Analysis of By-Catch Data Collected by Washington Department of Fish and Wildlife in Areas 10, 11 and 12 during 2011 Puget Sound Non-Tribal Gill Net and Purse Seine Fisheries.

by

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ABSTRACT

This report confirms the major conclusions from an earlier report (Mathews, 2012) that the by-catch rates of both chinook and coho by purse seines (number caught per 1,000 chums) during the Puget Sound chum season are greater than those by gill nets. The by-catch rate of coho by gill nets appears to be adequately measured from fish ticket catch data but not necessarily so for chinook. My conclusion that the purse seine chinook by-catch rate tends to be higher than that for gill nets was considered controversial by WDFW according to their analysis of observations taken during the 2011 chum season. My conclusion was strengthened by on-board sampling two months earlier that showed a relatively high rate of capture of small chinook by purse seiners during a 2011 pink salmon experimental fishery.

For non salmonid by-catch, the main conclusions from the 2011 data sets were these: (1) The by-catch rate and mortality rate for marine birds are higher for gill nets than for purse seines; most birds caught are common murres, whose populations on a continental scale are healthy; (2) dogfish is the only significant non-salmon fish species taken as by-catch and most are taken by gill nets, from which almost all can be released alive; and (3) direct marine mammal encounters in purse seines may be more frequent than in gill nets, although the relative lethality in each is not certain. Indirect marine mammal encounters registered as damaged fish in gill nets, occurred as a low percentage of the total gill net catch, and probably also occur in purse seines at some rate difficult to measure.

A discussion of relative by-catch consequences of gill netting and purse seining, presented in a 2012 Concise Explanatory Statement (CES) on Puget Sound salmon regulations by the Washington Department of Fish and Wildlife (WDFW) is mostly unsubstantiated by data or analysis. WDFW makes the barest of references to their 2011 observations and only for negative gill net opinions; they reference no facts or analysis from a 2001-2010 data set of purse seine observations that they consider to be adequate for demonstrating a "low" by-catch encounter rate for ESA species; and they minimally reference the abundant scientific literature on by-catch mortality in salmon fisheries, thus failing to confirm opinions on important by-catch issues.

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Contract Report for Puget Sound Salmon Commission (PSSC)

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INTRODUCTION

In Feb. 2012, I submitted a report to PSSC on salmonid by-catch in non-Indian purse seine and gill net fisheries for chum salmon in Puget Sound. My major conclusions were: (1) that the coho salmon by-catch rate (numbers caught per 1,000 chums) is two or three times greater for purse seiners than gill netters, but that the majority of coho caught by seiners could be released unharmed if careful handling rules were enforced; and (2) for chinook salmon the purse seine by-catch rate is substantially greater than that for gill netters, and the majority of these small, immature fish would be dead or moribund on capture and therefore incapable of survival by careful handling and release.

In the 2012 Concise Explanatory Statement (CES) for Puget Sound Commercial Salmon Regulations, the WDFW criticized my by-catch rate estimates, which I based primarily upon two sets of data: (1) fish ticket landings by gill nets (which

are allowed to land by-catch of chinook and coho in all years and areas) and by purse seiners in the relatively few circumstances where landings of coho were allowed (purse seiners were never allowed to retain chinook for my years' of analysis); and (2) by-catch rates of chinook and coho by purse seiners in the Apple Tree Cove Point chum salmon run update test fishery. About 30-40 test sets are made each year over the course of the chum season at Apple Tree Cove Point near Kingston, and trained biological observers are aboard.

WDFW's main concerns about my Feb. 2012 conclusions can be summarized as follows:

1. Additional data were available that I did not analyze or discuss.

2. My analysis did not include species other than salmon.

3. My analysis assumed that fish tickets give an accurate representation of by-catch.

4. My analysis did not address additional sources of fishing induced mortality.

I will discuss each of these concerns in reverse order, which will lead me to the focus of the present report – analysis of the 2011 WDFW by-catch observational data for Areas 10, 11, and 12.

Regarding point (4) I believe they are referring primarily to sea lion or seal depredation in gill nets, which is well

registered by the damaged parts left in the nets. I doubt that WDFW is simultaneously referring to likely, but less obvious, marine mammal predation that may occur in purse seine sets. Sea lions are seen within and occasionally caught by purse seine sets. They apparently do not get killed in purse seines or gill nets, being pretty tough, smart animals. But it is quite likely that – just like with gill nets – they are drawn to seine sets because of the concentration of salmon to eat. However, most of what they would maim, injure, or kill without eating in a seine set, would fall to the bottom, unlike in a gill net – i.e., out of sight, out of mind. To measure this for seiners would be difficult of course, but an objective viewpoint on non-capture fishing mortality would consider this potential occurrence as well as the gill net depredation by marine mammals. WDFW monitored 3,407 purse seine sets between 2001-2010, according to their Oct. 5, 2011 e-mail to a PSSC board member. They should review and publish the record of these sets to report on the frequency of seals or sea lions in purse seines, as well as report on other by-catch issues that could be clarified by these data.

Regarding their concern about fish tickets, I make no claim that such data are 100% accurate for estimating salmonid by-catch. The full sequence of events of filling out the tickets at the point of first sale, interpreting the various scrawls and random slop on the tickets by the data recorders, and correctly programming the electronically encrypted information leaves some room for errors. In defense of my reliance on such data, I would emphasize that most fisheries agencies around the world base their management upon some trust of their systems of recording

the catch. And why would gill net and purse seine by-catch of coho salmon from fish tickets in circumstances where both can legally land such by-catch not be valid for comparison?

Regarding point (2), I was asked by PSSC to analyze only salmonid by-catch for the Feb. 2012 report. But for the present report I have been specifically asked to extend my analysis to all other by-catch species.

For point (1) I concur that any and all relevant data should be reviewed, presented, and discussed. In this present report, I specifically address the 2011 on-board monitoring of gill netters and purse seiners during the chum season, to which the WDFW refers. I also reviewed some on-board observer data for an Area 10 special experimental purse seine fishery for pink salmon in 2011, which has relevance to the by-catch issues for the chum season. I suggest that WDFW should do their own analysis of their previous relevant data sets such as Apple Tree Cove Point test set data prior to 1996, and a substantial body of purse seine and gill net observations of theirs from 2001-2010, and present reports on these for public review..

