications for Chinook excluder device (starting November 2003)
- 13) Preparation of EFP field work for Chinook salmon excluder (November-December 2003)

- 14) Pre-test of Chinook excluder under NMFS research charter (tentative, January 2004)
- 15) Field work for EFP test of Chinook excluder (January or February, 2004)
- 16) Data entry and analysis for Chinook excluder portion of work (February-March 2004)
- 17) Presentation of results of Chum and Chinook excluder EFP results and submission of final (April 2004 or as requested by NPFMC).

Responsibilities Of Parties For The EFP Project

Critical to the success of the development of a BRD and the use of an EFP to test its performance are clear assignments of duties, expectations, and contingency planning steps for all parties involved in the work. While not all of the possible outcomes can be anticipated, experience has shown that some aspects of the work are more likely to experience unavoidable roadblocks and thus benefit most from planning for contingencies. Clearly defined roles in project management are key elements of project success.

Responsibilities of EFP applicant:

- 1) Drafting of EFP and modifications based on NMFS and other review
- 2) Project coordination and troubleshooting of unanticipated events and circumstances
- 3) Holding informal meetings to collect information on a voluntary basis from fishermen and gear manufacturers
- 4) Preparation of materials for RFP process to select vessel for field work (in conjunction with NMFS RACE Division).
- 5) Coordination of RFP process under direction of NMFS RACE Division
- 6) Preparation for, staffing of, and project management for at-sea work. Note: as has occurred in the past, EFP applicant serves an intermediary role for monitoring progress of field work, making sure project stays within prescribed catch and bycatch limits, and assisting negotiations with vessel owner if unanticipated circumstances affecting conditions of the permit arise.
- 7) Under circumstances where EFP field work will clearly be unable to accomplish the desired objectives of the test (e.g. salmon are not able to be located at all, device does not appear to be functioning in the intended manner at all (release of salmon unharmed and retention of target catch), EFP applicant, in consultation with NMFS RACE Division and NMFS Regional Office will attempt to re-schedule, postpone, or modify project. Should this situation arise, the goal would be to make best use of resources expended for the project and minimizing economic losses of industry to the extent practicable.
- 8) Technical and material assistance in data set preparation and analysis of EFP data
- 9) Preparation of reports to the interested public on BRD performance and presentations of results as per NPFMC direction

Expectation of work and assistance from NMFS Race Division and NMFS Regional Office

- 1) Review of EFP application, development of EA or other supporting analysis for EFP application, approval and implementation via federal approval process (AFSC and AK Region)
- 2) Oversight and assistance of project coordination and troubleshooting of unanticipated events and circumstances (AFSC)
- 3) Attending (as necessary) informal meetings to collect information on a voluntary basis from fishermen and gear manufacturers (AFSC)
- 4) Review of materials drafted by EFP applicant for RFP process to select vessel for field work (AFSC)
- 5) Review of EFP field work applications and selection of preferred vessel application (AFSC)
- 10) Project management for at-sea work and assistance with handling contingencies that may arise (AFSC, possibly AK Region)
- 11) Technical assistance in data set preparation and analysis of EFP data
- 12) Assistance with preparation of reports on BRD performance and presentations of results as per NPFMC direction, as requested (AFSC)

Responsibilities of vessel owner or his agents for vessel selected to do EFP field work

- 1) Timely submission of a completed application for the EFP field work
- 2) Signed commitment to carry out the field work (unless released by NMFS or EFP applicant) under the negotiated timing for the chum salmon BRD test work (fall 2003), and Chinook salmon BRD test (winter/spring 2004)
- 3) Furnishing materials for and providing for the construction of the BRD devices (up to three devices) under the direction of Dr. Craig Rose prior to each stage of the EFP field work
- 4) Conducting the field work as specified in the application materials and EFP permit including taking specified number of scientists, project managers, and fishery observers for field work and provision of and payment for the specified number of NMFS-certified fishery observers
- 5) Signed agreement to waive any confidentiality claims to data generated by EFP testing or pre-testing

Experimental Design

Recapture device in lieu of comparisons of modified and non-modified trawl net comparisons The fundamental element that drives the design of this EFP test is the use of a secondary trawl webbing device to capture and account for fish that exit the trawl through the excluder device. This approach is taken in lieu of a design which sets out to compare the performance of a modified trawl (with the excluder) to an unmodified trawl. While both approaches have merit, measurement of the performance of the salmon excluder device in this test is more practical with a recapture device.

