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Fishing for Atlantic salmon: inferences about dispersal, survival and ecological impacts following two large-scale escape events

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Fishing for Atlantic salmon: inferences about dispersal, survival and ecological impacts following two large-scale escape events

Executive summary

Two major escapes of farmed Atlantic salmon occurred in south-eastern Tasmania during late 2020. The first involved the loss of an estimated 50,000-52,000 fish with an average weight of about 4 kg and the second, nine days later, the loss of 120,000-130,000 fish averaging about 550 g in weight. These escape events attracted significant interest from recreational fishers as well as providing an opportunity to better understand some of the implications of such large losses of fish.

The dynamics of dispersal, survival and feeding activity of the escaped Atlantic salmon was examined by drawing on the experiences and observations of recreational fishers in combination with an assessment of fish condition after different times post escape. An on-line panel survey of recreational fishers attracted over 210 participants who provided information about their fishing activities targeting escapees, observations about the condition and feeding of the escapees and motives and attitudes relevant to fishing for escapees. Dispersal from the farm sites was rapid but appeared to be largely restricted to within the D'Entrecasteaux Channel, Storm Bay region and associated freshwater tributaries. During the first four weeks there were reports of escapees being schooled up in various locations throughout the Channel, in such situations they were readily captured by gillnet and line fishing methods. Of note, these catches were dominated by the cohort of larger-size fish, comparatively few of the small-sized cohort were reported captured despite over double the number of smaller fish having escaped. Research fishing using both gillnet (including small mesh nets) as well as line fishing also resulted in poor representation of these smaller fish, restricting inferences that can be made about this cohort.

Based on fisher reported capture dates, and assuming that most if not all the Atlantic salmon were from either of the late 2020 escape events, it can be inferred that at least some fish had survived at liberty for almost four months. Research fishing included samples collected at least five months after the escape event, suggesting that small numbers of fish may survive longer than suggested by the fisher survey. However, after the first month or so following the escape recreational catches were observed to drop off markedly, likely associated to dispersal and low abundances of surviving fish.

Survival for several months does not necessarily mean that these fish were thriving, in fact there was very limited evidence to suggest active feeding on native fauna and, based on physical condition indicators, it was likely that fish were exhausting energy reserves and effectively wasting away. This finding implies that the ecological impact arising from predation on native species by the escapees was likely to be minimal.

An additional but indirect ecological consequence of such escape events is the impact on inshore and estuarine finfish species taken as bycatch when fishing for escapees. While it was not feasible to assess the magnitude nor survival of such bycatch in the present study, heavy and concentrated fishing activity, especially by gillnets, is expected to have at least some implications for localised fish populations.

Most recreational fishers target escapees motivated to capture a premium table fish and/or to take advantage of a windfall opportunity. Many fishers did, however, express concern about the potential ecological impacts of escapees and were also motivated to contribute to the fish-down of the introduced species, a sentiment that was expressed more strongly than in a similar survey following a mass escape event in 2018.

Introduction

Commercial farming of salmonids commenced in Tasmania in the mid-1980s and is centred on Atlantic salmon (*Salmo salar*) and to a lesser extent rainbow trout (*Oncorhynchus mykiss*). Atlantic salmon are native to the North Atlantic and were introduced to Australia in the late 1800s as sportfish for recreational anglers. Today Tasmania produces over 80,000 tonnes of salmonids per annum, with Atlantic salmon accounting for the bulk of the production. Salmonids are typically grown-out in sea cages which allow high density fish rearing and low overhead costs compared to equivalent land-based facilities. The industry has significant economic benefits, with current annual production valued at over AUD$800M.

A consequence of the worldwide expansion of aquaculture based on salmonids has been the accidental escape of large numbers of farmed fish into the environment. Escapes occur as large pulses or through small leakages, a consequence of human error and natural causes, such as predator or storm damage to cages (Gausen and Moen 1991, McKinnell et al. 1997). Within their natural distribution range, the impact of Atlantic salmon escapees can be genetic, through hybridisation and genetic introgression, and ecological through competition for food and space, disturbance of spawning beds and transfer of diseases or parasites into wild salmonid populations, sometimes with disastrous effects for wild stocks (Heggberget et al. 1996; Gross 1998). The development of marine aquaculture for salmonids in the southern hemisphere, in particular Chile and Australia, has given rise to concerns surrounding the potential impacts of farm escapees on native fauna through predation and competition for food, disease and pathogen transfer and the establishment of self-sustaining populations in the wild (Soto et al. 2001; Abrantes et al. 2011; Sepulveda et al. 2013).

In Tasmania there have been several significant escape events, typically attracting strong interest from recreational fishers seeking to take advantage of this 'windfall'. In one such event, storm damage to holding pen infrastructure in Storm Bay resulted in the escape of about 120,000 Atlantic salmon in May 2018. Recreational fishers reported catching large quantities of the escapees for several weeks immediately following the event as they dispersed widely throughout the coastal waters and tributaries of south-eastern Tasmania (Lyle 2019).

In late 2020 there were a further two large escape events, again attracting considerable interest from recreational fishers (Dunlevie, 2020; Kitto, 2020) as well as giving rise to public concern about potential ecological impacts, including feeding on native fauna, possible biosecurity risks through the transference of disease and even the establishment of self-sustaining Atlantic salmon populations. The first escape occurred on 23rd November 2020 when fire damaged a holding pen in the D'Entrecasteaux Channel, with an estimated 50,000 - 52,000 fish averaging about 4 kg fish lost (Huon Aquaculture 2020a). The second escape occurred on 2nd December 2020 and was the result of a net tear in a Storm Bay fish pen (Yellow Bluff lease) and involved the loss of between 120,000-130,000 fish with an average weight of 550 g (Huon Aquaculture 2020b).

In order to help understand the dynamics of dispersal, survival and potential ecological impacts of such large escape events an online survey of recreational fishers who had fished for the escapees was conducted, based on the approach undertaken by Lyle (2019). In addition, targeted research fishing was conducted to address how the condition of escapees changed through time which, in conjunction with fisher observations, can contribute to understanding escapee dispersal and survival in the marine environment and impacts on native prey species (ecological impacts and risks).

Objectives of this study were to:

1. Characterise the spatial and temporal dispersal of the escaped Atlantic salmon.
2. Examine changes in body condition of the escapees following the escape event.
3. Assess the potential impacts on native fauna due to predation by escapees
4. Assess motivation and opinions of recreational fishers in relation to large-scale escape events.

Methods

Fisher survey design and implementation

Given the opportunistic nature of the fisher survey and issues related to reporting biases, especially recall bias, a modified panel survey approach was adopted. This involved an initial questionnaire-based survey (Phase 1) that was promoted using a variety of media platforms (Appendix 1) and implemented within three weeks of the first escape event. This initial survey was designed to collect information from respondents about their fishing for escapees and identify those with an expectation to continue fishing for the escapees and willingness to be re-contacted. This latter group was contacted again (Phase 2) about six weeks later and asked about any fishing they had done for escapees since completing the initial survey. Those respondents who indicated an intention to continue fishing for escapees were contacted again about six weeks later (Phase 3) and asked about any fishing they had done since completing the Phase 2 survey. This resulted in the coverage of more than four months of relevant fishing activity, generally with recall periods of no more than 6-8 weeks. Although the fishing information was self-reported, issues related to recall bias are likely to be minor, giving confidence in the quality of the data provided.

The Phase 1 questionnaire was developed using the on-line platform 'Survey Monkey' (Appendix 2). The questionnaire was designed to collect profiling information from each respondent (age, previous fishing experience, and postcode), fishing activity for escapees since the first escape event (number of days fished, methods used and catch numbers). In order to inform on the spatial and temporal pattern of dispersal, respondents were asked to identify the earliest date and location that they had captured an Atlantic salmon following the first escape event in late November. Respondents who had fished on multiple occasions were also asked to identify the most recent date and location that they had caught an Atlantic salmon escapee. Information on the size, condition and any observations on the stomach contents of the catch was canvassed. Recognising that the quality of such reports was likely to be variable, respondents were asked whether their observations were based on direct measurements or estimates for some or all their catch. Since the two escape events involved vastly different cohorts of fish, the earlier being close to harvest size (3-4 kg) while the second group were small fish of less than about 600 g, it was considered reasonable to assume that fishers could readily distinguish these two groups based on size. In doing so, comments and inferences about the dispersal and survival of each group was considered feasible. Respondents were also asked about the catch of non-target species taken whilst fishing for escapees.

To understand motivations around fishing for escapees, respondents were asked to rate the level of importance (from "very important" to "not at all important") that they attributed to statements relevant to fishing for escapees. The final section of the survey established whether respondents were likely to do any more fishing for escapees in the near future and, if so, whether they consented to be recontacted (for Phase 2).

The Phase 1 questionnaire was made accessible to the public between December 2020 and early February 2021. The survey was promoted through social media, including IMAS and DPIPWE Fisheries Facebook pages, via local radio and print media. The survey was also promoted using an extensive email list of subscribers (over 20,000) to the DPIPWE *Fishing News* network and was shared by various Facebook groups with interests in fishing in Tasmania. The survey distribution thus involved strategic targeting and self-selection (non-probabilistic) sampling which introduces inherent limitations that prevent making generalisations about the number of persons who fished for the escapees, their collective effort and total catch. Rather, the survey has value in identifying patterns in the dispersal and availability (survival) of the escaped Atlantic salmon through time and general observations about fisher behaviour and motivations in relation to fishing for escapees.

