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National Marine Fisheries Service

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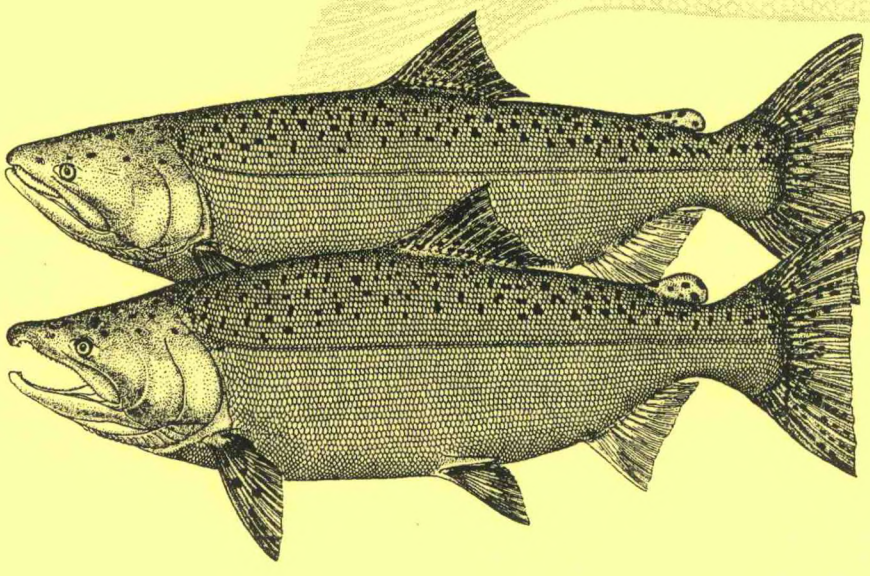

EVALUATION OF SUBYEARLING FALL CHINOOK SALMON PASSAGE IN THE MCNARY DAM JUVENILE FISH BYPASS FACILITY, 2000

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EXECUTIVE SUMMARY

In 2000, the National Marine Fisheries Service completed the second year of a study to estimate post-detection bypass survival of juvenile subyearling fall chinook salmon at McNary Dam. The first year of study indicated a delay associated with passage through the juvenile fish bypass system. During 2000, radiotelemetry receivers were deployed to determine areas of delay within the gatewell, collection channel, and separator.

River-run subyearling chinook salmon were collected and radio tagged at the McNary Dam juvenile fish collection facility, released into a gatewell, and monitored as they passed through the bypass system.

Of the 114 radio-tagged fish released, 113 (99.1%) exited the separator. Median residence time in the gatewell was 2.8 hours, accounting for 96% of bypass delay. Median residence times in the collection channel and separator were 3.8 and 2.2 minutes, respectively.

CONTENTS

INTRODUCTION

Fish diversion from turbine passage is an important component for increasing survival of juvenile salmonid migrants at hydroelectric dams of the Columbia River Basin (Iwamoto et al. 1994; Muir et al. 1995, 1996). Numerous studies have examined post-diversion fish survival following structural or operational changes at these dams. However, there have been few studies which evaluate fish passage and timing through the fish collection system after diversion.

Extensive delays within juvenile fish collection systems can affect survival and overall fish health. The McNary Dam collection facility has been shown to affect stress levels in fish (Maule et al. 1988). Stress caused by each element of the collection system can have cumulative effects on the fish. Maule et al. concluded that the amount of time a juvenile chinook spends in the bypass system can have serious impacts on fish health. Therefore, any reduction in delay at the gatewell, collection channel, or separator should reduce total stress experienced by the fish and diminish impacts on fish health.

In 2000, the National Marine Fisheries Service research objective was to use radiotelemetry to evaluate subyearling chinook salmon passage and delay through the McNary Dam juvenile fish bypass system. To accomplish this goal, we divided the work into these two tasks:

Task 1	Monitor passage of radio-tagged fish through McNary Dam juvenile fish bypass system.
Task 2	Determine residence times of radio-tagged fish in the gatewell, collection channel, and separator.

