

Steelhead Bycatch and Mortalities in the Commercial Skeena Net Fisheries of British Columbia from Observer Data: 1989 to 2009



Prepared for:
The Pacific Salmon Foundation (Living Rivers Trust Fund) and
British Columbia Ministry of Environment, Skeena Region

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Ministry of
Environment

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EXECUTIVE SUMMARY

Interception of steelhead (*Oncorhynchus mykiss*) in the multi-species, mixed stock commercial net fisheries of the Skeena River has been an ongoing issue of concern since at least the 1970s (Andrews and McSheffrey 1976, Chudyk and Narver 1976, Oguss *et al.* 1977, 1978, and Oguss and Evans 1978). Early-run (summer) Skeena steelhead stocks co-migrate with much more abundant Skeena sockeye (*O. nerka*) and pink (*O. gorbuscha*) stocks along their adult migration route back to spawn in the tributaries of the Skeena River. Initial concerns centered on the possibility that Skeena steelhead were being overexploited and under-reported in commercial fisheries, primarily the Area 4 gillnet fishery near the mouth of the Skeena River. Concerns were heightened again in the early 1990s when steelhead abundance indicators from the Tye Test Fishery in the lower Skeena River reached historic lows. As a result, many new regulations were introduced through the 1990s to protect steelhead, primarily in the commercial Skeena gillnet and seine fisheries of British Columbia (Areas 3 and 4). Some of these changes included more selective fishing gear and techniques, mandatory use of onboard revival tanks and mandatory release of steelhead (and later, coho (*O. kisutch*), as well as changes to the areas and timing of chinook (*O. tshawytscha*), sockeye and pink fisheries for each gear type. Mandatory logbooks and inseason reporting of catch and release in these fisheries by fishermen was also introduced in the early 2000s. All these measures were implemented to reduce the impacts of the Skeena commercial net fisheries on steelhead and other less abundant non-target species while monitoring and maintaining harvest opportunities for more abundant target species. Many of these regulations are still in place today.

This report provides a chronological summary of a number of multi-faceted observer/monitoring programs that were conducted in the commercial approach fisheries to the Skeena River (primarily gillnet and seine fisheries in Areas 3 and 4) spanning the last two decades; from 1989 to 2009. Of particular significance is data pertaining to the capture and associated mortality of steelhead by gear type and year. For some years, studies using selective fishing gear or demonstration fisheries are highlighted. Other relevant observations on the catches of target species (sockeye and pink) and other bycatch species (such as chinook, coho and chum) are also included in most summaries. Short-term mortality studies on steelhead and other bycatch species are included when conducted. For some years, outcomes from studies with experimental gears or demonstration (selective) fisheries are discussed.

Data summaries from observer programs and selective or demonstration fisheries are further analyzed to provide annual estimates of the number of steelhead caught (bycatch) stratified by gear type (gillnet, seine, or experimental gear/fishery) and area (Area 3 or 4) for all years with accompanying data. Most estimates of steelhead bycatch were derived from a simple ratio of observed steelhead to target species (in most cases, sockeye) multiplied by the number of target species reported caught (landed and sold) in the particular strata (after Cochran 1977, and Labelle 1994). Other derivations of this ratio

multiplier are also used and described depending on the type and availability of data. All steelhead bycatch estimates are provided with 95% confidence intervals. Estimated 95% confidence intervals for the number of steelhead mortalities are also provided for strata where short-term mortality studies were conducted. Steelhead bycatch estimates are further compared to the number of steelhead reported (from sales slips) for all years and from mandatory reports made by fishers (phone-ins and logbook reports) in more recent years (2001 to 2009).

The bycatch estimates and associated confidence intervals are believed to be representative of the observed fishery or selectivity gear study. However, it should be noted that the estimates are based on seasonal (annual) summaries from a variety of observer/monitoring programs, often with different study designs and mandates, during years of variable stock abundances, catches and fishery periods. It is important to note that in some cases, small sample sizes for certain strata are indicated by large 95% confidence intervals around the bycatch estimates. Estimates with broad ranges should be used cautiously.

Only short-term (0 to 48h) observed mortalities and subsequent mortality rates are presented in this report. None of the observer programs formally addressed any long-term or delayed mortality beyond the holding or observation period. We cannot make any conclusions regarding the possible deleterious effects that steelhead or other non-target species may have experienced as a result of capture, handling and release from the fishing gear and subsequent survival beyond the time of release. Also, similar to the observed bycatch of steelhead, some mortality studies had small sample sizes and therefore large 95% confidence intervals around the estimates.

INTRODUCTION

Background

Commercial Fisheries Impacting Skeena Steelhead

Commercial fisheries that harvest Skeena salmon (*Oncorhynchus sp.*) and steelhead (*O. mykiss*) stocks are distributed from Southeast Alaska (District 1) to just south of the mouth of the Skeena River in Statistical Area 5. Purse seine and gillnet fisheries in Southeast Alaska (primarily the Tree Point (District 101) gillnet and Noyes Island (District 104) seine fisheries) are responsible for most of the Alaska harvest of Skeena sockeye, pink, and chum while Alaskan troll and sport fisheries are the major harvesters of Skeena chinook and coho.

Regulations in the Southeast Alaska commercial fisheries have allowed retention of steelhead for personal use but non-sale for seine and gillnet fisheries since 1997 with no reporting requirement. Prior to 1997, reported catch of steelhead by seine and gillnet fleets in Southeast Alaska averaged 2,900 per year (Steve Hoffman, ADF&G Sport Fish 2004). Based on catch reports from 1982 to 1992, the reported catch of steelhead in Southeast Alaska (Districts 101 to 104) was estimated to be 22% of the combined Southeast Alaska and Northern British Columbia (Areas 1 to 5) reported commercial catch (Labelle *et al.* 1995). These estimates were based on sale records only and were therefore considered to be minimum estimates.

Canadian marine fisheries use similar fishing gear as Alaska fisheries to harvest Skeena salmon in Areas 1 to 5, with the bulk of the harvest occurring in the gillnet and seine fisheries in the Chatham Sound portion of Area 3 (PFMAs 3-1 to 3-4) (Figure 1), Area 4 adjacent to the Skeena River (PFMA 4-12, 4-15, aka Smith Island and River/Gap/Slough) (Figure 2), and the northernmost portion of Area 5 (PFMA 5-1) (Figure 3). Labelle *et al.* (1995) calculated the percent of reported steelhead in Area 3 to be 18% of the combined northern boundary catch (S.E. Alaska Districts 101 to 104 and Northern B.C. Areas 1 to 5) and 55% for Area 4. The percent of reported steelhead in Area 5 was estimated to be 2% of the northern boundary catch.

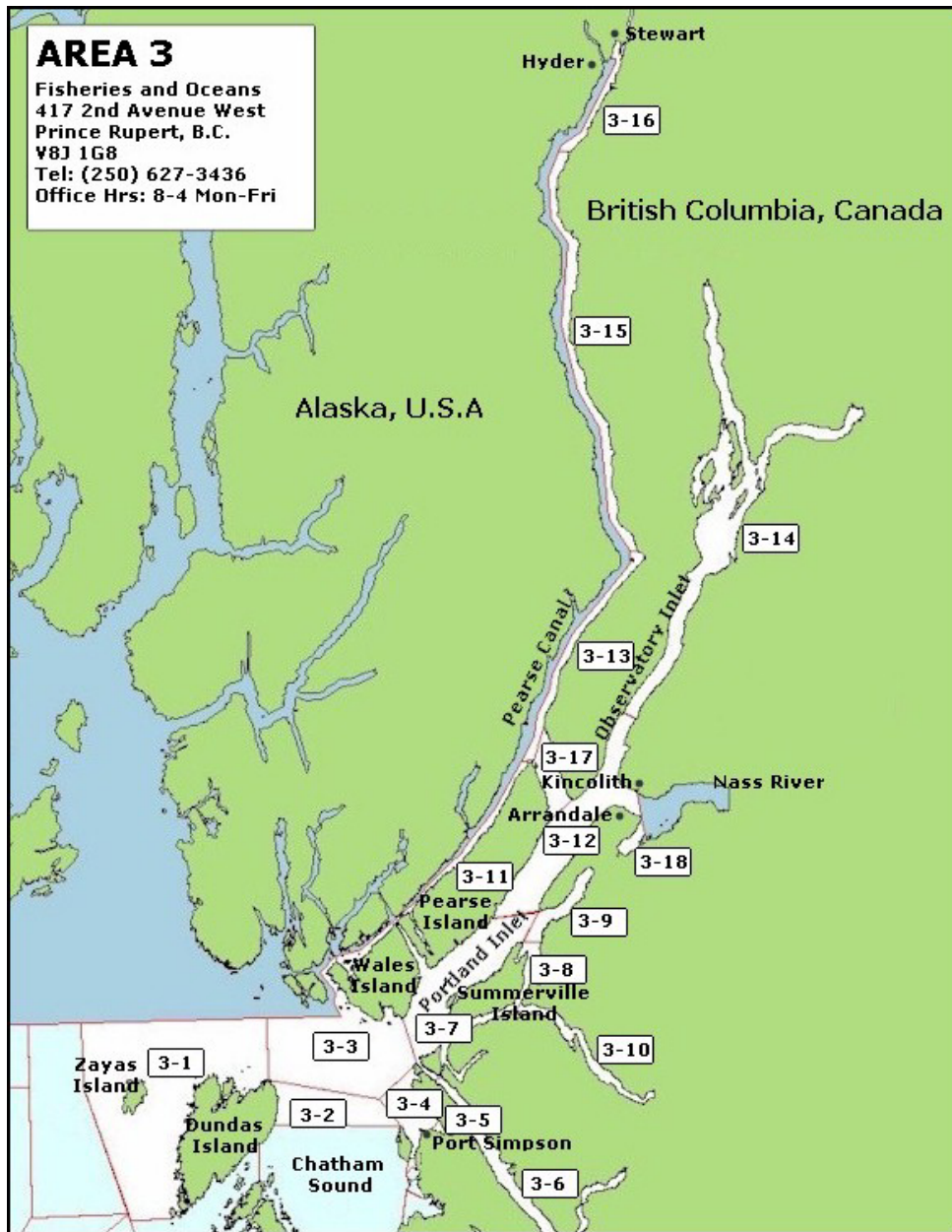


Figure 1. DFO Statistical Area 3 map.

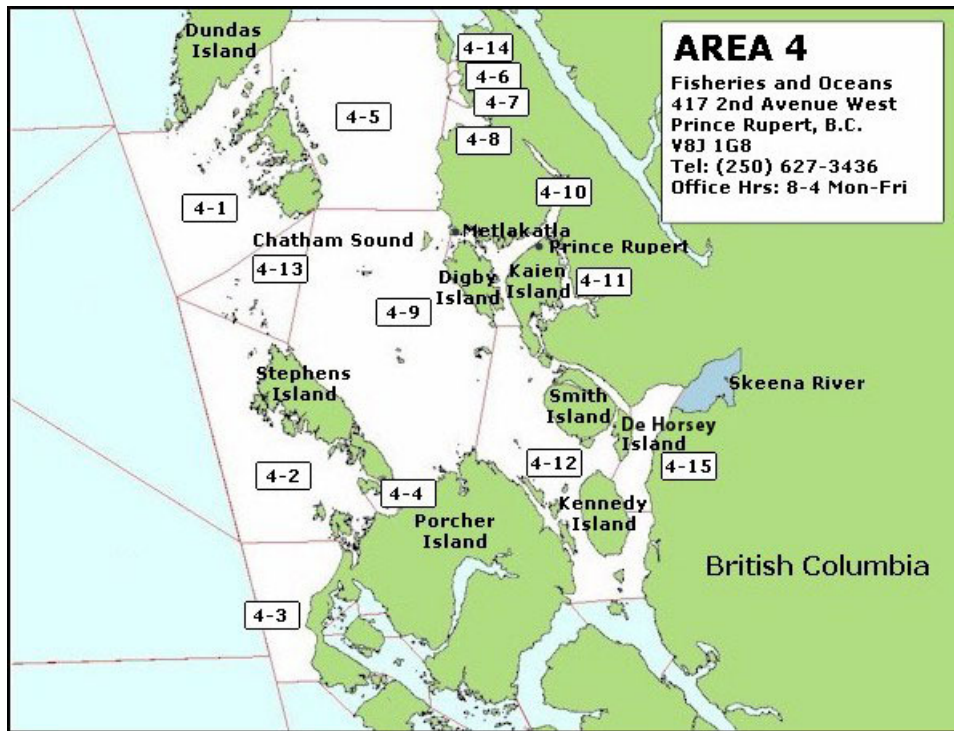


Figure 2. DFO Statistical Area 4 map.



Figure 3. DFO Statistical Area 5 map.

Skeena Steelhead Timing and Abundance

The DFO Tye test fishery in the lower Skeena River has been in operation in a similar manner since 1956 and is the main stock assessment tool used by fishery managers to estimate daily escapements of sockeye salmon into the Skeena River during the summer months. Other salmon species and steelhead are also caught in the test fishery and the catches have been used as relative abundance indicators of escapement for these species. Estimates are subject to error as the catchability of salmon by the Tye Test Fishery net varies from year to year due to varying environmental conditions (including water level, clarity and temperature, weather conditions, net saturation, and tide). However, it is considered to be the best indicator of timing and abundance for Skeena summer run steelhead returns (Walters *et al.* 2008).

The timing of the Skeena summer steelhead run compared to sockeye and pink salmon migrations using average weekly Tye Test Fishery indices is presented in Figure 4. The earliest part of the summer steelhead run overlaps the peak of the much larger sockeye run in about the fourth week of July, shadowing the pink salmon run and peaking through August and then continues through the fall to October and into November (not shown).

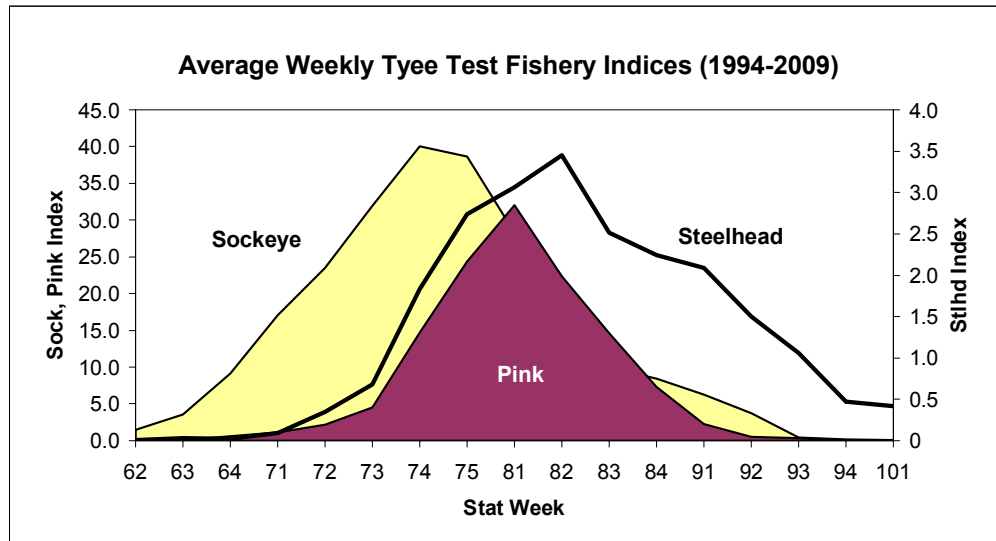


Figure 4. Migration timing and average abundance of summer run steelhead compared to sockeye and pink salmon from the DFO Tye Test Fishery, 1994 to 2009. Source: DFO.

Historical steelhead abundances for years 1956 to 2009, as indicated by annual cumulative indices in the DFO Tye Test Fishery are presented in Figure 5. These indices are compared against reported catches in Northern B.C. (Areas 3 and 4 gillnet and seine from 1952 to 2009) and S.E. Alaska (gillnet and seine in Districts 101 to 104 from

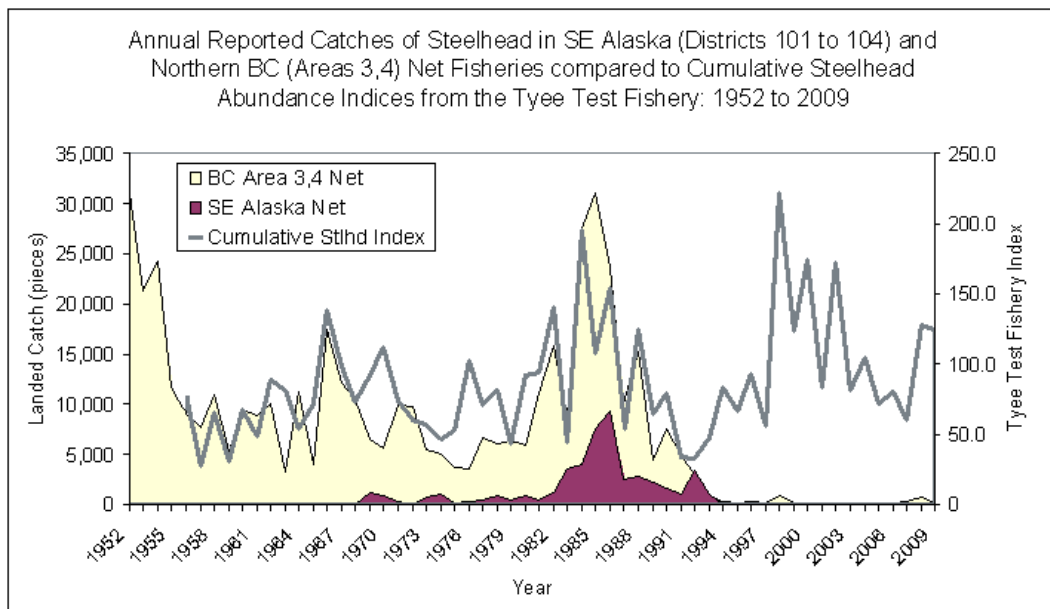


Figure 5. Annual reported catch of steelhead in Southeast Alaska (Districts 101 to 104) and Northern British Columbia (Areas 3 and 4) gillnet and seine fisheries, compared to cumulative steelhead abundance indices from the DFO Tyee Test Fishery from 1952 to 2009. Declines in reported catches beginning in the mid 1990s are the result of regulations that were implemented to prohibit the sale (Alaska) or possession and retention (B.C.) of steelhead in these fisheries. Sources: Larry Talley, Alaska Dept. Fish & Game, DFO (Canada), Pacific Region Catch Statistics, and DFO Tyee Test Fishery archived data.

1963 to 1997). Reported catches of steelhead in the Area 3 and 4 net fisheries of B.C. were at record highs in 1952 (~31,000 pieces landed). However, landed catches for these fisheries declined dramatically through the remainder of the 1950s and with the exception of 1966 (~17,400 pieces landed), remained under 10,000 pieces annually through to about 1981. Reported catches in S.E. Alaska were highest during the 1980s, peaking at about 9,000 in 1986 and averaging about 3,400 pieces from 1980 to 1989. In 1984, steelhead catches were again reported at all time highs in the Skeena net fisheries of B.C., primarily in the Area 4 gillnet fishery. After 1984 and into the early 1990s, reported steelhead catches steadily decreased. By the mid 1990s, Alaska implemented regulations to prohibit the sale of commercially caught steelhead. In B.C., non-retention, non-possession regulations for steelhead were also introduced around this time for gillnet and seine fisheries in Areas 3 and 4. These regulations resulted in an almost complete reduction of reported catches of steelhead for the remainder of the 1990s through to present time.

For most years where data is comparable, cumulative steelhead abundance indices from the Tyee Test Fishery have mirrored catches. Indices have fluctuated steadily with reported catches from the mid 1950s, peaked in 1984, then followed by a steady decline through the remainder of the 1980s, reaching historic lows in 1991 and 1992. Through

the remainder of the 1990s, abundance indices increased again reaching an all-time high of 222 in 1998. During the 2000s, steelhead abundances began steadily declining again until more recently in 2008 and 2009, where indicators have shown a moderate increase in abundance.

The Steelhead Bycatch Issue

Bycatch and related mortalities of steelhead in the multi-species and mixed-stock commercial Skeena net fisheries of British Columbia has been an ongoing issue of concern for the last 35 to 40 years. The issue was first reported by Chudyk and Narver in 1976 when they noticed dramatic declines of steelhead landings in the Area 4 gillnet fishery from approximately 27,000 pieces reported in 1952 to just over 3,000 in 1975. They concluded that the decline in steelhead abundance was directly related to an intensified Area 4 gillnet fishery targeting sockeye near the end of July. Around the same time, Andrews and McSheffrey (1976) highlighted problems with relatively high exploitation rates and suspected under-reporting of steelhead catch in the major gillnet fisheries throughout British Columbia, including those of the Skeena River. Data collected in follow-up studies in 1976 (Oguss *et al.* 1978) and 1977 (Oguss and Evans 1978) in the Area 4 Skeena gillnet fishery, estimated that incidental catches of steelhead were more than two times greater than those reported by the Fisheries and Marine Service catch statistics.

In the mid 1980s, reported steelhead catches were high. In 1985, over 30,000 steelhead were reported in Southeast Alaska and British Columbia northern boundary fisheries, with the majority (23,500) being reported in the Area 4 gillnet fishery (Figure 5). Following this peak year, cumulative steelhead abundance indicators from the Tye Test Fishery began to decline, reaching all-time lows in the early 1990s (33.1 in both 1991 and 1992). Evidence that reported steelhead catches were being underestimated (Oguss and Evans 1978, Oguss *et al.* 1978), coupled with an unknown number of steelhead that were caught and released in these fisheries as well as historic declines observed in escapements and abundance indices from test fisheries, led many to believe that Skeena steelhead stocks were being seriously over-exploited (Tautz *et al.* 1992; Ward, 1993; Ward *et al.* 1993; Cox-Rogers *et al.* 1994).

Following the decline in steelhead abundance witnessed in the Tye Test Fishery in 1991, fishery managers responded by introducing a number of changes to commercial Skeena net fisheries that were phased in throughout the remainder of the 1990s (DFO Integrated Fisheries Management Plans (IFMP) - 1991 to 1999, Plate *et al.* 2009). Some of these changes included more selective fishing gear and techniques, mandatory onboard fish revival tanks and mandatory release of steelhead (and later coho, in the late 1990s), as well as changes to the areas and timing of gillnet and seine fisheries targeting Skeena chinook, sockeye and pink. All these measures were aimed at limiting the impacts of the Skeena commercial net fisheries on steelhead and other less abundant non-target species

(coho, chum, and some wild sockeye and chinook stocks) while optimizing harvest on the more abundant target species (sockeye and pink). Following this period of experimentation with selective fishing practices and heightened awareness of the need for conservation of steelhead and coho, salmon fisheries management in British Columbia entered a period defined by Wood (2002) as the “New Directions period” (1998 to present). This new direction included a major restructuring plan for Pacific fisheries (Pacific Fisheries Adjustment and Restructuring) and set out a broad policy framework for fisheries management which outlined a number of principles for conservation, sustainable use, and improved decision making (Wood 2002, Plate *et al.* 2009). Other programs were also introduced that outlined allocation policies for harvestable surpluses in salmon fisheries as well as a large scale voluntary salmon licence retirement program, community economic development, adjustment and stewardship, and rebuilding of the resource through a Pacific salmon endowment fund, habitat restoration and salmon enhancement (PFAR Progress Report for Year Three, July 2000 to July 2001).

Non-retention and non-possession regulations that were also introduced in the mid 1990s for most non-target species meant that catches of these species were no longer being reported in the commercial fisheries. With these changes, it became apparent that it was necessary to monitor and assess the effectiveness of selective fishing practices and changes in regulations. Starting in the mid 1990s and intermittently throughout the 2000s, both federal and provincial government agencies partnered and implemented a number of onboard third-party fishery observer programs during both experimental and commercial Skeena net fisheries. These programs focused attention on gathering capture and release data on bycatch as well as target species, assessing experimental and regulated selective fishing gears and techniques, and monitoring compliance with new non-retention, non-possession regulations. Additional short-term mortality studies on bycatch species were also conducted from time-to-time in order to assess capture-related mortality by gear type.

Despite the relatively large number of observer programs that have been implemented in the commercial Skeena fisheries over the last two decades, there has been a relative lack of published information regarding estimates of steelhead bycatch and fishery related mortalities in these fisheries (Walters *et al.* 2008).

Terms of Reference

In a recently published report, the Skeena Independent Scientific Review Panel (“the Panel”) documented the current management process for salmon in the Skeena watershed, provided numerous options for a renewed approach, and identified what additional monitoring and data collection would be needed to manage the fisheries with regard to Canada’s Wild Salmon Policy (WSP) (Walters *et al.* 2008, 2009).

The Panel described a range of options regarding monitoring programs that would provide critical improvements to monitoring and estimation of fish abundance, fishing

activities, and habitat conditions. For commercial fisheries, the Panel suggested there be direct field monitoring each year that estimates the total catch and release of all species (particularly steelhead) by the commercial fisheries, using either a large-scale observer sampling program or mandatory video surveillance of gear retrieval on all vessels. In further discussions around this particular recommendation, the British Columbia Ministry of Environment (MoE), Skeena Regional Office, suggested that a comprehensive review was warranted of historical observer programs and selective fishery studies that have taken place in commercial Skeena salmon net fisheries. Of particular significance from these programs and studies were summaries and discussion of the data related to steelhead bycatch and estimates of mortality by gear type. The following report is the result of these discussions.

Some background reports, data, and comments for the final report have been graciously provided by Mark Beere of the Ministry of Environment, Skeena Regional Office. Funding for this report has been provided through the Living Rivers Trust Fund, solely administered by the Pacific Salmon Foundation.