2011 WDFW Sampling Protocols

WDFW observed 97 Area 12 gill net sets, 47 Areas 10 and 11 gill net sets, and 81 Area 10 and 11 purse seine sets during the 2011 fall chum season. The period of these observations was late Oct. through early Nov. Additionally they observed 104 purse seine sets during a 2011

experimental fishery targeting pink salmon in Area 10, which occurred in late Aug through early Sept.

According to WDFW, most of the gill net sets for Areas 10 and 11 and some in Area 12 were monitored by observers who were on-board for the entire fishing period. Usually these were fishers who volunteered to have observers on board. WDFW told me that some of the Area 12 gill net sets and all of the Areas 10 and 11 purse seine sets were monitored by observers who were placed aboard from a WDFW vessel for just one or two sets, and then taken off and transferred to another vessel. I surmised that if a hailed boat was unwilling to take an observer aboard, that the WDFW vessel would then go to another one waiting to make a set, and so forth, until a willing skipper was found. This would, as in use of volunteer gill netters, avoid any potential confrontation or discomfort involving an observer and an unwilling skipper. But, reliance on willing skippers creates biased sampling for either gear type, as I discuss later. However, the purse seine sampling process gets even murkier. WDFW informed me that some uncertain proportion of the purse seine sets were not fully sampled, start to finish; only the payload was observed. I discuss the likely bias of such incomplete sampling later. All of the Area 10 pink season sets were monitored by observers who were aboard for the entire day's fishing. In fact, since this was a new, experimental fishery, purse seiners were required to have observers aboard at all times in order to participate.

Much of the methodology can be understood by referring to their data forms – which are quite different for the two gear types. (Appendix 1:Charts 1A, 1B, 1C, 1D and 1E).

Each gill net set requires two separate pages (1A, 1B), which are front and back of a sheet. The observer records standard items relative to vessel, location, date, net, skipper, observer's name, timing of the observation, weather, etc. Then, detailed catch information for all animals caught on a particular set is recorded. There are 14 separate lines for the various species of fish that conceivably could be encountered. For each species, apparently, information is supposed to be added as to extent of harm due mostly it seems to marine mammals. Thus for target fish the observer is required to indicate how many were damaged but salable, and damaged but unsalable. The total catch of a retained species like chum would be the sum of four separate columns according to the form instructions (# retained marked, # retained unmarked, # salable damaged, # unsalable damaged). The form has 14 lines for up to 14 total species of fish. Thus, in addition to the six categories of salmon (chinook can be "adults" (>22") or "juveniles"), the form has lines for possibly eight more species of fish. The back side (1B) is where the observer can keep track of all birds and marine mammals caught, and their condition. There are lines for up to 11 potential species of birds and four species of marine mammals. There is also a lot of room for comments.

The purse seine forms (1C, 1D) are quite different. Each set is simply one line. The headings relate to a series of sets that may be observed on some day by a trained observer

who may be aboard one vessel for the entire day (1C), or who is transferred from vessel to vessel via the WDFW boat (1D). Unlike the gill net forms there are no places to indicate significant structural aspects of the net, such as depth or mesh size, or specific deployment information like time set, etc.

For each set on the purse seine form (1C, 1D) there are spaces only for total salmonids by species. There are no specific places on the form to record condition of fish or to urge the observer to look for damage to individual fish such as by marine mammals. Nor are there any columns for numbers of "other" fish caught, equivalent to the eight lines of the gill net form allowing for up to eight more species beyond salmonids. The apparent assumption is that seiners do not take "other" fish. For birds, marine mammals, and all other organisms possibly encountered, the purse seine form has simply one space for each set and no specific place to record condition information, compared to the entire back sheet of a full page for each gillnet set. Nor are there columns or spaces for "comments" about each seine set equivalent to the several lines for such on the gill net forms. Maybe it did not occur to the form designers that things worth commenting on might also occur on seine sets.

An associated purse seine form for each day's seine observation (1E) was for recording biological data on specific seine-caught fish. Note that form 1E has no specific spaces for recording condition of individual fish, such as extent descaled, marine mammal injuries, etc., in

sharp contrast to the gill net form with extensive spaces and headings to prompt the recorder to keep track of such things. There is only a general "comments" column on 1E.

DATA SUMMARIES

1. Gill Net Area 12, Chum Season (Table 1)

Ninety-seven sets were observed, which took 2,199 chums including those damaged-salable and damaged-unsalable. Of the total chums, 74,or 3.82%, were damaged, probably by marine mammals, and of those damaged, 33, or 1.50% of the chum total, were unsalable. No non-salmonid fishes were caught. Eighteen coho were caught of which two (11.11%) were too damaged for sale. Two chinook were caught, one "juvenile" (<22") and one "adult". One unidentified bird was caught, probably dead, no marine mammals, and no invertebrate animals.

The coho by-catch rate from these 97 sets was 8.18 per 1,000 chums, compared to the fish ticket estimate of this statistic for 2011 from Mathews (2012) of 9.71, (Appendix 2). Thus there is no indication that fish tickets underestimated the coho by-catch rate for Area 12 gill nets. However, the observed chinook by-catch rate of .91 chinook per 1,000 chums (two seen in 97 sets) inexplicably exceeds the apparent rate of 0.00 from the fish tickets in 2011 (Appendix 2).

2. Gill Net Areas 10 and 11, Chum Season (Table 1)

Forty-seven sets were observed which took 1,841 chums. Of these chums, three were damaged and salable and none unsalable. Two coho were seen, one damaged and unsalable, and five chinook of which four were "adults" (>22"). The only significant non-salmonid fishes were dogfish; 180 were caught of which the observers reported 178 being released uninjured. Nineteen birds were caught, one being a rhinoceros auklet, one unidentified, and the rest (17) common murres. The birds were all dead. No marine mammals or invertebrate animals were observed.

