Results of the 2001 Marine Recreational Chinook Catch and Release Mortality Study at Work Channel and Dundas Island, British Columbia

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This report documents short-term (<24 hour) catch and release mortality rates for adult ehinook captured in a marine reereational fishery at Work Channel and Dundas Island just north of Prinee Rupert, British Columbia, during June 2001. A total of 157 adult ehinook were captured and held for observation. Two gear types (motor-mooched herring and trolled herring from downriggers) were tested and up to six charter boats conducted the fishing. A total of 16 ehinook died, for a combined gear/study mortality rate of 0.102 (95% c.l. 0.062-0.163). Short-term mortality rates were not significantly different ($p>0.05$) for chinook captured on motor-mooched herring (0.091, 95% c.l. 0.042-0.167), or trolled herring from downriggers (0.121, 95% c.l. 0.049-0.236). The average size of fish held for study was 92.2 cm for males and 87.1 cm for females. No size-specifie relationships between hooking mortality and fish size were found.

Hook location was the major factor associated with hooking mortality. All of the fish that died were those that had been hooked in lethal areas (e.g. deep mouth) where hooking injuries to various blood vessels and structures associated with the gills, brain, heart and internal organs occurred.

RÉSUMÉ

Cox-Rogers, S. 2004. Results of the 2001 marine recreational chinook catch and release mortality study at Work Channel and Dundas Island, British Columbia. Can. Manuscr. Rep. Fish. Aquat. Sci. 2675: vi + 12 p.

Ce rapport documente (< 24 heure) pour le chinook d'adulte capturé dans une pêche récréationnelle marine à la Manche de travail et au nord juste d'île de Dundas de prince Rupert, Colombie Britannique, pendant juin 2001. Un total de chinook de l'adulte 157 ont été capturés et tenus pour l'observation. Deux types de vitesse (les harengs de moteur-mooched et trolled des harengs des downriggers) ont été examinés et jusqu'à six bateaux de charte ont conduit la pêche. Un total du chinook 16 est mort, pour une vitesse combinéetaux de mortalité d'étude de 0.102 (95% C.I. 0.062-0.163). Les taux à court terme de mortalité n'étaient pas sensiblement différents (p>0.05) pour le chinook capturé sur les harengs de moteur-mooched (0.091, 95% C.I. 0.042-0.167), ou trolled des harengs des downriggers (0.121, 95% C.I. 0.049-0.236). La taille moyenne des poissons tenus pour l'étude était de 92.2 centimètres pour des mâles et de 87.1 centimètres pour des femelles. Aucun rapport taille-spécifique entre la mortalité et la taille d'accrochage de poissons n'a été trouvé.

L'endroit de crochet était le facteur principal lié à la mortalité d'accrochage. Tous les poissons qui sont morts étaient ceux qui avaient été accrochés dans les secteurs mortels (e.g. la bouche profonde) où accrochant des dommages à de divers vaisseaux sanguins et structures s'est associée aux ouïes, cerveau, le coeur et les organes internes se sont produits.

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INTRODUCTION

Since 1998, Fisheries and Oceans Canada has conducted five eatch and release studies of adult salmon (4 coho studies, 1 chinook study) captured in marine recreational fisheries in northern British Columbia (Cox-Rogers 1998, Cox-Rogers 2000, Thomas 2000). The primary objective of these studies has been to gather data on short-term (<24 hour) hooking mortality rates for coho and chinook captured and released by anglers in different fishing locations. A secondary objective has been to gather data on factors affecting hooking mortality, and to compare the findings with results from similar studies.

The findings from these and other studies conducted to date (Cox-Rogers et al 1999) indicate that hooking mortality can vary for the same salmon species captured on similar gears in different fishing areas. These results have not been surprising, as hooking mortality is known to be influenced by a wide range of factors including fishing technique, fish size, fish behaviour and aggressiveness, food availability, fish abundance, stage of maturity, temperature/season, depth of capture, hook size and type, and angler skill in playing, landing and releasing (Muoneke and Childress 1994). In order to accurately characterize mortalities in British Columbia recreational salmon fisheries, it's necessary to measure encounters by gear and method type and apply mortality rates appropriate to the gears and methods being used in a specific fisheries (Cox-Rogers 1999).