Report Description

The report is divided into two main sections. The first section attempts to chronicle and summarize the past 21 years of steelhead bycatch data collected during Skeena commercial net fishery observer/monitoring programs and includes various selectivity gear studies or selective demonstration fisheries. The available data from programs or studies conducted between 1989 and 2009 (primarily by J.O. Thomas and Associates Ltd.) have been reviewed and summarized to highlight program objectives and critical results. Many of these historical observer programs were multi-faceted and collected data from different fisheries in the North Coast of B.C. Some summaries may include data from these other fisheries, however the focus of the report is the Skeena net fisheries, including selective gear studies or demonstration fisheries in Areas 3 and 4.

The second section provides a summary of estimates of steelhead bycatch in the gillnet and seine fisheries of Area 3 and 4. Comparisons are made to annual reported catch data from commercial net fishery landings in British Columbia (sales slips) for all years, and mandatory fisher catch reports (phone-ins and logbooks) that were implemented during the last decade (2001 to 2009). When possible, short-term fishery related mortality estimates for steelhead are also presented and reviewed by area and gear type from available data. Data collected by observers during selectivity gear studies or selective demonstration fisheries are also compared to data from conventional fisheries when available.

Limitations

The data in this report has been simplified to provide annual summaries and basic assessments and comparisons between areas and gears over time. Most discussion and analyses are primarily focused on Skeena steelhead bycatch and short-term mortality associated with capture. As a result, some data and results from the various programs may not be fully documented in this report.

The bycatch estimates and associated confidence intervals presented in this report are believed to be representative of the observed fishery or selectivity gear study. However, it should be noted that the estimates are based on summaries from a variety of observer/monitoring programs, often with different study designs and mandates, during years of variable stock abundances, catches and fishery periods. Catch (and release) of steelhead and associated mortalities may not have been the primary focus of the study or monitoring activity. As a result, and perhaps not surprisingly, estimates of steelhead bycatch and short-term fishery mortalities have been highly variable among the years and gear types examined and in some cases may have broad confidence intervals.

In addition, only short-term mortality rates (0 to 48h) are presented in this report. In some studies (e.g. 1996 Selective Seine Mortality Study), steelhead were released alive with external tags and some were later reported recovered in tributaries of the Skeena River. However, none of the programs formally addressed any long-term or delayed mortality or deleterious effects that steelhead may have experienced as a result of capture, handling and release from the fishing gear.

SECTION I: COMMERCIAL SKEENA OBSERVER/MONITORING PROGRAMS: A COMPREHENSIVE REVIEW

Prior to the late 1980s, DFO fishery officers or charter patrols using fishery guardians were the primary on-the-water source for fishery monitoring and observation. During the late 1970s and throughout the 1980s, there was a heightened awareness of the need for reliable catch monitoring. This was especially true for multi-species, mixed-stock fisheries like those of the Skeena, where impacts of these fisheries on co-migrating weaker salmon stocks, was rarely quantified. One way of achieving this goal was to place fishery observers aboard commercial fishing vessels to observe and record fishing activities and provide managers with reasonable estimates of encounter rates and subsequent mortalities for species of concern, such as steelhead.

By the late 1980s, and throughout the following two decades, a variety of observer programs were conducted in the North Coast region of British Columbia, primarily to monitor the impacts of commercial salmon net fisheries on weaker Skeena River stocks. During the late 1980s and early 1990s the main focus and concern was on steelhead. During the late 1990s to mid 2000s, the focus shifted to include new concerns for upper Skeena River coho stocks. There were major changes to the commercial salmon fishing industry during this time and a large number of observer programs were implemented in the North Coast net fisheries, as well as studies and small scale demonstration fisheries using a variety of experimental selectivity methods and gear types.

The following section summarizes some of the major observer/monitoring programs that have taken place in the commercial Skeena gillnet and seine fisheries, primarily in Areas 3 and 4, from 1989 to 2009. It also includes several case studies of relevant experimental selectivity gears and selective demonstration fisheries in Areas 3 and 4 that were conducted with onboard fishery observers during this period.

The primary source of the data presented in this report is from archived raw and electronic data files and mostly unpublished (or limited distribution) reports prepared by J.O. Thomas and Associates Ltd. Most final reports or inseason operational summaries mentioned in this report were prepared and distributed selectively to scientific authorities involved in the programs at the Department of Fisheries and Oceans Canada (DFO), the B.C. Ministry of Environment (MoE), or the Skeena Fisheries Commission (SFC).

Additional relevant observer programs may have occurred in these fisheries by government agencies or contracted third-party observers during the two decades covered by this report. We apologize for any omissions.

1989-1993: Skeena (Area 4) Packer Sampling Program (SPSP) and Salmonid Mark Recovery Program (MRP)

Funding Agencies: *Department of Fisheries and Oceans Canada (DFO): 1989-1993, and
the British Columbia Ministry of Environment (MoE), Smithers: 1992,
1993*

Lead Contractor: *J.O. Thomas & Associates Ltd.*

JOT Contract Code: *1008*

Final report(s):

- 1. 1989 Statistical Area 4 Fin Mark and Tag Recovery Packer Sampling Program (Contract Number: VPS 89-068)*
- 2. 1990 Statistical Area 4 Fin Mark and Tag Recovery Packer Sampling Program (Contract Number: VPS 90-091)*
- 3. 1991 Statistical Area 4 Fin Mark and Tag Recovery Packer Sampling Program (Contract Number: FP91-5085)*
- 4. 1992 Statistical Area 4 Fin Mark and Tag Recovery Packer Sampling Program (Contract Number: F92-5096)*
- 5. Catch Sampling and Tag Recovery Involving Steelhead Caught in the 1992 Northern British Columbia Net Fishery (Contract Number: CSK 1369)*
- 6. 1993 Statistical Area 4 Fin Mark and Tag Recovery Packer Sampling Program (Contract Number: F93-5046)*
- 7. Catch Sampling and Tag Recovery Involving Steelhead Caught in the 1993 Northern British Columbia Net Fishery (Contract Number: CSK 1768)*

Prepared by: *J.O. Thomas & Associates Ltd.*

Prepared for: *Department of Fisheries and Oceans (DFO), Prince Rupert (reports 1,
2, 3, 4, and 6), and the British Columbia Ministry of Environment
(MoE), Smithers (reports 5 and 7).*

Data Availability: *Summarized data from final reports only.*

Background:

From 1989 to 1993, the Statistical Area 4 Fin Mark and Tag Recovery Packer Sampling Program (aka Skeena Packer Sampling Program (SPSP)) was conducted during the commercial gillnet fishery in Area 4 (June or early July through August). The program was designed to complement and refine hatchery chinook (and coho, chum and steelhead) coded-wire tag (cwt) recovery and catch sample data exclusively from the Area 4 gillnet fishery.

Program Objective(s):

The primary objective of this program was to quantify the stock origin of enhanced salmon, in particular chinook, as determined by the recovery and analysis of coded-wire tags and fin marks from salmon specifically caught by gillnets in and surrounding the Skeena River (Pacific Fishery Management Areas 4-12 and 5-15). Such spatially refined stock information on chinook caught in this fishery was used as a basis for negotiating north coast chinook quotas in the United States/Canada Pacific Salmon Treaty (PST). Basically, if "sanctuary areas" of local Canadian origin chinook could be affirmed in fishing areas surrounding the Skeena River, then chinook caught inside these areas would meet the criterion of terminal exclusion and therefore could be excluded from the Canada/U.S. quota negotiations for this species.

Program Methodology:

Samplers were situated aboard commercial packers near the mouth of the Skeena River and collected pertinent catch sample data from individual gillnets delivering their catch. Data collection was primarily comprised of interviews with fishermen regarding catch location and fishing effort, counting catches of all non-target chinook, coho, chum, and steelhead and visually inspecting individual fish for missing adipose fins that indicated a hatchery released salmon containing a cwt. Adipose fin-clipped salmon were sampled for length, weight, age, sexual maturity, and their heads retained for cwt extraction and decoding. Ventral fin-clipped chum salmon fish were sampled for the above variables, but did not require head removal. Random biological samples for determination of age and size of chinook were also collected.

Program Summary:

Although the primary focus of the program was to obtain refined Area 4 catch sample and cwt mark recovery data, it also provided useful data on the harvest of other non-target salmon (especially steelhead) that were being harvested in the gillnet fishery. Catch sample counts from individual gillnet deliveries to both Skeena packers and shore-based processing plants often exceeded what was eventually reported as catch on sales slips. Steelhead were occasionally taken home by fishermen or reported and sold as coho. Since sales slips were used as the official government source of published catch statistics, the actual number of steelhead (or coho) being caught was often misrepresented (i.e. underestimated in the case of steelhead, and overestimated in the case of coho).

Efforts to raise awareness and increase the pool of data on steelhead caught in the commercial net fisheries in areas 3, 4, and 5 also led to additional MRP sampling requirements for steelhead. Data collected in 1992 and 1993 were summarized in two reports prepared for the British Columbia Ministry of Environment (BCE), Fisheries Branch in Smithers by J.O. Thomas and Associates Ltd. (1992, 1993). These reports

detailed the operations and provided revised catch estimates of steelhead in the gillnet and seine fisheries in areas 3, 4, and 5, summarized steelhead catch sampling and mark recovery data collected through the SPSP and MRP, as well as providing complete documentation of 2,380 individual steelhead biological samples (length, girth, weight, and sexual maturity).

Table 1 provides an annual summary of the catch sample data collected from the SPSP and the MRP during the years of operation from 1989 to 1993. The table also compares estimates of the total number of steelhead caught and landed by gillnets operating in Area 4 during these years by 1) DFO fishery officer hauls, 2) as reported in published DFO catch statistics, and 3) from the steelhead catch sample data collected by the SPSP/MRP. For most years of the study, DFO fishery officer estimates were slightly higher than the reported catch statistics (sales slips). However, direct catch sample data from gillnet deliveries estimated the steelhead catch in this fishery as substantially higher (on average, almost twice as high) than those reported on sales slips for all study years. These revised estimates corroborated similar findings in the Area 4 gillnet fishery done by Oguss *et al.* (1977, 1978) in the late 1970s.

Program Outcomes:

Due in part to the data collected and reported by the SPSP and MRP during the late 1980s and early 1990s, concerns were heightened regarding steelhead bycatch and under-reporting of steelhead catch, primarily in the gillnet fisheries near the approaches to the Skeena River. In 1991, the DFO acknowledged a problem with steelhead bycatch and reporting of catch and committed to a 50% reduction in Skeena steelhead harvest and harvest rate over a three year period, commencing in 1992 (Beere 1992).

The commercial fishing industry also acknowledged that steelhead bycatch were a concern, especially in the Area 4 gillnet fishery. Mandatory release of steelhead from gillnets was endorsed by DFO in the ensuing management plans and embraced by industry (under the auspices of the North Coast Advisory Board) as part of an overall steelhead conservation and research program aimed at meeting the DFO harvest reduction goals. However, additional concerns were raised during this time, particularly from the sportfishing community, regarding the questionable survival of released steelhead after capture by gillnets and whether actual steelhead encounter rates reported by industry would be accurate.

Table 1. Summary of gillnet catch sample data obtained by samplers onboard packers in Area 4 (Skeena Packer Sampling Program (SPSP)) and from deliveries by individual gillnets and packers to shore-based processing plants (Salmonid Catch Sampling and Mark Recovery Program (MRP)) from 1989 to 1993. A comparison of the total catch of steelhead estimated from DFO fishery officer hauls, as reported sold by fishermen on sales slips, and from SPSP/MRP catch:sample data is included.

Study year	Sample source ^a		No. of individ. vessels sampled ^b	--- Total number of salmon counted ---				Total number of fishing days ^c	Estimated total number of steelhead caught ^d		
				Chin	Coho	Chum	Stlhd		DFO Hails	Sales slips	SPSP/ MRP
	SPSP/ MRP	individ. gillnets	582	1,644	2,893	5,074	510				
	MRP	packer samples	1,756	2,632	6,108	9,116	1,179				
1989	Total:		2,338	4,276	9,001	14,190	1,689	7,575	3,518	3,075	5,472
	SPSP/ MRP	individ. gillnets	723	1,843	3,517	2,415	713				
	MRP	packer samples	2,129	2,787	14,952	6,129	2,344				
1990	Total:		2,852	4,630	18,469	8,544	3,057	9,910	5,635	6,656	10,622
	SPSP/ MRP	individ. gillnets	447	1,478	2,121	2,032	206				
	MRP	packer samples	2,279	3,661	12,822	11,867	1,709				
1991	Total:		2,726	5,139	14,943	13,899	1,915	11,143	3,859	3,079	7,828
	SPSP/ MRP	individ. gillnets	421	1,806	1,227	2,198	184				
	MRP	packer samples	2,071	3,505	8,686	18,424	1,507				
1992	Total:		2,492	5,311	9,913	20,622	1,691	10,595	2,250	1,454	7,189
	SPSP/ MRP	individ. gillnets	517	870	1,866	7,403	46				
	MRP	packer samples	3,092	3,946	9,182	34,452	419				
1993	Total:		3,609	4,816	11,048	41,855	465	10,909	1,439	462	1,406
	SPSP/ MRP	individ. gillnets	2,690	7,641	11,624	19,122	1,659				
	MRP	packer samples	11,327	16,531	51,750	79,988	7,158				
1989-1993	Total:		14,017	24,172	63,374	99,110	8,817	50,132	16,701	14,726	31,534

a. SPSP=Skeena Packer Sampling Program (onboard packer sampling of individual gillnets) and MRP=Salmonid Catch Sampling and Mark Recovery Program (processing plant sampling of individual gillnets and gillnet packers). Excludes samples from mixed areas outside Area 4.

b. Number of gillnet deliveries sampled for Area 4 only. Each individual delivery is equal to one gillnet fishing day.

c. Estimated from the total number of gillnets operating per day in Area 4 from DFO Fishery Officer reports.

d. Does not include estimates of steelhead released at-sea or kept by fishermen and not landed/sold.

1992: Skeena River Steelhead Observer Program

Funding Agencies: *BC Ministry of Environment (BCE, later MoE).*
Lead Contractor: *Robert Brown.*
Final report: *Skeena River Steelhead Observer Program: July 18 - August 18, 1992,
Skeena Fisheries Report # SK 80, October 1992.*
Prepared by: *M. C. Beere, BC Ministry of Environment, Recreational Fisheries Branch,
Smithers.*
Data Availability: *Published report and summarized tables in report.*

Background:

In response to rising concerns regarding steelhead bycatch in the commercial Area 4 gillnet fishery, the BCE Fisheries Branch in Smithers undertook the development of a third-party, independent observer program that operated from July 18 to August 18, 1992.

Program Objective(s):

The primary objective of the observer program was to examine the proportion of steelhead caught by gillnets that were alive (or dead) when landed and to judge subjectively the health of the fish that were alive. While it was recognized that verification of steelhead catch reporting was also a desirable objective it was understood that this could not be accomplished given the scope and design of the observer program. The program did however provide opportunity to make anecdotal observations on the catch reporting issue.

The program was developed and supervised by the BCE Fisheries Branch in Smithers. Robert Brown, an independent contractor, was retained to employ ten observers and oversee coordination of the field activities and deployment of all observers. BCE employees and volunteers from the sportfishing community also participated as observers in the program. Industry was approached for support in promoting the project to fishermen and for soliciting cooperation of vessel operators in accommodating observers when approached to do so. DFO was also supportive by reimbursing volunteers to the program for travel, meals, and accommodation.

Program Summary:

The program observed five gillnet openings from July 18 to August 18, 1992 in Areas 4-12 and 4-15 adjacent to the Skeena River mouth. Three hundred and nine complete

gillnet sets were observed for a total of 283.8 hours of fishing, during which 62 steelhead were captured (20% of all landings observed included steelhead). Of the 62 steelhead observed, 45 (73%) were dead when landed or died shortly after being extracted from the gillnets. A complete summary of the number of salmon observed caught by species and fishery week is presented in Table 2.

Table 2. Total number of salmon observed by species and fishery week in the 1992 Area 4 Gillnet Steelhead Observer Program (MoE). Steelhead and coho to target species (sockeye and pink) ratios are included.

Gear/ Area	Week	Number of Sets Observed	--- Total number of salmon observed ---											
			Sock	Coho	Pink	Chum	Chin	Chin (jack)	Stlhd ^a	Stlhd: Sock	Coho: Sock	Stlhd: Pink	Coho: Pink	
Gillnet	4	Jul 18-20	50	738	3	150	2	7	2	4	0.005	0.004	0.027	0.020
		Jul 25-28	85	1,205	8	388	18	4	0	9	0.007	0.007	0.023	0.021
		Aug 2,4	41	1,000	10	1,152	4	7	0	10	0.010	0.010	0.009	0.009
		Aug 9-11	75	1,321	18	2,136	84	2	0	16	0.012	0.014	0.007	0.008
		Aug 16-18	58	1,154	19	3,153	46	1	0	23	0.020	0.016	0.007	0.006
		Total:	309	5,418	58	6,979	154	21	2	62	0.011	0.011	0.009	0.008

a. Includes both dead and alive steelhead.

Although the sample size of steelhead observed during the study was relatively low, the results compared closely with mortality rates observed in experimental gillnet (weedline) studies conducted in the same area in 1991 (162/243 or 67%) and 1992 (233/315 or 74%) (Lewynsky, Western Renewable Resources, 1992). The report concluded from these findings that the mortality of steelhead caught by gillnets was very high. Furthermore, reliance on release of steelhead from gillnets to meet conservation goals for this species was highly questionable as a management tool.

Steelhead encounter rates were also noted to increase over the course of the study, reflecting closely the run timing pattern for adult steelhead migrating back into the Skeena River. Steelhead were captured in eight percent of all sets observed during the first week (Jul 18-20) and rose to 41 percent of all sets observed during the last week (Aug 16-18).

The number of steelhead observed caught compared to sockeye was also recorded during the study (overall steelhead:sockeye ratio of 0.011). This data was not used in the study report to estimate overall steelhead bycatch by gillnets in Area 4. However, estimates of the total number of sockeye caught by gillnets in Area 4 in 1992, as reported on sales slips, was 1,525,774 pieces. Based on the ratios of steelhead to sockeye observed in the study, approximately 17,742 steelhead were encountered by gillnets in the Area 4 fishery. Mortality estimates from this study and other concurrent weedline studies mentioned above, suggest that bycatch of steelhead in the Area 4 gillnet fishery in 1992 may have resulted in anywhere from 11,887 (67%) to 13,129 (74%) steelhead mortalities.

Program Outcomes:

Several concerns and recommendations were raised by the study. Functioning live resuscitation tanks were required by gillnetters in 1992 as a condition of licence. This was a relatively new requirement for fishermen, however despite being mandatory; several gillnetters were observed fishing without these tanks. Also, on-the-grounds support for this program, despite having verbal recognition and acceptance from industry advisors, was poor. Only about 20% of the vessels approached and requested to accommodate observers for short periods of time actually complied. This resulted in fewer observations than anticipated and much valuable time lost searching for volunteer fishing vessels on-the-grounds. Recommendations were made to deploy observers in advance of the fishery and have them stay aboard individual vessels for the duration of the opening. Requests were also made to DFO to consider amending licence conditions so that fishermen would be required to accept observers aboard when asked to do so.

1994: Skeena Watershed Fisheries Technician Program.

- Funding Agencies:** *British Columbia Ministry of Agriculture, Fisheries and Food (MAFF), Aquaculture and Commercial Fisheries Branch, the British Columbia Ministry of Environment, Lands and Parks (MELP), Fisheries Branch, Smithers, the British Columbia Ministry of Employment and Immigration (MEI) - BC21 Initiative, and the Department of Fisheries and Oceans Canada (DFO), Prince Rupert.*
- Lead Contractor:** *J.O. Thomas & Associates Ltd.*
- JOT Contract Code:** *1082*
- Final Report:** *Skeena Fisheries Resource Technician Program – 1994 Operations Summary*
- Prepared by:** *J.O. Thomas and Associates Ltd., December 1994, File # CEF 5023.*
- Prepared for:** *Ministry of Agriculture, Fisheries and Food (MAFF), Aquaculture and Commercial Fisheries Branch, the Ministry of Environment, Lands and Parks (MELP), Fisheries Branch, Smithers, and the Department of Fisheries and Oceans Canada (DFO), Prince Rupert.*
- Data Availability:** *Set data available in spreadsheet format. Summarized data in the operations summary report.*
-

Background:

Prior to the 1994 Skeena salmon fishery, the Aquaculture and Commercial Fisheries Branch of the Ministry of Agriculture, Fisheries and Food (MAFF) and Fisheries Branch of the Ministry of Environment, Lands and Parks (MELP) were signatories to the 1994 Skeena Watershed Committee (SWC) consensus regarding fisheries management initiatives. Objectives of the SWC were many, and included a reduction in the commercial Area 4 steelhead and coho harvest rates, while optimizing sockeye and pink salmon harvests.

With these concerns and agencies in place, a new impetus for an expansive observer program was initiated in 1994. The initial design was developed by MELP staff using the 1992 observer program as a basic starting point. It was seen as an opportunity to collect useful third-party fisheries data, as well as fulfilling an economic opportunity for the local community while also providing valuable experiential training for individuals interested in pursuing or furthering careers in fisheries monitoring, the environment, and conservation.

MELP was financially committed to other Skeena initiatives, so the Skeena Technical Committee deemed it appropriate that MAFF secure funding and coordinate this project. Since the project provided training and employment in a coastal community in British Columbia, it fulfilled the criteria of the BC21 Special Account (a BC government job

creation program for people receiving unemployment benefits), administered by the Ministry of Employment and Investment (MEI). An application for funding was submitted by MAFF staff, and funding was subsequently allocated to the program. Additional financial support was provided to MAFF by the federal Department of Fisheries and Oceans (DFO) with respect to additional observer monitoring and data collection on vessels fishing with experimental gillnet gear. J.O. Thomas and Associates Ltd. (JOT) was contracted to further refine the program, conduct all logistical hiring, training and deployment of observers, solicitation of volunteer host fishing vessels, as well as fulfilling all the necessary data collection, analysis and reporting requirements to address the conservation concerns raised by the STC. A final operations summary report detailing the activities of the program and summarizing key components was completed by JOT in December 1994 (unpublished, prepared for MELP, Smithers and DFO, Prince Rupert).

Program Objective(s):

The program had a broad scope which included hiring and managing technicians, a detailed classroom training component, on-the-grounds practical training, canvassing for host fishing vessels, and logistical deployment of observers.

The at-sea observer program focused on the gillnet and seine fisheries known to harvest Skeena River salmon stocks in areas 3, 4, and 5. In Area 3, sampling goals were prioritized for fisheries in management areas 3-1 through 3-7. Management areas situated east of 3-7 primarily harvest stocks endemic to the Nass River and systems draining into the head of Portland Inlet. All Area 4 management areas were sample priorities, while Area 5 management areas surrounding Browning Entrance alone were prioritized for monitoring activities. Monitoring of these fisheries was undertaken to quantify steelhead encounter rates, while assessing mortality and onboard resuscitation procedures for steelhead, as well as provision of additional biological sample data (length, weight, sexual maturity) for steelhead.

In addition to the at-sea component, technicians also participated in a freshwater sport fishing creel census in the Skeena River, spawner escapement enumerations, port/dockside sampling, and support to other biological sampling programs such as the Salmonid Catch Sampling and Mark Recovery Program (MRP).

Program Summary:

Data collection activities were continuous from late June through to the end of September. In excess of 600 solicitations to fishermen for host vessels were completed during the 1994 season. Sixty-one boats agreed to accept an observer for at least one fishery. However, of these host boats, only 25 originated from dockside solicitation. The

remaining 36 boats were recruited as a function of their acquaintance with hired program technicians or staff.

Observers worked aboard both standard and experimental (weedline) gillnet vessels and seines. In total, 128,147 salmon were observed and recorded from 2,774 sets in Areas 3, 4, and 5. A complete summary by area, gear and species is provided in Table 3.

Steelhead to sockeye ratios by area and gear ranged from a low of 0.005 in the Area 3 seine fishery to a high of 0.013 in the Area 4 standard gillnet fishery. Low steelhead to sockeye ratios in the Area 3 seine fishery were indicative of the location of these fisheries where minimal impact to Skeena stocks was anticipated. The ratios observed in the Area 4 gillnet fishery (standard and experimental) were similar to the ratio of 0.011 observed in the 1992 MoE seine observer study (Beere 1992) and other experimental weedline studies conducted in 1991 (Lewinsky 1992).

Table 3. Total number of salmon observed by area and gear^a (standard and experimental^b gillnet, and seine) in the 1994 Skeena Fisheries Resource Technician Program. Steelhead to sockeye ratios are included where applicable.

Area	Gear	Number of Sets Observed	--- Total number of salmon observed ---							
			Sock	Coho	Pink	Chum	Chin	Stlhd	Stlhd (rel)	Stlhd: Sock
3	Gillnet (Standard)	190	1,867	243	561	1,223	12	18	11	0.010
	Seine	888	19,398	3,285	53,103	15,585	653	101	82	0.005
4	Gillnet (Standard)	1,121	11,788	815	4,714	2,521	143	152	49	0.013
	Gillnet (Experimental)	521	5,596	688	2,048	2,111	39	58	25	0.010
	Seine^c	--	--	--	--	--	--	--	--	--
5	Gillnet (Standard)	22	228	25	48	78	0	2	0	0.009
	Seine	32	46	144	752	98	4	0	0	--
All Areas	Gillnet (Standard)	1,333	13,883	1,083	5,323	3,822	155	172	60	0.012
	Gillnet (Experimental)	521	5,596	688	2,048	2,111	39	58	25	0.010
	Seine	920	19,444	3,429	53,855	15,683	657	101	82	0.005
	All Gears	2,774	38,923	5,200	61,226	21,616	851	331	167	0.009

a. A total of 9428 salmon observed on seines in Areas 1 and 2W are not included.

b. 90 mesh gillnets with experimental weedlines (exclusive to the Area 4 fishery).

c. No seine fishery in Area 4 in 1994.

