

**PIT Tagging Juvenile Salmonids in the Lake Washington Ship Canal
for the Lake Washington General Investigation Study, 2001**

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Report of research by

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Contract W68MD911063244

September 2001

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Introduction

The Seattle District of the U.S. Army Corps of Engineers (USACE) contracted the National Marine Fisheries Service (NMFS) to PIT tag juvenile salmonid migrants in the Lake Washington Ship Canal in spring 2001. The goal was to tag 5,000-6,500 chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), and coho (*O. kisutch*) salmon smolts from each of two collection sites in the ship canal, for a total of 10,000-13,000 PIT-tagged fish. The Washington Department of Fish and Wildlife (WDFW) collected fish in the Montlake Boulevard Drawbridge and Gasworks Park areas of the ship canal. Collection methods used were purse seining and beach seining, and the WDFW will report on all collection activities. Here we report details of all PIT-tagging activities conducted by NMFS.

Methods

Marking Vessel

A vessel designed specifically for operations involved with handling, PIT-tagging, and holding juvenile salmonids was used for this study. The boat was docked at the Seattle Police Dock near Gasworks Park on the north side of Lake Union, where all tagging activities were performed. The marking vessel was equipped with four large 800-L tanks with associated oxygen supply systems. The tanks were supplied with fresh water via a water pump, with the intake submerged to approximately 2.5 m in the lake. Two other 120-L containers were also supplied with freshwater and oxygen and were used to hold fish sorted by species prior to tagging. Several other freshwater hoses were used for filling pans and buckets and for moving tagged fish to tanks during tagging activities.

Tagging

To initiate the PIT-tagging process, fish were dipped from one of the large tanks with a sanctuary dip net (Matthews et al. 1986). A measured volume of concentrated MS-222 anesthetic was added to the dip net, bringing the anesthetic solution to 40-50 ppm. After anesthesia, the most numerous of the three species (chinook, sockeye, or coho salmon) to be tagged were sorted for tagging, and the other two species were sorted to the 120-L containers and tagged later. During the tagging process, the anesthetic water in the pans was supplied with oxygen, and the water was changed frequently. Moribund, severely injured, or descaled fish were sorted out and not tagged.

Anesthetized fish were scanned to determine if they were previously PIT tagged, and all untagged fish of the specified species were PIT tagged using the technique described by Prentice et al. (1990). The components and setup of the PIT-tagging station were the same as those described by Prentice et al. (1990), except that we did not use a balance for recording weights.

An electronic PIT-tagging file was set up for each collection/release site and each species. After each fish's PIT-tag code was scanned into the file, its length was digitized and

added to the file, along with any appropriate comments. The digitizer was set up to designate "wild" or "hatchery" for the chinook and coho salmon, while all sockeye salmon were designated as "wild." Fish were held in the release tanks for a minimum of 0.5 hours to recover from anesthesia before release at the appropriate site. Four times during the course of the study, fish were held 24 hours in a live cage after tagging to determine delayed mortality and tag-loss rates (Appendix Table 1).

Releases

After tagging, fish collected near Gasworks Park were released at a site 100 m upstream from the Fremont Bridge, and fish collected under the Montlake Drawbridge were released near that area. After tagging and holding, the marking boat was moved to the respective release sites. All mortalities were removed from the tanks and the remaining live fish were released via a short 10.2-cm-diameter hose. PIT tags were removed from all mortalities and the corresponding codes were removed from the files.

Data Reporting

Within 24-hours of release, the electronic PIT-tag files e-mailed to R2 Consultants, along with daily data sheets. Daily data sheets were also faxed to the Seattle District Office of the USACE.

Results

Montlake Area Task

From 1 May to 26 June, 943 total fish of all 3 species were collected in the Montlake area of the Lake Washington Ship Canal (Table 1). Of these, 908 were PIT tagged and released. In addition, two wild steelhead and a previously PIT-tagged wild chinook and coho salmon were collected. The overall collection mortality was 1.0% and the overall post-tagging mortality was 1.9%. Table 1 includes a summary of all other tagging and release results for this task. Appendix Table 1 includes detailed daily tagging and release information.

Table 1. Summary of the numbers collected, PIT tagged, and released, and associated mortalities for three species of juvenile migrant salmonids collected near the Montlake Boulevard area of the Lake Washington Ship Canal and released under the Montlake Drawbridge from 1 May to 27 June 2001.

