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A Description of Escaped Farmed Atlantic Salmon *Salmo salar* Captures and Their Characteristics in One Pacific Salmon Fishery Area in British Columbia, Canada, in 2000

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ABSTRACT: Since 1995, the Canadian salmon farming industry as a whole has reported losing an average of 46,255 Atlantic salmon *Salmo salar* annually into the coastal waters of British Columbia. While the number of fish lost is arguably much higher, it is unarguable that the fate of these fish is largely unknown. This study was conducted on the fishing grounds of British Columbia by contacting commercial fishers frequently via VHF radio and boat visits. Atlantic salmon were collected directly from fishers, packers, and a processing plant. The goal of this project was to enumerate the number of Atlantic salmon caught by commercial fishers in Pacific Management Area 12, a region of intense salmon farm activity. Further, we wished to examine the condition of these escaped farm salmon to aid managers in determining their ability to survive in the wild. A total of 10,826 Atlantic salmon were caught in the 17 days of open fishing periods during this study, August 2, 2000 through September 22, 2000, by troll, seine, and gillnet gear. The mean fork length and weight of the sampled Atlantic salmon were 75.0 cm (±5.1 cm) and 4.8 kg (±1.3 kg), respectively. Autopsies on 775 whole or partial Atlantic salmon found identifiable stomach contents in 3.9% of the sample overall, and up to 24.4% at some sampling locations. Eighteen fish (2.3%) showed signs of sexual maturity. One group of escaped Atlantic salmon was sampled weekly over a fourteen-day interval, days 1, 8, 14, and an increase in foraging success was recorded. Gillnets were the most successful gear type in recovering escaped farm salmon. The present passive reporting system of Fisheries and Oceans Canada underestimates Atlantic salmon escapes. This study recorded 40.8% more Atlantic salmon caught in the 8 week study period in Pacific Management Area 12 by commercial fishers than the federal Fisheries and Oceans Canada's passive monitoring program.

INTRODUCTION

One of the least understood of the world's major environmental issues is the movement and eventual establishment of species beyond their native range (Cohen and Carlton 1998). In contrast to other significant environmental problems such as urbanization and pollution, 'biotic invasions' mean that living organisms are the threat. Invading species independently reproduce, grow, and spread, all the while adapting to and altering their new environment. The introduction of exotic species is the greatest threat to global biodiversity after habitat loss and is estimated to cost U.S. citizens $138 billion per year and is rising (Pimental et al. 2001). Alarmingly, 68% of recent freshwater fish extinctions from Canada to Mexico are attributed to introduced species (Stein and Flack 1996). A survey of 31 studies on fish introductions in Europe, North America, Australia, and New Zealand found 77% of introductions resulted in native fish population declines and half of these were due to the introduction of a non-native salmon species (Ross and Brenneman 1991).

Wild Pacific salmon *Oncorhynchus* spp. are a crucial resource in Alaska and are responsible for 47% of the private sector jobs. In 2000, wild Alaska salmon landings earned $288 million (ADF&G 2001b). Sixty percent of all seafood from North America is harvested in Alaska, including 217 million salmon (ADF&G 2002b). Given the importance of salmon to the Alaskan economy and the history of negative impacts caused by biotic invasions, the number and fate of Atlantic salmon escaped from British Columbia (B.C.) farms must be examined.

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Since its introduction to Pacific Ocean waters for the purpose of commercial culture in 1984, Atlantic salmon *Salmo salar* has grown to dominate salmon production in B.C. In 2000, approximately 8,665 mt of sockeye salmon *Oncorhynchus nerka*, 7,158 mt of pink salmon *O. gorbuscha*, 2,783 mt of chum salmon *O. keta*, 506 mt of chinook salmon *O. tshawytscha*, and 31 mt of coho salmon *O. kisutch* were landed. The total B.C. wild production of Pacific salmon *Oncorhynchus* spp. of less than 20,000 mt was considerably less than the 35,680 mt of Atlantic salmon (81% of total farm salmon production) that were produced in 2000 (FOC 2002, BCSFA 2002). The economic domination of farm salmon over wild salmon could predispose B.C. fishery managers to take a more lenient position on the definition of acceptable risk to wild stocks by cultured fish production.