METHODS

Study Area

McNary Dam, 471 km upstream from the Pacific Ocean, is the fourth dam from the mouth of the Columbia River. The study area was the McNary Dam juvenile fish bypass system including Gatewell 8A (of Turbine Unit 8), the collection channel, and the separator (Fig. 1).

Radio Tags

Radio tags, purchased from Advanced Telemetry Systems Inc.,[1] were pinger-type, measuring 15 mm in length by 6 mm in diameter and weighing 1.0 g in air. The radio tags had an expected battery life of 7 days and transmitted a pulse every 2 seconds.

Test Fish and Tagging Protocol

Fish used in this study were river-run subyearling chinook salmon collected from 19 June through 19 July at the juvenile collection facility at McNary Dam. Anesthetized fish were removed from the sample and allowed to recover in a 113.5-L container with flow-through water 24 hours prior to tagging. Study fish were measured and their condition noted. Test fish ranged from 98 to 117 mm in length.

Fish were radio tagged using surgical techniques similar to those described by Eppard et al. (2000). We tagged a total of 117 subyearling chinook salmon. Individual radio-tagged fish were returned for recovery through a water-filled pipe to 712-L holding tanks mounted on trucks.

Release Protocol

We maintained a post-tagging recovery time of 22 to 24 hours. The morning after tagging, fish were transported and released into Gatewell 8A through a 10.2-cm-diameter, water-filled hose that was 27.4 m in length. The hose was tethered so that fish entered the center of the gatewell, approximately 1 m below the surface. Releases were made between 0700 and 0800 PST. Prior to releases, mortalities were removed from the tanks and recorded.

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1 Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

