Review Estimation Methods for ORBS and OSP

FY 2010 Proposal

Dave Van Voorhees

Created: 05/13/2015

1. Overview

1.1. Sponsor

1.2. Focus Group

Survey Design and Evaluation

1.3. Background

In its Review of Recreational Fisheries Survey Methods, the National Research Council (NRC) concluded that estimation procedures for onsite surveys do not use the nominal or actual selection probabilities of the sample design, and that this deficiency could be a significant source of bias (NRC 2006). To address this concern, the Sampling and Estimation Work Group (SEWG and formerly the Design and Analysis Work Group), initiated a project in 2008 to review the sampling and estimation methodologies of the MRFSS Access Point Angler Intercept Survey (APAIS). This project has resulted in a revised estimation approach that will be implemented in 2010, as well as pilot study to test a more statistically robust sampling design (pilot study implemented in NC in 2010).This project proposes to expand the review of onsite survey estimation methodologies to include the Oregon Recreational Boat Survey (ORBS) and the Washington Ocean Sampling Program (OSP). Each of these surveys includes shore-based counts of recreational boat trips to estimate total fishing effort, as well as dockside intercepts of completed recreational boat fishing trips to estimate catch per trip.

1.4. Project Description

1.5. Public Description

1.6. Objectives

The objectives of this project are to, 1) review the current sampling and estimation designs of the Oregon Recreational Boat Survey and the Washington Ocean Sampling Program, 2) identify potential sources of bias, deviations from probability theory, and inconsistencies between sampling and estimation designs, and 3) develop and test any necessary improvements in the sampling and estimation designs. The results of this project will directly address concerns identified in the National Research Council’s Review of Recreational Fisheries Survey Methods (2006).

1.7. References

2. Methodology

2.1. Methodology

2.2. Region

Pacific

2.3. Geographic Coverage

2.4. Temporal Coverage

2.5. Frequency

2.6. Unit of Analysis

2.7. Collection Mode

3. Communication

3.1. Internal Communication

3.2. External Communication

4. Assumptions/Constraints

4.1. New Data Collection

4.2. Is funding needed for this project?

4.3. Funding Vehicle
ST Consultant Contract, Pacific RecFIN Grant

4.4. Data Resources

4.5. Other Resources
The completion of this project is contingent upon active participation by the Pacific RecFIN Technical Committee, its Statistics Subcommittee, and state-appointed survey managers and statisticians from Oregon and Washington.Two or three expert consultants who are already under contract with the NMFS will be assigned to support the project team. Dr. Jay Breidt and Dr. Jean Opsamer (both at Colorado State University) are experts in survey statistics who will be asked to support the project to help evaluate the current sampling and estimation methods and to help identify possible methodological improvements that could be implemented. At least one additional expert statistical consultant will be added who has knowledge of and experience with Pacific Coast fisheries.

4.6. Regulations

4.7. Other

5. Final Deliverables
5.1. Additional Reports

5.2. New Data Set(s)

5.3. New System(s)

6. Project Leadership
6.1. Project Leader and Members

First Name	Last Name	Title	Role	Organization	Email	Phone 1	Phone 2
Dave	Van Voorhees		Team Leader	NOAA Fisheries			

7. Project Estimates
7.1. Project Schedule

Task #	Schedule Description	Prerequisite	Schedule Start Date	Schedule Finish Date	Milestone
1	Initiate Project		05/01/2010	07/01/2010	Y
5	Review Survey Design		07/02/2010	10/01/2010	Y
7	Identify issues in sampling and estimation methods		07/02/2010	10/01/2010	
10	Develop sampling design and estimation methods		10/02/2010	05/01/2011	Y

Task #	Schedule Description	Prerequisite	Schedule Start Date	Schedule Finish Date	Milestone
11	Estimate sample selection probabilities		10/02/2010	05/01/2011	
12	Develop appropriate estimators that match survey design		10/02/2010	05/01/2011	
13	Deliverable. Report on any revisions to sample selection protocol and procedures for proper calcul	9,10	10/02/2010	05/01/2011	
3	Hire consultants		05/01/2010	07/01/2010	
4	Hold workshop to kick-off the project	2,3	04/27/2010	04/29/2010	
6	Collect available documentation		07/02/2010	10/01/2010	
8	Hold workshop to finalize specific recommended methodological improvements	6,7	07/27/2010	07/29/2010	
16	Estimate and report on catch rate/effort.		05/02/2011	10/01/2011	
2	Confirm project and staffing		05/01/2010	07/01/2010	
9	Deliverable. Report on current estimation procedures and list suggested revisions needed	6,7,8	07/29/2010	10/01/2010	
14	Implementation		05/02/2011	10/01/2011	Y
15	Conduct pilot studies		05/02/2011	10/01/2011	
17	Deliverable. Document procedures with a user training manual	13,14	05/02/2011	10/01/2011	

7.2. Cost Estimates

Cost Name	Cost Description	Cost Amount	Date Needed
Consultant Support	Will utilize consultants already under contract with ST1. Will not require additional 2010 funds.	$0.00	04/01/2010

Cost Name	Cost Description	Cost Amount	Date Needed
Project-specific Travel	Kickoff meeting; ORBS review; WAOSP review	$40000.00	04/27/2010
TOTAL COST		$40000.00	

8. Risk

8.1. Project Risk

Risk Description	Risk Impact	Risk Probability	Risk Mitigation Approach

9. Supporting Documents

"Final Report-Review of OR's Recreational Boat Surveys", page 1

Consultant's Report: Review of Ocean Recreational Boat Survey

F. Jay Breidt* and Jean D. Opsomer†
Colorado State University

July 27, 2010

1 Introduction

During the two-day meeting in Newport on July 19-20, 2010, we met with Oregon Fish and Wildlife staff to discuss the Oregon Department of Fish and Wildlife's Ocean Recreational Boat Survey (ORBS). In this document, we will provide our initial reaction to the survey procedures we learned about during the meeting. Our goal is to initiate a discussion on a range of possible improvements to the ORBS.

We begin by briefly summarizing our understanding of the survey itself. ORBS provides timely estimates of effort and catch, which are used for in-season management of key fisheries. The sampling effort for ORBS is focused on March through October and on major ports, with lower sampling rates outside of the main season and outside of the major ports. Currently, some times at some ports have no chance of selection into the sample.

Sampling is finely stratified, in space (by port) and in time (by week, and season within week when seasons open or close mid-week). Fishing effort is collected from a combination of sources, depending on the port. Effort is collected separately for charters (commercial guides with an identified office space) and other guides and private boats. Trip counts by type are collected for the entire week from charters. Efforts for private boats and guides are

*jbreidt@stat.colostate.edu.
†jopsomer@stat.colostate.edu.

obtained from bar crossing counts, where applicable, or from counts of empty slips and boat trailers. In some locations, bar crossing counts are obtained from an observer, and others are obtained by review of video. The ability to obtain daily effort estimates through monitoring of departures of fishing vessels is very helpful in obtaining accurate estimators of catch.

Dockside interviews are conducted to obtain catch information. Field crews by port range from 1–3 samplers. They are assigned blocks of time during which to conduct interviews, and record catch for all anglers on selected boats. Boats are selected within a time block in a systematic fashion.

According to ORBS staff, samplers have access to private landings, and night fishing is extremely rare. Thus, two potentially problematic issues that may lead to bias in other fisheries surveys seem to be largely non-issues in ORBS.

