Appendix: Expanded Discussion of
Chinook Salmon Bycatch Data Collection (RIR/IRFA) Alternatives 3 and 4

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Introduction to this Appendix

This appendix is a supplement to the RIR/IRFA analysis of Chinook salmon bycatch data collection options 3 and 4. It is intended to provide more detail, explanation, and scientific support for these data collection options, which were developed upon Council request by AFSC but analyzed in the RIR/IRFA by NPFMC.

This document aims to be as complementary as possible to the RIR/IRFA and to minimize redundancy wherever possible. It provides the scientific rationale for how the salmon bycatch program can be best analyzed and monitored, with the intent to meet the problem statement laid out by the Council. Specifically, data elements are presented that would facilitate the Council's stated intent of "evaluating the effectiveness of the IPA and the salmon bycatch action." The modeling philosophy developed is intended to be as simple as possible but as complex as necessary to best inform the Council.

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Executive summary of the data collection options

- The options developed in this analysis were chosen after consideration of the currently available data, the potential benefits of collecting new data, the quality of data that can be collected, and the burden imposed on industry through the data collection.

- The motivation for the proposed data options is exclusively to evaluate the effectiveness of the salmon bycatch IPAs. This means understanding how the incentives affect the bottom line (i.e., net revenues) of the fishery and appropriately accounting for the complexities that affect the fleet's experience and the included data elements have this intent.

- While the resulting quality of the data proposed under each alternative is uncertain, we expect to be better informed with enhanced data collection. It is likely that the collected data will improve our ability to estimate how the value of salmon changes across bycatch conditions, informing the Council about the effectiveness of the plan. Collecting cost data will also allow us to estimate the changes in travel costs that result from vessels fishing differently to avoid bycatch.

- Travel cost data can be observed for most vessels with as much accuracy as the Council deems necessary. AFSC's discussions with industry and Northern Economics' conversations with both vessel engineers and industry indicate that vessel operators can estimate average fuel consumption under different conditions. Collecting these averages appears to be an efficient means to collect relatively accurate data. If desired and deemed necessary, the Council could investigate whether this information should be recorded on log books or if the Observer Program could take regular observations of vessel flow meters in a safe manner. In Alternative 3, cost data are collected in two forms so that the data can be verified.

- The RIR/IRFA analysis of Alternative 3 suggests that it is very likely that the data collected will not only of poor quality, but misleading. Given that the proposed collection is focused on data that industry knows and generally collects, the likelihood of data being this erroneous to such an extent appears low. Additionally, while unknown data error by definition cannot be identified, there are many ways to check for consistency of data. Data in question can be added and removed from models to see whether their inclusion improves how well the model explains and predicts the observed behavior of the fishery. Individual observations can be compared to averages, costs can be compared to those for similar sized vessels, and information submitters can be asked about their survey responses. These are standard methods of checking for data consistency.

- The fundamental uses of travel cost data and improved product data collected in Alternatives 2 and 3 are to evaluate whether we observe persistent avoidance of bycatch at levels that should be affected by the IPA. Among other modeling and qualitative and quantitative analysis, we propose develop models to examine how observed choices in the fishery are correlated with expected revenue, travel to a location, and bycatch. Additional controls can be included to account for other observable factors (e.g., vessel size or efficiency, port location, weather) that have persistent, systematic impacts upon decision making processes. There are significant barriers to the development of this type of model using only the data available under the status quo. First, we do not observe the relative revenues observed from going to different areas. Second, we do not observe vessel costs. Currently, observed distances can act as a proxy for costs, but these do not capture the fuel consumption or cost variation that exists in the fleet that may affect vessels quite differently, especially under high fuel price conditions.

- Data available under the status quo will reliably inform us where and when fishing and bycatch are occurring. However, it is unlikely that they will provide sufficient information upon which to develop meaningful conclusions about the impact IPAs developed under Amendment 91 have at all levels of salmon bycatch because we do not accurately observe the economic variables (travel costs and spatially explicit revenues) that vessels must balance against the IPA incentives.

- While all data potentially have some amount of error in them, data elements, such as fuel costs and product revenues that match the information that companies collect and utilize themselves are most likely to be accurate. Conversations with a variety of people indicate that these are data that are collected, utilized, and carefully scrutinized by most companies in the industry.

- There is a small amount of existing cost data currently collected by AFSC and Northern Economics for North Pacific fisheries. These data have substantially informed our understanding of fuel cost data, but could not be reliably used in the Council's future analysis of the salmon bycatch program because they pertain only to catcher-processors using longline gear.

- Data on salmon and pollock markets have the potential to substantially inform the Council on the value of salmon bycatch to the pollock fishery. To reduce the possibility of misreporting and misinterpretation, the data should be collected in such a way as to maximize their quality.

- Collecting improved product values for roe and other products is a significant data collection undertaking. However, product prices (e.g., roe) are extremely valuable for characterizing the spatial trade-offs between pollock fishing and salmon bycatch avoidance and in turn, determining the financial impacts of proposed Amendment 91. Other product information would be valuable to better characterize the behavior of the fishery and could be cost-effectively collected if roe data is also collected. To reduce the burden on industry, these products were initially eliminated from the proposed data collection. However, additional conversations with industry have suggested there may be significant value from collecting these data.

- The primary proposed roe data collection (Alternative 3, roe data collection Option 1) does not propose to standardize roe grades across companies, but rather proposes to calculate or estimate the values for what vessels catch. With a relatively few exceptions, representing smaller participants in the fishery, companies have indicated that they track the value of their roe production and sales with substantial accuracy and can report this information.

- A second roe-collection option (Option 2) is presented in the analysis, at the request of some members of industry. This second option attempts to capture the information that most vessels collect on the general quality of data at the haul-level. While it is likely that this could improve our knowledge of the relative value of roe in different areas, it is difficult to know the quality of these data and it will be very difficult to verify.

- When combined with trip-level revenue data, cost data will allow analysts to examine how differences in vessel net revenues affect participation in salmon bycatch markets and avoidance behavior.

- Examining bycatch data and the net revenues from vessels fishing in different areas can potentially be evaluated to assess whether bycatch reduction costs can be reduced and/or bycatch performance improved by better informing vessels of the net benefits of fishing in different areas (after accounting for net revenue and the costs of bycatch).

