From the Archives

The Town of Summerville, Oregon

compiled by Heather Hall, GRMW

ABOVE: The historic Dry Creek School (built 1885) in Summerville is listed on the U.S. National Register of Historic Places
Image courtesy Ian Poellet, Wikimedia Commons

The town of Summerville was an early trading and commercial center in the Grande Ronde Valley. Settled in the spring of 1865, Summerville was founded by Mr. W.H. Patton as a stage coach station. Summerville was named after a good friend and neighbor of Mr. Patton's who lived in the Willamette Valley. Mr. Patton was the postmaster of the post office, which was established in 1865. His homestead was also the site of the original town center. One of the first businesses established in Summerville was a meat market operated by Mr. Henry Rinehart. As the only trading stop north of La Grande and Island City, Summerville boasted saloons, churches, its own town doctor, and even a large brewery soon after its founding. For many years, Summerville offered a daily stage coach service to Elgin, but with the construction of the railroad in 1891, the stage coach service soon disappeared, and the town of Summerville was no longer the trading center it used to be.

Today, Summerville has a population of around 117 citizens. It still has its own post office, store, and tavern.

This newsletter is funded by the Bonneville Power Administration and the Oregon Watershed Enhancement Board

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Winter 2011

Ripples in the Grande Ronde

RIVERS UNITING NEIGHBORS·QUARTERLY NEWS FROM THE GRANDE RONDE MODEL WATERSHED

The Results Are In!

The First Year of the Catherine Creek Chinook Salmon Tracking Project

by Lyle Kuchenbecker, GRMW & Scott Favrot, ODFW ELH
All images and figures courtesy of the ODFW ELH

ABOVE: Fish were tracked on foot using hand-held receivers when river conditions precluded the use of boats.

ABOVE: Juvenile Chinook salmon overwintering from November 2009 to January 2010 primarily occupied stream reaches between Union just below the rotary trap and Davis Dams just below Highway 203.

About the Project

The Catherine Creek spring Chinook population is one of the highest priority populations for restoration in the Grande Ronde subbasin due to the potential productivity of the population and the severe decline in numbers of wild fish. The Oregon Department of Fish and Wildlife (ODFW) Early Life History (ELH) Project has been conducting research on juvenile Chinook salmon in Catherine Creek since the early 1990s. The objectives of the research have been to document juvenile migration patterns, estimate egg-to-migrant survival rates, and determine overwinter mortality.

The Winter 2010 issue of the Ripples newsletter featured an article describing the latest ELH research effort. The research involved capturing juvenile salmon in a rotary screw trap on Catherine Creek just above the City of Union (see picture below center), implanting radio transmitters into the fish, and then tracking the movement of the fish throughout the valley. Juvenile Chinook were captured in October and November 2009 and tracked as long as the transmitter batteries lasted (an average of 41 days).

Juvenile Chinook salmon in Catherine Creek display two distinct migratory patterns. Early migrants begin leaving headwater rearing areas in late September and overwinter in the Grande Ronde Valley between Union and Elgin before out-migrating with high spring flows. Late migrants begin leaving headwater reaches in early February and continue out-migration through the valley with high spring flows.

Results of the ELH research indicate that early migrant survival to Lower Granite Dam on the Snake River is typically lower for Catherine Creek juveniles compared to other spawning tributaries in the Grande Ronde subbasin.

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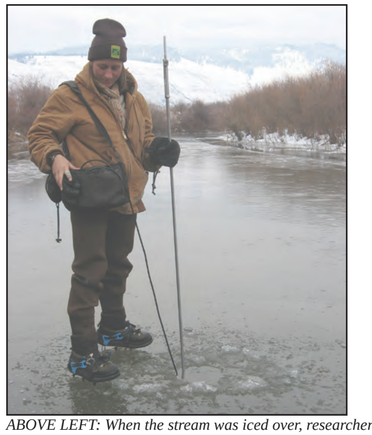
LEFT: Juvenile Chinook are captured in this rotary screw trap above Union as they migrate downstream. Radio transmitters are implanted in fishes' body cavities so they can be tracked as they migrate down through the Grande Ronde Valley.