Phases 2 and 3 follow-up surveys were conducted online with respondents who indicated a likelihood of doing more fishing for the escapees and consenting to be re-contacted. This group of respondents was contacted by an email that contained a link to the survey. These follow-up surveys were focussed on fishing activity and observations on the size, condition and evidence of feeding by the Atlantic salmon caught since last contact.

Biological sampling

Targeted research fishing for escapees was undertaken at varying intervals following the two escape events using gillnet and line fishing methods. Standard graball nets (mesh size 114 mm) and small mesh nets (89 mm)

were deployed in an effort to capture both cohorts (noting that the smaller-sized cohort are poorly selected by graball nets). Gillnetting was undertaken in the D'Entrecasteaux Channel and in particular in the area around Southport, as well as in Frederick Henry Bay. Line fishing was undertaken using soft plastic lures in the Southport area as well as in freshwater sections of the Huon River. Research fishing was supplemented with samples donated by recreational fishers along with a sample of the smaller-sized cohort that was provided by Huon Aquaculture as a pre-escape baseline sample.

The Atlantic salmon were measured for fork length (mm), total and gutted body weight (g), viscera weight (g) and liver weight (g). Stomachs were dissected and any contents identified and weighed. Body condition was assessed using Fulton's K condition index and hepatosomatic index (HSI) to make inferences about general well-being at differing times post-escape. Fulton's K is a morphometric index based on body mass at length and is calculated as $K = 100 \times (GW / FL^3)$, where GW is gutted body weight (g) and FL is fork length (cm). HSI is an indicator of energy reserves available and calculated as the ratio of liver to body weight, $HSI = 100 \times (LW / GW)$, where LW is liver weight (g). HSI has been applied in fish studies to monitor changes in body condition related to food deprivation/starvation.

Samples of muscle and liver tissue were also retained from each Atlantic salmon and stored frozen for potential future biochemical analysis.

Ethics and Permits

This study was approved by the Tasmanian Social Sciences Human Research Ethics Committee (Ethics reference S24021) and the University of Tasmania Animal Ethics Committee (Ethics permit 24105). Sampling of escapes by IMAS staff was conducted under the authority of Permit number 20075 issued under Section 14 of the Living Marine Resources Management Act 1995 in marine waters and in inland waters under Exemption Permits D21-7501 and D21-18953, issued under section 172 of the Inland Fisheries Act 1995.

Results and Discussion

Fisher survey

Response and respondent characteristics

The initial online survey (Phase 1) was open from 14th December 2020, 21 days after the first escape event. A total of 245 responses were received, 30 of these were incomplete and only provided demographic information, three were anti-salmon farming protest responses (did not answer survey questions), and one was a duplicate response where the respondent provided an update on an earlier response. This resulted in an effective sample of 211 responses, 123 (58%) indicated that the respondent held a recreational graball net licence. The relatively high representation of graball licence holders is likely influenced by the survey promotion through the DPIPWE *Fishing News* network which includes many recreational sea fishing licence-holders.

All age groups were represented, with modes in the 40-49 and 60-69 age groups (Fig. 1). Males (n = 197) accounted for 93% of the responding sample. In terms of reported years of fishing experience (32.6 ± 17.6 years [average ± standard deviation]) and number of days fished in saltwater in the previous 12 months (average 42.4 ± 41.5 days) respondents were, on average, highly experienced and avid fishers.

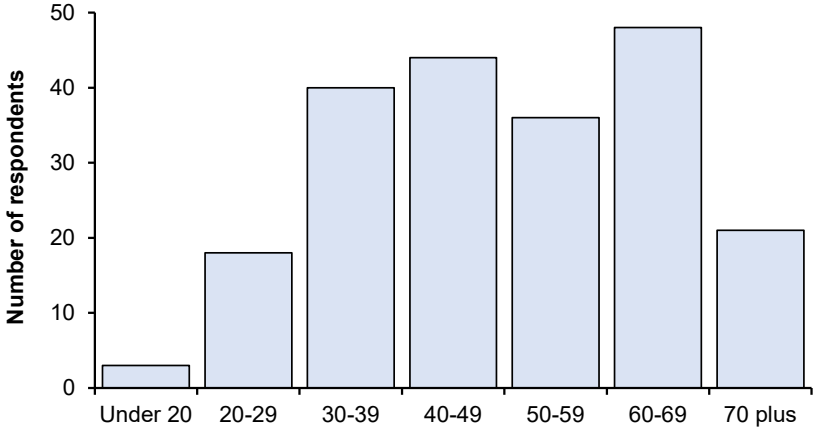

Fig. 1. Age distribution of Phase 1 respondents.

Overall, 187 (88.6%) respondents reported fishing for escapees since the first of the two escape events, with 174 (93.0% of those who fished) catching at least one Atlantic salmon within the reporting period. Excluding catch and effort reported by a commercial gillnet fisher targeting escapees, respondents reported total catch of 3211 Atlantic salmon based on 994 fishing days of effort (Table 1)[1]. Gillnets accounted for two-thirds, line fishing 20% and mixed methods (i.e. where respondents reported using both line and gillnets) 14% of the total catch numbers.

Atlantic salmon smaller than 1 kg (i.e. from the second escape event) accounted for less than 5% of the reported catch, this was despite the escape numbers being more than double those reported for the earlier event. Lower catchability, especially in graball nets, of these small fish is likely to have been a contributing factor to this apparent discrepancy.

[1] Tasmanian Scalefish Fishery catch returns indicate that a total of 1.3 tonnes of Atlantic salmon was taken commercially from south-eastern Tasmania during November/December 2020.

Table 1. Summary of fishing information reported by survey respondents

		Follow-up surveys		
	Phase 1	**Phase 2**	**Phase 3**	**Combined response**
Survey open	14/12/2020	11/01/2021	3/03/2021	
Survey closed	20/02/2021	14/02/2021	5/04/2021	
No. valid responses	211	82	27	
No. respondents who fished	187	52	13	187
No. respondents who caught escapees	173	42	6	174
Earliest date reported fished	23/11/2020	-	-	
Latest date reported fished	20/02/2021	26/01/2021	1/03/2021	
Total days fished for escapees	762*	198	34	994
Total no. escapees caught	2805*	383	23	3211
No. escapees < 1 kg	80*	30	0	110
% escapees < 1kg	2.9	7.8	0	3.4
No. caught by gillnet	1923	183	6	2112
No. caught by mixed methods	298	141	16	455
No. line caught	584	59	1	644

* Days fished and catches taken by a commercial gillnet fisher targeting escapees have been excluded from these totals.

Fish 'survival'

Based on the earliest and latest reported capture dates and the assumption that all reported Atlantic salmon were from either one of the two escape events, the data indicate the earliest catches were taken immediately following the first escape event (23rd November 2020) and that catches, although diminishing in number, were taken until at least early March 2021 (Table 1). This implies that some escapees may have survived at liberty for at least 98 days (14 weeks). This compares with the confirmed survival of 99 days for an acoustically tagged Atlantic salmon released in Macquarie Harbour (Bell *et al*. 2016) and 114 days inferred survival following the major escape event in 2018 (Lyle, 2019). Survival of Atlantic salmon for these lengths of time do not in themselves imply that individuals were thriving. In order to properly address this issue, it would be necessary to monitor changing fish condition through time, ideally using a range of physical condition and biochemical indicators (e.g. Abrantes *et al.* 2011).

Fish dispersal

Respondents provided information about the location and date of their earliest capture of an escapee and subsequent locations from which Atlantic salmon were captured. This provided information that could be used to map the dispersal of escapees from the farm sites through time. Within the first week following the initial escape (site A in Fig. 2) catches were reported throughout the D'Entrecastreaux Channel, as far north as Northwest Bay, into the Huon Estuary and as far south as Recherche Bay (Fig. 2). By Week 3, catches had been reported from Norfolk and Frederick Henry Bays, the Tasman Peninsula (around Nubeena and Port Arthur) and Southport. After about three weeks catches were reported in key tributaries, including the Huon, Lune River and Derwent Rivers, indicating movement of some survivors into freshwater rivers. Consistent with the 2018 experience (Lyle, 2019), dispersal of escapees away from the farm sites was rapid and widespread throughout Storm Bay and its adjacent bays and tributaries.