- Collecting these data will also allow us to understand the values that fishers receive for fishing at different times of the year. Industry representatives qualitatively and quantitatively discuss the value of fish recovered at different times of the year, but neither NMFS nor the Council possesses this information.

- The self-reported skipper survey data will not be verifiable, but should provide a valuable opportunity to systematically collect information on the fleet's salmon bycatch experience.

- Revenue, cost, and trade data together allow for the most thorough ability to analyze the Council's actions. Information from the market data can be integrated with cost and revenue data and analysis of the IPAs to provide an improved understanding of how Amendment 91 affects fishing behavior and how the salmon bycatch quota market functions. If the data are collected and models of fleet behavior are developed as proposed in Alternative 3, by definition "models" cannot include all elements or factors affecting decision makers. However, the models will possess the primary pieces of data that reflect the economic trade-off that vessel operators make when they fish in different areas with different expected revenues, travel costs, and salmon bycatch.

- The current action is about the collection of data and future analysis conducted with the data will be carefully evaluated after it is collected. Models will be subject to vigorous peer-review, evaluation by the SSC, and subject to public comment before any results will be provided to assist in fishery management decisions. As is discussed in the analysis and illustrated in the references included, the modeling approach we are likely to utilized is well-developed. Other modeling and analytical options will also be considered and applied as appropriate.

- The additional information collected under Alternative 4 supplements Alternative 3 data with some information about the costs of extending season by accounting for the basic costs of extending the season (for the vessel only). Thus this alternative provides insight into some additional costs imposed by the Council's actions, but does not capture the total costs of extending the season. True costs for industry of extending the season due to high bycatch include 1) the costs listed and the observer costs known to NMFS, 2) more minor vessels costs (e.g., insurance), 3) costs to plants, which are very difficult to estimate, and 4) opportunity costs to fishermen who fish longer for the same income.

- The Council's salmon bycatch program is a novel means of addressing bycatch and we would expect the nature of the IPA incentives to evolve with experience. A better understanding of the manner in which vessels respond to IPA incentives can inform industry on the means to improve the incentive mechanisms and provide transparency to this process.

- While the primary intent of collecting the data elements proposed in the alternatives is to better evaluate and understand the effectiveness of the IPAs and the salmon bycatch program, it is worth noting that there are other potential benefits of collecting these data. Travel cost data will allow for estimates of the costs of any Council action that alters where vessels fish (e.g., area closures, changes in seasonal allocations that alter fishing locations). Regular collection of roe data could also provide valuable biological information on the relationship between roe production and recruitment and environmental variation. This could in the future lead to be more effective and economically effective management of the pollock fishery. Additionally, improved product knowledge will better inform the Council in economic impacts benefits of fishing in different locations.

Alternative 3 Discussion

<u>Evaluation of quality of data to be collected</u>

Data quality issues for each of the sub-items for the alternative are addressed individually below. Except where noted, general data-quality controls that would be implemented for all data collections include the following:

- Ongoing consultations with submitters to identify data quality problems caused by survey instrument design
- Mandatory reporting, with penalties for noncompliance
- Certifications of accuracy and completeness of all submitted data, signed by submitters
- Census of each subject population
- Records-based validation audits.

Consultation with submitters is particularly critical in the preparation and initiation of the data collection. Careful pretesting of the survey instruments is essential to ensure that survey questions will be consistently interpreted by submitters and will produce consistent and accurate results. It should be noted, however, that previous experience suggests that mandatory completion and submission of data collection forms is often necessary to prompt submitters to devote the time and effort necessary to fully understand the reporting requirements and identify errors in the design of the survey instrument. As such, data quality may be somewhat limited in the first 1-3 years of data collected under this and other alternatives.

The mandatory reporting requirement coupled with the population census approach, while in themselves they do not assure accurate and complete reporting, do eliminate a number of potential data quality limitations associated with sampling and non-response error that would be encountered with voluntary and/or random selection for survey participation.

Records-based validation audits have been specified by the Council in both the BSAI Crab and Amendment 80 Economic Data Reporting programs and could be included as a provision in the preferred alternative. Validation audits have been implemented through contracts with certified public accounting firms acting as third-party auditors, and the audit protocols have evolved somewhat since they were first implemented for the Crab EDR program. Currently, individual data reports are selected for audit either on the basis of random sampling or, in a small number of cases, on the basis of anomalous reported data.[1] In both cases, selected data elements are identified by data collection managers which are then validated by auditors by comparison to supporting documentation supplied by the data submitter, which may include vessel logbooks, crew settlements, invoices, or other financial or operational records. Audits may be conducted either on-site at the submitter's premises or by means of documents delivered to the auditors. Records are analyzed and classified according to the quality of evidence they provide for validating the reported data. Where the quality of supporting documentation is sufficient, auditors identify the correct value to report for each audited data element, which is then compared to the original reported value. The quantitative validation results produced from these protocols include, for each audited data element, the percentage of survey response values that are supported by accurate recordkeeping and the mean and variance of the reporting error for supported values.

The validation audits permit documentation of quantitative data quality measures for these data and represent a rigorous standard for data quality assurance in self-reported social science data.[2] The audits also provide a means for enforcing complete and accurate reporting. With signed certifications of data accuracy and completeness, intentional misreporting revealed by the audits may be cause for enforcement actions. Enforcement has to date been invoked in the BSAI Crab and Amendment 80 EDR programs only in rare cases of gross noncompliance.

Quality of Data for Alternative 3, Sub-item 2: Surveys to estimate the costs of moving vessels and of gear/equipment purchases or modifications for salmon bycatch avoidance

Industry participants familiar with vessel operations have expressed that they are able to provide an average rate of fuel consumption (i.e., gallons/hour) when fishing and transiting with a high degree of accuracy. Many vessels have flow meters indicating the instantaneous rate of fuel use, which is precisely the information that is requested on the survey. Vessel flow meters can be extremely accurate, with some meters being accurate to +/- 1 percent.[3] However, industry participants have stressed that the cost for a particular vessel to travel a given distance can vary dramatically according to weather and currents even if the gallons of fuel burned per hour does not vary greatly. Utilizing VMS and observer data, analysts can examine the time spent on the grounds and estimate the amount of fuel used by each vessel over the course of the year, based on the hourly averages. One way to assess the accuracy of those estimates is to compare these values with the reported company records on actual fuel expenditures. If these are close, it is a good indication that the average fuel consumption rates are relatively accurate (the opposite holds true as well).