Our first reaction to ORBS is that it has many attractive features that simplify its analysis, relative to other fisheries surveys in our experience:

- large and thorough sampling effort
- fine spatial and temporal stratification
- required compliance by anglers
- census of charter efforts
- (almost) direct measures of effort, due to geography; relatively few sites are suitable for launching ocean boats
- possible bias due to lack of access to private sites seems to be a non-issue
- possible bias due to unsampled night fishing seems to be mostly a non-issue

In the remainder of this report, we outline our recommendations for possible improvements to the ORBS, as well as a number of areas where further study might be warranted.

2 Preliminary Findings and Recommendations

2.1 Small Area Estimation

The classical problem of small area estimation is to use a model to "borrow strength" across space and/or time to get estimates at a fine spatio-temporal resolution, meaning finer than the resolution supported by only the sample data occurring within the spatio-temporal cell. Our impression is that ORBS is reporting estimates at the level of small areas, but without small area models or estimates of precision. Given the objectives of ORBS, reporting at such a fine resolution seems unnecessary:

- quotas are coastal or regional, not port-specific
- quotas are seasonal, not weekly.

Our preliminary recommendation is to avoid "volunteering" to report port-week-species level estimates, and backing away from such reports wherever practical. Estimates for many objectives of interest are already being achieved with high levels of precision, and these successes should be emphasized.

2.2 Sample Size and Issues of Probability Sampling

For all of the major ports in high season, ORBS has a major sampling effort, dedicated to achieving 20% sampling fraction by port/week. From general sampling principles, it makes sense to target high-volume sites and times. Our reaction was, however, that even allowing for the mandatory 20% capture, it might be possible to reallocate some of the sampling effort to achieve other purposes. These could include gathering more information for smaller ports, for months outside the main season, or for rarer species.

Currently, some ports and some months have zero probability of selection. In sampling terminology, this is an undercoverage problem, which leads to the possibility of bias in estimation of some target parameters if the "uncovered" part of the population differs from the "covered", sampled part of the population. Even if the uncovered part of the population is similar to the covered part *now*, bias due to undercoverage can arise over time in a dynamic population. For example, while boats may almost never go out from some ports in winter *now*, this may change as anglers obtain better gear (e.g.,

GPS) or target different species in the future. One example that ODFW has already encountered is the targeting of tuna by recreational anglers. A second example is changing site characteristics, such as the changing erosion state of a beach meaning that sometimes it is possible and sometimes not possible to launch from shore.

For an "uncovered" part of the population, there is by definition no possibility of information obtained in a sample, so only extrapolation from the covered part of the population is possible. Lynn Mattes presented an excellent example of the possible problems of such extrapolation. In her example, smaller ports not sampled in winter had an *ad hoc* adjustment using

$$\frac{\text{(summer for small port)}}{\text{(summer for big port)}}\text{(winter for big port)} \equiv \text{(winter for small port)}.$$

Intuitively, there are clear problems with this assumption, but there is no way to fix the problems on the basis of sample data. With a probability sample, even one with a small sample size, it would be possible to develop a solution.

Our recommendation is, whenever possible, to move in the direction of a full probability sample of the population of interest by reallocating resources beyond those needed to achieve sufficient precision for the large ports in the main season. This could be done with a relatively small reallocation of the full sampling effort.

2.3 Weighting

Ideally, weights for estimation of means and totals in a probability sample are obtained as inverses of inclusion probabilities. Such weights guarantee unbiased estimation: the average of the estimator over all possible samples from the population is exactly the population parameter. For any given sample, the estimate may be higher or lower than the population parameter, but the variation of the estimates around the true population parameter can also be estimated from the sample data. This makes it possible to construct valid confidence intervals, which contain the true population parameter in a large and predetermined fraction of all possible samples.

In ORBS, there are typically two stages of selection. In the first stage, blocks of time within days within a week are selected for assignment to interviewers. Blocks appear because the interviewer assignments are typically shorter than the full fishing day. It is not clear to what extent blocks of time

are randomly selected. In the second stage, interviewers select boat trips within assigned time blocks. It is not possible for interviewers to enumerate boat trips within an assignment and randomly sample from the list, so systematic procedures are employed. To the extent that interviewers follow the "next boat" protocol, it may be reasonable to approximate the second stage of selection as simple random sampling without replacement from all boat trips returning during the time block.

Consider a particular port-week and let π_{db} = probability of selecting block b on day d. Let N_{db} denote the total number of returning boats in block b on day d and let n_{db} denote the intercepted number of returning boats. If N_{db} were observed, then a set of weights could be constructed as

$$w_{db} = \frac{1}{\pi_{db}} \frac{N_{db}}{n_{db}}.$$

In these weights, the second factor expands the n_{db} intercepted trips in the day-block to the N_{db} total trips in the day-block. The first factor expands the sampled day-blocks to the set of all day-blocks.

Weights $\{w_{db}\}$ are currently infeasible, since N_{db} is not observed. Instead, $N_d = \sum_b N_{db}$ = total effort for the day is observed, or at least well-estimated through a separate measurement (census of trips for charters, bar crossing count for private trips). Hence, a number of alternative weighting schemes could be investigated, for instance by using day weights (which would ignore the blocks within the days) or even multi-day weights (pooling blocks and days within a week). The latter is most similar to the method currently in use.

A critical consideration will be whether the bias due to using approximate weights is sufficiently small to be ignorable. The biases (and variances) of these various approaches depend on within-day (across blocks in the day) versus within-week (across days of the week) variation. It should be possible to characterize the bias analytically, approximate the variance, and derive variance estimation strategies for each. The various methods could also be compared via simulation, and using historical data.

2.4 Variance Estimation

Once an appropriate weighting scheme for the data is developed, it will be possible to construct a design-based variance estimation procedure. As noted

above, the design specified for purposes of weighting and variance estimation will be an approximation to the actual design implemented in the field.

An early goal in the review process will then be to put current data into the framework of a data set with the following elements:

- stratum identifiers (these can be collapsed strata for the purposes of variance estimation)
- primary sampling unit identifier: day or block within day (for proper two-stage variance estimation)
- sampling weight
- sampling fractions within strata (taking advantage of finite population corrections)
- response variables

Once the data set is in this form, point and variance estimation can be conducted using existing statistical software, including the `survey` package in R or `proc surveymeans` in SAS, among others. Use of existing software eliminates the need for a new programming effort and ensures that well-documented best practices are being employed.

2.5 Auxiliary Data

Effort estimation in particular may benefit from the use of auxiliary data. In some ports in high season, there is essentially a census of effort for charters, and in other ports and times, charter data may be available. Charter data may have some explanatory power for non-charter effort, and it would be worth exploring this possibility whenever a charter census is conducted along side a non-charter sample. In addition, weather, bar conditions, ocean conditions, and (where relevant) river conditions may have some explanatory power for effort, particularly in the off-season when other information may be difficult and costly to obtain. Note that even if regression relationships are imperfect, auxiliary data may be very useful in producing more efficient estimators using "model-assisted estimation." Like direct survey estimates, model-assisted estimators are design-unbiased or nearly so, and allow for consistent variance estimation and proper confidence interval construction (even if the regression model is imperfect). If the regression model has reasonable

explanatory power, the model-assisted estimator has smaller variance and narrower confidence intervals than the direct estimator that ignores auxiliary data.