RIGHT: During periods when Catherine Creek was free of ice and flows were sufficient, juvenile salmon were tracked using boats and canoes.

ABOVE LEFT: When the stream was iced over, researchers drilled holes through the ice to gather data on the types of habitat used by the migrating juveniles. By identifying the stream reaches and types of habitat preferred by the fish, restoration activities can create more of these types of habitat.

The average early migrant survival probability for fish migrating through Catherine Creek between 2004 and 2009 was 0.16, while upper Grande Ronde, Minam and Lostine river populations had a significantly higher aggregate mean survival probability of 0.25.

Poor survival rates of Catherine Creek juvenile salmon have prompted further efforts to identify causes of juvenile mortality. The ELH project has periodically attempted to identify overwinter rearing reaches used by Catherine Creek early migrant spring Chinook juveniles since the early 1990s. A variety of sampling techniques (e.g., minnow traps, seines, fyke nets, snorkeling) have been employed; however, habitat and gear limitations prohibited efficient sampling. During early 2009, an opportunity to address the low survival rates of Catherine Creek early migrants cooperatively with Bureau of Reclamation (BOR) and Bonneville Power Administration (BPA) enabled ODFW to develop and execute additional research using recent technological advances in radiotelemetry (e.g., tag size reductions).

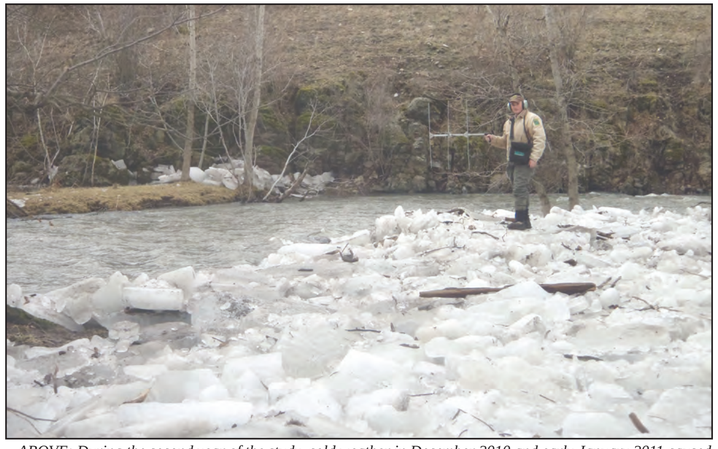
The specific objective of the 2009-2010 research was to locate and describe the stream reaches and types of habitat used by Catherine Creek juvenile Chinook during the fall and winter months. This data can help organizations like the Grande Ronde Model Watershed (GRMW) target the types and locations of habitat in Catherine Creek that would most benefit juvenile salmon through restoration efforts. By identifying the location and types of habitat used by the fish, restoration work can create or enhance that habitat to increase carrying capacity and overwinter survival for naturally produced Catherine Creek early migrant juvenile salmon.

Methods

Ninety-eight juvenile Chinook were captured in the rotary trap and implanted with radio transmitters (see article on page 3 for more information about the radio tag implantation surgery technique). The researchers located each radio-tagged fish once a week through March 2010. Biologists tracked fish on foot, by boat, and by helicopter. Geographic coordinates and microhabitat use variables, such as creek depth and velocity, were collected for all fish locations.

Results

Of the 98 fish tagged, 15 tags were excluded from analyses due to confirmed mortality (e.g., mink and bird predation), tag expulsion, or fish leaving the study area; 83 (85%) fish were located regularly. Biologists spent 650 hours tracking the fish, yielding approximately 700 fish locations. Weekly fish locations revealed that most Catherine Creek early migrants occupied a 3.7-mile reach downstream from Union for overwintering. During fall, early migrants primarily occupied high-gradient reaches.