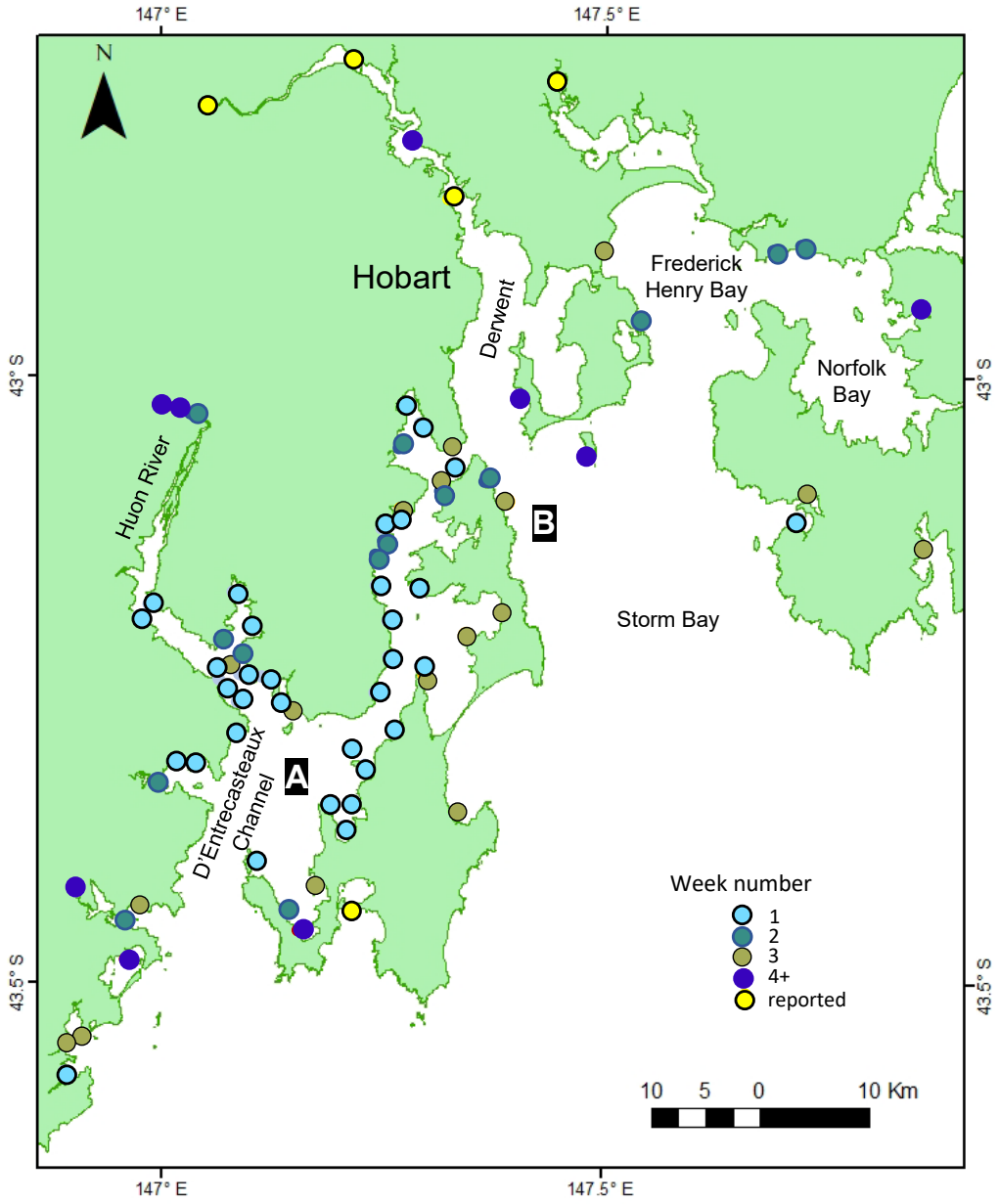

Fig 2. Map of south-eastern Tasmania showing the locations by earliest date (week) of reported Atlantic salmon captures following the first escape event - Week 1 refers to the 7 day period following 23rd November 2020, and so on. **A** represents the location of the farm site that experienced the first (November) escape event and **B** the site of the second (December) event. "Reported" refers to sites that respondents had heard other fishers had caught escapees.

Fishing methods

Gillnets have traditionally been the primary method used by Tasmanian recreational fishers to target escapees (Lyle and Tracey 2016). More recently, however, line fishing primarily with lures (soft plastics, silver slices and hard body lures) has become a popular method of catching escapees (Lyle, 2019). Of the 173 respondents who reported catching Atlantic salmon in Phase 1, most (72%) used gillnets, 36% were successful line fishing and 2% caught escapees spearfishing[2]. Linked, in part at least to the escape events and reflecting the prominence

[2] Eleven percent of respondents reported using both line and gillnets to target escapees.

of gillnet effort targeting escapees there was a 10% increase in graball licences issued in 2020-21 (over 6,500 issued) compared with the 2019-20 licence year. The dominance of gillnet effort in the present study contrasts the situation associated with the 2018 escape event, where most survey respondents (72%) caught escapees line fishing while just 38% reported using gillnets (Lyle, 2019).

Gillnet effort accounted for 58% of the reported days fished for escapees and 66% of the total numbers caught whereas line-only fishers represented 28% of the effort and 20% of the catch (Table 2, Fig 3). Respondents reporting mixed methods (gillnet, line and/or spear fishing) accounted for the remainder (14% of the effort and catch). Overall average catch rates (fish per day) were highest for gillnets (3.9), followed by mixed methods (3.5) and line fishing (2.5) (Table 2).

When the two size classes of escapees are considered, it was evident that line fishing accounted for disproportionately more of the smaller-sized cohort (51%) than gillnet (31%) when compared with catch proportions of the larger-sized cohort (19% for line and 67% for gillnets) (Fig. 3). A combination of factors will have contributed to these differences, including variability in mesh selectivity for either cohort, targeting preferences of fishers and fish behaviour.

Table 2. Catch and effort based on reported fishing method(s), catch (number of Atlantic salmon), effort (days fished) and average catch rate (number per day). "Mixed" refers to respondents who reported using gillnets in addition to other (including line fishing) methods.

Method	Effort (days)	Catch (no.)	Catch rate (no. per day)
Gillnet	535	2112	3.9
Line	253	644	2.5
Mixed	129	455	3.5

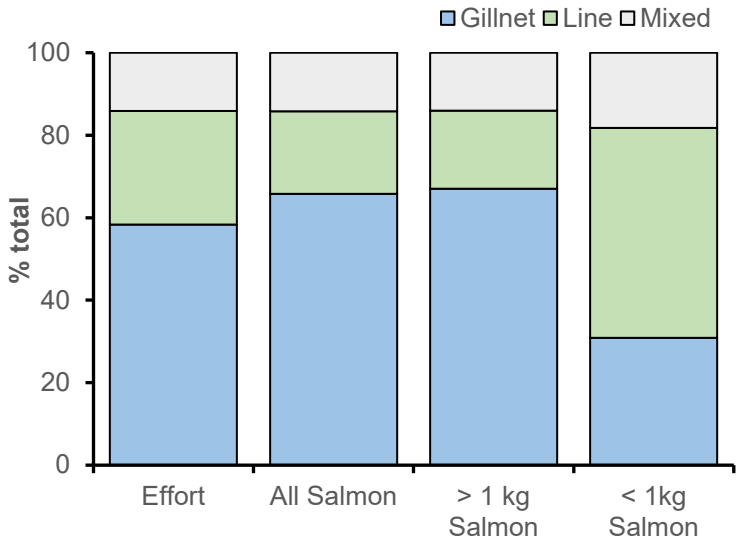

Fig. 3. Proportion (%) of total effort (fisher-days) and Atlantic salmon catch numbers (all and by size class) by fishing method reported by survey respondents (mixed refers to the use of gillnets plus other methods).

Feeding

Respondents were asked whether they had checked the stomachs of the Atlantic salmon they had caught and if so, whether any had food items in their stomachs. Overall, 133 Phase 1 respondents indicated that they had checked the stomachs of some or all of the fish they had caught, 107 (80%) reported that all examined were empty whereas 26 (20%) indicated that at least one Atlantic salmon examined had evidence of food items present (Table 3). Similarly for Phase 2, most respondents (78%) who examined stomach contents reported no

evidence of food in the stomachs while for Phase 3 which was based on a very small sample, none of the fish examined had evidence of recent feeding activity. Apart from those respondents who examined all their catch and reported that all stomachs were empty (total of 1590 Atlantic salmon), it is not possible to quantify the proportion of overall catch with food items. However, based on comments from those who did report observing food in stomachs it was clear that this generally applied to only small numbers of escapees in their catch.

Amongst the 34 respondents (Phase 1 plus Phase 2) who reported food items, 25 provided details confirming natural prey items, six reported pellets or mucus as the only stomach contents while three respondents provided no further information. Of those who reported observing natural prey items, 19 indicated the presence of fish, six reported crustaceans (four involving crabs, one involving shrimp and another the remains of a freshwater crayfish), and two reported other items (including "worms or some kind of grub" and "shells"). Small baitfish were the most frequently consumed fish (based on 16 reports, five of which were identified as whitebait or prettyfish), followed by leatherjackets (three reports) and flounder (one report).

Table 3. Responses to questions relating to observations of the stomach contents of captured Atlantic salmon based on survey phase. Responses for fishers who indicated that they had not checked for stomach contents have been excluded.