This report documents short-term (<24 hour) catch and release mortality rates for adult chinook captured in a marine recreational fishery at Work Channel and Dundas Island just north of Prince Rupert, British Columbia, during June 2001. Two gear types common to these fisheries (motor-mooched herring and trolled herring from downriggers) were tested and up to six charter boats conducted the fishing.

METHODS

Study Location and Fishing Methods

The study took place at the mouth of Work Channel from June 11-15, 2001 and at Dundas Island (Arniston Point) from June 25-29, 2001. Both study areas are just north of Prince Rupert and are popular sports fishing locations. Four to six local charter boats were hired to fish for chinook using a) motor-mooched herring and b) trolled herring fished from downriggers. A diverse cross-section of anglers fished aboard each boat most days. Up to four rods were fished from each boat. Fishing commenced at 0830 hrs and continued until early afternoon (1500 hrs). On each day, an equal number of boats were assigned to fish motor-mooched herring, and trolled herring from downriggers. An independent contractor was hired to record data and to co-ordinate holding activities.

Motor-mooched herring were fished head-off (cut-plug) on tandem 4/0 to 5/0 barbless J hooks. Light sliding weights (4oz to 8oz) were connected to the mainline above the swivel and leader system. Bait action was maintained using small auxiliary motors to hold boats relatively stationary to (or drifting slowly back with) the current when the tide was running. When eurrents were slaek, anglers maintained bait aetion by slowly trolling the baits through the water using forward movement of the boat. A preferred angle of 45 degrees or so was maintained on each line. Eddies and side currents off points close to shore were preferred mooehing locations. Fishing depths were 3 meters to 20 meters

Trolled herring were fished from downriggers without flashers. Herring were fished as eut-plugs on tandem barbless 4/0 to 5/0 J hooks. Constant forward movement of the boat (a slow sustained troll) maintained gear action. Fishing depths were 3 meters to 20 meters

Fish Handling and Holding

Anglers first played Chinook until they could be netted at the side of the boat. Once netted, skippers recorded biological and speeific hook location information for each fish on a standardised data form. If the hook (s) was not visible or easily extracted because of deep hooking, anglers often cut leaders and the hook (s) was left in the fish to avoid further injury. Following inspection, landed fish were either transferred directly to a live-tank equipped 6.3m retrieval Zodiac, or held for retrieval in 1.2m fish holding bags (pliant vinyl tubes) tethered to the stern of each boat until pick-up occurred. Upon retrieval, each chinook was tagged and transported to a holding site in closc proximity to the fishing grounds. Transport times between the fishing and holding sitcs ranged betwecn 2 and 5 minutes depending upon sea conditions. As many as six chinook were transported at one time using this approach. VHF radio contact was maintained between the holding site and the Zodiae at all times.

Data records kept by thc skippers for each chinook landed included the location of each hook (s), the degree of hook damage, the degree of bleeding, the degree of scale loss, and a fish tag number. An activity log for each rod being fished aboard each boat was also kept by each skipper to record the total number of strikes, hook-ups, losscs and landings for each rod. The skippers recordcd three major categories of hooking location by refcrencc to a record diagram.

Deep Mouth: for hooks located in the pharynx/gill area, including hooks swallowed or lodged into the pharynx, gill arches, or other posterior portions of the mouth. Hooks located in this area were not easily seen by casual inspection or easily removed, and were oflen left in the fish. Specific hook location categories for the deep mouth would include thc pharynx, gills, swallowcd, and "other", such as penetration wounds through thc roof of the mouth into thc brain.

Outer Mouth: for hooks located in thc outer jaw region, not ineluding areas associated with the deep mouth region, but including the upper and lowcr jaws, the roof or floor of

the mouth, the maxillary, the tongue, or other anterior portions of the mouth. Hooks located in this area were easily seen by casual inspection and easily removed. Specific hook location categories for the outer mouth would include the upper jaw, lower jaw, roof, maxillary, tongue, and "other", such as in the kype.

Outside of the Mouth: for hooks located outside of the outer mouth and jaw area but including the outer head and body, eye, fins, tail, isthmus, and other locations not associated with the mouth. Hooks in this area were easily seen by casual inspection and easily removed. Specific hook location categories for the outside mouth included the head, body, fin (s), tail, isthmus, eye and "other".