ABOVE: During the second year of the study, cold weather in December 2010 and early January 2011 caused large accumulations of ice in Catherine Creek. The thaw in mid-January combined with rain resulted in ice jams and out-of-channel flows, complicating this year's fish tracking activities.

Meet the Board

Dave Yost

Profile by Jeff Oveson, GRMW

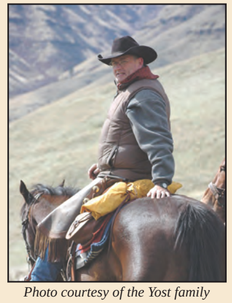


Photo courtesy of the Yost family

If you live in Wallowa County, chances are that the last name "Yost" rings a familiar bell. If not, chances are that you haven't lived in Wallowa County for very long. The first of the Yosts to live in the "county" was Paul, who moved from Canada to the Prairie Creek country in 1938 to work for Raymond Johnson. Paul met and subsequently married Gladys Lathrop, whose surname might be very familiar name to folks in the area, as the first of the Lathrops came to Wallowa County back in the 1880s.

Dave was raised by Gladys and Paul in the Prairie Creek country, where family members still farm. After getting his degree in Agricultural Education from Oregon State University (OSU) in 1978, Dave taught at Lost River High School in Klamath County for two years and since 1980 has been at Joseph High School (JHS), where he teaches agriculture classes and is also the Future Farmers of America Chapter Instructor. He has been a teacher at JHS for 23 years, with the exception of a six-year interruption to work on the family ranch.

Dave and Marianne, his wife of 26 years, have two daughters. Anna, 24, is pursuing a Master's degree in Speech Pathology at Portland State University after getting her Bachelor's degree in Agricultural Business through OSU. Megan, 22, is taking General Agriculture classes at Treasure Valley Community College through OSU.

In late 2010, Dave became a member of the Grande Ronde Model Watershed (GRMW) Board of Directors representing Agriculture and Education. His deep roots in Wallowa County are important to his personal background as well his vision for how the GRMW fits into the big picture during a time of social and technological transformation. Don't misunderstand: Dave is not a "that's the way we've always done it and that's the way we should continue to do it" kind of guy. His appreciation for "how it's always been done" provokes him to think about new ways to do things. He and Marianne share this vision. Together with Sharon and Larry Nall, they founded and operated the Wallowa Ranch Camp for eight years through the mid-1990s. Working with partners Sustainable Northwest and Wallowa Resources, the Wallowa Ranch Camp's innovative approach to reaching across social borders provided dozens of young people, mostly from the I-5 corridor, with the opportunity to experience of hands-on animal agriculture, the sustainable management of natural resources in Wallowa County, and a few local kids to keep the experience "real."

Dave offered some interesting reflections on his life in Wallowa County: "Growing up in the Wallowa Valley for me was instrumental in developing my adult life. The experiences that I had growing up on a livestock and forage production operation as well as the rural lifestyle helped to focus my future goals. I knew when I went away to college that I wanted to some day come back to the Wallowa Valley and live. My hope was to work in production agriculture, but I found my way into agricultural education, and it has been a good fit."

Dave continued on to say that he has seen "a lot of changes over the 50-plus years of living in Wallowa County, from a large resource-based economy that supplied numerous family-wage jobs to today's struggling times. One of the consistent observations I have made is of the people who still work and live in our valley and their commitment to the community. I know and help many families who make a living on the land, and their commitment and passion to the work they do is a joy to see. Over the years, I have seen many production operators find ways to adapt and progress in hard times. From unique marketing ideas such as cooperative selling to integrated management ideas, producers today have to stay progressive to keep solvent."

