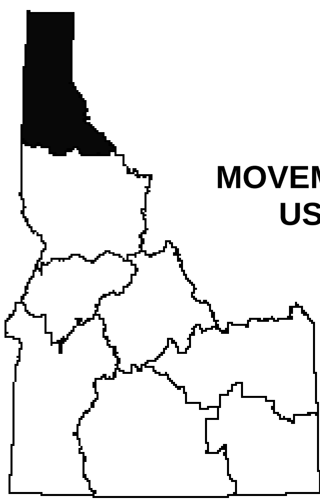
FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME
FISHERY MANAGEMENT ANNUAL REPORT

Calvin L. Groen, Director



MOVEMENT, MORTALITY, AND HABITAT USE OF COEUR D'ALENE RIVER CUTTHROAT TROUT
PANHANDLE REGION
2004

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IDFG 07-57
November 2008

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MOVEMENT, MORTALITY AND HABITAT USE OF COEUR D'ALENE RIVER CUTTHROAT TROUT

EXECUTIVE SUMMARY

Through a cooperative research project that involved state (Idaho Department of Fish and Game), federal (U.S. Forest Service, Bureau of Land Management), corporate (Avista Corporation), and private (North Idaho Fly Casters, Spokane Fly Fishers, Inland Empire Fly Fishing Club, Federation of Fly Fishers) entities, we evaluated the movement, mortality and habitat use of westslope cutthroat trout *Oncorhynchus clarkii lewisi* in the Coeur d'Alene River basin in northern Idaho from May 2003 to June 2004. The purpose of this study was to help determine why densities of cutthroat trout ≥300 mm had not increased at set snorkel transects in the Coeur d'Alene watershed in the past 30 years and to help direct restoration dollars in a manner that will have the greatest impact on the fishery. Based on our tracking of 75 different cutthroat trout and habitat quantification throughout the watershed, there appeared to be several factors that we believe help explain why densities of cutthroat trout ≥300 mm have been suppressed in the Coeur d'Alene River watershed. We believe noncompliance with the fishing regulations, degraded or loss of coldwater refugia, degraded or loss of overwinter habitat, and degraded summer rearing habitat all play some role in the suppression of cutthroat trout ≥300 mm in length.

Of the 75 cutthroat trout in which we put transmitters, 51 died or expelled their tags before the study was complete or before the transmitter batteries expired. Thirteen of these fish died from fishermen with nine of those being killed illegally. Estimated mortality rates for cutthroat trout ≥300 mm were as high as 69% in stream reaches where limited harvest is allowed, suggesting that illegal harvest is a major factor suppressing the fishery in this area. Concerted efforts should be made in these reaches to reduce noncompliance. Efforts should include increasing the public's awareness of the regulations and the impacts of noncompliance (post more signs and talk more with the public), as well as increasing enforcement activities.

During 2003, the maximum water temperature in the main channel of the entire North Fork Coeur d'Alene River downstream of Tepee Creek exceeded 22°C, temperatures that cutthroat trout have been found to avoid and/or result in death from prolonged exposure. We found radio tagged fish utilized four different strategies to cope with high water temperatures. Three of these strategies included moving short distances (<5 km) to areas where coldwater refugia occurred (4-9°C cooler than what occurred in the main river channel). This included moving to the mouths of tributaries, into tributaries, and into side channels with coldwater upwellings. Approximately half the radio tagged fish used one of these strategies while the other half appeared to move into shaded areas under cover such as undercut banks, large woody debris, or boulders. By late summer, these fish had lost a noticeable amount of weight and appeared in poorer condition than fish that utilized areas with coolwater refugia. Side channels appear to be the most important form of coldwater refugia in the lower North Fork subbasin as 50% of all radio tagged that utilized this subbasin during late July/early August were located in side channels. Unfortunately, habitats such as these are limited in number in the Coeur d'Alene watershed. Development, dyking of the river, and road construction have led to many side channels being cut off from the main river or eliminated altogether. The one reach of our study area that appears to provide the most coolwater refugia is the free flowing stretch of the Coeur d'Alene River where a large functioning floodplain exists. The majority of this reach of river never saw maximum temperatures exceed 22°C. However, only one radio tagged fish moved downstream into this reach when water temperatures began warming in the main river. The

apparent avoidance of the lower river may be related to the presence of elevated concentrations of heavy metals.

In our study, none of the radio tagged cutthroat trout migrated more than 15 km from summer habitat to reach areas where they spent the winter. Our habitat use data showed that radio tagged cutthroat trout tended to move to areas with wider floodplains and tended to select pool or glide habitat. We are unaware of any other studies that have shown larger cutthroat trout to select for glide habitat during winter. We found our radio tagged fish to congregate in only one area during winter and that was in the lower 3.5 km of Tepee Creek and a 4 km reach downstream of Tepee Creek in the North Fork Coeur d'Alene River. Approximately 2.3 km (66%) of the overwintering habitat in Tepee Creek was privately owned. Many of these stream reaches are now experiencing severe bank erosion and appear to be losing their cover, depth, and pool habitat. The Coeur d'Alene subbasin (downstream of the South Fork) has the most deep slow pool habitat of all the subbasins we evaluated, conditions that others have characterized as good overwinter habitat for cutthroat trout. However, none of our radio tagged cutthroat trout that spent the summer upstream of this subbasin moved downstream into this reach during winter. Continued work to reduce heavy metal concentrations should increase use of these waters during winter, which may be beneficial to overwinter survival especially during severe winters.

Summer rearing habitat for adult westslope cutthroat trout in the Coeur d'Alene River could be described as pool or run habitat where water depths exceeded 1 m, although depths >2 m tended to be selected more highly (chi-square, $P < 0.001$). The radio tagged fish were associated with some form of cover approximately 80% of the time. Large wood was the form of cover for which the radio tagged cutthroat trout showed the highest preference. For the most part, summer rearing habitat (excluding coldwater refugia) did not appear to be limiting to adult cutthroat trout in the Coeur d'Alene watershed. Exceptions were in Shoshone, upper North Fork, and the catch-and-release area of the Little North Fork subbasins where lack of pool habitat and deeper waters may be limiting cutthroat trout abundance. Adult cutthroat trout abundance in Prichard Creek may also be limited due to subsurface flows and elevated concentrations of heavy metals. Improvements in these areas could lead to increases in adult cutthroat trout abundance.

We found that radio tagged cutthroat trout displayed localized movements where they tended to stay in one of eight subbasins for the entire summer and winter period. Very little mixing of fish occurred between the subbasins except during the spawning season. Movement of these radio tagged cutthroat trout differed significantly between subbasins (ANOVA, $p < 0.001$) and months (ANOVA, $p < .0001$). Of the 13 fish that survived their spawning migrations, 12 returned to within 200 m of where they spent the previous summer, suggesting that the movement patterns we observed are not unique to that year and are repeated on an annual basis. Because of the localized movement the cutthroat trout display, we believe fishing regulations should consider each of these eight subbasins versus blanket regulations for the entire watershed. These movement patterns also suggest that fishing regulations could be developed that would provide more opportunities to a diverse group of anglers than the current regulations allow.

We found that radio tagged cutthroat trout spawned in numerous tributaries throughout the entire study area ranging in size from 2,000 to 20,000 ha. However, 41% (9 out of 22) of the radio tagged cutthroat trout spawned in the Tepee subbasin. These findings suggest the Tepee subbasin is important to spawning for the entire Coeur d'Alene River watershed cutthroat trout population. Radio tagged cutthroat trout that utilize the lower North Fork subbasin demonstrated the longest migrations and spawned in the most widespread areas. These movements suggest that fish from many areas contribute to the lower North Fork subbasin and may be helping to maintain this fishery at a low level. However, the high fishing mortality documented in this area may also be selecting against fish with long spawning migrations. Cutthroat trout utilizing the Coeur d'Alene subbasin were found spawning in tributaries downstream of Prichard Creek. Many of these tributaries were degraded by past development, mining, and other land use practices. Protection and enhancement of these streams may be important in maintaining and enhancing the fishery that has developed in the Coeur d'Alene subbasin.

Our telemetry work showed that cutthroat trout ≥300 mm did not move from snorkel survey sites. In addition, it appears that a small portion of this cutthroat trout population displays an adfluvial life cycle (2 out of 75 radio tagged fish migrated to the lake), and none of the radio tagged adfluvial fish were ever documented to use any of the stream reaches where the snorkel surveys are conducted. Based on the movement patterns of the radio tagged fish, we do not believe migrations outside areas where we conduct our snorkel surveys can explain the consistently low densities of cutthroat trout ≥300 mm observed in this system. The locations of our snorkel transects should adequately capture actual changes in densities of cutthroat trout, and consequently, we do not recommend changing or adding any new sites.

Twenty-three of the 75 fish in which we put transmitters expelled their tags before the study was completed (1 year period). For this reason, we caution against assuming that because a radio tagged fish has stopped moving that it died. Fish in our study expelled their tags 51 to 231 days after they were surgically inserted in the fish. Based on our observations of recaptured fish, the radio tags were expelled from the fish through a process called transintestinal expulsion, which entails envelopment of the transmitter into the intestine from which it would later be expelled by peristalsis through the anus. We found that tag weight, fish weight, and the length of the antenna were not significant ($p > 0.01$) in predicting tag expulsion. The timing of radio tagging our fish (post spawn — lack of developed gonads or abdominal fat) may have led to increased contact with the intestine and increased transintestinal expulsion.

Based on five different analyses of radio tagged cutthroat trout in the Coeur d'Alene subbasin, it appeared that water level management at Post Falls Dam was having an influence on cutthroat trout by causing them to avoid the inundated reach of the Coeur d'Alene River. This conclusion was based on findings that showed the radio tagged fish were tracked throughout the Coeur d'Alene River except in the inundated reach. Radio tagged cutthroat trout were often located just upstream of the slack water interface but appeared to only move downstream of it when they were migrating through or when they relocated to a deep (~10 m) pool at the Cataldo Mission Boat Ramp.

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INTRODUCTION

Westslope cutthroat trout *Oncorhynchus clarkii lewisi* are a highly sought after game fish native to northern Idaho attracting anglers from around the United States. The popularity of cutthroat trout stems from their eagerness to take a dry fly, their beautiful appearance, and the pristine environment they inhabit. In northern Idaho, major cutthroat trout fisheries occur in many of the major rivers and streams that drain the rugged landscape. During 1996, over 60,000 hours of fishing effort was estimated to have occurred on the St. Joe and Coeur d'Alene rivers, two of the more popular rivers for cutthroat trout fishing in the Panhandle Region (Fredericks et al. 1997). Evidence suggests fishing pressure for cutthroat trout has continued to increase in the Panhandle Region (Fredericks et al. 1997).

In the late 1800s and early 1900s, many considered the streams and rivers in northern Idaho to be some of the finest trout streams in America. The local newspaper of St. Maries, Idaho frequently reported catches of seven- to nine-pound trout and trips where anglers caught 50-100 cutthroat trout averaging three to five pounds in a few hours (Rankel 1971). Trout were observed by the thousands and supported a commercial fishery in the Coeur d'Alene River (Rabe and Flaherty 1974). By the 1960s, cutthroat trout abundance had declined in many rivers in the Panhandle, and studies were initiated to determine why these declines had occurred and what could be done to restore the fishery (Mallet 1967; Dunn 1968; Rankel 1971; Bowler 1974; Lewynsky 1986). In the Coeur d'Alene River, research indicated that declines in the fishery were largely a response to impacts from mining, splash damming, road building, logging, and excessive angler harvest (Ellis 1940; Rabe and Sappington 1970; Mink et al. 1971; Bowler 1974, Lewynsky 1986; Woodward et al. 1997; Bennett and Dunnigan 1997; Abbott 2000; IDEQ 2001).

As efforts were made to correct the reasons for the decline in the fishery, it was necessary to monitor trends in fish numbers to evaluate the success of recovery efforts. Transects were established in 1973 in the North Fork Coeur d'Alene River watershed that have been snorkeled on a regular basis ever since (Bowler 1974; DuPont et al. In Press). Fish counts at these snorkel transects showed that a strong increasing trend in the density of cutthroat trout occurred from 1973 until 1998. A series of floods in 1996 and 1997 were believed to cause this decline; however, since 1998, cutthroat trout abundance again increased. This increase in abundance was likely due to a combination of more restrictive fishing regulations, improvements in water quality in the South Fork Coeur d'Alene River, and substantial efforts to improve habitat conditions throughout the watershed.

Despite the increase in the overall density of cutthroat trout, cutthroat trout ≥300 mm showed no apparent increase in density had occurred over time (1973-2002). In addition, the observed density of these larger fish were considered low (0.06 fish/100 m^2) for rivers in northern Idaho. Some theories as to why this condition was occurring were: 1) habitat for juvenile trout (tributary habitat) was improving whereas habitat important for larger cutthroat trout (main river habitat) was not; 2) improving habitat conditions in the system could account for an increase in abundance of juvenile fish, whereas high incidental mortality and illegal harvest was cropping off larger fish; 3) as cutthroat trout in the Coeur d'Alene River increase in size, they move downstream or upstream to areas where snorkel transects were not located; 4) a large proportion of this cutthroat trout population was made up of adfluvial fish – the larger fish would therefore have migrated down to the lake by the time the snorkeling was conducted; and 5) some combination of the above.

Many restoration projects are being planned and have been conducted in the Coeur d'Alene River watershed without knowing what factors are limiting cutthroat trout number and if the work will result in improvements in the fishery. In the last 15 years, the United States Forest Service has spent $300,000 to $500,000 annually in the Coeur d'Alene River watershed to improve water quality and stream habitat (Ed Lider, U.S. Forest Service, Personal Communication). Eighteen stream segments in the North Fork Coeur d'Alene River watershed are currently listed as water quality limited totaling 167 stream miles (IDEQ 2001). As a result, potentially millions of dollars may be spent to improve water quality through 319 grants and other sources. Heavy metal cleanup in the South Fork and Coeur d'Alene River has exceeded 30 million dollars over the past 10 years and will continue into the future (Nick Zilka, IDEQ, Personal Communication). Currently, Post Falls Dam is in the process of being relicensed. The current Federal Energy Regulatory Commission license expires on July 31, 2007. Relicensing of Post Falls Dam could result in funds that could be put into protection and enhancement of trout habitat. The BPA has allocated 5.3 million annually for mitigation of Albeni Falls Dam due to lost habitat, some of which could be spent in the Coeur d'Alene watershed. Ongoing highway projects may spend hundreds of thousands of dollars for mitigation of lost habitat, some of which could be spent in the Coeur d'Alene River watershed.

Understanding why larger (≥300 mm) cutthroat trout densities in the Coeur d'Alene River watershed are so low is important to ensure actions address causative factors. The purpose of this study was to help determine why densities of cutthroat trout ≥300 mm have not increased at set snorkel transects in the Coeur d'Alene River in the past 30 years and to help direct restoration dollars in a manner where it will have the biggest impact on the fishery.

OBJECTIVES

1. Assess movement patterns of cutthroat trout radio tagged in the Coeur d'Alene over a one-year period.

2. Determine sources of mortality of cutthroat trout radio tagged in the Coeur d'Alene River system.

3. Assess habitat use of cutthroat trout radio tagged in the Coeur d'Alene River system and compare to the amount of available habitat in the watershed.

4. Evaluate how river temperature influences movement and habitat use of cutthroat trout in the Coeur d'Alene River system.

5. Evaluate how operations from Post Falls Dam influence habitat availability and movement of cutthroat trout in the Coeur d'Alene River.

STUDY SITES

The Coeur d'Alene River is located in northern Idaho and extends 183 km from its confluence with Coeur d'Alene Lake to its headwaters in the North Fork Coeur d'Alene River (Figure 1). The entire Coeur d'Alene River watershed drains approximately 379,000 ha and has a 50-year mean annual flow of approximately 72 m^3/sec and a 50-year mean peak flow of approximately 650 m^3/sec (USGS site 12413500). The summer elevation of Coeur d'Alene Lake is 649 m and the highest peak in the Coeur d'Alene River watershed is 2,084 m. Approximately 96% of the watershed occurs at less than 1,370 m, elevations considered to be susceptible to winter rain-on-snow events. The highest peak flows that have occurred in the Coeur d'Alene River drainage have been a result of winter rain-on-snow events. Flows over 1,000 m^3/sec occur at a rate of once every 9 years with the highest ever recorded peak flow (2,237 m^3/sec) occurring during the winter of 1974. Peak flows during 2003 and 2004 were 682 m^3/sec and 278 m^3/sec, respectively, whereas mean annual flows during 2003 and 2004 were 53 m^3/sec and 65 m^3/sec, respectively.

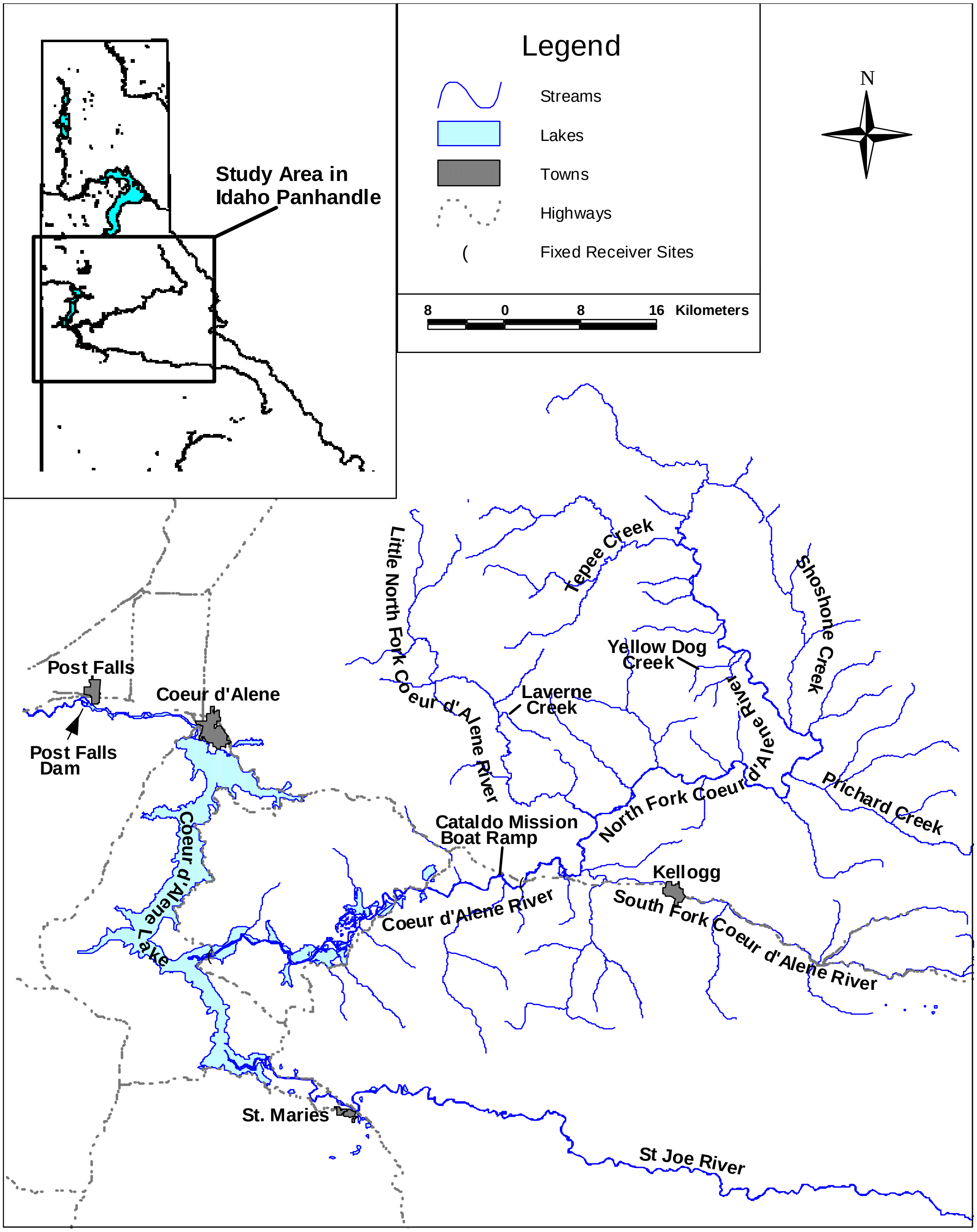


Figure 1. General area map of the cutthroat trout radio telemetry study from May 2003 through June 2004 in the Coeur d'Alene River watershed, Idaho.

The Coeur d'Alene River and its tributaries drain belt series geology with nonglaciated alluvial valleys. It has a dendritic drainage pattern with several major tributaries including the North Fork Coeur d'Alene River (123 km in length; 188,274 ha drainage), the Little North Fork Coeur d'Alene River (60 km in length; 43,857 ha drainage), and the South Fork Coeur d'Alene River (56 km in length; 77,699 ha drainage). Most 4^{th} order and larger tributaries in the watershed have a stream gradient <4% and the riparian vegetation mostly consists of red alder *Alnas rubra*, willow *Salix* spp., black cottonwood *Populus trichocarpa*, and redosier dogwood *Cornus sericea* and is often mixed with western red cedar *Thuja plicata* and grand fir *Abies grandis*.

The Little North Fork and North Fork Coeur d'Alene River watersheds are predominately (93%) owned and managed by the U.S. Forest Service. The Forest Service has intensively managed these watersheds for timber harvest over the last 100 years (Strong and Webb 1970). Prior to 1930, the Little North Fork Coeur d'Alene River, Independence Creek, and Shoshone Creek were all splash dammed and log drives occurred along the main North Fork Coeur d'Alene River (Strong and Webb 1970). These activities resulted in a straighter less complex river channel as logjams, woody debris, large boulders and sharp channel bends were removed. After 1931, road systems were developed to export logs. Many of these roads were constructed along streams and the riparian areas are now considered the most altered portion of the entire watershed (IDEQ 2001). The road density in the watershed averages 5 km/km^2 and is considered the most densely roaded, timbered watershed in the entire Columbia River basin (Quigley et al. 1996). Much of the floodplain in the lower 40 km of North Fork Coeur d'Alene River is privately owned and has been developed for housing or agriculture. Placer and hard rock mining has occurred in the North Fork Coeur d'Alene River – mainly in the Prichard Creek and Beaver Creek watersheds. The hard rock mining has resulted in elevated heavy metals in the substrates in both of these drainages. Fish from both of these drainages commonly have black tails, which may be a stress related symptom to elevated heavy metals. The placer mining in these watersheds has denuded large areas of the floodplains and left large mounds of loose cobble, which continue to be eroded back into the streams system.

The South Fork Coeur d'Alene River watershed is largely (44%) privately owned. Private land occurs primarily in the lower elevations and is mostly a combination of mining operations, home sites, small landowners, and timber companies. The private timberland is intensively managed and heavily roaded, similar to the North Fork Coeur d'Alene River watershed. Mining activities have been intensive over the last century in the South Fork Coeur d'Alene River watershed. Tailing piles occur in many areas along the South Fork and its tributaries resulting in reduced floodplain size and increased sediment delivery to the stream network. Historic mining (both placer and hard rock) and smeltering activities resulted in high loads of heavy metals being delivered to the South Fork and its tributaries. Heavy metal concentrations were so high in the lower half of the South Fork that it was devoid of life until the 1970s (Mink et al. 1971). Currently, the lower section of the South Fork Coeur d'Alene River floodplain is a superfund cleanup site. Cleanup efforts are beginning to pay off as low densities of fish and insects now occur in the South Fork. The Forest Service manages approximately 33% of the South Fork Coeur d'Alene River with most of this public land occurring in higher elevations. Interstate 90 and an abandoned rail bed parallels along much of the South Fork, restricting its access to most of the historic floodplain.

The Coeur d'Alene River is a low gradient (<1%), meandering river with wide floodplains, flowing 60 km in total length at high pool. Coeur d'Alene Lake naturally impounds water approximately 44 km up the Coeur d'Alene River to just downstream of the Cataldo Mission Boat Ramp. Post Falls Dam is located on the Spokane River downstream of the outlet of Coeur d'Alene Lake. It artificially holds water levels about 2.3 m higher during summer months, which inundates approximately an additional 4 km of the Coeur d'Alene River. A series of nine lakes and numerous sloughs are connected to the river throughout much of the inundated section of river. The land surrounding the Coeur d'Alene River is mostly (57%) privately owned. This land is a combination of home sites, agricultural areas, and timberlands, and occurs mostly in the lower elevations. The U.S. Forest Service manages approximately 20% of the land surrounding the Coeur d'Alene River. Heavy metal concentrations in the Coeur d'Alene River (delivered from the South Fork) were high enough to kill most life in the Coeur d'Alene River until the 1970s (Mink et al. 1971). Cleanup activities have improved water quality in the Coeur d'Alene River to the point where there is now a thriving cutthroat trout fishery in the free flowing reach. Many of the fish still have blackened tails, believed to be caused by still elevated heavy metal concentrations.

Throughout this study, we commonly summarized habitat and fish tracking data into nine different subbasins which included Coeur d'Alene Lake (lake), Coeur d'Alene River (CDA River), lower North Fork Coeur d'Alene River (NF-lower), middle North Fork Coeur d'Alene River (NF-mid), upper North Fork Coeur d'Alene River (NF-upper), Little North Fork Coeur d'Alene River (LNF), Tepee Creek (Tepee), Shoshone Creek (Shoshone), and Prichard Creek (Prichard; Figure 2). These subbasins ranged in size from approximately 18,000 ha to 69,000 ha (Table 1). In general, the farther downstream the wider the stream channels and floodplains became (Figure 3), and the lower the stream gradient was. All habitat work and ground tracking of fish in the Coeur d'Alene River subbasin occurred only in the free flowing reach (~20% of subbasin).

Currently, the free flowing section of the Coeur d'Alene River and all its tributaries support native stocks of westslope cutthroat trout, mountain whitefish *Prosopium williamsoni*, largescale sucker *Catostomus catostomus*, northern pikeminnow *Ptychocheilus oregonensis,* redside shiner *Richardsonius balteatus*, longnose dace *Rhinichthys cataractae*, torrent sculpin *Cottus rhotheus* , shorthead sculpin *C. confusus*, and mottled sculpin *C. bairdi*. Native bull trout *Salvelinus confluentus*, once common in some tributaries, have virtually disappeared from this drainage. Introduced rainbow trout *O. mykiss,* brook trout *S. fontinalis*, and Chinook salmon *O. tshawytscha* also occur in the watershed, although only in the lower North Fork, Little North Fork, and Coeur d'Alene rivers. Cutthroat trout are the most abundant trout in the Coeur d'Alene River and attract hundreds of fisherman each year. Interstate 90 provides easy access to the Coeur d'Alene River for fisherman from the Coeur d'Alene, Idaho and Spokane, Washington metropolitan area and the river annually receives over 33,000 hours of fishing pressure a year (Fredericks et al. 1997). Currently, the fishing regulations allow two cutthroat trout (none between 8 and 16 inches) to be harvested daily. Catch-and-release areas occur upstream of Laverne Creek in the Little North Fork Coeur d'Alene River and upstream of Yellow Dog Creek in the North Fork Coeur d'Alene River (Figure 1).