The observed gill net by-catch rate of coho for Areas 10 and 11 of 1.09 per 1,000 chums was less than the 2011 fish ticket rate of 2.58 coho per 1,000 chums (Appendix 2), indicating no underestimate from the fish tickets. This was not the case for chinook; the observed rate was 2.72 chinook per 1,000 chums compared to the 2011 fish ticket rate of only .10 chinook per 1,000 chums (Appendix 2).

3. Purse Seine Areas 10 and 11, Chum Season (Table 1)

Eighty-one purse seine sets were observed that took 6,846 chums, for which no observations were made to assess potential damage from marine mammals. Thirty-seven coho were recorded and one chinook (a "juvenile"), with no condition-at-capture observations taken. Also reported were 17 bottom fish (flounders, sculpins, ratfish), and 16 invertebrates (sea cucumbers, sea stars, Dungeness crabs). Eight birds were reported of which only one was identified, this being a common murre. In all cases the birds were reported to have been released alive. A harbor seal pup was taken and released alive according to the observer; no

other information was given such as whether or not this seal was hauled aboard, whether or not it sustained injuries, or if it was in any way stressed. Sea lions were seen on several occasions within the net, and six were reported as "released alive". The species of these sea lions was never reported, which is noteworthy since Steller's sea lions, one of two species that occurs in Puget Sound, are of ESA concern.

The 37 coho per 6,846 chums is a purse seine by-catch rate of 5.40 per 1,000 chums compared to the observed 2011 rate for gill nets in Areas 10 and 11 of 1.09 coho per 1,000 chums. The observed purse seine coho by-catch rate of 5.40 per 1,000 chums cannot be sensibly compared to any fish ticket information, since there was no allowed purse seine retention of coho in Areas 10 and 11 during 2011. (The occurrence of 77 purse seine coho reported on fish tickets in Areas 10 and 11 for 2011 (Appendix Table 2) exemplified occasional unexplained fish ticket anomalies). The single chinook observed in the purse seine sets translates to a by-catch rate of .15 chinook per 1,000 chums, compared to 2.72 per 1,000 chums observed for gill nets in Areas 10 and 11 for the 2011 chum season. The WDFW, from their analysis of these observations, stated in their 2012 CES: "In Areas 10 and 11 in 2011 gill nets had a higher impact on chinook per chum landed than purse seines." This judgment is questionable according some likely biased purse seine sampling protocols, and to my analysis (below) of their observer data from the 2011 experimental purse seine fishery for pinks in Area 10, as well as other data and published reports referred to in Mathews, 2012.

4. Purse Seine Area 10, Pink Season (Table 1)

One hundred and four purse seine set observations were made, mostly along the Edmonds shore. Lots of pinks were caught, 45,701, as well as all other salmonid species. The time was late Aug. through early Sept. when one would expect a few late Lake Washington sockeye, a few early run chums, the first leg of the fall coho runs, and some adult fall chinook. Adult fall chinook run through Puget Sound slightly earlier than pinks, but do overlap in timing. Not surprisingly, 196 chinook >22" were taken, but also 140 small ("juvenile") chinook. Some of the small chinook were probably mature 2-year-olds ("jacks"). However, according to WDFW hatchery escapement data, the average composition of fall Puget Sound chinook hatchery returns is only about 8% jacks (2000-2009 average). Thus, the ratio of jacks to adults in the mature run averages about 1:12 (92%/8%=11.5). Consequently, if all of the 196 chinook greater than 22" had been adults (unlikely since some of those >22" could have been immature 3- or 4-year-old fish), and if purse seiners were catching adult and jack segments of the mature run at equal rates, then for every 12 "adults" taken we would expect one jack. Or of the 196 "adults" caught we would expect about 16 jacks to be caught in the observed sets (196 /12=16). Apparently, then, most of the 140 "juveniles" were immature chinook and since some of the 196 "adults" were likely immatures, it looks to me that a high proportion of these 336 chinook (a third at least or maybe more) were immatures. This would amount to at least one immature chinook per set.

It is unlikely that immature chinook simply exited Area 10 en mass during the two months between the 2011 pink and chum seasons. Anyone familiar with Puget Sound fisheries would be aware that sport fishing for these (blackmouth) usually gets better or certainly no worse toward the fall. Nor would many of these small chinook have been removed by the sport fishery in these two months, since the minimum sport size limit is 22".I do not know which seine boats may or may not have been using the 5" top escape strip required for the fall. There is nothing recorded about the mesh size of any of them which adds difficulty to interpretation of the anomaly. Without the 5" strip the catch rate of smallest chinook would be more, but the 5" strip is only partially effective. Without knowing also the length distribution of the chinook caught it is hard to guess this effect. It would not explain the stark difference between the immature chinook catch rate of the two seasons.

The by-catch observations of the 2011 purse seine fishery for pinks were otherwise unremarkable (Table 1) except for the harbor porpoise seen to be tangled in the net. According to the observer it was "released", but no further statements were made relative to its condition or likelihood of survival.

DISCUSSION

I believe that the pink salmon season purse seine observations are at least as reliable as the chum season observations for indicating the extent of purse seine by-catch of immature chinook during the Area 10 and 11 chum season, and perhaps more so. Only one immature chinook was recorded in 81 observed Area 10 and 11 seine sets during the chum season, whereas it is likely that on the order of 100 or more immature chinook were caught in the 104 sets observed two months earlier in Area 10.

The time factor between the two data sets confounds the comparison to an uncertain degree. However, there are several factors that give me more confidence in the truth of the pink season data than that of the chum season data.

First, each pink season observer was aboard the single seine vessel for the whole day, whereas the chum season observers, according to WDFW, were jumped from boat to boat; little of their progress was recorded such as when they got aboard in relation to the timing of a particular set, or when they left. Something called "time" is recorded, but is this the time they got aboard, the time the set was started, the time finished, the time they got everything sorted, or the time they left the boat? It is likely that most of the seine boats sampled during the chum season were cooperative ones. If a seiner were to say "no" when asked if an observer could come aboard, it could be due to liability concern, should the observer fall into a hatch, or some such accident, or could be due to chinook or coho still aboard from a previous set, or maybe he is using a deep net more likely to take chinook than an average one. This is similar bias as could be introduced by

sampling only willing gill netters. Those who let you aboard might be those that release by-catch carefully, but those that do not want you aboard might be individuals who, say, hit dogfish over the head before returning them. The point is you do not introduce such bias if everybody who wants to partake in some fishery, like the 2011 Area 10 pink season, agrees to having an observer aboard through out.