2.6 Codifying Subject-Matter Expertise

Our impression from this preliminary review is that some key parts of the estimation process require manual input from a subject-matter expert, Eric Schindler. These include, for example, decisions on whether to eliminate early-returning trips. Wherever possible, it would be better to replace these manual adjustments by developing rule-based procedures and implementing them in the estimation code. This yields a reproducible and transferable methodology that is documented in the estimation software. Further documentation is also desirable. Development and documentation of such rule-based procedures shields the organization from potential criticism, and has the potential side benefit of allowing rigorous simulation testing of estimation methods. This would not be possible if every replication in a large simulation experiment required manual input!

3 Conclusion

The Oregon Department of Fish and Wildlife has done an excellent job conducting and improving ORBS, as noted at the beginning of this report. The recommendations for further improvements in the six subsections cover a range of issues, some of which would require further investigation. In particular, the possible sample redesign to capture less-frequented ports and times (§2.2), the most appropriate approach for weighting (§2.3) and the use of auxiliary data to increase the precision of estimators (§2.5) will require further study in order to determine how to best implement them.

Survey Review Final Status
Marine Recreational Information Program

Provider Name: **Maggie Sommer**
Survey: **Oregon Recreational Boat Survey (ORBS)**
Date of Review: **7/27/10**
Date of Final Response: **1/27/12**

Provider Instructions: Read the review and provide feedback if desired. Feedback includes accuracy, usefulness, and potential to implement recommendations. Comments on the review process are also welcome.

1. Accept final report: ☒ Yes ☐ No

2. Submitted MRIP proposal(s) in response to review: ☒ Yes ☐ No

3. Formal Feedback Provided: ☒ Yes ☐ No

   3a. Type of formal feedback provided: ☐ Corrections ☒ Comments

   3b. Corrections incorporated in final report: ☐ Yes ☐ No

   3c. Comments attached: ☒ Yes ☐ No

Notes:
Comments written by Eric Shindler

ODFW Comments on this report

2.1 Small Area Estimation

How would moving away from a port based expansion encompass the coded wire tag expansion needs? Resolution of CWT recoveries at the port level (especially for the recreational fishery) is very valuable.

2.2 Sample Size and Issues of Probability Sampling

I don't know if I was able to adequately explain the staffing needs relative to the effort during our meeting. Staffing is lined up for the season based on anticipated effort levels, port characteristics, and meeting the 20% minimum rate during the salmon seasons. Pulling a whole sampler from one port will likely result in not meeting the 20%.

Apparently, my description of the reason why boats would launch at Tierra del Mar vs. Pacific City created a overtly dramatic image of an effort shift. In a hope to clarify this, boats only launch at Tierra del Mar if the beach at Pacific City is in poor shape. However, only a very small part of the Pacific City fleet will ever launch at Tierra del Mar, and the Pacific City sampler is instructed to address such launches should they occur.

Within our current frame and funding, as noted above in an earlier sticky, this is not practical as assigned resources in the prime season are planned to meet the minimum. There may be a means by which to reassign some existing winter samplers where the strata is at the month level to collect some data from smaller ports. In the end, I still see a need for more resources to address the off-season small port issues.

2.3 Weighting

Based on the discussion at the meeting and the expressed importance of weighting, we will need to investigate the feasibility of weighting, and whether this is the best approach to resolving perceived bias issues with sampling assignments.

2.5 Auxiliary Data

The model approach using alternate data sources is, at least, very intriguing. There certainly could be any number of possible directions to explore along

these lines... but they will require both reliable data sources, likely from outside of ODFW, and the time to evaluate.

2.6 Codifying Subject-Matter Expertise

I probably made myself out to be more of an expert than I am... and the manual inputs to the process are not nearly as time of effort consuming as they probably appear. However, the point that rules should be documented to make the methods more transparent, repeatable, and possibly automated is well taken, and see this as a task to put at the top of the "to do list" for this winter... after all, you never know when a key player might get hit by a bus ;)

Consultant's Report: Preliminary Review of Washington's Ocean Sampling Program (OSP)

F. Jay Breidt* and Jean D. Opsomer†
Colorado State University

Virginia Lesser‡
Oregon State University

December 1, 2010

1 Introduction

During the two-day meeting in Montesano, Washington, on November 8–9, 2010, we met with Washington Department of Fish and Wildlife (WDFW) staff to discuss WDFW's Ocean Sampling Program. In this document, we will provide our initial reaction to the design and estimation procedures we learned about during the meeting.

We begin by briefly summarizing our overall reaction to OSP: it is a well-designed and executed program. The geography of the Washington coast offers distinct advantages, including a very small number of sites from which boat launches are practical. There is also limited shore and private access, so the spatial allocation of sampling effort is relatively straightforward. Anglers' required compliance with WDFW sampling efforts is another attractive feature of the program.

The program has a large and thorough sampling effort, with fine spatial and temporal stratification. The geography of sites makes it possible to obtain high-quality measures of effort, via exit counts for high-pressure sites, or

*jbreidt@stat.colostate.edu.
†jopsomer@stat.colostate.edu.
‡lesser@science.oregonstate.edu

entrance counts for low-pressure sites. OSP appears to have careful design in all of its aspects, and rigorous randomization. There is also a clear and clean match between the sampling design and the estimation methods, including appropriately weighted estimates and variance estimation procedures that properly take into account the stratified, two-stage survey design. The methodology is nearly assumption-free, given its rigorous basis in probability sampling. Nevertheless, the presentation that was shown to us explicitly listed the small number of assumptions that do appear in the methodology (e.g., assuming that systematic sampling can be treated as simple random sampling). The consultants had very favorable reactions to all of these characteristics of OSP.

In the remainder of this report, we outline our recommendations for possible extensions or improvements to OSP, as well as a few suggestions for further study.

2 Preliminary Findings and Recommendations

2.1 Domain Estimation

In what follows, a "domain" is any subpopulation of interest for producing estimates, such as trip type (e.g., salmon, halibut, groundfish, other). A domain may or may not be a "stratum", which is a subpopulation that is identifiable prior to sampling. Strata are sampled independently, with a sample size that is allocated in advance. This sample size can be treated as known (except for nonresponse issues). A "post-stratum," on the other hand, does not have a pre-allocated sample size. It is typically not identiable *a priori*, so the sample size in a post-stratum is an unpredictable random quantity. A post-stratum does, however, have a known population size, obtained outside the survey.

These distinctions are important when it comes to obtaining proper variance estimates for domain and population estimates. For domains that are not strata, estimates of domain means have a nonlinear (ratio) form, due to the random sample size in the denominator. Standard survey software can account for such nonlinearity if strata and domains are clearly identified. In the case of post-stratification, additional precision can be obtained from the known population information. We return to this point below.

2.2 Sample Size and Undercoverage Issues

For all of the major ports in the main season, OSP has a major sampling effort, dedicated to checking 20% of the landed salmon catch for coded wire tags. The data that we saw indicated that the 20% target is exceeded by a good margin. This suggests that it should be possible to reallocate some of the sampling effort to gain more information in shoulder-season months, to employ more on-board observers, and to devote more attention to known "undercoverage" issues. Undercoverage occurs when some parts of the population under study have zero probability of selection into the sample: e.g., shore mode fishing, minor ports like Tokeland and Nahcotta, or winter months. This leads to the possibility of bias in estimation of some target parameters if the "uncovered" part of the population differs from the "covered", sampled part of the population. For an "uncovered" part of the population, there is by definition no possibility of information obtained in a sample, so only extrapolation from the covered part of the population is possible.

Even if the uncovered part of the population is similar to the covered part *now*, bias due to undercoverage can arise over time in a dynamic population. For example, while boats may almost never go out from some ports in winter *now*, this may change as anglers obtain better gear (e.g., GPS). Anglers may begin using different gear; e.g., fishing from non-standard watercraft, like kayaks and jet skis. Or anglers may target different species in the future. An example is the targeting of tuna by recreational anglers, particularly on overnight trips.