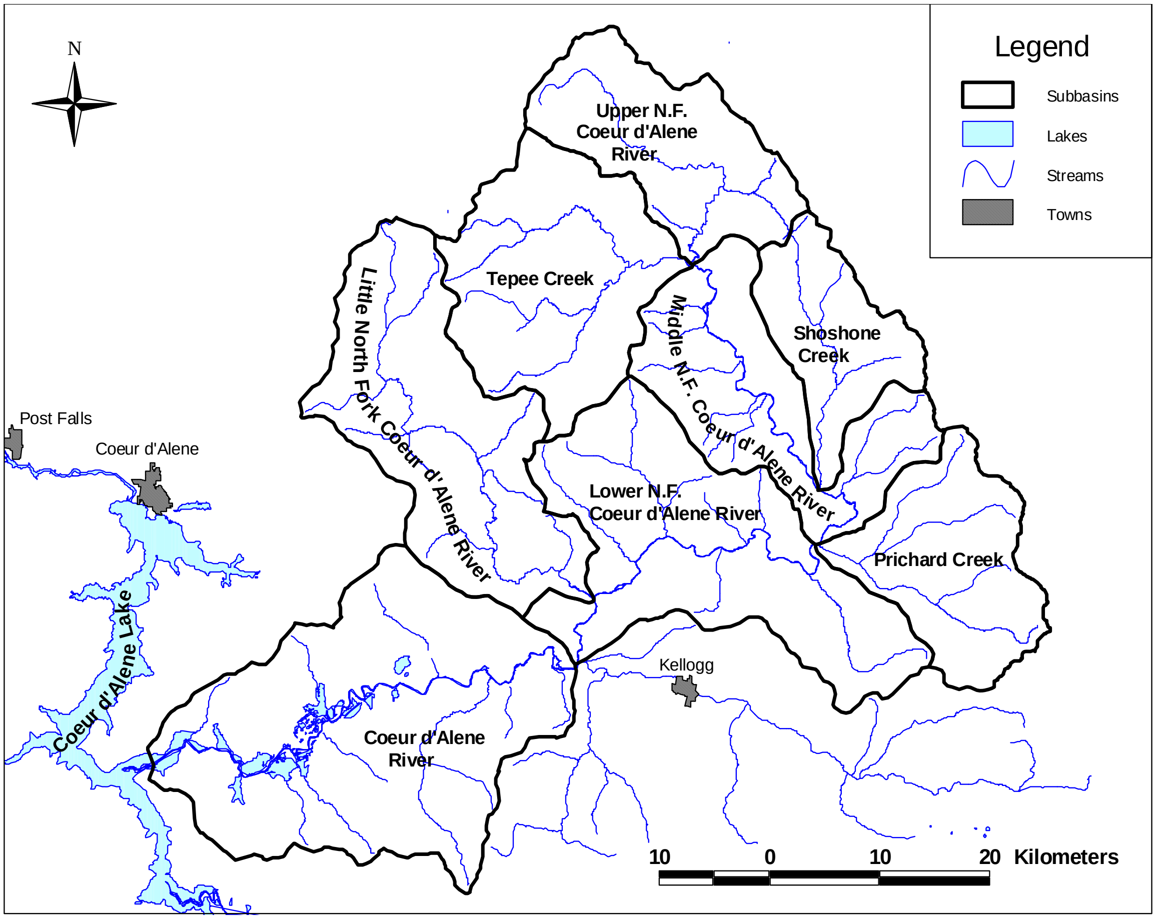


Figure 2. Subbasins within the Coeur d'Alene River watershed, Idaho, where habitat and fish tracking data was collected.

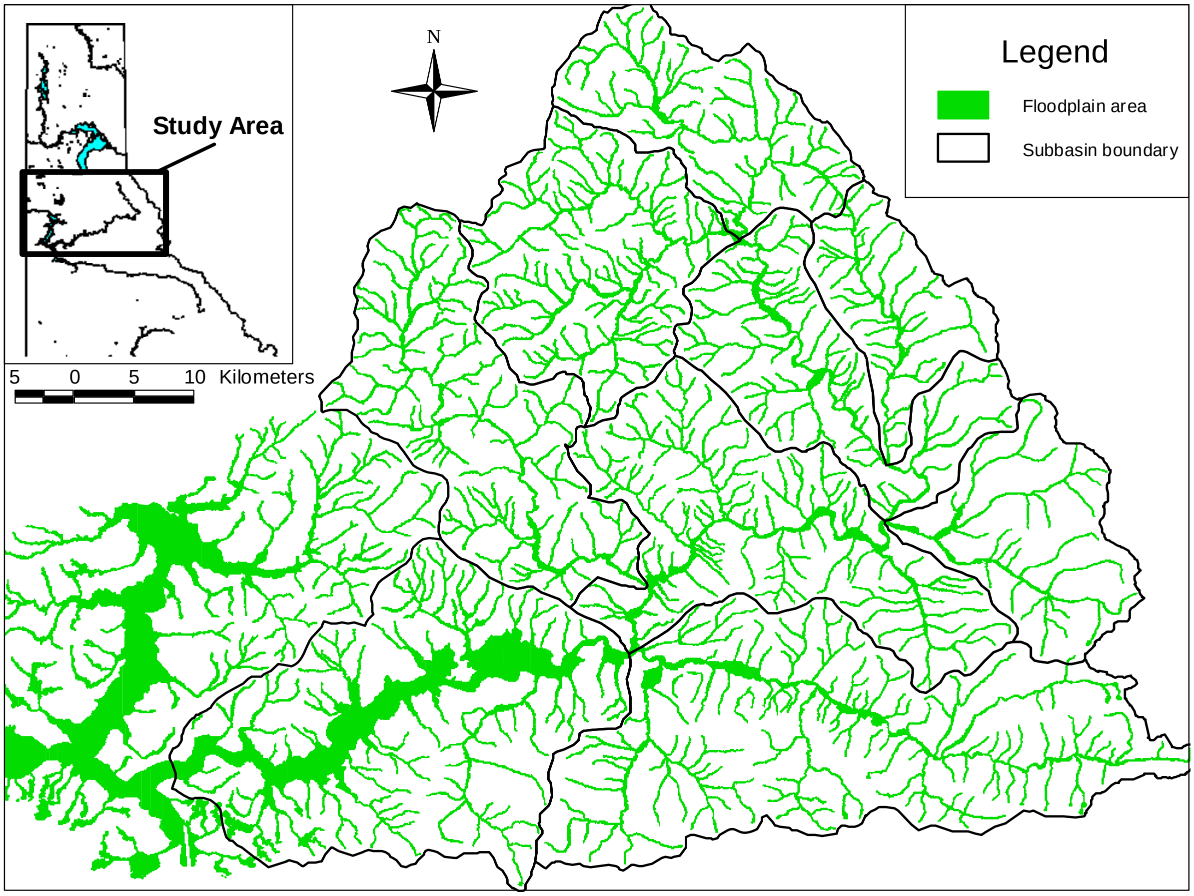


Figure 3. The distribution of floodplains in the Coeur d'Alene River watershed, Idaho.

Table 1. The different subbasins in the Coeur d'Alene River watershed, Idaho, where habitat data and fish tracking occurred.

Subbasin	Area (ha)	Length of main stem (km)
Coeur d'Alene River	69,200	60
(free flowing segment)	8,350	13
Lower NF Coeur d'Alene River	49,100	40
Middle NF Coeur d'Alene River	31,700	43
Upper NF Coeur d'Alene River	26,750	40
Little NF Coeur d'Alene River	43,850	60
Tepee Creek	37,050	28
Shoshone Creek	18,050	30
Prichard Creek	25,600	25

METHODS

Field Work

Capturing and Radio Tagging

To capture westslope cutthroat trout for this study we fished (rod and reel) seven different subbasins in the North Fork Coeur d'Alene River watershed (Figure 4). Sampling occurred between May 6 and June 9, 2003. Efforts were made to distribute transmitters in 46 cutthroat trout throughout these seven subbasins in proportion to the length of stream we believed we could effectively sample and capture cutthroat trout ≥300 mm (Table 2). This roughly correlates to all 4th order or larger streams that occurred in each subbasin (Figure 4). Attempts were also made to insert transmitters in fish ≥300 mm and within different size classes (Table 2). Sample locations in each subbasin were determined by randomly selecting predetermined stream km. When sampling these randomly selected sites, we would fish upstream or downstream until we captured a fish of the appropriate size to surgically insert a transmitter. Occasionally, repeated sampling efforts were required before a cutthroat trout of the appropriate size was sampled. In Shoshone Creek and Prichard Creek, we were unable to collect fish of appropriate size near each sample locations. Consequently, several fish were captured and tagged within close proximity of each other in these streams.

An additional 19 radio tags were implanted into cutthroat trout from May 2 to June 5, 2003 in the Coeur d'Alene River between the South Fork Coeur d'Alene River and the Cataldo Mission boat ramp near the slack water interface (Figure 4). These fish were added to our analysis as part of a relicensing study of Post Falls Dam and were captured using a Coffelt model VVP-15 DC control unit in a boom-mounted aluminum drift boat (Parametrix 2005).

Cutthroat trout selected for radio tagging were placed on their dorsum in a "V" shaped cradle constructed of rubberized wire mesh and an aluminum frame. The cradle was designed so that when it was placed in a tub filled with water, the fish's gills would be submerged and its abdomen would be out of water. This would allow the fish to breath while we inserted a radio transmitter through a 20-30 mm incision in its abdomen (off center of ventral line). The radio transmitter was inserted in the fish using a modification of the shielded needle technique (Ross and Kleiner 1982; Rich 1992). Three to four interrupted stitches using a half curved cutting tip needle and 3-0 polypropylene suture were used to close the incision. Betadine® was rubbed over the incision area and at the antenna exit site both before and after the surgery. During surgery, we used sterile rubber gloves or our hands were rubbed down with Betadine®. All surgical equipment and the transmitter were sterilized by soaking them in a 2% chlorhexidine solution for at least five minutes.

No anesthetic was used during the surgery, as once upside down, the majority of fish remained stationary throughout the entire process. An additional person was always available to help hold the few fish that attempted to struggle during the surgical process. The key to using this strategy is ensuring the gills are submerged in water. Because no anesthetic was used, the cutthroat trout were released back to the same place they were captured immediately after surgery. Cutthroat trout radio tagged in the Coeur d'Alene River were anesthetized before surgically inserting the radio transmitters (Parametrix 2005). After surgery, each fish was placed into a recovery tank with fresh water until it was able to swim off on its own. All these fish were released within 0.5 km of their capture site.

Table 2. Stream subbasin data used to determine how many radio transmitters (out of 46) should be implanted into cutthroat trout in different subbasins in the North Fork Coeur d'Alene River watershed, Idaho. The column "Stream km" refers to the length of stream that occurred within that particular subbasin that we believed we could effectively sample and capture cutthroat trout ≥300 mm to insert transmitters into (roughly >4th order stream).

					Size (mm) of Fish to Put Transmitter				
Subbasin	**Stream km**	**% of Total**	**% of 46**	**# of Tags**	**300-349**	**350-399**	**400-449**	**≥ 450**	**Total**
Lower NF CDA River	54.2	20	9.26	9	2	3	3	1	9
Middle NF CDA River	43.0	16	7.35	7	1	3	2	1	7
Upper NF CDA River	37.4	14	6.39	7	1	3	2	1	7
Little NF CDA River	48.6	18	8.31	8	2	3	2	1	8
Tepee Creek	45.9	17	7.84	8	2	3	2	1	8
Shoshone Creek	22.1	8	3.78	4	1	2	1	—	4
Prichard Creek	18.0	7	3.07	3	1	1	1	—	3
Total	269.3	100	46.00	46	10	17	13	5	46

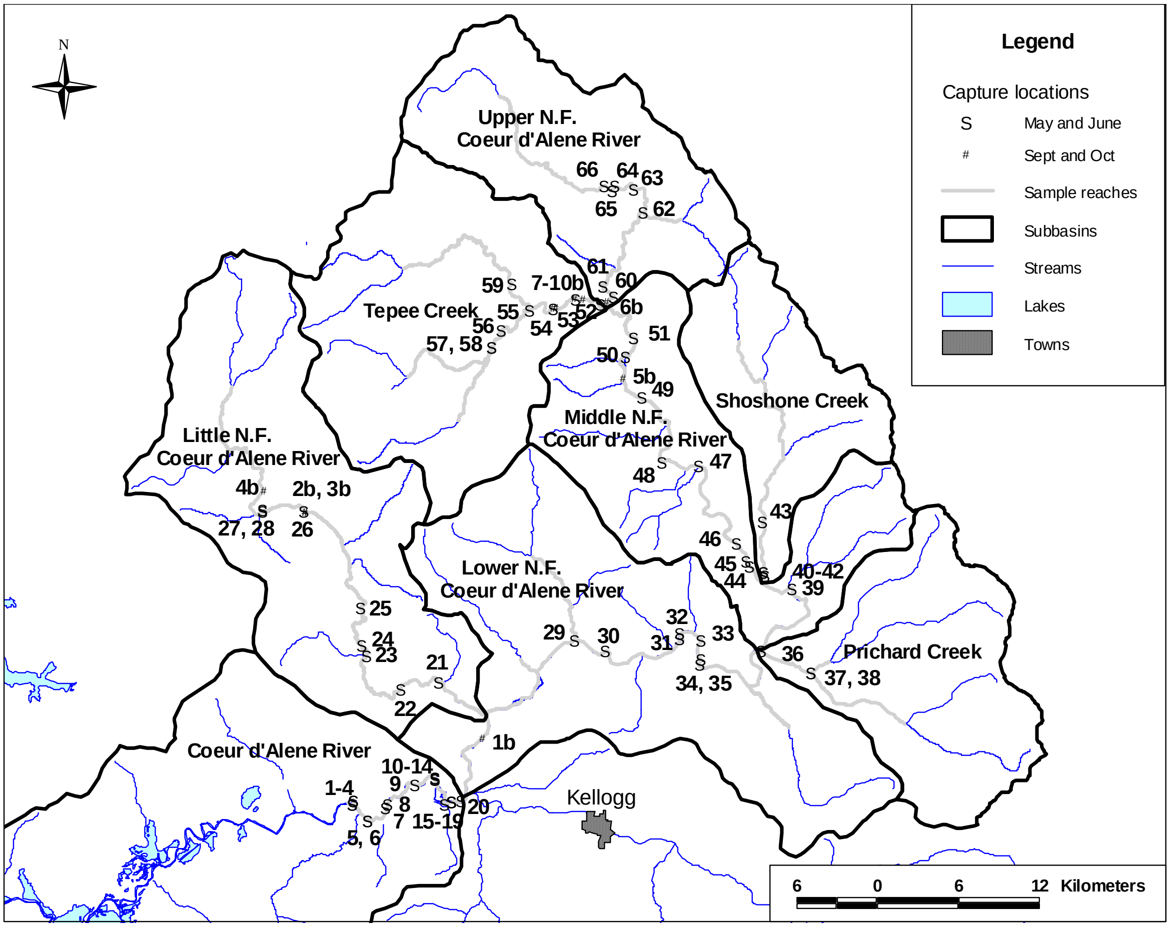


Figure 4. Locations where cutthroat trout were captured and radio tagged (N = 75) in the Coeur d'Alene River watershed, Idaho, during 2002.

We used two types of coded radio transmitters for this study, NTC6-2 and MCFT-3EM (Lotek Wireless Inc.), both with 4 sec burst rates. The NTC6-2 had a dry weight of 4.5 g and was programmed to turn on and off every 12 hours. These transmitters were inserted into cutthroat trout <350 mm in length. The MCFT-3EM had a dry weight of 8.9 g and was inserted into fish >350 mm in length. Both types of transmitter had a life expectancy of approximately one year. The weight of the transmitter did not exceed 2% of the body weight of the cutthroat trout based on recommendations from Winter (1983). The transmitter antenna was trimmed (44 cm total length) so that it did not extend past the caudal fin except for those fish radio tagged downstream of the South Fork Coeur d'Alene River.

Ten of the transmitters that were recovered from fish that had died or expelled their tag were put out into different fish during September and October 2003 (Figure 4). These fish were captured by rod and reel or with a Smith-Root SR 15 backpack electrofisher and a three-person crew. Many of these fish were captured in the Little North Fork Coeur d'Alene River or Tepee Creek, as these were streams we could effectively electrofish with a backpack shocker.

Tracking

Attempts were made to track each radio-tagged fish on the ground (foot, truck, boat, snowmobile, or four-wheeler) every other week during the spring, summer, and fall and once every month during the winter (December to March). No efforts were made to ground track fish once they migrated downstream of the Cataldo Mission Boat Ramp, approximately where the inundated section of the river occurred. Typically, it would take three to five days to ground track every fish in the watershed. Occasionally, during these three to five days we would track a fish every day to keep track of it during periods of large movements. Ground tracking utilized a LOTEK SRX-400 model W5XG receiver and the combination of omni direction car mounted whip antenna and a 3-element handheld Yagi antenna. When ground tracking, attempts were made to identify exactly where the fish was located. Often, the fish we were tracking were visually identified. The coordinates of where each cutthroat trout was located was recorded with a Global Positioning Unit (Garmin Map76S). The Global Positioning Units (GPS) also recorded the elevation and time. In addition, at each fish location we also documented the habitat type the fish was in (pool, riffle, run, or glide; Overton et al. 1997), the depth of water, the maximum depth within 50 m, the maximum depth within the habitat area the fish was located in, water temperature, stream width, dominate substrate type, and cover characteristics (Appendix A). For a fish to be considered using a form of cover, it had to be within 5 m of it. The type of cover used by each fish had to be either undercut banks, overhead cover, large woody debris, small wood debris, large substrate (>250 mm in diameter), or none at all. The total amount of cover within the habitat type in which the fish was located was also recorded, which was determined by visualizing what percent of the total surface of the habitat area was spanned by all cover types.

We also attempted to track each radio tagged cutthroat trout by air just prior to ground tracking to help locate lost fish and to ease ground tracking efforts. We used a fixed-wing aircraft, a LOTEK SRX-400 model W5XG receiver, and a two element Yagi antenna attached to the wing strut. Only GPS coordinates and time were recorded for each fish location when tracking by air.

In addition to mobile tracking, two fixed receiving stations were set up to determine if and when radio tagged cutthroat trout moved downstream of where we conducted our ground surveys and into Coeur d'Alene Lake. Each station consisted of an SRX-400 radio receiver connected to a 3-element Yagi antenna. The receivers were supplied with either AC or DC power, and solar panels were used to recharge the DC power systems. One station was located along the Coeur d'Alene River approximately 10 km downstream of the South Fork and the other where the Coeur d'Alene River entered Coeur d'Alene Lake (Figure 1). These receiver stations were monitored and downloaded by Parametrix (2005).

Mortality

When ground tracking each cutthroat trout we attempted to determine whether the transmitter was in a live fish or not. We accomplished this by getting close enough to the point where we could see the fish or the fish spooked off. Often in deeper water we would snorkel to determine the status of the fish. When we determined that the fish was dead or the transmitter was not in a fish we attempted to recover the transmitter to determine the reason why the fish died or why the transmitter was not inside the fish. During winter, it was often impossible to retrieve the transmitter in deep or swift water. Only once did we actually find a transmitter inside a dead fish. In the remaining situations, we determined the fate of the fish by examining the transmitter, its surroundings, and information from the previous time we tracked that particular fish (Figure 5).

Quantifying Habitat

Attempts were made to quantify available habitat in all areas that radio tagged cutthroat trout occupied during the summer and winter periods (July 2003 through March 2004) upstream of the Cataldo Mission Boat Ramp. Habitat surveys were conducted during late summer and early fall from 1994 to 2003 (Table 3 and Figure 6). Habitat conditions were assumed to be similar during these surveys to what radio tagged fish experienced during the summer and winter periods.

A modified R1/R4 methodology and protocol was used to collect habitat data (Overton et al. 1997). Within each designated habitat type (pool, riffle, glide or run) we measure the length, maximum depth, average width, dominant cover type, and amount over cover. Habitat unit numbers (in numerical order) were assigned to each habitat type starting from the headwaters working downstream. Wadeable streams and rivers were surveyed by foot and larger rivers (e.g., portions of the lower NF Coeur d'Alene and all of the Coeur d'Alene River) were surveyed using a drift boat or canoe. Habitat surveys were only conducted in the mainstream. When the stream channel split, surveys were conducted in only the larger channel.

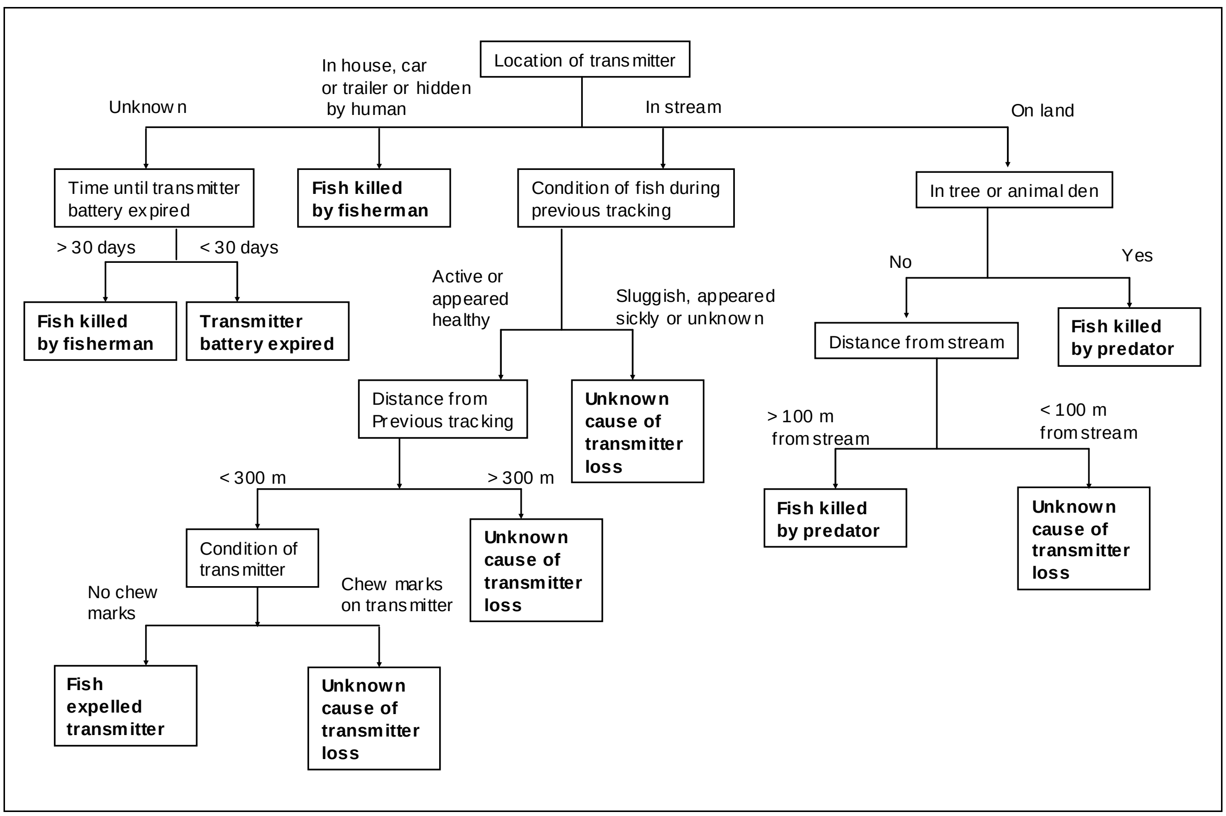


Figure 5. Classification tree used to determine why radio tagged cutthroat trout in the Coeur d'Alene River watershed, Idaho, died, or why the transmitter was recovered or disappeared. All transmitters recovered within one month of surgically implanting them into the fish were consider to have died from the surgical process unless they were caught by a fisherman.

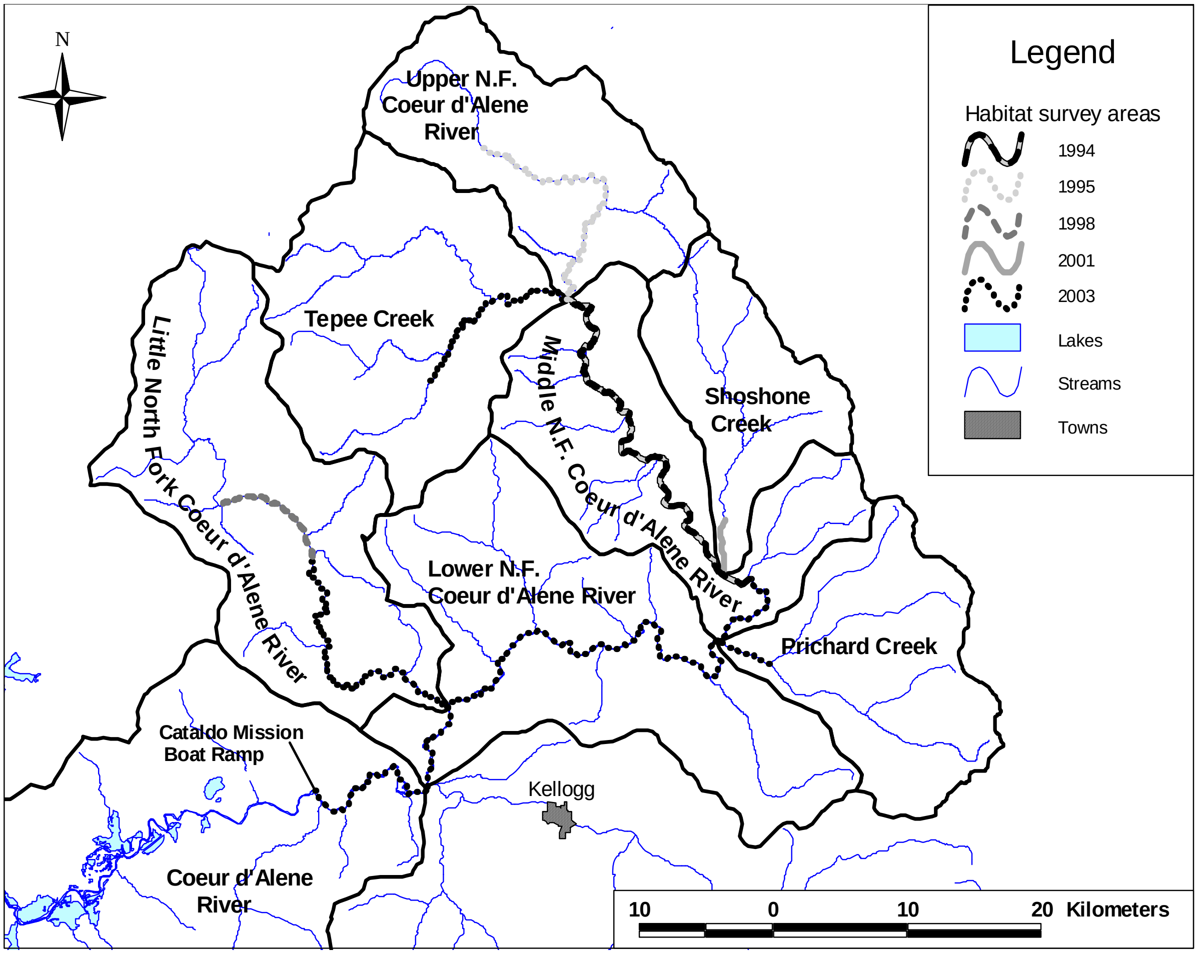


Figure 6. Location and dates when habitat surveys occurred in the Coeur d'Alene River watershed, Idaho.

Table 3. Locations of and year where habitat surveys occurred in different subbasins of the Coeur d'Alene River basin, Idaho.