In addition to at-sea sampling of catches, technicians recorded the physical condition of all steelhead encountered while aboard traditional and experimental (weedline) gillnet vessels in Area 4. This data is summarized in Table 4 by each gear type. For traditional gillnets, 63 percent of the observed steelhead were dead at time of landing. In the experimental (weedline) gillnets, 54 percent were dead at time of landing. Including steelhead that were lethargic and bleeding, these mortality rates are similar to those

observed in the 1992 MoE observer program (Beere 1992) and 1991 and 1992 experimental weedline studies (Lewynsky 1992).

Table 4. Observed physical condition of steelhead caught by standard and experimental (weedline) gillnets during the 1994 Skeena Fisheries Technician Program. Mortality rate estimates and 95% confidence intervals are presented for each gear type.

Area	Gillnet Type	Vigorous/ not bleeding	Vigorous/ bleeding	Lethargic/ not bleeding	Lethargic/ bleeding	Dead	Unknown	Mortality Rate (%)	(95% CI)
4	Standard^a	36	1	17	6	102	12	63.0	(55.3-70.0)
	Experimental^b	12	0	3	2	20	21	54.1	(38.4-69.0)
	Total:	48	1	20	8	122	33	61.3	(54.4-67.8)

a. Standard 60 mesh gillnet.

b. 90 mesh gillnet with experimental weedline.

Program Outcomes:

The observer training program was considered quite successful despite the absence of a seine fishery in Area 4, lower than expected returns of Skeena sockeye, and many logistical complications associated with managing a large-scale technical training and work experience program using volunteer host fishing vessels.

A number of recommendations were made in the final report that covered each aspect of the program from hiring, training and management of technicians to host vessel recruitment strategies, changes to licence conditions, as well as key procedural modifications to improve the quality of catch and biological sampling data and reporting from both at-sea and shore-based operations at processing plants.

Further analysis of the data collected by observers in 1994 was conducted by the British Columbia Ministry of Environment, Lands and Parks, Fisheries Branch in two separate reports (Labelle 1995; Labelle *et al.* 1995). The first report by Labelle, detailed methodologies to estimate the actual commercial catch of steelhead in Area 4 using observer ratios of steelhead to sockeye catch and fishery officer hail estimates of sockeye catch. A standard ratio estimator model, combined with a non-linear regression model, were described. The second report by Labelle *et al.*, detailed a catch and escapement monitoring plan for the commercial Skeena fisheries including a statistical analysis of observer monitoring requirements by fishery for steelhead catch estimation, a study design for radio telemetry operations, escapement estimation methodology, and recommendations for genetic methods of stock identification.

1995: Skeena Watershed Fisheries Resource Technician Program.

Funding Agencies: *Ministry of Agriculture, Fisheries and Food (MAFF), Aquaculture and Commercial Fisheries Branch, the Ministry of Environment, Lands and Parks (MELP), Fisheries Branch, Smithers, and the Department of Fisheries and Oceans Canada (DFO), Prince Rupert.*

Lead Contractor: *J.O. Thomas & Associates Ltd.*

JOT Contract Code: *1082*

Final Report: *The 1995 Skeena River Gillnet and Seine Sampling Program*

Prepared by: *J.O. Thomas and Associates Ltd., March 1996.*

Prepared for: *MAFF, Aquaculture and Commercial Fisheries Branch, Victoria, MELP, Fisheries Branch, Smithers, and DFO, Prince Rupert.*

Data Availability: *Summarized data in report only.*

Background:

Following the success of the 1994 Skeena Watershed Fisheries Technician Program, funding was acquired again in 1995 for a similar but scaled-down observer training and at-sea monitoring program that concentrated monitoring activities solely on gillnet and “Special Seine”¹ fisheries in Area 4 (primarily Areas 4-12 and 4-15) during late July and through August. Instead of canvassing host volunteer fishing vessels (see the 1994 program), a mothership was subcontracted in 1995 and positioned on the fishing grounds. Two inflatable boats were used to deploy observers from the mothership to individual fishing vessels.

Program Objective(s):

The objectives in monitoring the gillnet fishery were to identify areas and timing of steelhead related to sockeye abundance. Monitoring in the Special Seine fishery was designed to address concerns of vessel compliance to new fishery regulations, observe

¹ The “Special Seine” fishery was allowed to operate in 1995 in waters outside the mouth of the Skeena River to enhance harvest of Skeena pink and sockeye. However, special limitations and requirements were imposed on seines choosing to fish in this area. These conditions were designed primarily to minimize the impact of the fishery on non-target species, particularly, steelhead. These conditions also included having a functioning “blue box” revival tank onboard for resuscitation of prohibited species, hailing in and out of the fishery, mandatory brailing of each set, and requirements to allow observers onboard when requested to do so. For a detailed list of conditions for this fishery see “1995 Integrated Fisheries Management Plans for North Coast Salmon” at the DFO website:

<http://www-ops2.pac.dfo-mpo.gc.ca/xnet/content/MPLANS/archive.htm>.

vessel conduct and fishing strategies, identify catch locations of restricted species and assess the impacts of the fishery on the health of these species.

Program Summary:

Six gillnet fishery openings were observed in Area 4 from July 21 to August 21, 1995. A total 227 gillnets sets and 18,465 salmon were observed and recorded. Sample sizes were noted as being relatively small in the gillnet fishery due to problems in acceptance of observers by many gillnetters.

Five Area 4 Special Seine fishery openings were observed from July 28 to August 23, 1995. A total of 351 sets and 114,847 salmon were counted, of which 291 were steelhead. A summary by gear, fishery opening and species is presented in Table 5.

Table 5. Total number of salmon observed in Area 4 by gear (gillnet and Special Seine) and species in the 1995 Skeena Fisheries Resource Technician Program. Steelhead to sockeye ratios are included.

Gear	Fishery Opening	Number of Sets Observed	--- Total number of salmon observed ---						
			Sock	Coho	Pink	Chum	Chin	Stlhd	Stlhd: Sock
Gillnet	Jul 21,22	13	255	2	34	4	0	1	0.004
	Jul 24-26	82	4,358	16	2,366	40	32	19	0.004
	Aug 1-3	61	2,470	4	2,466	23	6	16	0.006
	Aug 7,8	22	748	8	1,684	16	0	15	0.020
	Aug 13,14	27	912	14	1,640	5	0	6	0.007
	Aug 20,21	22	541	15	724	18	0	7	0.013
	Total:	227	9,284	59	8,914	106	38	64	0.007
Special Seine	Jul 28,29	84	7,493	50	5,449	52	45	17	0.002
	Aug 4,5	107	11,325	129	47,676	195	20	108	0.010
	Aug 9	48	3,765	43	10,928	69	5	43	0.011
	Aug 18	49	1,750	86	8,236	74	8	29	0.017
	Aug 22,23	63	3,280	263	13,396	186	3	94	0.029
	Total:	351	27,613	571	85,685	576	81	291	0.011
All Gears	Total:	578	36,897	630	94,599	682	119	355	0.010

Program Outcomes:

No actual mortality studies were conducted on bycatch species (coho, chum, chinook or steelhead) in the gillnet or newly implemented Area 4 Special Seine fishery. However, observations on coho caught in the seine fishery raised new concerns about the impact of

these fisheries on the subsequent survival after release for this species. Many coho were observed to be more stressed than other restricted species and fewer were noted as being in good health after capture and subsequent release. Many recommendations were made through the study regarding improvements to onboard handling, correct speciation, and release of these species by fishermen. It was also recommended that future observer programs include more detailed mortality studies for coho, especially in the Area 4 Special Seine fishery. Compliance issues surrounding regulations and use of blue box revival tanks, and regulations requiring acceptance of observers aboard vessels as condition of licence were also discussed.

Steelhead to sockeye ratios were observed and reported for all commercial openings in the Area 4 gillnet and Special Seine fisheries. Estimates of steelhead bycatch were not presented for these fisheries in the final report. However, historical sales slip reports estimated that 1,363,959 sockeye were caught by gillnets and 315,503 sockeye were caught by seines in Area 4 in 1995 (DFO Catch Statistics). Using the observed steelhead to sockeye ratios from the observer data, an estimated 9,248 steelhead were caught (and released) in the conventional gillnet fishery and 3,325 steelhead were caught (and released) in the Special Seine fishery in 1995.

1996: Skeena Watershed Fisheries Resource Technician Program.

Funding Agencies: *British Columbia Ministry of Agriculture, Fisheries and Food (MAFF), Aquaculture and Commercial Fisheries Branch, the British Columbia Ministry of Environment, Lands and Parks (MELP), Fisheries Branch, Smithers, and the Department of Fisheries and Oceans Canada (DFO), Prince Rupert.*

Lead Contractor: *J.O. Thomas & Associates Ltd.*

JOT Contract Code: *1082*

Final Report(s):

- 1. 1996 Skeena Selective Gillnet Fishing Gear Study (Draft only)*
- 2. 1996 Seine Release Mortality Study*

Prepared by: *J.O. Thomas and Associates Ltd., June 1997.*

Prepared for:

- 1. The Skeena Watershed Committee, and*
- 2. DFO (Contract #F1599-6-0010/001/XSB*

Data Availability: *Some electronic data in spreadsheet format and summarized data in reports.*

Background:

Continued concern regarding the impacts of gillnet and seine fisheries on weaker steelhead stocks in the Skeena River dominated the issues surrounding management and monitoring of North Coast Skeena commercial fisheries in 1996. In addition, new concerns for other weak stocks of Skeena salmon species, such as chum, chinook and coho were also being raised.

Observer programs for Skeena gillnet and seine fisheries were again implemented in 1996 through the umbrella Skeena Fisheries Technician Program. Contracts were granted to J.O. Thomas and Associates Ltd. for the observer programs and were identified separately for each gear type and study mandate.

Program Objective(s):

Selective Gillnet Study:

Observers were placed in the 1996 gillnet fisheries in Areas 3, 4 and 5 in order to investigate the selectivity of various gillnet configurations on the capture of the target (pink and sockeye) and non-target (chinook, coho, and steelhead) species. The study consisted of two components: the “Outside” study which took place in Area 3 (Pacific

Fishery Management Units 1 to 4), Area 5 and the western portion of Area 4 (outside of the river), and the “Inside” study which took place in Areas 4-12 and a portion of 4-15 near the Skeena River mouth (also referred to as the River/Gap/Slough area).

The Outside fishing area study comprised eleven groups of four boats each. Each group provided four nets which were of the same mesh size and which were to be fished in “close proximity” to each other with each group rotating the nets within the group. The nets had to be of the following four types:

1. **Standard**: any normal 60 mesh net.
2. **Alaska Twist 60**: an Alaska Twist net of 60 meshes which was hung 400 fathoms of web to 200 fathoms of corkline and which incorporated a 1.2 metre weedline.
3. **Alaska Twist 90**: an Alaska Twist net of 90 meshes which was hung 400 fathoms of web to 200 fathoms of corkline and which incorporated a 1.2 metre weedline.
4. **Alaska Twist 120**: an Alaska Twist net of 120 meshes which was hung 400 fathoms of web to 200 fathoms of corkline and which incorporated a 1.2 metre weedline.

The Inside study group consisted of thirteen vessels fishing inside and in front of the Skeena River with nets that were half “standard” mesh and half test mesh. The standard half could be of any legal construction as long as it employed the same mesh size as the test half. The test half was either “19 gauge” or Alaska Twist mesh hung 200 fathoms of web to 100 fathoms of corkline. Of the thirteen vessels four used the “19 gauge” test half, eight the Alaska Twist, and one used a net of varying construction.

Observers collected data to assess the efficiency of the various net configurations in catching different species of salmon (specifically sockeye, coho, and steelhead). Data included the type of net being used, the specific area being fished, the date, the effort (time) expended, and the catch for each species. In addition to salmon, information on the catch of birds and marine mammals was recorded. Data collection also included the numbers of adipose fin-clipped coho, chinook and steelhead. Data on steelhead captures included the exact location of entanglement in the net, physical condition and whether fish were kept or released. Biological samples from sockeye caught by Alaska Twist gillnets were also compared to those caught by standard mesh gillnets.

Seine Release Mortality Study:

The 1996 Seine Release Mortality Study was primarily tasked to observe and report on the immediate or short-term fate of restricted species (coho, chinook, steelhead, and chum) caught by seines operating in the conventional Area 3, 4 and 5 fishery, the Area 4 Special Seine fishery and from a chartered seine operating for 1 day in Area 3 and 1 day in Area 4.

A transportation vessel with live holding tanks was used to transfer non-target, restricted species from seines to another vessel equipped with holding tanks. Each individual fish was spaghetti tagged and held for observation for up to 48 hours after capture and then released back into the ocean. Observations were made on the physical condition of each individual fish at time of capture and again at the time of release.

Program Summaries:

Selective Gillnet Study:

Data from the selective gillnet study was collected by observers between June 25 and August 14, 1996. A total of 188,118 salmon were observed. A summary of the observed number of salmon caught by each gear type is presented in Table 6.

Table 6. Total number of salmon observed in the 1996 Selective Gillnet Study by area, gear (test and standard gillnets) and species. Steelhead to sockeye ratios are included.

Study Area	Net Type	Number of Net-hours	--- Total number of salmon observed ---						
			Sock	Coho	Pink	Chum	Chin	Stlhd	Stlhd: Sock
Areas 3,4 (Outside)	Alaska Twist 120 (Test)	1,299	27,646	4,455	2,361	1,511	92	50	0.002
	Alaska Twist 90 (Test)	1,373	27,581	4,331	2,588	1,139	76	75	0.003
	Alaska Twist 60 (Test)	1,478	22,869	3,455	1,930	916	41	89	0.004
	Standard 60	1,629	26,144	3,850	2,647	813	59	216	0.008
	Outside Total:	5,779	104,240	16,091	9,526	4,379	268	430	0.004
Area 4 (Inside)	19 Gauge (Test)	267	5,440	838	7	26	25	28	0.005
	Standard 60	268	6,273	999	18	20	33	27	0.004
	Alaska Twist (Test)	789	16,537	3,274	38	39	132	108	0.007
	Standard 60	779	16,577	2,311	44	30	257	103	0.006
	Inside Total:	2,103	44,827	7,422	107	115	447	266	0.006

Seine Release Mortality Study:

Short-term mortality rates (0 to 48h) by species were reported from observations made on 378 restricted salmon species caught in Areas 3, 4 and 5. The majority of the salmon observed (70%) came from the Area 4 Special Seine fishery. The number of salmon observed and resulting short-term mortality rates by area and species are presented in Table 7.

Table 7. Short-term (0 to 48h) mortality rates of restricted species by area and species observed in the 1996 Seine Release Mortality Study, where n = number of observed dead and N = total number in the sample. 95% confidence intervals are included. Note: two coho caught in Area 5 are excluded from the table.

Area	Coho			Chinook			Chum			Steelhead		
	n	N	% Mort rate (95% CI)	n	N	% Mort rate (95% CI)	n	N	Mort rate (%)	n	N	Mort rate (%)
3	4	50	8.0 (3.2 - 18.8)	8	14	57.1 (32.6 - 78.6)	0	1	0 (0 - 79.3)	1	7	14.3 (2.6 - 51.3)
4	9	169	5.3 (2.8 - 9.8)	1	6	16.7 (3.0 - 56.4)	0	3	0 (0 - 56.1)	4	126	3.2 (1.2 - 7.9)
All Areas:	13	219	5.9 (3.5 - 9.9)	9	20	45.0 (25.8 - 65.8)	0	4	0 (0 - 49.0)	5	133	3.8 (1.6 - 9.3)

Observed catch numbers of target and non-target species were not published in the final seine mortality report. However, available electronic data files contained set by set observations of target and restricted species catches from the Area 4 Special Seine fishery. These numbers are summarized in Table 8.

Table 8. Total number of salmon observed by species and fishery date in the 1996 Area 4 Special Seine fishery. Steelhead to sockeye ratios are included.

Gear	Fishery Opening	Number of Sets Observed	--- Total number of salmon observed ---						Stlhd: Sock
			Sock	Coho	Pink	Chum	Chin	Stlhd	
Special Seine (Area 4)	2-Aug	51	2,537	22	2,961	86	4	47	0.019
	7-Aug	149	9,362	87	15,765	276	13	128	0.014
	8-Aug	114	4,757	163	12,603	327	9	89	0.019
	9-Aug	80	2,217	53	8,113	311	1	65	0.029
	11-Aug	51	1,704	79	9,124	160	2	43	0.025
	12-Aug	35	2,374	97	10,636	625	5	56	0.024
	Total:	480	22,951	501	59,202	1,785	34	428	0.019

In addition to catch sampling in Area 4 and the short-term bycatch mortality estimates, 128 surviving steelhead, 208 coho, 11 chinook and four chum salmon were tagged and released back into the ocean after being held. As of April 1997, nine steelhead and 11 coho tags were reported recovered. All the tagged steelhead recoveries and seven of the nine tagged coho were recovered in the Skeena River system.

Program Outcomes:

Gillnet Selectivity Study:

Based on the study results, Alaska Twist gillnets, and particularly the 90 mesh size, exhibited up to a 20% increase in the catch of sockeye compared to Standard 60 mesh gillnets while also reducing the catch of steelhead. However, increased coho catches were also observed in the Alaska Twist gillnets. Further comparisons between observations made during day and night fishing suggested that coho bycatch might be reduced by fishing during daylight hours only.

Comparisons of catches among the Area 4 Inside groups (nets comprised of half lengths of 19 Gauge and half Standard 60 mesh, and nets comprised of half lengths of Alaska Twist and half Standard 60 mesh) showed no appreciable differences in catch rates of sockeye, coho, or steelhead between the different configurations. However, no statistical analysis was presented to determine the significance of these results.

Steelhead to sockeye ratios were noted to be much lower in the Alaska Twist nets tested in the Area 3 and 4 Outside group compared to the Standard 60 mesh gillnets (Table 6). In the Area 4 Inside group, observed steelhead to sockeye ratios were higher in the Alaska Twist/Standard group compared to the 19 Gauge/Standard group. However, caution was advised when interpreting the inside observations due to reduced sample sizes for the 19 Gauge/Standard test group. In general, steelhead to sockeye ratios in the study were lower for observations using the Alaska Twist gillnets and similar for Standard 60 mesh gillnets when compared to studies conducted earlier in the 1990s (Beere 1992; Lewynsky 1992; Thomas 1995).

Measurements of sockeye length, girth and weight collected from Alaska Twist and Standard gillnet gears suggested no substantive difference in size selectivity between gears. However, as with catch data, no statistical tests of significance were presented to corroborate these statements.

In addition to assessing the effects of gillnet catches on salmon, the study was concerned about the capture of marine birds by Alaska Twist nets. Study gillnets fishing outside the Skeena River mouth were observed to kill 274 birds in 5,698 hours of fishing (0.048 birds/hour). Among the Alaska Twist nets tested, the Alaska Twist 90 mesh gillnets encountered the least amount of bird captures. Standard gillnets caught the least number of birds. Weed lines appeared to successfully reduce the catch of surface feeding birds, however all net types were observed to catch diving birds.

Fewer birds were caught by gillnet gear in and around the Skeena River (0.0073 birds/hour). Lower numbers of resident diving birds in this area was noted as a possible contributing factor. The Skeena River estuary is turbid and lacks the upwelling areas

common in the outside fishing areas. These geographic features limit productivity in the surface waters and hence fewer numbers of diving birds are commonly observed feeding in this area.

Seine Release Mortality Study:

Although sample sizes from the Area 3 seine fishery were relatively small, short-term mortality rates on restricted species were highest in this area when compared to those in Area 4. Samples from the Area 5 fishery were minimal (two coho caught, no mortalities). Based on the number of mortalities observed, ramping of catches in the Area 3 fishery was concluded as the main reason for the increased mortality rates observed in bycatch species. Lower mortality rates among bycatch species in the Area 4 fishery were believed to be the result of careful sorting and dipnetting of bycatch species during the drying up phase of the fishing operation or after brailing smaller catch loads onto the seine deck for sorting.

Short-term mortality rates for steelhead and coho caught by seines in combined Area 3 and 4 were found to be relatively low (3.8% and 5.9%, respectively). Short-term mortality rates on chinook were much higher (45.0%). However, small overall sample sizes and the predominance of small chinook jacks in the samples (eight of the 20 chinook observed were jacks, and six of these jacks died) was discussed as possible biases in the observed mortality rate for chinook.

Lower observed short-term mortality rates, especially for coho (5.3%) and steelhead (3.2%), in the Area 4 Special Seine fishery was seen as confirmation that improved handling practices and mandatory brailing were successful management tools for conservation of vulnerable species caught in this fishery.

1997: Skeena Watershed Fisheries Resource Technician Program.

Funding Agencies: *British Columbia Ministry of Agriculture, Fisheries and Food (MAFF), Aquaculture and Commercial Fisheries Branch, the British Columbia Ministry of Environment, Lands and Parks (MELP), Fisheries Branch, Smithers, and the Department of Fisheries and Oceans Canada (DFO), Prince Rupert.*

Lead Contractor: *J.O. Thomas & Associates Ltd.*

JOT Contract Code: *1082.*

Final Report(s):

- 1. 1997 Gillnet Monitoring Program (draft summary report only)*
- 2. 1997 Seine Coho Mortality Study (draft summary report only)*
- 3. 1997 Area 4 Special Seine Fishery Observer Program (draft summary report only)*
- 4. 1997 Area 1 Sockeye Seine Fishery Monitoring (draft summary only)*

Prepared by: *J.O. Thomas and Associates Ltd.*

Prepared for: *J.O. Thomas and Associates Ltd.*

Data Availability: *Some summarized electronic data in spreadsheet format and summarized data in draft in-house summary reports.*

Background and Fisheries Concerns:

Skeena commercial gillnet and seine fishery observer programs were continued in 1997 following recommendations and data collected during the 1996 fisheries and in consultations between DFO fishery managers and fishery advisors from industry. J.O. Thomas and Associates Ltd. was hired by DFO to provide independent, third-party services for a variety of monitoring and observer programs in North Coast commercial net fisheries.

In addition to ongoing concerns for Skeena River steelhead, new conservation concerns were being raised regarding the health of upper Skeena River coho stocks. Recent assessment of these stocks was indicating alarming rates of decline. Fishery managers were forced to consider and implement special measures in the commercial Skeena fisheries to protect these stocks from being overfished during targeted sockeye and pink fisheries.

Friction between the commercial gillnet and seine sectors was also rising due to new restrictions being placed on the gillnet fleet in Area 4 and the consideration of re-introducing seines into the Area 4 Special Seine fishery for a second year.

Program Objective(s):

Observers were concentrated primarily in the Skeena gillnet and seine fisheries in Areas 3, 4, and 5. Additional monitoring was provided in Masset to gather gillnet catch sample data from the Area 1 sockeye gillnet fishery and one observer was positioned on the fishing grounds in Area 1 to gather catch data and chinook encounter rates during the sockeye seine fishery in late July. Observer programs that monitored Skeena fisheries comprised three categories of monitoring: 1) to collect catch and encounter data from gillnet fisheries and assess catch rates by Alaska Twist 90 mesh vs. Standard 60 mesh configurations in Areas 3, 4, and 5, 2) observe catches and estimate short-term coho mortality rates in seine fisheries operating in Areas 3, 4, and 5, and 3) monitor and collect catch and release data from seines operating in the Area 4 Special Seine fishery.

Gillnet Monitoring Program:

Data collected and recommendations made from the 1996 Gillnet Selectivity Study in Areas 3, 4, and 5 (Thomas 1997) led to acceptance of the Alaska Twist 90 mesh configurations for use in the 1997 Area C commercial gillnet fisheries. In order to further verify the utility of this net and continue to monitor encounter rates of species of concern (primarily upper Skeena coho and steelhead) in the gillnet fishery, an observer monitoring program was implemented aboard packers to collect catch and encounter data from commercial gillnets operating in Areas 3, 4, and 5.

Additional data from gillnets operating in the Area 1 sockeye fishery in July was collected in a similar format to assess catch rates of target and non-target species by different gillnet configurations in that fishery.

Seine Coho Mortality Study:

New concerns for upper Skeena River coho stocks and to a lesser degree, ongoing concerns for other threatened Skeena stocks (steelhead, chum, and chinook), were the impetus for an observer monitoring program and short-term coho mortality study aboard seines operating during conventional commercial fishery openings in Areas 1, 3, 4, and 5.

Seine fishermen were asked to volunteer for the program, with the incentive of participating in an exclusive 12-hour opening later in the season as “payment” for their services. Volunteers were required to host an observer and continue to participate in the program for the remainder of the regular North Coast seine season. Each vessel was required to provide a functioning holding tank for fish (blue box), a survival suit for the observer, and food and accommodation for the observer while aboard. The aim was to recruit eight boats with exclusive northern (Area A) seine licences.

Volunteer fishermen were asked to fish in areas and using techniques they would “normally” use during scheduled fishery openings. Catches were sorted and numbers recorded by species for each set observed. Sockeye and pink numbers were estimated in the cases of large sets. All coho caught were examined for general physical condition, scale loss, abrasions and gill damage. Each live coho was tagged and placed in blue boxes for a maximum 6 hour holding period. After the holding period, the condition of each coho was re-evaluated and they were released back into the ocean.

Area 4 Special Seine Fishery Observer Program:

Monitoring of the Special Seine fishery in Area 4 near the mouth of the Skeena River was required to assess the continued viability of this fishery and to monitor compliance with strict regulations regarding brailing of catches, use of blue box revival tanks, and mandatory release of restricted species with the least amount of harm (coho, steelhead, chinook, and chum). Observations on the health and estimates of short-term mortality of bycatch species (especially coho) caught in this fishery were also conducted. Observers were transported to the fishing grounds via a rubber inflatable Zodiac boat during fishery openings and were distributed to seines throughout the fishery to obtain set by set catch and release data. Data was collated and summarized during the fishery and reported daily to DFO.

Area 1 Sockeye Seine Monitoring:

Fishery monitoring in the Area 1 sockeye seine fishery was conducted to assess catch rates for target species (primarily sockeye) and encounter rates for non-target species (primarily chinook). A single observer was positioned in the fishery and boarded, observed, and recorded catch and release data for each species.