It was clear to us that WDFW staff have been continually thinking of the dynamics of this target population, and we encourage them to continue to do so. It is also clear that OSP must stop somewhere in order to define the target population. Still, we encourage them to think broadly in defining the target population and, whenever possible, to move in the direction of a full probability sample of the target population by reallocating resources beyond those needed to achieve sufficient precision for the large ports in the main season. This could be done with a relatively small reallocation of the full sampling effort.

For the specific example of overnight tuna trips, it appears that estimates may be off by substantially, because up to 50% of the trips are not recorded. Estimates might be greatly improved by reallocating sampling effort to some combination of night sampling and studying charter logbooks (either a census or a sample from a list frame of charters). This may be possible since these

trips are all leaving from one location, Westport. More generally, undercoverage issues might be addressed through some combination of reallocated sampling efforts and collection of suitable auxiliary data.

2.3 Auxiliary Data

There may be opportunities to include auxiliary information into the estimation procedures, to gain precision at almost no additional cost. For example, weather, bar conditions, ocean conditions, and (where relevant) river conditions may have some explanatory power for effort and catch, particularly in the off-season when other information may be difficult and costly to obtain. Note that even if regression relationships are imperfect, auxiliary data may be very useful in producing more efficient estimators using "model-assisted estimation." Like direct survey estimates, model-assisted estimators are design-unbiased or nearly so, and allow for consistent variance estimation and proper confidence interval construction (even if the regression model is imperfect). If the regression model has reasonable explanatory power, the model-assisted estimator has smaller variance and narrower confidence intervals than the direct estimator that ignores auxiliary data.

To make things concrete, fix attention on one particular port and a given time period such as a month, and consider collecting data using the current stratified two-stage sample, but additionally recording (on the basis of weather and ocean conditions) whether the sampled day is a "good" or a "bad" fishing day. Denote the number of good sampled days at that port as d_{good} and the number of bad sampled days as d_{bad}. Next, let D_{good} denote the total number of good days (sampled or unsampled) and D_{bad} the total number of bad days for the time period, obtained by looking at external sources of information such as weather records. (If fishing was completely impossible on some days due to weather, then $D_{\text{good}} + D_{\text{bad}} < D =$ total number of days in the period.) Finally, let $\hat{C}_{\text{good}}$ denote the estimated total catch on good days at the port, and $\hat{C}_{\text{bad}}$ denote the estimated total catch on bad days. We assume that the catch on days that are not part of D_{good} and D_{bad} is zero, and for simplicity also assume that the days are sampled with equal probability. Then the post-stratified estimator of total catch at

that port and over that time period is

$$\hat{C} = D_{\text{good}} \frac{\hat{C}_{\text{good}}}{d_{\text{good}}} + D_{\text{bad}} \frac{\hat{C}_{\text{bad}}}{d_{\text{bad}}}.$$

This estimator is essentially unbiased whether or not catch on good days differs from catch on bad days. If the catch does differ, then the post-stratified estimator will have smaller variance than the estimator that ignores good versus bad. The same principles apply in more complicated situations, as long as the selection probabilities of the sampled days are known, and existing survey software can compute these estimators as well as their estimated variances.

2.4 Finer Stratification and Collapsed Strata Variance Estimation

One specific issue that arose in OSP was with both a primary and secondary launch site, like Neah Bay and Snow Creek in Area 4. Such sites can be divided into two strata, with different sampling rates within each. If the sampling rate drops to the level of a single site-day within stratum, then unbiased variance estimation is not possible. In this case, a standard approach is to create "collapsed strata" for the purposes of variance estimation. This simply means combining similar strata until there are at least two site-days per stratum, then treating the combined strata as if they were real strata. It can be shown that this leads to a slight overestimation of the variance, so the approximation is conservative. The greater the similarity of the combined strata, the smaller the overestimation. So, for example, if Snow Creek was sampled one day per week for each of 12 weeks, it might be sensible to combine adjacent weeks into six collapsed strata, with two days per collapsed stratum.

Collapsed strata can be used in existing statistical software for complex surveys, including the `survey` package in R or `proc surveymeans` in SAS, among others. In either case, a data set would be constructed exactly as if the collapsed strata were real strata. That is, the data would include the following elements:

- collapsed stratum identifiers

- primary sampling unit identifier: site-day (for proper two-stage variance estimation)
- sampling weight
- sampling fractions within strata (taking advantage of finite population corrections)
- response variables

2.5 Digital Data Recording

OSP has had the distinct advantage of a dedicated, long-term staff, including data entry specialists who transfer handwritten survey instruments to digital format. We recommend that OSP explore electronic data capture in the field, known as Computer-Assisted Personal Interviewing (CAPI). Electronic data capture speeds up data entry and editing, and can improve data quality because edits can be built into the survey instrument, allowing real-time corrections in the field. Further, both the basic data and various kinds of metadata (like information about the data collection process) can be recorded. Electronic data capture and transfer could also makes the OSP less reliant on hard-to-replace staff, like the data entry specialist with 30 years of experience. Building the expertise of staff into the design of a CAPI instrument and its edits would yield a well-documented and tranferable methodology. Finally, we note that electronic data capture devices are becoming increasingly powerful, robust, and inexpensive. We list some recent references on CAPI methodology below, and there is a large body of knowledge on this topic available within the survey community:

- Gravleel, C.C. 2002. Mobile Computer-Assisted Personal Interviewing with Handheld Computers: The Entryware System 3.0. *Field Methods*, 14(3): 322-336.
- Couper, M. 2005. Technology Trends in Survey Data Collection. *Social Science Computer Review*, 23(4): 486-501.
- Ice, G. 2004. Technological Advances in Observational Data Collection: The Advantages and Limitations of Computer-Assisted Data Collection. *Field Methods*, 16(3): 352-375.

3 Conclusion

The WDFW has done an excellent job of designing and conducting OSP, as noted at the beginning of this report. It is close to a "textbook" example of an applied probability sample. The discussion in this document contains a few suggestions for improvements, some of which would require further investigation. In particular, the possible reallocation of sample to address undercoverage issues (§2.2), the use of auxiliary data to increase the precision of estimators (§2.3) and the switch to CAPI would all require further study in order to determine how to best implement them.

Survey Review Final Status
Marine Recreational Information Program

Provider Name: **Cory Niles**
Survey: **Washington Ocean Sampling Program (OSP)**
Date of Review: **12/1/10**
Date of Final Response: **1/31/12**

Provider Instructions: Read the review and provide feedback if desired. Feedback includes accuracy, usefulness, and potential to implement recommendations. Comments on the review process are also welcome.

1. Accept final report: ☒ Yes ☐ No

2. Submitted MRIP proposal(s) in response to review: ☒ Yes ☐ No

3. Formal Feedback Provided: ☒ Yes ☐ No

   3a. Type of formal feedback provided: ☐ Corrections ☒ Comments

   3b. Corrections incorporated in final report: ☐ Yes ☐ No

   3c. Comments attached: ☒ Yes ☐ No

Notes:
None

WDFW Comments on OSP Review Report

The review of OSP was a highly informative and positive experience for WDFW. Likewise, we would like to recognize MRIP and the pilot projects it has supported for the contributions it is making to the monitoring of recreational fisheries. These projects have already allowed us to conduct evaluations that we would not have been able to conduct otherwise and to make improvements about our survey programs. We look forward to future collaboration and involvement with the program. Please consider this our formal response to the preliminary report.

