Request for a new exempted fishing permit (EFP) to continue research on salmon bycatch reduction devices

Date of Application: January 29, 2008
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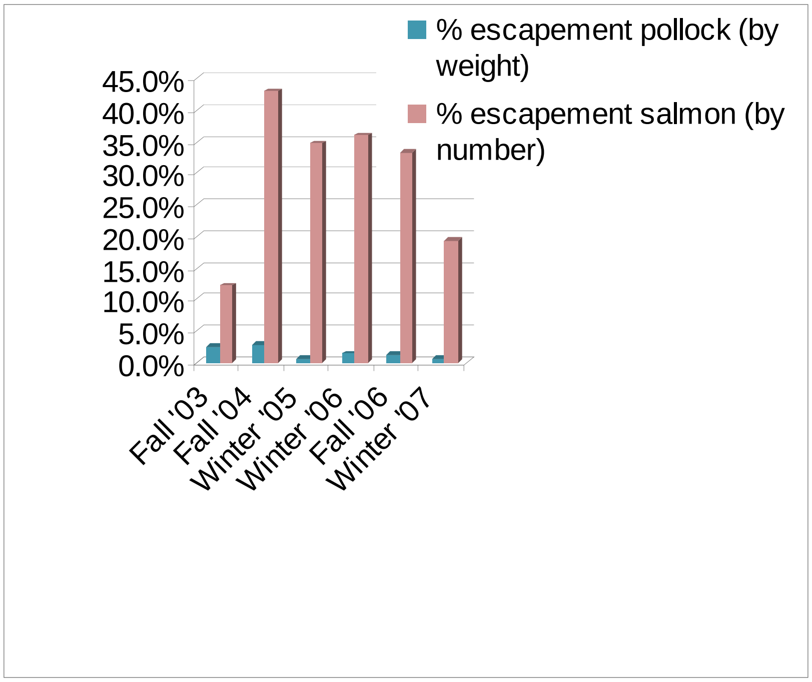
Purpose and Objectives of the EFP: This application has been prepared to request a new salmon excluder exempted fishing permit. A new permit is needed to allow us to continue research on the ways to modify pollock trawls to reduce salmon bycatch. The focus of this continuing research is to improve the performance of the salmon excluder designs that have shown the greatest potential for reducing salmon bycatch while being practical in terms of avoiding problems with bulges in the net. Based on our previous research, we believe that the most promising area of focus is the “flapper” design salmon excluder.

In some of our experimental tows in 2007, the flapper excluder reduced salmon bycatch rates to nearly the same degree as our earlier excluder designs (funnel and tunnel excluders) while avoiding the bulge problems, loss of door spread, and net damage that has been observed with the earlier excluders. Thus the flapper is a promising direction for focus, particularly for larger catcher vessels and catcher processors which have experienced problems with the funnel and tunnel excluders.

Figure 1 below summarizes the salmon bycatch reduction rates documented in our previous tests on tunnel, funnel, and, most recently, the flapper excluder. The figure reports escapement rates for Chinook salmon except in the first stage in fall 2003 where the chum (non-Chinook) escapement rates are reported. Escapement rates are in terms of the number of salmon escaping relative to the overall number of salmon for each portion of the separate field experiments. Pollock escapement rates in the figure are in terms of the weight of pollock escapement relative to the overall weight of pollock catch for each test.

Figure 1: Average escapement rates for pollock and salmon from salmon excluder research under EFP 03-1 and EFP 05-02.

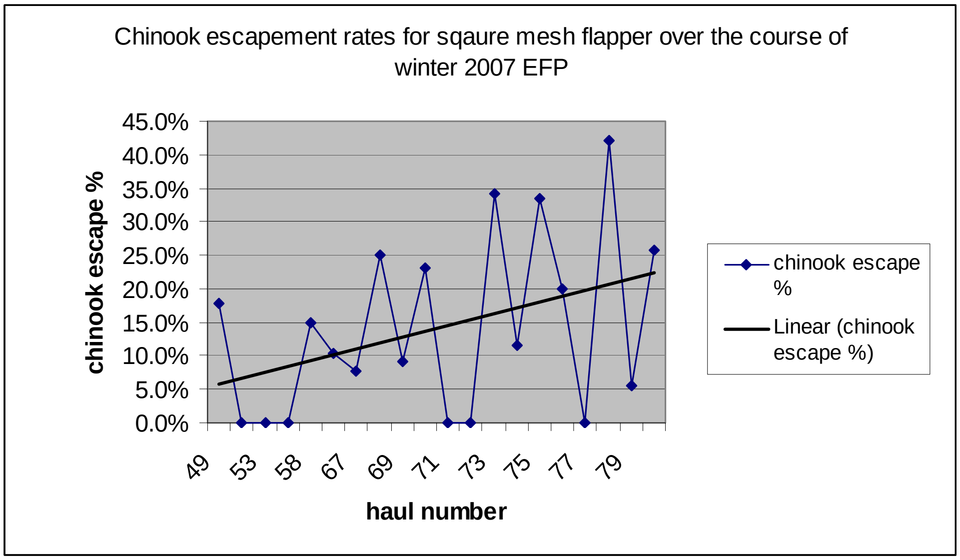


The flapper excluder device was the focus of testing in the winter of 2007 - the last stage of field work under EFP 05-02. The flapper excluder is essentially a sheet of weighted webbing that is held up against the escapement portals via water flow during normal towing speeds. This prevents access to the escapement portals when fishing is occurring. With the current design of the flapper excluder, periodic slowdowns of the vessel are needed to allow salmon to utilize the large escapement portals.

In our first test of the flapper device, an average Chinook escapement rate of 19% was achieved. This percentage was notably lower than what was achieved with tunnel and funnel excluders (Figure 1). Higher escapement rates for Chinook occurred on some of the individual tows and this is particular interest at this early stage of development of the flapper excluder (Figure 2). On these tows, the escapement rates in the vicinity of 30% to 40% occurred. These are approximately equal to the average rates achieved in earlier experimental trials of the flapper excluder.

These early results with the flapper device cannot, however, be taken as a definitive assessment of the salmon escapement potential with the device because they are based on limited testing and only evaluated a “first generation” concept for a flapper. Performance results were also highly variable on a tow by tow basis (Figure 2). From our previous experience with testing of excluders, this indicates that we have a lot to learn about elements affecting performance. For this reason, we feel that additional experimentation is needed to help identify design features to achieve higher and more consistent escapement rates.