Subbasin	Year Surveyed	Start – to – End Point
Coeur d'Alene River	2003	Start – Cataldo Boat Launch (Slack Water); End – S.F. Coeur d'Alene River Confluence;
Lower - NF Coeur d'Alene River	2003	Start – S.F. Coeur d'Alene River Confluence; End – Prichard Creek;
Middle – NF Coeur d'Alene River	2003	Start – Prichard Creek; End – Lost Creek;
Middle – NF Coeur d'Alene River	1994	Start – Lost Creek; End – Tepee Creek;
Upper – NF Coeur d'Alene River	1995	Start – Tepee Creek; End – Spruce Creek;
Little NF Coeur d'Alene River	2003	Start – Confluence with NF Coeur d'Alene River; End – Laverne Creek;
Little NF Coeur d'Alene River	1998	Start - Laverne Creek; End – Deception Creek;
Tepee Creek	2003	Start – Confluence with NF Coeur d'Alene River; End – Halsey Creek;
Shoshone Creek	2001	Start – Confluence with NF Coeur d'Alene River; End – Dam Creek;
Prichard Creek	2003	Start – Confluence with N.F Coeur d'Alene River; End – Eagle Creek;

The length and average width of each habitat type was measured using a handheld, laser range finder or measuring tape. Rangefinders were only used during 2003. The average width of each habitat type was calculated utilizing a minimum of three width measurements. Maximum depths in each habitat type were measured with a 2- or 5-meter stadia rod. When conducting surveys by boat this entailed probing along the thalweg and recording the deepest depth measured. In several pools in the Coeur d'Alene River, maximum depths exceeded 5 meters. In these cases, we measured depth using a field tape with a weight on the end. In 2003, maximum depths were not recorded for riffles, runs, and glides — only the average depth was recorded. Therefore, a corrected calculation was needed to obtain maximum depths from average depths in each of these habitat units. In 1994, 1995, 1998, and 2001, average and maximum depths for riffles, runs, and glides were collected in watersheds in the westslope cutthroat study area. A linear regression "least squares" was fit to this data so that maximum depths could be calculated from the average depth (Table 4).

Cover types evaluated during these surveys fell under one of the five categories: undercut banks, overhead cover, large woody debris, small woody debris, and large substrate (>250 mm in diameter). The dominant form of cover and the total amount of cover was recorded for each habitat type we surveyed. The total amount of cover was determined by visualizing what percent of the total surface area of each habitat type was spanned by all cover types. The dominant cover type spanned the highest percentage of the habitat's surface area when compared to the other cover types.

Table 4. Linear regression equations used to calculate maximum depth from average depth (y = maximum depth and x = known average depth) in riffle, run, and glide habitat throughout the Coeur d'Alene River, Idaho.

Habitat Type	n	r^2 =	r =	Equation	p-value
Riffle	336	0.32	0.57	y = 1.2739x + 0.13	0.0001
Run	251	0.51	0.71	y = 1.4963x + 0.187	0.0001
Glide	123	0.59	0.77	y = 2.0326x + 0.0204	0.0001

Temperature Work

Thermographs (Tidbit Temperature Loggers by Onset) were placed throughout the Coeur d'Alene watershed to help evaluate what role water temperature played in fish movement and distribution. All thermographs were calibrated in an icewater bath with a thermometer accurate to 0.1°C (National Institute of Standards and Technology) and were programmed to take temperature readings every hour, 24 hours a day. Thermographs were wired inside 2-inch perforated copper or PVC pipe and placed on the stream bottom in areas were ample depth and current would portray the water temperature of that stream reach. In 2003, 24 thermographs were placed at predetermined sites from May through November (Figure 7). During 2004, 14 additional thermographs were placed in the Coeur d'Alene River watershed to help evaluate temperature differences in areas radio tagged cutthroat trout used as refugia during the warm summer months of 2003 and to gain additional information where thermographs had been stolen or malfunctioned the year before (Figure 7). To aid in our evaluation of the role water temperature played in fish movement and distribution, we also took a single temperature reading utilizing a handheld pocket thermometer at every location we ground tracked a radio tagged fish from May 2003 through June 2004. Attempts were made to take these temperatures exactly where the fish were located. When deep, swift, and/or wide stream reaches or ice cover prevented us from taking temperature at the exact fish's location, we got as close as we could when taking temperatures. In deeper areas, we would suspend the thermometer by a string approximately 1 m deep when taking temperatures.

Water temperature data collected before our study (1998 to 2002) by the U.S. Forest Service in tributaries of the Coeur d'Alene River were also utilized during this study. These temperature data were collected in a similar manner as we did and were utilized to evaluate the potential for tributary streams to provide cold water for cutthroat trout during warm summer periods.

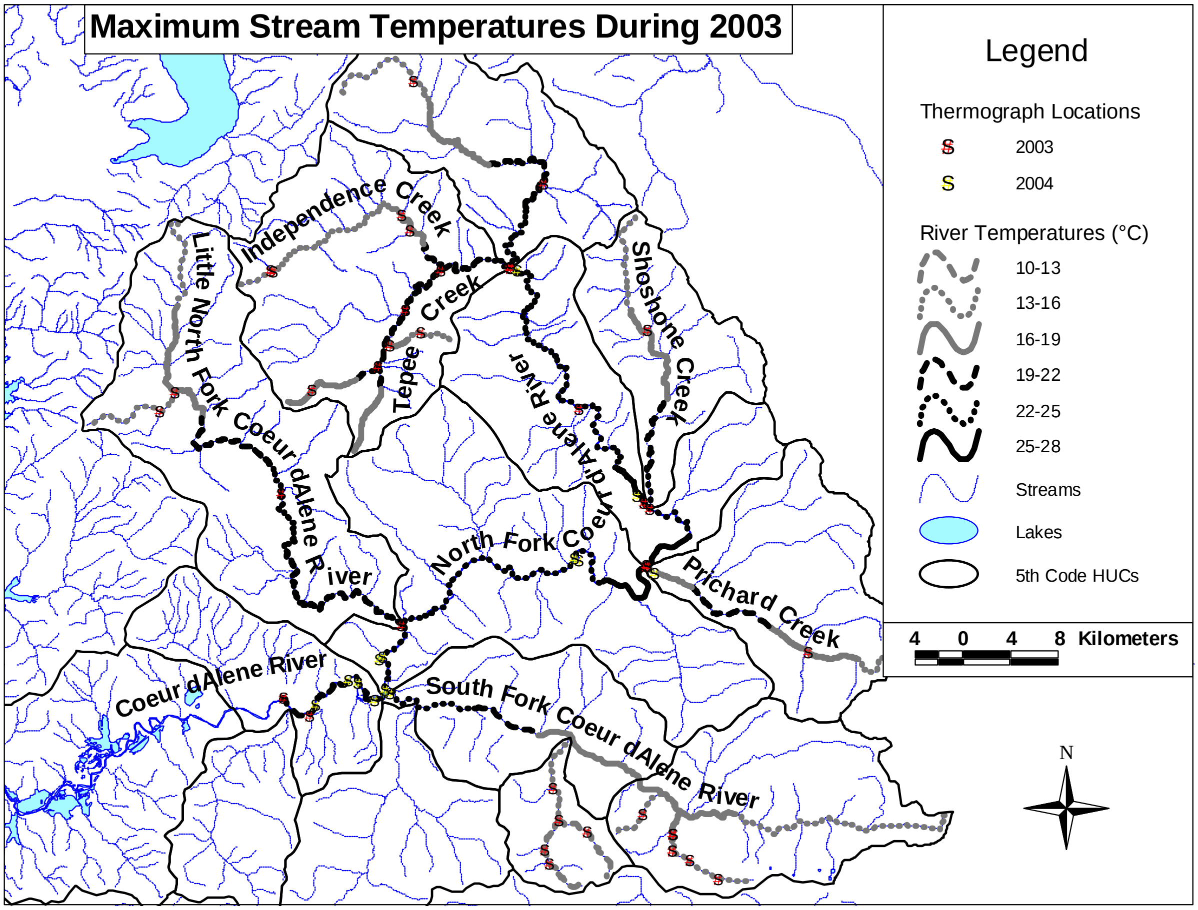


Figure 7. Thermograph locations during 2003 and 2004 and the maximum water temperatures that occurred in rivers and major tributaries in the Coeur d'Alene River basin, Idaho, during 2003 based on thermograph data and instantaneous temperature data collected when tracking cutthroat trout.

Data Analysis

Movement

The distance each fish moved between tracking efforts was calculated by snapping the GPS coordinates of each fish location onto a stream layer using ArcView. The stream distance between each coordinate represented the distance that fish moved between each tracking effort. Average monthly movement rates were calculated for each radio tagged cutthroat trout by summing the distance each fish moved during a month and dividing it by the amount of time that had lapsed between tracking efforts. This technique prevented a fish that was tracked more frequently during a month from providing more weight to any calculation.

Movement rates of the radio tagged cutthroat trout were categorized by month and by the subbasin in which the fish spent the summer (July through October). Using SAS® Proc Mixed we conducted a two-factor analysis of variance (ANOVA) to evaluate the effects time (month effect) and space (subbasin effect) had on movement rates of cutthroat trout. This analysis equally weights fish movement for each month and eight subbasins. This prevents months when we conducted the most tracking effort and subbasins that had the most fish in them from overly weighting the average movement rates. We did not utilize an analysis that included an interaction effect between month and subbasin as the degrees of freedom would limit many of the 96 month x subbasin comparisons and because the movements of one fish drove many of the significant relationships. We used a p-value ≤0.10 to denote when significantly different movement rates occurred between months or subbasins. This value is often used to show significance when evaluating fish and wildlife populations for management purposes (Peterman 1990; Johnson 1999; Anderson et al. 2000). If an ANOVA showed that a significant difference (p ≤0.10) in rates of movement occurred between months or between subbasins, we did a pairwise comparison using Fisher's Least-Significance-Difference (LSD) Test to evaluate which months or subbasins movement differed significantly. Fisher's LSD Test was chosen for this analysis, as this test tends to maximize the power, which increases that ability to show statistically significant differences with low sample sizes (Milliken and Johnson 1992).

Mortality

We used a staggered entry design of the Kaplan-Meier survival curves to estimate fishing mortality of radio tagged cutthroat trout in different subbasins of the Coeur d'Alene River watershed throughout the duration of the study (Pollock et al. 1989). Pairwise comparisons of 90% confidence intervals were used to evaluate if fishing mortality significantly differed between subbasins (Pollock et al. 1989).

We calculated the number of days each fish spent in each subbasin to estimate the average number of days elapsed before a fish was harvested by a fisherman. When a fish moved to another subbasin, we assumed that between tracking efforts fish spent half the time in each subbasin. When a fish died or expelled its tag it was assumed that it was living or retained its tag for half the time from when it was last seen alive to when it was determined to be dead or to have expelled its tag.

To evaluate what role various radio tag and fish characteristics played in tag expulsion, we conducted a logistic regression (SAS® Proc logistic data) with whether a fish expelled a tag or not as the dependent variable and fish weight, transmitter weight, and antenna length and the number of days the tag was in a fish as independent variables. P-values <0.10 denoted significant relationships. To help evaluate whether antenna length played a role in tag expulsion we conducted a chi-square goodness of fit test (Ott 1988). A significant finding (p <0.10) would indicate that the ratio of expelled tags with full length antennae to clipped antennae were not in the same proportion that were originally implanted into cutthroat trout.

Habitat Use and Availability

Chi-square goodness-of-fit tests (Ott 1988) were utilized to evaluate whether the radio tagged cutthroat trout selected habitat types (pool, riffle, run and glide) in proportion to their availability. A significant relationship (p-value <0.10) would indicate that the radio tagged fish were selecting specific habitat types and were not randomly distributed. Observed values were the number of times radio tagged fish were found in each particular habitat, and expected values were derived from the total area that each of these habitat types occupied. A separate chi-square analysis was conducted for eight subbasins (5th code huc) as well as all subbasins combined, for each season (spawn, summer and winter) amounting to 27 different chi-square analysis. To summarize these data, for each analysis we divided the observed value by the expected value and displayed the results in a table. Values >1.0 indicate habitat types the radio tagged fish were selecting for, and the larger the number the more preference they tended to show for this habitat type. Values <1.0 indicate habitat types that were avoided and a value of zero meant that no radio tagged fish were found to utilize that habitat type. All significant relations were also displayed in these tables.

Chi-square goodness-of-fit tests were also used to evaluate whether the radio tagged cutthroat trout selected water depths and cover types in proportions to their availability. Because the radio tagged fish were found to utilize mostly pools and runs during the summer season, depth and cover availability data only for pools and runs were used in the analysis. This allowed us to evaluate which if any habitat attributes in these pools and runs were important for selection by the radio tagged cutthroat trout during the summer. During the winter, cutthroat trout were found to avoid only riffles so chi-square analysis excluded depth and cover availability data from riffles only. The depth and cover analysis were summarized in the same fashion as we did with the habitat type data where we divided the observed value by the expected value and displayed them in a table.

The depth data used to evaluate fish use was the maximum depth within the habitat (pool, riffle, run, or glide) in which the fish was located. This was compared to the maximum depth that occurred in each habitat type. For this analysis, the depth data were categorized into 1.0 m increments. Observed values were the number of times each of the radio tagged fish was located in habitats within each of the designated depth categories, and expected values were derived from the total area of the habitat types that had maximum depths in each of the designated depth categories.

To evaluate cover availability versus use we analyzed three different forms of these data. One analysis compared whether the radio tagged fish were located near cover (within 5 m) to the amount of cover (by surface area) that was available. Another analysis compared the type of cover the fish used versus the amount of cover (by surface area) that occurred in each habitat type (see Appendix B for cover types). The other analysis compared the percent of cover that occurred in the habitat in which the fish were located to the percent of cover that occurred in each of the available habitat units. For this analysis, we broke the data into five percent increments.

Principal component analysis was utilized to depict changes in habitat use of the radio tagged cutthroat trout between the summer and winter periods (Johnson and Wichern 1992). Two principal component scores (Factor 1 = x-axis and Factor 2 = y-axis) were calculated for each site where we located fish based on maximum depth within 50 m, stream width, amount of cover, dominate substrate size, and valley width. Valley widths were calculated using GIS by measuring the distance between the valley walls (Williams et al. 2000). We utilized a correlation matrix and a varimax rotation for this analysis. To depict habitat use of the radio tagged cutthroat trout, we graphed the factor scores which represent the habitat conditions at each location they were tracked. Summer habitat use was considered July through October and winter use was considered November through March.

Temperature Effects

To evaluate what role water temperature played in movement and distribution of the radio tagged cutthroat trout we compared the location and movement patterns of fish during different times of the year to water temperatures collected when tracking the fish as well as water temperatures collected with thermographs placed throughout the watershed.

Thermograph data were compared to periods of movement to evaluate if and what temperatures might initiate this movement. Periods we were concerned with included spawning migrations, movement to coldwater refugia during summer and movement to winter habitat.

Using a combination of the thermographs and instantaneous temperature recordings at each fish location, we mapped maximum temperatures that occurred in the Coeur d'Alene River watershed. We then evaluated where areas of extreme and preferred water temperatures occurred during the summer period. Temperature data from tributary streams were also evaluated to determine whether they would provide suitable coldwater refugia during warm summer months. Thermograph data was not collected during the winter so we used instantaneous temperature recordings to evaluate whether extreme winter conditions occurred that could influence survival. In addition, during winter tracking periods, any observations of frazil or anchor ice were noted.

Effects from Post Falls Dam

Operations at Post Falls Dam artificially hold water levels approximately 2.3 m higher from approximately June through October. These higher water levels inundate approximately 4 km of the Coeur d'Alene River (segment 1) during this period (Figure 8). This analysis focused on what effect artificial inundation had on use of this 4 km segment of river from June through October. Because movement of fish is often based on many factors including changing water levels, we felt it necessary to conduct five different analyses to determine whether artificially raising water levels in the Coeur d'Alene River was having an effect on the cutthroat trout fishery. These analyses included the following:

1. Compare all the locations of the radio tagged cutthroat trout during June through October (high pool) and November through May (low pool). Comparisons focused on the fish locations within and just above the inundated segment.

2. Compare the number of different radio tagged fish that utilized the inundated reach during high pool versus low pool. These numbers were also compared to the number of fish that utilized a 2.5 km segment of stream just upstream of the inundated zone during high pool and low pool. For a radio tagged fish to be counted as using one of these segments it must have been tracked in that reach either by plane or on ground (excluding fixed receiver data). In other words if a fish passed through the reach but was not tracked there it was not counted.

3. Assess how all radio tagged cutthroat utilized different segments of the Coeur d'Alene River on a monthly basis with attention paid to the inundated zone. To accomplish this we separated the Coeur d'Alene River into five segments with one segment being the section of river that is inundated during the summer (Figure 8 and Table 5). The number of days each radio tagged fish spent in each river segment was calculated on a monthly basis and also summarized by the high-pool and low-pool periods. When a fish moved to

a different river segment between tracking efforts it was assumed that between tracking efforts the fish spent half the time in each segment. When a fish died or expelled its tag it was assumed that it was living or had retained its tag for half the time it was last seen alive to the time it was determined to be dead or to have expelled its tag. Based on the amount of time (days) all the radio tagged cutthroat trout spent in each segment, we calculated the percent of time all the fish spent in each segment during each month. These percent use values for the inundated segment were then summarized into three time periods (high-pool, early low-pool and late low-pool). An ANOVA was used to determine if radio tagged cutthroat trout utilized the inundated segment in significantly different amounts between these three periods. We used a p-value ≤0.10 to denote when significantly different amounts of use occurred between the three periods. This value is often used to show significance when evaluating fish and wildlife populations for management purposes (Peterman 1990; Johnson 1999; Anderson et al. 2000). If an ANOVA showed that a significant difference (p ≤0.10) in use occurred between the three periods, we did a pairwise comparison using Fisher's Least-Significant-Difference (LSD) test to evaluate which time period's use differed significantly. Fisher's LSD Test was chosen for this analysis, as this test tends to maximize the power, which increases that ability to show statistically significant differences with low sample sizes (Milliken and Johnson 1992).

4. Compare movement rates of radio tagged cutthroat trout within the five designated segments of the Coeur d'Alene River with emphasis on the inundated segment (segment 1). The distance each fish moved between tracking efforts (excluding fixed receiver data) was calculated by snapping the GPS coordinates of each fish location onto a stream layer using ArcView. The stream distance between each coordinate represented the distance that fish moved between each tracking effort. Movements were only calculated when a fish moved within a segment. If the fish moved between segments this distance was not evaluated. To determine if movement rates differed between the river segments we conducted an ANOVA. If an ANOVA showed that a significant difference (p ≤0.10) in movement occurred between the five river segments, we conducted a pairwise comparison using Fisher's LSD Test to evaluate which river segments movement differed significantly.

5. Evaluate movement patterns of all radio tagged fish that were located within 1 km of the slack water interface (boundary between segment 1 and segment 2) to assess if there was an avoidance of the inundated reach. Movement patterns were evaluated during both high-pool (June to October) and low-pool periods (November to May).

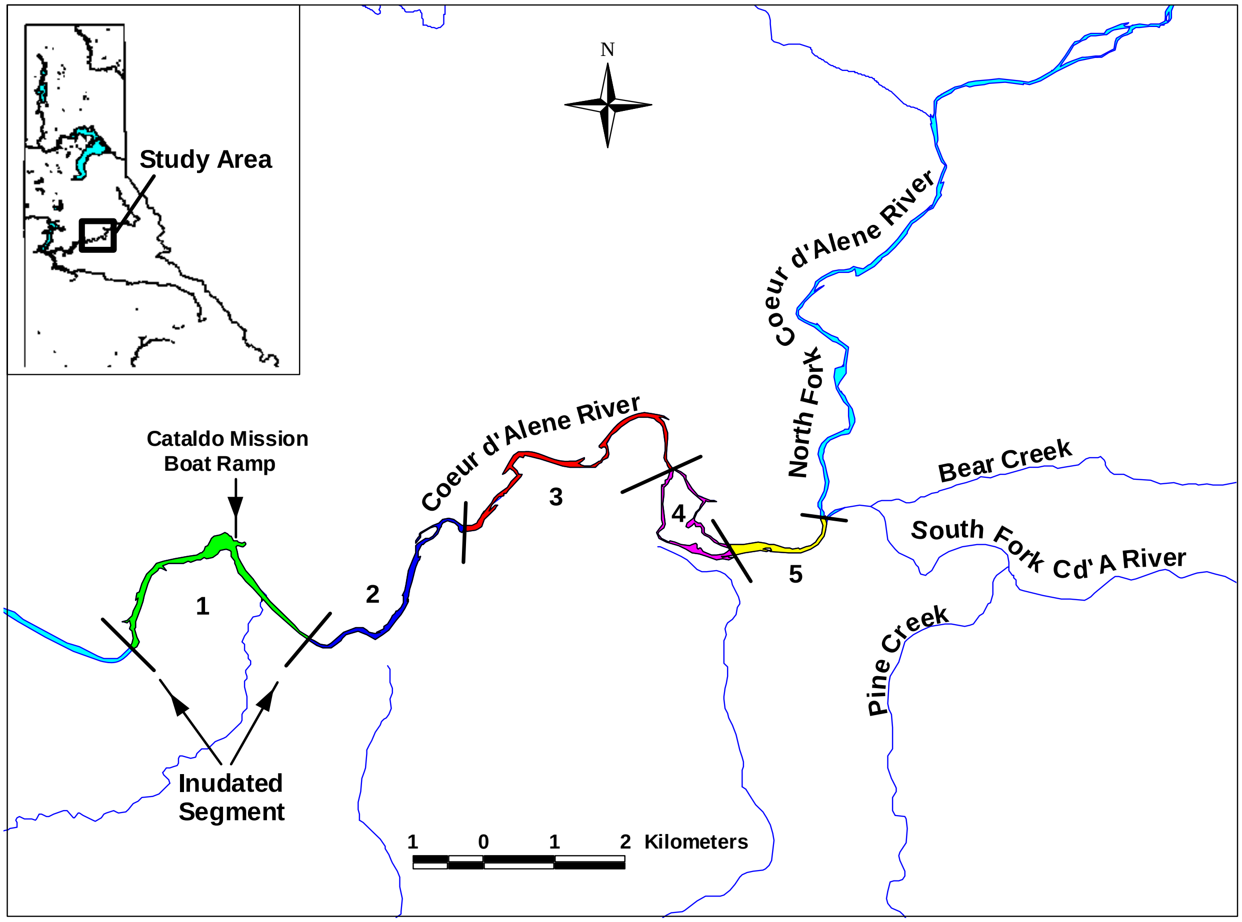


Figure 8. Stream segments of the Coeur d'Alene River, Idaho, evaluated to assess the influence of Post Falls Dam on cutthroat trout movement from May 2003 to June 2004.

Table 5. The segment lengths and number of cutthroat trout captured in each of the segments evaluated to assess the potential operational impacts from Post Falls Dam may have on cutthroat trout in the Coeur d'Alene River, Idaho, during May 2003 to June 2004.

Segment Name	Segment Length (km)	Number of Radio Tags
1 (inundated segment)	4.24	3
2	3.39	4
3	4.51	6
4	1.80	1
5	1.54	5

RESULTS

Movement

Seventy-five cutthroat trout were captured and radio tagged throughout the Coeur d'Alene River watershed from eight different subbasins (Table 6). These cutthroat trout ranged in total length from 282 to 502 mm at their time of capture (Figure 9 and Appendix C). Twenty-three of these cutthroat trout were >406 mm in length, the size of cutthroat trout that can be legally harvested. We met our capture goal in each subbasin except the lower North Fork Coeur d'Alene River, where due to sampling difficulty we put transmitters in only seven fish (goal was nine). The two extra transmitters were put into fish in the middle North Fork Coeur d'Alene River subbasin.

Our tracking efforts from May 2003 through June 2004 showed that cutthroat trout in the Coeur d'Alene River watershed have localized movements where they tend to stay in one subbasin for the entire summer and winter periods. This localized movement was consistent regardless of the size of the fish. Based on these movement patterns, we separated the radio tagged cutthroat into nine different assemblages, which were distinguished by the subbasin in which they spent the summer. These subbasins included Coeur d'Alene Lake (lake), Coeur d'Alene River (CDA River), lower North Fork Coeur d'Alene River (NF-lower), middle North Fork Coeur d'Alene River (NF-mid), upper North Fork Coeur d'Alene River (NF-upper), Little North Fork Coeur d'Alene River (LNF), Tepee Creek (Tepee), Shoshone Creek (Shoshone), and Prichard Creek (Prichard).

Lake—Two of the tagged cutthroat trout displayed an adfluvial life cycle (lake subbasin). These fish were 415 and 355 mm in length at the time of capture and both migrated downstream to Coeur d'Alene Lake in June. Their return migrations were quite different, however. One fish returned to Coeur d'Alene River in December whereas the other did not leave the lake and enter the Coeur d'Alene River until April. Neither of these fish was ever tracked upstream of the South Fork Coeur d'Alene River and neither was tracked to areas we believed spawning had occurred (Figure 10).

Table 6. Numbers, sizes and capture locations of cutthroat trout radio tagged in the Coeur d'Alene River watershed, Idaho during May and June 2003. Numbers in parentheses are fish that were captured in September or October and inserted with radio transmitters from previous fish that had died or expelled their tags.

	Size (mm) of Fish					
Stream Subbasin	**280-299**	**300-349**	**350-399**	**400-449**	**≥ 450**	**Total**
Coeur d'Alene River	3	11	4	1		19
Lower NF Coeur d'Alene River		2 (1)	2	3		7 (1)
Middle NF Coeur d'Alene River			3	4 (1)	2	9 (1)
Upper NF Coeur d'Alene River		1	4 (1)	2		7 (1)
Little NF Coeur d'Alene River	(2)	3	2	2 (1)	1	8 (3)
Tepee Creek		2	2 (1)	3 (3)	1	8 (4)
Shoshone Creek		1	1	2		4
Prichard Creek		1	2			3
Total	**3 (2)**	**21 (1)**	**20 (2)**	**17 (5)**	**4**	**65 (10)**

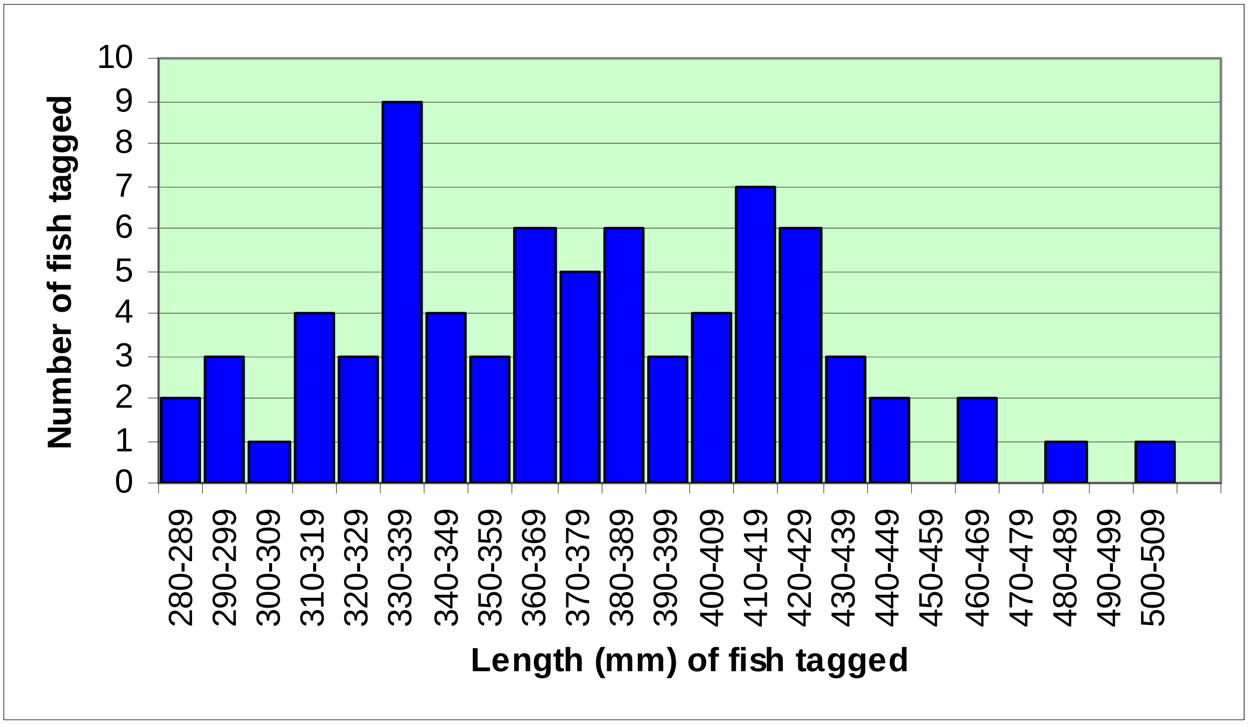


Figure 9. Length frequency histogram of 75 cutthroat trout inserted with radio transmitters during 2003 in the Coeur d'Alene River watershed, Idaho.