Species	Number collected	Number of collection mortalities	Number PIT tagged	Number of PIT-tagging mortalities	Number of PIT-tagged fish released
Sockeye	169	1	167	3	164
Hatchery coho	6	0	5	0	5
Wild coho	39	0	37	0	37
Hatchery chinook	659	7	648	13	635
Wild chinook	70	1	69	2	67
Totals	943	9	926	18	908

Gasworks Park Area Task

From 1 May to 26 June, 5,069 total fish of all three species were collected in the Gasworks Park area of the Lake Washington Ship Canal (Table 2). Of these, 4,797 were PIT tagged and released. In addition, four wild steelhead (*O. mykiss*) and one wild cutthroat trout (*O. clarki*) were collected. Eight hatchery chinook, two wild chinook, and three wild coho salmon that were previously PIT tagged were also collected. The overall collection mortality was 0.3% and the overall post-tagging mortality was 4.1%. Most of the collection and post-tagging mortalities were chinook salmon (8.1%). Table 2 includes a summary of all other tagging and release results for this task. Appendix Table 1 includes detailed daily tagging and release information.

Table 2. Summary of the numbers collected, PIT tagged, and released, and associated mortalities for three species of juvenile migrant salmonids collected near the Gasworks Park area of the Lake Washington Ship Canal and released 100 m upstream from the Fremont Bridge from 1 May to 26 June 2001.

Species	Number collected	Number of collection mortalities	Number PIT tagged	Number of PIT-tagging mortalities	Number of PIT tagged fish released
Sockeye	2,279	0	2,262	42	2,220
Hatchery coho	337	0	333	1	332
Wild coho	246	0	240	0	240
Hatchery chinook	2,084	16	2,045	148	1,897
Wild chinook	123	0	123	15	108
Totals	5,069	16	5,003	206	4,797

Discussion

During the first 3 weeks of the study, collections of fish were slow at both the Gasworks and Montlake sites. Most fish collected during this time were sockeye salmon. On 15 May, it was decided to hold all tagged fish (221) overnight due to spill at the locks for pool drawdown because of predicted high winds and potential destructive waves in Lake Union. The higher-than-expected mortality (14.5%) for these held fish can be attributed to stress caused by crowded conditions in the live cage in combination with turbulent conditions due to the wave action. However, no tags were lost during this holding period. Few fish were collected in the Montlake area during most of the study.

In the fourth week of the study, hatchery chinook salmon began dominating the catch at the Gasworks collection area. Collection and tagging mortalities were low, due to continued moderate water temperatures (13.0°C). However, during week five, (29 May) water temperatures rose to 16.5-17.5°C. In addition to the higher water temperatures, several chinook salmon with severe bacterial kidney disease (BKD) symptoms were inadvertently tagged. The symptoms included distended abdomens with the body cavities filled with water. This combination of higher water temperatures and disease caused high mortality (11.4%) for chinook salmon tagged that week.

During the sixth week, water temperatures remained between 16.0 and 16.5°C. We held 88 fish of mixed species for 24 hours during this period. Mortality was 7.9%, and tag loss was 1.1% for these fish. During the seventh week, water temperatures declined to 14-15°C. Consequently, our overall post-tagging mortality was 1.1%. We held 87 fish of mixed species for 24-hours. Mortality was 3.4% and tag loss was 0% for these fish.

During the eighth week, water temperatures increased again to 16-17°C, and the few fish collected near the Montlake area (56) all survived tagging; however, collection and post-tagging mortality for chinook salmon collected from the Gasworks area was 5.7%. The sockeye and coho salmon handled the collection and tagging much better, with an overall mortality of 0.2%.

During the ninth week, water temperatures increased to 17-18°C, and collection and tagging mortalities for chinook salmon were 24.0 and 17.5% at the Montlake and Gasworks collection sites, respectively. In contrast, the overall collection and post-tagging mortalities for sockeye and coho salmon were only 4.3 and 0.9% for the Montlake and Gasworks collection sites, respectively. All 115 fish collected from the Montlake area site were held overnight, with overall delayed post-tagging mortality of 11.3% and tag loss of 1.7%.

Following the extremely high collection and tagging mortalities for chinook salmon from both collection sites during the ninth study week, the decision was made to discontinue all collection and tagging activities. This eliminated the final 2 weeks scheduled for the study. We accomplished the lower bound for total fish tagged from the Gasworks area site (5,003); however, the total fish tagged from the Montlake area site was far below expectations (926).