Dave recalled, "When my family first bought a ranch on the Chesnimnus in the early 1970s, my dad, Paul Yost, recognized the need to improve water quality, and he was one of the first ranchers in the area to fence the main creek off to help improve and maintain habitat. From then on, I became interested in the evolution of habitat improvement and in the methods and the techniques used to manage sensitive areas. I have a basic belief in the responsibility of the people on the land to care for the land in a way that will keep it productive and healthy for the generations to come."

"One of the life lessons my dad taught me," Dave said, "was to give back to the community what they have given to me by being involved in community activities. In accepting the position on the GRMW Board, I hope to give back to our community in an area that I have had interest in for several years. I hope that my years in public education as well as my roots in production agriculture will bring a needed view to the Board. I have chosen to live and raise my family in Wallowa County because of the people who live here, the lifestyle we can pursue, and the open spaces around us."

Fish Online!

www.grmw.org

- Adult salmon counts at the dams
- Snake River Basin stream flows
- Snow and precipitation reports
- Habitat enhancement projects
- Meetings, activities, and events
- Past issues of *Ripples* and more!

Grande Ronde Model Watershed

Upcoming Board Meetings

The public is welcome to attend

- **Tuesday, February 22: 5:00 p.m.**
  Elgin Community Center
  260 North 10th Street
  Elgin, Oregon
- **Thursday, May 26: 6:30 p.m.**
  Wallowa Community Center
  204 East Second Street
  Wallowa, Oregon

Meeting dates are subject to change. Please call 541-663-0570 to confirm. Thank you!

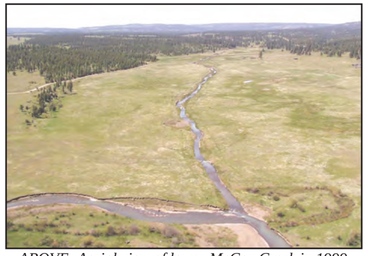
The McCoy Meadows Restoration Project: A Short History

By Allen Childs, Fish Habitat Project Leader & Jason Grant, Assistant Fish Habitat Biologist, Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Images courtesy of CTUIR

The McCoy Meadows Ranch is located in Union County about 20 miles southwest of La Grande, Oregon, near the confluence of Meadow Creek with the upper Grande Ronde River. Due to its geographical location and topography, the ranch has the potential to be a stronghold for native fish and wildlife and to provide important habitat for a variety of focal species. A diversity of fish and wildlife use the area, including bald eagles, beavers, spotted frogs, yellow warblers, rocky mountain elk, white-tail and mule deer, coyotes, and cougars. The property encompasses nearly 2.9 miles of lower Meadow Creek, 3.3 miles of McCoy Creek, and 0.5 miles of McIntyre Creek, which provide spawning and rearing habitats for Snake River Basin summer steelhead and rearing habitat for spring-summer Chinook salmon, both of which are listed as threatened under the Endangered Species Act (ESA) and are important cultural and subsistence resources for the Confederated Tribes of the Umatilla Indian Reservation (CTUIR).

A History of Simplification

Historically, McCoy Meadows was a large wetland meadow complex with an abundance of sinuous stream channels, backwater areas, ponds, and what was believed to be one of the larger beaver colonies in the upper Grande Ronde subbasin. Alteration of the wetland complex probably began in the early 1800s with extensive beaver trapping. By the early 1900s, livestock grazing, road and railroad construction, logging, and farming severely altered the character and function of the meadow system; by the late 1960s, the meadow's wetlands were subject to aggressive draining efforts to promote agricultural uses. The lower reaches of McCoy Creek were channelized, straightened, and relocated in two phases, first in 1968 and again in 1977. In addition, the lower portion of McCoy Meadows was land-leveled in the late 1970s. Channelization and subsequent channel widening and deepening resulted in the loss of wetlands, the simplification and reduction of in-stream habitats, decreased channel stability, and increased erosion. Channelization also damaged the natural function of the meadow and its ability to absorb large flood events, dissipate energy, and recharge groundwater, which can contribute to increased stream flow during summer periods.