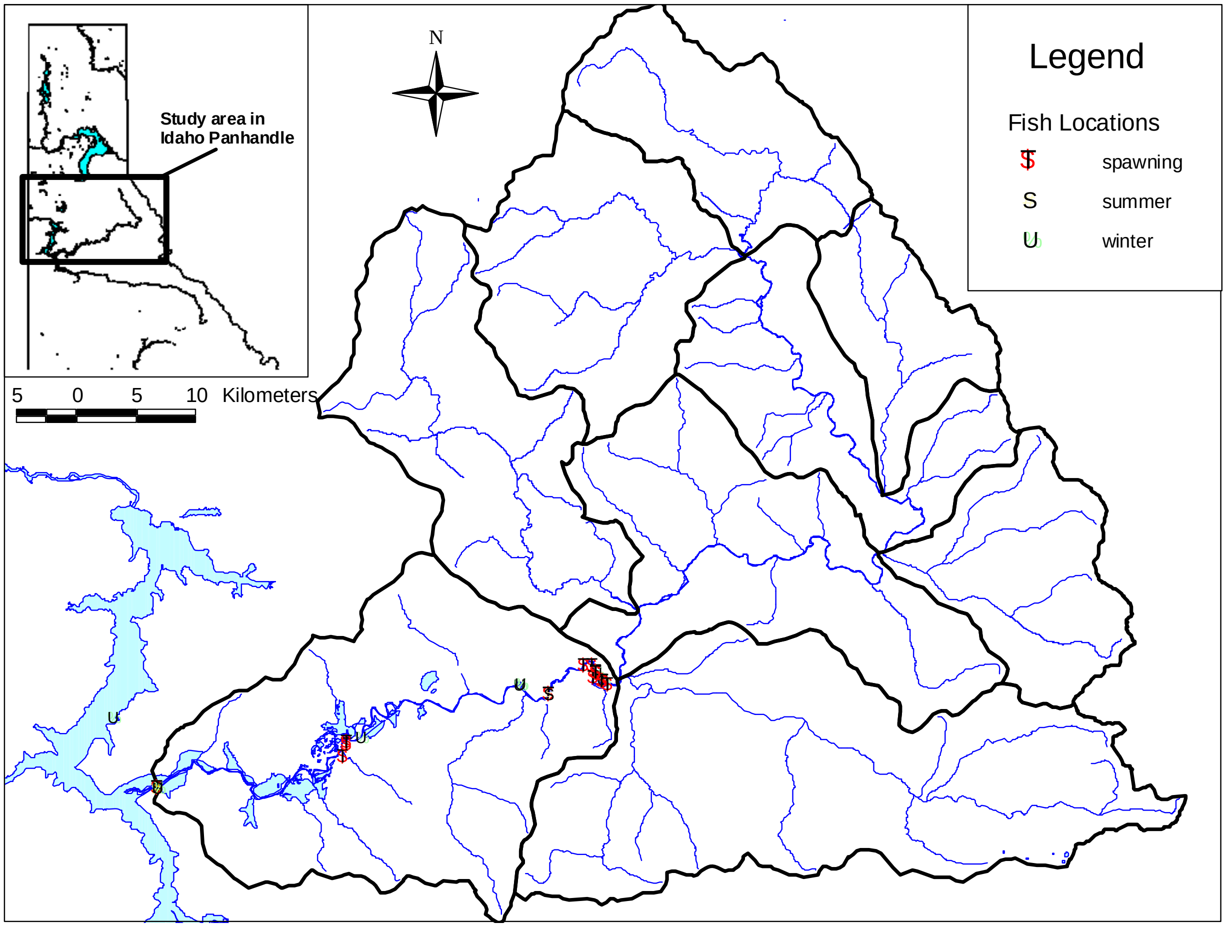


Figure 10. Locations of two radio tagged cutthroat trout assigned to the lake subbasin assemblage, Idaho, from May 2003 to June 2004.

CDA River—Twenty different radio tagged cutthroat trout were grouped into the CDA River fish assemblage. These fish moved predominantly in the free flowing section of the Coeur d'Alene River (only two fish were ever tracked downstream of the Cataldo Mission Boat Ramp) and never migrated upstream of the South Fork except during their spawning run. All documented spawning migrations for these fish were from Prichard Creek downstream (Figure 11). More detailed descriptions on the movement patterns of these fish are documented in the "Post Falls Dam" section of the result.

NF-lower—Eleven different radio tagged cutthroat trout were grouped into the NF-lower subbasin fish assemblage. These fish spent the entire summer and winter in this section of river. Movement during summer was minimal with no fish migrating more than 2 km during this period. Due to high fishing mortality, only two of these fish survived to winter. Both made short (<1 km) upstream or downstream movements from summer to winter habitat. During winter, one fish essentially did not move and the other migrated downstream approximately 5 km during January. During the spawning migrations, these fish appeared to spawn in tributaries within the LNF, NF-mid, and Tepee assemblages. These fish utilized the most diverse areas for spawning and displayed the longest spawning migrations, with one fish migrating 72 km to the headwaters in the Tepee subbasin during its spawning run (Figure 12).

NF-mid—Ten different radio tagged cutthroat trout were grouped into the NF-mid subbasin fish assemblage. These fish spent the entire summer in this section of river and all but one utilized this reach during the winter (one moved into Tepee Creek during winter). Movements during summer never exceeded 6 km. Migrations to winter habitat never exceeded 4 km and during winter none moved more than 5 km. Most spawning migrations were quick, and consequently, we were not able to document exact spawning locations. Because of these quick migrations, we believe most spawned in tributaries within the NF-mid subbasin, although some did migrate into the NF-upper subbasin to spawn (Figure 13).

NF-upper—Seven different radio tagged cutthroat trout were grouped into the NF-upper subbasin fish assemblage. These fish spent the entire summer in the NF-upper subbasin. One of these fish made a 6 km upstream migration during peak summer temperatures. None of the other radio tagged fish moved more than 0.5 km throughout the summer. During winter every one of the surviving radio tagged fish migrated downstream of Tepee Creek to overwinter in the NF-mid or Tepee subbasins. None of these fish migrated more than 15 km from summer habitat to reach areas where they spent the winter. Once these fish reached winter habitat they essentially remained in the same pool or glide. However, one fish moved approximately 5 km throughout the winter. Spawning migrations occurred upstream into Tepee Creek and into tributaries of the NF-upper subbasin (Figure 14).

LNF—Ten different radio tagged cutthroat trout were grouped into the LNF fish assemblage. These fish never left the subbasin during our tracking efforts. Movement patterns consisted of a spawning run where they quickly ascended and descended the river (approximately two-week span). All six fish we tagged in May and June that survived implantation (two fish died within a month of implantation) were located downstream of Laverne Creek (limited harvest area) for the entire summer and winter period. Two of these fish were initially tagged upstream of Laverne Creek. Between the summer and winter, movement was minimal although at the onset of winter there was a trend of downstream movement (Figure 15). We tagged three fish in late October upstream of Laverne Creek. None of these fish migrated downstream more than 300 m throughout the remainder of the study.

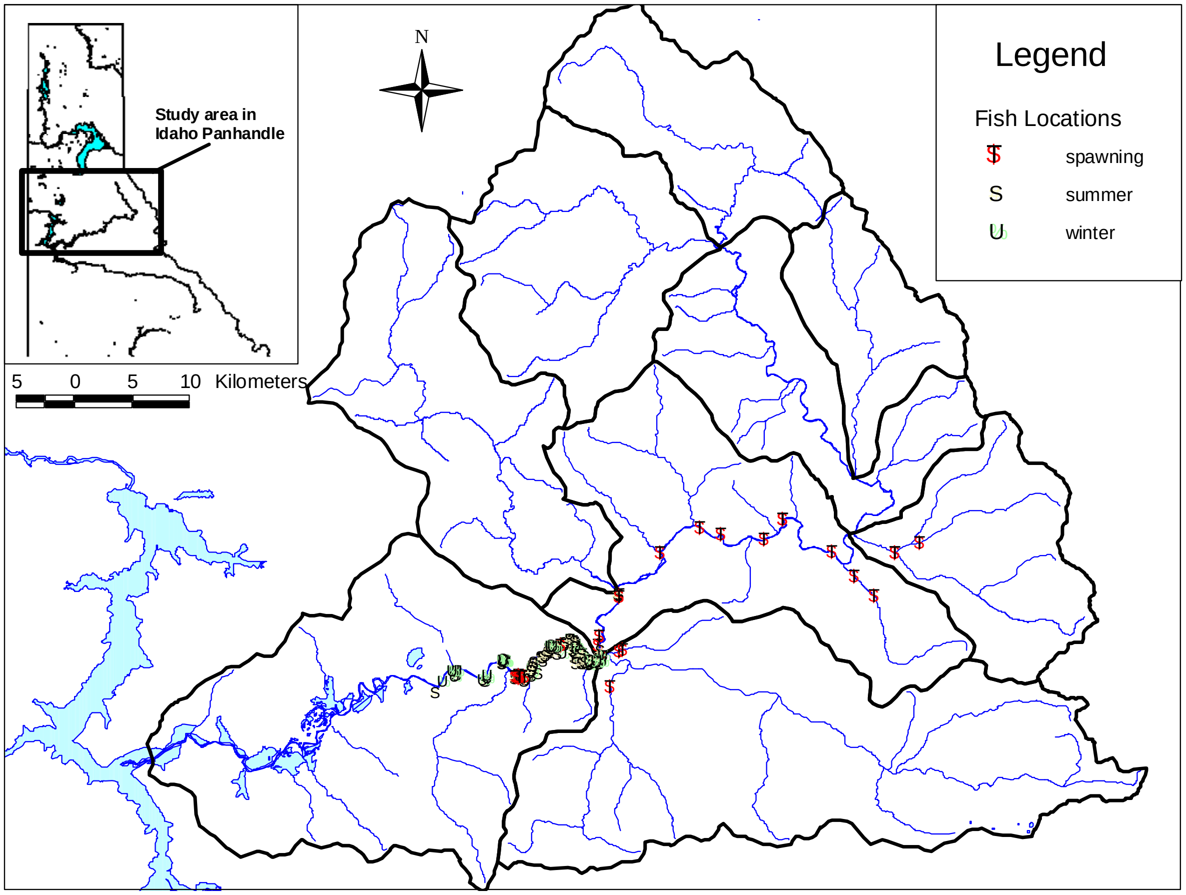


Figure 11. Locations of 20 radio tagged cutthroat trout assigned to CDA River subbasin assemblage, Idaho, from May 2003 to June 2004.

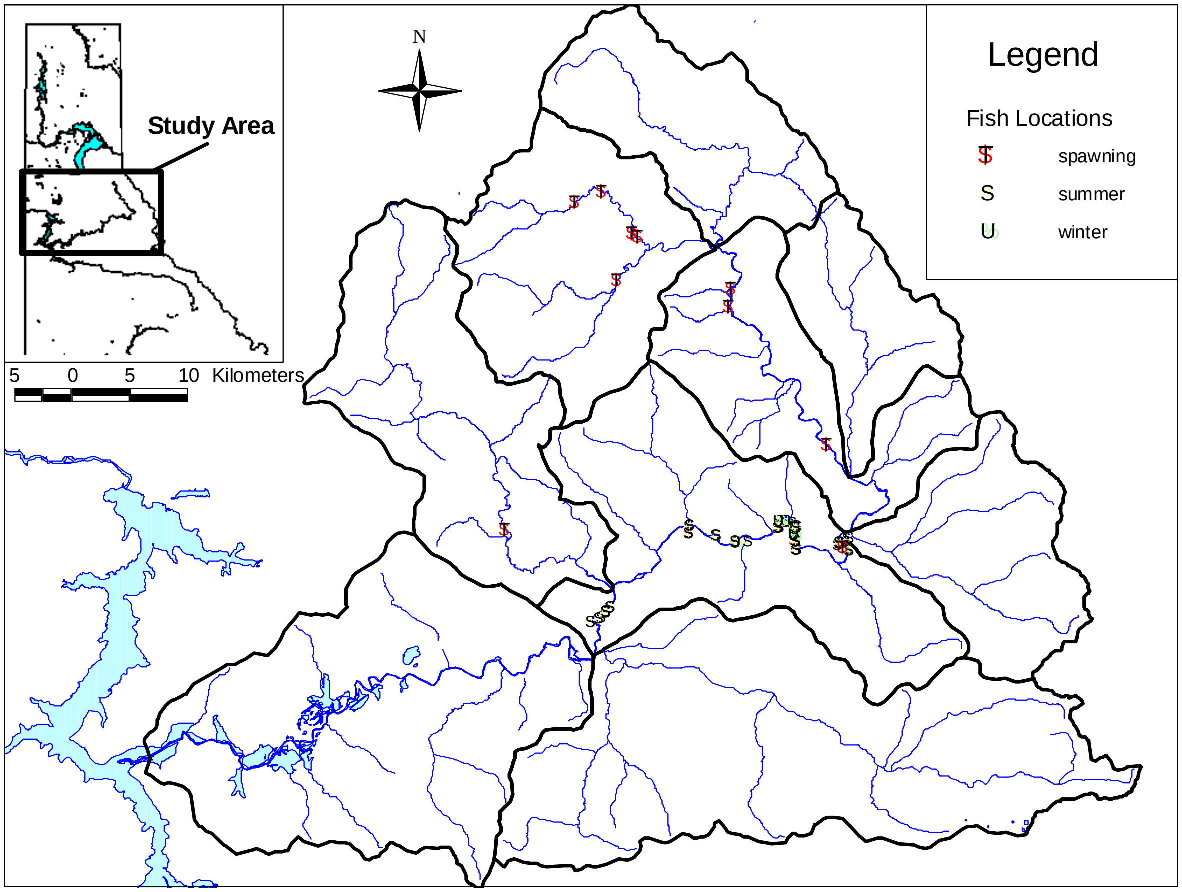


Figure 12. Locations of 11 radio tagged cutthroat trout assigned to the NF-lower subbasin assemblage, Idaho, from May 2003 to June 2004.

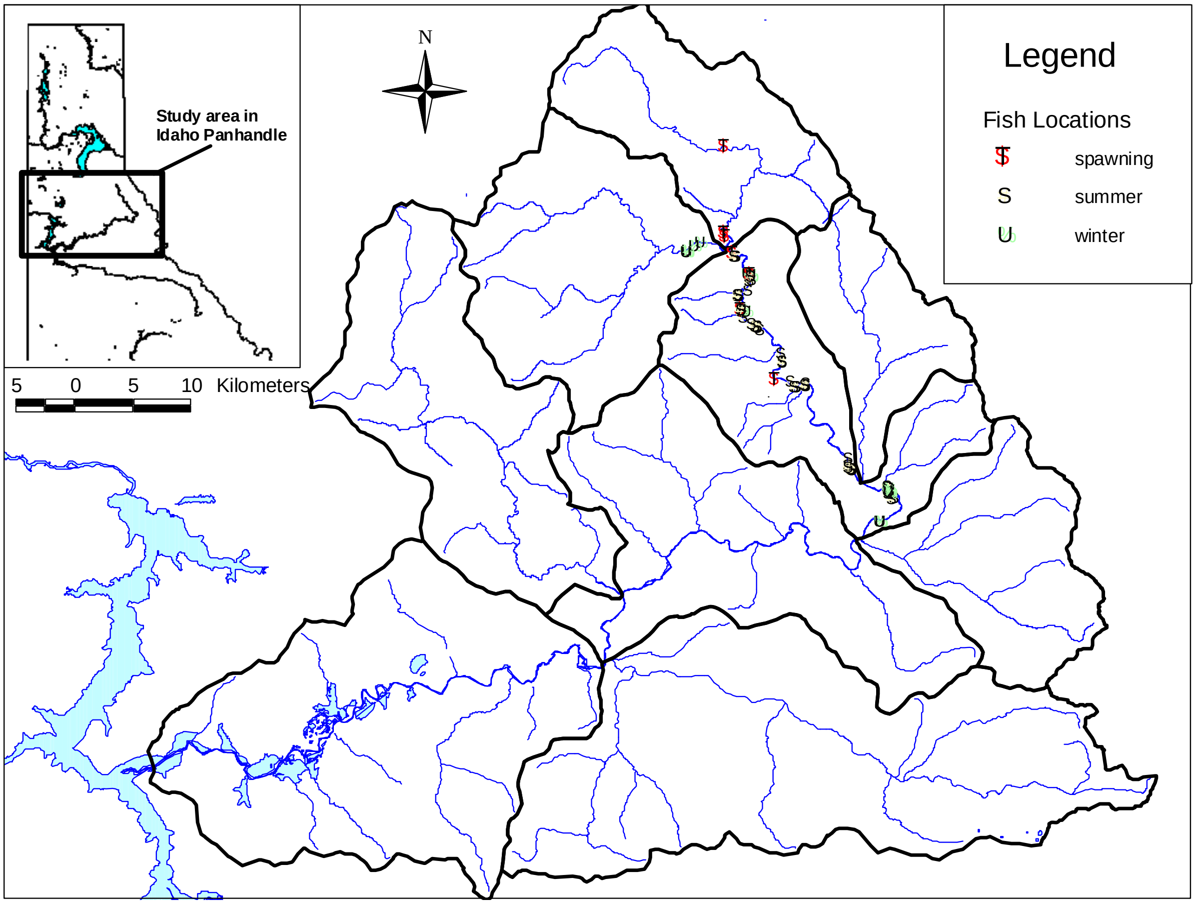


Figure 13. Locations of 10 radio tagged cutthroat trout assigned to the NF-mid subbasin assemblage, Idaho, from May 2003 to June 2004.

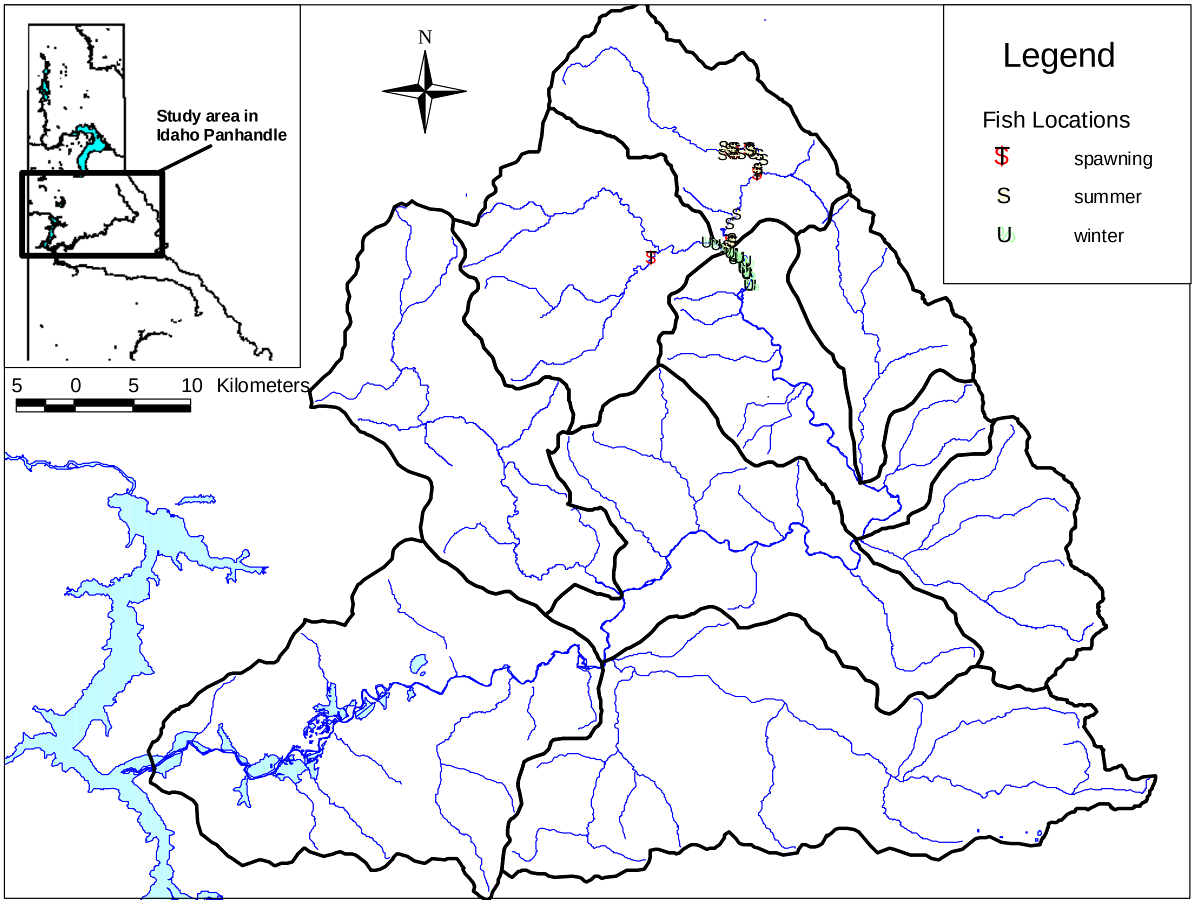


Figure 14. Locations of seven radio tagged cutthroat trout assigned to the NF-upper assemblage, Idaho, from May 2003 to June 2004.

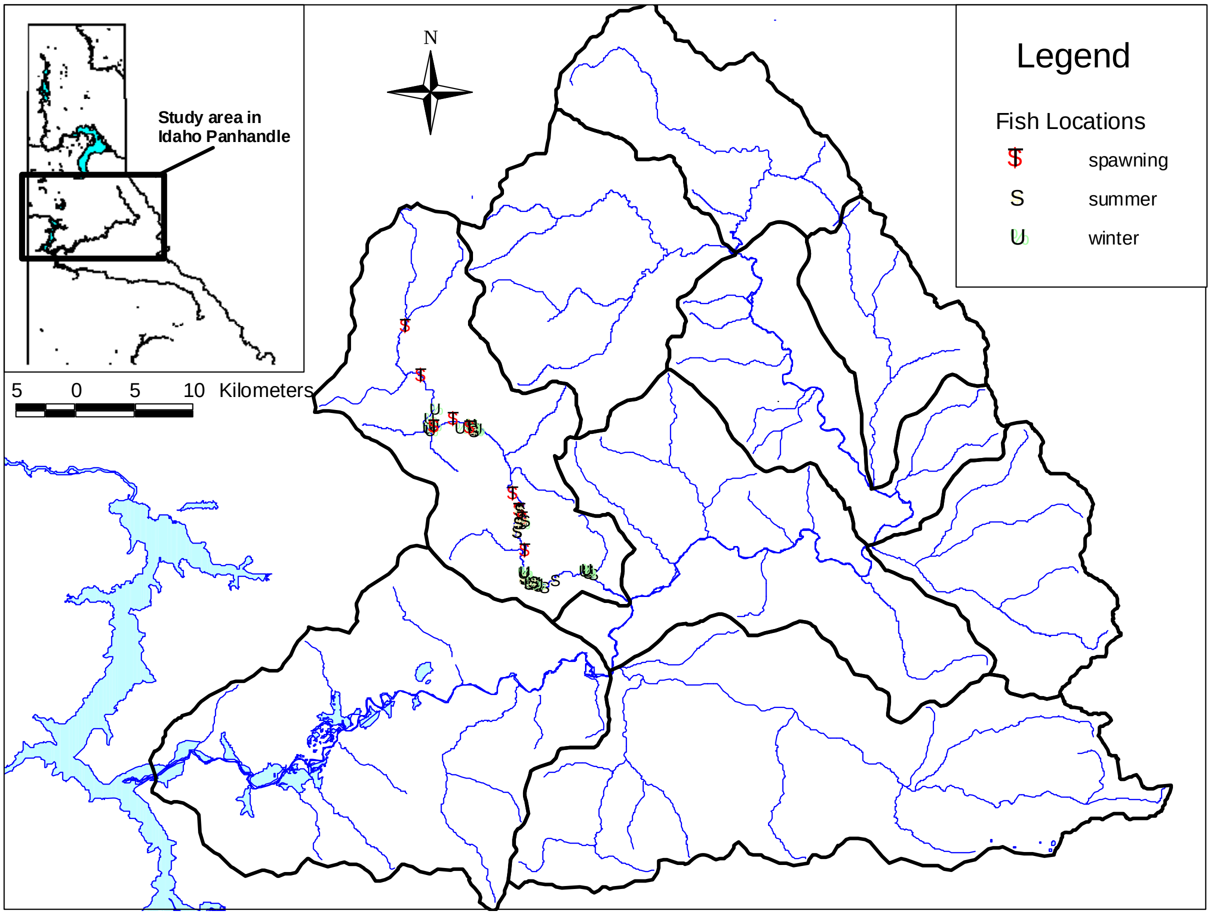


Figure 15. Locations of 10 radio tagged cutthroat trout assigned to the LNF subbasin assemblage, Idaho, from May 2003 to June 2004.

Tepee—Nine different radio tagged cutthroat trout were grouped into the Tepee subbasin fish assemblage. These fish never left the subbasin during our tracking efforts. Movement patterns consisted of little movement during summer (none moved over 3 km) followed by downstream movements to lower Tepee Creek (up to 9 km) to reach winter habitat. Up to five different radio tagged fish were located in the same run/glide at one time during the winter. During winter no fish moved more than 2 km. Spawning migrations were relatively short (<10 km) with documented spawning occurring in the mainstream channel (Figure 16).

Shoshone—Five different radio tagged cutthroat trout were grouped into the Shoshone subbasin fish assemblage. All five of these fish spent some time in Shoshone Creek during the summer. One utilized Shoshone Creek for less than a month during the warmest time of year and another migrated from Shoshone Creek 30 km down the North Fork and then returned all during the month of June. When in Shoshone Creek these fish tended to be relocated in the same pool or run. All the surviving fish (2) wintered in NF-mid subbasin. One migrated upstream approximately 4 km and the other migrated downstream approximately 8 km to where they overwintered. Spawning migrations were as far upstream as the upper Tepee subbasin (56 km) from where it overwintered (Figure 17).

Prichard—One fish was assigned to the Prichard subbasin fish assemblage. This fish spent the entire summer near the mouth of Prichard Creek. At the onset of winter, it migrated downstream into the NF-lower subbasin. This fish moved 23 km downstream through the winter before it returned to Prichard Creek (Figure 18). The movements this fish made during winter were unique from all the other radio tagged fish and were the farthest migration any fish made from summer to winter habitat. The battery in this fish's radio tag expired prior to the 2004 spawning season.

Two factor ANOVA testing showed that movement of radio tagged cutthroat trout differed significantly between subbasins (p value <0.001) and months (p value <.001). The highly significant subbasin effect was largely because of the two cutthroat trout that migrated to Coeur d'Alene Lake (Lake subbasin). These fish made faster migrations and migrated at different times than fish in other subbasins, and during many months, these movements were based on one fish. For this reason, we did another analysis that excluded the two fish that migrated to the Lake. The two factor ANOVA that excluded the lake subbasin fish also showed that movement of radio tagged cutthroat trout differed significantly between months (p value <.001) although the subbasin effect was far less significant (p value = 0.087).

Fisher's LSD Test (excluding lake subbasin fish) showed that significantly more movement was observed in fish that occurred in NF-lower and Shoshone subbasin fish than the NF-mid and Tepee subbasin fish. Significant differences in movement of fish between the other subbasins were not as clear (Table 7 and Figure 19). Based on Fisher's LSD Test, fish moved significantly more during April, May, and June than the rest of the year (Table 7).