An additional consideration to note is that even if the information requested in the fuel cost survey is collected or tracked by industry, data quality problems can arise when the specific form of the information requested in the survey is misunderstood by respondents or differs somewhat from the way in which they keep their records.[4] That being said, the number of data elements to

[1] Similar protocols are used in the AM80 fleet data audits, but a census is currently being utilized due to the small number of vessels and a desire to assess potential data quality issues more broadly in the first year of the program.

[2] It should be noted, however, that data error still may be present in audited data that is supported by financial records if the submitter misinterprets the question. This underscores the importance of the pretests and close work with industry described in the previous section.

[3] See, for example http://www.nauticexpo.com/prod/aquametro/fuel-flow-meter-for-ships-br-with-electronic-counter-30761-190938.html for specs of one flow meter.

4 It may be the case that a respondent's expenditure records include purchases that reflect activity in more than just pollock fishing. In such cases, the aforementioned quality check on the data would have to include VMS data on time at sea in all fisheries.

be collected under this item is small and therefore less prone to confusion than more complicated data collections. Data quality problems can be mitigated up front by conducting industry focus groups and refining the survey to reflect any detected misinterpretations, but there will still likely be an evolution in the quality of the data collected. During this analysis, members of the pollock industry provided significant constructive input into refining preliminary surveys.

Quality of Data for Alternative 3, Sub-item 3: Skipper Survey

The nature of the information sought from the post-season vessel operator survey is substantially different from the objective measures collected in the other surveys. In addition to a series of yes/no questions, the bulk of the survey is comprised of qualitative questions regarding conditions in the fishery relevant to salmon bycatch, to which respondents are prompted to provide descriptive responses. As envisioned, the survey will be administered as an in-person or telephone interview with a random sample of the population of vessel operators, and in written form to the rest of the population.

The objectives of the survey suggest somewhat different expectations of data quality compared to other surveys proposed in the alternatives. To a certain extent, the survey is intended as a mechanism for validation of the information collected in the other surveys. That is, the survey is intended to provide NMFS and the Council a broader perspective on both the routine dynamics of the fishery that would be monitored through ongoing and proposed data collections as well as to identify anomalous events experienced during the fishery that may be important in interpreting the more quantitative data collected elsewhere. The broader, more open-ended nature of the data collection will also provide a structured means of identifying important features of the fishery that may suggest the need for changes or additions to the more structured, quantitative data collected.

Data quality concerns for the vessel operator survey are largely related to compliance and response rate, particularly for the written survey. Assuming a mechanism for ensuring compliance is included for all in the data collections in the final preferred alternative, the most likely data quality concern for the written survey would be minimal, pro-forma completion that does not provide any valid or useful information. It would be infeasible to implement a formal validation protocol such as a records audit for the descriptive data elicited in the survey. As such, data quality for the written survey would be limited to the extent to which survey participants were personally motivated to provide accurate and complete information. The interview segment of the survey is likely to produce both a higher response rate and more detailed and complete answers to the descriptive questions.

Further work on question formulation and formal pretesting of the survey instrument will be essential to maximizing the potential for complete and accurate responses. While the survey as currently drafted relies largely on open-ended, descriptive responses, incorporation of more categorical responses that impose a lower cognitive burden on the respondent may be possible with further development and as the range of responses to open-ended questions is identified after the survey has been administered.

In both the written and interview components of the survey, there is some potential for strategic bias in responses to some questions that would result in inaccurate or misleading data. For example, respondents may attempt to portray uncontrollable events during the season (e.g., weather) as having a greater effect on elevated bycatch levels than factors under the respondents' control. This and other bias effects will be addressed in the interpretation of the data.

The timing of the survey is likely to have a significant effect on both the precision and accuracy of the responses. Both are likely to decline with a longer interval between the end of the pollock season and the completion of the survey. If survey completion is delayed for a period of months after the season, responses will be less specific regarding individual events and other details and will produce a more general and impressionistic depiction of the fishery as a whole. There may be somewhat greater latitude in timing for the interview component if the interviews can be conducted in such a way that they include availability of logbooks or other written records that can be consulted to improve the accuracy and detail of the responses. Nonetheless, both detail and accuracy will require that incentives be provided for completion of the written survey within a period of weeks after the end of the pollock season, and perhaps within two to three months for the interview component.

One proposed method of cost collection for vessel movement described in Alternative 2 also includes a method very similar to what is proposed here under Alternative 3. The other method described in Alternative 2 of having vessels record the amount of fuel each time they move could provide excellent information if we could distinguish when variation in the data comes from actual differences in travel conditions rather than from variation in the vessel operator's estimation. Vessel operators must estimate the average rate of fuel consumption and the time required for movement. An alternative (not described under Alternative 2) to this process would be to have the vessel operator record the rate of fuel consumption at different times and travel conditions, which could then be averaged and statistically examined for the relationship of fuel consumption to vessel speed, weather conditions, etc.

Quality of Data for Alternative 3, Sub-item 4: Survey of roe quantity, quality, and revenues

Here we discuss the data quality for the roe quantity and revenue data proposed to be collected under both Sub-Option 1 and Sub-Option 2 under Alternative 3, sub-item 4. It is not practical to require the companies within all sectors to report the company grade of roe at the haul level. As discussed below, there is haul-level sampling that is part of a "quality control" (QC) process, but this process designates roe at a general roe category rather that at the level at which roe is actually sold. Additionally, representatives of the off-shore sector have noted that haul-level grading of the roe at the company standard roe designations would require a significant increase in the handling of roe that would interrupt standard processing and decrease product value.

If graded haul-level earnings data were available to analysts it would provide the most detailed information for understanding the expected revenue differentials that exist in one area versus another with a different Chinook bycatch level. However, in reality data are typically collected at a coarser scale. Because in-shore catcher vessels do not separate hauls based upon roe content (or salmon bycatch), trip-level revenue data appears to be the most reliable means for better understanding the observed trade-offs in fishing for this sector.