The first documented recovery of a cultured Atlantic salmon in a B.C. fishery was in 1987, and by 1995 an additional 6,725 had been reported, most from the Johnstone Strait area (McKinnell et al. 1997; Figure 1). In 1991, the Atlantic Salmon Watch Program (ASWP), was created by Fisheries and Oceans Canada (FOC, formerly the Department of Fisheries and Oceans DFO) and the B.C. Ministry of Agriculture, Food and Fisheries, to monitor the presence of Atlantic salmon in B.C. coastal streams. In 1992, ASWP was further expanded to gather information and specimens caught in salt water using mail-outs, phone calls, and a poster campaign (McKinnell et al. 1997). Since 1992, B.C. commercial, sport, and native fishers have been requested to voluntarily report Atlantic salmon captures and sightings to ASWP. In addition, commercial fishers have the opportunity to report Atlantic salmon when they hail their catches to FOC patrolmen, but this is not mandatory and so reporting of these catch data is at the discretion of the individual fisher and patrolman (G. Neidrauer, Fisheries and Oceans Canada, Echo Bay, B.C., personal communication).

The ASWP reports that from 1991– 2001, an estimated 396,522 Atlantic salmon escaped from salmon farms (ASWP 2002), averaging 46,255 fish per year. However, this enumeration of Atlantic salmon escapes is considered inaccurate since the number lost through