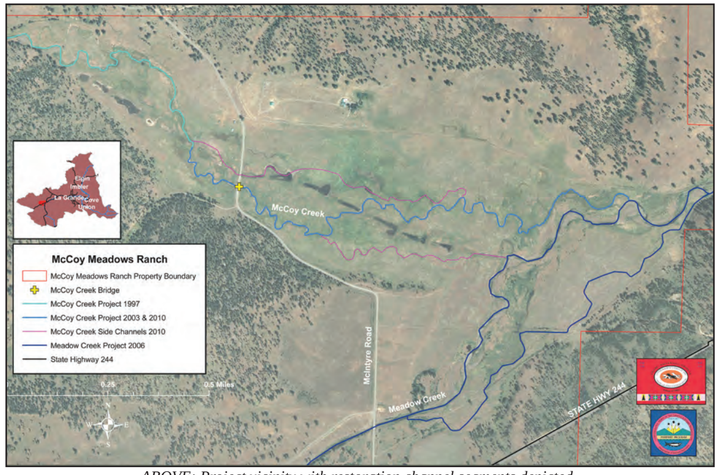
ABOVE: Aerial view of lower McCoy Creek in 1999 illustrating the lower channel reach of McCoy Creek

Cooperative Habitat Restoration Partnerships

The Oregon Department of Fish and Wildlife (ODFW) initiated stream protection and restoration efforts in 1988 in McCoy Meadows with the construction of approximately 8 miles of livestock exclusion fencing along Meadow Creek and McCoy Creek under the Bonneville Power Administration's (BPA) Fish and Wildlife Program. Fencing and protection from livestock facilitated improvements in stream bank stability along both streams. However, channelized stream reaches in their widened and deepened condition continued to actively erode, limiting the ability of these streams to progress toward a stable, natural channel configuration with access to the floodplain to dissipate energy and vegetation capable of strengthening stream banks through extensive root systems.

At the request of the landowner, a working group was established in 1995 to inventory and assess existing conditions, identify factors limiting production of cold-water fish, develop goals and objectives, and identify potential restoration strategies that could augment the benefits achieved from the initial ODFW project. The group included the landowners and representatives from tribal, state, and federal agencies including the CTUIR, ODFW, Environmental Protection Agency (EPA), Oregon Department of Environmental Quality (DEQ), and Natural Resource Conservation Service (NRCS).

By late 1996, the working group completed a restoration analysis that established project goals, objectives, initial restoration actions, and a framework from which to plan and design future restoration actions. The resulting overall project goals were defined as "restoring, to the extent feasible, the



ABOVE: Project vicinity with restoration channel segments depicted

the natural function and character of the wetland meadow complex." Key objectives included restoring stream channel morphology, fish and wildlife habitat, and palustrine emergent and shrub-scrub wetlands; enhancing floodplain connectivity and groundwater; and improving water quality (i.e., decreasing summer stream temperatures, increasing winter stream temperatures, and decreasing turbidity). The project was implemented in several phases: Phase 1 (upper meadow) in 1997, Phase 2 (lower meadow) in 2000-2002, Meadow Creek in 2006, and McCoy Creek enhancements in 2010.

Phases 1 and 2

Phase 1 included re-activating an approximately 0.23-mile reach of upper McCoy Creek to its historic (pre-1977) channel alignment. The project was relatively simple conceptually, as most of the historic alignment in the upper meadow remained intact and only required the removal of an earthen dam that had been left in place during the channelization process. Rather than divert McCoy Creek into the historic channel all at once, project sponsors elected to activate the channel over a period of a couple of years to facilitate re-establishment of vegetation through a combination of natural regeneration and planting prior to final diversion. During the summer of 1999, McCoy Creek was completely diverted and the channelized reach reclaimed through the installation of a series of earthen terraces and ponds.