By contrast, because catcher processors and motherships take trips that are several weeks in duration, trip-level data would blend values across a relatively long time-period and spatial locations and could significantly diminish the resolution of the price signals dictating observed site choices. As such, for these sectors, recording the daily quantities of roe by grade would provide analysts more accurate data to evaluate how vessels trade of expected revenues with salmon bycatch.

One of the challenges in utilizing any roe value or grade data that is collected is determining the extent to which this information is known and/or utilized by the skipper when making fishing decisions, especially in light of the uncertainty that exists. Roe quality is a primarily function of timing, where fish are caught, and the handling of the roe. However, substantial value differences may also arise as a result of what happens in the factory or at the roe auction rather than on the fishing grounds. This suggests that even with data that is reported to NMFS accurately, there is likely to be uncertainty for vessel operators over the value associated with the pollock while they target and catch pollock roe, and modeling efforts to incorporate this information should reflect this uncertainty. The section below on ‘Analytical uses of the data’ addresses this issue.

Another challenge in collecting additional data on roe grades and quality pertains to the number of grades used by different companies operating in the pollock fishery. Some companies use more than a dozen roe grades in their portfolio and the labels used to distinguish a particular type or quality of roe differ among companies. This complexity is one of the motivating factors for considering the sub-option that only collects information on general classes of roe (standard or off-grade), although we have also been told that some grades don’t fit perfectly into either general class. The difficulties in properly interpreting roe grades can in part be offset by collecting information on the value associated with each company’s grades, as it allows analysts to “monetize” the roe grade or quality information into a metric that is comparable among companies. This step facilitates the use of this information in models which compare the revenue opportunities that exist over time and space during the pollock fishery.

While the format laid out under Sub-option 1 provides the most accurate portrayal of the value of roe collected, there is a trade-off because the data are collected at the daily/trip level rather than potentially at the haul level. The alternative laid out in Sub-option 2 would collect the value/grade information at a more coarse scale but the temporal resolution would improve to the haul level. Because we do not know the accuracy of the QC data or the variability between hauls within a day (that is not captured at the daily level), it is very difficult to assess the costs and benefits of the trade-off. Sub-option 1 provides the most disaggregated detail regarding the value of roe in the fishery. Sub-option 2 is appealing because fishermen report that they are often unable to carefully consider the details of the exact roe grade but more the general quantity and quality, although some companies have internal price estimation mechanisms that fully incorporate the estimated values of different grades of roe.

With Sub-option 2, there remains significant uncertainty about how accurately the general grade information is estimated, especially for the inshore sector. Verifying the data collected under this option would be extremely difficult. In order for this option to be selected, more information would need to be obtained to suggest that these data are of sufficient quality and that they accurately reflect the relative roe-value of fishing in different areas. Conversations with industry indicate that most vessel operators do conduct roe recovery and fish size analysis at the haul-level, but it is unclear what challenges would exist to developing a standardized interpretation of this information from different companies and vessels.

In summary, Sub-option 1 could provide a substantial improvement in the information available to analysts to assess the decisions vessel operators make when they trade-off the value they receive from pollock with the costs of travel and with salmon bycatch, subject to the caveats discussed above. The degree to which this is true for Sub-option 2 is less certain.

Here the proposed data collection concentrates on collecting quantities and values of roe because it is the by far the highest valued product in the fishery (on a per-pound basis), although clearly there are fish characteristics other than roe value that affect skippers’ targeting strategies. Data on fish size is collected by the Observer Program, suggesting that we could potentially utilize that data in the future to incorporate size-based considerations in location choice models. Analysts intend to pursue further research in this area. However, it should be noted that while the roe-value information is important for analysis of the salmon bycatch program, there are likely other fish or product characteristics relevant to targeting strategies that would not be collected under this alternative. Including data on other product values would likely improve the quality of the analysis conducted with the proposed data to be collected under this alternative.

Discussion of analytical uses of the data

The core purpose of the additional data contained in Alternative 3 is to allow for an improved ability to understand the trade-offs made on the pollock fishing grounds between pollock revenues and the costs of travel, salmon bycatch purchases, IPA incentives, and other costs of salmon bycatch.

The rationale to support the consideration of costs and revenues in the evaluation of salmon avoidance by vessels is that vessels can almost always choose to fish in areas with low salmon, but they cannot necessarily do this and make an acceptable economic return. The Council recognizes that this it is impossible to completely avoid salmon when fishing for pollock and has therefore allowed for the pollock fishery to catch salmon up to a hard cap. The goal of this research is to provide more information to the Council about whether the effort expended in avoiding salmon by the fishery is reasonable, from the Council's perspective, and whether the incentives present in IPAs are commensurate with the costs of salmon avoidance such that they are likely to influence behavior at all levels of salmon abundance.

A key aspect of understanding the impacts of Amendment 91 is to examine how it affects where and when vessels choose to fish and the benefits and costs associated with those efforts. High salmon bycatch in profitable areas may force vessels to leave these high-value areas; similarly, at periods of time when vessels are well below the hard cap and overall bycatch encounters are low, incentives may or may not be sufficient to cause vessels to fish in lower bycatch areas if the level of bycatch experienced in the higher areas is "acceptable" to the vessel operators.

Vessel operators typically make choices about where to fish by utilizing their own experience and by speaking with others about fishing conditions in different areas, including information about roe recovery rates and the quality and the size of fish caught. With their knowledge of their own operational costs and the revenue that they expect to gain from fishing in different areas, captains will typically choose the location that they believe will be most profitable in which to fish. This notion of profit maximization may not be the sole consideration by vessel operators at all points in time, but its relevance and persistence is the basis for the creation of IPAs. Thus, the assumption of profit maximization should not be dismissed. One of the decision factors that will be given additional weight beginning in 2011 is the expected salmon bycatch in different areas. A major purpose for this data collection is to provide the information necessary to better understand how the IPA incentives and hard cap affect the decisions that vessel operators make on the grounds.

Data on travel costs will substantially improve the ability of analysts to understand the impacts of movement and to compare these impacts to the hard cap and to the incentives contained in any proposed IPAs. Collecting vessel-specific rates of fuel consumption (combined with existing VMS and observer data) will allow us to estimate the differences in travel costs that come with traveling further to fish because of salmon in other areas. Among other research, over time, we can examine whether and/or how high and low bycatch vessels fish differently.