But, the most incriminating evidence that leads me to believe that the entire data set of 2011 chum season purse seine observations should be tossed out, specifically as being used for chinook by-catch comparison with gill nets, is that some unknown proportion of the sets were incompletely sampled .The "times" recorded on certain series of sets were so closely spaced that not all of them could have been fully observed start to finish.

For example, on 10/24/11 three sets by three separate seine boats were observed by a single named observer at recorded times of 1412, 1430, and 1451 at, respectively, Pile Point, Point Richmond, and Anderson Point. I could not conceive how one observer in a 39 minute period could have gotten on and off three seine boats at three disparate locations and sensibly observed three seine sets, which are about one hour long processes each.

Another example is three different purse seine sets observed by one person on 10/18/11 at Apple Tree Cove Point at recorded times of 1245, 1315, and 1320. Same problem –

an observer could not have adequately sampled the entire setting and retrieving process of two sets in five minutes.

There were other circumstances where 2011 Area 10 and 11 purse seine sets were reported so closely in times that it was unlikely that each was made by an observer on-board for the full set; e.g. three on 11/7/11 at Point Richmond ten minutes apart. These are not the only examples.

The anomaly was explained by WDFW in that observers would, on occasion, come aboard the seiner for just the haul-aboard part of the set. Hauling the bunt and dumping the payload in the hold takes only a few minutes. So the observer could get from one seiner to another and observe two or more hauling/dumping processes in a short time. WDFW assured me that no purse seine set observations were recorded unless the observer was aboard to see, at least, the payload on deck.

Clearly, negative bias in estimating by-catch occurs if only the payload is observed. It is common knowledge that much of the the salmonid by-catch in purse seines is taken as gilled fish in the 3 ½ to 5" mesh of most of the net, or comes aboard in the folds of the main part of the net as it leads towards the power block. The bunt, with its small mesh and heavy twine, would not have all of the salmonid by-catch by any means, particularly small chinook. Nor would sea birds and marine mammals entangled along the net be seen by an observer who did not watch the full 1800 feet pulled aboard.

My next point reflecting my opinion that the chum-season purse seiners may not have been adequately sampled with respect to the chinook by-catch issues is bird identification. Seventeen out of 18 birds were identified to species by the Areas 10 and 11 gill net observers; these people were aboard for the entire fishing period. Whereas, just one of eight birds during the Areas 10 and 11 chum season was identified by the purse seine observers. If these observers could not identify the birds, can one be sure they got the salmon species right?

Next consider the form (1E) for recording biological data on individual seine-caught fish. Extensive observations were recorded with this form during the pink season, whereas nothing was recorded on forms 1E during the chum salmon season sampling. This suggests that the observers looked closer at the fish during the pink season than during the chum season. The pink salmon purse seine fishery was new and experimental – not often have commercial net fisheries been allowed in Area 10 waters at the height of the summer's sport fishing season. This would have prompted WDFW to pay very close attention to the by-catch of chinook and coho that the seiners were required to release.

Here is probably a minor, subjective concern; it was apparent that the data recorded by the pink season observers were more consistent and more readable than similar data by the chum season observers.

However, beyond these concerns, but certainly heightening them, was how far out of line the single chinook per 81

chum season sets was from all other data-based considerations that I have seen. Previously published chinook by-catch rates for purse seiners fishing Puget Sound during the chum season, based upon hundreds of on-board observations, were on the order of one to several blackmouth per set (Cole, 1975; Fiscus 1964). The Apple Tree Cove Point chum run update test fishery, in a total of 509 observed purse seine sets over years 1996-2011, took an average of 2.49 immature chinook per set (Mathews, 2012), although 2011 was the second lowest in these years in terms of chinook per set, at only six in 30 sets. This Area 10 test fishery is run by the Northwest Indian Fish Commission, with biologists aboard for all sets. In the fall of 2012 the Apple Tree Cove Point test fishery took 27 immature chinook in 29 sets, almost one per set.

As I worked on this report and my previous one, I wondered why WDFW was not doing what I was doing. It is their data. They have immediate access to all records and have expressed abundant concern about the by-catch issues. They can walk down the hall to get the on-board observer's opinions on questions of data interpretation. I put the data of Table 1 together in two or three days, using ledger sheets and hand tallies. A computer was not needed. Maybe WDFW did something similar with their 2011 observations, but I am unaware of any reports for out-of-office circulation.

It certainly did not seem as if the writers of the 2012 CES looked closely at the 2011 observer data, or assembled it in front of them similar to my efforts for Table 1. For example, on page 4 of the 2012 CES they say "increasing

attention has been focused on spiny dogfish, including a request by the Fish and Wildlife Commission for estimates of by-catch of dogfish in Puget Sound commercial fisheries". Yet, from compiling a similar version of my Table 1, they could have put some of these dogfish concerns to rest by pointing out that their 2011 observer data confirm that virtually all dogfish caught by gillnetters in Puget Sound can be released without injury, which would be "end of story", unless they think they need 10,000 more observations to prove the point (178 out of 180 were released uninjured in Areas 10 and 11 in 2011, according to the observers' reports).