Figure 2: Tow by tow Chinook salmon escapement rates from March 2007 EFP tests of the flapper excluder



Perhaps the most encouraging aspect of our preliminary testing of the flapper is that the device appears to avoid loss of door spread and bulges in the trawl intermediate. These problems, which result from pollock becoming pinned in the leading edge of the funnel and tunnel excluders, are fundamentally problematic to the widespread adoption and use of funnel and tunnel excluders in the regular pollock fishery. In our previous salmon excluder EFP (05-02), a great deal of design and testing effort was expended to resolve the bulge problem without a great deal of success. For this reason, our focus turned to the flapper excluder design where the successful operation of the excluder does not involve a tapered funnel to reduce the diameter of the trawl at a faster rate than the net's normal taper.

The specific objectives of the continued research we wish to conduct over the next three (calendar) years under a new EFP are: (1) ground truth the results of the first test of the flapper excluder, (2) evaluate the effects of small adjustments to the flapper in combination with variations to the way slowdowns are done during fishing (3) attempt in the latter phase of the EFP to optimize salmon escapement with the flapper device. In our experience, work on performance optimization is likely best done when more is known about the factors determining escapement rates.

Variations to the excluder design and to the slowdowns done during fishing include factors affecting the shape, materials, construction of the excluder including the amount of weight placed on the webbing that shields the escapement portals in combination with the amount of time the vessel speed is reduced to allow escapement to occur. Other potential areas for adjustments include the location of the excluder in the trawl and changes to the intervals between slowdowns. Likely combinations of these fishing and design elements will be evaluated in sequential controlled tests. All or just a subset of these variables may affect the performance of the flapper excluder.

The experimental design section below outlines the methods that will be used to conduct the tests described above. For reasons explained in detail below, all testing under this new EFP will utilize the recapture net that has been effectively used in our earlier EFP work.

<u>Note to explain why our current EFP applications focuses mostly on experimental design and changes in testing methods</u>: With the expiration of EFP 05-02, we have discussed with NMFS Alaska Region personnel the steps needed for obtaining a new exempted fishing permit. Because nearly all aspects of the administrative and functional elements of the new EFP would be identical to EFP 05-02 (including the exemptions to regulations that are needed), this application focuses mostly on changes to the experimental design for research under a new EFP. For example, under a new EFP we will use the same method for selecting a vessel for each stage of the field work, the same responsibilities for the vessel selected for the field work, the same role for Dr. Craig Rose of the Alaska Fisheries Science Center to guide and assist the research. This also includes the use of sea samplers for catch sampling and the same limits on where EFP fishing can occur. Finally, this EFP application requests essentially the same limits on groundfish and salmon allowances over the course of the EFP. The only difference being that with a fall 2008 start, the annual catch amounts will be spread over three calendar years (2008-2010).

Because all these basic EFP elements are essentially the same as those in our 2005-2007 EFP, this application for a new EFP essentially focuses more narrowly on a description of changes in the experimental methods from those described in our 2005 EFP application. This information should be sufficient to explain to the Alaska Regional Office of NMFS, the North Pacific Fishery Management Council, and the NPFMC's Science and Statistical Committee how we intend to modify our experimental design and why these adjustments make sense based on our prior experiences and stage of development of the salmon excluder.

<u>Justification for the EFP</u>: Mandates to reduce bycatch and bycatch mortality are set out in the Magnuson-Stevens Act. Tools to reduce and avoid salmon bycatch that are currently available increase fishing costs and sometimes even lower the value of the catch with longer fishing trips and degradation of fish quality due to excessive holding time before processing. For example, the salmon bycatch "Rolling Hotspot" closed areas currently in place under Amendment 84 temporarily close fishing areas when salmon bycatch rates are relatively high. Unfortunately, alternative fishing grounds with high pollock catch rates and lower salmon bycatch rates are sometimes not readily available. Therefore Rolling Hotspot Closures can impose high fuel costs on the fishery because more towing hours are needed to catch the pollock TAC.

The flapper salmon excluder has shown potential for reducing salmon bycatch. If the device can be improved, it may reduce the need for closures of key pollock fishing grounds due to salmon bycatch. Among salmon excluder designs tested thus far, the flapper excluder appears to be able to lower salmon bycatch rates with the least negative effect on fishing and the lowest level of problems and associated net repairs. With further development, the flapper excluder may be able to achieve salmon bycatch reduction objectives with fewer of the operational problems that have occurred with earlier excluders. A viable excluder would allow pollock fishermen to have a means of reducing or avoiding the costs of searching for and moving vessels to alternative fishing areas and other inefficiencies associated with salmon bycatch avoidance measures.

<u>Names of participating vessels, copies of vessel Coast Guard documents, names of vessel masters</u>: For each stage of our field testing under the new EFP, the principal investigator will notify the AKR Regional Administrator in writing of the name of the vessel selected including associated document numbers. The principal investigator will also notify all relevant enforcement agencies of the vessel documentation and dates and area of operations for the EFP work. This will include ADF&G, NMFS, and the US Coast Guard.

Exemptions needed to regulations affecting regular pollock fishing during 2008 and 2009

1. While conducting EFP testing under this permit, the EFP vessel must be exempted from the pollock industry's EFP that establishes "Rolling Hot Spot" area closures (now promulgated under Amendment 84) so that we can conduct our EFP testing in the salmon bycatch hotspots as necessary.
2. Ability to do up to 100% of testing inside the Sea Lion Conservation Area (SCA) as long as this area remains open for the regular pollock fishery. We are not requesting permission to conduct testing in any SSL protection areas such as rookeries and the SSL foraging areas.
3. Ability to conduct EFP testing with a catcher processor inside the Catcher Vessel Operations Area (CVOA) during B season. Catcher processors are normally excluded from this area in B season, but at times the CVOA has preferable conditions for EFP testing so we will need an exemption to this regulation for our testing on catcher processors.
4. Exemption from regular observer coverage requirements for vessels when participating in our salmon excluder EFP field tests. We need to be able to place up to two sea samplers on vessels participating in this EFP and redirect sampling to concentrate on effects of the excluder on salmon and pollock catches. This is the same exemption we have had in the past salmon excluder EFPs.
5. All groundfish and salmon catches during the EFP will not count against the TAC or any salmon bycatch caps or other inseason salmon bycatch measures in place during our EFP.