Because differences in revenues are balanced with differences in costs when vessel operators choose where to fish, improved data on roe quantity and value will further improve the data available for this analysis. Focusing on costs and ignoring the substantial differences in expected revenue that come with different levels of roe recovery or product grade could potentially provide misleading estimates of the impacts of salmon bycatch on the fishery. For example, one could believe that vessels were unwilling to make changes in location for small differences in pollock recovery, but in fact there were very strong reasons for the vessels to fish where they were because of the high roe value of fishing in those areas.

With accurate estimates of vessel travel costs and expected revenues, economic analysts can examine how all of the factors that we observe about vessels, areas, and bycatch appear to affect the choices that different vessels make. AFSC economists will build upon existing models developed for the inshore pollock catcher vessel fleet, as well as alternative model specifications drawn from a robust literature in fisheries economics (e.g., Eales and Wilen 1986, Holland and Sutinen 2000, Smith and Wilen 2003, Smith 2005, Haynie 2005, Haynie and Layton 2009).

The primary model proposed for this analysis is a discrete choice random utility model (RUM) that will model vessel choices as a function of expected revenue per site, travel costs/distance, pollock catch and salmon bycatch rates, remaining pollock quota and salmon allocations, IPA-related information (e.g., incentives, available savings if applicable), weather conditions, observed vessel- and cooperative-specific characteristics, seasonal trends, and other factors that are believed by analysts or industry to affect where vessels choose to fish.

One recent paper (Holland 2008) explores alternative assumptions about how fishermen perceive risk and rewards. Behavioral economics has raised a number of questions about the assumptions of economics models in general that are potential considerations for this type of model. Expected utility theory is the core of the field of economics and assumes that people and firms rationally maximize utility.

One example cited that illustrates the imperfection of expected utility theory is a study of New York City taxi drivers that concluded taxi drivers will work fewer hours on days when they earn more money per hour after they earn a certain total amount of money (this is sometimes referred to as "satisficing" model). Other research (Farber 2005) has suggested that the methodology of that particular study was flawed in reaching that conclusion, but the example captures the complexity of how agents may consider of earnings.

For the pollock fishery, members of industry present differing views of the rationality of fishermen in choosing locations. Pollock captains speak about their first priority needing to be to "get their fish." However, pollock captains report using satellite phones to learn of current catch rates, fish size, and roe recovery from other vessel operators. In some cases, vessel operators will call several dozen other people to decide what location to visit. Some cooperatives communicate expected revenue information from all of their landings to all vessel operators and there are financial incentives for many vessels to communicate information with other vessels through revenue sharing within companies.

The references section provides a large number of papers that discrete choice utilize random utility (RUM) models to investigate the response of fishermen to expected revenues and mileage. Holland (2008) notes that while there is anecdotal evidence of fishermen not conforming to strict definitions of economic rationality, there are few empirical studies that demonstrate this. Eggert and Martinson (2004) look at risk preferences (how vessels respond to variance of returns), and observe that there are conditions under which they behave in a manner that does not conform to expected utility theory, namely that some vessels appear to be risk-prone.

Despite these questions, most of the cited studies find that vessels avoid travel, all other things being equal, and that after controlling for distance, recent expected catch or revenue in different areas is an effective predictor of the area in which vessels choose to fish. In this current analysis, fleet behavior can be examined in low salmon periods to examine how vessels respond to price and cost signals (e.g., test the implied risk aversion of fishermen to examine their risk preferences or aversion to risk).

Considering alternative assumptions about how vessels respond to revenues and bycatch will be part of the process in modeling the vessel response to the IPAs. Haynie and Layton (2009) build upon conventional models by jointly modeling catch and choice and modeling catch as a Weibull distribution, which more accurately reflects catch distributions than conventional models. In a separate project currently underway, Haynie and Abbott are working on improved statistical modeling of bycatch in the flatfish fishery, recognizing and accounting for the zero-inflated nature of bycatch.

All of these studies and discussions with fishermen confirm that a broad range of factors drive such fishing location decisions. The skipper survey contained in this data collection alternative attempts to capture several of these factors that may or may not appear in the quantitative information that is collected from the fishery. In addition, variation in vessel characteristics, technology, and production goals all play an integral role. One example of vessel diversity that impacts bycatch behavior is that the cost for vessels to travel to more distant and cleaner locations is greater for some vessels than for others. The relative value of products (e.g., roe) for different vessels will also impact their willingness to avoid salmon or to pay for additional salmon allocation if it is available.

Members of industry have commented about the complexity of the fishing decision process and expressed concern about whether models can capture this complexity. Certainly non-economic factors can play an important role in where captains choose to fish. Weather and safety play important roles in vessel location choice, and the presence of salmon avoidance skills and the adoption of salmon excluder devices and other types of bycatch-reduction technologies will also impact choices. By recognizing and controlling for some non-economic factors, through both the skipper surveys and independent weather data collected throughout the Bering Sea, we can better focus upon how we observe vessels to behaviorally trade-off revenues, travel costs, and salmon bycatch. To whatever degree captains are actually considering these three factors, there will be data which will allow for the independent assessment of whether there is evidence that the IPAs are inducing significant changes in vessels' fishing behavior. As was noted by one member of the Council's economic data collection committee, the Council agreed to a higher cap with the belief that vessels could respond to IPAs to effectively limit bycatch.

Many hypotheses can be formulated and tested about how an IPA affects vessel behavior. The following questions/hypotheses are examples of questions that can be evaluated with the collected data:

- Do differential vessel travel costs affect bycatch behavior?
- Does avoidance behavior differ depending on the prices for different pollock products?
- Are bycatch avoidance costs born disproportionately by certain vessels or cooperatives?

- If the incentives from the IPA can be financially estimated, do fishermen avoid bycatch in a manner that corresponds to the incentives? Are fishermen avoiding bycatch beyond what we would expect from the IPA?

This research is "data analysis" – it involves the statistical examination of how vessels behave when choosing different areas. It does make some assumptions about the nature of fishing, most importantly that fishermen are trading off the costs (including travel and salmon bycatch) and benefits of fishing in different places. The model assumes that they are making decisions utilizing available information that is on-average not systematically optimistic or pessimistic. But the heart of the analysis is the examination of the data that we observe for bycatch, costs, revenues, seasonality, vessel characteristics, weather, etc.