In 1999, the project team initiated Phase 2 to develop a restoration strategy for the lower meadow. Activities included contracting with Ducks Unlimited (in cooperation with the Union County Public Works Department) to design and install a new bridge in order to improve fish passage and water transport through the McIntyre Road (see photo at right). NRCS completed the design, and Phase 2 of the project was implemented during 2000-2003. Implementation included 6,500 feet of channel construction, installation of rock and wood structures, revegetation, and reclamation of the channelized reach, which involved construction of earthen berms and floodplain ponds. Additionally, new boundary fences were constructed around the newly established 450-acre permanent conservation easement.

Phase 1 of the project has been successful in improving channel morphology in terms of increased sinuosity, decreased slope, decreased channel width-to-depth ratios, enhanced in-stream complexity and fish habitat, and promotion of riparian and wetland vegetation. Overall, the project reach is stable, provides complex habitat, and demonstrates improving groundwater elevation and water temperature trends. Phase 2 of the project has also progressed toward achieving multiple objectives but has experienced several shortcomings, including localized channel incision and elevated slope, stream bank erosion in areas with excessive energy, and lack of vegetation colonization due to factors such as stream bank erosion and depredation by big game.

ABOVE: The Phase 2 McIntyre Road bridge replacement project improved fish passage and water transport

Despite some of these limitations, a number of positive responses have also been observed, particularly in the lower reaches of the project that remain relatively stable. Key achievements have included increased channel length and habitat complexity, moderation of daily maximum and minimum water temperature fluctuations, and increased groundwater elevation in multiple areas, which promotes establishment of desirable riparian and wetland vegetation.

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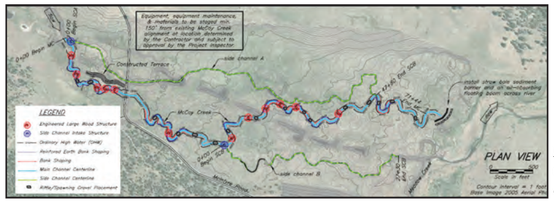
ABOVE: Aerial view of the Phase 1 project area in 2010

ABOVE: Photo within Phase 1 project area showing a recovering channel segment being used by beavers



LEFT: 2010 McCoy Creek project overview

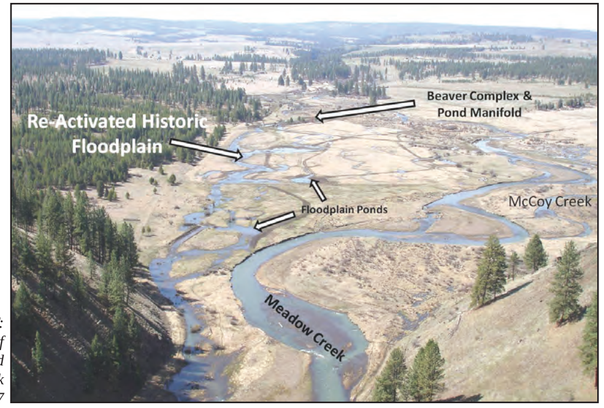
Meadow Creek and McCoy Creek Enhancements

In order to address the shortcomings of the Phase 2 project, the NRCS, CTUIR, and ODFW initiated restoration planning and design efforts in 2009 and prepared for construction in 2010. Primary objectives included decreasing channel slope, distributing energy from high-water events by improving floodplain connectivity, and stabilizing stream banks through bioengineering techniques. Project elements included installation of engineered large wood structures and rock riffles at strategic locations along McCoy Creek to adjust channel slope; construction of 5,500 feet of wetland side channels to direct stream energy from McCoy Creek to the floodplain and provide off-channel habitat; and installation of 4,000 feet of stream bank treatments such as erosion-control fabric and extensive planting and seeding. A total of 12 wood structures and 16 rock riffles were constructed along the project reach. The Oregon Department of Transportation (ODOT) provided large wood material through its Highway 244 hazardous tree removal program. More than 30 big game fence exclosures of various sizes have been constructed throughout the project area to protect plants from depredation and facilitate development of riparian shrubs within the meadow.

