Behavior and survival of adult steelhead incidentally caught in a tangle net test fishery using radio telemetry.

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Abstract

We conducted an evaluation of the impact on non-target adult steelhead caught in a commercial Chinook salmon tangle net test fisheryon the Columbia River downstream from Bonneville Dam during spring 2003 using radio telemetry. In contrast to capture rates from the previous year, relatively few steelhead were collected during the 2003 study period. From a total of 15 fishing trips made between 20February and 19March 2003, consisting of 5-7 sets each, only 13 steelhead were collected and outfitted with radio transmitters. Another thirteen fish were tagged in the adult fish facility at Bonneville Dam and released downstream from the dam as a control group. All fish in the study were released at Butler's Eddy rKm 225.5, approximately 9 Km downstream of Bonneville dam (rKm 235.1). Of the 13 tangle net-caught fish, 76.9% passed Bonneville Dam versus 100% of the control group and 69.2% of the tangle net-caught fish escaped to tributaries compared to 76.9% of the control group. Adult steelhead caught in the fishery had longer passage times to reach and pass Bonneville Dam than fish in the control group. The majority of the fish that successfully passed Bonneville Dam eventually escaped to Hood River as their spawning tributary, one fish was recaptured at Lower Granite Dam (rKm 694.6) on the Snake River and another ascended several lower Columbia tributaries and was last recorded in the Cowlitz River.

Introduction

Because of the recent relatively large returns of adult spring Chinook salmon, there has been increased interest in conducting commercial fisheries in the lower Columbia River, targeting returning hatchery fish. To reduce the potential impact on returning salmon from ESA listed stocks, a selective harvest fishery has been evaluated that utilizes tangle nets rather than gill nets as the means of harvest . The intent of this technique was that fish tangled in the smaller mesh of tangle nets could be collected alive, and then retained (marked hatchery fish), or released (unmarked fish) to the river. Being a new fishery, there is interest in developing best practices and gear specifications that will maximize catch rates while minimizing effects on non-targeted fish. During the early spring of 2002, using a 4.5" mesh, the commercial fleet unintentionally caught and released a large number of winter steelhead (cite WDFW report for this). In order to better evaluate the impact on the survival of intercepted steelhead the Bonneville Power Administration contracted the Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, and the Washington Department of Fish and Wildlife to conduct a study to evaluate behavior and survival of steelhead that have

been intercepted and released from a tangle net fishery. Movement patterns and escapement of adult steelhead caught in tangle nets, outfitted with radio transmitters, were compared to that for a control group of steelhead collected from the adult fish facility at Bonneville Dam.

Methods

The area fished was downstream from Bonneville Dam between Beacon Rock (rKm 227) and Horsetail Falls (rKm 222.4) (see Figure 1). The methods of capture for the treatment group were similar to those used by commercial fisherman in the selective spring Chinook salmon fishery. An experienced group of commercial fishermen were contracted to fish with gear and methods similar to those used for the commercial spring Chinook salmon fishery. Fishing trips, which lasted between 4-7 hrs, were conducted using a 28 ft gill net vessel. Nets were deployed in sets with a maximum of 30 minutes between the first cork in and the first cork out. The net used was a 150 fathoms long and 40 feet tall with 4.25" multi-strand mesh hung on a cork line with hangers 1 fathom apart.

As the net was retrieved, fish would be disentagleg from the net and… Steelhead brought on board were evaluated as follows; Condition 1 active and vigorous, Condition 2 active and vigorous with bleeding, Condition 3 lethargic, Condition 4 lethargic and bleeding, and Condition 5 not ventilating or swimming in any way. All? Fish were then transferred to anesthetic tank containing dilute solution (20 ppm) of clove oil, fork length and presence of marks or injuries were recorded, the radio transmitter was inserted into the stomach through the mouth and a passive integrated transponder (PIT) tag was inserted to abdomen by syringe. The fish was then placed in a recovery box to recover from anesthesia (revived to a condition 1) and was transported to Butler's Eddy for release. Transmitters used were 14 mm diameter and 43 mm long, weighed 11 g in air, 4.1 g in water. Tags transmitted a coded signal on a set frequency (channel) every 5 s and had a rated battery life of 278 d.