The 2012 CES (page 4) goes on with "other wildlife concerns in Puget Sound include federal ESA-listed killer whales, stellar sea lions and marbled murrelets, along with common murres, a State species of Concern "candidate" species". Yet their 2011 data showed no killer whale or marbled murrelet encounters by either gear. Six sea lions were seen in Areas 10 and 11 purse seine sets. If WDFW is so concerned about Steller's sea lions, they have not so advised their observers, because none of these six sea lions was identified to species. Yet the California and Steller's sea lions are easily distinguished from one another by size and color differences (Angell and Bascomb, 1984). Does WDFW think they need to keep sampling forever into the future until a killer whale is captured by a gill netter or purse seiner in Puget Sound before they can report to the public and/or summarize for their own use any of their findings such as those of 2011? They continue in this vein (page 5) saying, "seabird by-catch mortalities are of special concern", and relating this again to

threatened marble murrelets. Yes, the 2011 observer data do show a greater bird mortality in gill nets than purse seines, but that purse seines also catch marine birds. Why not report it like this, exactly as the data show, and furthermore state that the observers found no marbled murrelets in either gear (unless like with the killer whales, they want to wait for that dead murrelet, wherever and whenever it occurs, before presenting their current studies). And more on page 5, such as "Marine mammal by-catch may also be a problem with gillnets"; and "however, two porpoises were entangled and appeared dead when removed from the (2009 Area 10 gill net) net". Yet, if they had looked carefully at their 2011 data set they would have seen no marine mammal gill net encounters, but that there was a harbor porpoise in one purse seine set, a seal pup in another, and sea lions in several others, hopefully urging them to make a better balanced story regarding marine mammal by-catch issues. Next, WDFW tells us, referring only to chinook (page 6): "Preliminary examination of the 2011 gillnet observer data has raised some questions about whether fish tickets can be used to evaluate by-catch of non-target salmon species." But my analysis of these data demonstrates that for coho, with larger sample sizes than for chinook, the fish tickets would have provided perfectly adequate by-catch estimation.

Next, the 2012 CES writers cherry-pick the chinook encounter rates from the 2011 chum season observer data to conclude (page 19), "In Areas 10 and 11 in 2011, gill nets had a higher impact on chinook per chum landed than purse seines", without, it seems, visiting their own observer data from the 2011 Area 10 pink season, which seems an

obvious counter to their claim or at least deserving of a serious footnote.

Finally, WDFW summarizes their apparently strong concern about the salmon that may be removed or damaged in gill nets by marine mammals with this quote (page 20): "For example anecdotal reports by Treaty and non-Treaty commercial fishermen suggest that marine mammal predation of fish caught in commercial nets (they mean gill nets) can be extremely high." In fact, for all of the 4,147 chum, chinook and coho observed in the 2011 Areas 10, 11 and 12 gill nets, only 36 (33 chums and three coho), or less than 1%, were so damaged as to be unsalable. A few others were less badly scarred. Who knows what else may have been taken by marine mammals, but what factual basis is there for assuming additional but unregistered loss would be extreme, or greater from gill nets than purse seines? The 2011 data are not convincing evidence that there is an "extreme" gill net problem. The WDFW should rely on their data, not "anecdotes".

There are much other data in WDFW files that bare on these by-catch issues that they have not yet thoughtfully analyzed as far as I can see. These data should be objectively and inclusively summarized and reported upon for outside review and internal use. Such potentially useful, informative, and relevant data bases include some 3,407 purse seine sets and 194 gill net sets observed from 2001-2010, and several decades of Apple Tree Cove Point test fishing data. My cursory review of an excel file of the former set of observations, of which only a minor portion was directly taken during Areas 10, 11 and 12 chum

seasons, indicated that an inclusive analysis would be useful for contemplating the present by-catch issues. These data seem to be a conglomerate of on-board, hovering boat, and interview observations, requiring intimate knowledge of the sampling protocols, locations of the original data sheets, and access to individual observers, in order to best complete an objective summary. The agency that collected these data should do the job.

The Apple Tree Cove Point chum salmon run update tests have been made for decades. I have analyzed these data since 1996, the year the 6-1/4" minimum mesh requirement was put in place (Mathews 2012). I think it started at least a couple of decades earlier. The Northwest Indian Fish Commission now runs the program, but prior to 1996, it was run by WDFW. These data are probably in boxes, memos and various data reports within the WDFW. They are clearly relevant to the current issues and should be summarized and made available to all. They must have kept track of all species caught. Probably sometime in the past, samplers may have even measured the chinook and coho, which would be relevant information; or perhaps kept track of condition of such by-catch. Observers were aboard the chartered seine boats at all times; they had to be allowed aboard in order for a purse seiner to get the Apple Tree Cove Point test-fishing contract. There is nothing so relevant in fishery management as a series of records kept over a long period of time and based upon some consistent, objective sampling protocols. The Apple Tree Cove Point test sets are a prime example.

As if I have not yet put enough on the plate of WDFW, I urge that future by-catch observations should utilize sampling forms that are more similar for the two gears than the present ones; and why not exactly the same form for both? If you have extensive spaces on one for by-catch and condition, but minimal such places on the other, you are not doing the job fairly (unbiased) to each gear type. The present forms themselves make this concern very obvious. Futhermore, only full set sampling, start to finish, should be done for purse seiners as well as gill netters. By sampling by-catch of gill netters with observers aboard for the entire night, yet sampling purse seiners by just looking at the payload, one would be comparing apples to oranges.

It is my opinion, after considering the various by-catch controversies now for about one year, that both gear types have specific, but different by-catch issues, but that by-catch of either non-target salmonids or other marine life is sufficiently inconsequential as to be a non-factor in allocating catch opportunities between the two gear types during the Puget Sound fall chum salmon fishery. Other factors like historical catch shares, or economic viability, or honoring treaty requirements, or meeting escapement needs should guide the harvest rates and allocation percentages – not by-catch rates. Of course by-catch mortalities should be reduced as much as practical, but without unfair emphasis on one or the other gear type.

Both gears take sea birds; they are usually dead in gill nets whereas many of them can be expected to survive release from purse seiners. Common murres are the main

species. According to popular natural history websites (Wikipedia, Nature Canada, Whatbird.com, Stanley Park Ecology) this species of some 18 million individuals on both coasts of North America is demonstrably stable, widespread and secure, and of "least" conservation concerns; though locally it is seen as potentially sensitive to hunting (East Coast of Canada), oil spills, and food supply as might be diminished by global warming (one website implicated gill nets as a potential threat to local abundance).

In Puget Sound, purse seines fish deeper than gill nets, and by consequence take occasional catches of bottom organisms, but any serious harm to the bottom community in Areas 10, 11 and 12 appears slight, according to the 2011 observations.