The need to structure this test around the use of a recapture device became evident when salmon bycatch data from salmon hotspots were evaluated. The data demonstrate that even if areas with relatively high bycatch rates are targeted for the experimental work, salmon bycatch would not be expected to occur consistently on each trawl tow. This was not the case in previous work to test BRDs for halibut, where it was a reasonable

expectation that most trawl hauls in the Gulf of Alaska or Bering Sea will have at least some halibut bycatch and conditions affecting the probability of catching halibut on a given tow were not highly variable. In the case of this salmon excluder test, if a comparison of modified versus unmodified nets were undertaken, the desired number of pairs of reasonably similar tows (pairs of tows under similar conditions) would require a prohibitive amount of experimental fishing because the relative inconsistency and rarity of salmon bycatch. For this reason, a recapture device is preferred.

Experience with experimental tests on trawl modifications raises the issue that the “recapture” device may affect the performance of the device to some degree. The manner in which this could occur is by changing the direction or magnitude of water passing through the trawl webbing (such as would not occur with the excluder alone) thus affecting the shape and function of the trawl meshes in that portion of the trawl and hence possibly affecting the probability of escapement of the bycatch or target species. The potential ramification is that the device under the test conditions with a recapture device would not function as it would be expected to perform in actual commercial fishing with the excluder but without the recapture device. Under certain conditions, performance differences with the recapture device might be in the positive or negative direction depending on the actual effect of the recapture device on the excluder portion of the trawl modification.

While it is recognized that a recapture approach to the test can pose problems for determination of the performance of the BRD, this project includes a component to evaluate the effects of the recapture device on the function of the excluder. This will be accomplished through camera devices placed in specific locations during the pre-test charter work. This will allow for adjustments in the size or placement of the recapture device to correct for recognized problems. For instance, if trawl mesh tension appears to be affected by the recapture device or if fish appear to mill around the egress point of the excluder, adjustments can be made to rectify this situation. While this approach cannot guarantee that the effects of the recapture device will be removed completely, at least by the time of the EFP experiment, steps will have been made to reduce its effect to the extent possible.

Statistical Power To Detect An Effect

A pelagic pollock trawl is equipped with very large meshes (30 meters or greater) in the in the mouth and wings of the net which gradually taper to as little as four inch meshes in the codend. This reduction in mesh size occurs over a distance of approximately 400 meters (stretched mesh basis). Salmon and pollock can escape through the large meshes in mouth and wing sections of a pelagic net, but once they have been successfully herded back into the smaller meshes of the net, there is little chance of escapement from an unmodified trawl due to the relatively small openings.

An important consideration regarding experimental design is that once the pollock and salmon are in the small mesh sections of the trawl intermediate, there are only two possible outcomes for a net rigged with an excluder device. Specifically an individual fish (pollock or salmon) can drop back into the trawl codend or it can “escape” through

the excluder, which means in this case it is retained and accounted for in the recapture device used for our experiment.

This "either/or" set of discrete outcomes is suited to statistical treatments that evaluate the probability of detecting the proportion of effect. In this case, the proportion of interest is the percentage of individual salmon escaping (desired effect of the device), thus the proportion of the total number of salmon accounted for in the recapture device relative to total number of salmon caught in the recapture device and trawl codend.

The conventional approach to determination of sample size for proportions is to generate a statistical power relationship (based on the binomial probability distribution) between sample size and statistical power to detect a given effect at a desired statistical confidence level. This relationship is normally depicted as a curve with sample size on the horizontal axis and the power of detecting a difference of a given magnitude.

Of importance is that the magnitude of the effect that is built into this sample size calculation should be designed to be useful to the research question itself. For instance, designing the sample size for the EFP test around the question of whether the excluder has any effect at all on salmon escapement is not really useful to the fishing industry that must later consider the potential tradeoffs associated with using the excluder. Because the pollock industry is faced with the very real possibility of reducing target catch rates in exchange for lowering the bycatch rate of salmon, the sample size for the experiment needs to be designed to allow detection of a performance difference of a fairly small magnitude in terms of reduction of salmon bycatch from the expected level of performance.

