15

Utilizing Radiotelemetry to Investigate Passage Behavior and Survival of Juvenile Salmonids in the Columbia River Basin

Gordon A. Axel, Eric E. Hockersmith, Byron L. Iverson, Samuel L. Rambo, Darren A. Ogden, and Douglas B. Dey
Northwest Fisheries Science Center
Seattle, Washington

gordon.axel@noaa.gov

A primary focus of recovery efforts for depressed salmonid stocks has been assessing and improving fish passage conditions at hydroelectric projects and through their reservoirs. Since the listing of Columbia River basin salmonids under the Endangered Species Act, juvenile salmonid passage and survival studies at Lower Monumental, Ice Harbor, and McNary dams have been conducted to make informed decisions in the best interest of the stocks (Figure 1).

Figure 1. Locations of the hydroelectric facilities on the Snake and Columbia rivers.

Over the course of the last 10 years, we have improved the detection efficiency of our telemetry receivers, thanks in large part to the designs created by RF Engineering (Lynnwood, Washington). Unlike other telemetry receivers currently being used to track fish, the NMFS 30 megahertz (MHz) multichannel receiver detects amplitude modulated (AM) pulse-coded carrier frequency signals on nine channels simultaneously without using digital signal processing (DSP) technology. Each channel is optimized for wide dynamic range and high adjacent channel rejection, and provides excellent sensitivity. Once a tag is detected, the receiver decodes the signal to determine which individual tag sent the signal. The receiver then records one line of data to a local file containing the time stamp of the detection, the channel and code that together uniquely identify the fish, and power (signal strength).

In 2003, we began to design a wireless network for data acquisition and management. The original network consisted of FreeWave 900-MHz Wireless Data Transceivers (FreeWave Technologies, Boulder, Colorado) that were connected to our telemetry receivers. This configuration allowed a single person to download more than 50 telemetry sites within the constraints of an 8-hour work day (approximately 140 miles of study area). However, the 900-MHz system had limited range and did not allow for automated downloading. During 2004 and 2005 we changed to the airBridge TOTAL 2.4-GHz client (SmartBridge, San Jose, California). Powered through the use of an Ethernet cable, this unit has higher receiver sensitivity and rugged weatherproof design, and provides error-free data transfer with auto-fallback data rate for long-distance communication in noisy environments.

Currently, we are pursuing a smaller radio transmitter that will enable us to tag a larger portion of the total population. When we began tagging juveniles in 1997, we used a 1.8-g tag. In 2005, our tags weighed 0.9 g. Limitations on tag size include the overall output of the tag and the battery life required for such output. In order to provide complete detection of juvenile salmonids through the study area, we require a battery life of 10 days. We are examining the use of different potting substances to decrease the weight of the tag and ways to decrease the length of the antenna that trails behind the animal as it swims. In addition, we are also investigating a transition from an AM transmitter to a frequency modulated (FM) transmitter. With a slight modification to our current RF receiver board, we will be able to detect and code an FM tag. This modification will substantially increase the number of individual tag codes and reduce the power consumption of our current tag, thus allowing for a smaller, more efficient juvenile RF tag. Because FM tags would require less power to produce the same output and tag life that we currently need, we would be able to use a smaller battery and reduce the tag weight by one-third.

Our electronics technicians are developing quarter-wave two and three element receiving antennas. These antennas will reduce antenna size by 50%, while keeping the antenna tuned to our carrier frequency of 30 MHz. This will increase antennas' versatility and durability. For underwater applications, the electronics shop is developing a dual plane dipole antenna (Figure 2). This antenna will increase the number of detections by allowing detections in both horizontal and vertical planes.

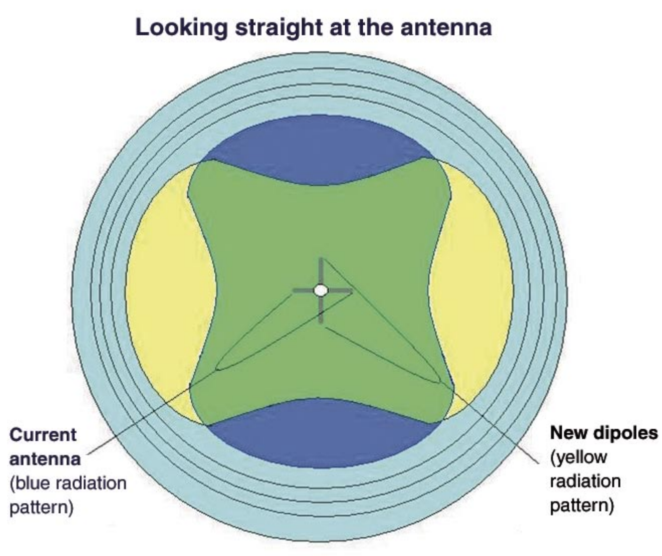

Figure 2. Diagram of the detection field of the antenna attached to the upstream face of the dam demonstrates the difference between radiation patterns of current antennas used for radiotelemetry work with salmonids and the new dipole antenna being developed.

While modifications to our antennas and receivers will be helpful, data communications efficiency is paramount to the success of the juvenile salmonid radiotelemetry studies. The current data communication is done via RS-232 serial port. We are investigating a transition from RS-232 to Ethernet that will provide a minimum of 10 megabits per second of data transfer, thus improving network reliability and speed. This will allow us to download from receivers several times daily and receive site reports that will provide the electronics staff with the information necessary to keep the telemetry receivers running at their optimal capabilities.

With recent technological enhancements, radiotelemetry will continue to provide critical information on passage and survival for juvenile salmonids at hydroelectric dams and through their reservoirs. As we take advantage of these enhancements, we will be able to improve our assessments of the stocks and determine the best course of action to recover, conserve, and manage endangered and threatened salmonids and their habitats.