Average movement of the radio tagged cutthroat trout was minimal during the summer (July to October) and winter months (November to March) averaging <3 m/hr between tracking periods (Figure 20). During the summer, it was not unusual to locate the same fish in the same pool and under the same log for two months straight. Only two fish were found to make movements over 7 km between July and September. Both fish made these movements in July and appeared to be migrating to areas with cooler water. Nineteen fish were tracked during both the summer of 2003 and summer of 2004. Of these 19 fish, 18 were located in the summer of 2004 within 1 km of where they were located during the summer of 2003. Sixteen were located within 200 m during both summers and ten utilized the same pool or run during both summers.

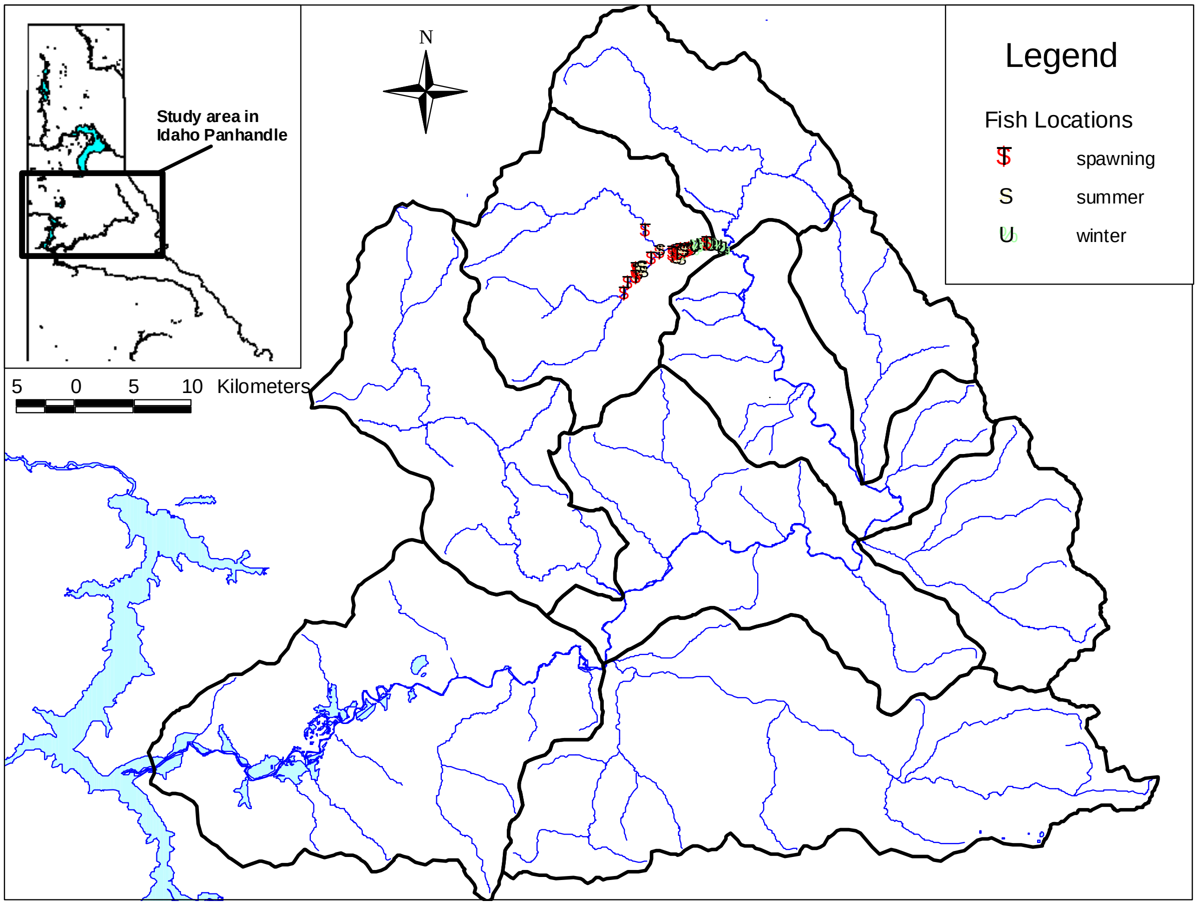


Figure 16. Locations of nine radio tagged cutthroat trout assigned to the Tepee subbasin assemblage, Idaho, from May 2003 to June 2004.

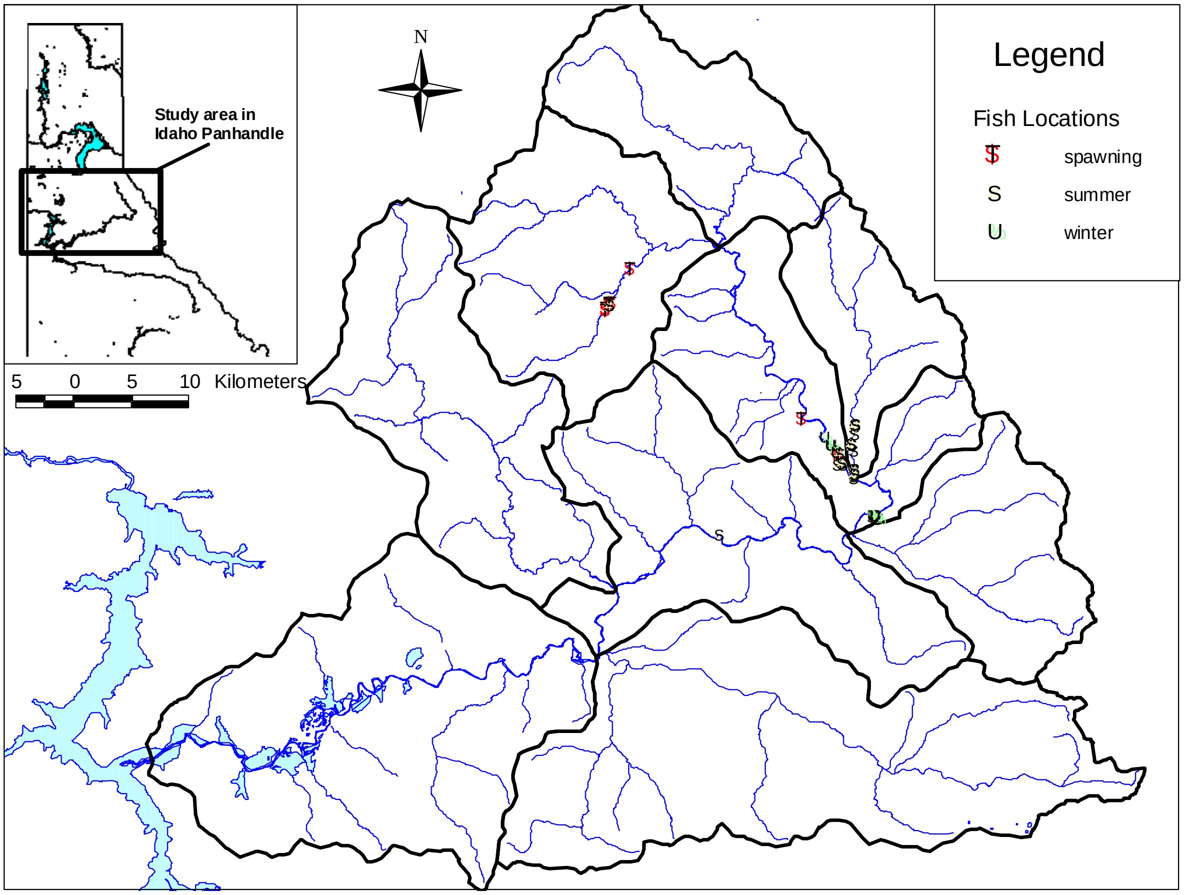


Figure 17. Locations of five radio cutthroat trout assigned to the Shoshone subbasin assemblage, Idaho, from May 2003 to June 2004.

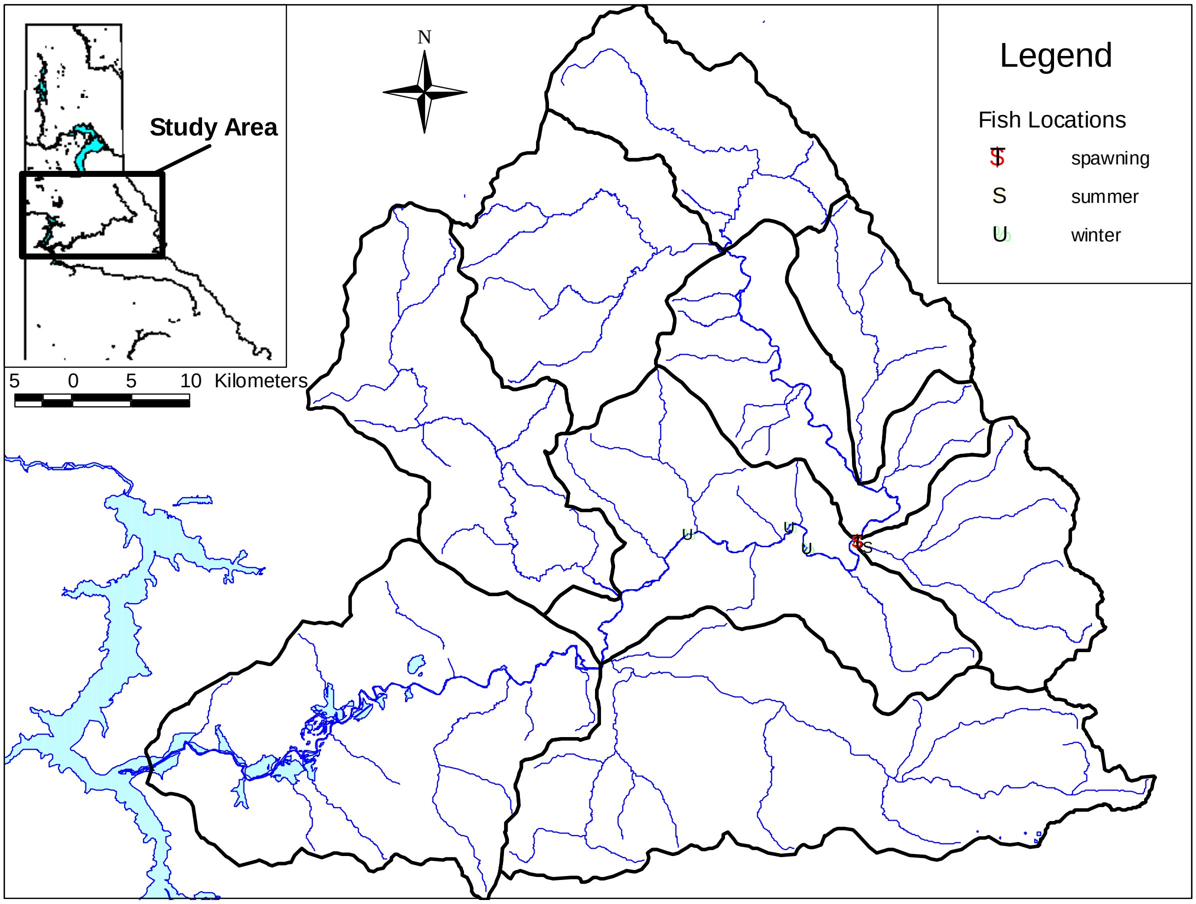


Figure 18. Locations of the one radio tagged cutthroat trout assigned to the Prichard assemblage, Idaho, from May 2003 to June 2004.

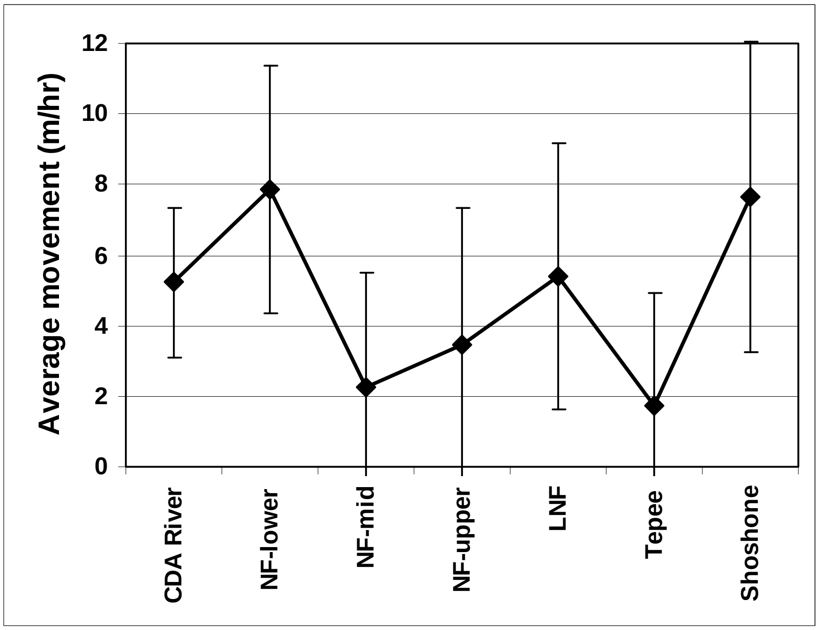


Figure 19. Mean movement estimates of radio tagged cutthroat trout in seven different subbasins of the Coeur d'Alene River watershed, Idaho, that were tracked from May 2003 to June 2004. Mean estimates were calculated by equally weighting fish movement for each month and seven basins (using SAS prox mix). Two fish that migrated to Coeur d'Alene Lake were excluded from this analysis. Bars indicate 90% confidence intervals.

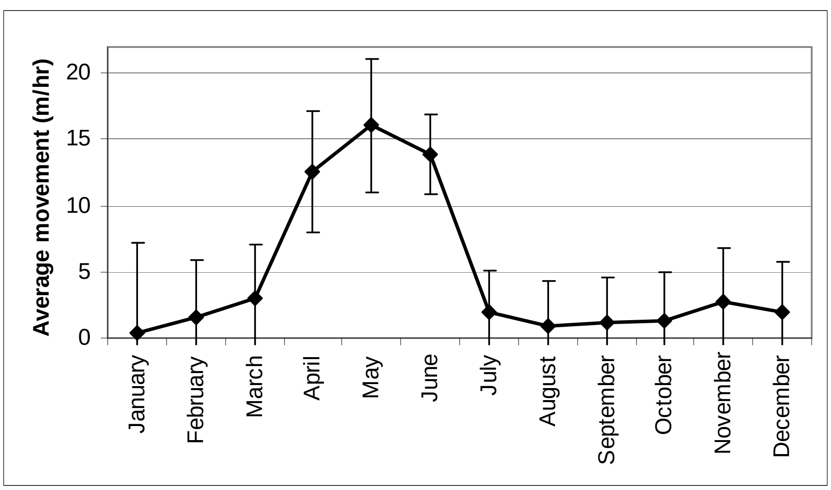


Figure 20. Mean monthly movement estimates of cutthroat trout radio tagged in Coeur d'Alene River watershed, Idaho, that were tracked from May 2003 to June 2004. Mean estimates were calculated by equally weighting fish movement for each month and seven different basins (using SAS prox mix). Two fish that migrated to Coeur d'Alene Lake were excluded from this analysis. Bars indicate 90% confidence intervals.

Table 7. Estimated mean movement values (calculated using SAS® proc mixed) of cutthroat trout radio tagged in Coeur d'Alene River watershed, Idaho that were tracked from May 2003 to June 2004.[a]

	Effect				
Obs	Basin	Month	Mean Estimate	Standard Error	Letter Group
12		January	0.44	3.75	B
8		February	1.57	2.40	B
4		March	2.97	2.29	B
3		April	12.58	2.54	A
1		May	16.08	2.82	A
2		June	13.84	1.68	A
6		July	1.99	1.76	B
11		August	0.93	1.85	B
10		September	1.13	1.91	B
9		October	1.33	2.03	B
5		November	2.77	2.23	B
7		December	1.91	2.17	B
13	NF-lower		7.86	1.80	A
14	Shoshone		7.66	2.26	AB
15	LNF		5.40	1.93	ABCD
16	CDA River		5.22	1.10	ABC
17	NF-upper		3.45	2.00	BCD
18	NF-mid		2.26	1.68	CD
19	Tepee		1.71	1.67	D

[a] Two fish that migrated to Coeur d'Alene Lake (Lake basin) were excluded from this analysis. Pairwise comparisons (Letter Group) were conducted using Fisher's Least-Significance-Difference Test with a p-value of 0.10 denoting significant differences.

During the summer months, radio tagged cutthroat trout distribution throughout the study area was similar to their distribution when they were tagged (Figure 21). An exception was in the Prichard subbasin where only one of four fish tagged there remained there. Only the lower 1.2 km of Prichard Creek had continuous surface flow during the summer. In the NF-lower subbasin, two fish moved into side channels during summer. When we snorkeled these side channels to determine the status of these fish, we observed 50 to 100 other cutthroat trout congregated with the radio tagged fish.

Most radio tagged cutthroat trout relocated to different sections of river between the summer and winter months, but most migrations were short (70% <2 km; 80% <5 km). Exceptions to this were fish located in the NF-upper subbasin. These fish migrated as much as 17 km downstream during October or November to overwinter downstream of Tepee Creek. Once fish reached their overwinter locations (typically Late October or early November) they tended to move very little (80% moved <1 m/hr) until March. During winter, the radio tagged fish remained fairly uniformly distributed in the CDA River, LNF, NF-lower, and NF-mid subbasins (Figure 22). No fish utilized the Shoshone, Prichard, and NF-upper subbasins during winter. Concentrations of radio tagged fish did occur in the lower 3.5 km of the Tepee subbasin (six or seven fish) and the upper 4 km of NF-mid subbasin (four fish), where all fish from the Tepee and NF-upper subbasins overwintered. From November through January, up to five of the seven radio tagged fish that overwintered in the Tepee subbasin were located within 100 m of each other. In February no radio tagged fish were located this stretch of the river. During this winter period, it was not uncommon to observe 20 or more cutthroat trout located in close proximity to the radio tagged fish we were tracking. In the main Coeur d'Alene River, two of the radio tagged cutthroat trout were observed swimming with a school of over 200 other fish.

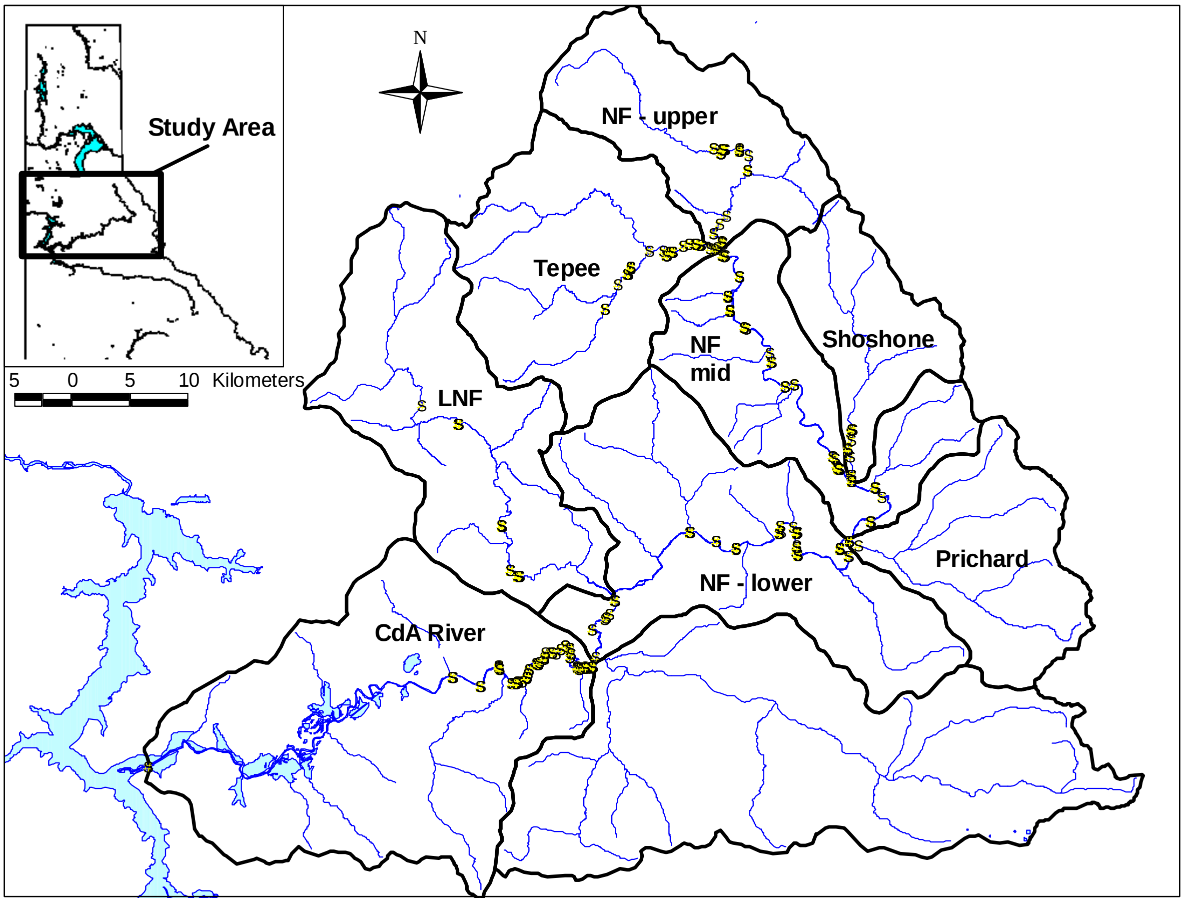


Figure 21. Locations of radio tagged cutthroat trout during the summer of 2003-2004 (Return of spawning run through October) in the Coeur d'Alene River watershed, Idaho.

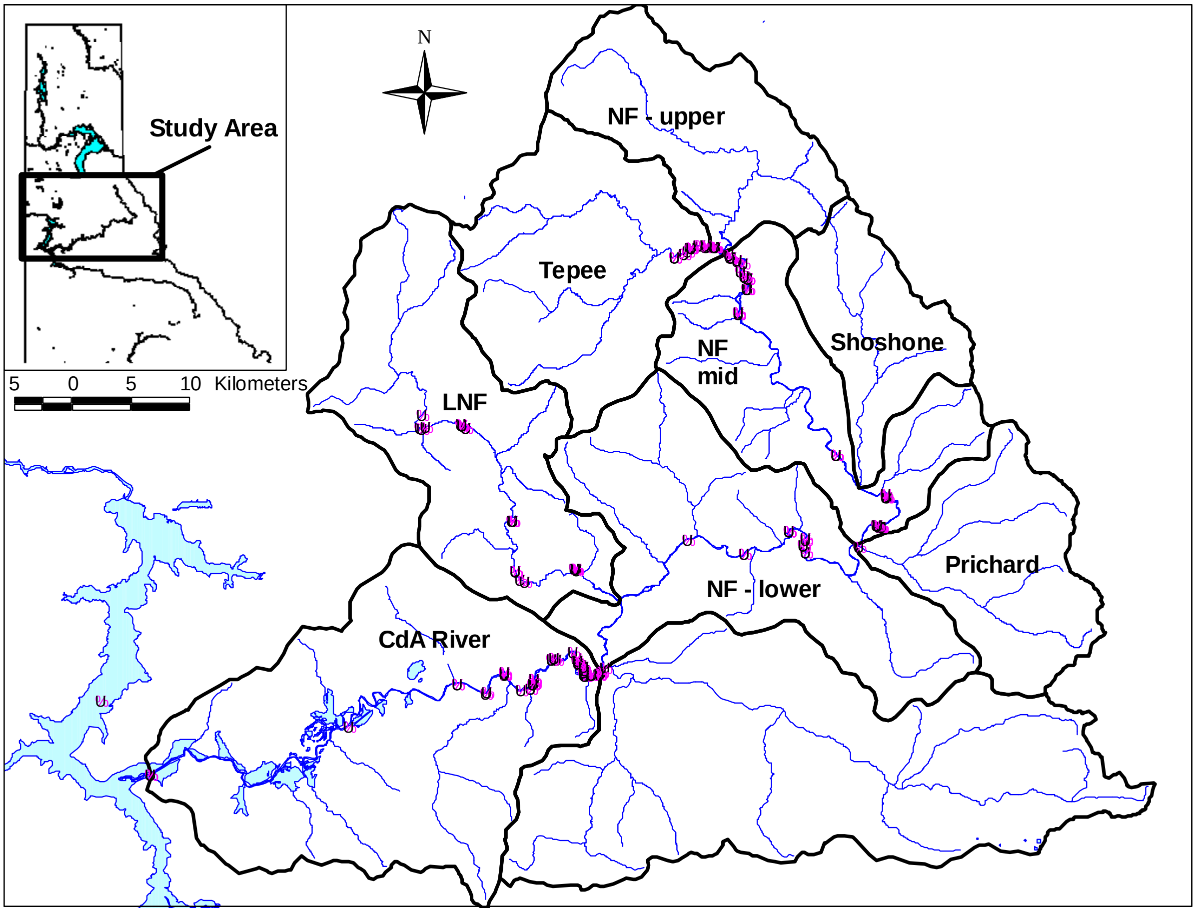


Figure 22. Locations of radio tagged cutthroat trout during the winter of 2003-2004 (November to beginning of spawning run) in the Coeur d'Alene River watershed, Idaho.

From April to June, monthly movement rates of the radio tagged cutthroat trout increased sharply averaging between 12 and 16 m/hr (Figure 20). This increase in movement was a result of fish migrating to and from their spawning areas. The longest spawning migration we documented was over 72 km, which occurred from the NF-lower subbasin to the headwaters of Tepee subbasin. During spawning runs, upstream migration rates typically ranged between 30-200 m/hr with one fish swimming over 300 m/hr to reach its spawning grounds. Downstream migrations were typically faster (50-500 m/hr) with two individuals migrating approximately 1000 m/hr over a 40 hour period to reach areas where they spent the summer. We tracked 29 different fish throughout the spawning season. We documented spawning migrations for 22 of these fish with most spawning occurring between mid-April and early May (Table 8). Many of the fish made fast migrations, quickly spawned, and returned to the main river, which prevented us from locating their exact spawning location. Often the fish could not be located for two or more weeks and then were relocated where they spent the previous summer. The radio tagged cutthroat trout appeared to spread out and spawn in many different tributaries throughout the entire Coeur d'Alene River watershed (Figure 23). However, many (9 out of 22 spawners) radio tagged cutthroat trout from NF-lower, NF-upper, Shoshone, and Tepee subbasins all spawned in the Tepee subbasin (Table 8). Six of the fish we tracked were located on or near (within 50 m) a redd. Two of these fish were found near a congregation of redds (4-6 redds). The size of the watershed where redds were observed ranged from approximately 2,800 ha to 20,000 ha (Table 9).

All spawning migrations that we documented were upstream. Of the 22 different fish that made spawning migrations, 13 survived long enough or were tracked long enough for us to document their return migration. Of these 13 fish, 12 returned to within 200 m of where they spent the previous summer with 10 of them returning to the exact same pool, often locating under or behind the same log or boulder. Of the 29 cutthroat trout that we tracked throughout the spawning season, 7 were ≤355 mm when we tagged them and 4 of these (57%) probably did not spawn. Twenty-two of these fish were >355 mm and three of them (14%) probably did not spawn. The smallest spawning fish was 288 mm, when we tagged it one year earlier.

Fish Mortality and Tag Expulsion

Of the 75 cutthroat trout in which we put transmitters, 51 (68%) died or expelled their tags before the study was complete or before the transmitter batteries expired (Table 10 and Figure 24). Thirteen of these fish were killed by fishermen with nine (69%) of them being killed illegally (eight were too small to keep and one was killed in a catch-and-release area). Fishing mortality was higher in NF-lower and Shoshone subbasins than the other six subbasins. Fish using these two subbasins lived on average <200 days during the open fishing season before they were killed by a fisherman (Figure 25). Fish from these two subbasins also displayed the longest migrations and most mixing with fish from other basins. Within the NF-lower subbasin, 75% of the main river (30 out of 40 km) is paralleled by a road on each side. In this section of river, radio tagged fish lived on average 132 days before they were killed by a fisherman. There were 184 days during 2003 when cutthroat trout could be harvested in limited harvest areas of the Coeur d’Alene River watershed. One radio tagged fish was killed by a fisherman in catch-and-release waters. A total of 33 fish spent a minimum of eight days in catch-and-release water in the Coeur d’Alene River watershed for a total of 5,475 fish days.