Sample Size Calculation

The specific goal that was selected for sample size determination to test escapement of chum salmon from the BRD is based on the number of chum salmon needed to have an 80% chance of detecting an effect that is ten percent different from the underlying or expected effect, at a 95% degree of statistical confidence. The number of salmon needed for the test essentially drives sample size because pollock are obviously far more abundant relative to salmon. Effectively, this means that our confidence that we have correctly detected the effect of the device on pollock retention will occur long before we are confident on the question of how the BRD affects salmon escapement.

Although we have some preliminary information from Dr. Rose's video work suggesting that salmon will egress through an aperture in the top panel of a pollock net, we have no *a priori* or empirical notion of the underlying proportion of salmon that will successfully make use of the excluder developed for the test. Lacking an expectation for this underlying proportion, the risk averse approach to sample size determination (so as to avoid under-sampling) is to assume a proportion of 50%, (probability of 0.50). This, in effect, maximizes sample size for a given set of desired statistical power and desired degree of statistical confidence.

For the chum salmon escapement portion of the experiment, we assumed an underlying proportion of effect (salmon utilizing the escapement device) of 50% ($p = 0.5$). Our goal is thus to have sufficient statistical power to have an 80% percent probability of detecting a 10% difference in proportion of effect from the underlying proportion of 0.5 with 95% statistical confidence ($\alpha = 0.05$). A statistical power curve for those criteria is reproduced in Figure 2 below.

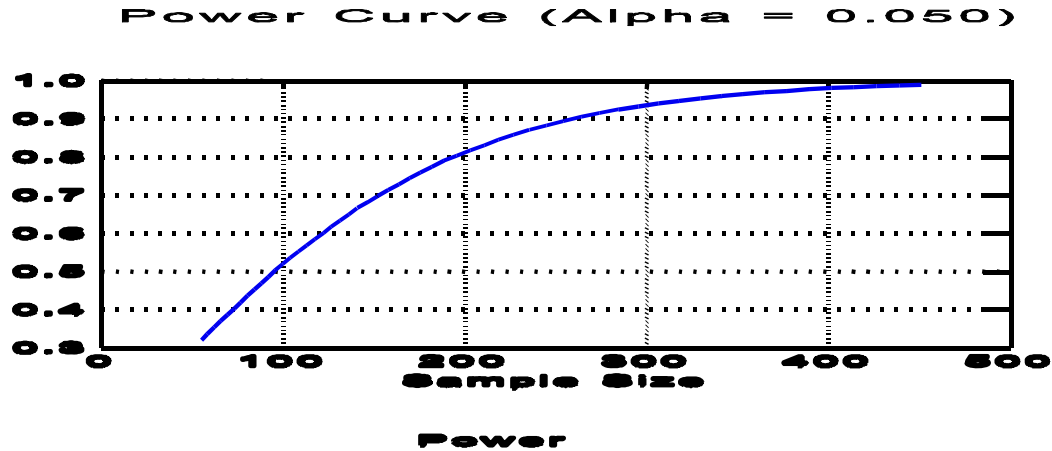


Figure 2: Probability of detecting difference from proportion of 0.6, when the underlying proportion is 0.5

Figure 2 above shows that the desired statistical power for the EFP test requires a sample size of 200 salmon. Recall that the driving factor for sample size is the number of salmon encountering the excluder. This means that for the first part of the EFP work on chum salmon, the goal would be undertake fishing that has an expectation of encountering at least 200 chum salmon.

Calculation of Pollock Catch That Would Be Expected To Generate A Sample Of Approximately 200 Chum Salmon

Because salmon are essentially a byproduct of pollock target fishing, the desired sample size of 200 chum salmon cannot be explicitly and directly generated in an EFP test for the pollock fishery. A practical means of obtaining a sample of 200 chum salmon is to estimate the quantity of pollock fishing that is likely to generate that number of chum salmon. We have done this below based on past conditions associated with chum salmon bycatch in the pollock fishery. We believe that the most reliable representation of what the fishery will encounter when the test is performed next fall is the chum salmon bycatch rates from fall of 2002. This is because strong runs of salmon tend to persist serially based on trends in ocean conditions and year class strength. Thus the most reliable approximation of the availability of chum salmon to the pollock fishery is last fall's bycatch rates. Based on that approach, the target amount of pollock catch that would be likely to achieve a sample of the desired size is derived below.