	Phase 1		Phase 2		Phase 3		Atl. salmon	
Response	**Fishers**	**Salmon**	**Fishers**	**Salmon**	**Fishers**	**Salmon**	**Total**	**%**
Checked ALL of my catch, all stomachs were empty (excluding sticks, stones or bait items)	77	1390	19	195	5	20	1590	56.6
Checked SOME of my catch, all stomachs were empty (excluding sticks, stones or bait items)	30	446	10	78	1	3	525	18.7
Checked ALL of my catch, at least one stomach had food items present	20	511	2	18			529	18.8
Checked SOME of my catch, at least one stomach had food items present	6	96	6	67			163	5.8
Total	133	2443	37	358	6	23	2807	
% empty stomach reports	80.5		78.4		100.0			

Fish condition

Respondents who had caught escapees were asked about any observations on the general condition of the escapees, with responses linked to the specific size group(s) of fish caught. According to Phase 1 responses most of the larger-sized Atlantic salmon (>3 kg) caught within the first month or so were in good to excellent condition, with some respondents commenting on flesh colour (bright orange) and high fat content (Table 4). A small proportion of respondents did, however, note that fish were starting to show evidence of declining condition and occurrence of red spots or lesions on the skin, especially in the belly area. Most of these reports related to catches taken after four weeks at liberty. While fish in good condition still dominated reports in the later surveys (Phases 2-3), the proportion of reports indicating changing condition (including loss of fat and flesh colour) and occurrence of red marks or lesions had increased. There were very few reports relating to the < 1 kg cohort and while most indicated that the fish were in good to excellent condition, some respondents did note that flesh colour was pale, even immediately following the escape event (Table 4).

Table 4. Percentage of fisher observations regarding the condition of escapees.

	> 3kg fish		< 1kg fish
Condition	**Phase 1**	**Phases 2-3**	**Phases 1-2**
Good/excellent	73.3	52.5	73.7
Good flesh colour	18.1	12.5	-
High fat content	7.6	7.5	-
Declining/poor	9.5	17.5	15.8
Pale flesh colour	1.0	17.5	21.1
Loss of fat	1.0	7.5	-
Red spots/lesions on skin	8.6	25.0	-
Jaw deformity	-	-	5.3
Total fishers reporting	105	40	19

Bycatch

A potential consequence of target fishing for escapees is the incidental capture of non-target species or bycatch. To better understand this aspect of the fishery, respondents were asked about any bycatch they encountered when fishing for escapees, regardless of whether it was kept or released. Overall, leatherjackets and wrasse followed by bream, Australian salmon, flathead, draughtboard shark and bastard trumpeter were the most common bycatch species encountered by gillnets (Table 5). By contrast, Australian salmon and flathead were by far the most frequently caught bycatch of line fishing. Line fishers also reported catches of trout, presumably linked to targeting Atlantic salmon as they moved into the freshwater tributaries.

Unfortunately, given the way the surveys were conducted (i.e. based on recalled rather than shot by shot diary information) it was not feasible to ask respondents to report the numbers of individual bycatch species nor implications for survival for any non-retained catch. Several respondents did, however, note that the bycatch was released in a healthy condition. Nonetheless, consideration of bycatch does highlight an indirect ecological consequence of such escape events, that being the potential for increased pressure on a range of inshore and estuarine finfish species associated with intensive fishing for escapees.

Table 5. Reports of bycatch taken whilst targeting escapees, based on fishing method.

	Gillnet		Line fishing	
Species	**No. reports**	**% respondents**	**No. reports**	**% respondents**
Leatherjacket	56	51.4	1	1.8
Wrasse	46	42.2	3	5.4
Bream	23	21.1	3	5.4
Australian salmon	14	12.8	37	66.1
Flathead	12	11.0	35	62.5
Draughtboard shark	12	11.0		
Bastard trumpeter	11	10.1		
Skates & Rays	9	8.3	1	1.8
Gummy shark	8	7.3	1	1.8
Flounder	6	5.5		
Silver trevally	5	4.6		
Marblefish	5	4.6		
Elephant fish	4	3.7		
Boarfish	4	3.7		
Mullet	3	2.8	3	5.4
Banded Morwong	3	2.8		
Gurnard	2	1.8	2	3.6
Jackass morwong	2	1.8	1	1.8
Luderick	2	1.8		
Stargazer	2	1.8		
Cod	1	0.9	1	1.8
Blue warehou	1	0.9		
Conger eel	1	0.9		
Herring cale	1	0.9		
Tailor	1	0.9		
Bullseye	1	0.9		
Longfinned pike	1	0.9		
Saw shark	1	0.9		
Trout			5	8.9
Couta			4	7.1
Whiting			2	3.6
Squid			1	1.8
Mackerel			2	3.6
No. respondents	109		56	

Fisher motivation

Respondents were asked to rate the importance of a number of statements relevant to fishing for Atlantic salmon escapees. The vast majority (85%) indicated that the opportunity to catch a quality fish species to eat was an important (quite or very) motive for fishing for escapees (Fig. 4). To take full advantage of a “windfall” situation and to remove an introduced species from the environment were also important motivations for more than half of the respondents. The challenge of catching Atlantic salmon and because escapees are easy to catch in good numbers, were important motivations for slightly fewer than half of the respondents. Of least importance was the opportunity to avoid having to buy Atlantic salmon, only a third of respondents indicated that this was an important motivation.

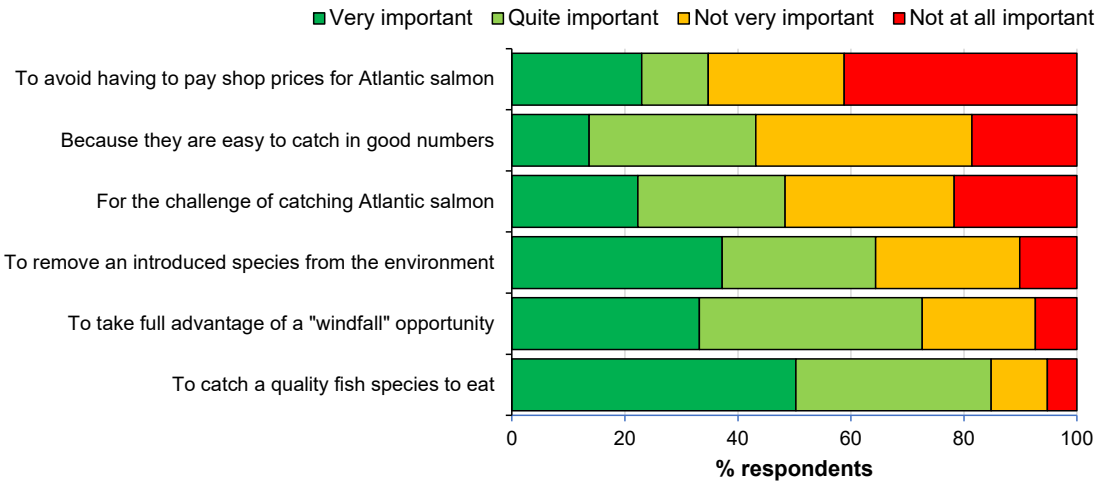

Fig. 4. Statements about possible motivations to fish for escapees and their importance to respondents (n = 184-191 depending on question).

The same motivation questions were posed in the survey of fishers targeting Atlantic salmon escapees following the major escape event in 2018 (Lyle, 2019). In order to compare between surveys, motivational importance was ranked on a four-point likert scale, where 1 is “not at all important” and 4 is “very important”, and responses to each question compared between surveys using the Mann-Whitney U test. Overall, the pattern of importance scores was similar in both surveys, with the highest importance linked “to catch a quality fish species to eat” followed by “to take full advantage of a “windfall” opportunity” and lowest importance associated with “to avoid having to pay shop prices for Atlantic salmon”. Statistically, however, greater importance was associated with the motivations to catch Atlantic salmon to eat, to remove an introduce species from the environment and to avoid having to pay shop prices in the current survey. The strongest difference related to the motive to remove an introduced species, with almost two-thirds of respondents indicating that it was an important motive for fishing for escapees following the most recent events compared with just 43% of respondents to the 2018 large-scale escape event.

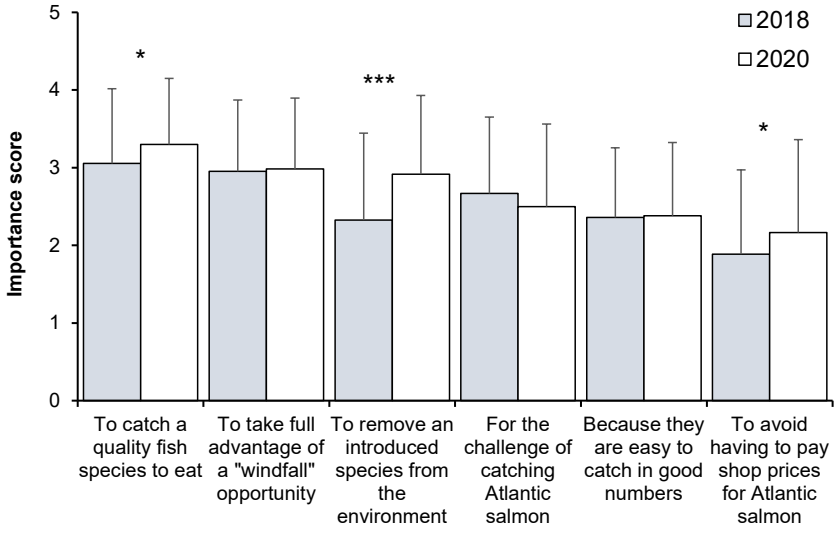

Fig. 5. Comparison of importance scores for possible motivations for fishing for Atlantic salmon escapees conducted following major escape events in 2018 and 2020. Error bars represent standard error, significant differences (p-values) are shown as * < 0.05 and *** <0.0001.