Both gears in Puget Sound occasionally encounter marine mammals, but so uncommonly that little can be concluded as to the relative harm by each gear. That marine mammals can be killed extensively by either gear type is abundantly apparent from well known worst case examples elsewhere, such as (1) the tropical Eastern Pacific purse seine fishery for tuna, where millions of porpoises of several species were killed before measures to slow the fishing operations down and release the porpoises alive were forced on the industry by public pressure; and (2) the thresher shark/swordfish gill net fishery off California which for many years killed all sorts of marine mammals, non-target sharks and other species.

The only non-salmon fish species caught significantly during the chum season, according to the present analysis, is dogfish, by the gill nets. However, most of these can apparently be released unharmed, and probably would be if gill netters were encouraged to do so by laws requiring dogfish and all other by-catch species to be released with as little harm as possible (like the live recovery box rules for salmon are intended).

Both gear types take small amounts of coho and immature chinook salmon during the chum season. Fact-based evidence shows that gill nets using a 6-1/4" minimum mesh tend to take less of each per 1,000 chums than do seiners with the smaller mesh sizes of 3-1/2 to 5". Simple geometric considerations confirm what the data show. For fish less than about four pounds, which is about 22" in length, the greatest girth is less than the perimeter of a 6-1/4" net mesh so most are able to swim through. If gill netters used 5" nets in the fall rather than 6-1/4" nets they would likely take small, immature chinook, which are far more abundant in Puget Sound than larger ones at this time, at rates more similar to those of purse seiners with their 5" mesh escape, top strip. For coho and chinook the gill net salmon are mostly dead, and gill netters are therefore allowed to retain them. For seiners the majority of coho can likely be released alive, if carefully handled. Thus, the probable live-release survival rate of seine-caught coho may offset the greater by-catch capture rate of this gear, and the two gear types could be similar in coho by-catch mortality consequences.

That mature coho can be released from Puget Sound purse seiners with good chance of survival is apparent from the scientific literature (Mathews 2012), but confirming that they are being so released in good shape does not seem to be a high priority concern to WDFW to my knowledge. For example, in the 2011 Area 10 experimental pink fishery, 1,570 coho and 336 chinook were released by the participating seiners as required. Yet no records were kept on condition of these fish at capture or at release. Recovery boxes were apparently in use. Observers were aboard at all times. This would have been a prime opportunity for WDFW at no extra cost to evaluate their 2011 CES and 2012 CES claim that "the majority of coho and chinook encountered by this (purse seine) gear will survive being sorted and returned to the water". Each of these chinook and coho came aboard along with an average of about a ton of pink salmon per set to sort through before release. Should not someone in that Department have been curious about the condition of the chinook and coho relative to likely survival? According to WDFW, one of their observers recalls a "high percentage" of these "fish" being released in "good shape", without reference to the species. Such remembrance is a year and a half later. Better, would have been some records kept at the time on each fish, such as species, size, percent descaled, condition (e.g., 1- dead, 2- lethargic; 3- appeared unharmed and 4- excellent), use or non-use of recovery box, and condition after recovery. A lot of the fish were examined for fin marks according to data recorded on forms 1E, so noting condition would not have additionally stressed the fish. Are the seiners getting a pass on this issue or does, in fact, WDFW have some data, either their

own or from other researchers? I asked them for their evidence on this question, which is so crucial to their by-catch management, in preparing my previous report, but have received no reply to date.

For immature chinook, abundant scientific evidence indicates that the majority caught by purse seines are dead, moribund, or will die from capture stress shortly after release. This has been known for about as long as purse seiners have been catching salmon in Washington. Rich (1920) states that "the majority of these fish (sub-legal chinook and coho) when taken with nets (of 3" stretch mesh or greater at the time) are either dead or so injured that they cannot live". Many immature chinook are gilled when landed aboard purse seiners, and should be considered dead, just like WDFW and most others assume for gill-net-caught salmonid by-catch. Jensen (1954) observed that in West Pass Nov. 17-23, 1954, of 115 immature chinook caught in 13 purse seine sets using 4-1/4" mesh, 88 of these fish were gilled. Jensen further indicated the likely fate of many of the rest: "The constant rolling action brought about by the harsh seine often removes most of the scales and slime from the fish thus leaving little to ward off parasites and fungus." The more current literature on this issue was referenced by Mathews (2012) and I won't repeat it all. For example of small chinook (<21") landed by SE Alaska purse seiners during non-retention periods of 1985-1988, the annual average observed to be dead when landed was 62.8%. Many of the SE Alaska purse seiners also fish in Puget Sound, where a 5" minimum top strip is required for the fall. The latter would improve the situation by allowing the smallest, most vulnerable chinook through, but

even for chinook of medium size (21-28") 50.5% were dead when brought aboard (the same four-year average in SE AK). What dies later from capture stress is less well known; but on the order of 20% of medium sized chinook released alive from purse seiners died soon after release, according to an accepted B.C sonic-tag-tracking study.

If WDFW has additional research of their own or others, that may indicate an improvement on the above scenarios for immature chinook, they need to provide this evidence. Without it, the belief that the majority of immature chinook encountered by actively fishing purse seiners will survive being sorted and returned to the water would be akin to believing that the majority of sea birds encountered by gill nets will fly away.

Nonetheless, immature chinook in Puget Sound during the fall are only on the order of 1-2% of the target purse seine catch. Many other industries exact far greater mortality on chinook as by-catch of their products — logging, mining, hydro-electricity, farming etc. Perhaps WDFW should allow purse seiners to retain immature chinook during the chum season. The State of Alaska recognizes the reality of high mortality of small chinook in SE AK purse seines, and has allowed various provisions for their legal retention. Small chinook are not of much sale value and would never be targeted. But at least the crew could keep them for home use.

SUMMARY

The bottom line is that gill netters kill more marine birds than purse seiners and that purse seiners kill more blackmouth than gill netters in the Puget Sound fall chum fishery. The former is not disputed by anyone I know, but the WDFW continues to dispute the latter. The other by-catch issues seem to be an undetermined wash.

WDFW sent out some purse seine observers in a skiff looking for willing seine boats on which to come aboard. They found some, and observed some sets completely. But for others they observed only the payload, thereby missing by-catch entangled along the length of the seine. These observers had forms with no spaces on them to prompt them to look for injured or lethargic, or dead for that matter, chinook salmon. We don't know how well the observers were trained, but they did not seem to know the marine birds or mammal species too well.