To evaluate sample size, pollock and salmon catch location-specific data were obtained on a daily basis from Sea State Inc. for the fall pollock fishery in 2002. Daily bycatch rate information on an area-specific basis was used to evaluate variation in daily chum

bycatch rates in a specific area identified by Sea State Inc. as a “hotspot” for chum salmon bycatch. This approach was taken because this EFP work will utilize information on chum bycatch rates from the regular pollock fishery to target a specific area with relatively high chum salmon bycatch rates for conducting the experiment. Experience has shown that chum salmon tend to aggregate and that areas of relatively high concentrations can be identified at certain times. While certainly not static and not the only areas where chums are taken as bycatch, these areas are identifiable from the fishery bycatch reporting and management system that is now formalized into the pollock cooperative management system, which industry has agreed to make available to this project.

The goal is to focus the EFP test fishing where salmon are abundant and to plan to do enough fishing so that if bycatch rates are somewhat lower next fall or location of a relative concentration is not as effective as in past years, sufficient fishing will still take place to create a reasonably high probability of obtaining the desired sample size of chum salmon. Assuming that our success at finding an area of relatively high salmon concentration is within the range of what has occurred in the past, this approach in conjunction with somewhat modest expectations of expected bycatch rates will serve to generate the desired sample size.

Use Of Fishery Data To Estimate Bycatch Rates For The Chum Salmon EFP Test

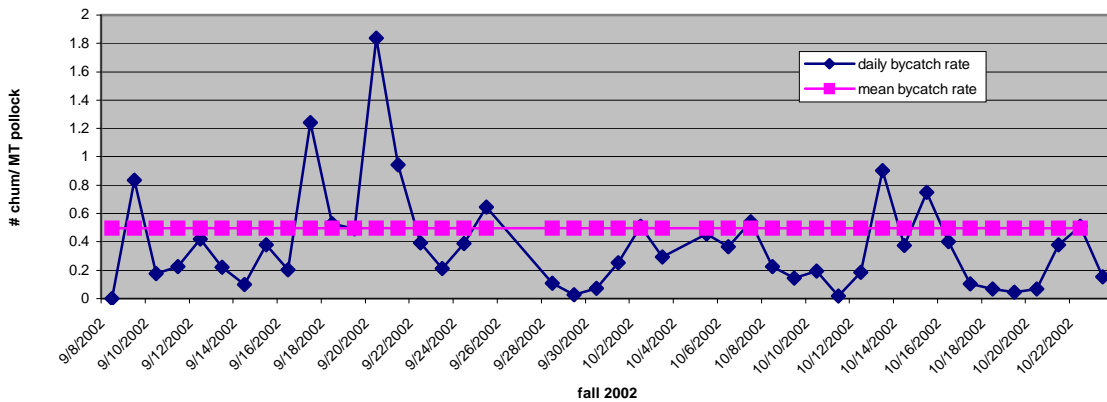
In evaluating potential chum salmon bycatch rates, the most useful data for projecting the quantity of pollock catch that would be likely to achieve the target sample size was determined to be data from catcher vessels delivering to motherships during the fall of 2002. This data source was selected for the following reasons. Portions of the Bering Sea shelf area are restricted to catcher vessel operations (Catcher Vessel Operations Area) and this area has consistently experienced relatively high chum salmon bycatch rates (Witherell and Pautzke 1997). For this reason, catcher vessel data was the most applicable for determination of expected chum salmon bycatch rate associated with a concentrated bycatch area.

In addition, for the subset of catcher vessels delivering to motherships, salmon bycatch rate data are available on a haul by haul basis. This allows for assignment of the location and a daily rate of salmon bycatch. Data from catcher vessels delivering to shoreside plants cannot be used consistently to calculate salmon bycatch rates on a haul by haul or daily basis. This is because salmon are not systematically accounted for, in most cases, until observer sampling that occurs at the time of shoreside delivery. For shoreside delivery vessels, quantity of pollock and salmon taken over the course of the fishing trip is the most detailed level of data available. That effectively means bycatch rates for shoreside delivery vessels can only be determined over a three to four day period. During that time, a vessel may fish several different areas, with fish from all areas mixed in the vessel’s holding tanks. For this reason, daily chum salmon bycatch rates from catcher vessels delivering to motherships was preferred.