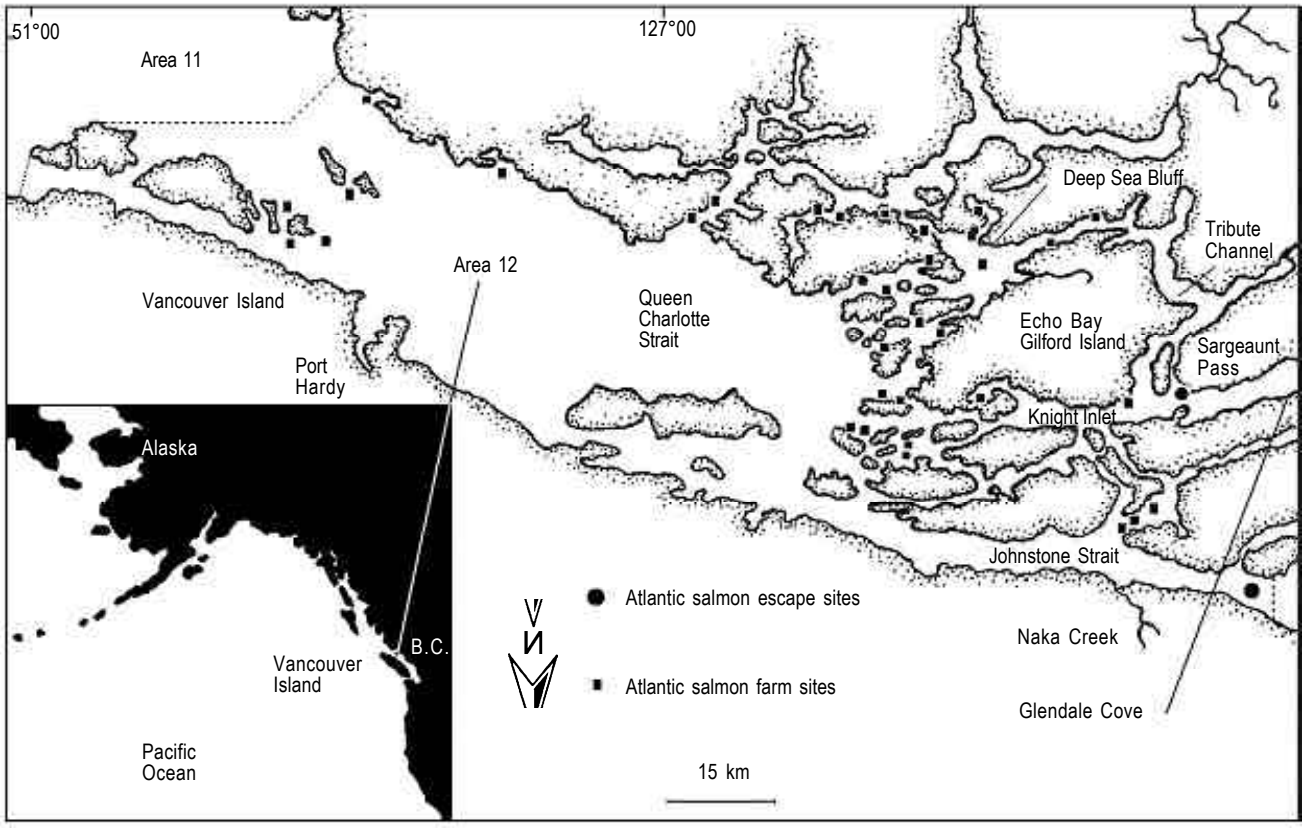

Figure 1. Map of Pacific Fisheries Management Area 12 with the Johnstone Strait and Sargeaunt Pass escape sites and salmon farm sites indicated. Atlantic salmon *Salmo salar* capture reports were received from Naka Creek to Port Hardy.

chronic net pen leakage is likely much larger than reported escape values (Volpe et al. 2001). Since the fish farmer's count on the number of fish that go into a pen is only accurate to within 3%, the exact loss through mortality and decomposition is not known. In addition, escape of up to 20% of some stocks is considered normal as the "non-performer," slow growing fish pass through nets of increased mesh sizes installed at intervals to maximize circulation. This "leakage" is perhaps 3% of annual production or 350,000 fish per year at present production levels (ADF&G 2001a).

While salmon farming is not permitted in Alaska, Atlantic salmon are clearly ranging considerable distances from their farms of origin. The first report of an Atlantic salmon caught in Alaskan waters was in 1990 (Wing et al. 1992). The Alaska Department of Fish and Game (ADF&G) Atlantic salmon recovery program has been in operation since 1994, with recoveries documented back to 1991 by the National Marine Fisheries Service. About 50–150 Atlantic salmon have been recovered annually in Alaskan waters since 1994 including four from fresh water (ADF&G 2002a), and a recovery as far north as the Pribilof Islands in the Bering Sea (Brodeur and Busby 1998).

One of the most important factors in assessing Atlantic salmon colonization risk in the eastern Pacific is their ability to find suitable spawning grounds. Since 1994 Atlantic salmon have been reported in 78 B.C. rivers (ASWP 2002), at least three of which support naturally reproduced feral juvenile Atlantic salmon populations (Volpe et al. 2000). Feral juvenile populations are expected to be competitively viable when sympatric with native Pacific salmon (Volpe et al. 2001). FOC recognizes that escaped Atlantic salmon have a high potential to colonize B.C. rivers, but has chosen to "downplay the idea" (Ginetz 2002):

> In my view it is only a matter of time before we discover that Atlantics are gaining a foothold in B.C. (residency)… Do we prepare public user groups for the possibility, and strategically plant the seed now, or do we downplay the idea and deal with the situation if and when it occurs (Ron Ginetz, Fisheries and Oceans Canada, Chief of Aquaculture Division memo, 1992).

This study was conducted in FOC's Pacific Management Area 12, which supports a major commercial fishery averaging a harvest of 1,837,329 salmon annually (1996–2001; FOC 2002), and 35 salmon farm sites with up to 1.5 million fish per site. In 2000, ASWP reported 36,500 Atlantic salmon escaped from two containment (net pen and transport vessel) failures within the study area and time frame (Figure 1). On August 1, 2000, approximately 4,500 adult Atlantic salmon were accidentally released from the transport M/V *Orca Chief* in Johnstone Strait. On August 14 and 15, 2000, commercial fishers, who had caught up to 250 Atlantic salmon in 24 hours, called workers on the nearest salmon farm, Stolt Sea Farm's site, "*Sargeaunt Pass*" to alert them to a potential rupture in their net pens (Tribune Channel) (Figure 1). The fishers felt certain their Atlantic salmon catch were from recent escapes because some had intact pellets in their throats and stomachs. The company, unaware of the hole, estimated that approximately 32,000 Atlantic salmon had escaped before their net pens were repaired.

The primary objective of this study was to groundtruth the accuracy of the data set on escaped Atlantic salmon swimming in B.C. waters reported to the ASWP. Secondarily, we wished to provide preliminary data on the condition of captured Atlantic salmon. The occurrence of two large-scale escapes during this study permitted us to also examine the success rate of various gear types in recovering escaped farm salmon and whether recently escaped farm salmon can successfully feed naturally. This study is the first to apply an alternative method of counting Atlantic salmon landed by commercial salmon boats in British Columbia and to report on the physical condition of those fish.