Program Summaries:

Observer programs in 1997 included observations derived from the Area 1 gillnet and seine sockeye fisheries. These fisheries targeted migrating Fraser sockeye salmon and were observed primarily due to concerns with capture rates on mixed passing stocks of chinook salmon. The emphasis of this report is on Skeena fisheries and steelhead, therefore the results and discussion of the observations made in the Area 1 fisheries are limited.

Gillnet Monitoring Program (Areas 3, 4, and 5):

With the cooperation of the fish processing industry, observers were placed aboard packers in the Prince Rupert Harbour to monitor offloads from individual gillnets following conclusion of gillnet openings in Areas 3, 4, and 5. Individual fishermen were

interviewed regarding area(s) and duration fished, type of gillnet configuration used, and the number of restricted salmon (chinook, coho, and steelhead) released during the fishery. Where possible, all salmon landed from individual vessels were counted by species and grade.

Observers interviewed and collected catch data from a total of 639 gillnetters delivering to packers in Prince Rupert Harbour following seven fishery openings between July 10 and July 31, 1997. Due to procedural difficulties associated with working aboard packers, not all the gillnet deliveries sampled could be used in the final analysis of the data. In some cases, more than one vessel was offloaded to the packer at one time and catches could not be properly allocated to an individual vessel. In other cases, counts did not achieve 100% for some species due to the speed of the offload, the quantity of fish, or mixing of catches from different vessels as noted above. Also, some fishermen reported gillnet configurations or combinations that could not be clearly categorized as either Alaska Twist 90 and Standard 60 mesh types.

Analysis of the data to determine catch rates and ratios between target (sockeye and pink) and non-target (chinook, coho, and steelhead) species and the efficacy of Alaska Twist 90 vs. Standard 60 mesh gillnet configurations was severely limited by the available data. Also, the actual number of non-target species released by fishermen in the fishery was not always recounted or was anecdotal accounts only from fishermen interviews and therefore could not be verified as accurate.

A summary of the data that was collected and could be compared for complete gillnet deliveries using either Alaska Twist 90 and Standard 60 mesh gillnets by area and species is presented in Table 9. Numbers for chinook, coho, and steelhead are from landed and verified counts only. Counts for these species do not include estimates of numbers released during the fishery from interviews with fishermen.

Table 9. Total number of gillnet deliveries sampled^a and salmon counted in the 1997 Gillnet Monitoring Program by area fished, gear type (Alaska Twist 90 vs. Standard 60 gillnets) and species. Data presented are from vessel deliveries where all species of landed salmon were fully counted. There was non-retention, non-possession of steelhead in the gillnet fishery in 1997. Requests to release all live chinook and coho with the least amount of harm were also issued. Fishermen were interviewed to collect estimates of the number of coho, chinook and steelhead released in the fishery, however this data was unverifiable and therefore is not included in this table. Coho (landed only) to sockeye ratios are presented.

Study Area	Net Type	Number of Gillnet Deliveries	--- Total number of salmon observed ---						Coho: Sock
			Sock	Coho	Pink	Chum	Chin	Stlhd	
3	Alaska Twist 90	32	6,543	228	1,781	694	10	4	0.035
	Standard 60	8	1,155	23	293	55	7	0	0.020
	Total:	40	7,698	251	2,074	749	17	4	0.033
4	Alaska Twist 90	102	17,883	276	4,998	1,067	50	2	0.015
	Standard 60	286	37,384	340	11,520	1,294	170	11	0.009
	Total:	388	55,267	616	16,518	2,361	220	13	0.011
All Areas	Total:	428	62,965	867	18,592	3,110	237	17	0.014

a. Note: Data collected from vessels that fished multiple areas or with gear types other than Alaska Twist 90 or Standard 60 mesh are not included. Two gillnet deliveries from Area 5 not included.

Over 90% of the gillnets sampled came from the Area 4 fishery. Comparisons of sockeye catch rates between Alaska Twist 90 and Standard 60 mesh gillnets supported more elaborate experimental studies conducted in 1996 (Thomas 1997). In general, the Alaska Twist 90 gillnets caught more sockeye per vessel than vessels fishing the Standard 60 mesh configuration.

Unfortunately, due to the constraints of the program (i.e. no direct observations on the fishing grounds), no conclusions could be made regarding further efficacies of Alaska Twist 90 vs. Standard 60 mesh gillnets, especially with regards to target vs. non-target catchability, night vs. day fishing comparisons, and encounter rates and estimates of released numbers for restricted species such as coho, chinook, or steelhead.

Seine Coho Mortality Study (Areas 1, 3, 4, 5, and 6):

Response of seine fishermen to the coho mortality study was initially slow, but with active canvassing efforts from members of the observer program and contacts in the fish processing industry, the goal of recruiting eight seiners was achieved. Each participating vessel was required to take an observer aboard during every seine opening, and was assigned one observer for the entirety of the program.

Observers recorded data from 751 sets conducted in Areas 1, 3, 4, 5, and 6 between July 19 and August 12, 1997 (Table 10). No coho were caught in Area 5 and only 1 vessel fished in Area 6 for a total of 11 sets, in which five coho were caught. A total of 661 coho were caught, of which 20 were recorded as dead on arrival. Of the remaining 638 coho that were alive, 545 were tagged and placed in blue boxes for holding and observation. Ninety-three coho were released alive immediately due to capacity issues in the holding tanks. Of the remaining coho that were held for observation, 105 died during the holding period.

Short-term coho mortality rates were observed to be highest (21.9%) in the Area 1 seine fishery, followed by Area 3 (18.6%) and Area 4 (15.3%). Sample sizes in Area 5 and 6 were too small to be considered in the analysis.

Table 10. Summary of observed catch by species and estimated short-term mortality rates and 95% confidence intervals for coho by area from the 1997 Seine Coho Mortality Study. Steelhead to sockeye and coho to sockeye ratios are included.

Area	Number of Sets	--- Total number of salmon observed ---					Stlhd	Number of Coho Morts	Coho Mort Rate (%) (95% CI)	Stlhd: Sock	Coho: Sock
		Sock	Coho	Pink	Chum	Chin					
1	186	5,027	324	4,234	992	405	22	71	21.9 (17.8 - 26.7)	0.004	0.064
3	165	2,100	97	14,878	2,356	25	10	18	18.6 (12.1 - 27.4)	0.005	0.046
4	385	16,871	235	20,920	715	83	163	36	15.3 (11.3 - 20.5)	0.010	0.014
5	4	84	0	113	3	0	0	0	-- --	0.000	0.000
6	11	135	5	1,225	403	2	3	0	0 (0 - 43.4)	0.022	0.037
All Areas:	751	24,217	661	41,370	4,469	515	198	125	18.9 (16.1 - 22.1)	0.008	0.027

Area 4 Special Seine Fishery Observer Program:

The Area 4 Special Seine fishery operated for a total of eight days between July 29 and August 12, 1997. Inseason estimates indicated a total of 194 seines operating over the course of the fishery with an estimated 97,130 sockeye and 148,133 pink (DFO hauls). The official post-season reported seine catch in Area 4 from sales slips was reported to be 98,406 sockeye and 209,653 pink (DFO Catch Statistics). The observers boarded 58 boats and observed a total of 426 sets. Approximately 20,821 sockeye and 36,743 pink

were observed, representing 21.4% and 24.8% of the inseason estimated catch, respectively. A summary of the number of salmon counted by fishery date is provided in Table 11.

Table 11. Total number of salmon observed by species and fishery date in the 1997 Area 4 Special Seine Fishery. Steelhead to sockeye and coho to sockeye ratios are included.

Gear	Fishery Opening	Number of Sets Observed	--- Total number of salmon observed ---							
			Sock	Coho	Pink	Chum	Chin	Stlhd	Stlhd: Sock	Coho: Sock
Special Seine (Area 4)	28-Jul	26	1,474	17	3,158	31	10	13	0.009	0.012
	29-Jul	33	1,904	8	1,117	29	4	3	0.002	0.004
	1-Aug	70	1,738	29	3,351	159	19	16	0.009	0.017
	2-Aug	31	581	15	3,420	67	1	11	0.019	0.026
	5-Aug	68	3,026	36	6,490	283	4	23	0.008	0.012
	6-Aug	79	7,320	67	10,454	365	22	63	0.009	0.009
	11-Aug	57	2,869	32	5,127	116	20	130	0.045	0.011
	12-Aug	62	1,909	52	3,626	209	14	111	0.058	0.027
Total:		426	20,821	256	36,743	1,259	94	370	0.018	0.012

The number of steelhead and coho observed suggested low abundance for these species during the fishery. However, the number of steelhead observed caught did increase substantially during the last two days of the fishery (Aug 11, 12). Based on the observed sockeye:coho and sockeye:steelhead ratios presented in Table 11 and a reported sockeye catch of 98,406 from sales slips, there were an estimated 1,180 coho and 1,771 steelhead caught and released in the Area 4 Special Seine fishery in 1997.

Observations on the physical condition of restricted species (chinook, coho, steelhead and chum) caught in the Area 4 Special Seine fishery suggested that coho had the highest short-term mortality rate of 5.1% among those placed in blue boxes or immediately released (Table 12). Estimated short-term mortality rates for chinook, chum and steelhead were 1.2%, 1.4% and 1.1%, respectively. Observations showed that almost all the observed restricted species were released back into the water alive (98%) of which approximately 89% were in a vigorous and not bleeding condition. Observers also witnessed that blue boxes were used sparingly by fishermen. Only 65 observed salmon (about 3.5%) were placed in blue boxes and only one chum was observed to die while in a blue box.

The Area 4 Special Seine fishery was closed abruptly on August 12, 1997 amidst allegations of non-compliance by some seine fishermen to the rules stipulated in the

conditions of licence for participating in this fishery, and the discovery of restricted species by DFO enforcement in some offloads.

Table 12. Observed physical condition of restricted species at time of release by species in the 1997 Area 4 Special Seine fishery. Short-term mortality rate estimates and 95% confidence intervals are presented for each handling method.

	Vigorous/ not bleeding	Vigorous/ bleeding	Lethargic/ not bleeding	Lethargic/ bleeding	Dead	Unknown	Mortality Rate (%)	(95% CI)
Coho								
Blue-boxed	11	0	6	0	0	2	0	(0 - 18.4)
Immediate release	178	0	29	1	12	17	5.5	(3.1 - 9.3)
Total	189	0	35	1	12	19	5.1	(2.9 - 8.6)
Chinook								
Blue-boxed	2	0	0	0	0	0	0	(0 - 65.8)
Immediate release	78	0	3	0	1	10	1.2	(0.2 - 6.6)
Total	80	0	3	0	1	10	1.2	(0.2 - 6.4)
Chum								
Blue-boxed	22	0	10	0	1	0	3.0	(0.5 - 15.3)
Immediate release	1,045	6	76	2	15	82	1.3	(0.8 - 2.2)
Total	1,067	6	86	2	16	82	1.4	(0.8 - 2.2)
Steelhead								
Blue-boxed	7	0	6	0	0	0	0	(0 - 22.8)
Immediate release	312	2	31	2	4	6	1.1	(0.4 - 2.9)
Total	319	2	37	2	4	6	1.1	(0.4 - 2.8)

Area 1 Sockeye Seine Monitoring:

A single observer was positioned in the Area 1 seine fishery for five days between July 18 to 23, 1997. Forty-four individual seines were boarded and a single set was observed on each vessel. The total number of salmon observed by date and species is presented in Table 13. In total 6,386 salmon were observed, the majority being sockeye and pink target species. No bycatch species (coho, chinook, or steelhead) were observed to die during the observation period and all were released alive and in good condition back into the ocean.

Coho and chinook comprised the majority of the bycatch species (74 coho and 142 chinook). Only five steelhead were observed in the catches. When compared to target sockeye catches, the average bycatch of was estimated to be 1 steelhead per 1,000 sockeye, 38 coho per 1,000 sockeye, and 20 chinook per 1,000 sockeye.

Table 13. Summary of observed catch by species observed in the 1997 Area 1 Seine Observer Program. Steelhead to sockeye, coho to sockeye, and chinook to sockeye ratios are included.

Area	Date	Number of Sets	--- Total number of salmon observed --- ^a					Stlhd	Number of bycatch morts ^b	Stlhd: Sock	Coho: Sock	Chin: Sock
			Sock	Coho	Pink	Chum	Chin					
1	18-Jul	2	475	3	80	--	6	0	0	0.000	0.013	0.006
	19-Jul	14	632	23	606	--	61	2	0	0.003	0.097	0.036
	20-Jul	17	1036	23	751	--	54	2	0	0.002	0.052	0.022
	22-Jul	5	1280	10	640	--	11	0	0	0.000	0.009	0.008
	23-Jul	6	295	15	370	--	10	1	0	0.003	0.034	0.051
Total:		44	3,718	74	2,447	--	142	5	0	0.001	0.038	0.020

a. No records of chum were kept in the database.

b. Bycatch species include coho, chinook, and steelhead.

Program Outcomes:

Gillnet Monitoring Program (Areas 3, 4, and 5):

A full-fledged observer program or experimental study was not conducted to compare the catch rates between the Alaska Twist 90 mesh nets and standard 60 mesh nets in 1997. However, the information collected from informal interviews with the gillnet fishermen and catch sampling as they unloaded their catches onto packers did support some of the findings of the 1996 selective gillnet study. Vessels fishing with the Alaska Twist 90 mesh net caught up to 1.5 times the number of sockeye observed on vessels fishing with the Standard 60 mesh net.

Unfortunately, the number of coho and steelhead bycatch could not be properly estimated in the gillnet fishery due to the lack of direct on-the-grounds observations of catch releases for these species.

Seine Coho Mortality Study (Areas 1, 3, 4, 5, and 6):

Prior to the 1997 study, the only estimates of short-term coho mortality caught by seines in North Coast fisheries were from the Area 4 Special Seine fishery conducted in 1996. The special conditions placed on seines for handling and sorting catch (brailing, etc.) in this fishery were expected to improve survival rates of bycatch species. In fact, short-term mortality rates for coho in the Special Seine fishery in 1996 were the lowest (5.3%) among the areas studied (Thomas 1997).

The 1997 study was conducted primarily to estimate coho mortality rates in conventional fisheries outside of the Area 4 Special Seine fishery. The results of the 1997 study confirmed that short term mortality rates were 3 to 4 times higher in Areas outside of the Area 4 Special Seine fishery (Tables 10 and 12).

Area 4 Special Seine Fishery Observer Program:

Short-term mortality rates of bycatch species (coho, chinook, chum, and steelhead) observed in the Area 4 Special Seine fishery ranged from 1.1% (95% CI: 0.4% to 2.8%) for steelhead to 5.5% (95% CI: 3.1% to 9.3%) for coho. Despite low numbers of bycatch mortalities confirmed by the observer program, the Area 4 Special Seine fishery was closed prematurely in 1997 amidst allegations and some seine fishermen being charged for not complying with the rules of the fishery. Low returns of pink salmon, extremely low overall abundances of coho² and continued concerns for Skeena steelhead, as well as frustrations regarding “extra” fishing opportunities being provided to seines, fuelled political controversy surrounding this fishery.

Area 1 Sockeye Seine Monitoring:

The results of the Area 1 Sockeye Seine Monitoring Program provided fishery managers with direct and reliable third-party estimates of incidental catch rates for chinook, coho, and steelhead encountered in this fishery. Onboard observations were also useful in indicating low (0; 95% CI of 0 to 1.7%) combined instantaneous catch mortalities for these species.

² Cumulative coho indices from the 1997 DFO Tyee test fishery were the lowest ever recorded and totalled 4.76 for the entire season (from early July to the end of August).

1998: North and Central Coast Observer Programs.

Funding Agencies: *Department of Fisheries and Oceans Canada (DFO), Prince Rupert.*

Lead Contractor: *J.O. Thomas & Associates Ltd.*

JOT Contract Code(s): *2005, 2007*

Final Report(s):

- 1. 1998 North Coast Net Monitoring Program (draft summary report only).*
- 2. 1998 Central Coast Net Monitoring Program (draft summary report only).*
- 3. 1998 North Coast Selective Seine Monitoring Program (draft summary report only).*
- 4. 1998 North and Central Coast Seine Dockside Validation Program (draft summary report only).*

Prepared by: *J.O. Thomas and Associates Ltd.*

Prepared for: *DFO, Prince Rupert.*

Data Availability: *Some raw and summarized electronic data in spreadsheet format and summarized data in draft in-house summary reports.*

Background and Fisheries Concerns:

A discussion paper entitled “A New Direction for Canada’s Pacific Salmon Fisheries” was released by DFO in 1998 to industry stakeholders. The report described a new approach to the management and conservation of Pacific salmon fisheries and ushered in an era of a precautionary approach to management, more emphasis on selective fishing practices, and ecological approaches to guide management decisions and provide adequate conservation needs for all salmon and steelhead stocks.

In the North Coast, conservation and protection of upper Skeena coho stocks was a priority for DFO in 1998. In 1997, the DFO Tyee Test Fishery in the Skeena River recorded the lowest cumulative coho index ever recorded for this species (4.76 for the entire fishing season). In response to this concern, approach areas to the Skeena River were mapped out and classified as coho “Red Zones”. Fishing in these areas was restricted after July 16 and could only be prosecuted with assurances of zero mortality on coho. These concerns for coho stocks in the upper Skeena River (as well as the upper Thompson River in the south coast) were the first indications of what would later be dubbed the “Coho Crisis” of the late 1990s.

The monitoring of bycatch in 1998, especially coho, was critical to the fisheries management mandate of achieving zero coho mortality for all commercial salmon fisheries. As a result, a variety of commercial fishery monitoring/observer programs were implemented in the North Coast. J.O. Thomas and Associates Ltd. was hired by

DFO to provide independent, third-party observer/monitoring services for some of these programs.

Program Objective(s):

Observer programs that DFO implemented in 1998 included at-sea observations and monitoring of conventional net and troll fisheries, an experimental selective seine fishery, and an extensive dockside seine monitoring and validation program. These programs covered the entire North and Central coast and are described here for completeness. However, it should be noted that the majority of observations relating to Skeena stocks in 1998 were made in Area 3 conventional gillnet and seine fisheries. Area 4 gillnet fisheries were only permitted from late June to July 18, and there were no seine fisheries in Area 4 due to the concerns for coho and lower than anticipated escapements of Skeena sockeye. The experimental selective seine fishery was also limited in scope and was conducted for two days only in Areas 1 and 3 and one day in Area 6. Discussion of the seine dockside validation program is limited to a description of the program objectives and brief summary only.

North and Central Coast Net Monitoring Program (Areas 1, 2E, 3, 6, 7, and 8)

The objective of the 1998 North and Central Coast Net Monitoring Program was to place observers aboard individual gillnets and seines during scheduled North and Central Coast salmon fisheries. Observers were required to monitor and record catches of all target and non-target species, take tissue samples from coho for DNA stock analysis, and assess the physical condition of all coho caught and released. Extended observations of captured live coho and estimates of mortality were also to be included when time and conditions allowed.

North Coast Selective Seine Monitoring Program (Areas 1, 3, and 6)

An experimental, selective seine fishery was approved and developed in 1998 by a joint North Coast DFO/industry advisory board. The plan was to allow groups of designated seines to fish for sockeye or pink in Skeena approach areas classified as coho “Red Zones”. In return for the opportunity to fish in these zones, vessels had to carry observers aboard, abide by a set of conditions outlined by DFO, and demonstrate an ability to either avoid coho, or when they were encountered, to release them with zero mortality.

Seines organized themselves into groups of three vessels, of which ten groups were permitted to fish on any given opening. Each group of three vessels required a single observer to monitor and report catches, collect data on short-term coho mortality, tag and release coho, and conduct tissue sampling on coho for DNA stock analysis. Only one seine in the group was allowed to fish a time so that all sets for the group could be monitored.

North and Central Coast Seine Dockside Validation Program (Areas 1, 2E, 2W, 3, 6, 7, and 8)

A seine dockside validation program was initiated in 1998. The objective was to monitor seine offloads and validate catches from approximately 80% of all individual seines operating in North and Central coast salmon fisheries, Areas 1 to 10. Monitors were allocated to plants in Prince Rupert, Bella Bella, Port Hardy, and Vancouver. Individual seines delivering to plants in these locations were monitored to collect weights on all target species (sockeye, pink, and chum) and count all restricted species (coho, steelhead, and chinook). Tissue sampling for DNA was also conducted on coho whenever possible.

This program worked closely with the Catch Sampling and Mark Recovery Program (MRP) to facilitate logistics and avoid overlap in data collection requirements between the two programs.

Program Summaries:

North and Central Coast Net Monitoring Program (Areas 1, 2E, 3, 6, 7, 8)

Observers monitored catches in conventional gillnet and seine fisheries in Area 2E (Cumshewa), seine fisheries in Area 2W, and gillnet and seine fisheries in Area 3 and in Areas 6, 7, and 8 of the Central Coast. The program collected data from these fisheries from July 18 to August 31, 1998.

Observers were deployed either by direct canvassing of vessels at the docks prior to a fishery opening, or in some cases, from a chartered vessel that was hired to deploy observers to vessels directly on the fishery grounds.

A summary of observed catches by species, gear, and area and estimated short-term mortality rates for coho are presented in Table 14. Steelhead and coho to target species (sockeye, pink or chum) ratios are included where applicable.

Table 14. Summary of observed catches by species, gear (gillnet and seine) and area and estimated short-term mortality rates for coho in the 1998 North and Central Coast Net Monitoring Program. Steelhead and coho to target species (sockeye, pink or chum) ratios are included where applicable. Gear totals are not provided across areas in the North Coast since target species were different in each area. 95% confidence intervals are included for coho mortality rates.

North Coast

Gear/ Area	No. Sets Obs.	--- Total number of salmon observed ---						No. of Coho Morts	Coho Mort Rate (%) ^a (95% CI)	Stlhd: Sock	Coho: Sock	Stlhd: Pink	Coho: Pink	Stlhd: Chum	Coho: Chum
		Sock	Coho	Pink	Chum	Chin	Stlhd								
Gillnet															
2E	89	0	134	3	5,256	0	0	83	61.9 (53.5 - 69.7)	--	--	--	--	0	0.025
3	76	254	23	1,200	751	0	17	17	73.9 (53.5 - 87.5)	0.067	0.091	0.014	0.019	0.023	0.031
Seine															
2E	299	0	634	523	23,275	1	0	11	1.7 (1.0 - 3.1)	--	--	--	--	0	0.027
2W	42	0	5	54,230	2,466	1	0	0	0 (0 - 43.4)	--	--	0	0	0	0.002
3	258	677	400	16,612	11,424	71	37	12	3.1 (1.7 - 5.2)	0.055	1.693	0.002	0.024	0.003	0.035

Central Coast

Gear/ Area	No. Sets Obs.	--- Total number of salmon observed ---						No. of Coho Morts	Coho Mort Rate (%) ^a (95% CI)	Stlhd: Sock	Coho: Sock	Stlhd: Pink	Coho: Pink	Stlhd: Chum	Coho: Chum
		Sock	Coho	Pink	Chum	Chin	Stlhd								
Gillnet															
6	117	78	129	745	4,914	3	1	67	51.9 (43.4 - 60.4)	--	--	0.001	0.173	<0.001	0.026
7	7	1	7	18	279	0	1	2	28.6 (8.2 - 64.1)	--	--	0.056	0.389	0.004	0.025
8	85	17	27	46	1,404	0	2	15	55.6 (37.3 - 72.4)	--	--	0.043	0.587	0.001	0.019
Total:	209	96	163	809	6,597	3	4	84	51.5 (43.9 - 59.1)	--	--	0.005	0.201	0.001	0.025
Seine															
6	146	896	750	9,556	6,314	107	6	31	4.1 (2.9 - 5.8)	0.007	0.837	0.001	0.078	0.001	0.119
7	53	3	802	837	3,326	60	1	62	7.7 (6.1 - 9.8)	--	--	0.001	0.958	0.000	0.241
8	188	199	1,785	7,487	11,057	212	20	51	2.9 (2.2 - 3.7)	--	--	0.003	0.238	0.002	0.161
Total:	387	1,098	3,337	17,880	20,697	379	27	144	4.4 (3.7 - 5.1)	--	--	0.002	0.187	0.001	0.161

a. Three coho of unknown condition released from seines observed in Area 3 are excluded from mortality rate estimates.

b. Fifty-five coho of unknown condition released from seines observed in Area 8 are excluded from mortality rate estimates.

The physical condition of all captured coho at the time of release was recorded for each set observed. The summary of these observations by gear and area and the estimated short-term mortalities are presented in Table 15.

Table 15. Observed physical condition of coho at time of release from observations made during the 1998 North Coast Net Monitoring Program. Short-term mortality rate estimates and 95% confidence intervals are included.

North Coast

Gear / Area	Vigorous/ not bleeding	Vigorous/ bleeding	Lethargic/ not bleeding	Lethargic/ bleeding	Dead	Unknown	Mortality Rate (%)	(95% CI)
Gillnet								
2E	31	0	20	0	83	0	61.9	(53.5 - 69.7)
3	0	0	6	0	17	0	73.9	(53.5 - 87.5)
Total:	31	0	26	0	100	0	63.7	(55.9 - 70.8)
Seine								
2E	559	6	55	3	11	0	1.7	(1.0 - 3.1)
2W	5	0	0	0	0	0	0	(0 - 43.4)
3	325	5	50	0	12	8	3.1	(1.8 - 5.3)
Total:	889	11	105	3	23	8	2.2	(1.5 - 3.3)
All Gears/Areas:	920	11	131	3	123	8	10.4	(8.7 - 12.2)

Central Coast

Gear / Area	Vigorous/ not bleeding	Vigorous/ bleeding	Lethargic/ not bleeding	Lethargic/ bleeding	Dead	Unknown	Mortality Rate (%)	(95% CI)
Gillnet								
6	27	0	32	3	67	0	51.9	(43.4 - 60.4)
7	4	0	1	0	2	0	28.6	(8.2 - 64.1)
8	9	0	2	1	15	0	55.6	(37.3 - 72.4)
Total:	40	0	35	4	84	0	51.5	(43.9 - 59.1)
Seine								
6	588	4	126	1	31	0	4.1	(2.9 - 5.8)
7	667	0	73	0	62	0	7.7	(6.1 - 9.8)
8	1,491	3	183	2	51	55	2.9	(2.2 - 3.7)
Total:	2,746	7	382	3	144	55	4.4	(3.7 - 5.1)
All Gears/Areas:	2,786	7	417	7	228	55	6.6	(5.8 - 7.5)

North Coast Selective Seine Monitoring Program (Areas 1, 3, 6)

Selective seine fisheries were granted two openings in 1998. The first took place on August 7 and 8 in which 8 groups of 3 seines fished in Areas 1 and 3. The second opening was for one group of 3 seines that fished in Area 6 on August 15. One or two observers were assigned to each group of three seines and recorded catch and encounter data for each vessel. A summary of the observed catches by species and area and estimated short-term mortality rates for coho are presented in Table 16. Steelhead and coho to target species (sockeye, pink or chum) ratios are included where applicable.