Table 8. Statistics regarding spawn timing and migration of radio tagged cutthroat trout tracked during the springs of 2003 and 2004 in the Coeur d'Alene River watershed, Idaho. An N/A under "Return to same summer location" means that we did not track this fish during both summers.

Frequency	Sex	Size (mm)	Summer Subbasin	Spawning Subbasin	Minimum Migration Distance (km)	Migration Timing	Approximate Spawning Date	Duration (days) of Migration	Return to Same Summer Location
42 166	female	420	NF - upper	NF - upper	17.2	3/01/04 to 4/27/04	4/15/2004	57	yes
42 167	female	438	Tepee	Tepee	8.0	3/16/04 to 4/21/04	4/10/2004	36	yes
42 169(2)	male	446	Tepee	Tepee	13.0	3/16/04 to ???	4/25/2004	>36	N/A
42 170	female	370	NF - upper	Did not spawn					
42 174	female	393	Tepee	Tepee	1.8	3/16/04 to 4/20/04	4/10/2004	35	yes
42 176	unknown	313	CDA River	Did not spawn					
42 194	unknown	312	CDA River	Did not spawn					
42 195	unknown	312	CDA River	NF - lower	43.3	4/27/04 to 6/02/04	5/20/2004	36	yes
42 198	unknown	368	CDA River	NF - lower	12.4	4/04/04 to ???	4/20/2004	>16	N/A
42 205(2)	female	376	NF - mid	NF - upper	3.4	4/20/04 to 5/17/04	5/01/2004	27	N/A
42 208	female	430	Shoshone	Tepee	55.9	3/17/04 to 5/07/04	5/05/2004	51	No
42 209	female	463	LNF	LNF	2.0	4/19/04 to 5/03/04	4/20/2004	14	yes
42 210	female	377	CDA River	Prichard	37.4	??? to 6/12/03	5/10/2003	>33	N/A
58 168(2)	male	422	LNF	LNF	18.7	4/16/04 to 4/27/04	4/22/2004	11	yes
58 169	female	407	LNF	LNF	36.5	4/19/04 to 5/13/04	5/05/2004	24	yes
58 170	male	450	Tepee	Tepee	0.4	??? to 5/06/03	4/30/2003	>6	N/A
58 171(2)	female	445	NF - mid	NF - mid		3/16/04 to 5/03/04	4/20/2004	48	yes
58 172	female	383	CDA River	Prichard	45.5	??? to 6/26/03	5/05/2003	>52	N/A
58 174	male	464	Tepee	Tepee	0.4	3/16/04 to 4/19/04	4/05/2004	34	yes
58 182	unknown	288	CDA River	Prichard	43.3	5/13/04 to ???	6/05/2004	>36	N/A
58 185	unknown	299	CDA River	Did not spawn					
58 193	unknown	415	Lake	Unknown					
58 195	unknown	341	CDA River	South Fork	9.3	4/16/04 to 4/27/04	4/22/2004	12	yes
58 204	unknown	355	Lake	Unknown					
58 207	female	411	NF - lower	Tepee	72.8	3/17/04 to 6/09/04	5/05/2004	84	yes
58 208	male	481	NF - mid	Did not spawn					
58 210	female	502	Shoshone	NF - mid	4.4	3/01/04 to 4/20/04	4/10/2004	50	yes
58 211(3)	female	425	NF - upper	Tepee	2.9	3/16/04 to 4/27/04	4/10/2004	42	yes
58 212(2)	female	417	NF - upper	Tepee	10.0	3/16/04 to 4/27/04	4/15/2004	42	N/A

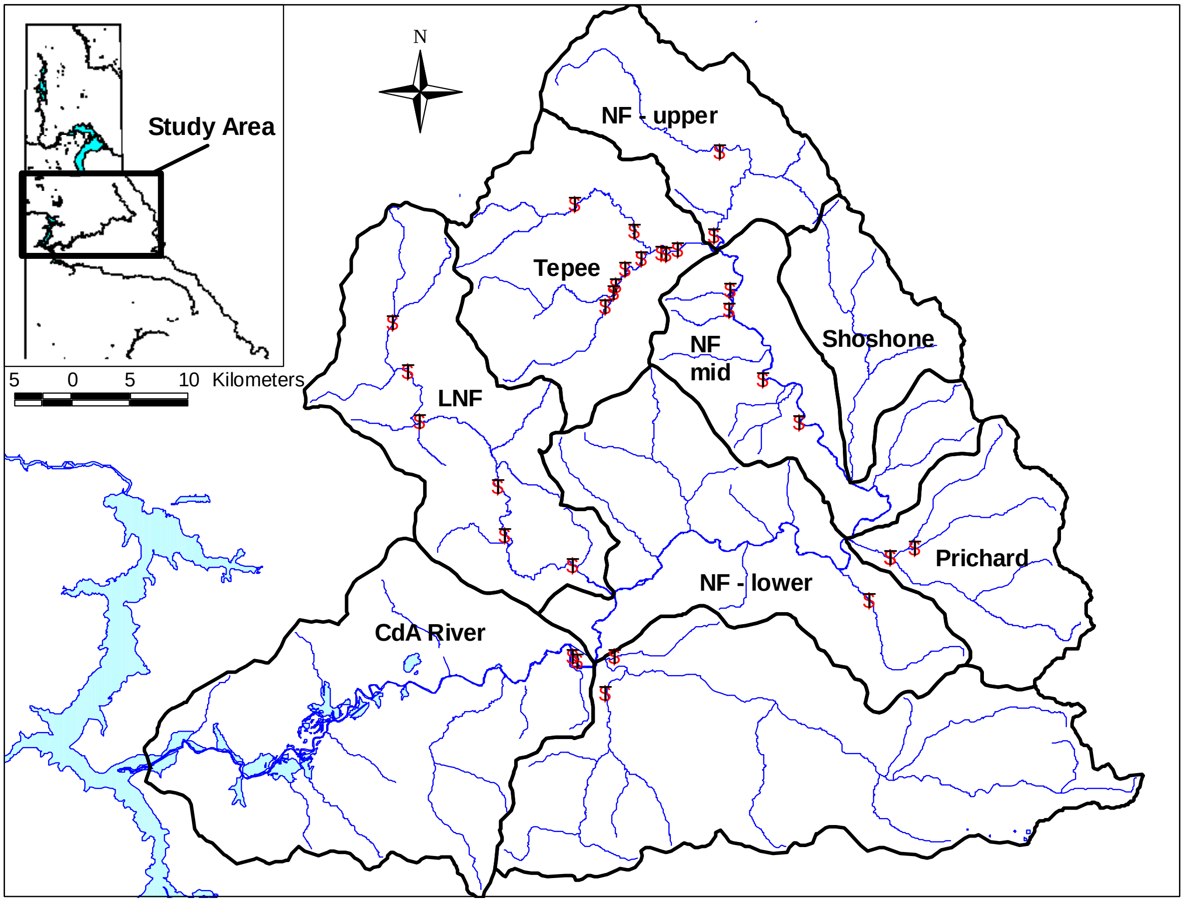


Figure 23. The most upstream location of each radio tagged cutthroat trout during the spawning season (April to June 2003 and 2004) in the Coeur d'Alene River watershed, Idaho.

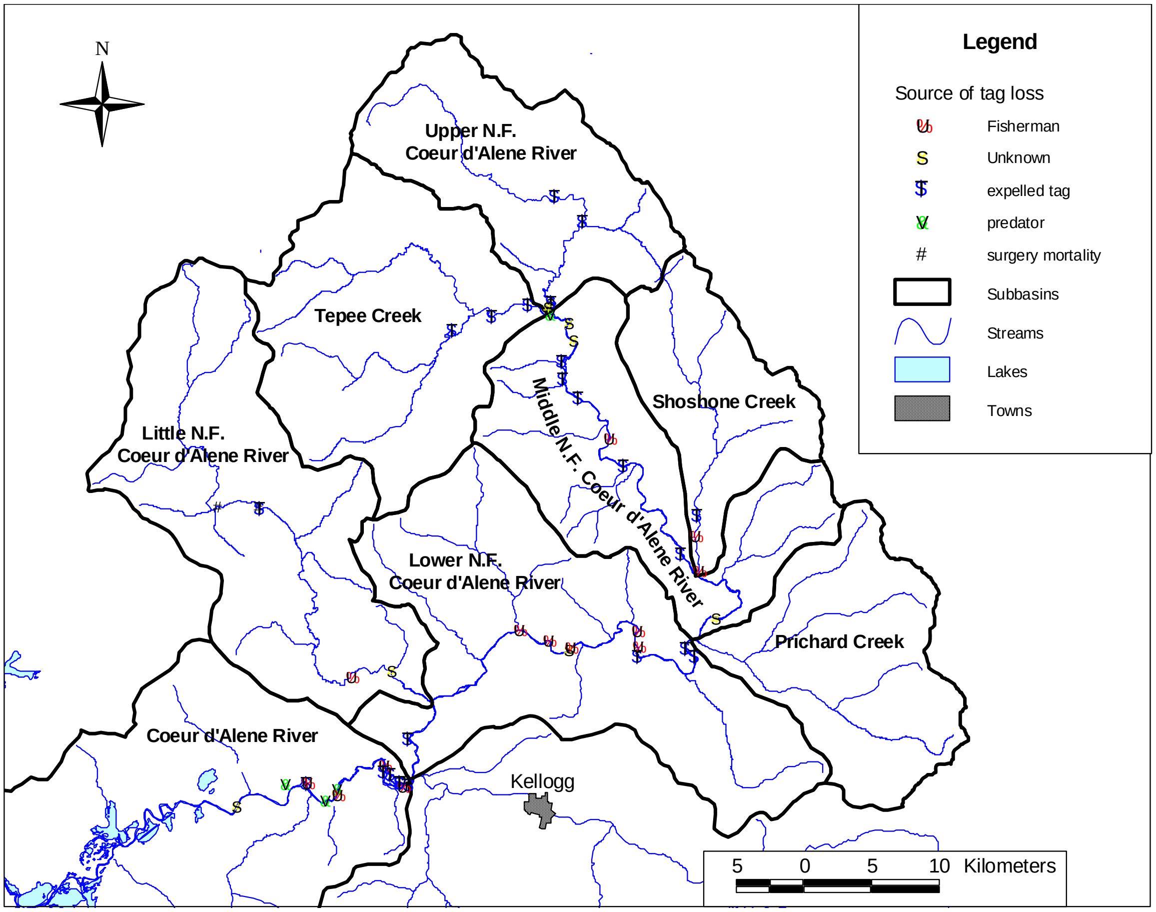


Figure 24. Last known location of radio tagged cutthroat trout (n = 51) in the Coeur d'Alene River watershed, Idaho, that died or expelled their tags during a telemetry study that occurred from May 2003 to June 2004.

Table 9 The size of the watershed where cutthroat trout redds were observed while conducting radio telemetry surveys in the Coeur d'Alene River watershed, Idaho from May 2003 to June 2004.

Subbasin	Watershed Size (ha)
Bear Creek	2,810
Little NF Coeur d'Alene River	6,925
Beaver Creek	9,565
Tepee Creek	9,068 and 18,645
Pine Creek	20,356

Table 10. The fate of seventy-five cutthroat trout radio tagged and tracked in the Coeur d'Alene River watershed, Idaho from May 2003 to June 2004.

Fate of Radio Tagged Fish	Number of Fish
Surgery mortality	3
Fishing mortality	13
Predator mortality	4
Expelled tag	23
Unknown cause of death or tag loss	8
Battery expired	8
Study complete	16
Grand Total	75

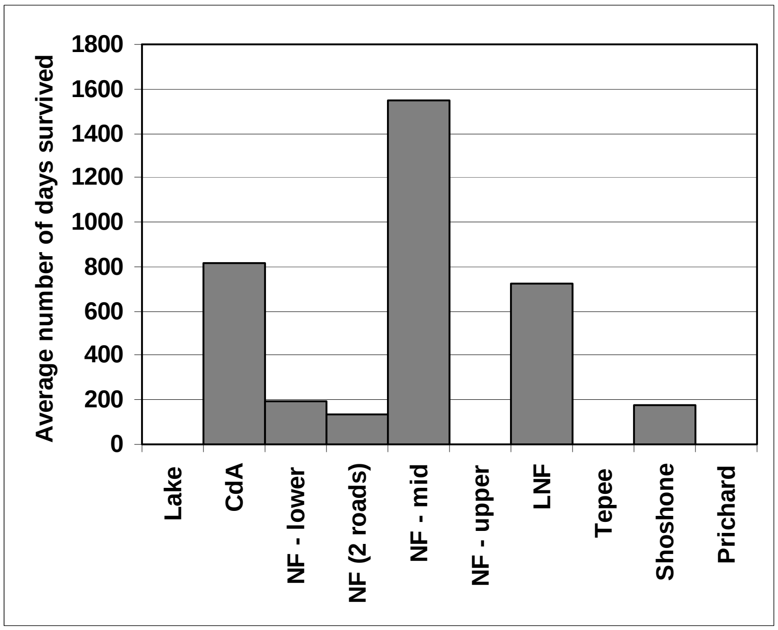


Figure 25. The average number of days radio tagged cutthroat trout survived during the open fishing season (May 31 to Nov 30, 2003) in each subbasin in the Coeur d'Alene River watershed, Idaho before being harvested by a fisherman. No fish were harvested in NF-upper, Prichard, Tepee, and the Lake subbasins.

Kaplan Meyer staggered entry survival curves found that throughout the duration of our study (May 2003 through June 2004) fishing mortality of the radio tagged cutthroat trout ranged between 69% to 0% (Figure 26). Wide confidence intervals prevented us from stating that mortality rates were significantly different between most subbasins, although estimated mortality rates in NF-lower (69%) and Shoshone (67%) subbasins were at least twice as high as in any of the other subbasins.

Twenty-three of the 75 fish (31%) in which we put transmitters expelled their tags before the study was completed (1 year period). We are confident that radio tagged cutthroat trout were expelling their transmitters based on the following findings:

- These transmitters were never found near a dead fish or around any fish parts.
- These transmitters did not have chew marks on them to suggest mortality from predation.
- The previous time these fish were tracked, they appeared active or healthy.
- We recaptured two radio tagged cutthroat trout, both of which had tissue enveloping the transmitter and one was in the process of expelling the tag through its anus.
- We also believe we observed one cutthroat trout swimming about after it had expelled its transmitter. We did not capture this fish to prove this with 100% certainty.

Fish in our study expelled their tags 51 to 231 days after they were surgically inserted in the fish (Figure 27). Logistic regression showed that a significant relationship existed between the number of days a tag was in a fish and the likelihood the tag would be expelled ($p = 0.0212$). Essentially, the more days a tag was in a fish the more likely it would be expelled. Logistic regressions showed no significant relationships between antenna length, fish size, transmitter size, or percent body weight of the tag and whether a fish expelled its tag or not.

Nineteen (25%) of the 75 transmitters inserted into fish had full length antennae (44 cm in length). Four (17%) of the 23 transmitters that were expelled had a full length antenna. A nonsignificant (p value = 0.37) chi-square goodness of fit test indicates that the proportion of expelled tags with full length antennas were in the same proportion that were originally inserted into cutthroat trout. Despite this insignificant finding, the four transmitters with full length antennae remained in the fish longer (185-278 days) then the other expelled transmitters that had trimmed antennae (20-30 cm in length) (Figure 27).

Habitat Use and Availability

Throughout this study, 75 different radio tagged westslope cutthroat trout were tracked, and habitat use data was collected at their locations 671 different times (Table 11). In addition, 190.7 km of stream were surveyed (1,805 habitat units) to quantify habitat in the study area and to compare to what the radio tagged fish were found to use (Table 12). Of the 671 times we inventoried the habitat at radio tagged fish locations, 16 (2%) occurred outside the stream reaches where we quantified the habitat. Ten of these observations (eight fish) occurred during the spawning season as fish ascended streams to spawn and six observations (two fish) occurred during the summer or winter season (Figure 28).

Based on the habitat data collected, pool habitat (33%) and riffle habitat (30%) were the most abundant (by area) habitat types in the entire Coeur d'Alene River watershed, although the habitat availability varied considerably between subbasins (Table 13). Tracking data collected throughout the entire Coeur d'Alene River watershed showed that radio tagged fish were located primarily in pool habitat (65.9%) and seldom in glides and riffles (Table 14 and Figure 29).

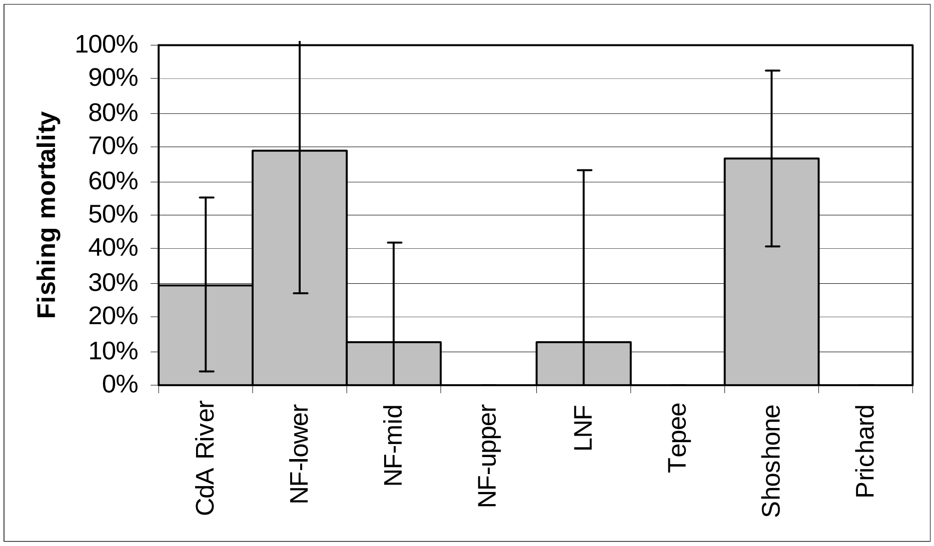


Figure 26. Fishing mortality estimates (based on Kaplan-Meier staggered entry survival curves) of radio tagged cutthroat trout in seven different subbasins in the Coeur d'Alene River watershed, Idaho, throughout the duration of the study (May 2003 through June 2004). Vertical lines indicate 90% confidence intervals. No fish were harvested in NF-upper, Prichard, Tepee, and the Lake subbasins.

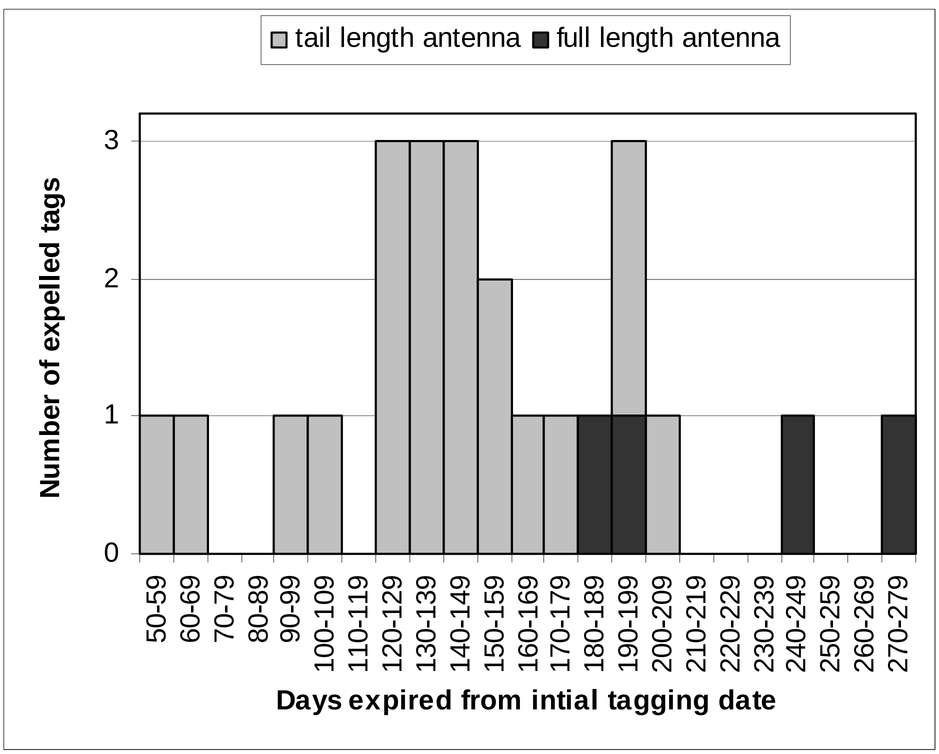


Figure 27. The number of days it took for radio tagged cutthroat trout in the Coeur d'Alene River watershed, Idaho, to expel their tags depending on if their transmitters had full length antennae.

Table 11. Number of different radio tagged cutthroat trout tracked and the number of habitat use observations recorded for each of these fish in eight different subbasins in the Coeur d'Alene River watershed, Idaho.

Subbasin	Number of different fish tracked	% of Total	Number of habitat use observations	% of Total
CDA River	22	22.0	174	25.9
Lower NF CDA River	17	17.0	77	11.5
Mid NF CDA River	18	18.0	134	20.0
Upper NF CDA River	9	9.0	57	8.5
Little NF CDA River	11	11.0	72	10.7
Tepee Creek	14	14.0	114	17.0
Shoshone Creek	5	5.0	28	4.2
Prichard Creek	4	4.0	15	2.2
Totals	100[a]	100%	671	100%

[a] Note: This total is higher than the number of fish we radio tagged (75) as some fish utilized multiple subbasins.

Table 12. The number of river kilometers (Rkms) surveyed to quantify habitat within each subbasin of the Coeur d'Alene River watershed, Idaho.

Subbasin	Rkms (%)	Habitat Units
Coeur d'Alene River	12.3 (6.4%)	57
Lower NF Coeur d'Alene River	43.9 (23.0%)	210
Middle NF Coeur d'Alene River	44.0 (23.1%)	344
Upper NF Coeur d'Alene River	25.3 (13.3%)	264
Little NF Coeur d'Alene River	37.4 (19.6%)	479
Tepee Creek	18.5 (9.7%)	311
Shoshone Creek	4.7 (2.5%)	65
Prichard Creek	4.6 (2.4%)	75
Total	190.7	1,805

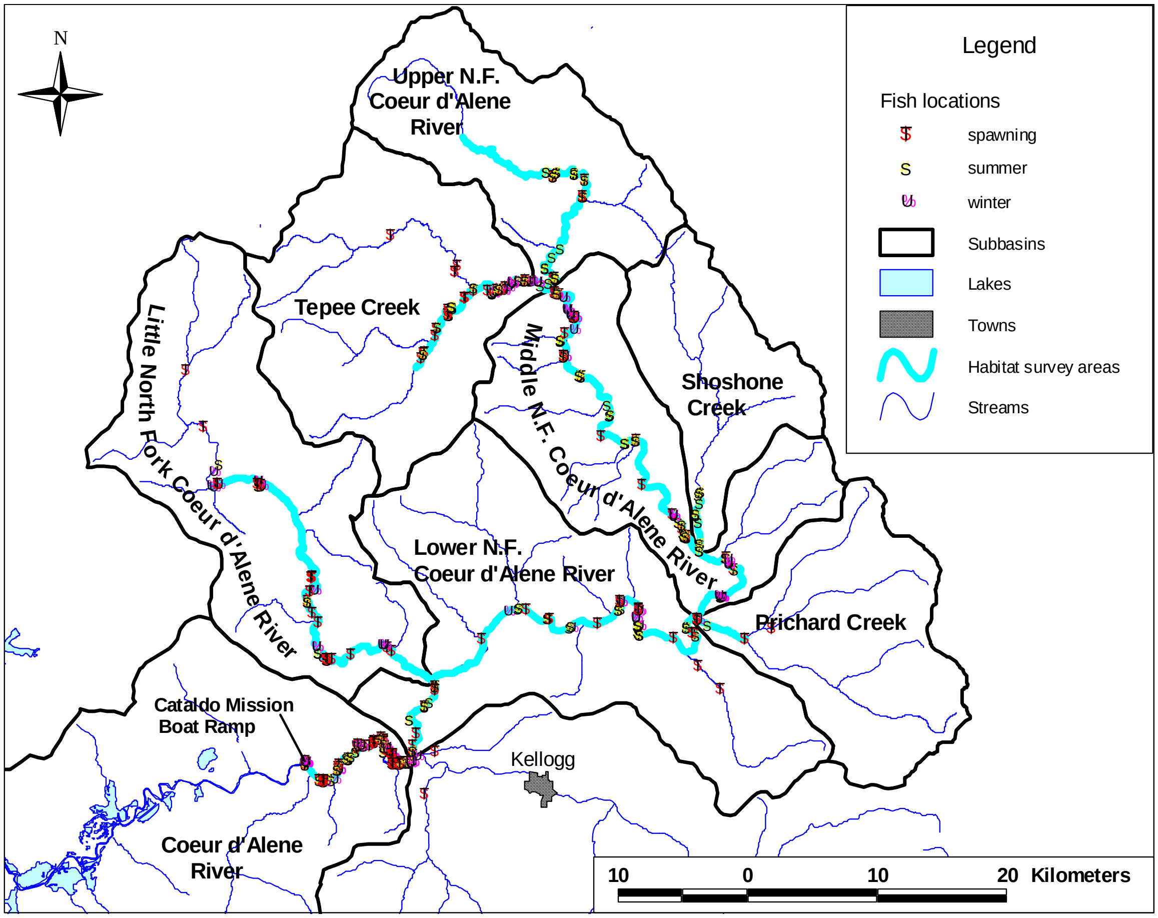


Figure 28. Locations where habitat survey and use data was collected when ground tracking radio tagged cutthroat trout in the Coeur d'Alene River watershed, Idaho, from May 2003 to June 2004.

Table 13. The amount of area surveyed of each habitat type and their representative percentages within each subbasin of the Coeur d'Alene River watershed, Idaho.