<u>Proposed catch limits for the salmon excluder EFP</u>

Proposed catch limits for Salmon Excluder EFP

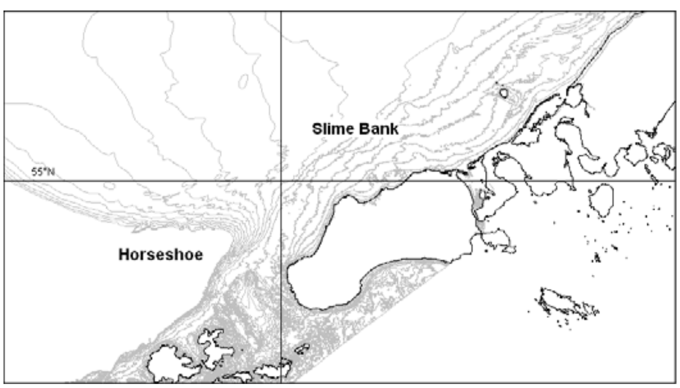
Field work stage	MT of groundfish (in pollock target)	Number of chinook salmon	Number of non-chinook salmon
Fall 2008	2,500	2,500	2,500
Winter 2009	2,500	2,500	
Fall 2009	2,500	2,500	2,500
Winter 2010	2,500	2,500	

Areas where EFP testing is expected to occur during fall 2008-winter 2010 testing:
For valid tests of salmon excluders, we need to be able to conduct EFP testing in areas with sufficiently high concentrations of salmon to achieve the sample size objectives of our experimental design. We also need to test where pollock catch rates are representative of actual fishing conditions in order to evaluate the effects of the excluder on pollock catch rates and to understand how salmon escapement rates are affected by realistic concentrations of pollock in the net. Conducting testing with realistic catch rates for pollock is important because the density of pollock in the net may affect the performance of the net for pollock fishing. It may also affect the success rate for salmon escapement. This is because salmon escapement depends on access the escapement portals which are at times blocked by dense aggregations of pollock. So successful testing depends in part on being able to access areas where pollock and salmon concentrations are representative of what can occur in the regular fishery.

Predicting where adequate concentrations of salmon and pollock will occur from year to year is inherently difficult. For this reason, it is difficult to predict where EFP fishing will need to occur. Locations of pollock have been highly variable in recent years, probably due in part to temperature anomalies in the Bering Sea. The spatial overlap of the salmon and pollock is even more difficult to predict.

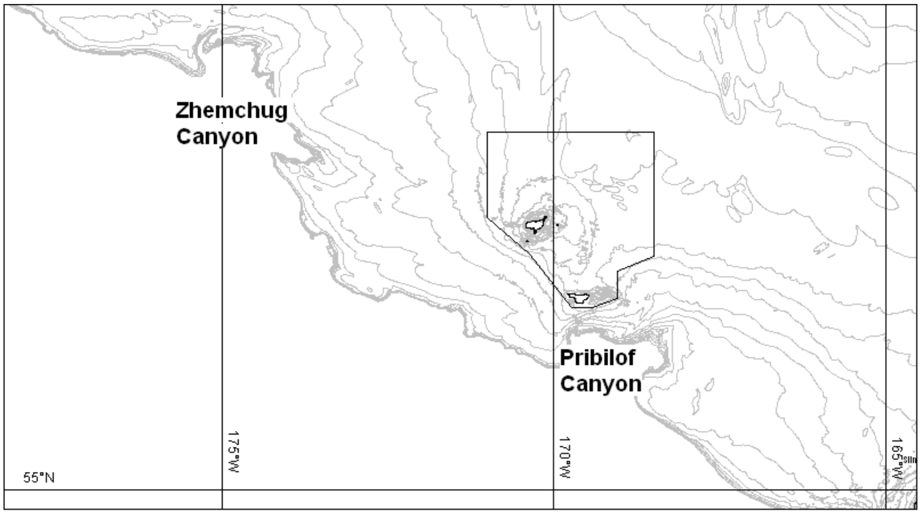
Despite year to year variability, we anticipate doing our EFP tests during the pollock A season for the two field seasons covered under this EFP (winter testing) somewhere within the areas known as the “Horseshoe” or the Slime Bank (see Figure 1 below). These areas are located to the northwest and north/northeast of Unimak Pass. Detailing exact testing locations within these areas is impossible given all the factors affecting variability.

Figure 1: Common pollock fishing areas adjacent to Unimak Pass



For fall testing, the general area where we can find adequate testing conditions is even more difficult to predict. During earlier salmon excluder EFP tests, we have found suitable testing conditions in the Horseshoe during late September and October. This is ideal because it is relatively close to Dutch Harbor in case we have equipment failures or need to obtain materials to repair our excluder or the recapture net. If suitable pollock and salmon conditions cannot be found in the Horseshoe, then we may have to conduct testing on the shelf area adjacent the Pribilof no trawl zone or in the headlands of Pribilof or Zemschug canyons. These areas are identified in the figure below. In most cases, the 80-200 fathom shelf outside of the Prbilof Islands no trawl “box” or the headlands of the canyons would be where we would expect to find adequate concentrations of salmon and pollock. In temperature anomaly years, pollock may school up in the canyons themselves and in that case we might need to conduct testing in the canyons themselves.

Figure 4: Common fishing areas around the Pribilof Islands



All or a portion of the EFP testing may need to be conducted within the temporary closure area under the pollock fishery's Rolling Hotspot closure area measures (Amendment 84). This is the case because these areas have tended to have more predictable salmon bycatch rates. From our past experience, we have found that at times the Hotspot Areas are the only locations where adequate testing conditions occur. This is particularly true when test vessel availability pushes our EFP testing to time periods which generally involve lower salmon abundance.

An assessment of effects of the EFP on "Affected Environment"

Pollock ABC and TAC in the context of groundfish FMP stock management objectives: The pollock TAC for 2008 is considerably lower that pollock TACs in recent years. According to the 2007 groundfish SAFE report, the downswing in pollock biomass seen in the stock assessment reflects several years of lower-than-average recruitment. Additionally, cyclical and/or anomalous climate and water temperature patterns may be affecting stock dynamics and recruitment success. The 2008 Bering Sea pollock ABC of one million MT is actually lower than the Tier 1 model ABC of 1.12 MMT. This more conservative harvest level was recommended by the AFCS stock assessment author at the Groundfish Plan Team meeting in November 2007 where the rationale was to add precaution in face of unknowns about recruitment and temperature/climate conditions. In December of 2007, the North Pacific Council's SSC and the Council adopted the stock assessment author's recommendation for the one million MT ABC in spite of the continued Tier 1 status of pollock within Bering Sea stock assessment framework. The NPFMC then opted to set TAC 1 million MT so in effect the Bering Sea pollock TAC is set at the ABC for 2008. This raises the issue of potential effects of allowing the additional pollock harvest for the salmon excluder EFP in 2008 and for 2009-2010 to the degree we can look at out years prior to the stock assessments.