Figure 3 below illustrates daily bycatch rates of chum salmon for an area identified by Sea State to have generally high chum salmon bycatch rates during the fall of 2002. Note

that there are several daily periods with relatively high bycatch rates compared to the arithmetic mean rate for the total number of salmon taken by the vessels in the data set divided by the total pollock tons by these vessels. Because the EFP test must be scheduled in advance, and because it is probably unwise to assume that the EFP test will encounter peak bycatch rates, the expectation for daily salmon bycatch rate used for this calculation of pollock tons needed for the experiment was based on only the days with rates that were less than the mean daily rate during the period of data provided by Sea State (9/8/02 – 10/23/02). This removed 11 of the 42 days for which daily rates were available for catcher vessels delivering to motherships in the zone of relatively high bycatch rates from our data set.

Figure 3: Daily Chum Bycatch Rates



The above treatment of the chum salmon bycatch data attempts to balance the ability to target a chum salmon bycatch hotspots with the practical reality that timing for the EFP is not completely flexible and bycatch rates may not be as high as those peak rates encountered in the hotspots within the CVOA last fall. From the above data and the procedure used to remove all the daily rates above the mean bycatch rate, the baseline bycatch rate of 0.23 salmon per ton of pollock was used to calculate the probably amount of pollock needed to generate the desired sample size. Calculation of that expected quantity of pollock was done in the following manner: 200 (number of salmon for desired sample) divided by 0.23, or approximately 870 MT.

Based on the assumptions made above, this should be a sufficient quantity of pollock to derive a sample of 200 chum salmon for the EFP under conditions that occurred in the recent past. Another 100 MT of pollock catch is needed for the chum salmon portion of the EFP work to allow for two pre-test trawl tows with a closed codend and recapture

device to ensure that the device is deploying sufficiently on trawl gear of the vessel selected for the EFP work. This brings the overall pollock catch for the chum salmon portion of the EFP to 970 MT.

Establishment Of Limits On The Amount Of Pollock Available For The EFP

The approach to derivation of sample size for the development of the chum salmon excluder portion of the EFP (and later the Chinook EFP work) was based on determination of a sufficient quantity of pollock that was expected to achieve the desired sample size. In reality, given that chum salmon catch rates vary considerably on a tow by tow basis, it is possible that a large fraction of the expected sample size could come from a few hauls during the EFP. This presents a practical consideration for the EFP test. Given that the opportunity to catch pollock outside of the total allowable catch is being used to help fund the EFP research, the EFP work must be structured around a predictable outcome for the vessel owner who is interested in applying to do the EFP work. Specifically, the applicant needs to know how many tons of pollock are available for the EFP work in order to calculate his costs and expected revenues associated with participation in the field work.

This approach of basing the EFP catch limits on the amount of target catch instead of catch of the desired number of salmon for the sampling design was done specifically to make the EFP work feasible for industry applicants. An alternative approach of conducting fishing until the target number of salmon are caught might mean that the EFP test fishing could be accomplished in a few tows or a very large number of tows with a large amount of pollock catch relative to the specified 970 MT of catch for the chum salmon excluder test. We believe the “fish until you obtain the sample” approach is simply not practical for the applicant who, in the end, has to assume the risk of undertaking all the costs of the experimental fishing associated with the EFP. Likewise, fishery managers are not likely to approve an open-ended amount of pollock for this EFP.

Our approach attempts to strike a balance between the goals of the research, the funding model for a portion of the EFP work, fishery management’s need for concrete limits for consideration of an EFP application. The actual ability of the EFP to achieve its goals for chum and Chinook salmon sample generation depends heavily on the reliability of the approaches taken to estimate sample size and associated amounts of pollock catch. We have examined other approaches to generating the desired sample size and concluded that the approach described here is reasonable (based on past experiences with EFPs) and preferable given the needs of all parties.

Sample Size For The Chinook Salmon Field Test Portion Of The EFP Work

As is explained above, differences in behavior and depth preference characteristics as well as factors relating to environmental conditions at different times of year (spring versus summer/fall) make a separate test of the salmon excluder necessary if we are to know how the excluder functions for reducing bycatch of Chinook salmon.