Answers to questions from the Operations Team to WDFW

1. Is it possible to assess effort during fringe waves using offsite sampling methods that are potentially less expensive?

We respond to this question by giving our best thinking on the issues involved with offseason sampling, including cost, and why we proposed the project the way we did. We are certainly open to more discussion.

First, we considered running the project with fewer samplers. Doing so would lower personnel costs, yet it also raises travel costs (we have relatively few ports to cover on the coast yet the distances between them can be surprisingly far). Overall cost would drop but not as much as one might think. More significantly, we'd be worried about the lower coverage level that would result and the risk to the project that the lower coverage would pose.

The risk comes from the "rare event" nature of what we're proposing to sample here: fishing trips are likely few and far between in the off months in Washington. As you know, with low coverage and low probably events, highly variable estimates of catch and effort are to be expected. High variance is one thing if the project is run over time and fishing patterns are relatively stable across years, yet with a one-time project like we're proposing here, that variance tells us that we'd be unlikely to achieve the project's objective. We ran a similar project some years ago with relatively low sampling coverage and are not very confident in the results. The OSP reviewers and our sampling folks agreed that this was a high priority project because of that lack of confidence (that and fishing behavior does change over time).

And, yes, there are potential offsite ways to get at the question. For example, we could look using the phone survey that we use for Puget Sound. We'd have to

design and plan and discuss this approach of course. Our initial reactions would be that the phone survey would be less expensive, yet as you know, we don't use phone surveys to get at the catch by species info. Catch by species is the main objective of this project and of OSP in general. We might also use the phone approach to get at the effort patterns and use that information to plan for the port sampling. This would be a two-year project at least, with no guarantee that we wouldn't arrive at the same answer about the necessary coverage level.

2. Assessing Current Sampling Allocations and Reallocating Sampling to Address Coverage Issues.

This question was raised and discussed with the consultants during the OSP review. We are limited in our ability to reallocate sampling efforts because of other sampling requirements. There are effectively two ways to "redirect" sampling effort by decreasing current sample sizes – either we reduce the number of days sampled during the week, or we reduce the number of samplers per sampled day.

Reducing the number of sampled days per week could work during times of the year when daily fishing activity during a given week is fairly homogenous (e.g., during April or May when only bottomfishing or halibut fishing is open). However, during the July-September time period, we frequently have three or four fisheries open during a week with different closed days. For example, in Ilwaco in August, we may have a halibut fishery open on 1 weekday and 2 weekend days, an ocean salmon fishery open 4 weekdays and one weekend day, and a river salmon fishery, bottomfish fishery, and sturgeon fishery each open 7 days per week. Target trip types and catch makeup differs significantly depending on which fisheries are open on a given day. Therefore, we believe that we can't representatively cover a week if we reduce the number of days sampled during those time periods.

Reducing the number of samplers per day presents different concerns. We currently schedule samplers with the goals of (1) sampling the entire time period that boats may land, and (2) covering all potential landing areas within a port. Again, our overall goal is to give all boats on the exit or entrance count an equal chance of being included as part of the sample. Due to limited funding, each sampler we schedule in a day fills a unique temporal/spatial niche (i.e., there is little sampling overlap at the temporal/ spatial level). By reducing a

sampling team by even one sampler in a day, we remove from the potential sample boats landing in that time/location combination.

Thirdly, there are a number of "rare event" occurrences throughout the season – anything from encountering illegally retained yelloweye or canary rockfish (intensively managed species) to finding low abundance coded wire tagged salmon groups. While we typically exceed our contractual sampling obligations (a minimum 20% sample), we believe that a level of sampling higher than the contractual minimum is necessary for estimating these rare events.

Finally, funding for the Ocean Sampling Program comes from many different sources; each source has a specific associated work statement. Very few funding sources allow us the flexibility to redirect their funds to something not included in the contract, and we have specific sampling obligations that must be met. While redirecting existing sampling effort may sound easy, finding the funding to redirect that effort would be much more difficult.

3. Use of Auxiliary Data, such as Weather, Bar Conditions, Ocean Conditions, etc.

This question was also raised in our review of the preliminary OSP report. Section 2.3 of that report suggests using auxiliary information on weather conditions to calculate harvest by apportioning the observed catch between good and bad weather days, then expanding each by the appropriate sampling fraction, e.g. the proportion of good weather days sampled out of the total good weather days. Before considering testing such an approach, we would like clarification of how this type of information or method would reduce bias and/or improve precision of total harvest estimates.

Under current sampling protocols, sampling days are selected at randomly a week or two prior to sampling. Good and bad weather days have equal chances of being included in the sample proportional to their occurrence, on average. There is no preference for sampling based on weather conditions under current sampling protocols and thus should be no bias (on average) in harvest or CPUE estimates based on this issue.

It is not apparent that precision would be improved by including auxiliary data in calculations of harvest. If the proportion of good and bad weather days in any week/month strata and their associated sampling fractions are a random quantities then they should be incorporated into variance calculations. Subsequently, it is unclear that post-stratification based on weather type would improve precision in harvest estimates.

We are also concerned with the potential subjectivity, inconsistency, and other logistical challenges of indexing days based on weather or ocean conditions. The benefit to precision might not outweigh the effort of the indexing or the potential for bias. Again, we are asking for further explanation on this point and are open to further discussion and consideration of employing auxiliary information in sampling.

Consultant's Report: Review of Washington's Puget Sound Catch Record Card Study

F. Jay Breidt[1] and Jean D. Opsomer[2]
Colorado State University
Virginia Lesser[3]
Oregon State University
April 7, 2011

1 Introduction

The authors of this report met in Montesano, Washington, on November 8-9, 2010 with Washington Department of Fish and Wildlife (WDFW) to discuss WDFW's Ocean Sampling Program and the Puget Sound Sampling Program. Reports have previously been provided to MRIP and WDFW summarizing these reviews. During this meeting, WDFW staff mentioned the use of catch record cards to estimate salmon harvest in Puget Sound. Along with the intercept survey, catch record cards are used to obtain estimates of salmon harvest. Catch record cards have been used to estimate salmon harvest in Puget Sound marine waters since 1964.

Following the November meeting, WDFW confirmed that the Puget Sound catch record cards are a necessary component to consider in the Puget Sound review. A seven page document provided by WDFW in January 2011 summarized briefly the catch card methodology used to estimate Puget Sound salmon harvest. A conference call on February 7 with WDFW and MRIP consultants addressed some preliminary questions on this document and the catch card study. An additional document titled *Northwest Fishery Resource Bulletin - Estimating the Harvest of Salmon by the Marine Sport Fishery in Puget Sound: Evaluation and Record Cards* was provided, giving background on the catch record cards methodology. This document provides details of a thorough study conducted between 1985-1990 to assess the biases of estimates that are produced from the intercept survey and estimates produced from the catch record cards. Based on the results of this study, bias factors were developed and are currently applied to the estimates of salmon

1 jbreidt@stat.colostate.edu
2 jopsomer@stat.colostate.edu
3 lesser@science.oregonstate.edu

harvest from the catch cards. The report by Conrad and Alexandersdottir (1993) also provides details of the history of the catch record cards used in Washington, the methodology used to collect data for the bias study, and the development of the estimators used to produce the bias factors.