If the salmon excluder EFP application is approved, the research plan calls for a catch of 2,500 Mt of groundfish in the Bering Sea pollock target fishery in B season of 2008. Assuming all the 2008 TAC is harvested, the EFP amount would push the overall annual pollock catch to 0.25 percent or one-fourth of one percent above the 2008 pollock ABC. While technically an overage, it stands to reason that this very small additional catch relative to the 1 million MT ABC. For this reason, it is doubtful such an overage would have a negative (or even a measurable) effect on the pollock resource in the Bering Sea.

Additionally, in recent years, several AFA cooperatives in the shoreside sector have not harvested their entire B season pollock allocations. This is likely due to the time cut off (end of October) currently in place as a Steller sea lion protection measure. If less than the entire pollock TAC is taken by the regular groundfish fisheries again in 2008, then ABC will not even be exceeded as a result of the allowance for the additional 2,500 MT pollock catch for the EFP.

For 2009, the EFP research plan includes A and B season EFP catches of 5,000 MT that year split evenly between A and B seasons. If we assume for the purpose of comparison that the pollock TAC and ABC in 2009 are the same as what was set for 2008, then the total amount of 5,000 MT for the EFP in 2009 would amount to a maximum of 0.5% (one-half of one percent) above ABC. Once again, the actual magnitude of the percentage of the potential ABC overage depends on how close the regular pollock fishery catch is to the TAC/ABC in 2009. While certainly nominally larger than the potential TAC overage that may occur in 2008, an overage of one-half of one percent of the pollock ABC is probably still not large enough to have a measurable effect on the pollock stock.

The annual ABC and TAC specification process for Alaska in fact includes a new stock assessment for the pollock resource in the fall of 2008. This would allow for a reconsideration of the salmon excluder EFP allowance prior to EFP field work. Thus if the 2009 ABC is considerably lower than for 2008 and hence the potential percentage ABC overage associated with the EFP is significantly larger than what is described here, consideration could be given to this issue prior to EFP fishing in 2009.

Potential effects of requested salmon excluder EFP groundfish harvest for 2010 (a requested allowance for 2,500 MT for the final stage of EFP field work) is not evaluated here because this last stage of the EFP is so far into the future that we do not really have a reliable way of predicting pollock ABC and the fraction that 2,500 MT comprises of that ABC.

Expected effects on other groundfish species: The percentage of the pollock fishery's catch that is comprised of pollock has remained at approximately 99% since the start of the AFA management system for pollock. EFP catches in previous salmon excluder EFPs have also maintained the same high fraction of pollock catch that occurs in the regular fishery. For this reason, our expectation is therefore that the catch of non-target groundfish species will be less than one percent of the overall EFP catches during each field season. This would involve approximately 25 MT of non-pollock groundfish catch in the fall of 2008, 25 MT in the winter of 2009, 25 MT in the fall of 2009, and finally 25 MT in the winter of 2010. This is a very small amount relative to the overall catches in non-pollock groundfish fisheries and therefore of little or no consequence even if it were comprised of a single non-pollock species.

Prohibited Species: Incidental catch amounts of halibut, crab, and herring in the pollock fishery have remained low for many years. For this reason, the expected catch of those species during salmon excluder EFP trials are expected to be insignificant. The principle prohibited species issue affecting the Bering Sea pollock fishery is the incidental take of Chinook and "non-Chinook" (principally chum) salmon. Our EFP application proposes limits of Chinook and non-Chinook salmon for the EFP of 2,500 Chinook for each field season (fall 2008, winter 2009, fall 2009, and winter 2010) and a take of 2,500 chum for the two fall field seasons (2008 and 2009). To look at the requested Chinook and non-Chinook salmon allowances for the EFP in the context of the bycatch from the regular pollock fishery, the Table 1 below lists the number of salmon taken as bycatch in the regular pollock fishery from 2005-2007 and the average numbers for the last three years.

Table 1: Salmon bycatch in the Bering Sea pollock fishery 2005-2007.

Year	# Chinook	# Non-Chinook
2005	74,967	711,938
2006	87,730	326,445
2007	130,139	98,140
05-07 Average	97,612	378,841

Numbers of Chinook salmon taken as bycatch in the pollock fishery have increased over this period while numbers of non-Chinook have actually decreased dramatically. For this reason, the number of Chinook and non-Chinook salmon proposed as limits for this EFP are compared in this section to the average numbers over the last three years. For 2008 where 2,500 Chinook and 2,500 non-Chinook are proposed as limits for the EFP, the requested EFP allowance for Chinook and non-Chinook salmon amounts to approximately 2.5% of the average number taken of the three year period for Chinook and 0.6% for non-Chinook. For 2009, the EFP proposes a limit of 5,000 Chinook (roughly 5% of the three year average take) and 2,500 non-Chinook (2.5%). Finally in 2010, 2,500 Chinook are proposed as an EFP limit which is 2.5% of the 2005-2007 take. These percentages for Chinook salmon are higher than other potential effects on the prohibited species discussed above so additional consideration of the effects is warranted.

Our EFP application below explains how the proposed limits for this EFP were arrived at. This was done to clarify the reasoning behind what at first glance may seem to be a relatively high proposed limit compared to the amount of EFP groundfish and in relation to historical monthly averages in the regular fishery during the months when testing is slated to occur. Our proposed limits on EFP salmon catches are intended to be high to avoid reluctance on the part of the vessel owner/captain of the EFP vessel to fish in high bycatch areas during the EFP. Fishing in these areas is necessary for sample size attainment objectives for the sequential trails for different variations of excluders. Another reason the proposed EFP salmon bycatch allowances are intentionally set high is to avoid hamstringing the research from the outset and possibly affecting our ability to engage an industry vessel as platform for the research. This is explained below.

To efficiently accomplish the sample size objectives, EFP testing will likely occur in areas with relatively high salmon bycatch rates including the Rolling Hotspot areas (formerly an EFP and now Amendment 84). This allows us to use the available groundfish allocation for the EFP efficiently thereby allowing us to test several variations of excluder designs in each stage of the field work (see experimental design below). The benefit here is that progress on the excluder design can be more rapid than would otherwise occur if the EFP could only test one excluder design each field season.