Recommendations

1. When large numbers of juvenile chinook salmon are present in the Lake Washington Ship Canal, no collection and tagging of any species should be conducted if water temperature reaches or exceeds 17°C.
2. The disease problems with the juvenile chinook salmon (both wild and hatchery) should be investigated in the area waters and hatcheries.
3. The USACE should consider pursuing the new sonic tag for future studies to define survival and movement of smolts through the Lake Washington Ship Canal and associated locks.

Acknowledgments

Thanks to Ron A. Marr for valuable help in handling fish and operating the marking boat. Also, thanks to Charles J. Ebel (USACE), Richard Zabel (NMFS), and Debbie Frost (NMFS) for their excellent assistance in handling and PIT tagging fish for this study.

References

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Appendix Table 1. Summary of tagging and release information for the tagging files in 2001.

Tagging file	Species	Tagging date	Tagging time (start)	Tagging temperature (start) (°C)	Release site	Release date	Release time	Release temperature (°C)	Number tagged	Number tagging mortality	Number of tagged released	Number of PIT tag recaptures	Number of lost tags
SA01121.GS1	Sockeye	01 May	10:53	10.5	Fremont	01 May	11:40	11.0	56	0	56	0	---
SA01128.MS1	Sockeye	08 May	11:40	12.0	Montlake	08 May	15:00	12.0	4	0	4	0	---
SA01128.MO1	Coho	08 May	11:43	12.0	Montlake	08 May	15:00	12.0	1	0	1	0	---
SA01128.MC1	Chinook	08 May	11:30	12.0	Montlake	08 May	15:00	12.0	19	0	19	0	---
SA01128.GS1	Sockeye	08 May	07:12	12.0	Fremont	08 May	14:30	12.0	438	3	435	0	---
SA01128.GO1	Coho	08 May	08:30	12.0	Fremont	08 May	14:30	12.0	11	0	11	0	---
SA01128.GC1	Chinook	08 May	08:36	12.0	Fremont	08 May	14:30	12.0	3	0	3	0	---
SA01135.GS1	Sockeye	15 May	08:00	12.5	Fremont	16 May	07:00	12.0	205	31	174	0	0
SA01135.GO1	Coho	15 May	08:17	12.5	Fremont	16 May	07:00	12.0	16	0	16	0	0
SA01142.GS1	Sockeye	22 May	09:45	13.0	Fremont	22 May	13:15	14.0	155	1	154	0	---
SA01142.GO1	Coho	22 May	10:42	14.0	Fremont	22 May	13:15	14.0	58	0	58	0	---
SA01142.GC1	Chinook	22 May	08:04	13.0	Fremont	22 May	13:15	14.0	304	0	304	1	---
SA01149.MS1	Sockeye	29 May	14:49	17.5	Montlake	29 May	16:56	18.5	12	0	12	0	---
SA01149.MO1	Coho	29 May	14:54	17.5	Montlake	29 May	16:56	18.5	2	0	2	0	---
SA01149.MC1	Chinook	29 May	14:21	17.5	Montlake	29 May	16:56	18.5	112	2	110	1	---
SA01149.GS1	Sockeye	29 May	09:40	16.5	Fremont	29 May	14:00	17.5	367	1	366	0	---
SA01149.GO1	Coho	29 May	09:37	16.5	Fremont	29 May	14:00	17.5	68	0	68	1	---