After release, radio-tagged fish were monitored using of a series of fixed-site radio receivers positioned at dams, reservoirs and tributaries throughout the Columbia River basin. In addition to the receivers at Bonneville Dam and upstream locations in place as part of a study to evaluate passage of adult salmon and steelhead through the Columbia River Federal Power System (CRFPS), additional receivers were positioned to monitor the use of the Sandy, Willamette, Washougal, Cowlitz, Lewis and Kalama rivers downstream from Bonneville Dam. Additional information on locations of fish was collected by mobile tracking areas between fixed sites using boats and trucks outfitted with antennas and receivers.

Data downloaded from receivers were electronically transferred to the NOAA Fisheries office in Seattle, WA for initial processing. This involved screening individual files and removing obvious errors and records produced from electronic background noise. Screened files were then transferred to the University of Idaho for coding. Coding involved inspection of all records for a fish and assigning a code to appropriate

records that defined behavior of a fish (e.g. first detection at a tributary site, passage of the tailrace receiver, entrance or exit from a fish way). Coding was facilitated by using an automated program developed using Visual Basic software (VisualBasic.net). Coded data were used to identify and summarize movements of radio-tagged fish.

During the sample period, x to y, a total of 13 steelhead were collected and outfitted with transmitters from a proposed sample of 190 fish proposed to be used for this evaluation. An equal number (13) of adult steelhead were tagged at Bonneville Dam and released downstream from the dam for the control group. Because of the small sample size, the number and types of analyses possible were limited. In general, we compared escapement and passage metrics between the treatment (fishery-captured) and control (Bonneville-captured) steelhead. Variables compared were proportions of fish passing Bonneville Dam and escaping to spawning tributaries, and times from release until fish first reached and passed Bonneville Dam.

Passage times were compared using a non-parametric Mann Whitney test which can be used to compare groups with small sample sizes. Passage at Bonneville was divided into segments based on time of release, first detection at tributaries or in the tailrace of Bonneville Dam and last record at the top of the dam as they exited fishways (. Table 1). Times for individual control and treatment fish were ranked and rankings between groups were compared for each passage segment. The control group was assigned U_1 and the treatment group U_2.

Table 1 Radio telemetry coding events and abbreviations.

Event	Abbreviation	Description
Release	TAG	Date for the time and site of the fish's release after tagging.
First detection within Bonneville influence	F1	First time a fish is detected at a pair of fixed receivers located 3.2km downstream of Bonneville Dam.
First Approach to a Fishway	A1	First time a fish is detected at a fishway entrance.
First Entrance	E1	First detection of a fish with in the fishway.
First Transition Pool	FP	First time a fish is detected in the transition pool.
Last Transition Pool	LP	Last time a fish is detected in the transition pool
Last Top	LT	Last detection of a fish as it exits the fish way in the fore bay.

Results

Of the approximately 90 sets of the tangle nets, 13 adult steelhead were caught and tagged with radio transmitters. In addition to the tagged fish, 11 steelhead judged to be 2002 summer fish in poor condition prior to their capture, and one kelt, were

released without tagging. Also one summer fish radio tagged for another study in June of 2002 was intercepted and released. Of the 13 tagged treatment steelhead, one fish was judged to be a 2002 summer steelhead and one was judged to be a 2003 summer steelhead. Four steelhead were classified as condition 1 at capture, and the remaining nine were classified as condition 3. No steelhead were captured in conditions 2, 4, or 5. In addition to any injuries the fish might have incurred prior to their capture, 12 of the 13 steelhead appeared to have obtained external injuries as a result from capture in the tangle net. These injuries ranged from light net marks on the head to heavy descaling and split fins. We were unable to determine potential extent of internal injuries resulting from capture or handling during the fishery. Due to the large range in severity of external injuries and the small sample size no meaningful comparisons could be made on effects of condition and injuries on survival and behavior. Of the 13 control fish collected at Bonneville Dam, four were judged to be 2003 summer steelhead and two were possibly 2002 summer fish. These fish had various external injuries from marine mammals and other unknown sources consistent with the population at large.