But EFP testing in these hotspot areas could conceivably generate salmon catches at the level of the proposed limits because bycatch rates in these “hotspot areas” can be very high at times. This is one reason we elected not to propose limits based on the average monthly rates for the months in recent years. If based on averages, we could expect to attain the limits on average half of the time which would mean that the EFP work would in concept have a 50% chance of being curtailed before it is completed. Furthermore, monthly rates in the regular pollock fishery are based on most of the fishing occurring outside the hotspot closures. So the tradeoff is that we need to have relatively high salmon limits (particularly for Chinook) on the EFP testing.

In all likelihood, our testing will not utilize up to the limit of Chinook for the test. But to be successful in engaging an industry vessel as a platform for the testing, we need to have limits that will adequately cover the high range of salmon bycatch numbers for the areas we propose to conduct the testing. Without these, there would be a significant chance that the EFP vessel would attain the salmon limits prior to catching the groundfish and therefore would not be able to catch the groundfish that is essentially helping to cover the vessel’s fishing and fuel costs during the EFP.

<u>Potential effects on Steller sea lions:</u> The EFP application does not seek any exemptions to the existing set of Steller sea lion protection measures. So EFP fishing will only occur in the areas that would otherwise be open to regular directed fishing for pollock. So for purposes of looking at the potential effect of the EFP, the focus here is on how the additional pollock harvest above the ABC might affect Steller sea lions. From this

perspective, the amounts of EFP pollock catch and the percentage of catch over the ABC (one-fourth to one-half of one percent of the 2008 ABC) assuming the TAC is actually taken in each of the EFP years and assuming TAC is set at ABC in 2009 and 2010. Because these potential overages are relatively small and because EFP fishing will not occur in areas that are not otherwise open to regular pollock fishing, the potential effects of the EFP on sea lions are expected to be negligible. Finally, it is worth noting that annual survey counts of sea lion numbers at sites adjacent to where EFP fishing will occur have been increasing in recent years.

Detailed description of experimental methods for our continuing EFP research for 2008-2010

This application for a new salmon excluder EFP is intended to support research that builds upon the excluder design that was the subject of the last stage of testing under EFP 05-02. As is pointed out in our final report on EFP 05-02 and as we related to the NPFMC in October 2007, significant work remains to understand the factors affecting encouraging but highly variable escapement rates achieved in winter of 2007 using the flapper excluder. The new EFP is requested to provide pollock and salmon bycatch allowances necessary for controlled testing of different device configurations and fishing procedures for the flapper excluders.

Experimental Design: The testing methods used for this new EFP would be limited to the use of the specialized recapture net that was developed for our salmon excluder testing under EFP 05-02. The reasons for relying solely on testing with a recapture net are as follows. For a portion of the testing done under previous EFPs, paired comparisons were used to attempt to detect the effects of the excluder on catch rates. These pairs of "standardized tows" (pairs of tows with and without the excluder device attempting to hold all other factors equal) were intended to evaluate performance of the excluder. The objective for testing without a recapture net was to avoid any potential influence of a recapture net on escapement rates. The potential for a recapture net to affect escapement has been noted in other fishing gear modification research. For our work, there was potential for the recapture net to mask problems with pollock escapement from the excluder. This issue was raised by several pollock fishermen during presentations of the results from our testing during the first year of the EFP work in 2003.

In spite of our hope that paired comparisons would help to ground truth our earlier results, our tests with that methodology in the fall of 2005 showed that the degree of ambient variability was simply too great to allow valid comparisons. For this reason following the fall of 2005 test, we focused on reducing potential effects of a recapture net on our test results. This was done through examination of underwater video and work in a flume tank whereby we came up with a plan to improve our recapture net design. Steps here included improved water kites, changes to the method of attachment to the main net, and the use of a one-way funnel to reduce chances for reversed escapes. Due to these improvements and the video footage and sonar images we obtained during use of the recapture net, our confidence has since increased that the tests with recapture net are valid. For this reason, all of our EFP tests since the fall of 2005 have relied on a recapture device.

Experimental design elements in conjunction with testing with a recapture net: For the portions of our previous EFPs where recapture nets were used, we relied on a statistical power analysis described in detail in our 2003 EFP application. This new EFP application relies upon some aspects of the basic power analysis from 2003 so the power analysis and how it was used to come up with the amount of fishing needed to generate the desired sample size is reviewed below. A departure from our original approach to sample size generation is also described as part of our methods for this new EFP. This new approach is based on our experiences with excluder testing in the recent tests wherein we have been able to conduct multiple tests of excluder designs during a given stage of our field work instead of a single test which resulted in our earlier tests. Hence through our experiences since the first tests utilizing the power analysis developed in 2003, we have made some important adjustments to the way the 2003 power analysis is now used. These are explained in detail below.

The basic approach behind testing with a recapture net is to evaluate the proportion of the number of salmon (or weight of pollock) that escapes relative to the total number of salmon (weight of pollock) that are caught during the test. Sample size determination is based on determination of the number of salmon offered the “escapement opportunity” that the excluder provides. Hence the power analysis is the determination of the number of escapement opportunities needed to assess performance at the desired level of precision needed for the statistical power relationship.

The sample size determination portion of our 2003 EFP application was based on the assumption of a proportion of 50%, (probability of 0.50) as the expectation for the proportion of effect of the excluder on salmon escapement. This value maximized sample size for a given set of desired statistical power and desired degree of statistical confidence. So it was a conservative value that avoided under-sampling. Based on our tests of funnel excluders and preliminary work on a flapper excluder, this initial assumption of a 50% escapement proportion still appears to be a reasonable expectation for eventual performance of the excluder. This is because in some of our trials we have been able to achieve average escapement rates of up to 43%. So for our experimental design in our 2003 EFP and in this proposal for continued EFP tests, we have assumed a proportion of effect (salmon utilizing the escapement device, i.e. escaping) of 50% ($\bar{p}$ = 0.5) which still makes good sense in terms of escapement performance potential and practical sampling objectives.

The accompanying statistical power analysis evaluated the tradeoffs associated with different sample sizes and our goal for evaluation of salmon escapement proportion was to design for an 80% percent probability of detecting a 10% difference in proportion of effect from the underlying proportion of 0.5. The preferred level of confidence interval here was a 95% statistical confidence level or alpha of 0.05.