Between the 2003 and 2010 project periods along McCoy Creek, the NRCS, CTUIR, and Grande Ronde Model Watershed (GRMW)/BPA implemented an additional project component along Meadow Creek to facilitate re-activation of an historic wetland located on the southeastern portion of McCoy Meadows. A railroad grade and highway road built in the 1920s transected the meadow, restricting the ability of Meadow Creek and associated side channels to access the floodplain. Like the McCoy Creek phases, restoration objectives included increasing stream channel sinuosity and length, boosting groundwater elevations, decreasing high stream temperatures during the summer and increasing low temperatures during the winter, and enhancing the habitat use among anadromous fish during the summer and winter months. The project's primary strategies involved designing and constructing a wetland channel network to re-activate the abandoned floodplain and allow flood flow to dissipate energy on the low gradient floodplain, expanding an existing wetland beaver complex, and increasing the amount of in-stream habitat complexity.

ABOVE: Stream bank stabilization (erosion control) during implementation in 2010

This component of the project encompassed approximately 144 acres and included construction of 2,800 feet of side channels and 3 floodplain ponds, installation of geomorphic riffle weirs (vertical channel grade control), and extensive planting. Large wood placement along Meadow Creek and the wetland side channels was also implemented to encourage fine sediment deposition for re-vegetation establishment.



RIGHT: Overview of completed Meadow Creek project in 2007

Summary and Conclusions

The challenging and rewarding McCoy Meadows project has provided an incredible opportunity to enhance and restore fish and wildlife habitat, watershed processes and functions, and water quality on a large scale in a key area of the Upper Grande Ronde River subbasin. Although the project collaborators have experienced a number of setbacks in achieving project objectives, the overall project is progressing toward the desired goal of achieving a self-maintaining, naturally stable meadow complex that can support multiple life history stages of Chinook salmon and summer steelhead populations, provide high-quality habitat for riparian- and wetland-dependent wildlife, and contribute to restoration projects promoting ESA-listed fish recovery and overall watershed health throughout the Grande Ronde subbasin.

Thanks to the financial support of the BPA/GRMW and NRCS that funded the majority of this large-scale project, many valuable partnerships have been formed among the Oregon Watershed Enhancement Board (OWEB), the Union County Public Works Department, U.S Fish and Wildlife Service, Pacific Coast Salmon Recovery Fund, the DEQ, the EPA, Ducks Unlimited, ODOT, ODFW, and the CTUIR.

This article offered an overview of the multiple project activities that have occurred at McCoy Meadows. A future article will report results, changes, and trends at McCoy Meadows associated with stream channel geomorphology, fish habitat, water quality, groundwater hydrology, and biological responses. ■

Continued from page 2

During winter, distribution expanded to include low-gradient reaches. Linear range (i.e., movement) was high during fall migration in late October and early November, while fish exhibited more sedentary behavior from mid-November to early January. Movement increased during mid-January and coincided with an unseasonal increase in water temperature. For both high-gradient and low-gradient stream reaches, early migrants were found at moderate depths with slow currents, near cover, and close to the stream bank. High-gradient fish locations were associated with coarse substrates, boulders, and woody debris, while low-gradient fish locations often featured fine substrates and streamside vegetation.

During the first year of the study (late 2009 and early 2010), Catherine Creek early migrants overwintered in a relatively small portion of stream, indicating that habitat restoration efforts may be most productive in the 3.7-mile reach just downstream of Union. However, high survival rates of radio-tagged fish during winter may indicate that early migrant low survival to Lower Granite Dam occurs during spring out-migration rather than during overwintering months. Therefore, the lower 35 miles of Catherine Creek, which have been altered and degraded due to channelization, sedimentation, and predator fish, appear to function primarily as a migration corridor. The low quality of this reach could be principally responsible for high rates of early migrant mortality.