From the records that these observers collected in the 2011 chum season, the WDFW office staff found one chinook in eighty-one observed purse seine sets and mostly on this basis denied that purse seiners kill more blackmouth than gill netters. In fact they turned it around. They ignored about 100 years of other evidence contrary to their opinion, on both the catch rates and the mortality rates, on chinook caught during Puget Sound fall chum by purse seining (none of which, is particularly damming to the seiners in a broad context, but is quite relevant if comparing the two gears). The information WDFW discounts is from the following sources, which I have referenced in either this or my previous report:

1. Their own data from fully observed sets collected in AREA 10 two months earlier.
2. Extensive past data from fully observed chum season set by WDFW or previously named WA marine fish agency.
3. Extensive data from fully observed sets by the NW Indian Fishery Commission.
4. Alaska Department of Fish and Game on-board sampling.
5. Canadian Department of Fisheries and Oceans sampling and experimentation.
6. Pacific Salmon Commission Chinook Technical Committee.

So, what was the truth for 2011? Which gear had the higher catch rate on blackmouth? This cannot be adequately answered from the 2011 data per se. The chum-season purse seine data were biased by two specifics: reliance on willing skippers and payload-only sampling. The gill net observer sampling results did not correspond with the fish ticket information. The pink salmon sampling is compromised by the two-month difference in sampling times. You have to put the question in a broader context. What is the average, or expected, circumstance from year to year? This requires consideration of data other than just what was collected in 2011. It also requires thinking about how the two gears work in relation to the size distribution of immature chinook in Puget Sound. There are many more small chinook, say less than 22", than larger ones. I discuss this in my earlier report and give evidence. The bigger the mesh, the better will it pass small chinook. There is a great deal of difference between what will swim through a 6 1/4 in. mesh and mesh of 3 1/2 to 5 in. I stick with my earlier opinion that purse seiners will tend to have a substantially higher catch rate on immature chinook in Puget Sound than gill

netters. If it is true for coho, which are modestly smaller than chums on average, It would be even more so for chinook, for which the average size of those present in Puget Sound is much less than that of chums.

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Table 1. Summary of 2011 WDFW Observer Sampling of Puget Sound (Areas 10,11,12) Gill Net and Purse Seine Fisheries.

	Gill net Area 12 chum season	Gill net Areas 10,11 chum season	Purse seine Areas 10,11 chum season	Purse seine Area 10 pink season
No. sets obsevered	97	47	81	104
Dates	10/19-11/08	10/19-11/08	10/08-11/07	08/22-09/08
Total catch of target species (chum/pink)	2,199	1,841	6,846	45,701
No. damaged/salable	41	3	***	***
No. damaged/unsalable	33	0	***	***
Total catch of non-target salmonids				
steelhead	0	0	0	3
sockeye	0	0	0	8
chum	****	****	****	12
pink	0	0	0	****
total coho	18	2	37	1,570
coho damaged/unsalable	2	1	***	***
juvenile chinook	1	1	1	140
adult chinook (>22")	1	4	0	196
Non-salmon by-catch in nos.				
dogfish	0	180	0	3
hake	0	2	0	0
bottomfish*	0	1	17	0
common murre	0	17	1	0
rhinocerous auklet	0	1	0	0
unidentified bird	1	1	7	1
sea lion	0	0	6	0
harbor seal	0	0	1	0
harbor porpoise	0	0	0	1
invertebrate**	0	0	16	0

*sculpin,flounder,ratfish
***not recorded
**starfish,sea star,sea cucumber,dungeness crab
****target species

Puget Sound Salmon Management Unit

Gill Net Monitoring Form 10-16-11

Observer Name Mike Parker Vessel Name AZTAREL Date 11/13/11 Time 1130

Area 10 Location SKAT PT

Weather Cloudy Complete Trip (y/n) y Water Depth (feet) 72 ft Tide (ebb/flood/slack) EBB

Net Depth (meshes) 240 Mesh Size (inches) 6 1/4 Net Length (fathoms) 300 fm

Set Number 2

Net Deployment Start Time 2132 End Time 2145 Length Deployed All Latitude N 47 39 489 Longitude W 122 29 553

Net Retrieval Start Time 115 End Time 150 Length Retrieved All Latitude N 47 [illegible] 119 Longitude W 122 25 551

Interuption (y/n) N Duration (minutes) X Interuption Reason X

Fish Species Name	Chinook Size	# Released			# Retained		Fish Damaged by Marine Mammals (separate from retained)	
	< or > 22"	Uninjured	Injured	Dead	Marked	Unmarked	# Salable	#Unsalable
Chum						19		1
Dogfish		12		2				

Bird Species Name	# Released Alive			# Retained			
	Uninjured	Injured	Unknown	Lethally Removed	Entangled Dead	Floaters	Depth in Net
MuR					2		Top

Marine Mammal Species Name	Released Uninjured	Released Injured	Released Dead	Notes

Comments

Appendix 1, Chart 1B. Back side of WDFW gill net observation form.

Area 10

Puget Sound Commercial Salmon Management

Page: 1 of: 1

Date: 8/30/2011 Time- Start: 0445 End: 2004 Craft: New Oregon Launch: Port of Edmonds

Observers: Katrina Gilhof Weather Conditions: Overcast, calm

Time	Location Description	Vessel Name	Boat Type	Set #	Sockeye	Chum	Pink	Adult Chinook	Juvenile Chinook < 22"	Coho	Steelhead	Birds/ Mammals /Other	Latitude / Longitude
0624	Edmonds Fish Docks	New Oregon	19	1	0	0	454	1	1	12	0	0	47°48.2'N 122°24.8'W
0715				2	0	0	135	0	0	9	0	0	47°48.3'N 122°24.6'W
0832				3	1	1	170	2	0	10	0	0	47°48.4'N 122°24.9'W
1015				4	0	0	393	2	0	13	0	0	47°48.5'N 122°24.8W
1116				5	1	0	313	0	0	20	0	0	47°48.6'N 122°24.7'W
1217				6	0	0	552	0	0	10	0	0	47°48.4'N 122°24.5'W
1310				7	0	0	415	0	2	12	0	0	47°48.3'N 122°24.6'W
1408	↓			8	0	0	26	0	1	10	0	0	47°48.1'N 122°24.8'W
1530	Kayaks Point			9	1	3	110	8	4	17	0	Harbor porpoise entangled then released 1	47°49.0'N 122°24.6'W
1659	Edmonds Fish Docks			10	0	1	227	4	1	18	0	0	47°48.1'N 122°24.5'W
1904				11	0	0	1130	6	3	13	0	0	47°48.4'N 122°24.2'W
1903	↓	↓	↓	12	0	0	64	7	0	6	0	0	47°48.4'N 122°24.0'W
Totals				12	3	5	4019	30	12	150	0	1	