Under the data to be collected under this alternative, we will not always accurately observe the roe or production bonuses that skippers and crew receive. While having a comprehensive accounting of the actual bonus structure would be helpful in predicting how vessels would respond to changes in expected revenues, the collection of actual revenue differentials is likely to considerably improve the analysis we can currently undertake with existing data. Here we will examine how vessels respond to differences in revenues, costs, and salmon. Some vessels may be more or less responsive to differences in revenues, which may be due to different roe bonus structures, concerns about risks, habits, or other factors. Whatever the precise payment made to a particular crew, the choice to fish in areas with lower expected revenues (from roe or catch) will on average produce lower revenues. By modeling the revenue trade-offs of moving to avoid salmon bycatch, we can estimate (with uncertainty) the average costs of salmon bycatch reduction at different points during the season.

This analysis will produce information on how vessels respond to changing expectations in salmon abundance on the fishing grounds. It will examine to what degree vessels are able to identify changes in abundance and to respond to them in a cost-effective manner.

In addition to the issues discussed above, other related hypotheses can be investigated utilizing these data. For example, one might expect to observe the "pricing" of salmon at a higher rate on the grounds during periods of higher abundances. People will work harder to avoid salmon when there is high abundance than low, so long as there are differences among areas in the levels of bycatch. One could also examine whether vessels that have lower net costs of moving (both in terms of their reduction in revenues and increases in travel costs) are more likely to have lower bycatch.

These data will also provide some information about the costs of bycatch avoidance. Moving from high-roe areas to avoid bycatch has the potential to cost industry tens of millions of dollars and there will be extremely limited data available to help us understand this from the status quo.

Collecting these data will also allow us to understand the values that fishers receive for fishing at different times of the year. Industry representatives qualitatively and quantitatively discuss the value of fish recovered at different times of the year, but neither NMFS nor the Council possesses this information.

Contrasting the information available here with the analysis under the status quo, several features are noticeable. (More detail on research that can be done under the status quo is discussed in detail under Alternative 1.) Roe data will certainly be most important for the A-season, but to the degree that vessels are making decisions in the A-season that will affect the quantity of salmon quota available throughout the year, the impacts of not having these data will impact analyses of both seasons.

Without directly collecting cost data, researchers have to estimate costs based on how vessels trade-off expected revenue with distance traveled (as in Haynie 2005 and Haynie and Layton 2009), or utilize anecdotal averages that have been informally provided by industry. Given that vessel operators consider their particular estimated costs of fishing in different areas when operating their vessel, vessel-specific estimates are expected to be much more accurate. Vessel-specific cost estimates will also allow us to observe how vessels with different costs may avoid salmon bycatch differently, which could not be done under the status quo.

If implemented, the skipper survey will provide a more systematic means to provide input about experiences of the fleet in relation to the salmon bycatch program. It has been immensely helpful for analysts to regularly have conversations with the captains and the formal skipper survey will ensure that this happens regularly and in a manner that insures broad, comprehensive input from different cooperatives and companies.

The data collected under sub-items 2-4 of this alternative can be combined with data currently collected and with those collected under sub-item 1 on pollock and salmon transactions to provide the most thorough analysis of the salmon bycatch program. The nature of salmon bycatch transactions (and thus the quality of data collected from the salmon bycatch quota market) is unknown. If a substantial number of arms-length transactions with no in-kind considerations are observed in the market, changes in these values will be very informative to analysts about how difficult and costly it is to avoid salmon bycatch on the fishing grounds. This information can then be compared with the salmon bycatch avoidance costs implied from models that utilize cost and revenue data collected under Alternative 3. If the market does not produce sufficient data on arms-length salmon bycatch transactions, then the modeling discussed above and the examination of observed bycatch behavior will be the best information available to inform the Council about the costs and effectiveness of the salmon bycatch program.

Other uses of the data

Aside from the salmon-based questions the Council is presently considering, related questions may come up in the future. For example, if the Council was interested in how changes in the structure of an IPA would impact salmon bycatch levels or avoidance behavior, transaction-level salmon and pollock trade data collected under any alternative, or the fuel cost data collected under Alternatives 3 or 4, could be particularly useful.

While IPAs may change significantly because of the Performance Standard contained in Amendment 91, the general way in which the incentives of the previously-developed incentive plans work is by allowing i) vessel owners to "bank" salmon bycatch and use it at a later date by keeping bycatch levels below a specified threshold in each year; or ii) by rewarding low-bycatch levels in a given year with a relatively large share of a financial "ante" pool. Should i) be modified in the future to either allow for changes in how much salmon can be banked, or how long banked salmon can be utilized, estimates of salmon bycatch values can be used to estimate how changes in access to those valuable salmon privileges would impact the parties governed by the IPA. Changes to ii) could similarly be evaluated by comparing the size of the new "antes" one could earn in the IPA with the salmon bycatch value estimates to evaluate whether behavior could be markedly impacted by the changes. Industry representatives have suggested that the IPAs currently being developed are of the first variety, where savings now will provide for future flexibility (though within the limitations of the Performance Standard).

Together, the transaction data on pollock quota and salmon allocations collected under this alternative could be informative in the context of assessing trends in profitability in the industry, which could potentially be impacted by the new salmon bycatch program. Lease price data for target species quota reflect what vessel operators are willing to pay to land an additional unit of that species, which according to economic theory reflects the marginal profit earned on that species. Assuming the transactions can be adequately categorized to facilitate consideration of arm's length, cash transactions, the quota lease data should provide an indication of how much wealth is generated though the lease of pollock quota and salmon bycatch allotments.

In addition to facilitating potential follow-up analyses of salmon-related questions, the information collected under Alternative 3 could also be quite useful for analysts tasked with answering other questions pertaining to the pollock fishery. For example, there are other current and possible future spatial regulations that govern where and when pollock fishing can be undertaken, including Steller sea lion protection measures, essential fish habitat (EFH) designations, and general marine protected areas that could be enacted to provide protection for other species of concern. To effectively analyze the economic impact of such regulations, one must have knowledge of the costs associated with traveling to alternative fishing sites as well as the expectations about the net revenues that would be earned in each of the locations. The cost and earnings data collected under this alternative would provide the data required to address these questions.