METHODS

The study area was limited to Pacific Management Area 12 (Area 12), off northeastern Vancouver Island (Figure 1). We recorded the number of Atlantic salmon caught by commercial salmon fishers (troll, gillnet, and seine) for the entire 2000 commercial salmon fishing season in Area 12. The 2000 season in this area consisted of 17 days from August 2, 2000 through September 22, 2000. Commercial, native, and/or scientific test fisheries (a coho survivorship project) were all surveyed in the same manner during these multi-day openings with closures in between. The sport fishery was not surveyed.

Requests for the number, size, presence or absence of fin erosion, location, and capture details on Atlantic salmon were broadcast 10 times daily, on 11 different VHF channels used by the commercial fishing fleet (President LTD 915 VHF radio with a Morad antennae broadcasting on channels 04, 07, 08, 09, 10, 12, 13, 14, 77, 78, 79). Respondents were located between Port Hardy and Naka Creek (Figure 1). Multiple reports from an individual vessel were checked for redundancy. Atlantic salmon reports were received from a total of 249 boats. Fishermen who reported catching Atlantic salmon were asked to hold the fish on deck for pickup.

We visited all vessels (n=215) within range of the research craft, a 22′ speedboat, to gather samples and confirm radio reports. No vessel refused boat visits; however, radio responses were entirely voluntary.

During the Tribune Channel openings, 100% of the fleet of all gear types was contacted either directly or via the packer they delivered to. During the Johnstone Strait fishery openings, the percent of the fleet contacted was high for western Johnstone Strait (n=65), but decreased to the east (n=13). The total number of boats fishing this area was 202 (A. Thomson, Fisheries and Oceans, Nanaimo, B.C., personal communication).

Atlantic salmon are usually easily distinguished from Pacific salmonids by their unique body morphology, coloration, distinctive kypes in adult males, and the presence of large black spots on the operculum (Webb and Youngson 1992). Worn dorsal and tail fins were secondary identifying features (Lund et al. 1989). Fin wear is indicative of a fish reared in captivity. We documented 53 anomalous Atlantic salmon which completely lacked opercular spots but did have worn fins and were confirmed by a local salmon farm operator (Anonymous, personal communication) as Atlantic salmon (Figure 2). These fish are much more difficult for commercial fishers to identify and report as Atlantic salmon. Other characteristics which identify escaped cultured Atlantic salmon include obese body size relative to head-size, and fibrinous adhesions between internal organs and one site on the internal body cavity associated with injection of adjuvant-based vaccines (Bruno and Poppe 1996).

Commercial fishers donated 268 Atlantic salmon to this project. The number of samples collected was limited by the establishment of a market for these escaped farm salmon partway through the season, making collection increasingly difficult through the study period. Fish were weighed to the nearest 0.1 g, fork length measured to the nearest 0.1 cm, and the number of sea lice, fish skin coloration, number of spots, number and type of wounds, shape of head and relative size of teeth, sex, maturity (size and symmetry of gonads, formation of kypes), occurrence of adhesion between internal organs, and detailed description of stomach and intestine contents were recorded. The viscera from Atlantic salmon landed at a wild salmon processing plant from the first Tribune Channel opening were also examined for stomach contents, sex, maturity, and adhesion of internal organs, but this work was not permitted thereafter due to the controversial nature of the findings of wild food in the stomach contents.

In contrast to ASWP's passive data collection from voluntary fisher reports, our data were actively collected by repeatedly soliciting data from all fishers on the fishing grounds. Data collection was done by one person on the grounds in a speedboat who was on the radio throughout the night and day, followed the boats into the plant, and did the autopsies as the boats were unloading with assistance from local people.

RESULTS

During the 17 days of Area 12 commercial fishing activity, 10,826 Atlantic salmon were reported captured by 249 different vessels in 399 reports. A total of 8,449