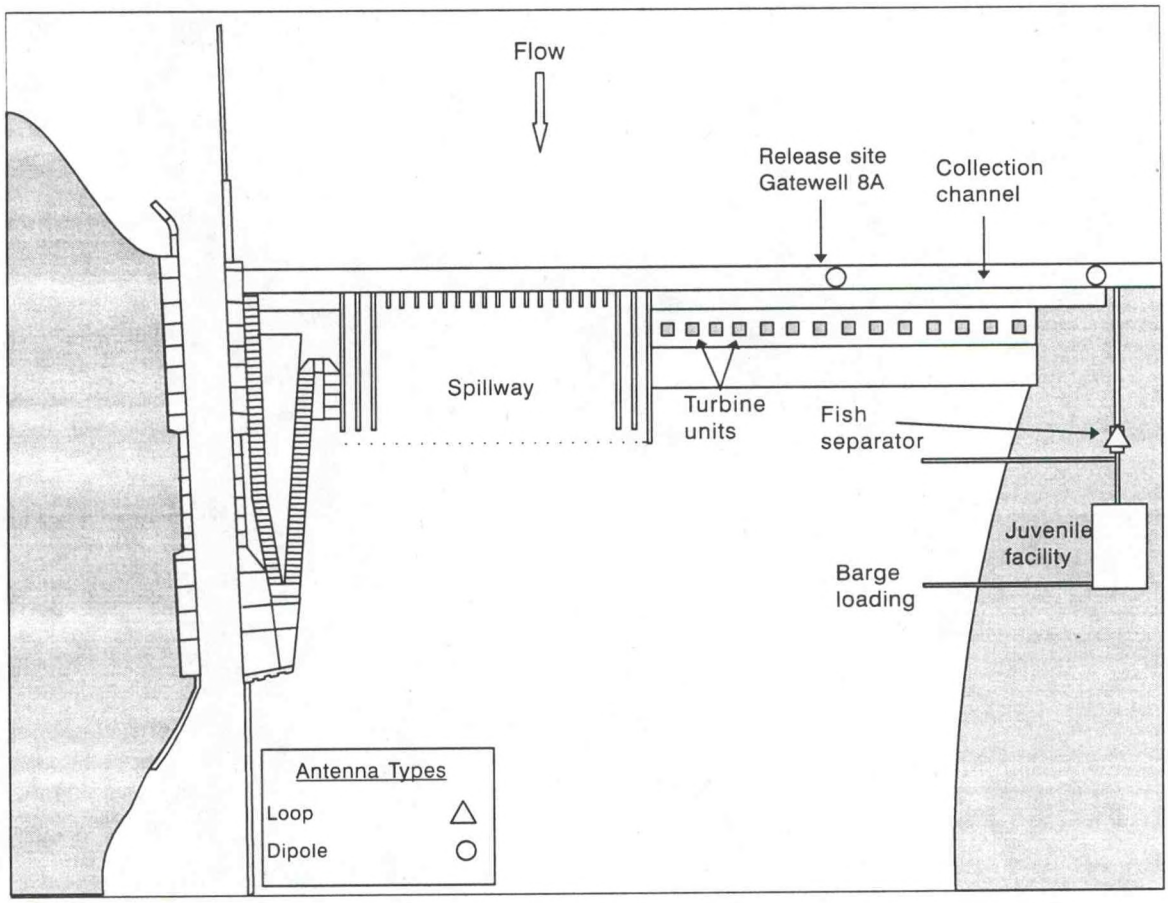

Figure 1. McNary Dam with locations of release site, telemetry receivers, and types of antennas.

Monitoring of Radio-Tagged Fish

Radiotelemetry receivers were installed at McNary Dam to monitor the orifice entrance from Gatewell 8A to the collection channel, collection channel exit, and separator (Fig. 1). Dipole antennas were deployed in the collection channel in order to increase range of detection. We mounted an air antenna (loop type) on the separator to determine entrance and exit times.

Data Analysis

Data files were downloaded daily from telemetry receivers at McNary Dam during the study period. Downloaded files consisted of records for each time a radio-tagged fish was detected. Records included a date/time stamp and the channel and wavelength (code) of an individual transmitter. Each file was then compiled to combine and count records wherein an individual fish had been detected by the same receiver within a 5-minute interval.

Compiled records were sorted by receiver location and loaded to a database. False detections were eliminated using the following criteria:

1) The number of detections on a given receiver occurred at an approximate rate of one every 2 seconds for a predetermined minimum number of detections (4 detections within a 10-second interval) and

2) There was an incorrect chronological progression through the bypass facility.

Residence times in the gatewell were determined by the difference between the release date and time and the first detection at the orifice entrance into the collection channel. Residence times in the collection channel were calculated by the difference between first detection at the orifice entrance and the last detection at the collection channel exit. Separator residence times were determined by first and last detections on the separator receiver.

RESULTS AND DISCUSSION

In 1999, we observed a delay in the bypass system for PIT-tagged subyearlings released into Gatewell 8A, which resulted in poor downstream mixing with control groups released into the tailrace of McNary Dam for survival estimates (Smith et al. 2000). Median residence time from release into the gatewell to first detection at the separator at McNary Dam was approximately 12 hours (Fig. 2). In 2000, we conducted a second year of post-detection survival studies using PIT-tag methodology and the addition of radiotelemetry releases to determine timing of passage throughout the bypass system. Bypass system residence times in 2000 were much lower, with a median of 2.5 hours (Fig. 2).

We released 114 radio-tagged subyearling chinook salmon into Gatewell 8A at McNary Dam. Of these, 113 (99.1%) eventually exited the separator. Gatewell residence times were determined for 107 fish. Residence times ranged from 2 minutes to 184 hours with a median of 2.8 hours (Fig. 3).

Collection channel residence times were determined for 106 fish. Residence times ranged from 10 seconds to 4 hours with a median of 3.8 minutes (Fig. 3). During the study, we frequently observed large schools of subyearling chinook salmon holding near the dewaterer at the downstream end of the collection channel.

Separator residence times ranged from 5 seconds to 2.2 hours, with a median of 2 minutes (Fig. 3).

In 1999, the estimated daily smolt collection at McNary, which is an estimate of the number of subyearling chinook salmon passing through the juvenile collection and sampling facility, decreased fairly rapidly as a result of 30-50% spill levels. Residence times began to increase as daily counts declined to approximately 150,000 (Fig. 4). In 2000, there were 4 million more fish released than in 1999, releases were volitional, and there were much lower spill levels at McNary Dam. All of these factors may have led to the protracted period of high daily collection estimates. The higher fish density in the bypass system in 2000 may have contributed to the lower residence times.