Chinook were held for observation in a 3m X 3mX 3m net pen and in six live-tanks aboard a specially equipped holding vessel contracted to Fisheries and Oceans Canada. Upon arrival at the holding site, each chinook was measured, sexed, tissue sampled (caudal punched) for later DNA analysis, and transferred into either the net pen or into one of the holding tanks maintained on the aft deck of the holding vessel. Dead chinook were removed from each holding tank as they were found during hourly inspections, while dead chinook in the net pen could not be removed (accessed) until the pen was cleared the morning following the day of capture. Chinook were held in the net pen and in the holding tanks for periods of up to 24 hours. All chinook were released prior to commencement of the next day's fishing.

Statistical Analysis

Field data were entered into a spreadsheet database for analysis. For the different gear and method treatments in each study, mortality rates were calculated using a simple proportion calculation from a binomial distribution (Zar 1984). The observed mortality rate was calculated as:

1) $$\hat{p} = \frac{X}{n}$$

where $\hat{p}$ is the mortality rate estimate, X is the number of fish mortalities, and n is the total number of fish sampled. Landing rates by hook treatment type were calculated the same way. Using a relationship between the F distribution and the binomial distribution, lower (L_1) and upper (L_2) confidence limits about p were calculated (Zar 1984):

2) $$L_1 = \frac{X}{X + (n - X + 1) F_{0.05(2),\nu_1,\nu_2}} \quad \text{with} \quad \nu_1 = 2(n - X + 1) \quad \text{and} \quad \nu_2 = 2X$$

3) $$L_2 = \frac{(X+1) F_{0.05(2),\nu_1',\nu_2'}}{n - X + (X+1) F_{0.05(2),\nu_1',\nu_2'}} \quad \text{with} \quad \nu_1' = 2(X+1) \quad \text{and} \quad \nu_2' = 2(n - X)$$

Contingency analysis (Systat 1996) was used to assess the dependence of overall mortalities on various faetors potentially affeeting mortality. Observed landing and mortality frequeneies for the study period (eolumns) by treatment factor (rows) were tabulated in contingency matrices and the calculated Chi-square statistic:

3) $$\chi^2 = \Sigma\Sigma \frac{(f_{ij} - F_{ij})}{F_{ij}}$$ where f_{ij} = observed frequency of row i and column j

and F_{ij} = expected frequency of row i and column j

was used to test the null hypothesis of no significant difference in mortalities among the various factors at the 5% level of significance.

RESULTS

Landing Rates

Landing rates were recorded by the skippers for each rod being fished and represent the proportion of fish hooked and played that were actually landed. As salmon played and lost could not be identified as to definite species, the landing rates are for all salmon encountered and therefore providc a general indication of success by gear treatment. The majority of the fish lost were expected to have been chinook, although some coho salmon were also present in the study area.

Landing rates were not significantly different ($p>0.05$) for trolled herring compared to motor-mooched herring (Table 1). Landing rates for trolled herring and motor-mooched herring were 0.624 and 0.651 respectively. However, there was considerable variability among landing rates within gear treatments over the course of the study period (Table 1). Daily landing rates for trolled herring ranged from 0.375 to 0.909, while daily landing rates for motor-mooched herring ranged from 0.632 to 0.800.

Mortality Rates

A total of 157 adult chinook were captured and held for short-term observation (<24 hours). A total of 16 fish died. Short-term mortality rates were not significantly different ($p>0.05$) for chinook captured on motor-mooched herring (0.091, 95% c.l. 0.042-0.167), or trolled herring from downriggers (0.121, 95% c.l. 0.049-0.236). The combined gear mortality rate was 0.102 (95% c.l. 0.062-0.163).

Hook Location

For both gear treatments, the most common hook location in the landings was the outer mouth (Table 2). For motor-mooched herring, 63.3% of the landings were hooked in the outer mouth, 22.4% were hooked in the deep mouth, and 14.3% were hooked

outside of the mouth. For trolled herring, 60.0% of the landings were hooked in the outer mouth, 22.2% were hooked in the deep mouth, and 15.8% were hooked outside of the mouth. The relatively high proportion of landings hooked outside of the mouth, for both gear treatments, is probably due to the tendency of chinook to slash at gear prior to hook-up, or as a result of hooks tearing free during playing and re-hooking elsewhere. Similar findings were observed in the 1999 and 1998 coho studies (Cox-Rogers 2000, Cox-Rogers 1998).