The seven page summary provided in January 2011 also provided additional details on the catch cards issued from the Washington Interactive Licensing Database (WILD) system. Unique identifiers are assigned to each angler in the licensing database. Temporary licenses issued by charter boats, and anglers that purchase "Hot Key" licenses, are not entered in the database.

Response rates in most surveys conducted nationally have been declining over the past 10 years. The procedures outlined in the catch card study adopt well established survey methodology approaches, such as reminder mailings, that are among the best strategies available to improve response rates. Here we provide our initial review of the catch card procedures.

2 Current Data Collection Methodology and Estimation

2.1 Data Collection

Anglers are required to have a catch record card to record salmon harvested during a "license year," currently defined as April-March. This provides a documentary record of salmon catch and is an excellent tool to record catch for the angler over the year. For example, it reduces recall error when the angler is asked to report catch for the license year. While anglers are legally required to turn in their catch cards, there is no penalty for not doing so, resulting in the low return rates for the catch cards. There is a $10 penalty for late return of crab cards.

WDFW randomly selects 25% of the cards issued each year for use in generating salmon catch estimates based on the catch cards. This group is referred to as the "in-sample group." Anglers from the in-sample group who have not voluntarily returned catch cards are then contacted to request their catch information. An initial postcard with instructions requesting the catch record card is sent. Two months later a letter is sent with a form to enter the catch data. In the early years of the survey an additional letter was sent, but this was discontinued due to cost constraints. Multiple contacts are one of the best survey approaches to improve response rates in mail surveys.

Data are entered and verified for the in-sample catch cards. Data collected and entered include the catch area, date, salmon species, and clip type.

2.2 Estimation and Development of Bias Correction Factors

The total number of catch cards issued is not known and has to be estimated. While the number of cards issues through the WILD system is known, there is an unknown number of catch cards distributed by charter boats and the number of "hot key" licenses that are issued is also unknown. The latter categories of catch cards are approximately 5% of the total catch card issued.

A five-year intensive study was conducted by WDFW in the late 1980's to compare harvest estimates based on the different methodologies. Estimates of harvest based on the intercept survey were treated as a "gold standard" in a detailed comparison for the same areas for data collected from the catch card study. This provided data to estimate relative bias. The Conrad and Alexandersdottir report (1993) also described a comparison of a ratio-of-means method and an error-in-variables method to estimate catch card bias. In addition, a comparison of three variance estimators was also presented in this report.

3 Concerns on the Current Approach

The intensive study conducted in the late 1980's provided the data needed to estimate catch card bias. This was an important and critical study. However, we note the following with regard to the current approach.

- The intensive study was conducted nearly 25 years ago. Fishing patterns may have changed over this time, because of changes in the population of anglers residing around Puget Sound, changes in the salmon population itself, etc. For example, areas with low harvest in the late 1980's that did not provide data to estimate catch card bias with adequate precision may now have much larger catches.

- Response rates to all surveys are declining. A conclusion in the Conrad and Alexandersdottir report stated that a minimum 70% response rate is needed or the estimates of salmon harvest from catch cards will be compromised. It is unclear how this minimum response rate was determined, but it is clear that a low response rate will negatively impact the characteristics of estimates based on this survey. The response rate for the 2009 survey was about 56%.

- The number of catch cards issued used to be unknown, which introduced some variability for this value. More recently, with the introduction of the WILD licensing system, this situation is significantly improved. As noted above, there are still charter/hotkey cards where the number is not known, but these make up less than

5% of total cards issued (3.2% in 2009). Hence, this source of additional variability is potentially small enough to be ignored.

- Recommendations in the last intensive study comparing intercept and catch card estimates of harvest stated that if nonresponse remains high, intercept survey estimates of bias will be necessary on a periodic basis to detect changes in the bias factors currently adopted in Washington. Nonresponse remains high in the most recent surveys.

- Given that only 25% of returned catch cards are included in the in-sample, additional "voluntary" cards that are returned would be out-of-sample. Only out-of-sample catch cards returned with steelhead catch are processed but are not used for salmon estimation. Since data from "volunteer" surveys are not generally considered statistically representative, they cannot be directly combined with the in-sample data to create estimates.

- Catch record cards are also collected for sturgeon, steelhead, halibut and crab, with different approaches to bias correction applied to them over time, ranging from carefully developed bias corrections to no correction at all. Even if each of them might make sense on its own (i.e. the bias correction for each survey is appropriate given the current knowledge about the survey), this is potentially inefficient in terms of departmental resources and confusing to communicate to the public. It is also an open question whether each approach *is*, in fact, currently appropriate for each survey.

4 Considerations for Updating the Contribution of the Catch Card Data in Estimating Salmon Harvest

The following are some suggestions to consider for the catch card study. The amount of money, staff time and other resources required to implement each suggestion varies, and would need to be evaluated to determine what may be possible given these constraints. We begin by listing several immediate possible improvements to the current catch card program:

- There is a pressing need to revisit the bias adjustments calculated in the late 1980's. In the most recent year that data were finalized in Washington, 2007, 55% of the Puget Sound salmon catch was obtained by the catch card harvest estimates (Van Buskirk, email communication, March 21, 2011). Given that these bias adjustments

were derived over 20 years ago, the necessary bias corrections could now be quite different. It may not be reasonable to assume that the relationships of the catch card harvest estimates to the intercept harvest estimates for the late 1980's and 2011 are identical, so that applying the old adjustments to the current data might be inappropriate. Given the diversity of surveys (salmon, sturgeon, halibut, crab, etc), we would recommend investigating bias correction methodologies that are applicable to all these card programs, and develop uniform protocols for this across all of them.

- In order to obtain a more complete list of anglers, consider obtaining and entering names and addresses, telephone numbers, and/or email addresses for those anglers who purchased temporary licenses outside of the WILD system into the database. This would expand the Washington Interactive Licensing Database to include the subset of anglers with contact information which could be used in future surveys of anglers to obtain representative samples. Not including some subgroups would not provide a complete list of anglers..

- Currently, the voluntary catch card returns are not used in general estimation (although they appear to be used for steelhead estimation, to detect rare events and for smooth the catch estimates for areas with low catch). However, because the domain of voluntary returns can be identified from the sample, it seems conceptually possible to use the voluntary returns more fully to estimate characteristics of the "voluntary-return domain", potentially yielding a more precise estimate of the population total. Of course, this would require processing all of the voluntary returns, or a random sample of the voluntary returns, in order to be implemented. Another possibility worth investigating is to allow internet reporting, which would consist of a third respondent domain. These possibilities would need to be carefully evaluated for feasibility and statistical validity.

The previous three items are suggestions for improvements to the catch card data collection and estimation procedures. A more ambitious and long-term suggestion is to consider a redesign of Puget Sound recreational fishery survey programs as a whole, taking advantage of the strengths of different potential sampling frames and sampling methods to develop a more integrated survey approach. Possible surveys include: general population through random digit dialing telephone surveys using landline and cell phone lists or through the U.S. Postal Service address-based list, license frame samples, intercept surveys, and catch cards (both voluntary returns and those sampled and returned). Each of these has its own strengths and weaknesses in terms of costs, timeliness, data quality, and coverage properties. For instance, the intercept survey yields high quality data at a fine temporal and spatial scale, but suffers from potentially serious under-coverage due to the

lack of access to private fishing sites. It is also expensive. In contrast, the catch cards are inexpensive and have nearly complete coverage, but the data are only available at the end of the season, from sampled respondents and from volunteers. At least conceptually, these various sources of data might be combined to yield estimators with better accuracy and precision than estimators that use only one of the sources.