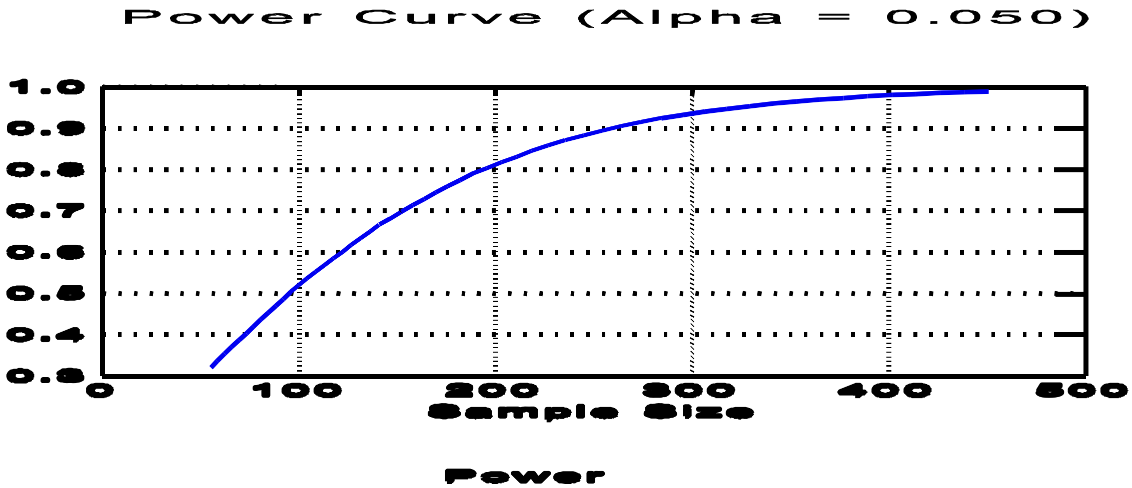


Figure 2 from our 2003 EFP application: Probability of detecting difference from proportion of 0.6, when the underlying proportion is 0.5

Applying these power analysis objectives resulted in a target sample size of 200 salmon subjected to the test (provided the opportunity" of escapement via the excluder). This target was used to estimate the salmon catches necessary for a valid test of each excluder configuration. It is important to recall, however, that this approach was used to generate a target sample size for chum salmon (non-Chinook) only and an alternative approach was used for Chinook back in 2003. This was because achievement of a sample size of 200 Chinook salmon was not feasible at that time. Tow-specific Chinook catch rates per ton of pollock in the winter 2002 pollock fishery data (data obtained from Sea State in 2003) were at that time in the hundredths of Chinook per ton. To have a reasonable expectation of generating a sample size of 200 Chinook salmon back then, a prohibitive amount of pollock fishing would have been needed. This is important to understanding the approach we took in 2003 and how this has evolved over time.

In 2003, Chinook salmon bycatch rates based on the Sea State data we used for the power analysis were actually roughly 0.025 Chinook per ton (during the "A" season for the catcher vessel sector). So based on the bycatch rates at that time, we estimated that as much as 8,000 MT of pollock fishing to generate a sample of 200 Chinook salmon. For this reason, as we reported to the NPFMC's SSC back in 2002, it was not pragmatic to conduct a test with the more widely accepted 95% confidence level.

For this reason, we eventually decided in consultation with the Alaska Fishery Science Center and the NPFMC's SSC that for our evaluation of the performance of the excluder for Chinook salmon, we would accept a lower level of statistical confidence (alpha of 0.10 or a 90% confidence interval instead of the more conventional 0.05 or 95% confidence interval). The sample size needed for the alpha = 0.10 test was only 30 Chinook salmon. This reduced the necessary amount of pollock fishing to a more manageable amount but also created a reduction in expected confidence in the test results. This was an unfortunate trade-off given the importance of having a firm assessment of the performance of the excluder on Chinook salmon.

Evaluating how the assumptions used for the 2003 EFP to generate sample size apply to the current pollock fishery: In the years since our 2003 power analysis, Chinook rates per ton have been significantly higher. On a gross level, approximately 130,000 Chinook salmon taken in the Bering Sea pollock fishery in 2007 for a total catch of approximately 1.4 million metric tons. This translates into an overall average rate of about 0.09 Chinook per ton of pollock for 2007. Of course, the time window where the pollock fishery tends to catch Chinook salmon is actually the winter season and the latter portion of the pollock fall season. Hence a more relevant indicator is the monthly bycatch rate for Chinook salmon in months when Chinook salmon bycatch can be expected to be high. For 2007, the number of Chinook taken per ton of pollock in the Bering Sea pollock fishery overall (all sectors) was 0.26, 0.13, 0.05, and 0.28 for the months of January, February, March, and October respectively. Given this, we can comfortably say that average Chinook salmon bycatch rates for that window of time have generally been close to 0.2 Chinook per metric ton of pollock (data provided by Karl Haflinger, Sea State Inc).

So one consequence of the higher Chinook bycatch rates in the pollock fishery today is that we can now make use of the higher, more acceptable alpha= 0.05 level for statistical confidence relationships for evaluating the performance on Chinook salmon.

As we have learned from our testing experiences in recent years, average Chinook bycatch rates in the pollock fishery are not necessarily indicative of rates that can be attained in our EFP testing. EFP testing in areas with concentrations of salmon is most efficient because it allows us to attain the necessary sample size in the shortest time period possible and with a smaller amount of pollock catch in the EFP than would otherwise be possible. This is the reason we have requested an exemption to allow us to conduct testing in the Rolling Hotspot Closure areas (now in place under Amendment 84). This has allowed us to attain higher rates than the fishery on average when this is needed for objectives of our tests. For instance, in March of 2007, the average rate of Chinook per ton of pollock in the regular pollock fishery was 0.05, as reported above. In that same month, we conducted the tests of the flapper device inside the pollock industry's Rolling Hotspot closure areas and achieved Chinook bycatch rates of over 0.2 Chinook per ton of pollock on average. We also had some individual tows well in excess of one Chinook per ton of pollock. The ability to access these areas of higher salmon concentrations is important because it essentially allowed us to conduct effective testing at a time when pollock vessels had mostly finished their regular AFA pollock fishing and were thus available to work as test platforms.