Nine (69%) of the 13 treatment fish escaped to tributaries and one fish was harvested in a gillnet fishery. The remaining treatment fish were last recorded in the tailrace of Bonneville Dam. Ten (76.9%) of the 13 control group fish escaped to tributaries and one fish was recaptured in a gillnet fishery. The remaining two control fish were last recorded in the Columbia River near the mouth of the Hood River. Final fates of fish are shown in Table 2.

All (100%) of the 13 control fish passed Bonneville dam. Of the 12 upstreambound treatment fish, 10 (83.3%)passed Bonneville (Table 2, Figure 1). All treatment fish that were classified as condition 1 passed Bonneville DamIt is not possible to judge the effect of capture condition on tributary escapement. Of the four treatment fish captured in condition 1, two escaped to tributaries; of the unsuccessful fish one fate was unknown and the other was harvested in the main stem Columbia River during a gillnet fishery.

Time for fish to pass Bonneville Dam from point of release was significantly longer for treatment fish than for control fish, as determined from the Mann-Whitney comparison test (U=89, Critical value $U1_{(1),13,10}$=87). The individual passage segment that showed a significant difference was from time of released until the first approach(U=89, Critical Value $U1_{(1),12,11}$=88), other differences were not significant using this analysis (Figures 2 **& 3**).

Individual fish exhibited some interesting behaviors. One fish tagged in the Adult Fish Facility was determined to be a winter steelhead from visual inspection but eventually migrated to Lower Granite Dam (rKm 694.6) where it was recaptured in the adult trap 12.7 days after tagging, an average migration rate of 36.9 Km per day.. Another four fish were recorded falling back over Bonneville Dam, possibly as kelts after entering what we judged to be their spawning tributaries. These fish spent an average of 13.6 days in the respective tributary. Three of the four fish were judged to be females

during tagging based on visual cues. Two of the fish were possibly 2002 summer fish and one was a winter fish, the race of the last the fish was unrecorded.

Discussion

Significantly fewer steelhead than expected were caught in the tangle-net evaluation during the spring of 2003 which may have been related to location if the test fishery.

Because of small sample size, few conclusions can be drawn regarding the long term survival effects of fish caught in a tangle net fishery. We noted that three of the treatment steelhead reached but then did not pass Bonneville Dam, and then went unaccounted for, while two control fish passed Bonneville Dam and disappeared after reaching the vicinity of the mouth of Hood River. These five fish may have died, been harvested but the tags not returned to us, or they may have entered a tributary without being detected at a receiver site. It is likely that one or more of the missing transmitters will be returned to us in the future, which may allow us additional insight on the final fates of the missing fish.

Differences in passage times between fishery and control steelhead may be related to recovery times for the respective groups. Control fish passing through the AFF facility are diverted directly into anesthetic tank, outfitted with a transmitter, and transferred to the recovery/transport vessel, all with in a 5-6 min period. Fishery steelhead may have been caught up to 30 min prior to being removed from nets. Nine of the 13 treatment steelhead were classified as lethargic when removed from the net, indicating they had struggled until exhausted. All control fish were collected at Bonneville Dam, and their familiarity with this portion of the river may also have contributed to their fast return rate to the dam.

Figure 1. Map of Study Area Need smaller map that shows location of this segment of river and tributary streams, we have this. Large map should contain Bonneville Dam.