Following the first test of the excluder, a process involving input from fishermen will be undertaken to review potential modifications to the device based on how well it

performed on chum salmon and what differences would be expected in terms of its expected performance for Chinook salmon. This process may lead to a decision to change the placement or design of the existing excluder device, or it may simply result in a decision to test the device exactly as it was deployed for the chum salmon test. In either case, the question of performance of the device should be treated as a separate question, that of “what proportion of the Chinook salmon does the (modified?) device have the desired effect upon relative to the total number of salmon that encounter the device”?

Sample Size Calculation For The Chinook Excluder Test

Unfortunately, given the relatively low expected bycatch rate for Chinook salmon even under peak bycatch timing and conditions, our ability to build statistical power into this portion of the EFP test is lower than it was for the chum salmon test. In the test for chum salmon escapement, the experiment is based upon the ability to discern as small as a 10% difference from the underlying proportion (again \bar{p} is set at 0.50). After evaluating expected bycatch rates for Chinook salmon, it was obvious that this degree of statistical power is not practical for the Chinook EFP test. This is because such statistical power would mean that the EFP would have to catch as much as 8,000 MT of pollock to obtain a sample of 200 Chinook salmon.

For this pragmatic reason, a lower standard of statistical power was adopted for the Chinook salmon BRD test. Our goal for this portion of the test is to have an 80% power to detect a 25% difference from the underlying proportion of 0.50 with 95 % statistical confidence. Sample size under that set of criteria for statistical power is derived below:



Figure 4: Probability of detecting difference from proportion of 0.75, when the underlying proportion is 0.5

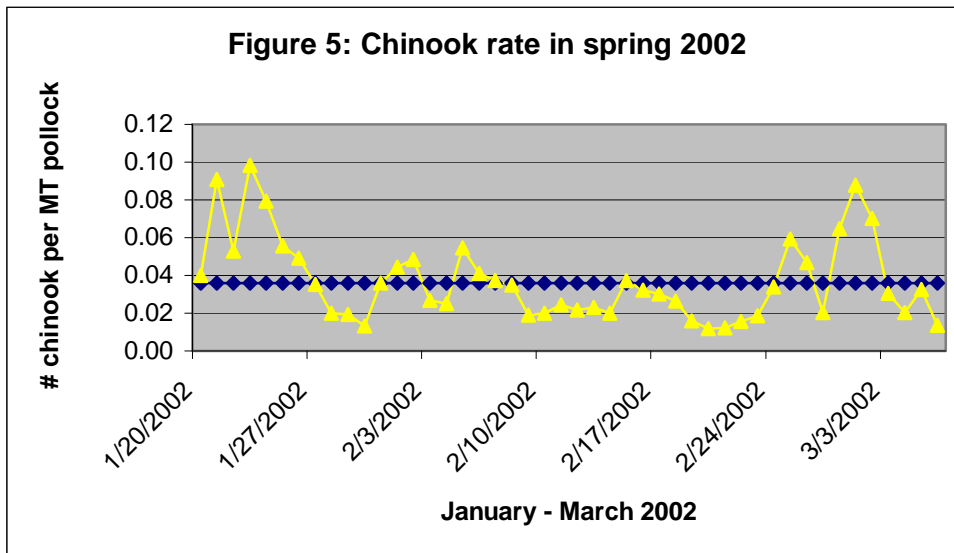
Under this somewhat lower but still meaningful level of resolution to measure the effect of the excluder for releasing Chinook salmon, a sample size of 30 Chinook salmon is expected to provide an 80% probability of detecting a 25% difference from the underlying proportion of 0.50 with alpha set at 0.05 once again (see power curve above). As will be seen below, this sample size is practicable given expected bycatch rates for

Chinook salmon. These bycatch rates were once again based on hotspots during the 2002 pollock fishery, this time during the spring pollock fishery.

Use Of Fishery Data To Estimate Bycatch Rates For The EFP Test

Data used to generate an expected rate of salmon bycatch for this portion of the EFP test were once again supplied by Sea State, Inc. This time, however, observed bycatch rates from a Chinook salmon hotspot were from pollock catcher processors during the spring of 2002. In the case of the spring fishery, there are no special regulatory restrictions that affect the areas where catcher processors can fish as was the case for chum salmon bycatch data. The high observer coverage on at-sea vessels fishing in the spring of 2002 makes their data highly suitable for assessing daily bycatch rates.