Evolution of our approach to determination of sample size and amount of testing that can be accomplished during a given stage of field work:
Our approach to determining the amount of fishing needed to generate minimum sample size has evolved considerably from the methods developed for the original tests done with a recapture net. So in the portion of our 2005 EFP application that set out to use a recapture net, we explained in our application that we would likely be able to accomplish a suite of tests with a reasonable expectation that each individual test of a given excluder design would achieve at least the desired sample size of 30 Chinook. We also speculated

at that time that we could achieve a sample size of 200 Chinook for each of those tests (hence achieving the sample size for the more preferable confidence level for the experiment). And in fact, in most cases, we were able to achieve in excess of 200 Chinook for each of those individual tests. The single factor that appears to have made attainment of the higher number of Chinook salmon needed for the power analysis objective for the 95% confidence level (200 Chinook) was our ability to use the salmon bycatch hotspot areas identified in the fleet's Rolling Hotspot avoidance program.

Hence a more pragmatic approach to testing was to identify the amount of test fishing we felt we could accomplish with a practical amount of pollock and salmon bycatch allowance for the EFP. Under this approach, the main considerations for determining those quantities of pollock and salmon were the amount of time we could staff the field experiments, the minimum amount of fishing necessary for making the opportunity practical for engaging a pollock vessel for the EFP test, and the number of adjustments to the excluder device that we could practically test given that a number of performance outcomes that have to be considered in preparing for field work.

So in conjunction with Dr. Rose at the Alaska Fisheries Science Center, we worked out a plan to optimize the amount of testing that could be done during each stage of the field testing. For each proposed stage in the field, we allocated approximately 2,500 MT of pollock. This amount allowed us to conduct sequential tests of either different excluders or tests of the same excluder with sequential adjustments in the placement or fishing methods with a given excluder. Each of these sequential tests was continued until approximately 200 Chinook salmon were taken. After at least the target sample of Chinook was taken, we moved on to the next test of a different configuration of the same excluder.

In addition to achievement of the minimum sample size, we set some additional guidelines to ensure a sufficient amount of test fishing under various conditions that we expected to affect performance of the excluder (e.g. day versus night fishing, fast pollock fishing versus slow). Therefore, even if the guideline number of Chinook were taken in a given test, we would continue the test until we felt that we had tested the device under a reasonable cross section of fishing conditions. On three occasions, the minimal sample size was achieved in fewer than eight tows and testing continued with the same device until at least 10 tows were completed.

In this manner, we essentially adopted the guideline of 2,500 MT of groundfish catch in the pollock fishery for a given stage of field work. This amount of pollock was sufficient for generating the salmon sample size for trials of approximately two to three different excluder designs or variations in the way vessel slowdowns were conducted. So for each field season under the last EFP two to three different excluder variations were tested such as the amount of weight on the device, location in the net, or the duration of the slowdown to allow the device to collapse. The target amount of catch per tow has been between 60-80 MT, so this typically allowed for between 30 to 40 tows per field testing stage and the salmon sample size was generally achieved in approximately 8-10 tows.

For most pollock vessels, this translates into between two and four weeks of testing depending on catch rates and the distance to the fishing areas with suitable pollock and salmon bycatch rates. For catcher processors, 2,500 MT of groundfish works out to be closer to ten days to two weeks of testing. But on catcher processors, two different excluders can be tested simultaneously if they are placed in separate nets (same net design) and fished in rotation. This is possible because unlike catcher vessels that need to return to port every 2-3 days, these vessels do not have to return to port until their frozen product hold capacity has been reached. Also, catcher processors have the sampling facilities for haul by haul catch accounting and sufficient personnel and deck space to allow two designs to be tested at once.

In 2006 we constructed a second recapture net for simultaneous testing work on catcher processors. With two operational recapture nets, we therefore were able to accomplish more testing per day provided the devices being tested were second or third generation devices that were expected to work reasonably well.

So under this approach to testing, we have been able to test several logical adjustments to a device in a single stage of field work. For each separate test, we held all the testing variables (e.g. towing speed, location and configuration of the device, duration of vessel slow downs etc) constant during each test during a given stage of field testing. Once that test is completed, we then move to what we have anticipated as the next logical step for testing that excluder.

In our experience, catcher vessels are best suited as testing platforms for the basic design work for new excluder concepts. This is because these vessels typically have the flexibility to break off from testing and resume the work when we are ready. Asking the testing vessel to curtail testing and make a partial trip or do multiple starts and stops of the testing is generally workable for catcher vessels. The potential need to break off testing as well as work with the EFP personnel to repair the recapture net before test fishing can recommence is made clear in the contract that engages vessels for testing. As long as the potential applicant knows this may be needed and plan for that eventuality when they are apply for the EFP work, problems and misunderstandings are avoided.

For catcher processors, this flexibility is not really feasible given their schedules and the costs of slowdowns due to the number of people on board and the economics of those vessels. At different stages in the development a proofing of a given excluder device do need to utilize catcher processors because they provide excellent catch sampling facilities as well as a platform that can offer the advantage of being able to accomplish multiple tests simultaneously. So the selection of the best vessel for a given stage of testing essentially depends on the degree of confidence we have in the basic performance expectation for a given excluder design. Once we have sufficient confidence that a given excluder works under most conditions that can be expected in the fishery, we can move to testing on catcher processors. On the catcher processor vessels, the larger towing force and water flow and mesh opening parameters are also of specific interest for understanding how the excluder functions.

Considerations for the relative merits of this sequential approach to testing compared to earlier methods

The advantage to being able to multiple excluder variations at each stage of field work is that this likely allows for faster progress in the development of a viable excluder than was possible before. But the downside is that we are relying on what many might consider to be a relatively small amount of test fishing to make decisions about the performance of changes in the excluder. This raises the question of the applicability of the test to a broad range of fishing conditions given that performance is typically evaluated from testing that comprises 8-10 tows. The specter of Type II error is also a consideration here. Results from one test to another might vary more from differences in the ambient testing conditions (pollock catch rates, proportion of day versus night) than from actual differences in the excluder design. For this reason, we cannot eliminate the possibility that over the course of our tests, we may have made decisions about the factors affecting escapement rates that were driven more by the conditions affecting testing that by actual performance differences from variations in those facts.

So our decisions on excluders along the path of development of salmon excluder could have taken some wrong turns or at least abandoned some excluder variations that had at least as much promise as the ones we have continued to work on. However, the tradeoff here is that increasing sample sizes and testing over a wider range of conditions for each excluder variation would decrease our ability to evaluate promising excluder configurations and identification of a truly effective device.