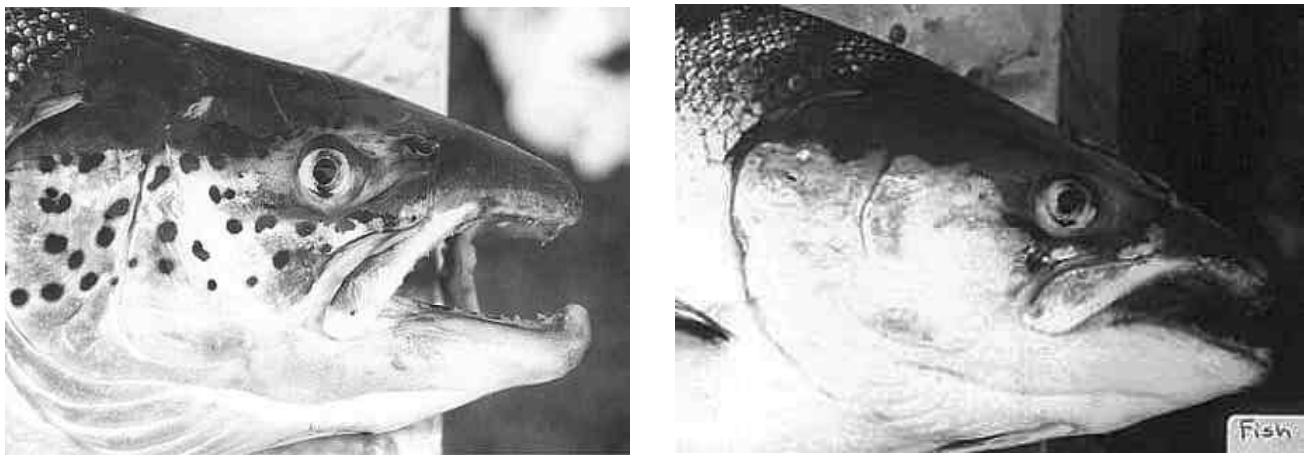

Figure 2: The range in occurrence of number of spots on the operculum of Atlantic salmon *Salmo salar* caught in Pacific Management Area 12 in 2000. The left photograph is a well-spotted Atlantic salmon from Queen Charlotte Sound, portraying typical coloration for this species. The right photograph is one of the 53 Atlantic salmon with no spots caught in Tribune Channel.

Table 1. Total reported number and mean catch per day, by gear type, of Atlantic salmon *Salmo salar* captured during the 17-day fishery monitoring survey from August 2, 2000, to September 22, 2000. Atlantic salmon reported from fish packers and one processor are combined and reported as "Other."

Gear Type	Number of Vessels Reporting	Number of Reports	Total Atlantic Salmon Caught	Mean Number Caught Per Daily Report (±SD)
Gillnet	167	282	6,592	62.7 (52.3)
Seine	77	112	1,848	19.4 (25.0)
Troll	5	5	9	1.8 (0.0)
Other		13	2,377	
Total	249	399	10,826	

Table 2. Number and mean weights and lengths of sampled, whole Atlantic salmon *Salmo salar* captured.

Location	Number	Mean Weight kg (±SD)	Mean Fork Length cm (±SD)
All areas	268	4.8 (1.3)	75.0 (5.1)
Johnstone Strait (M/V*Orca Chief* escape site)	24	4.8 (1.2)	73.5 (5.7)
Glendale Cove	41	4.3 (1.2)	73.6 (4.8)
Tribune Channel (Stolt farm escape site)	81		73.8 (8.3)
Queen Charlotte Strait	113	5.1 (1.2)	76.1 (5.2)
Maturing fish outside Sargeaunt Pass farm	8	5.1 (1.4)	77.6 (7.4)

Atlantic salmon captures were reported by commercial vessels at sea (Table 1). An additional 2,377 Atlantic salmon were recorded from three fish packers willing to participate in this survey; these salmon were delivered by boats that had not responded to the broadcasts. Every vessel visited during our survey had Atlantic salmon onboard.

Gillnets caught 6,592, seine boats caught 1,848, and trollers caught 9 Atlantic salmon during the sample period. Virtually all respondents using gillnets estimated that the Atlantic salmon were caught in the top third of the net between the surface and a depth of 4 m. All Atlantic salmon reported by trollers were taken on "red gear" (pink "hoochie" lures resembling an octopus preceded by a red or green-rimmed flasher) typically used for pink and sockeye salmon. These numbers represent actual counts; we did not extrapolate values to reflect non-reporting boats.

The mean fork length and weight of the 268 whole Atlantic salmon we sampled were 75.0 cm (±5.1 cm, range 56.0–88.5 cm) and 4.8 kg (±1.3 kg, range 1.8–9.8 kg), respectively. Mean fork length and weight showed variation between capture sites (Table 2).