The same data treatments were performed on this Chinook salmon bycatch rate data as were performed above for the chum salmon data. To remove the effects of the high bycatch rates days from the data, we once again removed all the daily rates above the average (average based on the total number of salmon divided by the total tons of pollock for the period January 20, 2002 through March 6, 2002). That average rate was 0.04 Chinook per MT of pollock. This procedure to drop above-average bycatch rates removed 15 days with relatively high Chinook salmon bycatch rates from the overall number of 45 days in the data set supplied by Sea State (Figure 2 below).



From this procedure, we arrived at a “conservative” daily expected rate of 0.025 Chinook per metric ton of pollock. Once again, the purpose of this manipulation was to develop an expectation of the bycatch rate in an area with a relatively high rate but account for the possibility that the somewhat inflexible timing of the spring 2004 EFP work on Chinook salmon may not allow us to conduct the test during peak periods. If the field work for the test is able to hit a peak period, then sample size will be higher than expected and this

will serve to augment the ability of the test to determine the precise effects of the excluder.

Amount Of Pollock Catch That Would Be Expected To Generate The Desired Sample Size of 30 Chinook Salmon For The Chinook Salmon Excluder

Based on the data and data manipulations described above, we calculate that 1,200 MT of pollock needs to be caught to generate a sample of 30 Chinook based on an expected bycatch rate of 0.025 Chinook per ton of pollock (30 Chinook / 0.025 Chinook per MT). Once again, the EFP work will need two pre-test hauls with the cod end and recapture device in place and to make sure the excluder is deploying reasonably for the test work. This brings the overall amount of pollock for this portion of the EFP work to 1,300 MT.

Target and incidental species harvested in the EFP work:

Groundfish: The estimated total harvest of allocated groundfish species including both the chum salmon stage of the EFP work (970 MT of pollock in fall of 2003) and the Chinook salmon stage (1,300 MT in spring of 2004) is 2,270 MT of groundfish. Approximately 98% of which is expected to be pollock and 2% is expected to be other groundfish species such as Pacific cod and flatfish. Retention standards for the EFP work will be the same as those for the directed fishery for pollock.

Pacific salmon: The determination of sample size for each species of salmon for each excluder trial is based on a target amount of pollock catch which, under the assumptions of the EFP work, is expected to have a reasonably high probability of generating the desired sample sizes for the two stages of the EFP. To reduce the risk of “under sampling” if salmon abundance turns out to be lower than it was in the data for the period used to develop sample size calculations, only below average bycatch rates for the period covered by the fishery data used for sample size estimation were used for sample size calculations. This procedure was adopted to increase the probability that the EFP achieves its sampling goals should the EFP fishery work encounter only “below average” salmon abundance conditions in areas where pollock fishing occurs.

An “upper end” estimate for salmon mortality associated with this project is 2,183 chum salmon and 217 Chinook salmon. This estimate was made based an assessment of the highest individual vessel salmon bycatch data used for calculating sample size above. Vessel-specific chum or Chinook salmon bycatch rates (respectively) were evaluated on a weekly average basis to determine what the highest weekly rate for an individual vessel was in our data. These rates (2.25 chum salmon per ton of pollock and 0.17 Chinook per ton of pollock) were then applied to the overall quantity of pollock (including the two test tows) to produce the upper bound estimate of salmon bycatch by species discussed above.

As the Council and NMFS have approved for other EFP experiments dedicated to bycatch reduction, groundfish and prohibited species taken during the experiment should not be counted against the annual total allowable catch and prohibited species bycatch caps. The taking of salmon during the experiment is crucial for determination of the

effectiveness of the excluder device. Were the salmon bycatch deducted from the respective salmon bycatch caps, the potential exists that the additional salmon bycatch during the EFP period would increase the chance that annual chum or Chinook salmon PSC limits for the pollock fishery are attained. Thus the additional salmon taken in the experiment would create a burden on the pollock trawl industry and may lead to closures of the salmon savings areas that may not otherwise have occurred. The additional amount of pollock taken in the EFP is not expected to cause the Bering Sea pollock fishery to exceed its acceptable biological catch. Pollock taken during the testing will be sold to help offset the costs to the vessel operations during the experimental work.