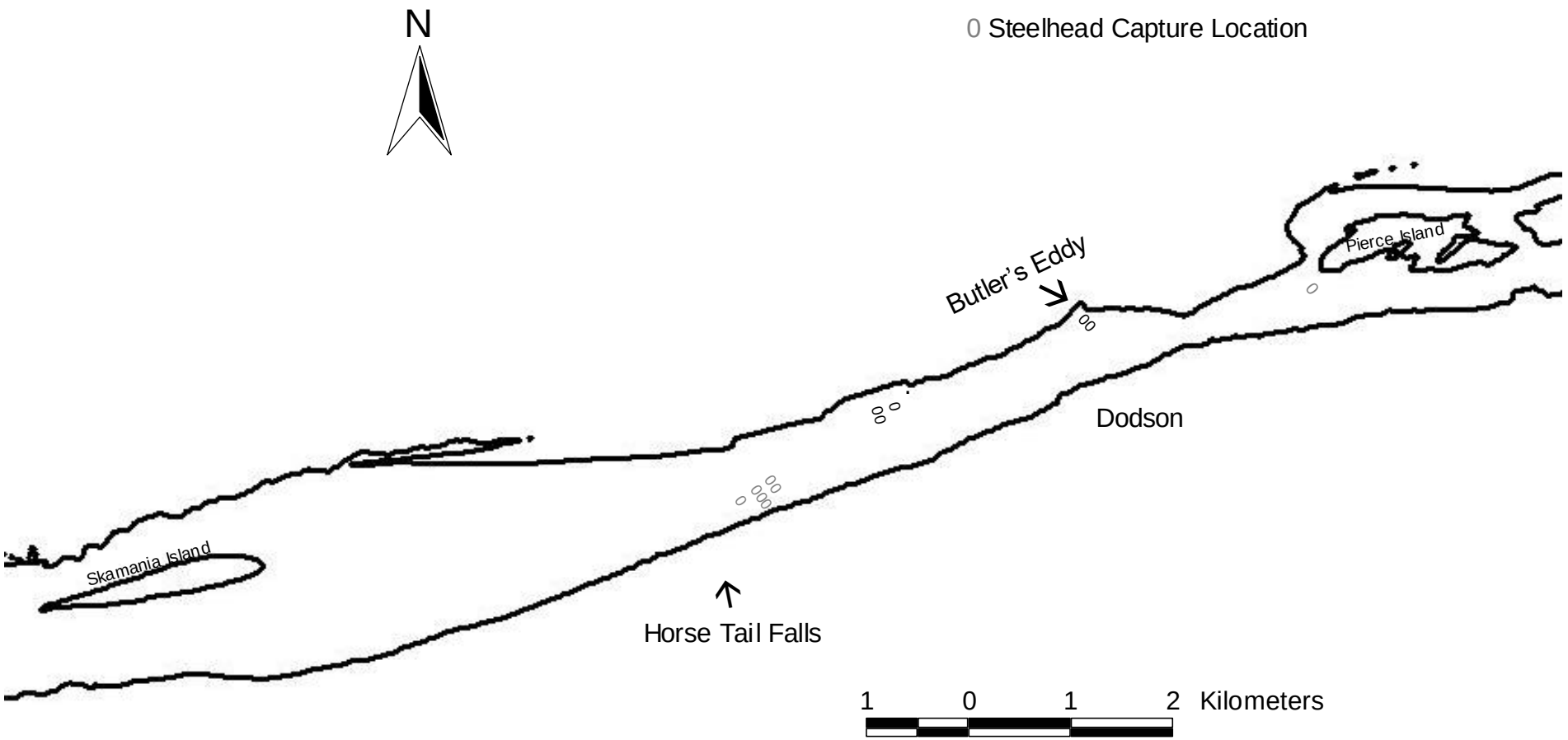
N
0 Steelhead Capture Location
Butler's Eddy
Pierce Island
Dodson
Skamania Island
Horse Tail Falls
1 0 1 2 Kilometers

Figure 2.