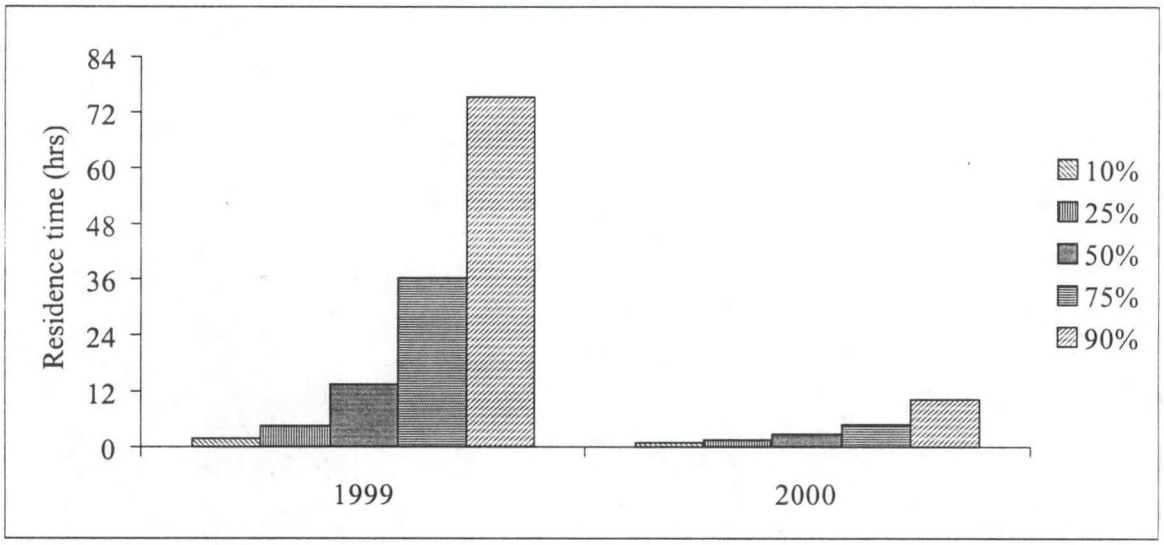

Figure 2. Juvenile fish bypass system residence times for percentiles of fish passage at McNary Dam, 1999 and 2000.