Biologists will repeat the 2009-2010 radio tracking project in 2010-2011 to determine the reach-specific mortality of both early and late migrants during spring emigration. For the second year of the project, biologists are placing additional emphasis on tracking the fish further into the 2011 out-migration. Preliminary results of the ongoing tracking indicate the juveniles are displaying a much different distribution pattern this year than a year ago. Far more juvenile Chinook have moved out of the reach below Union and are distributed throughout lower Catherine Creek and into the Grande Ronde River down to Elgin. A number of fish have even moved below Elgin beyond the study area.

Final results of this year's radio tracking will not be available for a few months. Because the data from the first and second year of the study are so variable, at least another year of the study will be necessary to determine which stream reaches are the most critical to the survival of juvenile Chinook in Catherine Creek. ■

The Radio-Tagging Surgery Technique

by Jesse Steele, GRMW

As described in the previous article, the Early Life History (ELH) project of the Oregon Department of Fish and Wildlife (ODFW) undertook the first radio telemetry study of wild juvenile Chinook salmon in the Catherine Creek drainage. This multi-year radio telemetry study is part of the larger cross-agency Catherine Creek Assessment effort. Scott Favrot (ELH) designed the study based on the most current literature and techniques, and this article gives Ripples readers a step-by-step guide to the process ELH used to surgically implant radio tags into juvenile Chinook salmon.

1.) The ELH crew collected the juvenile Chinook salmon using a rotary screw trap located approximately two miles upstream from Union, Oregon. Only those fish weighing more than 8.5 grams were large enough and selected for radio tag implantation. The radio tags weigh 0.27 grams on average, so in order to have a proper tag-to-body weight ratio, only larger fish were used in this study. A portion of these fish were randomly selected for radio tagging. The tag-to-fish weight ratio remained less than or equal to 3%.

2.) The ELH surgeon then anesthetized the Chinook (see photo at right) one at a time in preparation for surgery. Each fish was then placed on a wet sponge, belly side up (see photo at right). The sponge was coated in a protective layer of mucus to minimize damage to the fish's natural mucus covering. A small tube was inserted in the fish's mouth, which supplied oxygenated water over the gills.

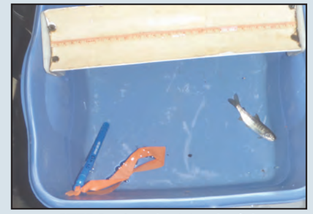
3.) Next, the surgeon made a small incision (~5mm) just to the side of the fish's midline between the pectoral and pelvic fins. A small hollow needle protected with a plastic sleeve (to prevent internal damage) was inserted into the incision. Once in place, the surgeon pulled back the plastic sleeve to expose the needle tip and then pushed the needle out the fish's side behind the pelvic fins. The antenna of the radio tag was threaded through the needle.

4.) The surgeon then removed the hollow needle out of the punctured body wall while leaving the antenna of the radio tag running from the incision through the body cavity and out the hole in the lateral wall created by the needle. The surgeon then pulled the antenna posteriorly from the hole until the transmitter was inserted just inside the incision.

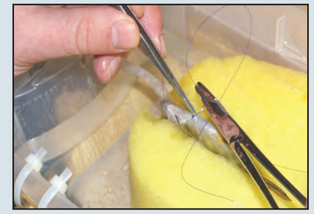
5.) Finally, the surgeon made two stitches closing the incision (see photo at right) to ensure tag retention and fish recovery. An antibiotic was applied to the sutures to prevent infection.

6.) Tagged fish were allowed to recover for several minutes to ensure they would survive the surgery before being released back into Catherine Creek near the point of capture.

Collected data indicates that mortality induced by the surgical procedure in the 2009 study is minimal. Of the 98 fish radio tagged, 12 fish were confirmed mortalities. Field observations indicate that of those 12 fish, most died from natural predation and not due to the surgery.



STEP 2a: Anesthesizing the fish



STEP 2b: Fish on wet sponge with protective layer of mucus

STEP 5: Fish with closed incision