

**BAKER R. FISH PASSAGE TECHNICAL COMMITTEE  
BAKER RIVER PROJECT, FERC NO. 2150**

**Summary Results of Steelhead Kelts Behavior Study - Radio Tag Tracking 2002**

*Nick Verretto, 12/12/02*

**Purpose**

- Provide information on the migratory behavior of steelhead kelts in Upper Baker reservoir.

**Method**

- Used fixed (aerial and underwater antennae) and mobile telemetry (directional antennae affixed to boat) to track kelts' daily position in reservoir from 04/29/02 to 06/20/02,
- Radio tags were gastrically implanted in ten steelhead, with antennae protruding.

**Results**

- Eight of ten kelts migrated from Shannon Creek to forebay, other two located in upstream end of reservoir entire period (not necessarily alive),
- Range of travel time was three to ten days, median was eight days,
- Individuals spent between one to 14 days within the forebay,
- Kelts were in upper layers of water when in the forebay,
- Over 80% of forebay detections (not distribution) were at the surface collection barge (SCB) entrance (but not inside)
- Most fish moved up and reservoir several times, two went straight to SCB.

**Weaknesses**

- Potential behavioral influence of extended holding, tagging, handling, release,
- Small sample size (prevalent in all individual-fish tracking studies),
- Steelhead used did not rear in Baker Lake, and had not been in Baker prior to study,
- Zone of detection incomplete,
- High mortality rate of fish initially collected for tagging (20 of 30), and potential consequent mortality after release (two of ten tags recovered, one never moved after four days),
- High tag expulsion rate at time of tagging (two of ten), and potential for same after release (two of ten tags never detected one week after release – carried away by birds or bipedal predators, sunk mid-channel, tag died, moved far up river or tributaries?),
- Expectation of specific migratory behavior may be misplaced,
- Apparently random behavior makes identifying collective behavioral patterns futile,
- Steelhead did not spawn naturally, so post-spawning behavioral patterns may vary from that seen.

**Significant Findings**

- Kelts migrated reservoir successfully under all operating conditions, found SCB entrance, were in upper water column when in forebay.



## Summary Results of Smolt Migration Study - PIT Tag Recapture 2002

*Nick Verretto, 12/12/02, with edits from 12/13/02 mtg.*

### Purpose

- Determine and compare success rates and travel times of sockeye and coho smolts under various Project operating conditions (low vs. high pool, 7-day periods of generation on vs. off: parallel far-field and near-field study releases), and determine delay in travel/detection between SCB and trap (control).

### Method

- PIT tags were injected anterior to the pelvic girdle, just above midline. Detection was in 6-hr. increments at the fish trap via physical sampling and/or electronic tag detectors,
- Low and high pool elevations ranged from 683.43-691.17 and 702.71-719.67; generation was either on (4,200 cfs or higher) or off; 2,060 coho and 1,069 sockeye were released.

### Results

- **Far-field:** migration success varied widely by species (coho 19-36%, sockeye 5-67%), release location (coho success higher at Little Park Cr. than Shannon Cr.), test condition (coho travel time faster in high pool – median 9d vs. 13d & 10d vs. 12d; sockeye similar; Little Park coho similar in high and low conditions) (see report, p. 23); long travel time suggests milling or searching pattern; coho had higher success under low pool, sockeye under high pool; coho moved into trap at night (1800-0600 hrs) and sockeye during the day (0600-1800 hrs.),
- **Near-field:** migration success was higher for near-field than far-field test groups; sockeye had lower success in no-generation condition; coho had lower success during generation & low pool, and higher success during generation & high pool; coho travel time among all treatments and test conditions was median 2.3-3.3d; sockeye travel time within treatment was similar among all treatments and test conditions was median 2.5-5.3d, overall was 3-17d; generally higher success was experienced during generation than non-generation,
- **Control:** travel time for fish released as controls into the SCB hopper ranged from 0.25-1.50d (median 0.25-1.0d).