One of the more basic ways in which the additional roe data will be useful is to improve current estimates of the prices of pollock at both the first-wholesale and ex-vessel levels. The Commercial Operator's Annual Report (COAR) collects data on the value of pollock roe, but no grade or quality information is reported, making it difficult to understand the extent of heterogeneity in value for the numerous grades of roe. This limitation also makes it difficult to understand whether roe prices are generally increasing or decreasing, as changes in reported roe value may reflect changes in roe grade (driven by biological trends or perhaps shifts in market demand for some grades). In addition, our understanding of the way in which prices paid for pollock differ during the roe season from the rest of the year is currently incomplete. The fish ticket and e-landings data do not include any roe bonuses paid to vessel operators after the time of landing, and the payment data reported in the COAR is at an annual level, so therefore the best information currently available is an average price of pollock for the entire year, rather than separate prices for both the roe and non-roe seasons.

The fuel consumption data to be collected under sub-item 2 will have numerous uses. In most if not all fisheries, anecdotal evidence suggests that fuel costs are the largest expense[5]. Having information on the largest portion of the costs of fishing will go a long way toward improving our ability to estimate the net benefits (revenues less all costs) derived from fisheries. Estimates of how much fuel vessels burn will also help analysts estimate the economic impacts of fuel price shocks, such as those in 2006 and 2007. Just as with the roe data discussed above, fuel consumption data will also facilitate analyses of all management actions which affect the spatial location of fishing.

The AFA has restricted the ability of the fleet to rebuild vessels. Information on how variation in costs (between, for example, newer and older or smaller and larger vessels) affects salmon

5 At present fuel cost data is unavailable in most of the fisheries in and off Alaska. However, discussions with vessel operators and knowledge of fuel costs in other regions suggest that fuel is largest expense.

bycatch could provide information into potential biological benefits of allowing the fleet flexibility in rebuilding.

The greatest benefit of collecting the roe data as part of this Alternative could potentially be biological. The North Pacific Observer Program currently collects a very limited amount of data on pollock roe maturity (2 fish for each haul for which an age-length sample is collected). It is possible that either daily/trip production data or haul-level QC information on roe could be utilized to supplement/complement this observer process. This information could provide extremely valuable information about the spawning behavior of the fishery. Biologists at AFSC have examined how spawning is linked to water temperature and other environmental covariates. Consistently collecting this information about the pattern of roe grades from cooperating vessels could provide insight on how environmental conditions affect year-class strength and roe grades.

Alternative 3 Conclusions

Complete observer coverage, as is collected under the status quo, will allow an analysis of how Chinook salmon bycatch rates change over time, but it will be very difficult to compare the magnitudes of any economic incentives contained within IPAs with the costs and benefits of fishing in different locations. Without additional data, it will be challenging to judge whether or not the incentives are sufficient to alter behavior. It will also be difficult to assess whether bycatch levels below the hard cap come as the result of the incentives from an IPA or how bycatch would have varied without an IPA or in the presence of an IPA with stronger incentives.

The primary advantage of Alternatives 3 and 4 over the status quo is that these allow one to estimate the magnitude of the change in behavior that results from the IPAs. Because travel costs are unknown and the value of fishing in different locations subject to substantial error, modeling trade-offs between costs (including salmon avoidance incentives) and revenues must rely on average miles and gross product values that do not account for the spatial variation in revenues that come from different valued fish. It is possible that the IPA reports will provide considerable insight into the performance of the IPAs, but it will be difficult to verify the information in these reports.

The first sub-item of this alternative involves collecting data on the transactions of salmon and pollock allocations. The issues involved with collecting these data are described under Alternative 2, but these data can be valuable in comparing the market value of salmon with the results of analysis conducted with other data items collected under Alternative 3. For those observations in which arms-length, cash transactions are observed for salmon bycatch quota, the value will represent the market price at which salmon bycatch can be purchased. This value can be compared with the estimated cost of avoiding salmon bycatch on the fishing grounds throughout the year. Having both of these sources of salmon bycatch value for the pollock fishery will best inform the Council about the effectiveness of its action.

If the price of salmon observed in the market and the estimated costs of avoidance based upon examining vessel behavior are high, this would imply that at the bycatch level experienced by the fishery, avoiding additional bycatch would have been very expensive and difficult. If the price observed is very low, this implies that it was relatively easy for the fleet to achieve the level of bycatch that it experienced/achieved. This will inform the Council about the degree to which it is adhering to National Standards and reducing bycatch to the extent practicable. Information from the skipper survey will ensure that this analysis thoroughly considers complexities and challenges that the fleet experiences when avoiding bycatch.

Sub-items 2 and 4 of this alternative, which propose the collection of vessel travel and bycatch-reduction gear costs and roe revenue data, have been focused to as narrowly as possible to address the needs of this analysis process. Many conversations have been held with stakeholders and the results of that process have helped to improve and refine the questions asked here. Future pre-testing will further refine the questions asked. The AFSC is ready to quickly refine the draft data forms so that they can meet OMB, PRA, and other public input requirements.

The question has been asked about whether phased implementation is feasible so that some new data collection can begin with the implementation of the salmon bycatch program in 2011, even if all elements of the data collection program cannot be implemented with the start of the program. Of the data elements above, all items require a similar process of public input, instrument refinement, and writing of regulations. It is assumed that all data collection elements will not begin with program implementation. Starting collection after the first year of the program will nonetheless help facilitate understanding of the costs and experiences of the first year of the program. Costs are not expected to dramatically change for vessels from one year to the next, so fuel cost averages could potentially be applied retroactively (skipper surveys can be used to verify that this is the case). This is unlikely to be as true for roe and other product values, though this information could potentially be retroactively collected, where available.

Alternative 4 Discussion

Description of Alternative 4, sub-item 5: Survey of daily vessel operating costs (labor, observer, etc.).