Management and general comments

Respondents were reminded of the marine fishing regulations relevant to Atlantic salmon which include a daily bag limit of 12, a possession limit of 24 fish per person and that size limits do not apply. In addition, it was noted that gillnets as well as line fishing methods are recognised as effective fishing methods. Respondents were then asked whether they wished to share any comments regarding the management of this fishery or general comments about fishing for escapees.

Almost half of those who responded indicated that since Atlantic salmon is an introduced species bag (and possession) limits should not apply; the priority should be to remove them from the environment as quickly and efficiently as possible (Table 6). Linked to this latter point and despite "benefiting" from such escape events, many of the comments related to concerns over environmental impacts of large-scale marine farming and escapees. While there was some support for gillnetting to capture escapees there was also concern expressed about poor fishing practices mainly associated with gillnets, including impacts on bycatch. There was very little support expressed for the current regulations as they relate to escapees. Similar questioning following the 2018 escape event also highlighted opposition to bag limits for escapees but also that such escape events represent a bonus for recreational fishers (Table 6). Concern was expressed about the impacts of salmon farming, although this issue did not feature as prominently in fisher's comments at the time.

Selected individual responses to the various key theme areas are provided in Table 7.

Table 6. General themes about management and issues surrounding escapees raised by survey respondents (2018 survey responses are provided for comparison).

Themes	No.	%	2018 (%)
Bag limits should not apply to escapees or be increased	54	49.1	27.0
Opposed to and/or concerned about environmental impacts of marine farming	28	25.5	7.9
Concerned about impact of escapees feeding on native fauna	12	10.9	11.1
Salmon farms should be penalised when escape events occur	10	9.1	
Escape events represent a bonus for recreational fishers	10	9.1	27.0
Supportive of using gillnets to catch escapees	10	9.1	3.2
Concerned about the increase in gillnetting associated with escape events, including poor fishing practices and impact on bycatch	8	7.3	7.9
Need for education and more policing to improve fishing practices	7	6.4	
Salmon farms should be land based to reduce environmental impacts	5	4.5	
Salmon farms should be moved offshore to reduce environmental impacts	3	2.7	
Generally supportive of current management arrangements	2	1.8	4.8
Other	10	9.1	15.9
No. respondents	111		63

Table 7. Selected responses to opened ended questions relating to the management and general issues surrounding the escape of Atlantic salmon.

Theme	Selected comments
Bag and possession limits	The bag limits seem a good idea to let more people catch some. I have enjoyed sharing them with friends. A bag limit on a pest species such as this is counterproductive. Understand that the idea is to give everyone a chance but the fact is that these fish do not belong in our waters and if people choose to remove them in large numbers, even if they are wasted, then that should be considered a positive outcome. Should be no bag limit at all. Feral fish should be removed without penalty. There should be no bag limit, they are an introduced species and fishermen should be encouraged to catching them, especially if caught in a net, throwing back dead or damaged fish like Atlantic Salmon in a waste especially as you normally end up netting large numbers in a single shot after that many escape. If salmon are an introduced species then total elimination should be the goal - no bag limit. With a 15% chance of the escapees surviving in the marine environment then a viable longer term management plan needs to be carefully considered. It is an absolute joke that there is a daily take limit and total possession limit on Atlantic Salmon a feral species, I am particularly flabbergasted when the take and possession limit is less than the native Australian Salmon. Why is this so when we have no idea of what the impacts of these escaped feral fish will be on the natural fishery. Furthermore what about the Atlantic Salmon that have escaped taught to eat by dropping food from the sky in their penned environment from birth, their chance of survival slim dying a slow horrible death if they are unlucky enough to not get caught. Where is the ethics in that? The only reason that I am able to come up with is the protection of the Salmon farming industry by government. I don't think bag limit should apply. Not hard to catch a 100 accidentally. I don't see any sensible reason for the current catch limit. If the salmon are an environmental issue, then the sensible course is to catch as many as possible as fast as possible. Why the bag limit on an introduced species, I'm sure the farms would like them moved from the wild asap.
Feeding	Have caught them in the past on rod and line. I and others who have caught plenty in nets have never found anything in their stomachs other than semi-digested pellets. These fish are a threat to our native environment and the rubbish the farms feed the public about how they don't eat native food is just lies to try to cover their continual stuff ups. These farms make many millions of dollars every year but are never prosecuted, this needs to change. I have never caught a poorly conditioned fish. Over the last 20 years, I estimate I have caught 200 fish. They must be feeding on native species. I have been catching Atlantic salmon fairly regularly in the upper middle Huon (ie upstream of Judbury) since the mid-1980s. Total catch over that time possibly of the order of 80(?) individual fish. All have tended to be empty of food organisms, and losing, or totally devoid of, teeth: classic signs of salmon on their way upstream for spawning, as they would in their native environment. Those caught late in the season (autumn) have been spilling ripe roe or milt at that point; early season (spring/summer) generally much less well-developed. All have followed a pattern of arriving in the pools after the river has experienced a fresh flow and is beginning to drop in level after being swollen. In the past I have caught Atlantic salmon which have had whitebait and crabs in their stomachs. These are fish that have learned to adapt many months after an escape. It would be interesting to know what percentage adapt. Also it would be interesting to know if any of them swim far away from Tasmania like the original salmon did 150 years ago. Maybe you should put a GPS on some.

Fish farms	Fish farmers need to be held accountable for these events and fines should reflect the seriousness of these mistakes by the industry. Fish farms should be cleaning up their own industrial spill, as with all other responsible industries. And not promoted as a windfall .... more of an environmental disaster. Recreational fishing in Tasmania is a very important pastime to local communities and economies. These escapee events increase participation and activity by local recreational fishers so must be seen at least particularly as a positive benefit. The fish farms have ruined fishing in the Cygnet area so being able to catch large numbers of salmon is being seen as a small 'win' after the many years of 'losses'. I have not seen this type of activity on the water or the same buzz around conversations at the boat ramps for many years. Fishing used to always be like this once upon a time, especially when Cygnet held its annual Fishing Carnival, however the waterway has been severely impacted by fish farms, rising water temp and stormwater runoff for years. Its sad, but I understand the importance of Aquaculture for the region. I just wish they could find better ways of doing it offshore.
Gillnets	It was also on my mind about the damage to more natural species numbers with the onset of so many nets in the area targeting the less welcome Atlantic Salmon. My experience fortunately however, was there was very little by catch when net fishing for the salmon. Very heavy impact on native species because of vastly increased total number of net hours. How can you possibly police a bag limit of 12 on netters. Don't the fish die in the net? And they could have 50 in the net. Also I noticed that a dolphin and its baby dies in a net not long after the escape. Perhaps it's time we get rid of inshore netting. There should be no daily bag limit and no possession limit....the current restrictions limit the timely removal of this invasive species from the marine environment. Likewise overnight gill netting should be permitted whilst targeting this species. Catching escapees by angling is virtually impossible so I wouldn't bother trying to 'manage' the 'fishery'. Just let the netters clean them up. We need to keep graball nets legal for this exact event. The rules around nets have been improved. Ie check them every 2 hours etc. During an event like this how about relaxing the licensing requirements and letting other family members check and set, pull nets. I was exhausted.!!! Tried numerous times to catch the escapees with a lure, but despite seeing the fish jumping, they still wouldn't take a lure. Gillnets are effective and productive and bycatch isn’t a concern if soak times are observed (2hs) and bycatch released fresh and unharmed. Recreational gillnet fishing must be allowed to continue to assist in the removal of these fish from our waters. These fish escapes have been a regular occurrence since the fish farms became established in Tasmania. Netting is brilliant for these species & needs to be maintained with its current rules. Bag limit should be increased to avoid having to throw back week or dead fish. Wild fish are generally fine for less than 2hrs and release ok but the salmon seem to die quick. Allow overnight netting for 2 weeks after mass escape so as to catch as many as possible before they die

Biological sampling

General

A total of 106 Atlantic salmon were examined, 80 assumed linked to the November escape event (cohort of large-sized fish), six associated with the December escape event (cohort of small-sized fish) and 20 farm-based fish from the same cohort as those involved in the December escape event. These latter fish were sampled from the fish pen 19 days after the escape event and were provided as a baseline or reference sample[3]. Targeted sampling of escapees with gillnets and line fishing commenced shortly after the November 2020 escape event and continued until April 2021 and included fish provided by recreational fishers and DPIPWE.

The two cohorts are clearly apparent based on length frequency distributions (Fig. 6) and collection details are reported separately for each cohort in Tables 8 and 9. The smaller-sized group averaged 364 mm fork length (range 283-400 mm) and 716 g body weight (range 298-990 g) which compared with an average of 618 mm (range 535-731 mm) and 3498 g (range 2139- 4173 g) for the larger-size group. Despite concerted fishing effort, sample sizes of the larger-size group declined sharply after December. Capturing representatives of the smaller-sized cohort proved especially challenging, with very few individuals sampled despite the larger number of initial escapees. These experiences mirrored those of surveyed fishers who also reported low catches of fish in the < 1 kg size class compared with the > 3 kg group (refer Table 1).

Assuming that all sampled escapees were derived from either the November or December 2020 events, our data suggest that some individuals had survived for 160 days in the case of the larger-size group and 150 days in the case of the small-sized cohort, substantially longer than indicated by previous studies (Bell *et al.,* 2016; Lyle, 2019) and based on the present fisher surveys. Interestingly, all fish sampled after February 2021 were captured in freshwater river habitats.