A total of 775 whole or partial Atlantic salmon caught in Area 12 were examined for stomach contents. Overall identifiable stomach contents were revealed in 30 individuals (3.9%), of which 26 (3.4%) had consumed wild prey. Identifiable food remains were herring *Culpea harengus pallasi*, sand lance *Ammodytes hexapterus*, salmon, shrimp (too digested to identify), and invertebrates (too digested to identify) (Table 3).

Prey consumption varied by location. One of 24 (4.2%) Atlantic salmon examined from Johnstone Strait and 6 of 113 (5.3%) Atlantic salmon examined from Queen Charlotte Strait had consumed wild food (Table 4). None of the 80 Atlantic salmon caught *during* the escape event at the Sargeaunt Pass farm contained wild food, and 4 contained pellets. Eight days later, 9 of 497 (1.8%) Atlantic salmon from the same locale had attempted to feed; woody debris were found in 3 fish, unidentified fish remains in 4 fish, a 15-cm herring in one fish, and an 8-cm salmon smolt (species unidentifiable) in one fish. Fourteen days later, 10 of 41 (24.4%) Atlantic salmon examined from nearby Glendale Cove (Figure 1) contained wild food: 9 unidentified fish (9–11 cm), 2 shrimp (7 cm, species unrecognizable), and 1

Table 3. Number of salmon with identifiable stomach contents. A total of 775 whole or partial Atlantic salmon *Salmo salar* were sampled from catches during 17 days of open fishing periods from August 2, 2000 through September 22, 2000 in Pacific Management Area 12.

Stomach Contents	Number of Individuals
Sand lance	1
Unidentified salmonid smolt	1
Herring	5
Shrimp	2
Unidentified fish	6
Unidentified invertebrate	3
Pellet feed	11
Styrofoam	1
Woody debris	6

Table 4. The number of fish and percent occurrence of various physical characteristics and stomach contents exhibited by sampled Atlantic salmon *Salmo salar* by capture location, August 2, 2000 through September 22, 2000. The number examined for each characteristic within each group does not always equal *n*, e.g., the viscera examined from Tribune Channel could not provide data on number of spots, sea lice prevalence, or kypes.

	Queen Charlotte Strait	Tribune Channel/ Glendale Cove	Johnstone Strait	Sargeaunt Pass Mature Salmon
Number of Fish	113	622	24	8
Female	66.4%	67.4%	33.3%	25.0%
% males w/ kypes	13.3%	1.6%	4.2%	75.0%
No spots	27.4%	38.1%	0%	17.5%
Sea lice	25.7%	10.2%	8.3%	37.5%
Wild food	5.3%	2.4%	4.2%	0
Pellets	0	1.5%	12.5%	0
Non-food	0	0.6%	0	0
Adhesions	5.3%	1.6%	54.2%	12.5%

unidentified larval invertebrate. One Atlantic salmon consumed woody debris. Consumption of wild food by captured Atlantic salmon in the vicinity of the Sargeaunt Pass escape increased significantly (c^2=17.325, P=0.000) from 0 on day 1, to 24.4% 14 days later.

The Atlantic salmon from each capture site expressed "signature" dominant morphologies (Table 4). We found 53 Atlantic salmon caught in the immediate vicinity of the escape site in Sargeaunt Pass that possessed atypical coloration for the species, having none of the diagnostic opercular and body spots (Scott and Scott 1988; Figure 2). Identification of these fish as escaped farm salmon was confirmed by the excessive wear on tail and dorsal fins (Lund et al. 1989). Species confirmation was provided by farm workers (Anonymous, personal communication). While they had no spots, these 53 shared the morphological characteristics of the majority of the other Atlantic salmon caught in the area, i.e., obese body relative to head size, jaw shape, and a low prevalence of organ adhesions.

Fibrinous organ adhesions were found in 13 (54.2%) Atlantic salmon examined from the August 2–3, 2000 Johnstone Strait gillnet, troll, and seine fishery. In contrast, only 10 (1.6%) of the Atlantic salmon from Tribune Channel and Glendale Cove fisheries exhibited this characteristic, suggesting some Atlantic salmon were present from escape events other than Sargeaunt Pass (Table 4). Most of the Johnstone Strait Atlantic salmon shared other physiological characteristics such as equivalent obese body types, pulpy flesh, and white frills of accumulated fat along the intestines and other organs.