	Area (m^2) Represented by Each Habitat Type				
Subbasin	**Glide**	**Pool**	**Riffle**	**Run**	**Total**
All subbasins	736,580	1,522,430	1,361,480	969,350	4,589,840
Coeur d'Alene River	41,880	311,317	125,357	58,936	537,490
Lower NF CDA River	432,315	450,848	353,551	329,814	1,566,528
Middle NF CDA River	34,164	427,163	396,062	391,368	1,248,758
Upper NF CDA River	22,250	36,309	209,214	75,988	343,761
Little NF CDA River	140,578	183,022	155,564	64,107	543,271
Tepee Creek	59,555	78,836	64,024	32,699	235,114
Shoshone Creek	1,797	12,007	34,217	14,628	62,648
Prichard Creek	4,041	22,927	23,491	1,810	52,270
	Percent of Area Represented by Each Habitat Type				
Subbasin	**Glide**	**Pool**	**Riffle**	**Run**	**Total**
All subbasins	16	33	30	21	100
Coeur d'Alene River	8	58	23	11	100
Lower NF CDA River	28	29	23	21	100
Middle NF CDA River	3	34	32	31	100
Upper NF CDA River	6	11	61	22	100
Little NF CDA River	26	34	29	12	100
Tepee Creek	25	34	27	14	100
Shoshone Creek	3	19	55	23	100
Prichard Creek	8	44	45	3	100

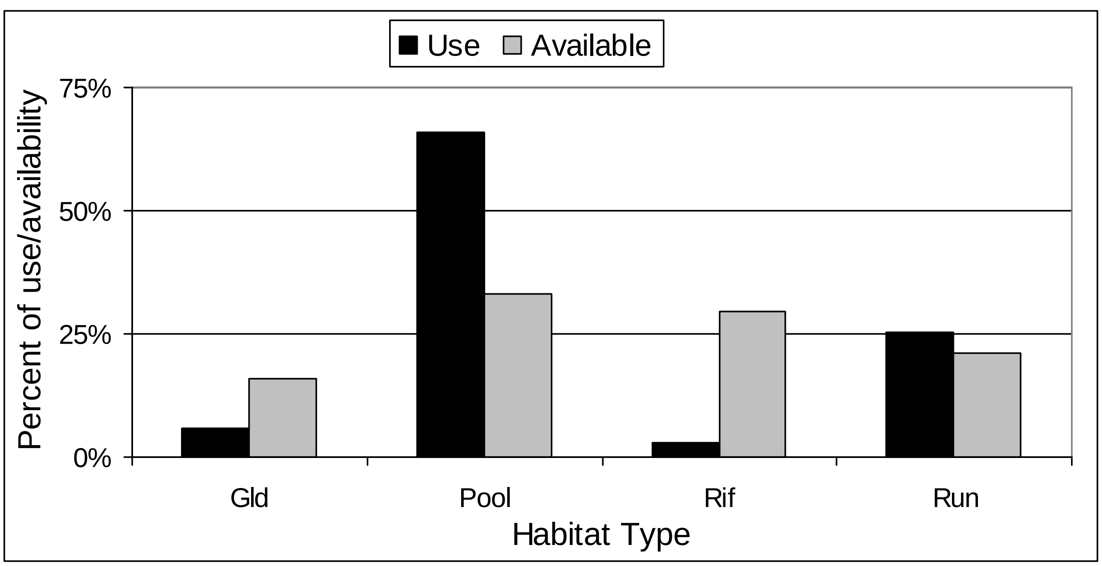


Figure 29. Frequency of habitat types used by radio tagged cutthroat trout located throughout the entire Coeur d'Alene River watershed, Idaho, from May 2003 to June 2004 in comparison to its availability.

Table 14. Percent use of different habitat types by radio tagged cutthroat trout in eight different subbasins of the Coeur d'Alene River watershed, Idaho from May 2003 to June 2004.

		Habitat types			
Subbasin	**Season**	**Glide**	**Pool**	**Riffle**	**Run**
All subbasins	All seasons	5.9	65.9	2.9	25.4
	Summer	2.8	71.5	3.1	22.6
	Winter	20.7	55.6	0.7	23.0
CDA River	All seasons	2.3	77.5	1.2	19.1
	Summer	1.1	85.4	1.1	12.4
	Winter	5.1	76.9	0.0	17.9
Lower NF CDA	All seasons	5.6	81.9	4.2	8.3
	Summer	0.0	86.8	5.3	7.9
	Winter	33.3	58.3	0.0	8.3
Middle NF CDA	All seasons	7.5	61.2	0.0	31.3
	Summer	0.0	68.7	0.0	31.3
	Winter	31.3	40.6	0.0	28.1
Upper NF CDA	All seasons	0.0	68.4	5.3	26.3
	Summer	0.0	72.7	6.1	21.2
	Winter	No fish were located in upper NF CDA during winter			
Little NF CDA	All seasons	12.5	76.4	4.2	6.9
	Summer	25.0	75.0	0.0	0.0
	Winter	4.5	81.8	4.5	9.1
Tepee Creek	All seasons	10.5	43.0	1.8	44.7
	Summer	2.4	46.3	0.0	51.2
	Winter	37.9	20.7	0.0	41.4
Shoshone Creek	All seasons	0.0	25.0	17.9	57.1
	Summer	0.0	26.3	21.1	52.6
	Winter	No fish were located in Shoshone Creek during winter			
Prichard Creek	All seasons	0.0	86.7	6.7	6.7
	Summer	0.0	87.5	12.5	0.0
	Winter	No fish were located in Prichard Creek during winter			

Habitat selection of radio tagged fish changed seasonally, especially during winter when more fish were located in glides and fewer in runs and pools than during the summer and spawning periods (Table 14 and Figure 30). Riffle habitat was seldom used during any of the seasons. A significant chi-square relationship ($P < 0.001$) indicates that these fish were not randomly distributed during any of the seasons as they were located in pool and run habitat types (spawning and summer) or pool and glide habitat types (winter) at a higher proportion than their availability (Table 15 and Figure 30).

Over 63% of the area of the habitat units we evaluated had a maximum depth ≤1.0 m and approximately 9% of the habitat units had a maximum depth >4.0 m (Table 16). Most radio tagged fish were located in habitat units with maximum depths that tended to range from 1.0 to 2.0 m deep (Table 17), and chi-square analysis ($P < 0.001$) indicated that these fish were not randomly distributed by depth as they tended to avoid areas with maximum depths ≤1.0 m (Table 18).

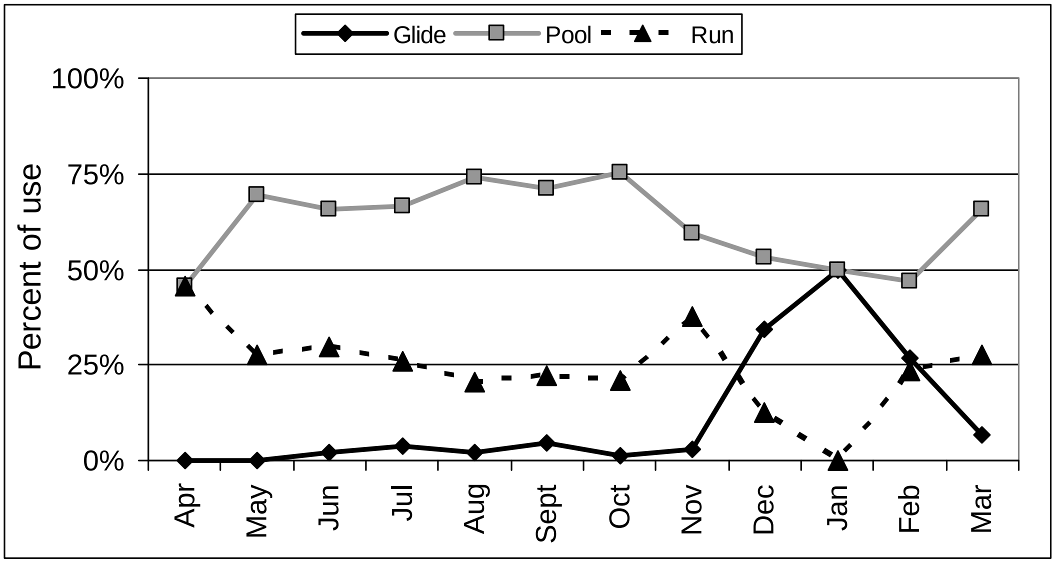


Figure 30. The frequency of habitat types used by radio tagged cutthroat trout on a monthly basis throughout the entire Coeur d'Alene River basin, Idaho, from May 2003 to June 2004.

Over 90% of the surface area of the streams we surveyed did not have any form of cover (Table 19). Of those areas with cover, large substrate was the most common type available (>55% of cover; Table 20). Radio tagged cutthroat trout were located within 5 m of some form of cover >75% of the time although use of cover declined during winter (Table 21). Large substrate was the most common type of cover used (Table 22). Chi square analysis (P <0.001) showed that radio tagged fish did select for areas with cover regardless of which subbasin we tested. Chi-square analysis (P <0.001) also showed that these fish preferred certain cover types over others as they were located in areas with large wood (LW) at a much higher proportion than their availability (Table 23). The amount of cover available in a particular habitat unit did not appear to have as much influence on where a fish was located (as long as some cover was available) as general patterns for this attribute were not apparent (Table 24).

We conducted separate habitat availability versus use analyses for each of the eight subbasins to assess the condition of their habitat. We only evaluated habitat conditions in pools and runs during the summer and pools, runs, and glides in the winter as the radio tagged fish were seldom located outside these habitat types during these periods. During the spawning season, seldom were we able to locate exact spawning areas and often when tracking fish they were migrating between spawning sites and winter or summer locations. For this reason, we did not summarize habitat use during the spawning season.

Table 15. Chi-square observed/expected values depicting use by radio tagged cutthroat trout of the different habitat types in different subbasins and different seasons in the Coeur d'Alene River watershed, Idaho between May 2003 and June 2004.[a]

		Habitat Types			
Subbasin	**Season**	**Glide**	**Pool**	**Riffle**	**Run**
All subbasins	All seasons	0.37	1.99	0.10	1.20
	Summer	0.17	2.16	0.10	1.07
	Winter	1.29	1.67	0.02	1.09
CDA River	All seasons	0.30	1.34	0.05	1.74
	Summer	0.14	1.47	0.05	1.13
	Winter	0.66	1.33	0.00	1.64
Lower NF CDA	All seasons	0.20	2.85	0.18	0.40
	Summer	0.00	3.02	0.23	0.37
	Winter	1.21	2.03	0.00	0.40
Middle NF CDA	All seasons	2.73	1.79	0.00	1.00
	Summer	0.00	2.01	0.00	1.00
	Winter	11.42	1.19	0.00	0.90
Upper NF CDA	All seasons	0.00	6.48	0.09	1.19
	Summer	0.00	6.89	0.10	0.96
	Winter	No fish were located in Upper NF during winter			
Little NF CDA	All seasons	0.48	2.27	0.15	0.59
	Summer	0.97	2.23	0.00	0.00
	Winter	0.18	2.43	0.16	0.77
Tepee Creek	All seasons	0.42	1.28	0.06	3.22
	Summer	0.10	1.38	0.00	3.68
	Winter	1.50	0.62	0.00	2.98
Shoshone Creek	All seasons	0.00	1.30	0.33	2.45
	Summer	0.00	1.37	0.39	2.25
	Winter	No fish were located in Shoshone Cr. during winter			
Prichard Creek	All seasons	0.00	2.17	0.23	1.95
	Summer	0.00	2.19	0.44	0.00
	Winter	No fish were located in Prichard Cr. during winter			

[a] All chi-square analyses were significant (P >0.1). Values >1 indicate habitat types the radio tagged fish were selecting for and values <1 indicate habitat types that were avoided. A value of zero means that no radio tagged fish were found in that habitat type.

Table 16. The percent of area (summed by individual habitat units) that the specified maximum depths occurred within eight different subbasins in the Coeur d'Alene River watershed, Idaho.

		Maximum Depth (m)				
Subbasin	**Habitat Type**	**0.1-1.0**	**1.1-2.0**	**2.1-3.0**	**3.1-4.0**	**>4.0**
All subbasins	all habitat types	63.7	18.2	7.4	2.0	8.7
	pool and run	43.4	24.0	12.9	3.6	16.1
	pool, run and glide	49.8	24.6	10.4	2.8	12.4
CDA River	all habitat types	15.9	15.0	12.4	2.2	54.5
	pool and run	0.0	4.8	12.8	3.2	79.1
	pool, run and glide	0.0	10.7	15.3	2.9	71.1
Lower NF CDA	all habitat types	56.9	22.3	11.2	3.2	6.3
	pool and run	33.8	24.6	22.5	6.5	12.6
	pool, run and glide	44.4	28.9	14.5	4.2	8.1
Middle NF CDA	all habitat types	77.0	18.0	3.5	1.4	0.1
	pool and run	65.3	27.1	5.3	2.1	0.2
	pool, run and glide	66.3	26.4	5.1	2.0	0.2
Upper NF CDA	all habitat types	90.0	9.4	0.6	0.0	0.0
	pool and run	71.3	26.7	2.0	0.0	0.0
	pool, run and glide	74.4	24.0	1.7	0.0	0.0
Little NF CDA	all habitat types	70.8	18.0	8.5	1.3	1.3
	pool and run	39.3	36.1	18.8	2.9	2.9
	pool, run and glide	59.5	24.8	12.0	1.9	1.9
Tepee Creek	all habitat types	80.6	16.5	1.8	1.1	0.0
	pool and run	59.0	34.8	3.7	2.4	0.0
	pool, run and glide	73.3	22.7	2.4	1.6	0.0
Shoshone Creek	all habitat types	93.5	5.9	0.6	0.0	0.0
	pool and run	84.7	13.9	1.4	0.0	0.0
	pool, run and glide	85.7	13.0	1.3	0.0	0.0
Prichard Creek	all habitat types	87.2	10.0	2.9	0.0	0.0
	pool and run	76.4	18.3	5.3	0.0	0.0
	pool, run and glide	80.0	15.6	4.5	0.0	0.0

Table 17. Percent of located radio tagged cutthroat trout that occurred in habitat types with the specified maximum depths in eight subbasins in the Coeur d'Alene River watershed, Idaho during summer (pool and run habitat only) and winter (pool, run and glide habitat).

		Maximum Depth (m)				
Subbasin	**Season**	**0.1-1.0**	**1.1-2.0**	**2.1-3.0**	**3.1-4.0**	**>4.0**
All subbasins	All seasons	20.4	41.5	17.2	4.5	16.4
	Summer	19.7	43.4	13.8	3.0	20.1
	Winter	17.9	38.8	18.7	4.5	20.1
CDA River	All seasons	1.1	16.1	14.9	10.3	57.5
	Summer	0.0	13.8	11.5	9.2	65.5
	Winter	2.6	20.5	7.7	7.7	61.5
Lower NF CDA	All seasons	9.1	37.7	28.6	11.7	13.0
	Summer	2.8	47.2	36.1	2.8	11.1
	Winter	0.0	41.7	8.3	25.0	25.0
Middle NF CDA	All seasons	11.3	70.7	18.0	0.0	0.0
	Summer	11.9	79.1	9.0	0.0	0.0
	Winter	18.8	53.1	28.1	0.0	0.0
Upper NF CDA	All seasons	40.4	54.4	3.5	1.8	0.0
	Summer	29.0	67.7	3.2	0.0	0.0
	Winter	No fish were located in upper NF CDA during the winter				
Little NF CDA	All seasons	11.1	51.4	34.7	2.8	0.0
	Summer	0.0	61.9	38.1	0.0	0.0
	Winter	23.8	33.3	42.9	0.0	0.0
Tepee Creek	All seasons	43.9	43.9	12.3	0.0	0.0
	Summer	60.0	30.0	10.0	0.0	0.0
	Winter	37.9	51.7	10.3	0.0	0.0
Shoshone Creek	All seasons	82.1	17.9	0.0	0.0	0.0
	Summer	80.0	20.0	0.0	0.0	0.0
	Winter	No fish were located in Shoshone Creek during the winter				
Prichard Creek	All seasons	60.0	26.7	13.3	0.0	0.0
	Summer	85.7	14.3	0.0	0.0	0.0
	Winter	No fish were located in Prichard Creek during the winter				

Table 18. Chi-square observed/expected values depicting maximum depths in habitats selected by radio tagged cutthroat trout in different subbasin and different seasons in the Coeur d'Alene River basin Idaho between May 2003 and June 2004.[a]

		Maximum Depth (m)				
Subbasin	**Season**	**0.1-1.0**	**1.1-2.0**	**2.1-3.0**	**3.1-4.0**	**>4.0**
All subbasins	All seasons	0.3	2.3	2.3	2.3	1.9
	Summer	0.5	1.8	1.1	0.8	1.2
	Winter	0.4	1.6	1.8	1.6	1.6
CDA River	All seasons	0.1	1.1	1.2	4.7	1.1
	Summer		2.9	0.9	2.9	0.8
	Winter	NA	1.9	0.5	2.7	0.9
Lower NF CDA	All seasons	0.2	1.7	2.6	3.6	2.1
	Summer	0.1	1.9	1.6	0.4	0.9
	Winter	0.0	1.4	0.6	6.0	3.1
Middle NF CDA	All seasons	0.1	3.9	5.2	0.0	0.0
	Summer	0.2	2.9	1.7	0.0	0.0
	Winter	0.3	2.0	5.5	0.0	0.0
Upper NF CDA	All seasons	0.4	5.8	5.4		
	Summer	0.4	2.5	1.6		
	Winter	No fish were located in upper NF CDA during the winter				
Little NF CDA	All seasons	0.2	2.9	4.1	2.1	0.0
	Summer	0.0	1.7	2.0	0.0	0.0
	Winter	0.4	1.3	3.6	0.0	0.0
Tepee Creek	All seasons	0.5	2.7	6.9	0.0	
	Summer	1.0	0.9	2.7	0.0	
	Winter	0.5	2.3	4.2	0.0	
Shoshone Creek	All seasons	0.9	3.0	0.0		
	Summer	0.9	1.4	0.0		
	Winter	No fish were located in Shoshone Creek during the winter				
Prichard Creek	All seasons	0.7	2.7	4.6		
	Summer	1.1	0.8	0.0		
	Winter	No fish were located in Prichard Creek during the winter				

[a] Rows shaded gray indicate nonsignificant chi-square relationships (P >0.1). Values >1 indicate maximum depths that the radio tagged fish were selecting for and values <1 indicate maximum depths that were avoided. A value of zero means that no radio tagged fish were located in habitat types with that particular maximum depth. An "NA" indicates that none of the habitat types evaluated were found to have that particular maximum depth in them.

Table 19. The percent of stream surface area that had either some form of cover or no cover at all in different habitat types within eight different subbasins in the Coeur d'Alene River watershed, Idaho.

Subbasin	Habitat Type	Cover	No Cover
All subbasins	all habitat	9.7	90.3
	pool and run	10.4	89.6
	pool, run and glide	10.2	89.8
CDA River	all habitat	7.0	93.0
	pool and run	8.1	91.9
	pool, run and glide	7.6	92.4
Lower NF CDA	all habitat	13.6	86.4
	pool and run	15.3	84.7
	pool, run and glide	14.2	85.8
Middle NF CDA	all habitat	5.0	95.0
	pool and run	5.4	94.6
	pool, run and glide	5.2	94.8
Upper NF CDA	all habitat	16.4	83.6
	pool and run	17.5	82.5
	pool, run and glide	17.0	83.0
Little NF CDA	all habitat	7.2	92.8
	pool and run	9.8	90.2
	pool, run and glide	8.1	91.9
Tepee Creek	all habitat	9.4	90.6
	pool and run	13.5	86.5
	pool, run and glide	11.1	88.9
Shoshone Creek	all habitat	11.6	88.4
	pool and run	25.4	74.6
	pool, run and glide	25.5	74.5
Prichard Creek	all habitat	19.1	80.9
	pool and run	14.6	85.4
	pool, run and glide	14.1	85.9

Table 20. The percent makeup (by stream surface area) of cover types that occurred in different habitat types within eight different subbasins in the Coeur d'Alene River watershed, Idaho.

Subbasin	Habitat Types	Cover type LS[a]	LW[a]	OC[a]	SW[a]	UB[a]
All subbasins	all habitat types	55.6	8.9	18.5	5.8	11.2
	pool and run	59.5	9.4	15.0	6.3	9.7
	pool, run and glide	55.4	8.1	19.4	5.9	11.1
CDA River	all habitat types	58.0	13.6	15.0	6.9	6.6
	pool and run	62.3	13.2	13.6	5.1	5.9
	pool, run and glide	61.4	13.3	14.0	5.4	6.0
Lower NF CDA	all habitat types	59.2	4.5	20.4	3.9	12.0
	pool and run	63.5	5.1	16.2	4.7	10.5
	pool, run and glide	56.9	4.0	22.4	4.5	12.2
Middle NF CDA	all habitat types	74.6	8.2	2.3	10.5	4.5
	pool and run	76.5	4.8	2.3	11.5	4.9
	pool, run and glide	76.2	5.1	2.3	11.4	4.9
Upper NF CDA	all habitat types	61.1	11.6	18.1	4.8	4.5
	pool and run	60.5	11.7	18.1	4.9	4.8
	pool, run and glide	59.6	12.2	18.4	5.0	4.8
Little NF CDA	all habitat types	32.0	17.4	30.5	7.8	12.2
	pool and run	37.4	19.3	26.3	6.8	10.2
	pool, run and glide	33.5	17.1	29.9	6.9	12.6
Tepee Creek	all habitat types	28.7	18.7	20.8	3.6	28.3
	pool and run	24.8	24.5	17.3	4.4	28.9
	pool, run and glide	27.2	20.5	20.5	3.7	28.2
Shoshone Creek	all habitat types	36.1	10.8	39.2	8.2	5.7
	pool and run	38.2	10.0	37.5	8.2	6.1
	pool, run and glide	36.1	10.8	39.2	8.2	5.7
Prichard Creek	all habitat types	20.7	36.1	14.2	16.3	12.8
	pool and run	14.0	48.8	14.0	11.0	12.3
	pool, run and glide	15.8	43.8	16.1	13.2	11.1

[a] LS = large substrate; LW = Large wood; OC = overhead cover; SW = small wood; UB = undercut banks.

Table 21. The percent of times that radio tagged cutthroat trout were located within 5m of some form of cover versus no cover during different seasons within eight different subbasins in the Coeur d'Alene River watershed, Idaho.

Subbasin	**Season**	**Cover**	**No Cover**
All subbasins	All seasons	76.5	23.5
	Summer	78.3	21.7
	Winter	66.4	33.6
CDA River	All seasons	47.7	52.3
	Summer	50.6	49.4
	Winter	25.6	74.4
Lower NF CDA	All seasons	70.8	29.2
	Summer	72.2	27.8
	Winter	91.7	8.3
Middle NF CDA	All seasons	88.0	12.0
	Summer	91.0	9.0
	Winter	75.0	25.0
Upper NF CDA	All seasons	93.0	7.0
	Summer	100.0	0.0
	Winter	No fish were located in Upper NF CDA during winter	
Little NF CDA	All seasons	91.7	8.3
	Summer	90.5	9.5
	Winter	100.0	0.0
Tepee Creek	All seasons	86.0	14.0
	Summer	87.5	12.5
	Winter	75.9	24.1
Shoshone Creek	All seasons	96.4	3.6
	Summer	100.0	0.0
	Winter	No Fish were located in Shoshone Creek during winter	
Prichard Creek	All seasons	86.7	13.3
	Summer	100.0	0.0
	Winter	No fish were located in Prichard Creek during winter	

Table 22. The percentage of times that radio tagged cutthroat trout were located within 5 m of different forms of cover during different seasons within eight different subbasins in the Coeur d'Alene River watershed, Idaho.

		Cover Type				
Subbasin	**Season**	**LS[a]**	**LW[a]**	**OC[a]**	**SW[a]**	**UB[a]**
All subbasins	All seasons	56.2	15.2	14.0	3.4	11.2
	Summer	53.8	21.0	9.2	3.8	12.2
	Winter	73.0	5.6	12.4	4.5	4.5
CDA River	All seasons	29.3	20.7	26.8	9.8	13.4
	Summer	34.1	27.3	15.9	11.4	11.4
	Winter	30.0	0.0	20.0	30.0	20.0
Lower NF CDA	All seasons	66.7	21.6	5.9	0.0	5.9
	Summer	53.8	30.8	3.8	0.0	11.5
	Winter	81.8	9.1	9.1	0.0	0.0
Middle NF CDA	All seasons	82.1	12.8	1.7	2.6	0.9
	Summer	80.3	19.7	0.0	0.0	0.0
	Winter	83.3	8.3	8.3	0.0	0.0
Upper NF CDA	All seasons	56.6	11.3	3.8	0.0	28.3
	Summer	71.0	12.9	3.2	0.0	12.9
	Winter	No fish were located in Upper NF CDA during winter				
Little NF CDA	All seasons	47.0	19.7	12.1	7.6	13.6
	Summer	15.8	47.4	0.0	21.1	15.8
	Winter	71.4	9.5	4.8	4.8	9.5
Tepee Creek	All seasons	56.1	5.1	29.6	1.0	8.2
	Summer	51.4	2.9	25.7	0.0	20.0
	Winter	77.3	0.0	22.7	0.0	0.0
Shoshone Creek	All seasons	14.8	37.0	18.5	0.0	29.6
	Summer	6.7	26.7	26.7	0.0	40.0
	Winter	No fish were located in Shoshone Creek during winter				
Prichard Creek	All seasons	84.6	0.0	0.0	0.0	15.4
	Summer	85.7	0.0	0.0	0.0	14.3
	Winter	No fish were located in Prichard Creek during winter				

[a] LS = large substrate; LW = Large wood; OC = overhead cover; SW = small wood; UB = undercut banks.

Table 23. Chi-square observed/expected values depicting use of different cover types by radio tagged cutthroat trout in different subbasins during different seasons in the Coeur d'Alene River basin Idaho between May 2003 and June 2004.[a]

		Cover Type				
Subbasin	**Season**	**LS[b]**	**LW[b]**	**OC[b]**	**SW[b]**	**UB[b]**
All subbasins	all seasons	1.01	1.71	0.76	0.58	1.01
	summer	0.90	2.23	0.61	0.60	1.25
	winter	1.32	0.69	0.64	0.76	0.40
CDA River	all seasons	0.50	1.53	1.79	1.41	2.04
	summer	0.55	2.07	1.17	2.24	1.93
	winter	0.49	0.00	1.43	5.60	3.35
NF-lower	all seasons	1.13	4.84	0.29	0.00	0.49
	summer	0.85	6.06	0.24	0.00	1.10
	winter	1.44	2.25	0.41	0.00	0.00
NF-mid	all seasons	1.10	1.57	0.76	0.24	0.19
	summer	1.05	4.12	0.00	0.00	0.00
	winter	1.09	1.63	3.58	0.00	0.00
NF-upper	all seasons	0.93	0.98	0.21	0.00	6.33
	summer	1.17	1.10	0.18	0.00	2.71
	winter	No fish were located in Upper NF CDA during winter				
LNF CDA	all seasons	1.47	1.13	0.40	0.97	1.11
	summer	0.42	2.45	0.00	3.11	1.55
	winter	2.13	0.56	0.16	0.69	0.76
Tepee Creek	all seasons	1.96	0.27	1.42	0.29	0.29
	summer	2.08	0.12	1.48	0.00	0.69
	winter	2.84	0.00	1.11	0.00	0.00
Shoshone Creek	all seasons	0.41	3.42	0.47	0.00	5.23
	summer	0.17	2.66	0.71	0.00	6.61
	winter	No fish were located in Shoshone Creek during winter				
Prichard Creek	all seasons	4.09	0.00	0.00	0.00	1.21
	summer	6.14	0.00	0.00	0.00	1.16
	winter	No fish were located in Prichard Creek during winter				

[a] Rows shaded gray indicate nonsignificant chi-square relationships (P >0.1). Values >1 indicate cover types that the radio tagged fish were selecting for and values <1 indicate cover types that were avoided. A value of zero means that no radio tagged fish were found using that cover type.

[b] LS = large substrate; LW = Large wood; None = no cover observed; OC = overhead cover; SW = small wood; UB = undercut banks.