For both gear treatments, the most common (and only) hook location for the fish that died was the deep mouth (Table 2). 100% of all mortalities had sustained hook tearing or penetration wounds to critical areas that resulted in blood loss (Table 3).

Fish Size

The average size of chinook in the landings was 92.2 cm for males (n=70) and 87.1 cm for females (n=87). The length frequency distribution for the landings is shown in Figure 1. The average size of chinook in the mortalities was 96.0 cm for males (n=4) and 85.6 cm for females (n=12). There was no indication of a trend in mortality rates by size and although more females than males died, the proportion was not significantly different ($p>0.05$).

Holding Times

For fish held in the holding tanks (the net pen could not be checked at regular intervals), the mean holding time for the survivors was 18.75 hours, compared to a mean holding time for the mortalities of 8.83 hours. 62.5% of the fish that died did so within the first 6 hours of holding, 75.0% died within the first ten hours of holding, and 90.0% died within the first fifteen hours of holding. Very few of the fish died after the first 10 hours of holding and most of these were fish that had died in the tanks over night, so that the actual time of death could not be accurately established.

The influence of holding chinook in holding tanks or the net pen was compared to see if bias associated with the holding protocols was influencing the results. Although the larger chinook were more often held in the net pen, mortality rates for chinook held in the net pens or the holding tanks were not significantly different ($p >0.05$) among the gear treatments, suggesting that the holding environment was not a major factor determining mortality rates for this study. Similar findings were found for the coho hooking mortality study conducted at Dundas Island and Stevens Island in 1999 (Cox-Rogers 2000).

DISCUSSION

The objeetive of this study was to document short-term (<24 hour) cateh and release mortality rates for adult chinook captured in Work Channel and Dundas Island during June, 2001. Two gear types (motor-mooched herring and trolled herring from downriggers) were tested and up to six charter boats conducted the fishing.

Short-term mortality rates were not significantly different (p>0.05) for chinook captured on motor-mooched herring (0.091, 95% c.l. 0.042-0.167), or trolled herring from downriggers (0.121, 95% c.l. 0.049-0.236). The combined gear mortality rate was 0.102 (95% c.l. 0.062-0.163). These mortality rates are considered minimum cstimates for these fisheries, as much of the angler handling and landing variability actually associated with the process of releasing fish in the "at large" sport-fishing fleet at Work Channcl and Dundas Island was not duplicatcd.

For the fish that died, hooking mortality rates were associated with hook location and the incidencc of bleeding. All of the fish that died had sustained lethal hooking injuries to the deep mouth area (gill arches, the heart/liver, or the brain). The proportion of fish hooked in the deep mouth was similar for both motor-mooched herring and trolled herring gear treatments. This is in contrast to several northcoast studies on coho (Cox-Rogers 1998, Cox-Rogers 2000) and study reviews (McNair 1999) which notc, in general, a higher proportion of deep mouth hooking for mooching techniques compared to trolled herring or trolled artificial lures.

The results of this study indicate slightly lower short-term mortality rates for chinook captured on motor-mooched herring (0.091) compared to mortality rates for chinook obtained from similar studies conducted at Langara Island in 1990 (0.149, Gjernes 1990) and 2000 (0.157, Thomas 2000). Although the differences between the mortality rates from thc three studies are not large and are not significantly different (p>0.05), there does appear to be some potential for differential mortality rates by gear type among different northcoast fishing areas. Several questions remain unanswered from the 2001 Work Channel and Dundas Island studies. For example, should the same mortality rate be applied to chinook captured and released at different times of the year? Do size and behavioural differences influence gear-specific mortality rates over the course of the season? Additional studics would be required to evaluate these issues.