### Weaknesses

- Potential 6-hour error in recapture detection,
- Insufficient number and size of Little Park and trap fish led to variable handling,
- Potential migratory influence of extended holding, tagging, handling, release,
- PIT tags much more useful for tracking fish movement in more complicated migration routes,
- Areas of submerged barrier net float line allowed alternative escape route,
- Extreme logistical problems when combined with other studies and operating needs,
- Frequently, less than 100% (68-100%) of fish released as controls into the SCB hopper were recovered, suggesting detection or sampling error, and introduction of error in study results,
- Treatment window (and battery life) is too short, considering median travel time of up to 13d.

### Significant Findings

- No consistent pattern of influence from Project operating condition (pool elev. or generation) on migration success across species was observed (periods of generation in the near-field releases is the



possible exception). No diel pattern influence by test condition was detected. Migration patterns were inconsistent, making generalized decisions based on collective behavior difficult,

- Results were consistent with long-term mark-recapture studies. Travel time was identified, which was not done with previous mark-recapture studies, and the PIT tag study has provided confirmation of past study recapture rates,
- Future use may be for adult detection, with installation of fixed detector at new adult facility,
- Recommended improvement to study method is the installation of a real-time detector, as opposed to the 6-hour window installation of the 2002 study.

## Summary Results of Smolt Behavior Study - Radio Tag Tracking 2002

*Nick Verretto, 12/12/02, with edits from 12/13/02 mtg.*

### Purpose

- Describe the individual movement/migration behavior of coho and sockeye smolts in two-dimensions as they migrate the reservoir and enter the forebay under various test conditions (primary – high & low pool, secondary – 7-day periods of generation on & off), and attempt to identify collective behavioral patterns.

### Method

- Used fixed (aerial and underwater antennae) and mobile telemetry (directional antennae affixed to boat) to track smolts' daily position in reservoir from 04/29/02 to 06/20/02,
- Radio tags were surgically implanted in coho and smaller sockeye, gastrically implanted in larger sockeye (GTE 125 mm), with antenna protruding through suture area or mouth,
- Primary test condition of low or high pool elevations ranged from 683.43-691.17 and 702.71-719.67; secondary test condition of generation was either on (4,200 cfs or higher) or off,
- The outer log boom was identified as the "finish line".

### Results

- 131 coho and 44 sockeye were released, 24 were never detected,
- 27% of coho were detected by fixed receivers and 68% of sockeye,
- Median travel times for coho were faster during high pool (4.3-6.1d) than low (7.2-8.4d), which is consistent with that found for coho in PIT tag study,
- Median travel times for sockeye were similar during high pool (4.2d) and low (4.9d), which is consistent with that found for sockeye in PIT tag study,
- More coho and sockeye successfully migrated to the forebay in the low pool condition,
- Sockeye released at Little Park migrated at rate of 86%, as opposed to 50% for those released at Shannon Creek,
- Most fish appeared to be migrating along shores and were associated with tributary mouths or woody habitat,
- 45% of smolts migrated upstream after reaching the forebay, with many then staying in the upstream areas, although some showed high travel times (over 6 miles in 24 hrs., potentially indicating predation by bull trout),
- 87 released smolts were tracked in the upper reservoir, but never made it to the forebay, representing 60% and 18% of the coho and sockeye, respectively,
- Coho and sockeye behavior was similar while in the forebay,
- Smolts moved into and out of the forebay several times,
- Less than 10% of released fish were recovered in the trap, and size of fish was of predominantly large and small fish, indicating tagging effect and/or recapture system avoidance.