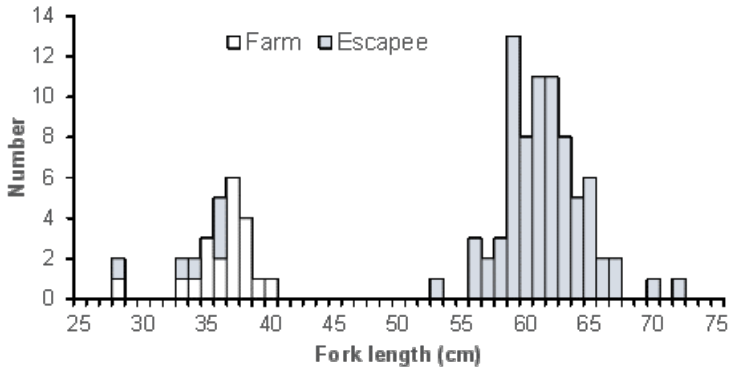

Fig. 6. Size composition of Atlantic salmon sampled for biological examination. Sample of farm fish provided as a baseline for the cohort of small fish is highlighted.

[3] This delay was unavoidable and linked to on-farm operational factors.

Table 8. Details of Atlantic salmon escapees sampled for biological examination assumed to be linked to the November 2020 escape event.

		Fork length (mm)			Body weight (g)		
Date(s)	**No.**	**Average**	**Min.**	**Max.**	**Average**	**Min.**	**Max.**
25/11/2020	20	598	535	630	3619	2139	4125
12-13/12/2020	16	617	570	655	3699	2630	4173
20-22/12/2020	12	617	579	731	3424	3051	4086
07-15/01/2021	3	595	591	599	3138	2729	3504
20/01/2021	4	648	637	659	3412	3188	3617
30/01/2021	5	629	605	660	3483	2915	4000
15-17/02/2021	4	643	605	670	3356	2940	3865
14/03/2021	5	640	620	660	3671	3307	4066
02/04/2021	2	613	610	615	3109	3077	3140
10/04/2021	6	636	625	650	3189	2845	3714
26/06 - 02/05/2021	3	623	620	625	3155	3005	3259
Total	80	618	535	731	3498	2139	4173

Table 9. Details of Atlantic salmon sampled for biological examination assumed to be linked to the December 2020 escape event. Samples include fish sourced from the same cohort that escaped and provided by the aquaculture company to represent a baseline for sampling (highlighted).

		Fork length (mm)			Body weight (g)		
Date	**No.**	**Average**	**Min**	**Max**	**Average**	**Min.**	**Max.**
17/12/2020	2	350	339	361	568	505	631
20/12/2020	1	344			494		
21/12/2020	***20****	***366***	***283***	***400***	***779***	***298***	***990***
15/01/2021	2	366	362	369	500	462	537
1/05/2021	1	375			479		
Total	26	364	283	400	719	298	990

Stomach content analysis

Of the 86 escapees examined for stomach contents only two individuals (<3%) had items present, a 635 mm individual captured on 10/04/2021 had unidentified organic detritus weighing 4.9 g while a second individual, a 375 mm individual captured on 01/05/2021 had consumed unidentified insects (as well as leaf matter). Both individuals were captured in the Huon River.

Condition

Changes in the condition (Fulton's K and HSI) of the larger-sized cohort are presented in Figs 7 and 8. Both indices declined over time, the decline in median values being particularly marked between week 1 (i.e. within the first seven days at liberty) and week 3 (6% reduction for Fulton's K and 23% for HSI). Thereafter, Fulton's condition index underwent a progressive and gradual decline with time whereas HSI remained relatively stable over the following four months such that the median HSI for weeks 9-23 combined was only 1% lower than that for weeks 3-8. The same comparison based on Fulton's K indicated a 16% decline. The involvement of energy reserves in the viscera was also suggested in Fig. 9, with a sharp decline in visceral weight (which included the liver) up until weeks 7-8 after which there was little change. Collectively, these data suggest energy reserves stored in the liver (and associated visceral fat) was used initially before drawing down on energy stored in the muscle tissue. Thus, although some escapees survived for several months in the wild, these data suggest that

they were gradually wasting rather than thriving and thus unlikely to survive long-term. Examination of biochemical changes in key sources of stored energy, such as fatty acid, lipid and protein concentrations, in the liver and muscle tissue would complement the physical indicators of condition to shed further light on this issue.

There was insufficient data to do a comparable analysis for the smaller sized cohort. However, declines in both condition indices were evident in the small number of individuals examined, falling to about 60% of the values determined in the sample of farmed fish (from averages of 1.40 and 1.27 for Fulton's K and HSI, respectively in the farmed fish to 0.85 and 0.74 in the longest surviving fish captured).

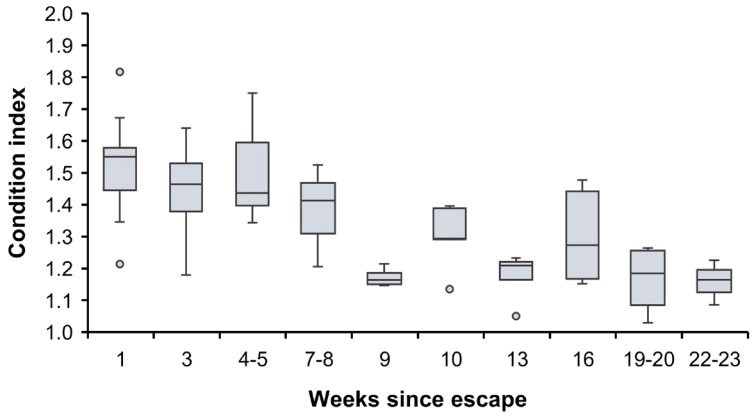

Fig 7. Temporal changes in condition (Fulton's K) for the cohort of large escapees by time since the late November escape event. Box and whisker plots show upper and lower quartiles, median and upper and lower extreme values. Outlier values are indicated by circles**.**

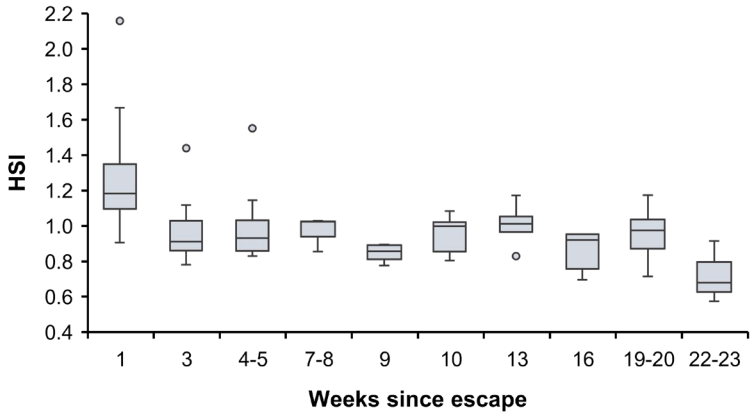

Fig 8. Temporal changes in hepatosomatic index (HSI) for the cohort of large escapees by time since the late November escape event.

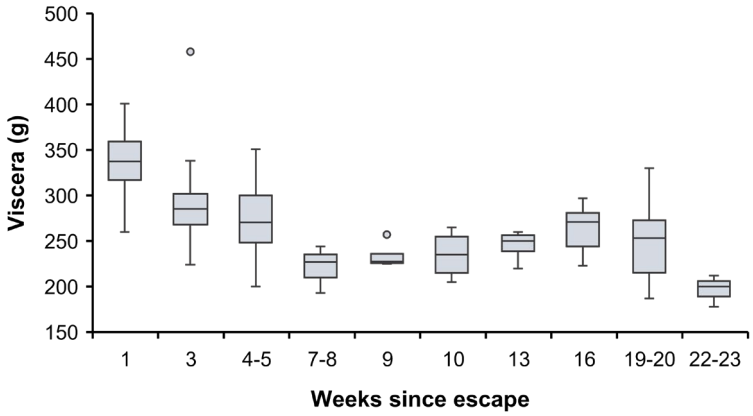

Fig 9. Temporal changes in viscera weight (not standardised for fish size) for the cohort of large escapees by time since the late November escape event.

Conclusions

Key findings

This study has provided further insight into the dispersal, survival and potential impacts on native fauna of Atlantic salmon escapees. Consistent with previous experience (e.g. Lyle, 2019), dispersal was rapid but appeared to be largely restricted to south-eastern Tasmania, within the general Storm Bay region but in particular in the D'Entrecasteaux Channel and associated tributaries. During the first four weeks there were reports of escapees being schooled up in various locations throughout the region, in such situations they were readily captured by gillnet and line fishing methods. Of note, these catches were dominated by the cohort of larger-size fish, comparatively few of the small-sized cohort were reported captured despite over double the number of fish associated with the escape event. Research fishing using both gillnet (including small mesh nets) as well as line fishing also resulted poor representation of these smaller fish, restricting inferences that can be made about this cohort.

Based on fisher reported capture dates, and assuming that most if not all of the Atlantic salmon were from either of the late 2020 escape events, it can be inferred that at least some fish had survived at liberty for almost four months. Research fishing included samples collected at least five months after the escape event, suggesting that small numbers of fish may survive longer than suggested by the fisher survey. However, after the first month or so following the escape recreational catches were observed to drop off markedly, likely associated to dispersal and low abundances of surviving fish.