Currently in British Columbia, a single domcstic short-term mortality ratc of 15% is applied to large adult chinook released in marine recreational fisheries, regardless of the time, area, or gears being used (Terry Gjernes, Canadian Department of Fisheries and Oceans, Nanaimo, pers comm.) The CTC (1997) applics a short-term mortality rate of 12.3% for chinook >33cm in British Columbia marine recrcational fisheries, regardless of the time, area, or gears being used, and then includes an add-on increment of 6.9% to account for drop-off mortality (total = 19.2%). From an assessment perspective, establishing the seasonal range of actual mortality rates for specific gears in specific north

coast marine recreational fisheries might be useful. The issue of actual drop-off mortality and actual longer-term survival (e.g. >24 hour) in these fisheries may also need to be addressed.

RECOMMENDATIONS

1. Based on information gathered in 2001, short-term hooking mortality rates for adult chinook captured and released in the June Work Channel and Dundas Island marine recreational fisheries can be expected to be 0.102 (95% c.l. 0.062-0.163) for chinook eaptured on motor-mooched herring or trolled herring fished from downriggers.

2. Further studies should focus on the degree of seasonal variation in short-term mortality rates, by gear treatment, within specific northcoast chinook fisheries where exploitation rates are significant or where the impact of catch and release fishing is of management concern. Assessments of drop-off mortality and longer-term survival (e.g. >24 hour) in these fisheries should also be considered.

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Date	Gear Treatment	Hookups	Landings	% Landed	Mortalities	Mortality Rate	95% lower c.l.	95% upper c.l.
11-Jun	Motor-Mooched Herring	12	8	66.7%	3	0.375		
12-Jun	Motor-Mooched Herring	7	5	71.4%	0	0.000		
13-Jun	Motor-Mooched Herring	14	7	50.0%	0	0.000		
14-Jun	Motor-Mooched Herring	15	12	80.0%	2	0.167		
15-Jun	Motor-Mooched Herring	5	4	80.0%	0	0.000		
Total		53	36	67.9%	5	0.139	0.046	0.300
25-Jun	Motor-Mooched Herring	19	12	63.2%	0	0.000		
26-Jun	Motor-Mooched Herring	29	19	65.5%	1	0.053		
27-Jun	Motor-Mooched Herring	25	17	68.0%	1	0.059		
28-Jun	Motor-Mooched Herring	7	4	57.1%	1	0.250		
29-Jun	Motor-Mooched Herring	19	11	57.9%	1	0.091		
Total		99	63	63.6%	4	0.063	0.018	0.158
11-Jun	Trolled Herring	5	3	60.0%	0	0.000		
12-Jun	Trolled Herring	6	4	66.7%	0	0.000		
13-Jun	Trolled Herring	13	6	46.2%	1	0.167		
14-Jun	Trolled Herring	8	3	37.5%	1	0.333		
15-Jun	Trolled Herring	2	1	50.0%	0	0.000		
Total		34	17	50.0%	2	0.118	0.011	0.377
25-Jun	Trolled Herring	19	11	57.9%	3	0.273		
26-Jun	Trolled Herring	14	11	78.6%	2	0.182		
27-Jun	Trolled Herring	11	10	90.9%	0	0.000		
28-Jun	Trolled Herring	4	2	50.0%	0	0.000		
29-Jun	Trolled Herring	11	7	63.6%	0	0.000		
Total		59	41	69.5%	5	0.122	0.021	0.266
Total	Trolled Baits	93	58	62.4%	7	0.121	0.049	0.236
Total	M-Mooch Cut-Plug	152	99	65.1%	9	0.091	0.042	0.167
Total	**All Gear**	**245**	**157**	**64.1%**	**16**	**0.102**	**0.062**	**0.163**

Table 1. Landing rate and mortality rate summary by gear treatment for Chinook salmon captured at Work Channel and Dundas Island, British Columbia, in 2001.

Landings	n	Mooched Herring	n	Trolled Herring	n	All Gear
Deep Mouth	22	22.4%	13	21.7%	35	22.2%
Outer Mouth	62	63.3%	36	60.0%	98	62.0%
Outside Mouth	14	14.3%	11	18.3%	25	15.8%
Total	98	100.0%	60	100.0%	158	100.0%
Mortalities						
Deep Mouth	9	100.0%	7	100.0%	16	100.0%
Outer Mouth	0	0.0%	0	0.0%	0	0.0%
Outside Mouth	0	0.0%	0	0.0%	0	0.0%
Total	9	100.0%	7	100.0%	16	100.0%

Table 2. Percentage hook location in the landings and mortalities by gear treatment for Chinook salmon captured at Work Channel and Dundas Island, British Columbia, in 2001.