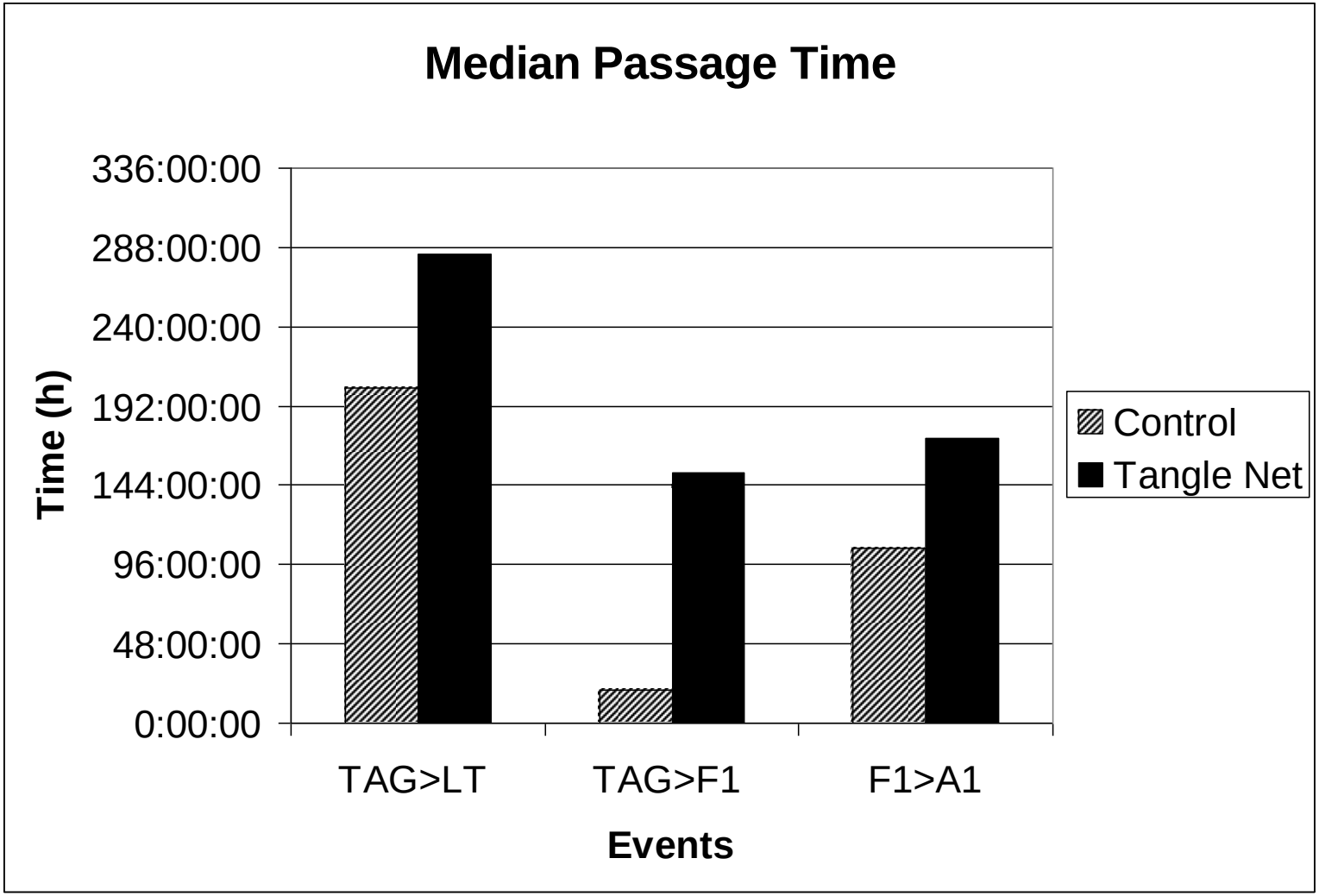
Median Passage Time
336:00:00
288:00:00
240:00:00
192:00:00
144:00:00
96:00:00
48:00:00
0:00:00
Time (h)
TAG>LT
TAG>F1
F1>A1
Events
Control
Tangle Net

Figure3.