Only one Atlantic salmon examined did not exhibit fin erosion. This 3.6 kg male was taken from Deep Sea Bluff (Figure 1) by a troller on the red gear nearest the surface. This fish had a sand lance in its stomach (Table 3), its body appeared lean and fusiform, and its flesh was considerably firmer than the other Atlantic salmon examined.

Of the 775 whole or partial Atlantic salmon examined, 18 (2.3%) showed signs of sexual maturation, i.e., kypes in males, and very mature gonads in males and females (12 males, 6 females). Of the mature Atlantic salmon caught in areas other than the Sargeaunt Pass farm, four paired males and females were found side-by-side in the gillnet. Two fishers commented independently that Atlantic salmon often appeared in their nets in association with steelhead *O. mykiss*. Only two captured Atlantic salmon showed marine mammal, or possibly shark, wounds.

Mean sea lice intensity (Margolis et al. 1982) on the 43 Atlantic salmon with lice was 25.8 (±77.0 or 7.7%), maximum infestation was 500 juvenile sea lice *Caligus* spp. Another 7 Atlantic salmon showed typical lice wear in a darkened surface patch above the anal fin, but no lice.

This study recorded 10,826 Atlantic salmon caught by commercial fishers from August 2, 2000 through September 22, 2000 in Area 12. In contrast, the ASWP reported 7,688 Atlantic salmon caught in Area 12 for the same period. Thus, this study accounted for 40% more Atlantic salmon captures than the ASWP.

DISCUSSION

The high number of Atlantic salmon captured by respondents was likely due to the two escapes that occurred during the study period, but the total number of escapees reported by ASWP for the year 2000 (37,462) was below the previous six-year annual average (46,255) (ASWP 2002). Therefore, the probable number of farm

origin, free-swimming Atlantic salmon on the coast of B.C. was unlikely to be exceptionally high in 2000. The large number caught by the commercial fleet was almost certainly due to the accidental convergence in space and time of escape events and fishing openings, and suggests that some commercial fishing gear might be successful in recovering farm salmon immediately after escape incidents. There is a misconception that farm salmon can not be recaptured with commercial gear (ADF&G 2001a), but in this study the fishermen were not targeting the Atlantic salmon and were required to cease fishing before Atlantic salmon recovery numbers began to decline. Had they been specifically tasked with Atlantic salmon recovery, we can only expect far more would have been caught.

The uniformity in appearance among the Atlantic salmon caught in Johnstone Strait suggests the majority of these fish could have originated from the transport M/V *Orca Chief* escape that occurred in Johnstone Strait 2 days prior. Most distinctive of this group of fish was the high occurrence of fish with pellet remains in their stomachs and fish with internal organ adhesions (Table 4). These characteristics were more variable or non-existent in areas with no recently reported escape events, such as Queen Charlotte Strait (Table 4). If these fish were from the transport vessel leakage and the escape numbers reported by the popular media were accurate, the fishing fleet caught approximately 36% of these escaped farm salmon as bycatch while targeting other species.

In Tribune Channel the dominant Atlantic salmon morphology was unique in two ways; they had few to no black spots and most had no adhesions between internal organs, unlike the bycatch in Johnstone Strait. This high occurrence of a distinctive set of characteristics also suggests a single source for the majority of Atlantic salmon recovered from Tribune Channel, most likely the Sargeaunt Pass Atlantic salmon farm's ruptured net pens. If this is the case, the fishing fleet recovered approximately 19% of the number of reported fish escapees. In both cases, the number of Atlantic salmon caught did not diminish with time and therefore we could expect this percentage to have risen with more fishing time.

Seine boats caught most (approximately 91%) of the wild pink salmon netted in Area 12 in 2000, while gillnets caught most (approximately 61%) of the Atlantic salmon recorded by this study, suggesting the gillnet is the most successful gear type for catching escaped, cultured Atlantic salmon. The gillnet crews expressed surprise that such large salmon could be caught in daylight in a net intended for pink salmon, a much smaller species. With a mesh size of only 13–14 cm (5.0–5.5 in), the majority of Atlantic salmon were too big to "gill" and thus most were merely tangled in the net by their teeth. Fishers reported that these fish, unlike wild Pacific salmon, did not struggle when they made contact with the net and were thus only minimally snared. However, when the net began its assent up the stern of the boat the inadequacy of the mesh size became apparent. The Atlantic salmon reportedly thrashed violently, leading many gillnetters to estimate they had lost up to an additional 50% of their Atlantic salmon catch in this manner.