Tag #	Gear Treatment	Comments
28	Trolled Herring	Hook swallowed and penetrated heart, internal bleeding
34	Trolled Herring	Tears to third and fourth gill arches, blood loss evident
232	Trolled Herring	Penetrating hook wound through back of mouth into brain
250	Trolled Herring	Hook swallowed and penetrated liver, internal bleeding
289	Trolled Herring	Hook swallowed and penetrated liver, internal bleeding
292	Trolled Herring	Tears to second and third gill arches, blood loss evident
300	Trolled Herring	Penetrating hook wound through back of mouth into brain
8	Motor-Mooched Herring	Tear to second gill arch, blood loss evident
22	Motor-Mooched Herring	Tear to third gill arch, blood loss evident
158	Motor-Mooched Herring	Hook swallowed and penetrated liver, internal bleeding
170	Motor-Mooched Herring	Hook swallowed and penetrated heart, internal bleeding
236	Motor-Mooched Herring	Tear to third gill arch, blood loss evident
246	Motor-Mooched Herring	Tear to first gill arch, blood loss evident
253	Motor-Mooched Herring	Hook penetration of heart cavity, internal bleeding
254	Motor-Mooched Herring	Tear to third gill arch, blood loss evident
257	Motor-Mooched Herring	Tear to second gill arch, blood loss evident

Table 3. Necropsy results (mortalities) by gear treatment for Chinook salmon captured at Work Channel and Dundas Island, British Columbia, in 2001.

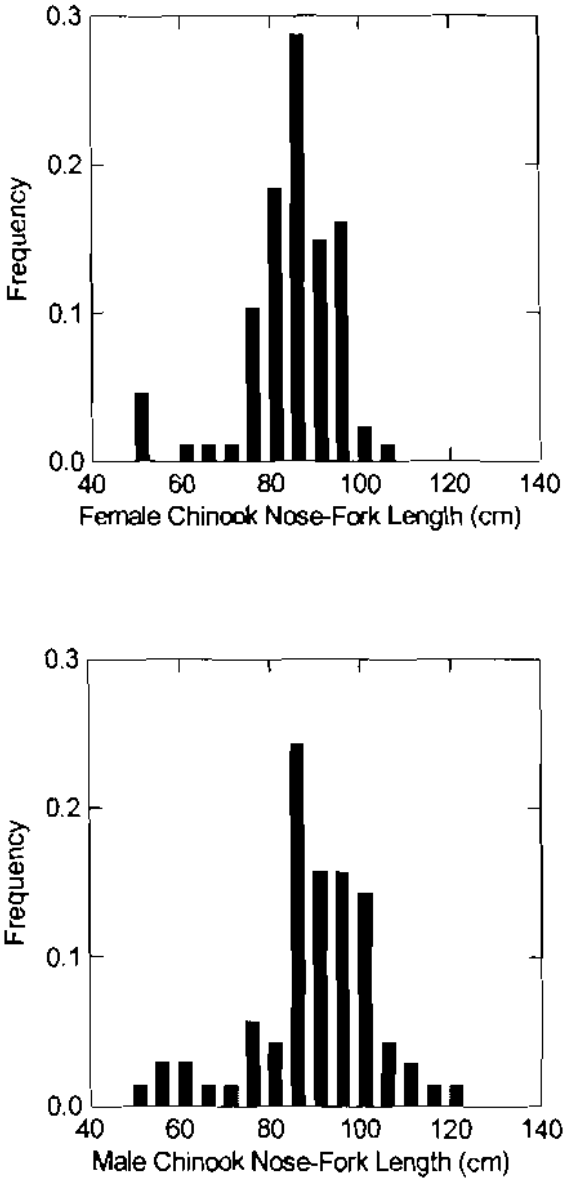

Figure 1. Length-frequency distributions for female (n = 87) and male (n = 70) Chinook salmon captured at Work Channel and Dundas Island, British Columbia, in 2001.