Table 16. Total number of salmon observed by species and area in the 1998 Selective Seine Fishery. Short-term coho mortality rates and 95% confidence intervals and steelhead and coho to target species (sockeye, pink, or chum) ratios are included.

Gear / Area	Number of Sets Observed	--- Total number of salmon observed ---					No. of Steelhead	No. of Coho Morts	Coho Mort Rate (%) ^a (95% CI)	Steelhead:	Coho:	Steelhead:	Coho:	Steelhead:	Coho:
		Sock	Coho	Pink	Chum	Chin				Sock	Sock	Pink	Pink	Chum	Chum
Selective Seine															
1	25	8,542	400	2,853	973	142	2	0	0.000	0.047	0.001	0.140	0.002	0.411	
								(0 - 1.0)							
3-1	77	1,564	2,312	19,535	1,502	180	26	94	0.017	1.478	0.001	0.118	0.017	1.539	
								(3.3 - 4.9)							
3-3	138	1,704	959	28,120	17,096	115	27	30	0.016	0.563	0.001	0.034	0.002	0.056	
								(2.2 - 4.4)							
3-7	124	5,656	1,554	24,539	9,240	137	57	27	0.010	0.275	0.002	0.063	0.006	0.168	
								(1.2 - 2.5)							
Total Area 3:	339	8,924	4,825	72,194	27,838	432	110	151	0.012	0.541	0.002	0.067	0.004	0.173	
								(2.7 - 3.7)							
6	13	1	105	342	520	0	0	2	1.9	--	--	0	0.307	0	
								(0.5 - 6.8)							
All Areas	377	17,467	5,330	75,389	29,331	574	112	153	2.9	0.006	0.305	0.001	0.071	0.004	
								(2.5 - 3.4)							

The physical condition of all captured coho at the time of release was recorded for each set observed. The summary of these observations by area and the estimated short-term mortality rates are presented in Table 17.

Table 17. Observed physical condition of coho at time of release from observations made during the 1998 Selective Seine Fishery. Short-term mortality rate estimates and 95% confidence intervals are presented for each area.

Gear / Area	Vigorous/ not bleeding	Vigorous/ bleeding	Lethargic/ not bleeding	Lethargic/ bleeding	Dead	Unknown	Mortality Rate (%)	(95% CI)
Selective Seine								
1	373	0	27	0	0	0	0	(0 - 1.0)
3-1	1,894	53	247	24	94	0	4.1	(3.3 - 4.9)
3-2	893	6	30	0	30	0	3.1	(2.2 - 4.4)
3-7	1,367	34	120	6	27	0	1.7	(1.2 - 2.5)
Area 3 Total:	4,154	93	397	30	151	0	3.1	(2.7 - 3.7)
6	77	1	23	0	2	2	1.9	(0.5 - 6.8)
All Areas:	4,604	94	447	30	153	2	2.9	(2.5 - 3.4)

North and Central Coast Seine Dockside Validation Program (Areas 1, 2E, 2W, 3, 6, 7, 8)

The North Coast Seine Dockside Validation Program observed a total of 402 seine offloads from seines delivering to plants in Prince Rupert, Port Edward, Port Hardy, and Vancouver from July 13 to Oct 6, 1998. Approximately 44% of all seines fishing in Areas 1 to 8 were validated and a total of 761 coho and 7 steelhead were observed during these offloads, for an overall average of 1.9 coho and 0.02 steelhead per offload. The average number of coho per offload was highest in Area 2E (5.2 coho per offload) and in the Central Coast areas 6, 7, and 8 (3.0 to 11.0 coho per offload).

Program Outcomes:

North and Central Coast Net Monitoring Program (Areas 1, 2E, 3, 6, 7, 8)

Deployment of observers to fishing vessels was the primary operational difficulty for the observer program. As a condition of licence, fishermen were required to take observers aboard when requested to do so. However, in practice, these requests were seldom accepted. Resistance on the part of fishermen to accept observers was also witnessed when observers were deployed from chartered vessels on-the-grounds. Without the direct aid of DFO enforcement or partnerships with the fishing industry, the deployment of third-party observers into conventional fisheries was problematic.

Despite the difficulties, a total of 1,360 individual sets were observed from gillnets and seines operating throughout the North and Central coast in 1998.

North Coast Selective Seine Monitoring Program (Areas 1, 3, 6)

Successful deployment of observers to vessels fishing in the experimental selective seine fishery was aided by the limited number of vessels designated to fish at any given time (10 groups of 3), the limited number of fishing opportunities (1 group for 1 day in Area 1, 8 groups in Area 3 for 2 days, and 1 group in Area 6 for 1 day), and the allocation of individual observers to vessel groups prior to the start of the fishery.

Due to restrictions on fishing opportunities, sample sizes were relatively small in Area 1 and Area 6. However, the ability of seines to avoid coho encounters was not witnessed by observers in any of the areas fished. Coho bycatch was relatively high in all areas with averages of 16 coho per set in Area 1, 15 coho per set in Area 3, and 8 coho per set in Area 6. In addition, the ability of seines to release coho without harm and maintain “zero” mortality was only witnessed in Area 1. Despite these findings, observed short-term mortality rates for coho caught by seines was fairly low: 3.1% in Area 3 and 1.9% in Area 6.

Due to small reported recovery sample sizes, definitive assessments from coho tagging operations were inconclusive. Of the 342 coho tagged and released in Areas 1 and 3, two were reported captured in Alaska fisheries, one was reported caught in McLaughlin Bay (Area 8), and one was recovered by technicians working at the Toboggan Creek counting fence near Smithers, BC.

North and Central Coast Seine Dockside Validation Program (Areas 1, 2E, 2W, 3, 6, 7, 8)

The addition of a seine dockside validation program in 1998 was in response to heightened monitoring and enforcement needs by DFO to ensure compliance with “zero” mortality on coho and non-retention, non-possession rules for other restricted species (coho, steelhead, and chinook). The goal of validating 80% of offloads in the North and Central coast seine fisheries was not attainable given the program resources and the fact that a large number of deliveries were to packers on the fishing grounds. However, approximately 44% of all the North and Central coast seine offloads were validated by program monitors in port deliveries to Prince Rupert, Port Edward, Port Hardy and Bella Bella.

Tissue sampling of coho for DNA stock analysis occurred in all monitoring programs. All samples were sent to the Pacific Biological Station for further analysis and cataloguing. The results of these analyses are unknown.

1999: North Coast Observer/Monitoring Programs and Selectivity Studies.

Funding Agencies: *Department of Fisheries and Oceans Canada (DFO), Prince Rupert.*

Lead Contractor: *J.O. Thomas & Associates Ltd.*

JOT Contract Code(s): *3015-3, 3015-7, 2004, 3015-1.*

Final Report(s):

- 1. 1999 Baltic Gillnet Selectivity Study (draft in-house summary report only).*
- 2. 1999 Skeena Selective Seine Pink Demonstration Fishery (draft in-house summary report only).*
- 3. 1999 North and Central Coast Seine Dockside Validation Program (draft in-house summary report only).*
- 4. 1999 Seine Selectivity Grid Study (no report)*

Prepared by: *J.O. Thomas and Associates Ltd.*

Prepared for: *DFO, Prince Rupert, Heimo Piirola (Baltic Gillnet Study) and Paul Brajcich (Seine Selectivity Grid Study).*

Data Availability: *Some raw and summarized electronic data in spreadsheet format and summarized data in draft in-house summary reports.*

Background and Fisheries Concerns:

The management of Pacific fisheries was entering a new period of development of selective and sustainable fisheries through partnerships and co-management arrangements with client groups and stakeholders that would share in decision making, responsibilities and costs. In 1999, DFO designated approximately \$1.5 million towards the development of selective fishing methods and gears used in commercial, recreational, and First Nations salmon fisheries on the west coast. In addition, 5 percent of the commercial total allowable salmon catch (TAC) was allocated to those participating in selective fisheries.

Integrated Fisheries Management Plans (IFMPs) were also introduced by DFO in 1999. These plans were distributed to the public prior to each season and detailed the objectives, outlooks and planned management for salmon fisheries in each sector and region.

The basis of the North Coast net fishing plan in 1999 was guided by the Minister's 1998 announcement of achieving a goal of zero fishing mortality in Canadian fisheries on upper Skeena River coho stocks, and promoting selective fisheries throughout British Columbia. Non-retention, non-possession of coho was in effect for all commercial fisheries in Areas 1 to 10. Red and Yellow Zones were used again in 1999 as well as the introduction of additional Special Management Zones (SMZs) to restrict fishing in

locations and during times when upper Skeena coho and other salmon stocks of concern are prevalent. It was also illegal for seines to land coho, chinook and steelhead from all areas and illegal for gillnets to land coho from all areas. Gillnets were requested to release all live steelhead to the water with the least possible harm. In some areas, gillnets were also requested to release all live chinook to the water with the least possible harm. In order to closely track the target species catch and non-target species bycatch, in particular for coho, monitoring programs were required to assist in meeting conservation objectives in 1999. More responsibility was also being placed directly on individual fishermen to supply timely information on the catch and release of bycatch species to DFO through the use of mandatory logbooks, daily phone-in reports, in addition to third-party at-sea observer/monitoring. Some of these fisher reporting initiatives were introduced in South Coast commercial salmon fisheries in 1998, and were being assessed by DFO for expansion into North and Central Coast fisheries.

Program Objective(s):

Four monitoring programs were contracted by DFO in 1999 that required third-party observers and were related to Skeena commercial salmon fisheries. The first was conducted in Area 3 and involved an investigative study into the selectivity of a modified, experimental gillnet, known as the Baltic gillnet. The second program involved at-sea monitoring of salmon catches and the condition at release of bycatch species during a short duration, limited entry, selective seine pink “demonstration” fishery in Areas 4 and 5. A third program was a continuation of the seine dockside validation program that was introduced in 1998. The fourth project involved at-sea testing of the effectiveness of a seine equipped with an experimental, “selectivity grid” panel sewn into the seine bunt that was designed to catch target species while allowing escape of non-target species with minimal harm.

Baltic Net Selectivity Study (Area 3)

This study was proposed to DFO under the Selective Fisheries Program by Heimo Pirrola, a local Prince Rupert gillnetter. The study was accepted by DFO and J.O. Thomas and Associates Ltd. was hired to provide onboard observers to record catch and release data during the study.

The primary objective of this study was to test three configurations of a modified small mesh Baltic net and a standard Baltic net against traditional 60 mesh gillnets to determine the effectiveness of the Baltic nets in selectively capturing target species (sockeye, pink, chinook) while allowing the live, unharmed release of bycatch species (coho and steelhead).

The Baltic net has been used extensively in Europe and to a certain degree in the United States. The net comprises three layers that act to tangle fish as opposed to gilling the

fish. Unlike the more common tangle nets where the slack in the net originates from a large horizontal hang ratio, the excess webbing in a Baltic net is hung vertically. A small mesh inner layer is held slack by two shorter, large mesh outer layers. The small mesh of the inner panel ensures that large fish are not gilled, and therefore encounter less lethal injuries. The outside layers act to keep the inner net slack, as well as to trap fish. In addition to minimizing injuries on non-target species, target species that are captured have exceptional market appearance and quality.

The study design involved having three gillnet vessels fishing in close proximity to each other. Two vessels fished with different configurations of a Baltic net. The third vessel acted as a control and fished using a traditional 60 mesh gillnet. The study was to occur over a three week period, fishing three days per week. All nets were fished at the same time in close proximity and sets were limited to 30 minute soak times. Each vessel accommodated one observer who recorded all catches by species for each set. The physical condition of all non-target species was recorded at time of capture and all were to be released with the least amount of harm. Tissue samples for DNA stock analysis were taken from coho whenever possible.

Skeena Selective Seine Pink Demonstration Fishery (Areas 4, 5)

A proposal through the Selective Fishery Program was submitted to DFO by three North Coast seine vessel operators in 1999. The primary objective of the project was to demonstrate that a limited entry seine fishery could fish selectively for surplus Skeena pink salmon near the Skeena River (Areas 4 and 5) while ensuring that all other species captured could be released safely with minimal harm. The proposal was accepted by DFO on the condition that observers were placed aboard each vessel to count and record the number of fish caught and released by species during all fishing activities. The intent was for a short duration fishery to be conducted over four days in August following the peak migration period of Skeena sockeye.

North and Central Coast Seine Dockside Validation Program (Areas 1 to 10)

A seine dockside validation program was conducted in 1999 in Prince Rupert, Port Edward, and Port Hardy. The program was similar to the program introduced in 1998 and its primary objective was to monitor and validate landed catches from all salmon seine offloads in the above mentioned ports. The intent was to achieve at least 80% of the total number of seine offloads from fisheries conducted in the North and Central Coast (Areas 1 to 10) from July to September, 1999.

In addition to counting and recording landed catches, dockside observers were also responsible for taking tissue samples for DNA analysis from coho whenever possible.

Seine Selectivity Grid Study (MV Franciscan No. 1 - Areas 3, 6)

J.O. Thomas and Associates Ltd. was subcontracted by Paul Brajcich to provide an observer aboard his salmon seiner, the Franciscan No. 1. The Seine Selectivity Grid Study was sanctioned by DFO for funding through the Selective Fishing Program. The primary objective of the study was to conduct experimental ocean trials and evaluate the efficacy of several different selectivity grid panels sewn into the bunt of the seine. The primary purpose of the grids was to retain catches of target species, while allowing coho salmon and other non-target species to escape unharmed. Observers were required to gather catch and release data from sets made using four different grid configurations as well as a conventional bunt.

Program Summaries:

Baltic Net Selectivity Study (Area 3)

The study was conducted in Area 3 (Portland Canal) from July 13 to August 31, 1999. The three study vessels fished in tandem approximately three days per week in between scheduled commercial gillnet openings. A total of 150 sets were observed; 97 using traditional 60 mesh gillnets, 37 using Baltic nets, and 16 using a modified Baltic net (Table 18).

Table 18. Total number of salmon observed by species and gear in the 1999 Baltic Net Study in Area 3 (Portland Canal). Short-term coho mortality rate estimates and 95% confidence intervals are provided for each gear. Steelhead and coho to target species (sockeye, pink) ratios are included.

Gillnet Gear	Number of Sets Observed	--- Total number of salmon observed ---						No. of Coho Morts	Coho Mort Rate (%) (95% CI)	Stlhd: Sock	Coho: Sock	Stlhd: Pink	Coho: Pink
		Sock	Coho	Pink	Chum	Chin	Stlhd						
Traditional	97	1,575	22	1,735	256	3	3	3	13.6 (4.7 - 33.3)	0.002	0.014	0.002	0.013
Baltic	37	301	3	86	9	1	0	2	66.7 (20.8 - 93.9)	0	0.010	0	0.035
Baltic (modified)	16	16	125	1,380	17	0	5	50	40.0 (31.8 - 48.8)	0.313	7.813	0.004	0.091

Problems occurred during the study with the design and ability to fish with two of three Baltic net designs. As a result, only 37 sets were observed and only 397 target species (301 sockeye and 86 pink) were caught. In addition, very few non-target species were observed (3 coho, 9 chum, 1 chinook, and no steelhead).

After witnessing the results from the original design of the Baltic net, modifications to the net were done by removing the large mesh outside panels. The modified version was tested during the last two days of the study (August 30, 31) for a total of 16 sets. Catches of pink salmon were noted to increase as a result of these modifications. However, bycatch and short-term mortality rates for coho were also high (40%, 95% CI: 31.8% to 48.8%, Table 18).

The physical condition of coho captured was recorded at time of capture and release (Table 19). A total of 22 coho were caught in the traditional 60 mesh gillnets of which three were observed dead (13.6%). Short-term mortality rates for coho caught in the original Baltic nets was high (66.7%). However, this rate was based on a very small sample size of only three coho that were caught, of which two died. Although the modified Baltic net was only observed for 16 sets over a two day period, it had the highest incidence of coho (a total of 125) and reported a very high short-term mortality rate of 40% (95% CI: 31.8% to 48.8%), Five coho were observed to be dead at the time the net was picked and an additional 45 later died after resuscitation efforts failed.

Table 19. Observed physical condition of coho at time of release from observations made during experimental studies of Baltic nets in Area 3 (Portland Canal) in 1999. Short-term mortality rate estimates and 95% confidence intervals are presented for each gillnet configuration.

Gear	Vigorous/ not bleeding	Vigorous/ bleeding	Lethargic/ not bleeding	Lethargic/ bleeding	Dead	Unknown	Mortality Rate (%)	(95% CI)
Traditional	17	0	2	0	3	0	13.6	(4.7 - 33.3)
Baltic	0	1	0	0	2	0	66.7	(20.8 - 93.9)
Baltic (modified)	30	11	29	5	50	0	40.0	(31.8 - 48.8)

Skeena Selective Seine Pink Demonstration Fishery (Areas 4, 5)

The Skeena Selective Seine Pink Demonstration Fishery took place over two days in Area 5-2 on August 12 and 13, and two days in Area 4-12 on August 16 and 17, 1999. Two seines fished in Area 5 and one seine fished in Area 4. A summary of the number of sets and observed catch by area, date and species is presented in Table 20. All species except pink were released. A total of 18,651 pink salmon were caught during the fishery compared to 1,054 non-target species (sockeye, coho, chum, chinook, and steelhead).

Table 20. Total number of salmon observed by species, area, and date in the 1999 Skeena Selective Seine Pink Demonstration fishery (Areas 4 and 5). Steelhead and coho to target species (sockeye and pink) ratios are included.

Area	Date	Number of Sets Observed	--- Total number of salmon observed ---									
			Sock	Coho	Pink	Chum	Chin	Stlhd	Stlhd: Sock	Coho: Sock	Stlhd: Pink	Coho: Pink
4	16-Aug	10	103	24	2,812	48	0	3	0.029	0.233	0.001	0.009
	17-Aug	10	215	42	6,274	107	0	20	0.093	0.195	0.003	0.007
	Total:	20	318	66	9,086	155	0	23	0.072	0.208	0.003	0.007
5	12-Aug	21	97	157	4,395	14	5	6	0.062	1.619	0.001	0.036
	13-Aug	20	74	112	5,170	14	0	13	0.176	1.514	0.003	0.022
	Total:	41	171	269	9,565	28	5	19	0.111	1.573	0.002	0.028
All Areas	Total:	61	489	335	18,651	183	5	42	0.086	0.685	0.002	0.018

The physical condition of all non-target species was observed and recorded at the time of capture and release. Most fish that were vigorous and not bleeding were released immediately to minimize any deleterious effects caused by additional handling. However, some fish requiring resuscitation were kept in blue box revival tanks for short periods of time and then released. The condition of fish at time of release along with short-term mortality estimates is summarized by species and release method in Table 21. Short-term mortality estimates were observed to be highest for chinook (33.3% for immediate release and 20% overall). However, these observations are based on a very small sample of only five chinook of which only one died. Among the non-target species, sockeye and coho were caught in the greatest numbers. Immediate mortality rates were observed to be 3.1% for sockeye and 2.5% for coho. However, fewer sockeye that were placed in revival tanks survived when compared to coho. No mortalities were observed for chum and steelhead and the majority were released in vigorous condition (96% and 95%, respectively).

Table 21. Observed physical condition of restricted species at time of release by species in the 1999 Selective Seine Pink Demonstration Fishery (Areas 4 and 5). Short-term mortality rate estimates and 95% confidence intervals are presented for each handling method.

	Vigorous/ not bleeding	Vigorous/ bleeding	Lethargic/ not bleeding	Lethargic/ bleeding	Dead	Unknown	Mortality Rate (%)	(95% CI)
Sockeye								
Blue-boxed	54	3	28	3	18	0	17.0	(11.0 - 25.3)
Immediate release	335	4	31	1	12	0	3.1	(1.8 - 5.4)
Total	389	7	59	4	30	0	6.1	(4.3 - 8.6)
Coho								
Blue-boxed	128	5	29	7	5	0	2.9	(1.2 - 6.5)
Immediate release	144	1	12	0	4	0	2.5	(1.0 - 6.2)
Total	272	6	41	7	9	0	2.7	(1.4 - 5.3)
Chinook								
Blue-boxed	0	2	0	0	0	0	0	(0 - 65.8)
Immediate release	1	0	1	0	1	0	33.3	(6.1 - 79.2)
Total	1	2	1	0	1	0	20.0	(3.6 - 62.4)
Chum								
Blue-boxed	3	0	1	0	0	0	0	(0 - 49.0)
Immediate release	171	2	3	3	0	0	0	(0 - 2.1)
Total	174	2	4	3	0	0	0	(0 - 2.1)
Steelhead								
Blue-boxed	10	0	0	0	0	0	0	(0 - 27.8)
Immediate release	30	0	2	0	0	0	0	(0 - 10.7)
Total	40	0	2	0	0	0	0	(0 - 8.4)

North and Central Coast Seine Dockside Validation Program (Areas 1 to 10)

The North Coast Seine Dockside Validation Program observed a total of 546 seine offloads from seines delivering to plants in Prince Rupert, Port Edward and Port Hardy. An additional 20 seine offloads were observed aboard packers in Prince Rupert Harbour and outside Namu. The program ran continuously from July 14 to September 9, 1999. Approximately 49% of all seines fishing in Areas 1 to 8 were validated and a total of 2,354 coho and 66 steelhead were observed during these offloads, for an overall average of 4.2 coho and 0.1 steelhead per offload. The average number of coho per offload was highest in the Central Coast, particularly in Area 7 (18.1 coho per offload).

Seine Selectivity Grid Study (MV Franciscan No. 1 - Areas 3, 6)

The Seine Selectivity Grid Study was conducted over three days in Area 3 (July 9, 10, and 11) and eight days in Area 6 (July 14 to 16 and 19 to 23). Observers recorded catch and release data from sets using a variety of selectivity grid panels (flexible PVC with

cut-out circles or ovals, and rigid aluminum bars) compared to sets using conventional bunts with no grids. The total number of salmon caught by area and species for sets made using grids and sets made without grids is presented in Table 22.

Table 22. Total number of salmon observed by species with and without seine selectivity grids tested in the 1999 Seine Selectivity Grid Study in Areas 3 (July 9 to 11) and 6 (July 14 to 23). Steelhead and coho to target species (sockeye and pink) ratios are included.

Area	Grid Type	No. of Sets Observed	--- Total number of salmon observed ---										
			Sock	Coho	Pink	Chum	Chin	Chin (Jack)	Stlhd	Stlhd: Sock	Coho: Sock	Stlhd: Pink	Coho: Pink
3	Grid	12	138	57	260	113	14	17	1	0.007	0.413	0.004	0.219
	No Grid	6	16	14	412	280	7	12	0	0	0.875	0	0.034
	Total:	18	154	71	672	393	21	29	1	0.006	0.461	0.001	0.106
6	Grid	29	127	133	747	582	18	25	0	0	1.047	0	0.178
	No Grid	24	211	133	4,896	702	33	25	1	0.005	0.630	0	0.027
	Total:	53	338	266	5,643	1,284	51	50	1	0.003	0.787	0	0.047
All Areas	Total:	71	646	408	6,987	2,070	93	108	3	0.005	0.632	<0.001	0.058

Program Outcomes:

Baltic Net Selectivity Study (Area 3)

Based on the observations of catch and efficacy of use made during the study, it was concluded that the Baltic net and the modified Baltic net were not very effective in catching sockeye and pink, while reducing bycatch or mortalities of non-target species when compared to traditional 60 mesh gillnets. Despite these conclusions, it was also noted the modified Baltic net did provide a high quality salmon product. The condition of target fish that were captured in the Baltic nets was deemed to be superior in market quality to those caught in tradition gillnets. Informal recommendations were made to DFO for further testing of the Baltic nets along with suggested improvements to the study design.

Selective Seine Pink Demonstration Fishery (Areas 4, 5)

The ability of seines to fish selectively near the Skeena River for surplus pink salmon and release all other species with the least amount of harm was deemed successful. Eighteen times more pink salmon were captured when compared to the sum of all other species.

Observed short-term mortality rates for chinook was high (20%). However, this number was based on only one observed mortality out of five chinook captured. Observed short-term mortality rates for sockeye and coho were 6.1% and 2.7%, respectively. No mortalities were observed for chum and steelhead.

North and Central Coast Seine Dockside Validation Program (Areas 1 to 10)

The North and Central Coast Seine Dockside Validation Program was repeated in 1999 in response to ongoing monitoring and enforcement needs by DFO to ensure compliance with “zero” mortality on coho and non-retention, non-possession rules for other restricted species (coho, steelhead, and chinook). The goal of validating 80% of offloads in the North and Central coast seine fisheries was not attained again in 1999 given the program resources and the fact that a large number of deliveries were to packers on the fishing grounds. However, approximately 49% of all the North and Central coast seine offloads were validated by program monitors in port deliveries to Prince Rupert, Port Edward, Port Hardy and Namu.

The number of observed restricted species increased in 1999 when compared to 1998. On average, there were twice as many coho observed per seine offload in 1999 (4.2) compared to 1998 (1.9). Five times as many steelhead were observed per offload in 1999 (0.1) compared to 1998 (0.02).