### Weaknesses

- High tagging-related mortality (27%), but caused by tangled antennae,
- Potential behavioral influence of extended holding, tagging, handling, release,
- Small sample size (prevalent in all individual-fish tracking studies),
- Fish sources varied due to insufficient numbers and sizes at times, and planned Little Park source fish were too small for use,



- Fish handling sometimes varied due to insufficient numbers and sizes at times,
- Zone of detection incomplete,
- Low battery life and consequent short duration of tracking opportunity,
- Extreme amounts of floating woody debris at the outer log boom may have impacted behavior,
- Can't determine whether fish move into or out of SCB entrance,
- Question remains whether recapture success is related to fish source.

### **Significant Findings**

- Smolts residence time in the forebay was in the upper water column along the barrier net and outer log boom,
- The greatest number of fish was detected near the SCB entrance (37-43%) and along the barrier net (38-40%), but smolts tended to reject the opportunity to enter,
- Fish moved extensively throughout the forebay and perhaps favored the north shore, distribution was similar under all test conditions, and patterns of movement were similar to those observed in acoustic study.

## **Summary Results of Smolt Behavior Study - Acoustic Tag Tracking 2002**

*Nick Verretto, 12/12/02, with edits from 12/13/02 mtg.*

### **Purpose**

- Describe the individual movement/migration behavior of coho and sockeye smolts in three-dimensions as they enter the forebay under various test conditions (primary – 7-day periods of generation on & off, secondary – high & low pool), and attempt to identify collective behavioral patterns.

### **Method**

- Used 15 fixed underwater hydrophones to continuously track smolts' three-dimensional movement within the forebay from 04/29/02 to 06/20/02, and a mobile hydrophone (dropped from a boat) to locate smolts outside of the forebay (one-dimension only) on a weekly basis,
- Acoustic tags were surgically implanted in the body cavity of coho and sockeye, 176 coho and 36 sockeye were released,
- Primary test condition of generation was either on (4,200 cfs or higher) or off; secondary test condition of low or high pool elevations ranged from 683.43-691.17 and 702.71-719.67.

### **Results**

- 201 of 212 released fish were tracked,
- Generating condition had little or no effect where tags life extended into next treatment condition,
- Individual fish movements were reviewed and aggregated into specific behavioral patterns and physical conditions in an attempt to identify consistent behavioral patterns and causal mechanisms. These included: milling, approach, crossing, diving, residence time, capture, entry, length, condition factor, density plots, site fidelity, barrier net use, shoreline use and forebay use,
- Primary and secondary treatments showed little effect on behavior,
- Half of sockeye were detected outside of the forebay, but only 20% of coho.

### **Weaknesses**

- High tag failure rate (8%),
- High tagging-related mortality (5%), and potential consequent mortality after release,
- Potential behavioral influence of extended holding, tagging, handling, release,
- Small sample size (prevalent in all individual-fish tracking studies),
- Fish sources varied due to insufficient numbers and sizes at times,
- Fish handling sometimes varied due to insufficient numbers and sizes at times,
- Zone of detection incomplete,
- Low battery life and consequent short duration of tracking opportunity,
- Software does not allow time-location analysis,
- Can't determine whether fish move into or out of SCB entrance.

### **Significant Findings**

- Individual tracks and density plots of release groups indicated that the majority of fish approached and/or remained in the vicinity of the SCB for extended periods of time,
- Coho displayed a predominantly surface-oriented behavior, whereas sockeye used the entire vertical column but were at the top 70-80 feet most of the time (although often showed deep diving behavior),



- Fish tracks indicated that the barrier net had a positive influence on “guidance” or restricted range of motion, and prolonged contact/opportunity for encountering an attraction device (searching pattern along the barrier net also seen in the smolt radio tracking study),
- Generating condition and pool elevation had no consistent influence on behavioral pattern,
- Low recapture rates were apparently due to fish rejecting the SCB,
- Fish that passed through the submerged section of the barrier net appeared to remain in the vicinity of the net and SCB, milling about behind the net similar to behavior in front of the net,
- Lobes of milling behavior behind the net and to either side of the SCB may be in response to the SCB pump side-discharge flows.