Survival for several months does not necessarily mean that these fish were thriving, in fact there was very limited evidence to suggest active feeding on native fauna and, based on physical condition indicators, it was likely that fish were exhausting energy reserves and effectively wasting away. Examination of biochemical changes in key sources of stored energy, such as fatty acid, lipid and protein concentrations, in the liver and muscle tissue would complement the physical indicators of condition to shed further light on this issue.

An additional but indirect ecological consequence of such escape events is the impact on inshore and estuarine finfish species taken as bycatch when fishing for escapees. While it was not feasible to assess the magnitude nor survival of such bycatch in the present study, heavy and concentrated fishing activity, especially by gillnets, is expected to have at least some implications for localised fish populations and thus may warrant further investigation.

Most recreational fishers target escapees motivated to capture a premium table fish and/or to take advantage of a windfall opportunity. Many fishers did, however, express concern about the potential ecological impacts of escapees and were also motivated to contribute to the fish-down of the introduced species, a sentiment that was expressed more strongly than in a similar survey following a mass escape event in 2018.

Response to future escape events

As a condition of their environmental licence, marine farm operators in Tasmania are required to report escapes of 500 or more fish to the regulator. While there are no requirements for industry to implement measures to recover the escapees, provision has been made to allow for targeted fishing for escaped fish in the past. For instance, in the early 2000s a commercial fisher was engaged by industry to fish down escapees following large escape events in Macquarie Harbour (Steer and Lyle 2003). Consistent with experiences from the northern hemisphere gillnets proved to be an effective fishing method (e.g. Skilbrei and Jorgensen 2010, Chittenden *et al.* 2011). However, the dispersal of the fish meant that catch rates declined rapidly through time, indicating that timing was critical if this strategy was to be effective.

In practice, large salmonid escapes tend to attract considerable interest from recreational and commercial fishers who have been shown to have significant and relatively immediate impacts on the number of escapees surviving (Skilbrei and Wennevik 2006, Skilbrei and Jorgensen 2010, Chittenden *et al.* 2011). This is certainly the case in Tasmania and, as evident in the current case, even though fishing effort was spatially widespread reflecting the dispersed distribution of the escapees, there were hotspots where catches were concentrated.

These observations suggest that if a more proactive stance in relation to the fish down of escapees was to be considered, targeted fishing of such locations with gillnets by contractors, rather than adjacent to farm sites, could represent an effective strategy.

Given the fact that large-scale escape events are rare and unpredictable developing a research response to address the ecological implications of these events is problematic and challenging. Nonetheless, engagement of recreational fishers has proven effective in delivering basic information about the behaviour and possible impacts of escapees.

There were, however, constraints in the present study. Firstly, delays necessitated by the time taken to scope out and design the fisher survey, to obtain appropriate ethics approvals and implement and promote the survey all meant that compromises were necessary. For example, the reliance on respondent self-selection and recalled information, limited detail about individual fishing events (contrast the detail achieved with the phone-diary approach, e.g. Lyle *et al*. 2019), and a limited ability to follow up respondents were issues. Secondly, challenges associated with catching escapees after the first month or so and, in particular the lack of samples of the smaller-sized cohort, meant that inferences about the ecological impacts were limited. If fish sampling is undertaken by researchers, prior animal ethics approval is required, along with adequate budget and logistic support for field collections and sample processing (including biochemistry). In order to move forward and begin to more formally address the implications of salmonid escapes in Tasmania, the ability to respond rapidly to future large-scale escape events will be paramount. Building on experiences from 2018, the recent research response has refined sampling protocols and arranged ethics approvals (valid for 3 years) that should provide a solid basis to respond more quickly in the event of further mass escape events.

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Finally, and most importantly, the support and interest of the fishers who participated in the survey is greatly appreciated.

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Appendices

Appendix 1. Survey invitation

Been fishing for escapee Atlantic salmon recently? – if so IMAS is interested in hearing from you.

Escapee Atlantic salmon fishing survey

In early May storm damage to a marine farm located to the east of Bruny Island resulted in the escape of a significant number of Atlantic salmon. While representing a bonanza for recreational fishers, relatively little is known about the impacts of such escape events. There are several important questions that arise, these include how widely and how quickly do escapees disperse, how long do they survive in the wild, and are they able to adapt to feeding on natural prey items.

Using this recent escape event as a case study we are inviting recreational fishers to share their experiences in catching escapees. By mapping the area over which the Atlantic salmon have been caught we can better understand patterns of dispersal and, by tracking catch rates through time, we hope to make inferences about survival rates. Finally, any observations about the presence or absence of food items in the stomachs will help understand whether the escaped fish feed on natural prey.

If you would like to find out more either go to:

https://www.surveymonkey.com/r/EscapeeSalmon

or, if you would prefer to receive information by mail, please contact Graeme Ewing (IMAS) on 03 6226 8228 or Graeme.Ewing@utas.edu.au so we can post you a copy.

Appendix 2. **Escapee Atlantic salmon fishing survey**

UNIVERSITY of TASMANIA | IMAS INSTITUTE FOR MARINE & ANTARCTIC STUDIES

Escapee Atlantic Salmon Fishing Survey 2020

Information for Participants

Thank you for considering taking part in this survey. Please note, respondents should be 18 years or older and have been fishing for escapee Atlantic salmon.

In late November and again in early December 2020 Huon Aquaculture reported the escape of a large number of Atlantic salmon from fish farms located in the D'Entrecasteaux Channel and in Storm Bay. In the earlier escape event, over 50,000 Atlantic salmon, each about 4 kg were reported lost. In the second event over 120,000 salmon of 500-600 g escaped.

Since then, there have been numerous reports of recreational fishers targeting escapees using a range of fishing methods. While these fish represent a bonanza for fishers there are outstanding questions surrounding the ecological implications of such a large loss of fish; specifically how far and how quickly they disperse; how long they survive in the wild; and do they consume native fauna? By harnessing your experiences and observations we hope to be able to better answer these questions.

This survey is being conducted by the Institute for Marine and Antarctic Studies (IMAS), participation is voluntary and expected to take 10-15 minutes to complete. There are four sections: (1) Information about you; (2) Your fishing for escapees; (3) General comments; and (4) Future fishing plans. Each section has an explanation of what is involved to answer the survey.

Please be assured, any personal identifying information that you provide will be treated in the strictest confidence and will be removed from the databases at the completion of the study. Other information will be held for five years and then destroyed. Any reports will involve combined information and thus any comments or responses will not be individually identifiable. When available, reports from this study will be promoted through various IMAS media platforms.

This study has been approved by the UTAS Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 2975 or email ss.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. Please quote ethics reference number S24021.

If you have any questions about the study feel free to contact me on (03) 6226 8255 or by email at Jeremy.Lyle@utas.edu.au.

By submitting your survey response you are providing your consent to participate in this study.

In anticipation, thank you for your co-operation and we look forward to your contribution to this important study.

Assoc Prof Jeremy Lyle

(Project Leader)

Escapee Atlantic Salmon Fishing Survey 2020

PART A: INFORMATION ABOUT YOU

First we have some questions about you and yourgeneral fishing experience.

1. How many years have you been actively involved in recreational fishing?

2. During the past 12 months how many days did you spend **saltwater fishing** in Tasmania, whether you caught anything or not?

3. During the past 12 months how many days did you spend **freshwater fishing** in Tasmania, whether you caught anything or not?

4. Are you the holder of a current Graball or Mullet net licence?

◯ Yes ◯ No

5. Your age? (Please note respondents should be 18 years or older)

◯ Under 20
◯ 20-29
◯ 30-39
◯ 40-49
◯ 50-59
◯ 60-69
◯ 70 plus

6. Your gender?

◯ Male ◯ Female ◯ Other

7. Your postcode?

Escapee Atlantic Salmon Fishing Survey 2020

PART B: YOUR FISHING FOR ESCAPEES

In this section, we want you to think about all of the fishing you have done for Atlantic salmon since the first of the two major escape eventsin late November 2020, in particular when and where you went fishingand how many escapees you have captured.

The two escape events involved vastly different size classes of fish -the first involved fish of about four kilos and the second fish of less than a kilo. We are particularly interested in understanding how the dispersal and behaviour of the two groups may have differed. If you have captured Atlantic salmon in both of these size groups we wouldappreciate any information you have that relates to either group.

Your information will be combined with that reported by other fishers to describe how far and over what timeframe the two groups of salmon dispersed from the farm sites. Trends in catch rates will help us understand the rate of fish-down of the escapees, noting that predation by seals, sharks and other marine predators as well as starvation are also expected to reduce numbers.

8. Have you done any fishing or netting for escaped Atlantic salmon since the 23rd November 2020?

- ◯ Yes - PROCEED TO NEXT QUESTION
- ◯ No - **PLEASE PROCEED TO THE END OF THIS PAGE AND CLICK "NEXT"**

9. On how many separate days have you fished for Atlantic salmon since the escape eventsin late November/early December?

10. Since the escape events in late November/early December, how many Atlantic salmon have you personally caught?

IF YOU ANSWERED ZERO, PLEASE PROCEED TO THE END OF THIS PAGE AND.