The underlying issue here relates to the relative amount of certainty we can have regarding our results. But this issue should be considered in the proper context. In fact, most of our work to date has concentrated on modifications to funnel and tunnel excluders to resolve problems with bulges in the net and other factors affecting pollock fishing. During the tests of adjustments to the excluder to resolve these problems, we have generally achieved Chinook salmon escapement rates in the range of 30-40%. Our tests were not designed to allow us to tell whether the different average escapement rates of those tests are statistically different from one another. But the repeated findings of Chinook escapement in that range suggest that what we have detected is probably real. Additionally, we have attempted to conduct tests with methods other than using a recapture net to help ground truth those results but the use of paired comparisons was not successful. Finally, we have received feedback from pollock fishermen who have conducted informal trials of our different excluders in the regular fishery. While this feedback has confirmed our findings regarding deployment issues and problems with pollock becoming entrained in the intermediate ahead of the excluder, it is not as useful in terms of confirming salmon escapement rates. Fishermen’s impressions of salmon escapement rates are of limited value because without are recapture net, it is unlikely that they would have any way of detecting a difference in their salmon bycatch rates.

Our EFP results will probably never be able to adequately address the criticism that our methods do not include independent replications of test results and other standard practices for laboratory science. But in reality most of our work to date has concentrated small adjustments to funnel and tunnel excluders and we have tested several versions of these excluders with enough of our salmon and pollock escapement rate results falling into the same general range to suggest that we are likely seeing a real effect of the excluder. As we move to testing the flapper excluder, a relatively new design, the importance of testing over a larger range of fishing conditions before modifying the design is clear. This issue is therefore taken into consideration in the plan for testing the flapper excluder under the new EFP.

In October of 2007, we presented to the NPFMC and its advisory bodies the results of our tests over the last two years, covering several adjustments to the funnel device and the first test of the flapper excluder. After considering the results and our methods, the NPFMC's SSC pointed out that while the development of the excluder through our EFP certainly suggests that there is potential for the device most recently tested (the flapper), it would be worthwhile to repeat the test with the same exact device and testing conditions to the extent possible. This is clearly a helpful suggestion at this of work on this new excluder design. For this reason, we have incorporated the SSC's suggestion for repeating our test of the first flapper excluder into the testing plan for this EFP. The plan for repeating the flapper test will utilize the same testing vessel, same net and the same flapper excluder but unfortunately due to timing constraints will not allow testing to occur at the same time of year as the 2007 flapper test.

Detailed plan for testing over the years covered by the EFP application.
We propose the following suite of excluder tests over next three calendar years:

<u>September/October 2008:</u> Test 1: A "repeat" of March 2007 "square mesh" flapper test with same test vessel, same net, same excluder, same recapture net; Test 2: Repeat test 1. Test 3: If sufficient groundfish and salmon bycatch allowance remains for a third test, test an appropriate adjustement to the same flapper or possibly different flapper. Ideas for the most promising adjustments to the flapper excluders for Test 3 will be developed in consultation with pollock fishermen prior to the September/October 2008 field tests. This will occur from captains' meetings conducted prior to the B season this summer. Quantity of pollock needed for fall 2008 testing: up to 2,500 MT of groundfish in pollock target and allowance of up to 2,500 Chinook salmon and 2,500 chum salmon.

<u>Winter (late February to March) 2009:</u> Additional testing of flapper device tested in fall of 2008. Some design adjustments to the flapper will be considered depending on the results of the fall 2008 testing. Once a baseline test of the flapper is conducted, the remaining tests will evaluate the effects of adjustments to the excluder or fishing methods for its use such as duration of the slowdown, manner in which slowdown is conducted (during turns versus regular towing). Ideas for adjustments to the excluder or manner in which it is used will come from informal meetings with captains following the 2008 "B" season. The type of vessel needed for this stage of the continuing work from fall of 2008 will depend on the stage of development of the excluder. If following the fall 2008 testing we have an excluder that is working reasonably well and the objective is to ground truth this performance on a vessel that can do this most efficiently, then a catcher processor vessel might be the preferred vessel for this test. If we are still struggling with design issues and cannot reasonably assume that the excluder will work without

disruptions to the testing and the need to repair the excluder or the recapture net, then we will focus on a catcher vessel for this stage of the testing. The vessel will be selected by NMFS AFSC review panel and applications will be solicited through an RFP process as was done in previous EFPs. Catch needed for this test is 2,500 MT of groundfish in the pollock target fishery, up to 2,500 Chinook salmon.

Fall 2009: Additional testing of device or devices tested in winter of 2009. After baseline tests to replicate the performance obtained from the most promising design tested from the winter of 2009 are completed, additional tests with adjustments to the excluder or fishing methods will be done. These will include adjustments such as duration of slowdown, manner in which slowdown is conducted (during turns versus regular towing), or other factors such as how far back in the net the excluder is placed. Prioritization for adjustments to the device of interest will come from informal meetings with captains following the 2009 "A" season. Depending on the stage of development of the excluder, a catcher vessel or catcher processor may be used for these tests. The test vessel will be selected by NMFS panel through RFP process as was done in previous EFPs (see 2003 or 2005 EFP application) Catch needed for test is 2,500 MT of groundfish in the pollock target fishery, up to 2,500 Chinook and 2,500 chum (non-Chinook) salmon.

Winter (February/March) 2010: Testing of the most promising devices from the testing from fall 2008-fall 2009 with the objective of improving/optimizing salmon escapement performance. Ideas here might include using artificial light or other attractants to improve performance of those excluders. Another approach might be place additional weight an earlier flapper excluder panel such that it would remain partially open during regular towing. This could potentially optimize escapement by allowing some salmon to exit during towing and additional escapement during periodic slowdowns. This design might also avoid the bulge problem encountered with funnel excluders because the over-weighted panel would be designed to push back up (to close) when a large concentration of fish is moving through the intermediate where the excluder is installed. Depending on the stage of development of the excluder, a catcher vessel or catcher processor may be used for these tests. Vessel will be selected by NMFS panel through RFP process as was done in previous EFPs (see 2003 or 2005 EFP application). The decision of what gear designs to test to optimize salmon escapement will be made follow a meeting with the pollock captains and interested gear manufacturers will be conducted during the Pacific Marine Expo in November of 2009. This meeting will solicit feedback on the results of our earlier testing and design features that appear to work the best. Feedback from that meeting will be used to prioritize ideas for modifications to the flapper excluder to optimize performance. Catch needed for test is 2,500 MT of groundfish in the pollock target fishery, up to 2,500 Chinook salmon.