This application also specifically requests that a salmon bycatch limit not be set for this EFP experiment. The success of the EFP work depends on our ability to target areas with concentrations of these salmon for the benefit of the experimental work. Further, catching additional salmon will increase the ability of the EFP work to determine the effectiveness of the excluder device. Even if the upper bound estimates of salmon catch numbers for the EFP work were attained, these are relatively small numbers of mostly juvenile salmon compared to respective biomasses. We believe that the merits of the research in reducing salmon bycatch outweigh any potential effects such salmon removals associated with the EFP work might have.

Further, an exemption from salmon bycatch management regulations establishing fishing area closures for the pollock and groundfish fisheries is also requested. The current array of salmon bycatch management rules include two types of area closures. One is for areas that are closed annually on a certain date. The other are closed areas that result from attainment of a PSC cap (trigger) number of salmon. These exemptions are proposed because the success of the EFP work depends on an ability to conduct the experiment in areas where salmon are concentrated.

On-Board Sampling and Data Collection

Expectations for at-sea sampling during the EFP work need to reflect the scientific objectives of the EFP work and the practical realities of what is possible on a Bering Sea pollock catcher vessel, the most appropriate platform for the EFP work. Performance of the excluder on Bering Sea pollock catcher vessel is the initial focus of the EFP work because catcher vessels catch the majority of the pollock harvest in today's pollock fishery. Additionally, catcher vessels also have restricted access in the summer and fall pollock fishery to an area known to be a salmon bycatch hotspot, the Chum Salmon Savings Area. Recognizing the physical limitations of typical Bering Sea pollock catcher vessels, which typically range in length from 90 to 130 feet in length (LOA), the following sampling design will be used for this project, subject to adjustments during the consideration of vessel applications for the EFP work.

Variables of primary interest for deck sampling to measure the effect of salmon excluder device:

1. Number of salmon in recapture net and codend (per tow)
2. Quantity of groundfish in the recapture device and codend (per tow)
3. Length frequency of salmon in recapture device and codend (per tow)

4. Length frequency of approximately 100 pollock from cod end and recapture device (each) per tow (depending on workload issues, this may not be possible on a tow by tow basis)
5. Determination of sex of pollock taken for length frequencies from cod end and recapture device (as workload allows)

EFP vessel log information of interest for EFP work:

1. Towing speed (average speed over ground)
2. Notations on whether vessel turned around during a haul or slowed or stopped for any reason
3. Sequence and duration of hauls (date of haul, start and end time, start and end time at fishing depth and start/end times for nets towed at non-fishing depths, (such as short-hauling))
4. Area where fishing occurred (Lat/Long of tow start and end points)
5. Average depth of bottom in fishing area and average fishing depth
6. Incidental observations of captain on surface light conditions and sea state
7. Incidental observations of captain on handling issues associated with rigging of or setting/retrieving net with excluder installed

To adequately collect data for the variables of interest for the EFP work, two NMFS-certified at-sea observers may be required for the at-sea EFP work. On deck facilities of certain catcher vessels may preclude complete removal of salmon from the catch in the main codend. Such vessels may be considered for the EFP if they have multiple RSW tanks that allow separation of the catches from each haul, which would then be re-screened during offloading of the catch at processing facilities. To allow consideration of alternative sorting and sampling proposals for these vessels, proposals for one at-sea observer and one additional observer stationed at the processing plant may be considered.

Vessels with a functional conveyor belt (or device with similar function) that can be used to transfer catches from the codend and recapture device to the holding tanks may be preferred. This could greatly facilitate removal of salmon from the pollock depending on the actual placement and function of such conveyors. Lastly, a catcher vessel with a NMFS-approved motion compensated flow scale, allowing more accurate estimation of total catch, may be preferred for the EFP work.

Data analysis will primarily focus on the estimation of the proportions of pollock and salmon excluded from the catch through the device. The experiment is designed to estimate these values for the combination of all tows, representing the value of the device in ordinary fishery conditions. Variability of escape rates between tows will be examined for indications of conditions affecting excluder performance. Combined size composition data will be tested for differences between retained and escaping fish. Video footage taken during the experiment will be reviewed to assess the physical condition of salmon that egress through the excluder into the recapture device. Results and analyses will be compiled into reports and presentations that will be made available to managers, trawlers, scientists and the interested public.

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