- Initially, a more formal program of comparisons of estimates obtained using catch cards and alternative sources such as the intercept surveys should be developed, in addition to repeating the bias evaluation from the original study as recommended above. Since both surveys (and possibly others, see above) at least partly overlap in scope, it would be possible and useful to obtain a more detailed understanding of both surveys, including costs, coverage issues, differences in respondent characteristics, bias/variance of the estimates, etc.

- The catch cards only provide data on a single species and a single (annual) point in time. Another use of the cards can be as a complement to a license-based survey, which was described in the report for the Puget Sound Sampling Program. The catch cards could still be used by each angler to record salmon catch over the license year. Once the sample of anglers is selected, a questionnaire could be sent using repeated mailings as currently used. This would provide an opportunity to ask the angler catch information as well as additional questions that are not covered on the catch cards. A cost comparison of this approach to the current method can evaluate the most cost efficient design.

- If the catch card study is reexamined, consider the use of focus groups with a group of anglers to determine their attitudes about the catch card survey. For example, it would be helpful to determine what might motivate an angler to complete the catch card survey. The focus group could address if a mandatory program that denies a future license to nonrespondents is an approach to consider. Once issues important to anglers and issues that may improve the catch card study are identified, a probability survey of license holders may be worthwhile to quantify angler interest on the proposed changes. This information would be useful to support changes that WDFW may propose in a redesign of the catch card study.

- More generally, some combination of license-based, general population (through random digit dialing telephone surveys using landline and cell phone lists or through the U.S. Postal Service address-based list), intercept and catch card surveys might be constructed to provide high quality and cost-effective data suitable for a range of uses, including in-season and between-season management of individual

species, and state-level and national reporting of recreational catch and angler behavior. Surveys using a combination of methods could be examined initially to assess bias associated with the different methods, such as the self-reporting estimates from the catch cards. Development of such a comprehensive multi-frame, multi-mode approach would clearly take significant time and effort.

Survey Review Final Status
Marine Recreational Information Program

Provider Name: **Cory Niles**
Survey: **Washington Puget Sound Catch Record Card Study**
Date of Review: **4/7/11**
Date of Final Response: **5/13/11**

Provider Instructions: Read the review and provide feedback if desired. Feedback includes accuracy, usefulness, and potential to implement recommendations. Comments on the review process are also welcome.

1. Accept final report: ☒ Yes ☐ No

2. Submitted MRIP proposal(s) in response to review: ☒ Yes ☐ No

3. Formal Feedback Provided: ☒ Yes ☐ No

   3a. Type of formal feedback provided: ☒ Corrections ☐ Comments

   3b. Corrections incorporated in final report: ☒ Yes ☐ No

   3c. Comments attached: ☐ Yes ☐ No

Notes:
We would again like to thank MRIP for supporting this review. As you will see, we have found the comments very helpful and are already moving to implement certain recommendations.

Consultant's Report: Review of Washington's Puget Sound Sampling Program

F. Jay Breidt* and Jean D. Opsomer†
Colorado State University

Virginia Lesser‡
Oregon State University

February 7, 2011

1 Introduction

During the two-day meeting in Montesano, Washington, on November 8–9, 2010, we met with Washington Department of Fish and Wildlife (WDFW) staff to discuss WDFW's Ocean Sampling Program and its Puget Sound Sampling Program (abbreviated as PSSP in what follows). In this document, we will provide our initial reaction to the design and estimation procedures for the PSSP.

The PSSP collects large amounts of information on the characteristics of both catch and effort in Puget Sound, in a very challenging survey environment (as further detailed below). Data collection is done by several complementary surveys with designs of varying complexity, and those design features are currently not explicitly accounted for in estimation. While the resulting estimates of catch volume and characteristics certainly appear reasonable, the fact that they do not reflect the sampling design makes it difficult to fully justify them statistically, potentially making WDFW vulnerable to criticism about its estimates. An associated problem is that the

*jbreidt@stat.colostate.edu.
†jopsomer@stat.colostate.edu.
‡lesser@science.oregonstate.edu.

measures of precision such as confidence intervals and coefficients of variation are almost surely too optimistic.

The components of the PSSP form an excellent basis from which to start designing a survey program that is more statistically justifiable. Doing so will definitely require a more in-depth look at the PSSP, but we will provide some initial ideas in that direction later in this document.

2 A Challenging Survey Environment

Estimating characteristics of the catch and, to a lesser extent, the fishing effort in Puget Sound is clearly extremely challenging. Even a somewhat cursory list illustrates the range and magnitude of the problems faced by the PSSP:

- Unlike in the case of the OSP, access to Puget Sound is not restricted to a small number of ports. Instead, fishing boats can depart from a large number of ports of varying sizes, and a possibly large amount of shore fishing takes place as well. Not all of this angling activity is captured well in the PSSP. For example, a substantial fraction of the ports are not available for sampling (private ramps/marinas), and shore sampling is rare or non-existent. This leads to concerns about potential bias, since fishing behavior is likely to vary by public versus private and boat modes versus shore modes.

- Fishing behavior appears to display a component of "flash fishing" (a term we made up for lack of a better one), with heavy fishing activity concentrated in a specific place for a short time in a way that is difficult to predict ahead of time.

- WDFW is required to sample a large fraction ($> 20\%$) of the salmon catch, which limits the overall flexibility of the sampling program.

- Puget Sound fisheries are surveyed by three different entities (WDFW, Canadian fisheries agencies, US tribal agencies), making estimation of overall catch and effort characteristics for the region more difficult.

3 Some Highlights of the Current Approach

The PSSP is an intensive survey program and has many good features, which clearly reflect the fact that WDFW is committed to producing high quality and reliable estimates of the total catch and its characteristics in Puget Sound, at fine spatial and temporal scales. During our meeting in November, we noted the following:

- The core of the PSSP consists of the intercept surveys at public boat ramps, which are conducted year-round ("baseline sampling") and augmented with more intense sampling during the peak seasons ("intensive creel surveys"). This gives good temporal resolution throughout the year and captures a large fraction of the fishing activity.

- Interviewing for the two types of intercept surveys uses a uniform data collection method, allowing the data to be readily combined. Interviewing covers all or most of the fishing day and includes counting of all anglers/boats, resulting in high quality information at the site level.

- The intercept surveys are complemented by two additional data sources related to catch: the on-water surveys and the test fishing program. The on-water surveys make it possible to estimate the fraction of fishing activity that occurs from out-of-frame launch sites. This is an important element of the overall estimation procedure for what appears to be an unavoidable undercoverage issue. The test fishing program provides insights into some of the detailed characteristics of the catch, which is valuable as an external validation for the intercept survey data.

- Washington has an on-going licensing program, which provides a frame for a telephone survey to estimate fishing effort. This makes it possible to conduct a much more efficient and cost-effective survey of anglers than a random-digit dialing survey.

- We noted with appreciation the current efforts to interpret, re-code, and document the estimation methodology. This is extremely important for producing a system that can be continuously updated and improved over time, even with changes in staffing.

4 Some Issues

The following is a list of the major issues we identified related to the PSSP.

- The current intercept surveys (baseline and intensive creel) are clearly set up to cover most of the fishing activity, with an emphasis on sites and times with higher fishing pressure. It appears that significant components of the overall design are informal, with sampling supervisors making the assignments based on local knowledge and occasionally adjusting them "on the fly" when fishing activity is known to congregate in certain areas. Allowing this level of independence to sampling supervisors has the advantage of flexibility and makes it possible to maximize the number of interviews ("headhunting"), but lack of an overall formal sampling design opens the door for criticisms of subjectivity. It also makes the system heavily reliant on the experience and expertise of the sampling supervisors, which is not easily transferred to future WDFW staff unless it can be converted into formal protocols.