Seine Selectivity Grid Study (MV Franciscan No. 1 - Areas 3, 6)

Ocean trials and onboard observations made in 1999 helped to evaluate the efficacy of using selectivity grid panels in the bunt of a seine net under normal fishing conditions. Different materials (PVC panels and aluminum bars), opening sizes and shapes (circles, ovals, bars) were also assessed. Observations on catches and releases using different grids also helped to refine the study design and data requirements for future assessments.

2000: North Coast Observer/Monitoring Programs and Selectivity Studies.

Funding Agencies: *Department of Fisheries and Oceans Canada (DFO) – Pacific Salmon Treaty and Selective Fishing Programs.*

Lead Contractor: *J.O. Thomas & Associates Ltd.*

JOT Contract Code(s): *2027A, 3015-1.*

Final Report(s):

- 1. 2000 North Coast Commercial Seine Fishery Chinook and Coho Encounter Rate Observer Program (Areas 1 to 6) (draft in-house summary report only).*
- 2. 2000 Seine Selectivity Grid Study*

Prepared by:

J.O. Thomas and Associates Ltd.

Prepared for:

- 1. DFO, North Coast (Prince Rupert).*
- 2. Paul Brajcich and DFO, North and South Coast Areas.*

Data Availability:

Some raw and summarized electronic data in spreadsheet format and summarized data in unpublished reports.

Background and Fisheries Concerns:

Conservation and protection of upper Skeena River and outer Area 6 coho stocks and promoting selective fisheries throughout British Columbia were primary objectives of the DFO in 2000. Non-retention, non-possession of coho was in effect for all commercial fisheries in Areas 1 to 10. Red and Yellow Zones were used again in 2000 as well as the additional Special Management Zones (SMZs) introduced in 1999 that were used to restrict fishing in locations and during times when upper Skeena coho and other salmon stocks of concern are prevalent. It was also illegal for seines to land coho, chinook and steelhead from all areas and illegal for gillnets to land coho from all areas. Gillnets were requested to release all live steelhead to the water with the least possible harm. In some areas, gillnets were also requested to release all live chinook to the water with the least possible harm.

Mandatory fisher logbooks and daily phone-in reports were introduced for all commercial fisheries in the North and Central Coast. Gear and area specific observer/monitoring programs were implemented for some fisheries as well as observer monitoring of experimental studies using selective fishing methods and gear types. A proposal to conduct further testing of a modified Baltic net was submitted to the DFO Selective Fishing Program in 2000. However, the proposal was not accepted.

Fisheries and Oceans Canada also released a Wild Salmon Policy Discussion Paper on March 15, 2000 and began community discussions with various industry and government

sectors. The primary goals of the Wild Salmon Policy Discussion Paper was to ensure the long-term viability of Pacific salmon populations in natural surroundings, and the maintenance of fish habitat for all life stages for the sustainable benefit of the people of Canada.

Program Objective(s):

One observer/monitoring program requiring third-party observers was contracted by DFO for North Coast seine fisheries in 2000. The program involved at-sea monitoring of salmon catches and the condition at release of bycatch species during scheduled seine fisheries in Areas 3, 4, and 6.

In addition, a selective fishing study using selectivity grid panels in the bunt of salmon seines was accepted by DFO and conducted in select North, Central, and South Coast areas (Areas 3, 4, 6, 12, and 20). This study was expanded from initial ocean trials conducted by Paul Brajcich in 1999 in Areas 3 and 6. Two vessels were involved and observers were mandatory on each vessel. Observer services were contracted and paid for directly by fishermen involved in the study.

In 2000, mandatory fisher logbooks and daily phone-in catch reports were phased in for all commercial troll, gillnet and seine fisheries in all areas.

North Coast Commercial Seine Fishery Chinook and Coho Encounter Rates (Areas 3, 4, and 6)

The signing of the Pacific Salmon Treaty between Canada and the U.S. in 1999 required each country to provide ongoing estimates of non-harvest chinook mortalities in seine fisheries. The North Coast Commercial Seine Fishery Chinook and Coho Encounter Rate Observer Program was implemented by DFO in 2000 to observe bycatch of restricted species (primarily chinook and coho, but also steelhead) by seines fishing in Areas 1 to 6, but not including Areas 2E or 2W or fisheries that took place in September or later. Encounter rates and observations on the physical condition of bycatch species were to be the basis for estimating the total number of mortalities of these species in these fisheries. All seine fisheries in the above areas were required to be monitored by onboard observers with a goal of observing 15% to 20% of the fishing effort (or catch) in each area.

Seine Selectivity Grid Study (Areas 3, 4, and 6)

The purpose of the 2000 Seine Selectivity Grid Study was to gather information and further test the efficacy of eight different seine selectivity grid panels in a variety of different fisheries and conditions. The selectivity grids were constructed using a variety of different materials and opening shapes with the primary objective of allowing smaller

non-target (restricted) species to escape unharmed while retaining target species such as sockeye, pink and chum salmon.

Program Summaries:

North Coast Commercial Seine Fishery Chinook and Coho Encounter Rates (Areas 3, 4, and 6)

The North Coast Commercial Seine Observer Program was conducted from July 22 to August 22, 2000. A total of 293 sets were observed aboard seines fishing in Areas 3, 4, and 6. No seine fisheries were observed in Area 1 and 5. The total number of salmon caught by area and species and resulting bycatch (steelhead, coho) to target species (sockeye, pink) ratios are presented in Table 23.

Table 23. Total number of salmon observed by species and fishery date in the 2000 North Coast Commercial Seine Observer Program (Areas 3, 4, and 6). Steelhead and coho to target species (sockeye and pink) ratios are included.

Area	Number of Sets Observed	--- Total number of salmon observed ---										
		Sock	Coho	Pink	Chum	Chin	Chin (jacks)	Stlhd	Stlhd: Sock	Coho: Sock	Stlhd: Pink	Coho: Pink
3	128	7,220	558	22,933	1,721	72	196	41	0.006	0.077	0.002	0.024
4	47	3,818	106	1,032	56	21	3	7	0.002	0.028	0.007	0.103
6	118	816	1,353	84,014	2,484	13	41	15	0.018	1.658	<0.001	0.016
All Areas	293	11,854	2,017	107,979	4,261	106	240	63	0.005	0.170	0.001	0.019

The physical condition of restricted species at time of release was also assessed and recorded by observers (Table 24). Short-term mortality rates were highest for chinook in Area 4 (23.8%, 95% CI: 10.6% to 45.1%), and especially for chinook jacks in all areas (range: 18.8% to 36.7%, 95% CI: 6.1% to 79.2%). A total of 2,013 coho were caught, of which 1,912 were assessed at time of release. The short-term mortality rate for coho was lowest in Area 6 (0.6%, 95% CI: 0.3% to 1.2%) and highest in Area 3 (9.5%, 95% CI: 7.2% to 12.5%). Only 64 steelhead were caught and observed in the 2000 study, of which only two died in Area 3 and none died in Areas 4 and 6. Due to the relatively low number of steelhead and observed mortalities, short-term mortality rates were low (0 to 5.6%) but with large 95% confidence intervals (Area 3: 1.5% to 18.1%, Area 4: 0 to 25.4%, Area 5: 0 to 21.5%).

Observers also collected tissue and scale samples from bycatch species for DNA and age analysis.

Table 24. Observed physical condition of restricted species at time of release by species and area in the 2000 North Coast Seine Observer Program (Areas 3, 4, and 6). Short-term mortality rate estimates and 95% confidence intervals are presented for each species and area.

Species/Area	Vigorous/ not bleeding	Vigorous/ bleeding	Lethargic/ not bleeding	Lethargic/ bleeding	Dead	Unknown	Mortality Rate (%)	(95% CI)
Coho								
3	311	18	84	6	44	96	9.5	(7.2 - 12.5)
4	80	1	21	2	1	0	1.0	(0.2 - 5.2)
6	1,106	12	217	1	8	5	0.6	(0.3 - 1.2)
Total	1,497	31	322	9	53	101	2.8	(2.1 - 3.6)
Chinook								
3	45	2	3	0	1	19	2.0	(0.3 - 10.3)
4	10	0	6	0	5	0	23.8	(10.6 - 45.1)
6	12	0	1	0	0	0	0	(0 - 22.8)
Total	67	2	10	0	6	19	7.1	(3.3 - 14.6)
Chinook Jack								
3	53	1	13	2	40	73	36.7	(28.2 - 46.1)
4	1	0	0	1	1	0	33.3	(6.1 - 79.2)
6	21	0	5	0	6	8	18.8	(8.9 - 35.3)
Total	75	1	18	3	47	81	32.6	(25.5 - 40.7)
Chum								
3	1	0	0	0	0	0	0	(0 - 79.3)
4	27	0	1	0	0	0	0	(0 - 12.1)
6	564	0	3	0	1	14	0.2	(0 - 1.0)
Total	592	0	4	0	1	14	0.2	(0 - 0.9)
Steelhead								
3	27	3	4	0	2	7	5.6	(1.5 - 18.1)
4	7	0	0	0	0	0	0	(0 - 35.4)
6	12	0	2	0	0	0	0	(0 - 21.5)
Total	46	3	6	0	2	7	3.5	(1.0 - 11.9)

Seine Selectivity Grid Study (Areas 3, 4, and 6)

The Seine Selectivity Study was conducted in the North Coast (Areas 3 and 4) pink and sockeye fishery and the Central Coast (Area 6) pink and chum fishery in July, the Strait of Juan de Fuca (Area 20) sockeye fishery in August, and in the Johnstone Strait (Area 12) chum fishery in October. Two seine vessels were involved in the study, one equipped with grids (experimental) and one without (control). Both vessels fished at the same time in close proximity to each other. Observers were placed on each vessel and recorded catches and sizes of target and non-target species. The number of fish escaping

through the grids on the experimental vessel was also recorded to further assess each grid configuration tested.

Only catch summaries for Areas 3, 4, and 6 are presented in this report (Table 25). Detailed results of the study and assessment of the grids from all study areas can be found in a final report prepared by J.O. Thomas and Associates Ltd. for Paul Brajcich and the DFO (North Coast and South Coast Areas).

Table 25. Total number of salmon observed by species and area from vessels fishing with and without seine selectivity grids in the 2000 Seine Selectivity Grid Study. Steelhead and coho to target species (sockeye and pink) ratios are included.

Area	Gear	No. of Sets Observed	--- Total number of salmon observed ---										
			Sock	Coho	Pink	Chum	Chin	Chin (Jack)	Stlhd	Stlhd: Sock	Coho: Sock	Stlhd: Pink	Coho: Pink
3	Grid	8	77	20	25	34	0	4	0	0	0.260	0	0.800
	No Grid	9	69	35	30	69	6	5	0	0	0.507	0	1.167
	Total:	17	146	55	55	103	6	9	0	0	0.377	0	1.000
4	Grid	42	2,412	75	1,192	350	92	25	1	0	0.031	0.001	0.063
	No Grid	50	2,246	96	998	224	50	20	3	0.001	0.043	0.003	0.096
	Total:	92	4,658	171	2,190	574	142	45	4	0.001	0.037	0.002	0.078
6	Grid	18	156	24	5,205	251	10	36	1	0.006	0.154	<0.001	0.005
	No Grid	20	291	54	6,995	325	17	34	1	0.003	0.186	<0.001	0.008
	Total:	38	447	78	12,200	576	27	70	2	0.004	0.174	<0.001	0.006
All Areas	Total:	147	5,251	304	14,445	1,253	175	124	6	0.001	0.058	<0.001	0.021

Program Outcomes:

North Coast Commercial Seine Fishery Chinook and Coho Encounter Rates (Areas 3, 4, and 6)

Although 297 individual and representative sets were observed aboard seines over a one month period, the goal of sampling 15% of the catch (or effort) in the seine fishery was not fully achieved in 2000. Based on the reported catch of pink salmon by seines in these areas (2,076,050 pieces), it was estimated that approximately 5% of the catch was monitored by direct, third-party observations.

Despite this shortfall, valuable information was recorded regarding encounter rates, estimated mortality rates and biological sample data from bycatch species (chinook, coho, and steelhead) in these fisheries.

Seine Selectivity Grid Study (Areas 3, 4, and 6)

The grid study was conducted on July 1 and 2 in Area 3, July 3 to 9 in Area 4, and from July 11 to 13 in Area 6. As a result of this timing, very few steelhead were caught and observed during the study. However, bycatch of coho was greater, averaging from 1.8 coho per set in Area 4 to 3.2 coho per set in Area 3.

2001: North Coast Observer/Monitoring Programs.

Funding Agencies: *Department of Fisheries and Oceans Canada (DFO) – Pacific Salmon Treaty and Selective Fishing Programs.*

Lead Contractor: *J.O. Thomas & Associates Ltd.*

JOT Contract Code(s): *2027A, 3015-1, 3028-1.*

Final Report(s):

- 1. 2001 North Coast Commercial Seine Fishery Chinook and Coho Encounter Rate Observer Program (Areas 1 to 6) (no data, no report found).*
- 2. 2001 Tooth Tangle Net Study (Unpublished report).*
- 3. 2001 Seine Selectivity Grid Study (Unpublished report).*

Prepared by: *J.O. Thomas and Associates Ltd.*

Prepared for:

- 1. DFO North Coast Area (Prince Rupert).*
- 2. Fred Hawkshaw, and DFO, North Coast Area (Prince Rupert).*
- 3. Capilano Fishing Ltd. (Paul Brajcich), and DFO, North and South Coast Areas.*

Data Availability: *Some raw and summarized electronic data in spreadsheet (Excel) format and summarized data in unpublished reports.*

Background and Fisheries Concerns:

Due to strict conservation measures between 1998 and 2000, upper Skeena coho stocks began to show some early signs of recovery by 2001. However, conservation efforts were continued and fisheries were managed to ensure that the overall Canadian exploitation rate on coho did not exceed 10% in the 2001 season.

In 2001, a new Skeena Sockeye Abundance Based Management Plan was introduced. In past years, Skeena sockeye had been managed using a weekly escapement target for the aggregate of all stocks. Since the early 1980's, concerns for coho and steelhead limited the extent of Skeena sockeye fisheries, resulting in a relatively stable sockeye exploitation in the range of 35 to 70%. This in turn resulted in surplus escapements to the enhanced Pinkut Creek and Fulton River stocks. With the development of effective selective fishing techniques, sockeye exploitation rates became limited to a much lesser extent by concerns for other species. As a result, starting in 2001, management of Skeena sockeye was based on the abundance of wild sockeye. The weekly escapement target (expressed in numbers of adult sockeye) was replaced by a weekly exploitation rate target (expressed as a percentage of the total return).

During the late 1990's several different gillnet studies were conducted in the Pacific Region to develop techniques for more selective and efficient harvesting of salmon. Alaska twist nets with weedlines were tested and accepted for use in several gillnet

fisheries in both the North and South coast areas. In 2001, DFO planned to expand these studies to include areas where they had not yet been used, such as in the Central coast. Other selective gillnet studies using tooth tangle nets were also being considered or conducted in some areas, particularly in the Fraser River and approaches to the Skeena River.

The DFO also implemented mandatory fishing logbooks and daily phone-in catch reports in 2001 for all commercial troll, gillnet and seine salmon fisheries in all areas.

Program Objectives:

Tooth Tangle Net Study (Area 4)

A selective gillnet fishing experiment using tooth tangle nets in a small-scale pilot fishery was proposed to DFO in 2001 by a local gillnetter, Fred Hawkshaw. Mr. Hawkshaw had extensive experience with tooth tangle nets during previous selective fishing studies contracted by DFO from 1997 to 2000. The 2001 study was designed to test a 100 fathom long, 4 inch mesh tooth tangle net with a 2.3:1 hanging ratio to determine if the net could provide live capture of pink and sockeye (target species) coupled with decreased bycatch, and more importantly decreased bycatch mortalities, especially for coho and steelhead. The efficiency of the tooth tangle net was assessed by comparing the catch per effort of sockeye and pink in a test group of five vessels that fished with tooth/tangle nets to that observed in the conventional gillnet fleet fishing with standard 60 mesh gillnets.

The study was also interested in comparing catch and mortality estimates between each individual test vessel to evaluate the ability of fishers to learn and adapt to new fishing gear and techniques.

Seine Selectivity Grid Study (Areas 3, 4, and 6)

The Seine Selectivity Grid Study was resumed for a third year of testing in 2001. The study design was similar to that of the 2000 study except a second vessel equipped with grids was recruited instead of a control vessel. Several new grid panels were also developed for testing based on results seen in the past two studies.

Program Summaries:

Tooth Tangle Net Study (Area 4)

The tooth tangle net study took place near the mouth of the Skeena River (PFMAs 4-12 and 4-15) from July 6 to August 23, 2001. Five Area C (North Coast) licenced gillnet

vessels were granted scientific permits by DFO to be involved in the study. Observers were placed aboard each vessel and recorded set by set catch and release data. Observers evaluated the physical condition of all bycatch species at the time of release. For those fish that died, the possible cause of death was further categorized as net/gear related, predator (seal) related, related to multiple captures, or handling induced.

A total of 2,547 sets were observed over the course of the study. The number of salmon observed by species and bycatch (steelhead, coho) to target (sockeye, pink) species ratios are presented in Table 26.

Table 26. Total number of salmon observed by species the 2001 Tooth Tangle Net Study (Area 4). Steelhead and coho to target species (sockeye and pink) ratios are included.

Area	Number of Sets Observed	--- Total number of salmon observed ---									
		Sock	Coho	Pink	Chum	Chin	Stlhd	Stlhd: Sock	Coho: Sock	Stlhd: Pink	Coho: Pink
4	2,547	34,889	396	4,262	85	415	229	0.007	0.011	0.054	0.093

Observations on physical condition of bycatch species at the time of release and corresponding instantaneous mortality rates by species are presented in Table 27.

Table 27. Observed physical condition of restricted species at time of release by species in the 2001 Tooth Tangle Net Study (Area 4). Short-term mortality rate estimates and 95% confidence intervals are presented for each species.

Species	Vigorous/ not bleeding	Vigorous/ bleeding	Lethargic/ not bleeding	Lethargic/ bleeding	Dead	Unknown	Mortality Rate (%)	(95% CI)
Coho	282	2	3	0	6	8	2.0	(0.9 - 4.4)
Chinook	13	0	1	0	1	20	6.7	(1.2 - 29.8)
Chinook Jack	109	1	2	0	8	3	6.7	(3.4 - 12.6)
Steelhead	114	0	2	0	6	2	4.9	(2.3 - 10.3)

Seine Selectivity Grid Study (Areas 3, 4, and 6)

The Seine Selectivity Grid Study was conducted during July in the mixed stock fisheries in Areas 3, 4, and 6. Two seine vessels were employed to fish with grids in 2001 in order to maximize the number of grid combinations tested and to provide an opportunity to assess the ability of a new crew to adapt to fishing with the grid technology. The study

design required the vessels to fish in close proximity to compare catches and catch efficiency between the two vessels. The number of sets observed and catch by species and area is presented in Table 28 along with bycatch (coho and steelhead) to target species ratios (sockeye and pink).

The study was also conducted in the Strait of Juan de Fuca (Area 20) and in Johnstone Strait (Area 12) in 2001. However, results from tests in these areas are not presented in this report.

Table 28. Total number of salmon observed by species and area from vessels fishing with seine selectivity grids in the 2001 Seine Selectivity Grid Study. Steelhead and coho to target species (sockeye and pink) ratios are included.

Area	No. of Sets Observed	--- Total number of salmon observed ---										
		Sock	Coho	Pink	Chum	Chin	Chin (Jack)	Stlhd	Stlhd: Sock	Coho: Sock	Stlhd: Pink	Coho: Pink
3	23	113	58	106	178	15	42	0	0	0.513	0	0.547
4	87	8,106	143	975	275	91	45	11	0.001	0.018	0.011	0.147
5	4	91	0	11	5	4	10	0	0	0	0	0
6	36	327	182	6,717	1,302	59	109	6	0.018	0.557	0.001	0.027
All Areas	150	8,637	383	7,809	1,760	169	206	17	0.002	0.044	0.002	0.049

Program Outcomes:

Tooth Tangle Net Study (Area 4)

The tooth tangle net was effective in harvesting salmon when compared to the conventional gillnets used in the same fishing area, particularly when considering the abbreviated length and depth of the tooth tangle net. Fish quality of target species was considered to be excellent and low short-term mortality rates were observed for coho, chinook and steelhead.

Seine Selectivity Grid Study (Areas 3, 4, and 6)

All grids used in the study allowed escapement of by-catch species observed under a variety of conditions and in fundamentally different fisheries. However, due to substantial overlaps in fish sizes between target and non-target species, all grids also allowed escape of some target species. No grid clearly outperformed another by releasing large sized bycatch species and retaining small-sized target species simultaneously.

The majority of fish that escaped through the grids were found to be approximately 55 cm or less in length. As a result, selectivity grids most likely perform best in fisheries where the bycatch species are small, such as the Juan de Fuca sockeye fishery that often encounters local schools of feeding juvenile coho. The mixed stock Skeena fishery, where target species and bycatch species are both relatively large adult salmon was not necessarily seen as the best environment for using seine selectivity grids.

2002: North Coast Commercial Seine Fishery Chinook and Coho Encounter Rates Observer/Monitoring Program.

Funding Agencies: *Department of Fisheries and Oceans Canada (DFO) – Pacific Salmon Treaty.*

Lead Contractor: *J.O. Thomas & Associates Ltd.*

JOT Contract Code(s): *2027A.*

Final Report(s): *No reports (data only)*

Prepared by: *J.O. Thomas and Associates Ltd.*

Prepared for: *DFO North Coast Area (Prince Rupert)*

Data Availability: *Some raw and summarized electronic data in MS Access 97 and spreadsheet format and summarized data..*

Program Objectives:

Due to low returns of Nass and Skeena sockeye in 2002, pink salmon returning to the Nass River (Area 3) were the primary target species. As a result, the primary objectives of the observer programs were to monitor and observe the catches of target and non-target species in the Area 3 seine fishery and conduct short-term mortality studies on bycatch species.

Program Summaries and Outcomes:

Observer data was collected from July 15 to August 22, 2002. The majority of observations made during the North Coast Commercial Seine Fishery Chinook and Coho Encounter Rates Observer Program were made in Area 3 (Table 29). A total of 1,034 individual sets were observed of which 1,030 (99.6%) were conducted in Area 3 and only 4 (0.4%) were observed in Area 4.

Table 29. Total number of salmon observed by species and fishery date in the 2002 North Coast Commercial Seine Observer Program (Areas 3 and 4). Steelhead and coho to target species (sockeye and pink) ratios are included.

Area	No. of Sets Observed	--- Total number of salmon observed ---										
		Sock	Coho	Pink	Chum	Chin	Chin (jacks)	Stlhd	Stlhd: Sock	Coho: Sock	Stlhd: Pink	Coho: Pink
3	1,030	7,027	4,050	443,207	7,916	515	285	174	0.025	0.576	<0.001	0.009
4	4	174	27	6,280	74	5	3	7	0.040	0.155	0.001	0.004
All Areas	1,034	7,201	4,077	449,487	7,990	520	288	181	0.025	0.566	<0.001	0.009

Observations on short-term mortality were conducted on a total of 5,066 restricted species; coho, chinook (adult and jacks), and steelhead. The results of these observations are summarized in Table 30. Again, the majority of bycatch species in the 2002 observer program originated in the Area 3 fishery (99.2%) and most bycatch species caught and observed were coho (80.5%). Mortality rates were highest for chinook jacks (16.0%, 95% CI: 11.2% to 22.5%), followed by coho (10.1%, 95% CI: 8.9% to 11.3%), adult chinook (6.4%, 95% CI: 4.4% to 9.3%), and steelhead (0%, 95% CI: 0% to 3.6%).

Table 30. Observed physical condition of restricted species at time of release by species and area in the 2002 North Coast Seine Observer Program (Areas 3 and 4). Short-term mortality rate estimates and 95% confidence intervals are presented for each species and area.

Species/Area	Vigorous/ not bleeding	Vigorous/ bleeding	Lethargic/ not bleeding	Lethargic/ bleeding	Dead	Unknown	Mortality Rate (%)	(95% CI)
Coho								
3	1,404	50	581	23	233	1,759	10.2	(9.0 - 11.5)
4	20	0	6	0	0	1	0	(0 - 12.9)
Total	1,424	50	587	23	233	1,760	10.1	(8.9 - 11.3)
Chinook								
3	275	4	73	8	25	130	6.5	(4.4 - 9.4)
4	1	0	4	0	0	0	0	(0 - 43.4)
Total	276	4	77	8	25	130	6.4	(4.4 - 9.3)
Chinook Jack								
3	93	2	35	3	26	126	16.4	(11.4 - 22.9)
4	1	0	2	0	0	0	0	(0 - 56.1)
Total	94	2	37	3	26	126	16.0	(11.2 - 22.5)
Steelhead								
3	71	1	25	0	0	77	0	(0 - 3.8)
4	4	0	3	0	0	0	0	(0 - 35.4)
Total	75	1	28	0	0	77	0	(0 - 3.6)

2004: Seine Grid Selectivity Study.

Funding Agencies: *Capilano Fishing Co. Ltd. (Paul Brajcich)*
Lead Contractor: *J.O. Thomas & Associates Ltd.*
JOT Contract Code(s): *3015-1.*
Final Report(s): *2004 Seine Selectivity Grid Study*
Prepared by: *J.O. Thomas and Associates Ltd.*
Prepared for: *Capilano Fishing Co.*
Data Availability: *Some raw and summarized electronic data in spreadsheet format and summarized data – unpublished reports.*

Background and Fisheries Concerns:

Funding for most PFAF program initiatives involving observer/monitoring employment opportunities and selective fishing experiments or studies was completed by 2002. As a result, no observer/monitoring programs for salmon net fisheries were conducted in the North Coast from 2003 to 2005. Monitoring of catch and bycatch was continued through mandatory daily phone-in catch reports from fishermen during the season and completed fisher logbooks at the end of the season. A private service provider, Archipelago Marine Research Ltd. (AMR) was hired to collect data from fishers and enter into a regional DFO Fisheries Operations System (FOS) database.