The 53 atypically colored Atlantic salmon (no spots on their heads; Figure 2), make identification of Atlantic salmon more difficult for the commercial fisher. There has been no response from the salmon farming industry as to why they might be selecting for hard to identify fish. Many crews reported they had thrown all these fish back previous to being interviewed because they could not identify them, and were concerned they might be coho salmon, for which there was a non-retention restriction; many also thought they were sockeye salmon. This morphological type of farmed Atlantic salmon is more likely to go uncounted by ASWP or any other program and is known to have reduced the count of Atlantic salmon in this study.

The steady increase in wild food content in Atlantic salmon stomachs between the first and second Tribune Channel fishery openings suggests some portion of escaped farm salmon may have the ability to forage successfully within days of escape. If the morphologically similar Glendale Cove Atlantic salmon were the same stock as those caught in adjacent Tribune Channel, swept up the inlet with the over one million pink salmon headed for the nearby Glendale River at that time, the wild food predation rate escalated dramatically over a 14 day period from 0–24.4%. Rapid learning to consume wild food is another important factor in assessing Atlantic salmon colonization risk. The prey species recorded in this study are also cause for concern; the occurrence of herring and sand lance in Atlantic salmon stomachs represents potential competition with wild salmon, and the consumed salmon smolt demonstrates the potential for predation. The relatively high number of Atlantic salmon found with wild food in their stomachs in this study, limited in both duration and number of samples, contrasts starkly with other conclusions that escaped cultured salmon are unlikely to feed (Ginetz 2002) and highlights the need for further research on this question fundamental to evaluating Atlantic salmon colonization risks.

With an average weight of 4.8 kg (10.6 lb) the Atlantic salmon captured during this study were big fish with considerable fat buildup evident on internal organs. As such, they may not emaciate down and "fail" for a

long time. Their mass could afford them the ability to endure an extended period of trial and error as they learn effective predation techniques. Compared to young wild fish, if escaped Atlantic salmon don't feed immediately they may not suffer significant losses from starvation or predation due to slow growth.

The lack of fin wear on the 3.6 kg Atlantic salmon caught at Deep Sea Bluff on troll gear means this fish could have been spawned in the wild, or may have escaped soon after entering sea water. Regardless of its origin, that this fish was feeding on sand lance suggests it had successfully adapted to survival in the wild.

This study recorded 40.8% more Atlantic salmon recovered by the commercial salmon fleet in Area 12 than the passive ASWP count. In 2000, the ASWP counted 7,834 Atlantic salmon for the entire year and coast of B.C. Although our survey was confined to Area 12, another 637 Atlantic salmon were spontaneously and voluntarily reported to us from Pacific Management Area 13, to the north (Fitzhugh Sound), by gillnet boats that had participated in Area 12 or heard about the project. There are no salmon farms in Area 13. We did not survey western Vancouver Island where another 45 salmon farm sites exist, nor did we survey sport fishers or hatchery workers who catch Atlantic salmon in fresh water. Even though we did not survey the entire coast, overall this study counted 38.2% more Atlantic salmon than ASWP did throughout the entire year and coast of B.C. While fishers were encouraged to also report their catch to the ASWP, many were either unaware of the program or how to make contact. These data suggest the ASWP is significantly underestimating the catch of escaped Atlantic salmon. The large discrepancy in numbers between this study and that of the federal and provincial governments makes it clear that the ASWP data should be interpreted with caution. Because both the ASWP and our survey do not control for non-compliant fishers who capture Atlantic salmon, it is important to note that both data sources reflect only minimum estimates of Atlantic salmon occurrence in the Pacific salmon fisheries and no error estimates can be calculated.

Our study suggests that gillnets are the most successful gear type for recovery of escaped farm salmon, whether an escape was recent or not. Furthermore, an effective culling of the Atlantic salmon most likely to spawn naturally, those that are mature and free-swimming, might include routine, periodic gillnet fishing effort outside every salmon farm in B.C. and Washington State. The data collected herein suggest that Atlantic salmon-specific gillnets could be shallow, and fishing could occur during daylight hours, perhaps conserving wild Pacific salmon species while successfully culling Atlantic salmon.

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