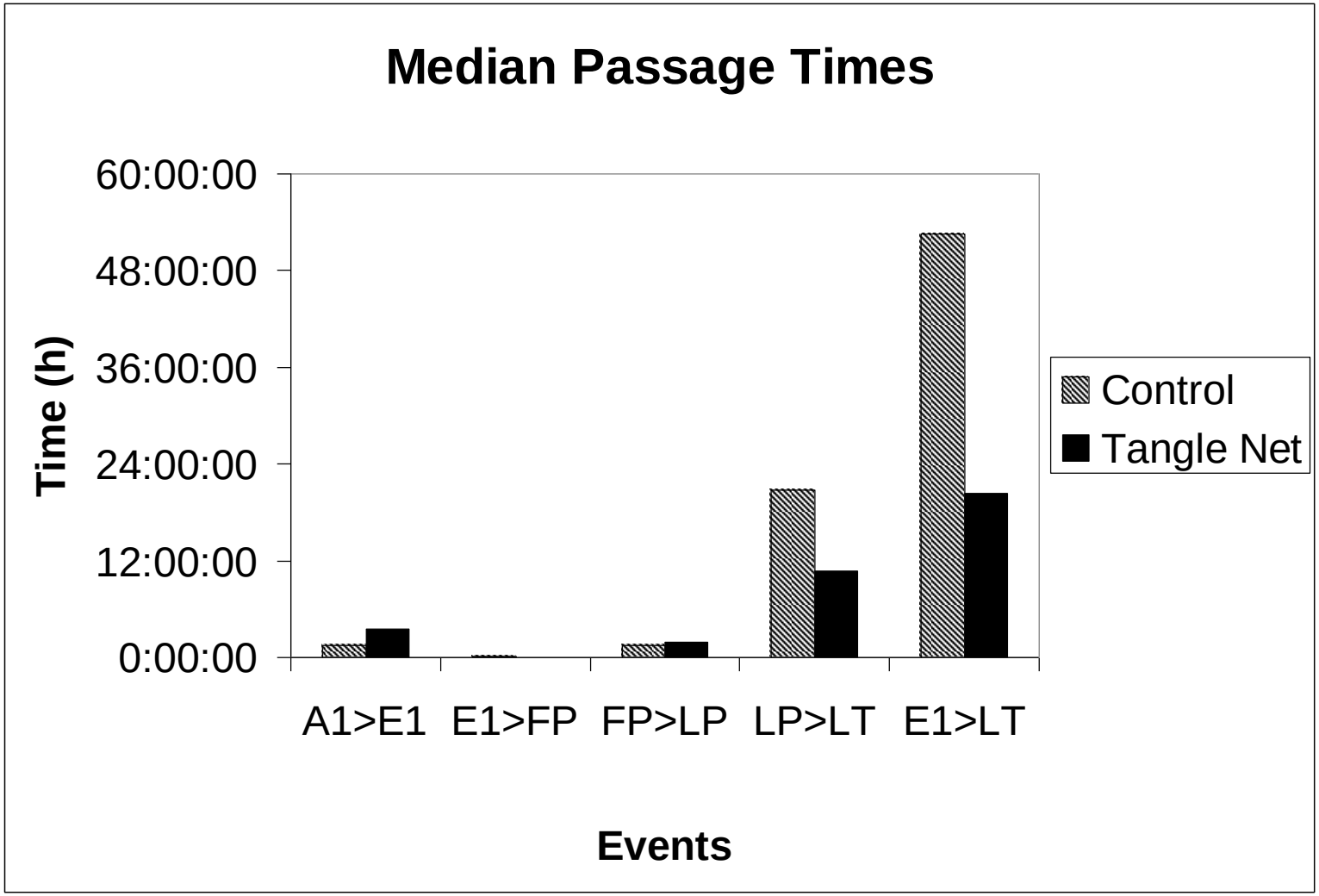
Median Passage Times
60:00:00
48:00:00
36:00:00
24:00:00
12:00:00
0:00:00
Time (h)
A1>E1
E1>FP
FP>LP
LP>LT
E1>LT
Events
Control
Tangle Net

Table 2. Transmitters, release date and time, date and time fish passed Bonneville Dam and time to pass Bonneville Dam (hh:mm:ss) from point of release, tributary river fish escaped to and final fate of adult steelhead outfitted with radio transmitters at Bonneville Dam (control fish) and in tangle net test fishery.