Program Objectives:

Despite the lack of continued funding through the PFAF program, seine selectivity grid studies were continued in 2003 and 2004 with assistance from DFO North and South Coast Areas and privately by Capilano Fishing Co. Ltd., owners of the grid technology. The studies were conducted in Areas 4 (Skeena) and 6 in the North and Central coast and Johnstone Strait (Area 13), the Strait of Juan de Fuca (Area 20), and Barkley Sound/Alberni Inlet (Area 23) in the South Coast.

The primary objective of the study was to conduct further selectivity tests using refined grid panels made of clear flexible polyvinyl chloride (PVC) and dark ethylene propylene diene Monomer (M-class) rubber (EPDM) materials with various size and shape openings conducted in seine fisheries where bycatch issues were of concern.

Program Summary:

Catches observed in the 2004 seine grid study, Areas 4 and 6 are presented in Table 31. The majority of sets were conducted in Area 6 (July 10, 11 and 15, 16). However, 45 sets were conducted on three seines in Area 4 outside the Skeena River on July 13.

Table 31. Total number of salmon observed by species and area from vessels fishing with seine selectivity grids in the 2004 Seine Selectivity Grid Study. Steelhead and coho to target species (sockeye and pink) ratios are included.

Area	No. of Sets Observed	--- Total number of salmon observed ---										
		Sock	Coho	Pink	Chum	Chin	Chin (Jack)	Stlhd	Stlhd: Sock	Coho: Sock	Stlhd: Pink	Coho: Pink
4	45	45	111	1,412	96	19	8	0	0	2.467	0	0.079
6	177	614	290	10,957	996	58	394	4	0.007	0.472	<0.001	0.026
All Areas	222	659	401	12,369	1,092	77	402	4	0.006	0.608	<0.001	0.032

Program Outcomes:

The 2004 study was only conducted for one day in Area 4, and therefore provided very limited information on Skeena coho and steelhead encounter rates. However, the study of seine selectivity grids continued to provide useful, in-situ experimental test data on various grid materials, and sizes and shapes of openings. The results of the studies also continued to show promise in certain fisheries for the unharmed release of bycatch species from seines.

2006: North Coast Observer/Monitoring Programs.

Funding Agencies: *Department of Fisheries and Oceans Canada (DFO).*
Lead Contractor: *J.O. Thomas & Associates Ltd.*
JOT Contract Code(s): *2027.*
Final Report(s): *No reports.*
Data Availability: *Some raw and summarized electronic data in spreadsheet format and summarized data.*

Program Objectives:

The 2006 North Coast Observer/Monitoring Program was designed to monitor and observe catch of target and restricted species as well as document the infestation of sea lice on sockeye caught by seines operating in the commercial sockeye fisheries in Area 3 and 4.

Additional biological sample data was also collected on sockeye including scales for age determination and DNA samples for stock assessment.

Program Summary:

Data was collected by observers aboard seines operating in Areas 3 and 4 from Jul 16 to August 5, 2006. Observers were transported throughout the fishing fleet by zodiac and boarded seines to observe and record catch and release data on a set by set basis. Observations were usually limited to one or two sets per vessel in order to maximize random sampling within the fishing fleet.

A total of 486 individual sets were observed over the course of the program. The number of salmon observed by species and bycatch (steelhead, coho) to target (sockeye, pink) species ratios are presented in Table 32.

Table 32. Total number of salmon observed by species and area in the 2006 North Coast Commercial Seine Observer Program. Steelhead and coho to target species (sockeye and pink) ratios are included.

Area	No. of Sets Observed	--- Total number of salmon observed ---									
		Sock	Coho	Pink	Chum	Chin	Stlhd	Stlhd: Sock	Coho: Sock	Stlhd: Pink	Coho: Pink
3	276	1,155	81	545	499	63	0	0	0.070	0	0.149
4	210	855	25	103	11	6	0	0	0.029	0	0.243
All Areas	486	2,010	106	648	510	69	0	0	0.053	0	0.164

2007: North Coast Commercial Seine Observer Program.

Funding Agencies: *Department of Fisheries and Oceans Canada (DFO).*
Lead Contractor: *J.O. Thomas & Associates Ltd.*
JOT Contract Code(s): *2027.*
Final Report(s): *No reports.*
Prepared by: *J.O. Thomas and Associates Ltd.*
Prepared for: *DFO North Coast Area (Prince Rupert),*
Data Availability: *Some raw and summarized electronic data in spreadsheet format and summarized data.*

Program Objectives:

The 2007 North Coast Commercial Seine Observer Program was designed to monitor and observe catch of target and restricted species as well as document the infestation of sea lice on sockeye, steelhead, and chinook caught by seines operating in the commercial sockeye fisheries in Area 3 and 4.

In addition to counting the number of fish caught and released per set, observers also randomly sampled sockeye, steelhead and chinook and counted the number of sea lice per individual, took tissue samples from sockeye for DNA stock analysis, and scale samples from chinook and chum for determination of age.

No short-term mortality studies on restricted species were conducted.

Program Summary:

Data was collected by observers aboard seines operating in Areas 3 and 4 from July 16 to August 14, 2007. Observers were transported throughout the fishing fleet by zodiac and boarded seines to observe and record catch and release data on a set by set basis. Observations were usually limited to one or two sets per vessel in order to maximize random sampling within the fishing fleet.

A summary of observed catches of target (sockeye, pink) and non-target (coho, chum, chinook, and steelhead) species is presented in Table 33.

Table 33. Total number of salmon observed by species and area in the 2007 North Coast Commercial Seine Observer Program. Steelhead and coho to target species (sockeye and pink) ratios are included.

Area	No. of Sets Observed	--- Total number of salmon observed ---									
		Sock	Coho	Pink	Chum	Chin	Stlhd	Stlhd: Sock	Coho: Sock	Stlhd: Pink	Coho: Pink
3	495	13,656	2,871	94,057	5,593	325	47	0.003	0.210	<0.001	0.031
4	161	4,377	828	37,330	268	73	53	0.012	0.189	0.001	0.022
All Areas	656	18,033	3,699	131,387	5,861	398	100	0.006	0.205	0.001	0.028

2009: Area 3 and 4 Commercial Gillnet and Seine Fishery Observer Program.

Funding Agencies: *Department of Fisheries and Oceans Canada (DFO).*
Lead Contractor: *J.O. Thomas & Associates Ltd.*
JOT Contract Code(s): *2027.*
Final Report(s): *No reports.*
Prepared by: *J.O. Thomas and Associates Ltd.*
Prepared for: *DFO North Coast Area (Prince Rupert),*
Data Availability: *Some raw and summarized electronic data in spreadsheet format and summarized data.*

Program Objectives:

The 2009 North Coast Commercial Gillnet and Seine Fishery Observer Program was designed to monitor and observe catch of target and restricted species as well as document the infestation of sea lice on sockeye, steelhead, and chinook caught by gillnets and seines operating in the commercial sockeye fisheries in Area 3 and 4.

In addition to counting the number of fish caught and released per set, observers also randomly sampled sockeye, steelhead and chinook for the number of sea lice per individual, took tissue samples from sockeye for DNA stock analysis, and scale samples from chinook and chum for determination of age.

Program Summary:

Data was collected by observers aboard gillnets in Area 3 and seines in Areas 3 and 4 from July 6 to August 19, 2009. A summary of observed target and non-target catches by gear, area, and species is presented in Table 34.

Table 34. Total number of salmon observed by species and area in the 2009 Area 3 and 4 Commercial Gillnet and Seine Observer Program. Steelhead and coho to target species (sockeye and pink) ratios are included.

Gear / Area	No. of Sets Observed	--- Total number of salmon observed ---									
		Sock	Coho	Pink	Chum	Chin	Stlhd	Stlhd: Sock	Coho: Sock	Stlhd: Pink	Coho: Pink
Gillnet											
3	148	712	59	1,623	750	9	7	0.010	0.083	0.004	0.036
Seine											
3	299	2,649	738	121,792	2,464	105	24	0.009	0.279	<0.001	0.006
4	178	0	1,325	136,695	302	21	231	--	--	0.002	0.010
Total:	477	2,649	2,063	258,487	2,766	126	255	0.096	0.779	0.001	0.008
All Gears/ Areas	625	3,361	2,122	260,110	3,516	135	262	0.078	0.631	0.001	0.008

All restricted species that were dead on arrival were recorded. Most restricted species that were brought aboard alive were released immediately back into the water without adjudication of physical condition. However, some observations of physical condition of individual live fish that were placed in blue box revival tanks was recorded at the time of release in the Area 3 gillnet fishery (Table 35). Unfortunately, sample sizes from these observations were minimal and therefore estimates of short-term mortality have broad confidence intervals.

Table 35. Observed physical condition of restricted species at time of release by species in the 2009 Area 3 Commercial Gillnet Observer Program. Short-term mortality rate estimates and 95% confidence intervals are presented for each handling method.

	Vigorous/ not bleeding	Vigorous/ bleeding	Lethargic/ not bleeding	Lethargic/ bleeding	Dead	Unknown	Mortality Rate (%)	(95% CI)
Coho								
Blue-boxed	5	0	14	2	8	0	27.6	(14.7 - 45.7)
Other	15	1	2	0	12	0	40.0	(24.6 - 57.7)
Total	20	1	16	2	20	0	33.9	(23.1 - 46.6)
Chinook								
Blue-boxed	0	0	3	0	2	0	40.0	(11.8 - 76.9)
Other	1	0	0	0	0	0	0	(0 - 79.3)
Total	1	0	3	0	2	0	33.3	(9.7 - 70.0)
Chum								
Blue-boxed	4	0	4	0	3	0	27.3	(9.7 - 56.6)
Other	33	0	35	4	5	0	6.5	(2.8 - 14.3)
Total	37	0	39	4	8	0	9.1	(4.7 - 16.9)
Steelhead								
Blue-boxed	2	0	0	0	1	0	33.3	(6.1 - 79.2)
Other	0	0	2	0	2	0	50.0	(15.0 - 85.0)
Total	2	0	2	0	3	0	42.9	(15.8 - 75.0)

SECTION II: SKEENA STEELHEAD BYCATCH AND MORTALITY ESTIMATES

In the following section, data from the various Skeena fisheries observer programs, demonstration fisheries, and selective fishing studies conducted specifically in the Area 3 and 4 gillnet and seine fisheries have been summarized and compiled annually from 1989 to 2009. The estimated number of steelhead and subsequent mortalities are presented only for years when observer data was available. Landed catches of sockeye (and in some cases, pink) and steelhead as reported on sales slips are presented for all strata (year, area, and gear type). From 2001 to 2009, steelhead bycatch (number kept or released) and sockeye and pink catch from fisher phone-in and logbook reports are also included for comparison. It should be noted that due to compliance and timeliness issues with fisher reports, phone-in and logbook data may not be a complete accounting for all vessels that fished. As a result, fisher reported catches (and releases for steelhead) have been expanded to represent the total number of vessels that fished in each strata (source: DFO Pacific Region, Fisheries Operations System (FOS)).

Estimation of Steelhead Bycatch

Steelhead bycatch by gear, area, and year strata were estimated using the standard ratio estimator described by Cochran (1977, p. 151):

$$(1) \quad \hat{Y}_r = \frac{y}{x} X$$

where:

- \hat{Y}_r = ratio estimate of steelhead bycatch in a given stratum
- y = observed steelhead bycatch in a given stratum
- x = observed target species (sockeye or pink) catch (kept and released) in a given stratum
- X = total number of reported target species catch (sockeye or pink) in a given stratum

Labelle (1995) modified this ratio estimator for estimating weekly stratified steelhead bycatch in the 1994 commercial Skeena net fisheries. For our study, we used an identical approach, however, data was pooled yearly for each gear (gillnet, seine, or experimental (i.e. selective)), and area (3 or 4). After adding subscripts for species and strata, Eq. 1 is transformed into an estimator of the total number of steelhead encounters in commercial net fisheries for a given gear, statistical area, and period (in this case, year):

$$(2) \quad \hat{C}_{st} = \sum_G \sum_A \sum_P \frac{c_{st,g,a,p}}{c_{sk,g,a,p}} \cdot S_{sk,g,a,p}$$

where:

- \hat{C}_{st} = estimate of total bycatch of steelhead
- $c_{st,g,a,p}$ = observed bycatch of steelhead by gear (g), area (a), year (p)
- $c_{sk,g,a,p}$ = observed sockeye (or pink: $c_{pk,g,a,p}$) catch (kept and released) by gear (g), area (a), year (p)
- $S_{sk,g,a,p}$ = reported sales slip catch of sockeye (or pink: $S_{pk,g,a,p}$) from sales slips in the corresponding strata

Substitution of sockeye with pink in Equation 2 was also used to estimate steelhead catch in a few cases where sockeye fisheries were not prosecuted in a given strata or where pink were more abundant in the catches than sockeye.

The proportion of observed steelhead ($c_{st,g,a,p}$) to observed target species catch ($c_{sk,g,a,p}$ or $c_{pk,g,a,p}$) may also be replaced in Equation 2 with the proportion of reported fishing effort to observed fishing effort (boatdays fished) and the reported catch of target species from sales slips replaced by observed steelhead bycatch. Substituting fishing effort for observed catches in Equation 2:

$$(3) \quad \hat{C}_{st} = \sum_G \sum_A \sum_P \frac{E_{g,a,p}}{e_{g,a,p}} \cdot c_{st,g,a,p}$$

where:

- \hat{C}_{st} = estimate of total bycatch of steelhead
- $E_{g,a,p}$ = reported fishing effort (boatdays) from sales slips or from DFO fishery officer hauls by gear (g), area (a), year (p)
- $e_{g,a,p}$ = observed fishing effort (boatdays) from sample data by gear (g), area (a), year (p)
- $c_{st,g,a,p}$ = observed steelhead bycatch from sample data in the corresponding strata

In our analysis, one of the three approaches may have been used depending on the available data and fishery dynamics for a given strata.

Given that observer data may not have been available for all weekly catch periods, we chose to pool sample and reported catch data by gear, area, and year. Essentially this was

done to increase sample size and improve the accuracy of the encounter estimates, while simplifying the estimation method to the ratio estimator method described above. Labelle (1995) used a more rigorous approach to estimating steelhead catch, when observer data was unavailable for some weekly catch periods. Observer-based steelhead catch estimates were regressed against the corresponding on-the-grounds hailed estimates for all weekly periods where both data sources existed. The resulting best-fit regression model was used to predict steelhead catch estimates for weeks where observer data was missing. The sum of the observer-based estimates and predicted estimates (for weeks where observer data was missing) provided total annual estimates of steelhead catch for a given area, gear, and year.

Observed catches of sockeye (or pink) were not collected in the Area 4 gillnet fishery sampling programs from 1989 to 1993 (Skeena Packer Sampling Program and Salmonid Mark Recovery Program). Therefore, steelhead encounter estimates for these years are derived from the proportion of the number of boats operating per day from DFO fishery officer hails to the number of boats sampled per day (boatdays), multiplied by the number of steelhead observed in the sampling program(s) (see Equation 3). Most steelhead were kept by gillnet fishermen during these years for ultimate sale or for personal use, and therefore most observed catches would be a close approximation of bycatch. However, it should be noted that bycatch estimates reported in the Area 4 gillnet fishery for these years may be slight underestimates, since steelhead released back into the water or discarded were not observed.

Due to the possibility of uncertainties or biases in the data, 95% confidence intervals are presented for all stratified steelhead bycatch estimates. Confidence intervals for estimates of steelhead bycatch are calculated from the observed steelhead:sockeye (or steelhead:pink) or reported fishing effort:sampled fishing effort ratios for each strata using the Wilson score method for single proportions without continuity correction (Newcombe 1998). Expressions for the lower and upper limits L and U are given as follows:

$$L = \frac{2n\hat{p} + z^2 - z\sqrt{z^2 + 4n\hat{p}q}}{2(n + z^2)}$$

$$U = \frac{2n\hat{p} + z^2 + z\sqrt{z^2 + 4n\hat{p}q}}{2(n + z^2)}$$

where:

z = the $1 - \alpha/2$ point of the standard Normal distribution,

$$\begin{aligned}
 n &= \text{the observed target species catch: } \sum_G \sum_A \sum_P c_{sk,g,a,p} \text{ (for sockeye), or} \\
 &\quad \sum_G \sum_A \sum_P c_{pk,g,a,p} \text{ (for pink), or sampled fishing effort: } \sum_G \sum_A \sum_P e_{g,a,p}, \text{ and} \\
 \hat{p} &= \text{the proportion of observed steelhead to observed sockeye: } \sum_G \sum_A \sum_P \frac{c_{st,g,a,p}}{c_{sk,g,a,p}}, \\
 &\quad \text{or the proportion of observed steelhead to observed pink: } \sum_G \sum_A \sum_P \frac{c_{st,g,a,p}}{c_{pk,g,a,p}}, \\
 &\quad \text{or the proportion of reported to observed fishing effort: } \sum_G \sum_A \sum_P \frac{E_{g,a,p}}{e_{g,a,p}}, \text{ and} \\
 q &= (1 - \hat{p})
 \end{aligned}$$

The resulting 95% confidence intervals for the observed catch sample ratio were multiplied by the reported sockeye (or pink) catch from sales slips using the ratio multiplier described in Equation 2 to give lower and upper 95% confidence intervals for the steelhead bycatch. For cases where no target species catch were observed, the fishing effort ratio (Equation 3) was used. The 95% confidence intervals for the reported to sampled fishing effort were multiplied by the sampled steelhead catch to estimate lower and upper confidence intervals for total steelhead bycatch.

Reported catches of target species (or fishing effort) from sales slips is not generally available for demonstration fisheries or selective fishing gears. For years where observer data was collected from selective fishing gear studies or demonstration fisheries, estimates of steelhead encounters are derived from the observed steelhead:sockeye or steelhead:pink ratios (depending on the target species), and total reported sockeye (or pink) for gillnets or seines in a given area. This was done to allow comparison of the total estimated number of steelhead encounters if the fishery was prosecuted solely as a selective or demonstration fishery compared to the number of steelhead encounters estimated from strictly conventional gillnet and seine gear types.

Estimation of Steelhead Mortalities

Estimates of mortalities are calculated from observations made on instantaneous or short-term (< 6h) mortalities only. No long-term (> 48h) mortality studies on commercially caught Skeena steelhead were conducted in the observer programs or experimental studies reviewed in this report and therefore estimates provided here may underestimate the total number of post-release mortalities that may have resulted from encounters with fishing gear or handling prior to release.

Short-term mortality rates presented in this report were calculated as the proportion of observed steelhead that died to the total number of steelhead observed for a given gear, area and period (year) as follows:

$$(4) \quad \hat{M}_{st} = \sum_G \sum_A \sum_P \frac{X_{st,g,a,p}}{n_{st,g,a,p}}$$

where:

- \hat{M}_{st} = estimated short-term steelhead mortality rate
 $X_{st,g,a,p}$ = number of steelhead observed that died by gear (g), area (a), year (p)
 $n_{st,g,a,p}$ = total number of steelhead observed by gear (g), area (a), year (p)

When available, mortality rates and estimates of steelhead mortalities are provided as 95% confidence interval ranges only and applied to each gear, area, and year strata. Confidence intervals for mortality rates were derived from the proportion of observed steelhead that died to the total number that were observed caught in each strata using the same method used for encounter estimates, substituting \hat{p} for the short-term mortality rate, \hat{M}_{st} . The 95% confidence interval for the total number of steelhead mortalities in a given strata was estimated by multiplying the range of estimated steelhead bycatch by the range of estimated mortality rates.

For strata where mortality estimates were derived from observations made aboard experimental gear or during demonstration (selective) fisheries, the 95% confidence interval represents the lower and upper range of instantaneous steelhead mortalities that may have resulted if all bycatch resulted from using that gear type or fishery method.

Limitations and Uncertainty in the Data

In order to maximize sample sizes, steelhead bycatch and mortality estimates have been stratified and summarized by gear, area, and year. Weekly estimates by gear and area were not conducted. Therefore, it is possible that biases exist in the resulting bycatch or mortality estimates if fisheries were conducted in certain weeks or areas and no concurrent observer data was collected.

In addition to uncertainties that may have resulted from lack of observer data in some areas or weekly periods, there are gaps in the analysis for some gears, areas, or years where observer programs were not implemented. As a result, annual estimates of steelhead encounters or mortalities could not be generated for all gears and areas even though fishing may have occurred in those years.

Results and Discussion

Area 3 Gillnet

Annual reported catches of steelhead and sockeye (or pink) in the Area 3 gillnet fishery are presented in Table 36. Comparisons with steelhead and sockeye (or pink) catches from observer programs, experimental selective fishing studies, or demonstration fisheries conducted in 1994, 1996 to 1999, and 2009 are presented along with estimates of the total bycatch of steelhead in each strata. Short-term observations on mortality in the Area 3 gillnet fishery were only conducted more recently in 2009 and are therefore only available for that year.

In 1994, all observations in the Area 3 gillnet fishery were made aboard vessels fishing with standard 60 mesh gillnets. Approximately 1,757 steelhead were estimated to be caught in this fishery with 95% confidence intervals ranging between 1,113 and 2,768 steelhead.

In 1996, a large number of observations were conducted aboard vessels fishing with standard 60 mesh gillnets and experimental Alaska Twist (60, 90, and 120 mesh) gillnets with weedlines. Observations aboard vessels fishing with standard 60 mesh gillnets indicated they caught about 3 times more steelhead (4,205) compared to vessels fishing with experimental Alaska Twist 60, 90, or 120 mesh gillnets with weedlines (1,395 steelhead). 95% confidence intervals ranged from 3,682 to 4,801 steelhead encounters for standard 60 mesh gillnets, and 1,220 to 1,594 steelhead for Alaska Twist gillnets with weedlines (all depths combined).

In 1998, observations were restricted to vessels fishing with standard 60 mesh gillnets in Area 3. Observations were also limited to 78 individual gillnet sets and less than 0.2% of the reported sockeye catch. Resulting estimates suggested that 8,768 steelhead (95% CI: 5,529 to 13,697) were encountered in this fishery. However, due to the low number of observations, these estimates should be interpreted with caution.

Similarly in 1999, samples sizes from observer data were small. Less than 0.5% of the reported sockeye catch was observed aboard vessels fishing with standard 60 mesh gillnets. The resulting steelhead encounter estimate of 636 steelhead (95% CI: 216 to 1,866) should also be considered with caution. Observations made aboard vessels fishing with the experimental Baltic net in 1999 also provided small sample sizes of both target and non-target species. The low capture efficiency of the net was probably the major factor contributing to small sample sizes and was discussed as a possible drawback to its widespread use. Resulting steelhead bycatch estimates for this gear was estimated as zero with large 95% confidence intervals of zero to 4,210 steelhead. The range of numbers may be more indicative of the number of steelhead that encountered the gear and were not captured. However, data from the study was insufficient to make any

Table 36. Summary of annual reported and observed catches of steelhead and sockeye and estimated total bycatch and short-term (0 to 48h) mortalities of steelhead in the Area 3 gillnet fishery, 1989 to 2009.

Area 3 Gillnet

Year	----- Reported Catch -----										----- Fishery Estimates -----								
	Sales Slips ^a			Fisher phone-ins ^b			Fisher logbooks ^b				Gear	Observed Catch -----			Estimated steelhead bycatch	95% confidence intervals	Estimated mortality rate (95% CI)	Estimated range of steelhead mortalities	Data Source
	Steelhead	Sockeye	Stlhd: Sock	Steelhead	Sockeye	Stlhd: Sock	Steelhead	Sockeye	Stlhd: Sock	Steelhead		Sockeye	Stlhd: Sock	Steelhead					
1989	528	76,767	0.0069	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
1990	492	55,541	0.0089	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
1991	899	170,171	0.0053	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
1992	796	593,474	0.0013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
1993	155	514,882	0.0003	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
1994	43	182,267	0.0002	--	--	--	--	--	--	--	--	18	1,867	0.0096	1,113 - 2,768	--	--	--	JOT
1995	22	429,354	0.0001	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
1996	21	508,934	<0.0001	--	--	--	--	--	--	--	--	216	26,144	0.0083	3,682 - 4,801	--	--	--	JOT
1997	4	250,397	<0.0001	--	--	--	--	--	--	--	--	214	78,096	0.0027	1,220 - 1,594	--	--	--	JOT
1998	0	131,002	0	--	--	--	--	--	--	--	--	17	254	0.0669	5,529 - 13,697	--	--	--	JOT
1999	1	334,106	<0.0001	--	--	--	--	--	--	--	--	3	1,575	0.0019	216 - 1,866	--	--	--	JOT
2000	0	256,784	0	--	--	--	--	--	--	--	--	0	301	0	0 - 4,210	--	--	--	JOT
2001	0	127,645	0	110	96,387	0.0011	104	101,779	0.0010	--	--	--	--	--	--	--	--	--	
2002	0	655,550	0	621	495,743	0.0013	641	497,722	0.0013	--	--	--	--	--	--	--	--	--	
2003	0	567,771	0	605	410,313	0.0015	455	429,282	0.0011	--	--	--	--	--	--	--	--	--	
2004	2	311,088	<0.0001	390	257,814	0.0015	433	263,495	0.0016	--	--	--	--	--	--	--	--	--	
2005	0	161,665	0	174	132,980	0.0013	175	141,330	0.0012	--	--	--	--	--	--	--	--	--	
2006	0	264,040	0	214	235,888	0.0009	264	242,924	0.0011	--	--	--	--	--	--	--	--	--	
2007	0	126,222	0	220	122,736	0.0018	226	130,131	0.0017	--	--	--	--	--	--	--	--	--	
2008	0	44,145	0	119	39,229	0.0030	117	39,236	0.0030	--	--	--	--	--	--	--	--	--	
2009	0	111,686	0	336	105,680	0.0032	358	99,034	0.0036	--	--	7	1,623	0.0043	404 - 1,715	15.8% - 75.0%	64 - 1,286	JOT	

a. DFO Catch Statistics (as of 10-Apr-2010). Includes catch from DFO test fisheries.

b. DFO Fishery Operations System. Reported catch is estimated from actual fisher phone-in and logbook reports of kept and released salmon or steelhead multiplied by DFO estimates of total fishing effort (boats fishing). Data as of 14-Jan-2010 and may be subject to change.

c. Pink used as target species.



conclusions regarding the number of steelhead that may have encountered the net and were not captured (“drop-out”).