Appendix Table 1. Continued

Tagging file	Species	Tagging date	Tagging time (start)	Tagging temperature (start) (°C)	Release site	Release date	Release time	Release temperature (°C)	Number tagged	Number tagging mortality	Number of tagged released	Number of PIT tag recaptures	Number of lost tags
SA01149.GC1	Chinook	29 May	08:11	16.5	Fremont	29 May	14:00	17.5	202	23	179	3	---
SA01150.GS1	Sockeye	30 May	11:31	16.5	Fremont	30 May	12:37	16.5	36	0	36	0	---
SA01150.GO1	Coho	30 May	11:43	16.5	Fremont	30 May	12:37	16.5	44	0	44	0	---
SA01150.GC1	Chinook	30 May	10:11	16.5	Fremont	30 May	12:37	16.5	271	1	270	0	---
SA01156.MS1	Sockeye	05 June	15:37	16.5	Montlake	05 June	16:35	16.0	11	0	11	0	---
SA01156.MO1	Coho	05 June	15:43	16.5	Montlake	05 June	16:35	16.0	12	0	12	0	---
SA01156.MC1	Chinook	05 June	14:37	16.5	Montlake	05 June	16:35	16.0	238	2	236	0	---
SA01156.GS1	Sockeye	05 June	08:06	16.0	Fremont	06 June	08:09	16.5	4	0	4	0	0
SA01156.GO1	Coho	05 June	07:59	16.0	Fremont	06 June	08:09	16.5	59	1	58	0	1
SA01156.GC1	Chinook	05 June	07:31	16.0	Fremont	06 June	08:09	16.5	25	6	19	0	0
SA01156.GS2	Sockeye	05 June	12:27	16.0	Fremont	05 June	13:00	16.5	19	0	19	0	---
SA01156.GO2	Coho	05 June	11:50	16.0	Fremont	05 June	13:00	16.5	73	0	73	0	---
SA01156.GC2	Chinook	05 June	12:38	16.0	Fremont	05 June	13:00	16.5	4	0	4	0	---
SA01163.MS1	Sockeye	12 June	15:52	15.0	Montlake	12 June	17:37	14.0	63	1	62	0	---
SA01163.MO1	Coho	12 June	16:09	15.0	Montlake	12 June	17:37	14.0	17	0	17	1	---
SA01163.MC1	Chinook	12 June	15:11	15.0	Montlake	12 June	17:37	14.0	182	0	182	0	---
SA01163.GS1	Sockeye	12 June	11:57	14.5	Fremont	12 June	16:48	15.0	59	0	59	0	---

Appendix Table 1. Continued

Tagging file	Species	Tagging date	Tagging time (start)	Tagging temperature (start) (°C)	Release site	Release date	Release time	Release temperature (°C)	Number tagged	Number tagging mortality	Number of tagged released	Number of PIT tag recaptures	Number of lost tags
SA01163.GO1	Coho	12 June	10:17	14.0	Fremont	12 June	16:48	15.0	108	0	108	1	---
SA01163.GC1	Chinook	12 June	09:45	14.0	Fremont	12 June	16:48	15.0	125	1	124	0	---
SA01163.GS2	Sockeye	12 June	13:42	14.5	Fremont	13 June	09:09	14.5	13	0	13	0	0
SA01163.GO2	Coho	12 June	13:28	14.5	Fremont	13 June	09:09	14.5	35	0	35	1	0
SA01163.GC2	Chinook	12 June	12:58	14.5	Fremont	13 June	09:09	14.5	39	3	36	1	0
SA01164.MS1	Sockeye	13 June	13:55	15.5	Montlake	13 June	14:44	15.0	4	0	4	0	---
SA01164.MO1	Coho	13 June	14:00	15.5	Montlake	13 June	14:44	15.0	5	0	5	0	---
SA01164.MC1	Chinook	13 June	13:12	15.5	Montlake	13 June	14:44	15.0	73	0	73	0	---
SA01170.MS1	Sockeye	19 June	16:29	17.0	Montlake	19 June	17:56	17.0	33	0	33	0	---
SA01170.MC1	Chinook	19 June	16:13	17.0	Montlake	19 June	17:56	17.0	23	0	23	0	---
SA01170.GS1	Sockeye	19 June	10:08	16.0	Fremont	19 June	17:15	17.0	385	1	384	0	---
SA01170.GO1	Coho	19 June	09:47	16.0	Fremont	19 June	17:15	17.0	71	0	71	0	---
SA01170.GC1	Chinook	19 June	09:12	16.0	Fremont	19 June	17:15	17.0	579	29	550	4	---
SA01177.MS1	Sockeye	26 June	17:01	18.0	Montlake	27 June	08:50	18.0	40	2	38	0	0
SA01177.MO1	Coho	26 June	17:13	18.0	Montlake	27 June	08:50	18.0	5	0	5	0	0
SA01177.MC1	Chinook	26 June	16:25	18.0	Montlake	27 June	08:50	18.0	70	11	59	0	2
SA01177.GS1	Sockeye	26 June	11:49	17.0	Fremont	26 June	18:00	18.0	525	5	520	0	---
SA01177.GO1	Coho	26 June	12:57	17.0	Fremont	26 June	18:00	18.0	30	0	30	0	---
SA01177.GC1	Chinook	26 June	09:32	17.0	Fremont	26 June	18:00	18.0	616	100	516	1	---