Boat Type
19 = Purse Seine
14 = Gill Net
20 = Reef Net
12 = Beach Seine

Set # is the set number the boat is performing - ASK what set you are observing

DO NOT record any catch information you do not directly observe

(Office use only)
Entered into database by: Date:

Appendix 1, Chart 1C. WDFW purse seine observation form as completed during pink season.

Area 11

Puget Sound Commercial Salmon Management

Page: 1 of: 1

Date: 10/24/11 Time- Start: 0700 End: 1130 Craft: ALMAR Launch: BREAKWATER MARINA

Observers: KATE UNDERWOOD Weather Conditions: CLEAR / PARTLY CLOUDY

ne	Location Description	Vessel Name	Boat Type	Set #	Sockeye	Chum	Pink	Adult Chinook	Juvenile Chinook < 22'	Coho	Steelhead	Birds/ Mammals /Other	Latitude / Longitude
0930	EDMONDS POINT	MARY LOUISE B	19	5		2							47 27 272 122 31 456
1412	PILE POINT	MYSTIC LADY		3						1		1 SEAGULL 2 REL ALIVE 1 RATFISH 2 SEA STARS 1 FLOUNDER	47 21 859 122 31 603
1430	NO OF PT. RICHMOND	JULIE ANN		3		103							47 23 414 122 32 873
1451	ALDERSON POINT	LUCIA		4		335							47 25 340 122 31 691
		4		4		400				1			

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Boat Type
19 = Purse Seine
14 = Gill Net
20 = Reef Net
12 = Beach Seine

Set # is the set number the boat is performing - ASK what set you are observing

DO NOT record any catch information you do not directly observe

(Office use only)
Entered into database by: Date:

Appendix 1, Chart 1D. WDFW purse seine observation form as completed during [illegible]

Appendix 1, Chart 1E. WDFW purse seine observation form for recording biological observations on individual fish.

Puget Sound Commercial Salmon Management
Individual Fish Sampled

	Date	Vessel Name	Set #	Species	Fk (cm)	Mark	Scale Card #	Line #	Vial #	Comments
1	8/24	NEW OREGON	1	1		AD				
2			1	1		UM				
3			1	1		UM				
4			2	1		AD x 8			X	8 observed & release d
5			2	1		UN x 25				25 UNKNOWN
6			3	1		AD x 4				
7			3	1		UM x 6				
8			3	1		UN x 4				
9			4	1		AD x 3				
10			4	1		UM x 6				
11			5	1		AD x 3				
12			5	1		UM x 7				
13			6	1		AD x 3				
14			6	1		UM x 5				
15			6	1		UN x 1				
16			7	1		AD x 2				
17			7	1		UM x 4				
18			8	1		UM				
19			8	1		UM				
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										

Species
1 = Chinook
2 = Chum
3 = Pink
4 = Coho
6 = Steelhead
5 = Sockeye
8 = Atlantic

Mark
AD = ad clip
Lv = Left Ventral
Rv = Right Ventral
UM = None / Unmarked
UN = Unknown

Fill out a line for each fish sampled. All criteria may not need to be recorded, but an individual line gives a count of how many fish were included in the sample.

Appendix 2. Table 3 from Mathews(2012) showing fish ticket catches in Areas 10,11,12 by species, year, and gear.

Table 3. Non-Indian purse seine(PS) and gill net(GN) reported catches in number of chum, coho, and chinook salmon taken in Puget Sound areas 10,11, and 12,during Oct. and Nov. (chum season), 1996-2011

Year	Areas 10&11						Area 12					
	PS chum	PS coho	PS chinook	GN chum	GN coho	GN chinook	PS chum	PS coho	PS chinook	GN chum	GN coho	GN chinook
1996	154183	244	4	29809	32	19	244652	36	0	33027	56	2
1997	9291	154	1	3270	7	2	176042	249	0	13238	0	3
1998	165607	60	0	29361	0	12	167865	913	0	17173	8	0
1999	45891	0	0*	8726	0	1	25295	84	0	9867	6	3
2000	87207	0	0**	12841	22	8	16901	60	0	6486	14	0
2001	413303	547	0	32950	56	2	187663	626	0	15555	8	0
2002	472330	9	0	26730	9	0	227125	9	0	2068	9	0
2003	244829	0	0***	37266	384	1	278356	2644	0	21777	82	0
2004	401122	6	0	73628	1517	8	523272	11505	0	29784	256	0
2005	148892	0	0	49758	732	7	62388	2547	0	37548	332	3
2006	255065	10	0	87050	201	2	286284	923	0	29110	97	0
2007	213553	40	0	95880	337	1	150066	3296	0	71602	517	2
2008	99525	0	0	28398	26	15	149786	6	0	50211	125	0
2009	86488	0	0	24239	106	2	93105	2820	0	50651	482	0
2010	155447	0	0	54100	51	4	136173	10	0	39216	152	0
2011	160782	77	0	40300	104	4	156232	1959	0	44395	431	0

*The data list one chinook landing of 246 fish at 2219 pounds; probably an error and should be chum
**The data list one chnook landing of 22 fish at 275 pounds; probably an error and should be chum
***The data list one chinook landing of 92 fish at 790 pounds; probably an error and should be chum

Data sources:

1996-2010; WDFW electronic data file of fish ticket non-Indian PS & GN catches furnished by WDFW 12/12/2011
2011; Prelimonary Puget Sound salmon catch data generated from the Quick Reporting System on 12/5/2011