No observations were conducted in the Area 3 gillnet fishery from 2000 to 2008. However, in 2009, an observer program was implemented for this area that included short-term mortality estimates for all non-retention species. Although sample sizes were again somewhat limited (0.8% of the reported pink catch), the number of steelhead caught in this fishery was estimated to be 833 (95% CI: 404 to 1,715). Estimated mortality rates from observations in this fishery were high and ranged from 15.8% to 75.8%.

Total annual reported steelhead bycatch from fisher phone-in or logbook reports have ranged from 104 in 2001 to 641 in 2002. The average annual number of encounters reported by fishers in the Area 3 gillnet fishery during the last decade (2001 to 2009) is estimated to be about 300 steelhead per year. The only comparison available for fisher reports and third-party observer reports was for the 2009 study year. Fisher reports indicated approximately 336 (phone-ins) to 358 (logbooks) steelhead encounters compared to observer estimates of 833 steelhead with a 95% CI of 404 to 1,715. However, it should be noted that observer estimates in 2009 were based on a very small sample size and may not be truly representative of the fishery.

Area 3 Seine

Observer programs were conducted in the Area 3 seine fishery in 1994, 1997, 1998, 2000, 2002, 2006, 2007 and 2009.

Annual reported catches of steelhead and sockeye in the Area 3 seine fishery are presented in Table 37 along with comparisons of steelhead and sockeye catches recorded from observer programs. In 1998 and 2009, sockeye fisheries were limited in Area 3 and pink catches are presented as the target species. Estimates of the total number of steelhead encounters are calculated for all of the above years. Resulting ranges of mortalities are presented for 2000 and 2002 when short-term mortality observations were available for steelhead.

With the exception of 2002, historical steelhead:sockeye ratios in the Area 3 seine fishery appear to have been relatively stable over the last two decades. Steelhead:sockeye ratios range from 0.003 to 0.006 for years 1994, 1997, 2000, 2006, and 2007 and <0.001 to 0.002 for steelhead:pink ratios in 1998 and 2009.

Encounter estimates have ranged from a low of 84 in 2009 to a high of 2,904 in 1997 and have averaged a little over 750 steelhead per year (95% CI: 559 to 1,066).

Observations on short-term mortality of steelhead conducted in 2000 and 2002 estimated mortality rates with 95% confidence intervals of 1.5% to 18.1% and 0 to 3.8%,

*Steelhead Bycatch and Mortalities in the Commercial Skeena Net Fisheries of
British Columbia from Observer Data: 1989 to 2009*

Table 37. Summary of annual reported and observed catches of steelhead and sockeye and estimated total bycatch and short-term (0 to 48h) mortalities of steelhead in the Area 3 seine fishery, 1989 to 2009.

Area 3 Seine

Year	----- Reported Catch -----						----- Observed Catch -----			----- Fishery Estimates -----				Data Source		
	Sales Slips ^a		Fisher phone-ins ^b		Fisher logbooks ^b		Gear	Steelhead	Sockeye	Stlhd: Sock	Estimated steelhead bycatch	95% confidence intervals	Estimated mortality rate (95% CI)		Estimated range of steelhead mortalities	
	Steelhead	Sockeye	Stlhd: Sock	Steelhead	Sockeye	Stlhd: Sock										Steelhead
1989	730	365,961	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--
1990	355	156,623	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--
1991	867	718,072	0.001	--	--	--	--	--	--	--	--	--	--	--	--	--
1992	514	399,035	0.001	--	--	--	--	--	--	--	--	--	--	--	--	--
1993	207	836,095	<0.001	--	--	--	--	--	--	--	--	--	--	--	--	--
1994	95	166,390	0.001	--	--	--	Seine	101	19,398	0.005	866	713 - 1,052	--	--	JOT	--
1995	18	1,042,367	<0.001	--	--	--	--	--	--	--	--	--	--	--	--	--
1996	9	535,657	<0.001	--	--	--	--	--	--	--	--	--	--	--	--	--
1997	7	332,089	<0.001	--	--	--	Seine	10	2,100	0.005	1,581	860 - 2,904	--	--	JOT	--
1998	0	23,429	<0.001	--	--	--	--	--	--	--	--	--	--	--	--	--
1999	0	82,126	<0.001	--	--	--	--	--	--	--	--	--	--	--	--	--
2000	0	114,400	0	--	--	--	Seine (includes control from Grnd study)	41	7,289	0.006	643	475 - 872	1.5% - 18.1%	7 - 158	JOT	--
2001	0	85,385	0	--	--	--	--	--	--	--	--	--	--	--	--	--
2002	0	56,820	0	731	48,321	0.015	Seine	181	7,201	0.025	1,428	1,237 - 1,648	0% - 3.8%	0 - 63	JOT	--
2003	0	77,243	0	334	57,842	0.006	--	367	57,727	0.006	--	--	--	--	--	--
2004	0	171,981	0	745	162,472	0.005	--	789	161,873	0.005	--	--	--	--	--	--
2005	0	42,177	0	285	49,266	0.006	--	305	51,156	0.006	--	--	--	--	--	--
2006	0	47,325	0	187	44,785	0.004	Seine	185	43,434	0.004	207	138 - 311	--	--	JOT	--
2007	0	126,986	0	613	119,005	0.005	Seine	606	114,906	0.005	437	329 - 581	--	--	JOT	--
2008	0	6,749	0	57	5,356	0.011	--	58	5,408	0.011	--	--	--	--	--	--
2009	0	9,724	0	135	14,686	0.009	--	124	14,668	0.008	--	--	--	--	--	--
Year	----- Reported Catch -----						----- Observed Catch -----			Gear	Estimated total no. of steelhead encounters	95% confidence intervals	Estimated mortality rate (%)	Estimated total no. of steelhead mortalities	Data Source	
	Sales Slips ^a		Fisher phone-ins ^b		Fisher logbooks ^b		Steelhead	Pink	Stlhd: Pink							
	Steelhead	Pink	Stlhd: Pink	Steelhead	Pink	Stlhd: Pink				Steelhead	Pink	Stlhd: Pink				
1998	0	416,301	0	--	--	--	Seine	37	16,612	0.002	927	673 - 1,277	--	--	JOT	--
2009	0	635,767	0	--	872,301	<0.001	Selective Seine	110	72,194	0.002	634	526 - 764	--	--	JOT	--
				135			Seine	24	121,792	<0.001	125	84 - 186	--	--	JOT	--

a. DFO Catch Statistics (as of 10-Apr-2010). Includes catch from DFO test fisheries.

b. DFO Fishery Operations System. Reported catch is estimated from actual fisher phone-in and logbook reports of kept and released salmon or steelhead multiplied by DFO estimates of total fishing effort (boats fishing). Data as of 14-Jan-2010 and may be subject to change.

c. Pink used as target species.



respectively. Large confidence intervals in 2000 were the result of a relatively small sample (41 steelhead caught and observed, of which 2 died).

Observations made aboard seines in conventional fisheries and seines fishing in selective demonstration fisheries were made during the 1998 observer program. Both of these fisheries primarily targeted pink salmon due to average returns of sockeye to the Nass River and poor returns of sockeye to the Skeena River. Steelhead: pink ratios were slightly less in the selective fishery (0.0015) compared to those observed in the conventional seine fishery (0.0022). Estimates of steelhead bycatch in Area 3 using selective seine methods was 634 (95% CI: 526 to 764), compared to 927 (95% CI: 673 to 1,277) for the conventional seine fishery.

Total annual reported steelhead bycatch from fisher reports have ranged from 57 in 2008 to 789 in 2004. The average number of steelhead captured and released and reported by fishers during the last decade is approximately 400 annually in the Area 3 seine fishery. Comparisons between fisher reports and third-party observer estimates are available for 2002, 2006, 2007, and 2009. Steelhead bycatch estimates made from observer data in 2002 suggested almost twice as many caught and released than reported by fishers (1,428 steelhead estimated from observer data compared to 731 to 747 steelhead from fisher reports). However, for subsequent comparative years: 2006, 2007, and 2009, fisher reports and third-party observer data for steelhead encounters were similar.

Area 4 Gillnet

Extensive observer coverage of the Area 4 gillnet fishery began in 1989 and continued in each year through to 1997. In the late 1990s and early 2000s, selective fishing studies and practices were being tested extensively. Results and recommendations made from from some of these studies, and in particular studies with weedlines, have been implemented into this fishery. It is generally considered that these measures along with a smaller gillnet fleet and changes to the timing of these fisheries, has helped to protect weaker Skeena stocks, in particular, steelhead and upper Skeena coho stocks.

There have been no dedicated at-sea observer programs in this fishery since 2001.

Reported catches of steelhead and sockeye and estimated bycatch and mortalities of steelhead in the Area 4 gillnet fishery from 1989 to 2009 are presented in Table 38.

From 1989 to 1992, most steelhead caught in the Area 4 gillnet fishery were kept and sold by fishermen. However, independent reports at the time indicated that many of the steelhead sold by fishermen were being recorded on sales slips as coho. Independent estimates of steelhead catch derived from observations of gillnet steelhead catch and fishing effort landed and sampled on packers or shore-based processing plants and hailed fishing effort (Equation 3), suggested that actual steelhead catch was anywhere from 1.5 to 5 times higher than reported (J.O. Thomas and Associates Ltd. 1991, 1992). An

*Steelhead Bycatch and Mortalities in the Commercial Skeena Net Fisheries of
British Columbia from Observer Data: 1989 to 2009*

Table 38. Summary of annual reported and observed catches of steelhead and sockeye and estimated total bycatch and short-term (0 to 48h) mortalities of steelhead in the Area 4 gillnet fishery, 1989 to 2009.

Area 4 Gillnet

Year	Reported Catch -----						Observed Catch -----			Fishery Estimates -----				Data Source				
	Sales Slips ^a		Fisher phone-ins ^b		Fisher logbooks ^b		Steelhead	Sockeye	Silhd: Sock	Gear	Steelhead	Sockeye	Silhd: Sock		Estimated steelhead bycatch	95% confidence intervals	Estimated mortality rate (95% CI)	Estimated range of steelhead mortalities
	Steelhead	Sockeye	Silhd: Sock	Sockeye	Steelhead	Sockeye												
1989	3,075	609,492	0.0050	--	--	--	1,689	--	Standard 60 mesh	1,689	--	--	5,472	5,292 - 5,661	--	--	JOT	
1990	6,656	806,236	0.0083	--	--	--	3,057	--	Standard 60 mesh	3,057	--	--	10,622	10,300 - 10,959	--	--	JOT	
1991	3,079	946,123	0.0033	--	--	--	1,915	--	Standard 60 mesh	1,915	--	--	7,828	7,578 - 8,089	--	--	JOT	
1992	1,454	1,525,774	0.0010	--	--	--	1,691	--	Standard 60 mesh	1,691	--	--	7,189	6,948 - 7,442	--	--	JOT	
1993	462	1,580,203	0.0003	--	--	--	62	5,418	Standard 60 mesh	62	5,418	0.0114	17,460	13,636 - 22,340	60.4% - 82.1%	8,237 - 18,345	MoE	
1994	210	651,311	0.0003	--	--	--	465	--	Standard 60 mesh	465	--	--	1,406	1,369 - 1,444	--	--	JOT	
1995	87	1,363,959	0.0001	--	--	--	152	11,788	Standard 60 mesh	152	11,788	0.0129	8,398	7,171 - 9,832	55.3% - 70.0%	3,966 - 6,882	JOT	
1996	231	2,500,500	0.0001	--	--	--	58	5,596	Alaska Twist 90	58	5,596	0.0104	6,751	5,228 - 8,711	38.4% - 49.0%	2,007 - 6,010	JOT	
1997	31	1,025,998	<0.0001	--	--	--	64	9,284	Standard 60 mesh	64	9,284	0.0069	9,403	7,369 - 11,993	--	--	JOT	
1998	806	93,994	0.0086	--	--	--	103	16,577	Standard 60 mesh	103	16,577	0.0062	15,537	12,818 - 18,827	--	--	JOT	
1999 ^f	100	5,506	0.0182	--	--	--	163	28,250	Alaska Twist 90, 19 Gauge	163	28,250	0.0058	14,428	12,381 - 16,810	--	--	JOT	
2000	3	1,337,788	<0.0001	--	--	--	11	37,384	Standard 60 mesh	11	37,384	0.0003	302	169 - 541	--	--	JOT	
2001	2	1,459,418	<0.0001	2,568	1,487,155	0.0017	2,300	1,513,720	Alaska Twist 90	2	17,883	0.0001	115	31 - 418	--	--	JOT	
2002	7	494,294	<0.0001	3,526	546,997	0.0064	3,742	539,684	Tooth Tangle Net	229	34,889	0.0066	9,579	8,419 - 10,897	2.3% - 10.3%	194 - 1,122	JOT	
2003	0	377,294	0	533	374,006	0.0014	588	363,543		--	--	--	--	--	--	--	--	
2004	0	129,613	0	723	123,592	0.0059	745	125,644		--	--	--	--	--	--	--	--	
2005 ^c	0	0	--	0	0	0	0	0		--	--	--	--	--	--	--	--	
2006	170	646,706	0.0003	3,274	720,258	0.0045	3,727	757,017		--	--	--	--	--	--	--	--	
2007	340	331,329	0.0010	814	366,565	0.0022	791	369,221		--	--	--	--	--	--	--	--	
2008	761	508,334	0.0015	119	15,584	0.0076	116	15,450		--	--	--	--	--	--	--	--	
2009	128	4,844	0.0264	67	122	0.5493	79	110		--	--	--	--	--	--	--	--	

a. DFO Catch Statistics (as of 10-Apr-2010). Includes catch from DFO test fisheries.

b. DFO Fishery Operations System. Reported catch is estimated from actual fisher phone-in and logbook reports of kept and released salmon or steelhead multiplied by DFO estimates of total fishing effort (boats fishing). Data as of 14-Jan-2010 and may be subject to change.

c. No gillnet fishery in Area 4.



observer program conducted by the MoE in 1992, suggested that the number of encounters that included both kept and released steelhead was up to 12 times the reported (kept) catch and short-term mortalities of released steelhead were also very high (95% CI: 60.4% to 82.1% mortality) (Beere 1992).

By 1993, DFO had implemented non-retention restrictions on the gillnet fleet to reduce landings of steelhead. Estimates of reported catches by independent observer programs indicated small reductions in the number of steelhead being kept by fishermen compared to previous years. Approximately 1,406 (95% CI: 1,369 to 1,444) steelhead were estimated to have been landed in the fishery compared to 462 reported landed on sales slips.

Despite some modest reductions in the estimated number of steelhead landed by fishermen, at-sea observer programs and selective gear studies from 1994 to 1996 indicated that steelhead catches in the fishery were still relatively high (approximately 1 steelhead per 100 sockeye caught) with fishery estimates ranging from 5,228 in 1994 (lower 95% CI) to 18,827 in 1996 (upper 95% CI).

During 1994, 1996 and 1997, studies with experimental gillnets (Alaska Twist 90 mesh depths with weedlines and 19 gauge webbing) were conducted to determine their effectiveness in reducing steelhead encounters and mortalities. Encounter estimates and short-term mortality ranges from the data collected revealed only minor differences between the standard 60 mesh depth gillnets and the experimental Alaska Twist gillnets with various depths. New conservation issues for upper Skeena coho in the late 1990s, coupled with observations of increased catches of coho in the Alaska Twist 90 mesh gillnets sidelined further study and use of these gillnets in this fishery.

Beginning in 1998, the Area 4 gillnet fishery was severely restricted due to concerns for upper Skeena coho stocks. The fishery was closed by mid July to protect these stocks and no observer programs were implemented for this fishery. In 1999, no sockeye or pink directed net fisheries were conducted in Area 4 due primarily to ongoing concerns for upper Skeena coho as well as expected low returns of sockeye. In 2000, gillnet fisheries resumed historical timing, however, a number of selective fishing methods and strategies were permanently implemented to reduce the impacts of gillnets on weaker Skeena stocks, especially steelhead and coho. Some of these practices included fishing only with standard 60 mesh gillnets with weedlines, daylight fishing only, mandatory revival tanks, and release of all bycatch species of concern with the least amount of harm.

In 2001, a selective fishing study was conducted and observed using an experimental tooth tangle net. Results from this study indicated that encounters were still high (estimated encounters of 9,579 steelhead, 95% CI: 8,419 to 10,897) when this type of net was used in this area. For comparison, conventional Area 4 gillnetters reported anywhere from 2,300 to 2,600 steelhead encounters from phone-in and logbook reports in 2001. However, short-term mortality estimates using tooth tangle nets were considerably

reduced over previous observations aboard standard or experimental gillnets. 95% confidence intervals for mortality estimates ranged from 2.3% to 10.3% using the tooth tangle net (J.O. Thomas and Associates Ltd. 2001) compared to previous estimates of 38.4% using Alaska Twist 90 gillnets with weedlines from the 1994 study (J.O. Thomas and Associates Ltd. 1994) to a high of 82.1% using standard 60 mesh gillnets in the 1992 MoE observer study (Beere 1992).

Since 2001, there has been no at-sea observer coverage in the Area 4 gillnet fishery. Fisher phone-in and logbook reports have indicated varying numbers of steelhead captures, ranging from less than 80 steelhead in 2009 to highs of over 3,700 in 2002 and 2006 (DFO - Fisheries Operation System (FOS)). The trend in steelhead bycatch in this fishery appears to be going down since 2006, probably due in part to reduced gillnet fishing opportunities in this area during July and August when the majority of steelhead are present. However, concurrent independent third-party observations are not available for direct comparison.

Area 4 Seine

At-sea observations of steelhead bycatch aboard seines operating in Area 4 began in 1995 when limited “Special Seine” fisheries were introduced for this area. Observations in this fishery continued in 1996 and 1997 with the addition of observations in the conventional seine fishery in Area 4 in 1997.

The Area 4 sockeye seine fishery was closed in 1998 and 1999. However, a small scale, selective pink demonstration seine fishery was allowed to take place in 1999 with observers onboard. In 2000, observations resumed in the conventional seine fishery as well as observations made aboard seines using selective grid panels. In 2001, observations were restricted to the selective grid study only. No observer programs were implemented in the Area 4 seine fishery from 2002 to 2004, and the seine fishery was closed in 2005. Observations resumed in 2006, 2007, and 2009.

A summary of reported catches of steelhead and sockeye (and pink for 1999 and 2009) and estimates of bycatch and number of mortalities are presented in Table 39.

In the Special Seine fishery from 1995 to 1997, observations suggest there were approximately 3,325 (95% CI: 2,966 to 3,727) steelhead caught in 1995, increasing to 17,658 (95% CI: 16,075 to 19,393) in 1996 and then decreasing to 1,749 (95% CI: 1,581 to 1,934) in 1997.

Estimates in the conventional Area 4 seine fishery in 1997, suggested fewer steelhead captures (951 with 95% CI: 816 to 1,107) than those estimated for the Special Seine fishery (1,749 with 95% CI: 1,581 to 1,934).

In 1999, the only seine fishery allowed to operate in Area 4 was a limited, Selective Pink

*Steelhead Bycatch and Mortalities in the Commercial Skeena Net Fisheries of
British Columbia from Observer Data: 1989 to 2009*

Table 39. Summary of annual reported and observed catches of steelhead and sockeye and estimated total bycatch and short-term (0 to 48h) mortalities of steelhead in the Area 4 seine fishery, 1989 to 2009.

Area 4 Seine

Year	----- Reported Catch -----										----- Fishery Estimates -----					Data Source				
	Sales Slips ^a			Fisher phone-ins ^b			Fisher logbooks ^b				Gear	Observed Catch -----			Estimated steelhead bycatch		95% confidence intervals	Estimated mortality rate (95% CI)	Estimated range of steelhead mortalities	
	Steelhead	Sockeye	Sthhd: Pink	Steelhead	Sockeye	Sthhd: Pink	Steelhead	Sockeye	Sthhd: Pink	Steelhead		Sockeye	Sthhd: Pink							
1989	109	12,894	0.0085	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
1990	39	21,672	0.0018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
1991	68	45,207	0.0015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
1992	106	129,436	0.0008	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
1993	24	103,553	0.0002	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
1994 ^c	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
1995	3	315,503	<0.0001	--	--	--	--	--	--	--	--	291	27,613	0.0105	3,325	2,966 - 3,727	--	--		
1996	48	946,892	0.0001	--	--	--	--	--	--	--	--	428	22,951	0.0186	17,658	16,075 - 19,393	1.2% - 7.9%	193 - 1,532		
1997	31	98,406	0.0003	--	--	--	--	--	--	--	--	370	20,821	0.0178	1,749	1,581 - 1,934	0.4% - 2.8%	6 - 54		
1998 ^c	--	--	--	--	--	--	--	--	--	--	--	163	16,871	0.0097	951	816 - 1,107	--	--		
1999 ^c	0	4,880	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
2000	0	694,349	0	--	--	--	--	--	--	--	--	10	6,064	0.0016	1,145	622 - 2,106	0% - 35.4%	0 - 746		
2001	2	501,938	<0.0001	3,300	557,141	0.0059	3,427	549,457	0.0062	--	--	1	2,412	0.0004	288	51 - 1,628	--	--		
2002	0	53,856	0	2,741	100,277	0.0273	2,567	88,262	0.0291	--	--	--	--	--	--	--	--	--		
2003	0	88,192	0	1,555	73,792	0.0211	1,498	77,688	0.0193	--	--	--	--	--	--	--	--	--		
2004	0	23,691	0	593	30,489	0.0195	604	31,518	0.0192	--	--	--	--	--	--	--	--	--		
2005 ^c	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
2006	0	225,097	0	1,608	285,608	0.0056	1,766	285,141	0.0062	--	--	18	4,945	0.0036	819	519 - 1,294	--	--		
2007	0	17,921	0	635	36,076	0.0176	595	35,097	0.0169	--	--	53	4,377	0.0121	217	166 - 283	--	--		
2008	0	204,542	0	1,785	136,999	0.0130	1,838	132,163	0.0139	--	--	--	--	--	--	--	--	--		
2009	0	11	0	424	0	--	411	0	--	--	--	--	--	--	--	--	--	--		
Year	Steelhead	Sockeye	Sthhd: Pink	Steelhead	Sockeye	Sthhd: Pink	Steelhead	Sockeye	Sthhd: Pink	Steelhead	Sockeye	Sthhd: Pink	Steelhead	Sockeye	Sthhd: Pink	Estimated total no. of steelhead encounters	95% confidence intervals	Estimated mortality rate (%)	Estimated total no. of steelhead mortalities	Data Source
1999	0	302,855	0	--	--	--	--	--	--	--	--	23	9,086	0.0025	767	511 - 1,150	0% - 8.4%	0 - 97	JOT	
2009	0	464,231	0	424	304,060	0.0014	411	363,115	0.0011	--	--	231	136,695	0.0017	785	690 - 892	--	--	JOT	

a. DFO Catch Statistics (as of 10-Apr-2010). Includes catch from DFO test fisheries.
 b. DFO Fishery Operations System. Reported catch is estimated from actual fisher phone-in and logbook reports of kept and released salmon or steelhead multiplied by DFO estimates of total fishing effort (boats fishing). Data as of 14-Jan-2010 and may be subject to change.
 c. No seine fishery in Area 4.
 d. Pink used as target species.



Demonstration fishery. Observations from this fishery indicated that approximately 767 steelhead (95% CI: 511 to 1,150) were caught.

In 2000, comparisons with observations made in the conventional seine fishery and those observed aboard seines fishing with selectivity grids suggest that encounters were about four times higher for the conventional seine compared to seines fishing with grids. However, fewer days fishing and fewer overall observations aboard the seines fishing with selectivity grids may partially explain differences seen in overall encounters. In 2001, only observations aboard seines fishing with selectivity grids were conducted. Steelhead to sockeye ratios from this study were similar to those witnessed in the 2000 conventional seine fishery, suggesting that steelhead encounter rates were not necessarily affected by differences between gear types.

In 2006 and 2007, observations made aboard seines fishing in Area 4 provided bycatch estimates of 819 (95% CI: 519 to 1,294) and 217 (95% CI: 166 to 283) steelhead, respectively. A total of 231 steelhead were physically observed by onboard observers in 2009. Estimates for this fishery totaled 785 steelhead encounters (95% CI: 690 to 892).

Reported encounters with steelhead from fisher phone-in and logbook reports have varied from a high of approximately 3,427 in 2001 to a low of approximately 411 more recently in 2009. Steelhead to sockeye ratios have varied from a low of approximately six steelhead per 1,000 sockeye caught in 2001 and 2006 to a high of 29 steelhead per 1,000 sockeye caught in 2002. Steelhead to sockeye ratios from fisher reports over the last decade has suggested capture ratios of approximately 10 steelhead per 1,000 sockeye.

Short-term mortality rates for steelhead were estimated in the Area 4 Special Seine fisheries in 1996 and 1997, the Area 4 Pink Demonstration fishery in 1999, and the conventional seine fishery in 2000. Most estimates have indicated mortality rates less than 10% with 95% confidence intervals ranging from zero in 1999 and 2000 up to 35.4% in 2000. However, it should be noted that the low mortality rate of zero and high upper 95% CI mortality rate of 35.4% seen in 2000 may be explained by a very low sample size for that year. Only seven steelhead were observed for short-term mortality estimates and none died prior to release. No short-term mortality studies have been incorporated in seine observer programs in Area 4 since 2000.

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