- In addition to the issues associated with subjectivity in site selection, a key problem with the lack of a formal sampling design is that it is difficult to create sampling weights that account for the fact that some sites are selected more often than others and to estimate the true sampling variability of the estimators. The lack of weighting can result in bias in the estimates, and the lack of recognition of the fact that the observations are clustered by site-day means that the estimated measures of precision (CV, confidence intervals) are too optimistic.

- There are clearly issues with undercoverage in the current intercept surveys. The issue of private boat ramps and marinas is something that is unlikely to be fixed, and the on-water intercepts seem like a good way to estimate (at least) the fraction of fishing activity launched from those inaccessible sites. The current intercept surveys seem to completely miss shore fishing, which might be a significant issue unless it is a trivial fraction of the total catch. It is possible that shore fishing targets a different mix of species, so that using a "ratio-ing" solution might not work in this case.

- The PSSP appears to have some components that are more closely related to convenience sampling. This includes the ability of sampling

supervisors to send interviewers to fishing sites that are "hot" because of short-term presence of large numbers of fish, and the Voluntary Trip Reports (VTR) card program. The former can most likely be formalized and incorporated in an overall intercept survey sampling design (see below). But because the latter is completely voluntary and lacks any controls on response quality, it cannot be viewed as a survey data source and hence should not be combined with the intercept data in making overall estimates of the catch characteristics.

- The effort estimates are based on a telephone survey of licensed anglers. There are some issues associated with this frame, including the fact that some licenses can be obtained from boat captains and are not available for sampling, the telephone number information is incomplete on the other licenses, and not all anglers are licensed.

5 Suggestions for Possible Improvements

The following are some suggestions for improvements to the PSSP. These are based on our initial understanding of the features of the PSSP. Of course, these suggestions would need to be investigated carefully to determine their statistical efficiency, logistical feasibility, and cost effectiveness.

- The baseline and intensive creel surveys already use a frame of access sites and partly apply a formal procedure to select sampling site-days, using the Murthy two-per-stratum PPS design. Extending the sampling design so that all or most (see the next point) of the interview assignments are determined by a formal mechanism would put the program on a much stronger statistical footing. Such a design could use some of features of the new MRIP design currently being field-tested in North Carolina, including assigning fishing pressures to sites and periodically updating them, and combining multiple low-pressure sites into "super-sites" for the purpose of making interviewing assignments. The key component of the sampling design would continue to be spatial and temporal stratification with PPS by pressure within the strata. Note that sampling supervisors' experience and expertise are ideally used in the construction of strata and pressure matrices, as an example of the kind of formal protocols noted under "Issues" above.

- If it is desired to continue allowing sampling supervisors to deploy interviewers to areas with very high short-term fishing activity, there are a number of ways to incorporate such a feature in a formal sampling design. One way is to update the fishing pressures prior to drawing samples to reflect the new information, so that samples are drawn in light of the most recent information and will contain a larger number of the newly more "interesting" sites. Another way is to hold back a fraction of the total assignments when drawing the samples, and then deploy them as needed to "hot spots." If the latter is done, then these assignments do not follow the overall design, and the way to incorporate those data into the overall sample is to make them "self-representing." An example of this in a different context might be a sample of companies, in which a few very large ones are thought to be so important that they must be part of the sample and are drawn with certainty. These companies become self-representing, which means they receive a weight of one.

- The license-based frame provides a cost-effective way to collect the data used for estimating fishing effort. However, like almost all such frames, it suffers from undercoverage, and it might be useful to investigate a dual frame approach, in which the license frame sample is supplemented by a general-population sample. The latter can either be used to make combined estimates across both frames, or can be used to determine the adequacy of the license frame. A separate issue concerns the fact that some people might have licenses but their contact information is either not available for sampling or is incomplete. Dual frame approaches typically cannot correct for this type of problem, so that efforts should be undertaken to ensure that the contact information is available for license holders.

- Because the ultimate goal of the PSSP is to estimate characteristics of the catch of anglers in Puget Sound, it seems important to coordinate data collection and estimation procedures across the different agencies responsible for Puget Sound fisheries (WDFW, Canadian fishery authorities, tribal fishing authorities). Of course, this point is broader than the PSSP and might not be something that WDFW has any control over.

Survey Review Final Status
Marine Recreational Information Program

Provider Name: **Cory Niles**
Survey: **Washington Puget Sound Sampling Program (PSSP)**
Date of Review: **2/7/11**
Date of Final Response: **5/13/11**

Provider Instructions: Read the review and provide feedback if desired. Feedback includes accuracy, usefulness, and potential to implement recommendations. Comments on the review process are also welcome.

1. Accept final report: ☒ Yes ☐ No

2. Submitted MRIP proposal(s) in response to review: ☒ Yes ☐ No

3. Formal Feedback Provided: ☐ Yes ☒ No

   3a. Type of formal feedback provided: ☐ Corrections ☐ Comments

   3b. Corrections incorporated in final report: ☐ Yes ☐ No

   3c. Comments attached: ☐ Yes ☐ No

Notes:
We would again like to thank MRIP for supporting this review. As you will see, we have found the comments very helpful and are already moving to implement certain recommendations.

WDFW Response: May 12, 2011

WDFW Comments on:
Consultant's Report: Preliminary Review of Washington's Puget Sound Sampling Program (dated 2/7/11)

We very much appreciated the opportunity to work with the MRIP consultants during the review of Washington Department of Fish and Wildlife's (WDFW) Puget Sound Sampling Program, conducted November 8-9 in Montesano, Washington. After thoroughly reviewing the MRIP consultants' document titled "*Consultant's Report: Preliminary Review of Washington's Puget Sound Sampling Program*" (dated February 7, 2011), we at WDFW are in full agreement with the consultants' analysis of our sampling program, issues raised, and recommendations made for possible improvements. We do not see any flaws in the review or misunderstandings of program, and we do not anticipate asking for revisions or re-visitation of any major issues.

The WDFW Puget Sound Sampling Unit (PSSU) is eager to address several of the MRIP consultants' recommendations for improving the intercept survey in particular, as exemplified in our submission of a proposal for MRIP funds that was submitted in late January 2011 (project concept attached). Specifically, our proposal focuses on work we can start immediately to improve the scientific rigor of the Baseline Sampling design. The consultants recommended incorporating a formalized site selection approach for the Baseline design that is scientifically defensible and repeatable rather than the current approach based on the sampling supervisors' discretion; i.e., a randomized, formalized probability-proportional-to-size (PPS) approach designed for selecting Baseline sampling sites, similar to the approach PSSU currently uses for selecting Intensive sampling sites. Also, the consultants recommended refining PSSU's database structure to enable distinguishing Baseline versus Intensive records in the recreational fishery database. In addition, they recommended adding a field to the recreational database that would contain the probability value (site "size measure") used for selecting Baseline and Intensive sampling sites. These probabilities would then be incorporated into subsequent catch estimation steps in our computer program. Each of these deliverables would be accomplished as part of fulfilling the objectives of our recently-submitted MRIP proposal.

Once again, we thank MRIP/NOAA and the expert consultants who worked with us for the objective, helpful reviews, clear communications, sharing of knowledge and expertise, and recommendations offered for our Puget Sound Sampling Program. We intend to carry forward with continued improvements to our sampling program in the years to come.