CLICK "NEXT"

11. How many of these Atlantic salmon that you caught were smaller than about 1 kg (presumably from the second escape event in early December)

12. Which of the following methods have you used successfully to catch Atlantic salmon from these recent escape events? (Please tick as many as are relevant to you)

- [ ] Graball
- [ ] Mullet net
- [ ] Lure
- [ ] Fly
- [ ] Bait
- [ ] Other

Any additional comments?

13. What was the earliest date following the recent escape events that you **caught** an Atlantic salmon escapee?

Date fished

Date

DD/MM/YYYY

14. Where was this?

15. If you have caught escapees since then, when was your **most recent successful fishingtrip** for the escapees?

Date fished

Date

DD/MM/YYYY

16. Where was this (if different to above)?

17. Are there any other locations you have also caught Atlantic salmon since the late November/early December escape events?

18. Are you aware of any other locations that recreational fishers have also caught Atlantic salmon since the late November/early December escape events (Please list)?

19. What was the approximate weight range of the escapees you caught?

20. Do you have any observations about the general condition (including flesh colour and appearance) and behaviour of the escapees that you would like to share?

3 kg plus size group (ifrelevant)

Less 1 kg size group (ifrelevant)

Other sizes (if relevant)

21. Escapees are generally considered poorly adapted to feeding on natural prey. Have you observed evidence that any of the Atlantic salmon from the recent escape events successfullyfed on natural prey items. (Tick which best represents your observations).

- Unsure, did not check stomach contents
- **Checked ALL of my catch**, all stomachs were empty (excluding sticks, stones or bait items)
- **Checked SOME of my catch**, all stomachs were empty (excluding sticks, stones or bait items)
- **Checked ALL of my catch**, at least one stomach had food items present
- **Checked SOME of my catch**, at least one stomach had food items present

If food items were present in the stomach contents, can you provide further details?

22. When **targeting escapees** what, if any, other species have you caught (including those you released)?

By gillnet (if used)

By line fishing (if used)

Other comments aboutbycatch

Escapee Atlantic Salmon Fishing Survey 2020

PART C: GENERAL COMMENTS

23. Motivations:

Below are some statements about motivations for fishing for Atlantic salmon escapees, please indicate how important each statement is to you and your decision to go fishing for escapees.

	Importance
To catch a qualityfish species to eat	
For the challenge of catching Atlantic salmon	
To remove an introduced speciesfrom the environment	
To take full advantage of a"windfall" opportunity	
Because they areeasy to catch in good numbers	
To avoid having to pay shop prices for Atlantic salmon	

24. Management:

The fishery for Atlantic salmon in marine waters is based exclusively on escapees from marine farms. Fishing regulations for Atlantic salmon include a daily bag limit of 12 and a possession limit of 24 per person. There are no size limits. Gillnets as well as line fishing methods are recognised as effective fishing methods.

Do you have any comments regarding the management of this fishery or general comments about fishing for escapees that you would like to share?

25. Additional comments:

Do you have any other comments that you would like to share?

Escapee Atlantic Salmon Fishing Survey 2020

PART D: FUTURE FISHING PLANS

26. How likely is it that you will go fishing again for escapees over the next couple of months?

◯ Quite likely ◯ Not very likely ◯ Not sure

27. Would you be willing to be contacted again in the near future about your fishing for escapees? The main reasons we would like to hear from you is to better understand how long escapees survive in the wild, whether they continue to disperse away from their releasesites, and how their condition and behaviour changes?

◯ No ◯ Yes

28. If you answered Yes to the previous question, what is your preferred method of contact?

Email ◯

Phone ◯

29. What are your contact details?

Name

Email Address

Phone Number

We will endeavour to be in touch again within the next 4-6 weeks.

THANK YOU FOR YOUR PARTICIPATION

Escapee Atlantic Salmon Fishing Survey 2020 – Follow-up

Information for Participants

Thank you for considering taking part in this follow-up survey.

In late November and again in early December 2020 Huon Aquaculture reported the escape of a large number of Atlantic salmon from fish farms located in the D'Entrecasteaux Channel and in Storm Bay.

Since then, there have been numerous reports of recreational fishers targeting escapees using a range of fishing methods. While these fish represent a bonanza for fishers there are outstanding questions surrounding the ecological implications of such a large loss of fish; specifically how far and how quickly they disperse; how long they survive in the wild; and do they consume native fauna? By harnessing your experiences and observations we hope to be able to better answer these questions.

This study has been approved by the UTAS Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 2975 or email ss.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. Please quote ethics reference number S24021.

Also, if you have any questions about the study feel free to contact me on (03) 6226 8255 or by email at Jeremy.Lyle@utas.edu.au.

By submitting your survey response you are providing your consent to participate in this study.

In anticipation, thank you for your co-operation and we look forward to your contribution to this important study.

Assoc. Prof. Jeremy Lyle (Project Leader)

PART A: INFORMATION ABOUT YOU

First we have some questions about you.

1. Your age? (Please note respondents should be 18 years or older)

- ◯ Under 20
- ◯ 20-29
- ◯ 30-39
- ◯ 40-49
- ◯ 50-59
- ◯ 60-69
- ◯ 70 plus

2. Your gender?

◯ Male ◯ Female ◯ Other

3. Your postcode?

PART B: YOUR RECENT FISHING FOR ESCAPEES

In this section, we want you to think about the fishing you have done for Atlantic salmon since you completed the original on-line survey – for most respondents this will relate to fishing undertaken on or after XXXXX [*LAST SURVEY DATE*].

The two escape events involved vastly different size groups of fish - the first involved fish of about four kilos and the second fish of less than a kilo (500-600 g). We are particularly interested in understanding how the dispersal and behaviour of the two groups may have differed. If you have captured Atlantic salmon in both of these size groups we would appreciate any information you have that relates to either group.

Your information will be combined with that reported by other fishers and added to responses collected as part of the original escapee survey to describe how far and over what timeframe the two groups of salmon dispersed from the farm sites. Trends in catch rates will help us understand the rate of fish-down of the escapees, noting that predation by seals, sharks and other marine predators as well as starvation are also expected to reduce numbers.

4. Have you done **any fishing or netting for escaped Atlantic salmon since completing the original survey (or at least since the XXXXX)?**

- ◯ Yes - PROCEED TO NEXT QUESTION
- ◯ No - **PLEASE PROCEED TO THE END OF THIS SECTION AND CLICK "NEXT"**

5. How many days have you fished for Atlantic salmon since completing the original survey (or at least since the XXXXX)?

6. How many Atlantic salmon did you catch for these additional fishing days?

IF YOU ANSWERED ZERO, PLEASE PROCEED TO THE END OF THIS SECTION AND CLICK "NEXT"

7. How many of the Atlantic salmon reported in Question 6 were smaller than about 1 kg (presumably from the second escape event in early December)

8. Which of the following methods have you used successfully to catch Atlantic salmon since completing the original survey (or at least since XXXXX)? (Please tick as many as are relevant to you)

- ☐ Graball
- ☐ Mullet net
- ☐ Lure
- ☐ Fly
- ☐ Bait
- ☐ Other

Any additional comments?

9. When was your **most recent successful fishing trip** for Atlantic salmon escapees?

Date fished

Date

DD/MM/YYYY

10. Where was this?

11. Are there any other locations you have also caught Atlantic salmon since completing the original survey (or at least since XXXXXX?

12. Are you aware of any other locations that recreational fishers have also caught Atlantic salmon since mid- December (Please list)?

13. What was the approximate weight range of your recent catches of escapees?

14. Do you have any observations about the general condition (including flesh colour and appearance) and behaviour of your **most recent catches** that you would like to share?

3 kg plus size group (ifrelevant)	
Less 1 kg size group (ifrelevant)	
Other sizes (if relevant)	

15. Escapees are generally considered poorly adapted to feeding on natural prey. Have you observed evidence that any of the Atlantic salmon from the recent escape events successfullyfed on natural prey items. (**Tick which best represents your observations that only relate to catches taken since completing the original survey and reported here**).

- ○ Unsure, did not check stomach contents
- ○ **Checked SOME of my catch**, all stomachs were empty (excluding sticks, stones or bait items)
- ○ **Checked SOME of my catch**, at least one stomach had food items present
- ○ **Checked ALL of my catch**, all stomachs were empty (excluding sticks, stones or bait items)
- ○ **Checked ALL of my catch**, at least one stomach had food items present

If food items were present in the stomach contents can you provide further details?

16. When **targeting escapees** what, if any, other species have you caught (including those you released)? Focus on your fishing since completing the original survey or at least since the XXXXX.

By gillnet (if used)	
By line fishing (if used)	
Other comments about bycatch	

17. Additional comments:

Do you have any other comments that you would like to share?

PART C: FUTURE FISHING PLANS

18. How likely is it that you will go fishing again for escapees over the next couple of months?

◯ Quite likely ◯ Not very likely ◯ Not sure

19. Would you be willing to be contacted again in the near future about your fishing for escapees? The main reasons we would like to hear from you is to better understand how long escapees survive in the wild, whether they continue to disperse away from their release sites, and how their condition and behaviour changes?

◯ No ◯ Yes

20. If you answered YES to the previous question, what is your preferred method of contact?

◯ Email

◯ Phone

21. What are your contact details?

Name

Email Address

Phone Number

22. Would you like to receive a summary of the survey results (when completed)?

◯ Yes

◯ No

AGAIN, THANK YOU FOR YOUR PARTICIPATION