Transmitter	Release Time	Bonneville passage date	Total passage time from release	Tributary used	Final Fate
Control Fish					
03-113	2/21/03 14:42	3/9/03 16:54	386:12:37	Hood River	Fell-back over Bonneville after trib. use
03-114	2/26/03 17:10	3/11/03 17:37	312:27:31	Wind River	Escaped to Wind River.
03-115	3/17/03 15:46	3/26/03 8:17	208:31:34	Hood River	Recaptured at Powerdale Trap, Hood River
03-117	2/26/03 17:10	3/4/03 17:59	144:49:51	Deschutes River	Fell-back over Bonneville after trib. use
03-119	2/25/03 16:11	3/1/03 22:27	102:16:07	N/A	Unknown. Last record is Mobile track at the mouth of Hood River
03-121	2/25/03 16:11	4/1/03 18:05	841:54:22	N/A	Recaptured Tribal fishery 12Apr03
03-122	2/26/03 17:10	3/1/03 12:33	67:23:14	Hood River	Escaped to Hood River
03-125	2/25/03 16:11	3/9/03 13:57	285:46:08	Hood River	Recaptured at Powerdale Trap, Hood River
03-127	3/17/03 15:46	3/18/03 9:02	17:16:53	Snake River > Lower Granite	Recaptured Lower Granite Trap
03-129	3/17/03 15:46	3/20/03 15:00	71:14:16	Hood River	Escaped to Hood River
03-133	3/17/03 15:46	3/28/03 19:45	267:59:12	Wind River	Fellback over Bonneville after trib. use
03-135	2/21/03 14:42	2/28/03 12:31	165:49:38	None	Unknown. Last record is mobile track outside the Hood River Mouth
03-136	2/26/03 17:10	3/7/03 4:22	203:12:24	Hood River	Angler recapture in? Hood River
Tangle Net-Caught Fish					
19-102	2/27/03 21:14	3/29/03 18:42	717:28:15	Hood River	Recaptured at Powerdale Trap, Hood River
19-104	2/27/03 10:55	N/A	N/A	N/A	Unknown. Last record outside Bonneville Dam fishway Entrance
19-107	2/28/03 8:49	3/12/03 7:56	287:07:04	Hood River	Recaptured at Powerdale Trap, Hood River
19-108	3/20/03 10:20	3/26/03 10:46	144:26:49	Hood River	Recaptured at Powerdale Trap, Hood River
19-110	2/27/03 21:14	3/11/03 17:23	284:09:57	N/A	Recaptured in Tribal Fishery 12Mar03
19-113	3/3/03 20:10	3/10/03 19:10	167:00:17	White Salmon	Fell back over Bonneville after trib. use
19-114	3/11/03 10:33	N/A	N/A	N/A	Unknown. Last record outside Bonneville Dam fishway entrance
19-115	3/13/03 12:18	3/28/03 18:19	366:01:51	Hood River	Escaped to Hood River
19-116	2/20/03 12:26	N/A	N/A	Cowlitz River	Escaped to Cowlitz River
19-118	3/14/03 10:19	3/20/03 16:43	150:24:45	Hood River	Angler Recapture in? Hood River
19-121	2/20/03 13:51	N/A	N/A	N/A	Unknown. Last Record Bonneville Dam

					tailrace
19-123	3/12/03 9:07	3/22/03 11:33	242:26:22	Hood River	Escaped to Hood River
19-125	3/14/03 7:41	3/27/03 19:46	324:05:36	Hood River	Recaptured at Powerdale Trap, Hood River

Discussion

Though this study suffers from a very small sample size it does show some differences between the control and treatment fish. Perhaps another study involving the use of radio telemetry and larger sample sizes could better determine if the differences seen are significant and answer many of the questions regarding steelhead and Chinook tanglenets.