Avoiding salmon bycatch directly increases operating costs by generating additional travel costs and may also reduce revenue if the new fishing site produces lower product value or catch per-unit effort. Additionally, if vessels travel further throughout the season, additional costs could be imposed on the fishery through the extension of the season and the costs that fishing operations incur from this extension. Because most of the labor participating in the pollock fishery is paid according to a share system, and the amount of fish caught is determined by the amount of quota held (not days fished), extending the length of the season would only affect the costs of employing those individuals who are paid on a per-day basis. Aside from these additional costs, discussions with industry suggest that another potentially valuable additional cost to track is the food costs of feeding all the crew aboard the vessel.

Evaluation of data quality for Alternative 4, sub-item 5: Survey of daily vessel operating costs (labor, observer, etc.)

Discussions with vessel owners and operators at public meetings have suggested that the elements to be collected under this data item can be reported relatively accurately. In discussion with industry, we have excluded data quality items that are likely to be “pennies on the dollar” and/or lead to large confusion in estimation. The costs of food and crew provisions are tracked by all vessel operators and are typically reported on settlement sheets to crew members. The wages paid to crew who work on a daily basis may be subject to greater error, however, as all vessel owners may not currently break out compensation expenses in their records according to the way in which individuals are paid. If vessel owners begin to break out expenditures in this manner (or already do so) it should be relatively easy to obtain accurate data. However, if some vessel owners guess how many daily- or hourly-wage individuals are typically on board and what they’re typically paid, data quality could be somewhat poor.

It is worth noting that the entirety of costs incurred from additional days at sea due to salmon bycatch avoidance may not be captured in this survey. Crew may incur direct losses from missing openings for other fisheries or opportunities aboard other vessels or for work outside of fisheries. Plants may also suffer disruptions in processing if vessels miss scheduled deliveries, which could increase production costs or lead the plant to operate at less than full capacity for a greater number of days. However, collecting and utilizing such information to analyze the primary questions of concern by the Council would be very difficult and complicated.

Just as with other variables we have discussed, we should note that even if the information requested in the cost survey is collected or tracked by industry, data quality problems can arise when the specific form of the information requested in the survey is misunderstood by respondents or differs somewhat from the way in which they keep their records. It may be the case that a respondent's expenditure records included purchases that reflect activity in more than just pollock fishing, making it difficult to derive a pollock-specific cost for certain items. Data quality problems can be mitigated up front by conducting industry focus groups and refining the survey to reflect any detected misinterpretations, but there will still likely be an evolution in the quality of the data collected.

Analytical use of the data for Alternative 4, sub-item 5: Survey of daily vessel operating costs (labor, observer, etc.)

The additional data collected under Alternative 4, sub-item 5 would allow analysts to calculate the additional costs experienced by the fishery of an additional day of vessel operation. The basic process of calculating the additional cost would be:

- From the collected data, estimate the cost of an additional day at sea for each vessel
- Estimate the additional travel time and trips that result from salmon avoidance for each vessel
- Estimate the additional operations cost per vessel from salmon avoidance
- Estimate the total additional cost of salmon avoidance for the fleet.
- Across years, compare how the cost estimates change with different levels of salmon bycatch on the grounds.

These data would allow only the estimation of the direct costs of labor and spending on food experienced by fishing operations. As discussed above, the impacts of salmon bycatch avoidance will also be felt by laborers who work longer for the same share of income and by processing plants that may be forced to slow their processing, extend their season, or spend extra resources shutting down and restarting the plant. Research could be done to collect data on these costs, but this would be a much more extensive data collection effort and the analysis would be very challenging because of the many ways in which processors dynamically make decisions to increase their profits.

Other uses of the data for Alternative 4, sub-item 5: Survey of daily vessel operating costs (labor, observer, etc.)

The data to be collected under this sub-item could be informative in any analysis in which one evaluates the likely effects of regulations which could lead to a lengthening of the fishing season. For example, spatial closures or vessel choices could force fishermen to take more lengthy trips or a greater number of shorter trips, in turn increasing transit time to and from the grounds and the number of days a vessel must operate to obtain a given level of catch. Obviously the additional fuel required (as collected under sub-item 4) would be the largest expenditure considered in such an analysis, but the cost of feeding crew for additional days and paying those workers that are compensated by day (rather than through a lay-system) could also be significant.

Alternative 4 Conclusions

The overall conclusions reached for this alternative are identical to those reached for alternative 3 with the exception of the data collection option that differentiates Alternative 3 and 4 (the daily cost survey, sub-item 5). In particular, this alternative recognizes that the costs of salmon bycatch mitigation include costs beyond variable travel costs.

The additional daily costs collected under this alternative may provide a more accurate view for fishery managers to assess the way in which the salmon bycatch program affects the costs of pollock fishing. In addition, these costs should be considered when evaluating the efficacy of the IPAs and whether the incentives present in those plans are sufficient to change fisher behavior, given the relatively complete accounting of bycatch avoidance costs that this alternative provides. Based upon the data quality and burden estimate discussions above, we believe that this alternative will be feasible and not overly complex or burdensome. The survey collects two relatively clear and simple cost categories that we understand vessel owners track on a regular basis. The one main complication in this effort will be to convert the cost records to a daily average cost, which will likely produce some measurement and estimation error. At present it is unclear how large the additional daily costs incurred by longer seasons are relative to other vessel costs (such as fuel), making it difficult to infer how important this information will be in Council decision-making processes. In addition, there are very likely other costs of the salmon bycatch program that are not captured here, such as the way in which the timing and accuracy of plant deliveries are affected by salmon bycatch avoidance, or the opportunity cost of crewmembers' time when seasons are extended for those reasons. However, given the complications associated with capturing those factors, collecting the data contained in this Alternative will improve the precision of estimates of the cost of salmon bycatch reduction efforts and may improve analyses of the efficacy of IPAs, while being sensitive to industry burden. This will not completely capture the costs to industry (especially if it affects plant behavior), but inclusion of the information is preferable to ignoring these costs that can be relatively easily collected.

Given the simplicity of the additional data collected under this Alternative, it is unlikely to markedly increase the workload of NMFS staff or the work associated with obtaining Paperwork Reduction Act (PRA) clearance, which will already be required for the other sub-items within this alternative. As such, the addition of this data collection element is unlikely to affect the timing of the overall data collection program or the likelihood of getting it in place simultaneously with the other aspects of the salmon bycatch program.

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