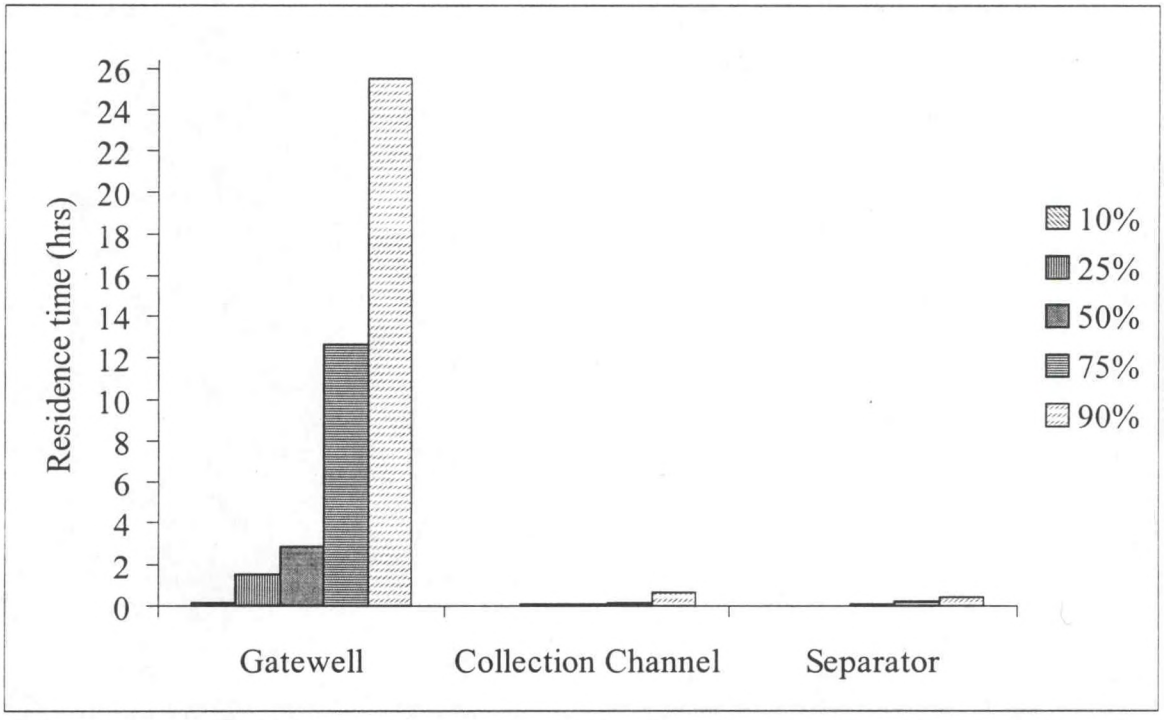

Figure 3. Gatewell, collection channel, and separator residence times for percentiles of fish passage at McNary Dam, 2000.

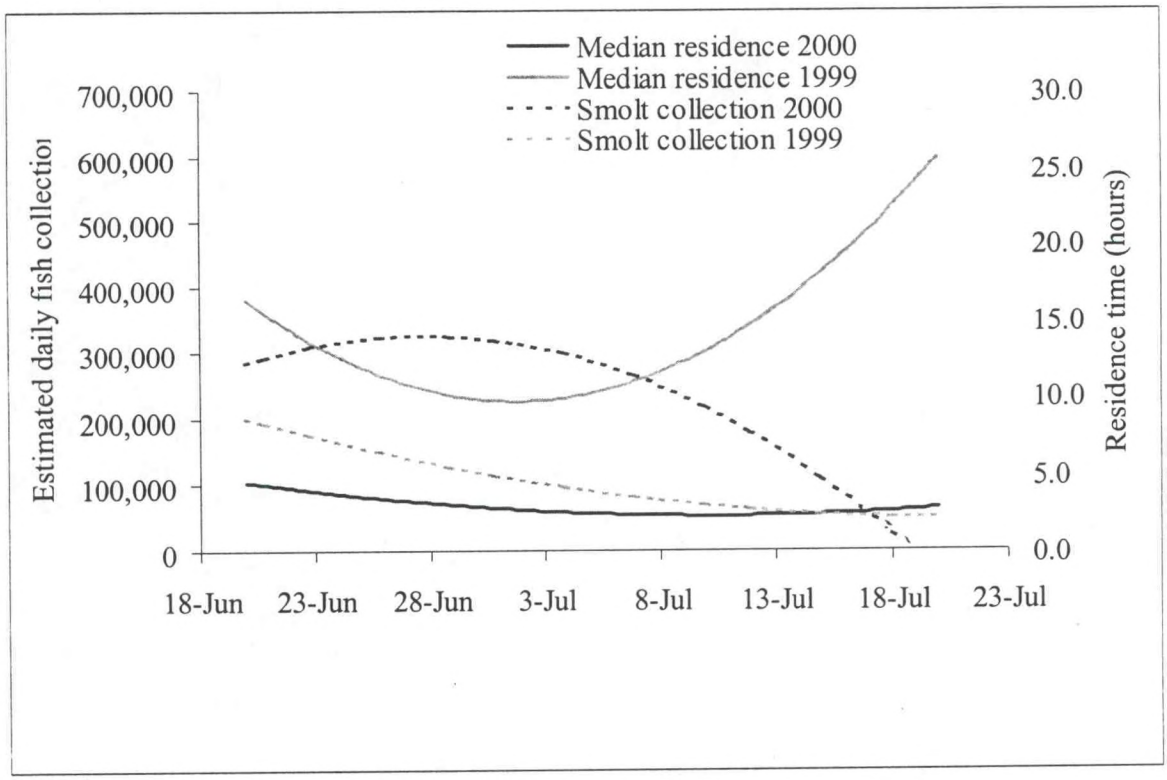

Figure 4. McNary Dam subyearling chinook salmon collection estimates vs. residence time, 1999 and 2000.

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