Table 24. Chi-square observed/expected values depicting amount of cover found in habitats selected by radio tagged cutthroat trout in different subbasin and different seasons in the Coeur d'Alene River basin Idaho between May 2003 and June 2004.[a]

		Percent of Habitat Surface Area With Some Form of Cover							
Subbasin	**Season**	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**>30**
All subbasins	all seasons	0.00	1.03	1.12	1.68	0.88	1.24	1.74	0.87
	summer	0.00	0.96	1.38	1.31	0.93	1.18	1.50	1.00
	winter	0.00	1.27	1.62	2.45	0.36	1.19	0.67	0.04
CDA River	all seasons	0.00	2.81	0.16	0.21	NA	NA	NA	NA
	summer	0.00	9.13	0.08	0.00				
	winter	0.00	4.75	0.08	NA				
Lower NF CDA	all seasons	0.00	1.30	1.36	2.00	0.34	0.00	0.00	0.13
	summer	0.00	1.98	1.33	1.66	0.20	0.00	0.00	0.00
	winter	0.00	1.42	1.80	0.76	0.00	0.00	0.00	0.00
Middle NF CDA	all seasons	0.00	0.28	3.02	4.67	2.06	2.56	2.62	17.01
	summer	0.00	0.11	3.82	4.30	1.50	3.96	1.27	23.66
	winter	0.00	0.54	3.07	6.09	2.19	0.00	1.39	0.00
Upper NF CDA	all seasons	0.00	1.05	2.72	0.17	0.23	0.30	2.21	1.58
	summer	0.00	0.81	2.97	0.00	0.00	0.24	2.80	1.53
	winter		No fish were located in Upper NF CDA during winter						
Little NF CDA	all seasons	0.00	0.26	1.54	6.30	3.95	6.04	19.38	0.25
	summer	0.00	0.09	0.25	0.00	23.72	6.28	37.21	0.00
	winter	0.00	0.08	2.42	5.80	1.59	7.31	0.00	0.72
Tepee Creek	all seasons	0.00	0.61	3.29	0.91	1.46	0.45	0.00	1.28
	summer	0.00	0.62	4.59	0.00	1.09	0.00	0.00	1.46
	winter	0.00	0.99	3.22	0.74	0.00	0.00	0.00	0.00
Shoshone Creek	all seasons	0.00	10.22	11.67	3.80	11.53	0.28	0.00	0.00
	summer	0.00	0.00	5.98	1.95	7.09	0.25	0.00	0.00
	winter		No fish were located in Shoshone Creek during winter						
Prichard Creek	all seasons	0.00	0.17	1.31	0.00	9.18	0.00	13.94	0.29
	summer	0.00	0.00	2.04	0.00	5.82		7.07	0.00
	winter		No fish were located in Prichard Creek during winter						

[a] Rows shaded gray indicate nonsignificant chi-square relationships (P >0.1). Values >1 indicate cover amounts that the radio tagged fish were selecting for and values <1 indicate cover amounts that were avoided. A value of zero means that no radio tagged fish were found using habitats with that amount of cover. An "NA" indicates that none of the habitat units evaluated where found to have that amount of cover in them.

Coeur d’Alene River Subbasin

Fifty-seven different habitat units covering 12.3 km of stream were surveyed in the free flowing reach of the Coeur d’Alene River subbasin to quantify and evaluate its habitat (Table 12). The Coeur d’Alene River subbasin had the highest proportion of pool habitat (58%) of all the eight subbasins (Table 13). The pool and run habitat located in the Coeur d’Alene River subbasin was also the deepest (79% had a maximum depth >4.0 m) of all the subbasins (Table 16), although none of the habitat units ever had >15% of the surface area represented by cover (Table 25). The most abundant cover type available was large substrate (represented >58% of cover; Table 20).

Twenty-two different radio tagged fish were located at least once in the Coeur d’Alene River subbasin where habitat use data was collected (Table 11). These fish were located in pool (77.5%) and run habitat (19.1%) the majority of the time (Table 14). During the summer (pool and run habitats), these fish were located in habitats that exceeded 4.0 m in depth approximately 65% of the time (Table 17) and were not associated with cover approximately 50% of the time (Table 21). During the winter (glide, pool and run habitats), habitat use by the radio tagged cutthroat trout was fairly similar to what we observed in the summer as the fish were predominately located in deeper water with little cover (Tables 17 and 21).

Chi-square analysis that evaluated the availability of the different habitat types in the Coeur d’Alene River subbasin versus their use by the radio tagged cutthroat trout was significant ($P < 0.001$; Table 15). This indicates that the radio tagged fish were not randomly distributed between the habitat types as they were located in pool and run habitat types at a higher proportion than their availability during both the summer and winter. Significant ($P < 0.1$) chi-square analyses also indicated that during the summer (pool and runs) and winter (glides, pools and runs) the fish were not randomly distributed throughout all depths, cover types, and cover quantities (Tables 18, 23, 24). The one exception ($P > 0.1$) was use of different cover types during the winter.

Although most radio tagged cutthroat trout were located in habitats with maximum depths >4.0 m, they did not appear to select for these depths, as these deeper habitats were also the most abundant. Fish tended to avoid habitats with maximum depths <1.0 m (Table 18). The radio tagged fish also appeared to select habitats with relatively little cover as they were located in habitats with ≤5% cover at a higher proportion than their availability during both summer and winter (Table 24). When located near cover during the summer (approximately 50% or more of the fish were not found associated with cover) these fish were found associated with large wood (LW) and small wood (SW) in higher proportion than their availability (Table 23). Use of cover during winter was not significant.

Lower North Fork Coeur d’Alene River Subbasin

A total of 210 different habitat units covering 43.9 km of stream were surveyed in the Lower North Fork Coeur d’Alene River subbasin (NF-Lower) to quantify and evaluate its habitat (Table 12). A fairly equal representation of all habitat types (pool, riffle, run and glide) occur in the NF-Lower with each habitat type representing between 21 to 28% of the area sampled (Table 13). The NF-Lower is the second deepest subbasin that we evaluated with approximately 20% of the pool and run habitat (by area) having maximum depths >3 m (Table 16).

Approximately 14% of the total surface area of all habitats has some form of cover with large substrate being the most common cover type available (Tables 19 and 20).

Seventeen different radio tagged fish were located at least once in the NF-Lower where habitat use data was collected (Table 11). These fish were located in pools over 86% of the time during the summer; in the winter, they were located primarily in pools (58%) and glides (33%; Table 14). During summer, over 83% of the fish were located in pools and runs with maximum depths between 1.1 and 3.0 m and were found associated with some form of cover over 72% of the time (Tables 17 and 21). When located near cover it was usually large substrate (54%) or large organic debris (31%; Table 22). During the winter there was an increase in the use of deeper water as the fish were located in habitats with maximum depths >3.0 m 50% of the time (Table 17). Another 42% of the fish were located in habitats with maximum depths ranging from 1.1 to ≤2 m. These depths correlate with the pool and glide habitat they selected during the winter. Association with cover increased during the winter as 91% of the time fish were located within 5 m of some form of cover with large substrate being selected approximately 82% of the time (Table 21 and 22).

A significant chi-square analysis (P <0.001) showed that the radio tagged fish were not randomly distributed between habitat types in the NF-Lower as they were located in pool habitat during the summer and pool and glide habitats during the winter at a higher proportion than their availability (Table 15). Significant chi-square analyses also indicated that during the summer (pool and runs) the fish were not randomly distributed throughout all depths, cover types, and cover quantities (Tables 18, 23, 24). During winter, nonsignificant relationships (P >0.1) were observed for use versus availability of the different cover types as well as the quantity of cover within a habitat.

During summer, the radio tagged fish were located in habitats with maximum depths between 1.1 m and 3.0 m at a higher proportion than their availability whereas during the winter the fish were found to select depths >3 m at a higher proportion than their availability (Table 18). The radio tagged fish were also located in habitats with lower amounts of cover (5-15%) at higher proportions than their availability during the summer (Table 24). Despite selection of habitat with lower amounts of cover, these fish were found associated with cover at a higher proportion than its availability. When using cover, the radio tagged fish were found to select LW as it was used in a higher proportion than its availability (Table 23). This was also the case in the winter, although the relationship was not significant due to the low number of fish we tracked during this period.

Table 25. The percent of area (summed by individual habitat units) that the specified amounts of cover occurred within eight different subbasins in the Coeur d'Alene River watershed, Idaho.

		Percent of Habitat Surface Area With Some Form of Cover							
Subbasin	**Season**	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**>30**
All subbasins	all habitat types	10.5	38.0	25.2	8.2	6.4	3.4	2.0	6.3
	pool and run	10.2	40.3	19.2	7.7	6.8	4.8	3.3	7.7
	pool, run and glide	9.9	37.5	17.1	6.7	6.2	3.1	2.2	17.3
CDA River	all habitat types	0.4	30.6	57.8	11.2	0.0	0.0	0.0	0.0
	pool and run	0.6	10.3	73.9	15.2	0.0	0.0	0.0	0.0
	pool, run and glide	0.6	19.4	66.4	13.6	0.0	0.0	0.0	0.0
Lower NF CDA	all habitat types	3.0	28.2	29.0	9.2	12.4	4.2	3.1	11.0
	pool and run	1.8	19.7	33.4	8.4	13.6	5.5	5.7	12.0
	pool, run and glide	1.3	23.5	32.5	11.0	13.5	3.6	4.0	10.7
Middle NF CDA	all habitat types	26.5	49.1	9.5	6.6	2.6	3.2	2.0	0.5
	pool and run	22.6	53.3	7.4	6.9	3.0	3.8	2.3	0.6
	pool, run and glide	24.9	52.0	7.1	6.7	2.9	3.6	2.3	0.5
Upper NF CDA	all habitat types	0.7	20.0	13.6	20.8	15.0	11.5	4.0	14.5
	pool and run	0.8	19.9	14.1	14.3	16.1	13.4	4.6	16.8
	pool, run and glide	0.7	22.1	14.1	13.6	16.5	12.7	4.4	16.0
Little NF CDA	all habitat types	9.7	59.2	16.5	3.4	2.5	2.6	0.6	5.6
	pool and run	5.3	53.7	19.8	5.9	1.1	4.0	1.1	9.2
	pool, run and glide	6.2	60.4	15.8	4.1	3.0	3.3	0.7	6.6
Tepee Creek	all habitat types	10.8	53.1	14.4	7.7	3.0	3.9	1.7	5.5
	pool and run	6.2	52.2	10.3	10.8	4.6	2.1	3.6	10.3
	pool, run and glide	9.6	49.0	13.9	9.3	4.0	5.2	2.3	6.7
Shoshone Creek	all habitat types	55.1	2.2	2.5	7.8	1.3	13.3	1.9	15.9
	pool and run	1.1	5.1	6.0	18.3	3.0	28.4	0.7	37.3
	pool, run and glide	1.1	4.8	5.6	17.2	2.8	29.3	4.3	35.0
Prichard Creek	all habitat types	7.9	38.8	15.2	6.1	5.8	2.5	1.0	22.6
	pool and run	5.0	57.5	7.0	2.1	12.3	0.0	2.0	14.1
	pool, run and glide	5.2	53.3	6.0	11.1	10.5	0.0	1.7	12.1

Middle North Fork Coeur d'Alene River Subbasin

A total of 344 different habitat units covering 44.0 km of stream were surveyed in the Middle North Fork Coeur d'Alene River subbasin (NF-Mid) to quantify and evaluate its habitat (Table 12). The NF-Mid was represented by near equal proportions of pool, riffle and run habitat (31-34%) with glides representing very little of the habitat (Table 13). Approximately 65% of the pool and run habitat in the NF-Mid had maximum depths ≤1 m with approximately 2% of these habitats having maximum depths >3 m (Table 16). The NF-Mid had the least amount of cover (~5% of the surface area) of any of the subbasins we evaluated with large substrate being the most common type available (~76%; Tables 19 and 20).

Eighteen different radio tagged fish were located at least once in the NF-Mid where habitat use data was collected (Table 11). These fish were only located in pools (68.7%) and runs (31.3%) during the summer; in the winter they were located in pools (40.6), glides (31.3), and runs (28.1; Table 14). During the summer (pool and run habitat), the majority of fish (79.1%) were located in habitats with maximum depths between 1.1 and 2 m deep and were found associated with cover 91% of the time (Tables 17 and 21). When located near cover it was large substrate 80.3% of the time (Table 22). During the winter (pool, run and glide habitat), these fish tended to use deeper water as 28.1% of the fish were located in habitat units with maximum depths between 2.1 and 3.0 m as compared to 9% during the summer (Table 17). Use of cover was less in winter than summer (75% versus 91%) and when found associated with cover it was large substrate 83.3% of the time (Tables 21 and 22).

A significant chi-square analysis (P <0.001) showed that the radio tagged fish were not randomly distributed between habitat types in the NF-Mid as they were located in pool habitat during the summer and glide and pool habitats during the winter at a higher proportion than their availability (Table 15). Significant chi-square analyses also indicated that during the summer (pool and runs) the fish were not randomly distributed throughout all depths, cover types, and cover quantities (Tables 18, 23, 24). The one exception (P >0.1) was use of different cover types during the winter.

During summer and winter, the radio tagged fish were located in habitats with maximum depths between 1.1 m and 3.0 m at a higher proportion than their availability, although during the winter they tended to select for deeper water (2.1 to 3.0 m; Table 18). The radio tagged fish were also found to avoid habitat with low amounts of cover (≤5%) during both the summer and winter although during the summer they selected habitat with more cover (>30%) than during winter (Table 24). When using cover, the radio tagged fish were found to select LW as it was used in a higher proportion than its availability (Table 23). Selection for specific cover types was not significant during the winter.

Upper North Fork Coeur d'Alene River Subbasin

A total of 264 different habitat units covering 25.3 km of stream were surveyed in the Upper North Fork Coeur d'Alene River subbasin (NF-upper) to quantify and evaluate its habitat (Table 12). The NF-upper had the most riffle habitat (61%) and least pool habitat (11%) of the eight subbasins we evaluated (Table 13). The pool and run habitat in the NF-upper is relatively shallow as none had maximum depths >3.0 m and 71.3% of these habitats (by area) had maximum depths ≤1.0 m (Table 16). Approximately 17% of the surface area of these pools and runs had some form of cover with large substrate being the most common (~60%; Tables 19 and 20).

Nine different radio tagged cutthroat trout were located at least once in the NF-upper where habitat use data were collected (Table 11). During the summer most of these fish were located in pools (72.7%) or runs (21.2%) and during winter all of our radio tagged fish had migrated downstream of this subbasin (Table 14). The majority (98%) of these fish were located in pools or runs where the maximum depth was ≤2.0 m and were associated with some form of cover 100% of the time (Table 17 and 21). Large substrate was the most common (71%) type of cover used (Table 22).

A significant chi-square analysis (P <0.001) showed that the radio tagged fish were not randomly distributed between habitat types in the NF-upper as they were located in pool habitat during the summer at a higher proportion than its availability (Table 15). Significant chi-square analyses also indicated that during the summer the fish were not randomly distributed throughout all depths, cover types, and cover quantities (Tables 18, 23, 24).

During summer, the radio tagged fish showed the strongest selection for habitats with maximum depths between 1.1 m and 2.0 m (Table 18). The radio tagged fish were also found to use habitats with higher amounts of cover (>25%) than they were proportionally available (Table 24). When using cover, the radio tagged fish showed the greatest selection for undercut banks as it was used in a higher proportion than its availability (Table 23).

Little NF Coeur d'Alene River Subbasin

A total of 479 different habitat units covering 37.4 km of stream were surveyed in the Little North Fork Coeur d'Alene River (LNF) subbasin to quantify and evaluate its habitat (Table 12). The LNF subbasin was represented by similar quantities of pool (34%), riffle (29%), and glide (26%) habitat and limited amounts of run habitat (Table 13). The pool and run habitat is relatively deep when compared to the other subbasins with approximately 40% (by area) of these habitats having maximum depths ≤1 m and approximately 6% >3 m (Table 16). Approximately 10% of the surface area of these pools and runs had some form of cover with large substrate being (37.4%) and overhead cover (26.3%) being the most common (Table 19 and 20).

Eleven different radio tagged fish were located at least once in the LNF subbasin where habitat use data was collected (Table 11). During the summer, these fish were located in either pools (75%) or glides (25%); in the winter, they were located mostly in pools (81.8%; Table 14). During the summer, (pool and run habitat), every fish was located in habitats where the maximum depths ranged between 1.1 and 3.0 m deep and were found associated with cover 90.5% of the time (Tables 17 and 21). When located near cover it was usually LW (47.4%) or SW (21.1%; Table 22). During the winter (pool, run and glide habitat), the same fish we tracked in the summer tended to use deeper water in the winter (more between 2.1 and 3.0 m). However, we captured and radio tagged three additional fish during the winter in the upper watershed where shallower depths occurred. For this reason, the data showed that some of the fish were using habitats with shallower maximum depths during the winter (Table 17). Use of cover increased in the winter as all fish were found associated with some form of cover (Table 21), with large substrate (71.4%) being used the majority of the time (Table 22).

A significant chi-square analysis (P <0.001) showed that radio tagged fish were not randomly distributed between habitat types in the LNF subbasin. They were located in pool habitat during the summer and winter at a higher proportion than their availability (Table 15). Significant chi-square analyses also indicated that during the summer the fish were not randomly distributed throughout all depths, cover types, and cover quantities (Tables 18, 23, 24).

During summer and winter, the radio tagged fish were located in habitats with maximum depths between 2.1 m and 3.0 m at a higher proportion than their availability, although during the winter these fish showed a greater selection for these deeper waters (Table 18). The radio tagged fish were also found to avoid habitat with low amounts of cover (≤5%) during both the summer and winter, although during the summer they selected habitat with more cover (>15%) than during winter (Table 24). When using cover, the radio tagged fish were found to select LW and SW as it was used in a higher proportion than its availability during the summer (Table 23). During the winter, fish were found to use large substrate in a higher proportion than its availability.

The LNF subbasin has a catch-and-release area (Laverne Creek upstream) and limited harvest area (downstream of Laverne Creek). We evaluated the habitat availability in these two zones to better characterize how the habitat is distributed in this drainage. Based on our habitat surveys the upstream catch-and-release area is represented by approximately 3.5 times fewer pools and shallower depths than in the downstream reaches where limited harvest occurs (Table 26).

Tepee Creek Subbasin

A total of 311 different habitat units covering 18.5 km of stream were surveyed in the Tepee Creek subbasin to quantify and evaluate its habitat (Table 12). The Tepee Creek subbasin is represented by similar quantities of pool (34%), riffle (27%) and glide (25%) habitat and limited amounts of run habitat (Table 13). Approximately 59% of the pool and run habitat had maximum depths ≤1 m and approximately 6% >2 m (Table 16). Approximately 13.5% of the surface area of these pools and runs had some form of cover (Table 19), with all cover types being used >17% of the time except SW (Table 20).

Table 26. Percent occurrence of different habitat type and maximum depths in pools and runs in the limited harvest and catch-and release zones of the Little North Fork Coeur d'Alene River subbasin, Idaho.

	Habitat types		
Habitat Type	**Limited Harvest Area**	**Catch-and-Release**	**Entire River**
Glide	0.26	0.25	0.26
Pool	0.43	0.12	0.34
Riffle	0.22	0.44	0.29
Run	0.09	0.19	0.12

	Maximum Depths		
Maximum Depth (m)	**Limited Harvest**	**Catch-and-Release**	**Entire River**
0.1 -1.0	0.32	0.67	0.39
1.1 -2.0	0.38	0.27	0.36
2.1- 3.0	0.22	0.06	0.19
3.1- 4.0	0.04	0.00	0.03
4.1-5.0	0.04	0.00	0.03

Fourteen different radio tagged fish were located at least once in the Tepee Creek subbasin where habitat use data were collected (Table 11). During the summer, these fish were located in either pools (46.3%) or glides (51.2%); in the winter, they were located mostly in runs (41.4%) and glides (37.9%; Table 14). During the summer (pools and runs), the radio tagged fish were located in relatively shallow habitats as the maximum depths were ≤1 m 60% of the time (Table 17) and were found associated with cover 87.5% of the time (Table 17 and 21). When located near cover it was usually large substrate (51.4%; Table 22). During the winter (pool, run and glide habitat), the fish tended to use deeper water (more between 1.1 and 2.0 m; Table 17) and were found associated with cover 75.9% of the time (Table 21); large substrate was used the majority (77.3%) of the time (Table 22).

A significant chi-square analysis (P <0.001) showed that the radio tagged fish were not randomly distributed between habitat types in the Tepee Creek subbasin as they were located in run and pool habitat during the summer and run and glide habitat in the winter at a higher proportion than their availability (Table 15). Significant chi-square analyses also indicated that during the summer and winter these fish were not randomly distributed throughout all depths, cover types, and cover quantities (Tables 18, 23, 24). The one exception (P >0.1) was use of different maximum depths during the summer.

Selection for different maximum depths was not significant (p >0.10) during the summer, although during the winter these fish showed a preference for habitats with maximum depths ranging from 1.1 to 3.0 m as they were located in these depths at a higher proportion than their availability (Table 18). The radio tagged fish were also found to select habitats with approximately 10% of its surface area represented by cover (Table 24). When using cover, the radio tagged fish were found to select large substrate as it was used in a higher proportion than its availability during both the summer and winter (Table 23).

Shoshone Creek Subbasin

Sixty-five different habitat units covering 4.7 km of stream were surveyed in the Shoshone Creek subbasin to quantify and evaluate its habitat (Table 12). The Shoshone Creek subbasin had the second most riffle habitat (55%) and second least pool habitat (19%) of the eight subbasins we evaluated (Table 13). The pool and run habitat in the Shoshone Creek subbasin was the shallowest of the eight subbasins we surveyed with the maximum depth of 84.7% of these habitats being ≤1 m (Table 16). The Shoshone Creek subbasin had the most cover of all the subbasins we surveyed with approximately 25% of the surface area being represented by some form of cover (Table 19). Large substrate (38.2%) and overhead cover (37.5%) were the most common cover types available (Table 20).

Five different radio cutthroat trout were located at least once in the Shoshone Creek subbasin where habitat use data were collected (Table 11). During the summer, most of these fish were located in pool and run habitat (52.6%) and during winter all of our radio tagged fish had migrated out of this subbasin (Table 14). The majority (80.0%) of these fish were located in pools or runs where the maximum depth was ≤1.0 m and were associated with some form of cover 100% of the time (Tables 17 and 21). Undercut banks (40.0%), LW (26.7%), and overhead cover (26.7%) were all commonly used cover types.

A significant chi-square analysis (P <0.001) showed that the radio tagged fish were not randomly distributed between habitat types in the Shoshone Creek subbasin as they were located in run and pool habitat during the summer at a higher proportion than their availability

(Table 15). Significant chi-square analyses also indicated that during the summer the fish were not randomly distributed throughout all cover types and cover quantities (Tables 23, 24). A nonsignificant relationship (P >0.1) was calculated during the summer for fish distribution among habitat based on their maximum depths (Table 18).

During summer, the radio tagged fish were located in habitats with 10-20% cover at a higher proportion than were available (Table 24). When using cover, the radio tagged fish showed the greatest selection for undercut banks and LW as they were used in a higher proportion than their availability (Table 23).

Prichard Creek Subbasin

A total of 75 different habitat units covering 4.6 km of stream were surveyed in the Prichard Creek subbasin to quantify and evaluate its habitat (Table 12). During these surveys, approximately 50% of the stream reach (upper half) either had intermittent surface flow or was totally dry. Many of the pools and runs that were evaluated were isolated by stretches of dry streambed. The Prichard Creek subbasin was dominated by riffle (45%) and pool habitat (44%; Table 13). The pool and run habitat in the Prichard Creek subbasin was the second shallowest of the eight subbasins we surveyed with the maximum depth of 76.4% of these habitats being ≤1 m (Table 16). Approximately 15% of the surface area was represented by some form of cover (Table 19) with LW (48.8%) being the most common cover type available (Table 20).

Four different radio cutthroat trout were located at least once in the Prichard Creek subbasin where habitat use data were collected (Table 11). Only one of these fish remained in Prichard Creek for more than one month during the summer, and by winter, all of the radio tagged fish had migrated out of this subbasin. During the summer, these fish were located primarily in pool habitat (87.5%; Table 14). The majority (85.7%) of these fish were located in pools or runs where the maximum depth was ≤1.0 m and were associated with some form of cover 100% of the time (Tables 17 and 21). Large substrate (85.7%) was the most commonly used cover type.

A significant chi-square analysis (P <0.001) showed that the radio tagged fish were not randomly distributed between habitat types in the Prichard Creek subbasin as they were located in pool habitat during the summer at a higher proportion than their availability (Table 15). Significant chi-square analyses also indicated that during the summer the fish were not randomly distributed throughout all cover types and cover quantities (Tables 23, 24). A nonsignificant relationship (P >0.1) was calculated for fish distribution during the summer among habitat based on their maximum depths (Table 18).

During summer, the radio tagged fish were located in habitats with 10-30% cover at a higher proportion than they were available (Table 24). When using cover, the radio tagged fish showed the greatest selection for large substrate as they were used in a higher proportion than their availability (Table 23).

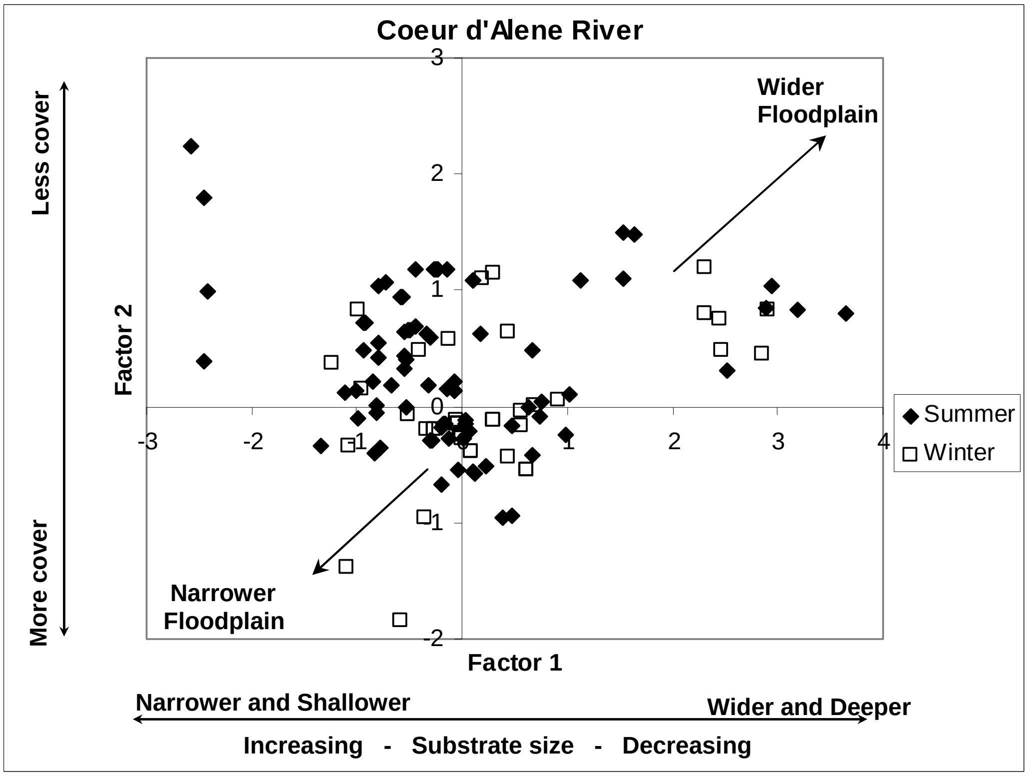
Summer Versus Winter Habitat Use

Through use of principal component analysis (PCA) we were able to depict habitat use of the radio tagged cutthroat trout during the summer and winter periods. We displayed these data by fish assemblage, grouping those assemblages together that utilized similar winter habitat. We made no attempt to portray habitat use of fish from Prichard Creek as only one fish was tracked more than once in this subbasin.

The general pattern we observed through our PCA is that most radio tagged fish moved to areas with wider floodplains during the winter with these movements being more prevalent with fish that utilized smaller subbasins (smaller drainage area and narrower floodplain) during the summer. These wintering areas also tended to have wider stream channels, greater depths, less cover, and smaller substrate sizes (Figures 31-33). Although we did not measure water velocity during our surveys, general observations were that these fish also used areas with slower water velocities during the winter.

Coeur d'Alene River Fish Assemblage—Every radio tagged cutthroat trout belonging to the Coeur d'Alene River Fish Assemblage spent the entire summer and winter in the Coeur d'Alene River subbasin. This assemblage of fish showed the least movement and change in habitat from summer to winter (Figure 31). The only noticeable difference was no fish were located in smaller side channels with shallower depths during the winter period that a few fish utilized during the summer.

Lower North Fork Coeur d'Alene River Fish Assemblage—Radio tagged cutthroat trout belonging to the Lower North Fork Coeur d'Alene River Fish Assemblage displayed little movement from summer to winter habitat. Habitat use did change some as fish tended to be located in reaches with wider, deeper water, less cover, and smaller substrates (Figure 31). There did not appear to be a movement towards or away from areas with wider floodplains.



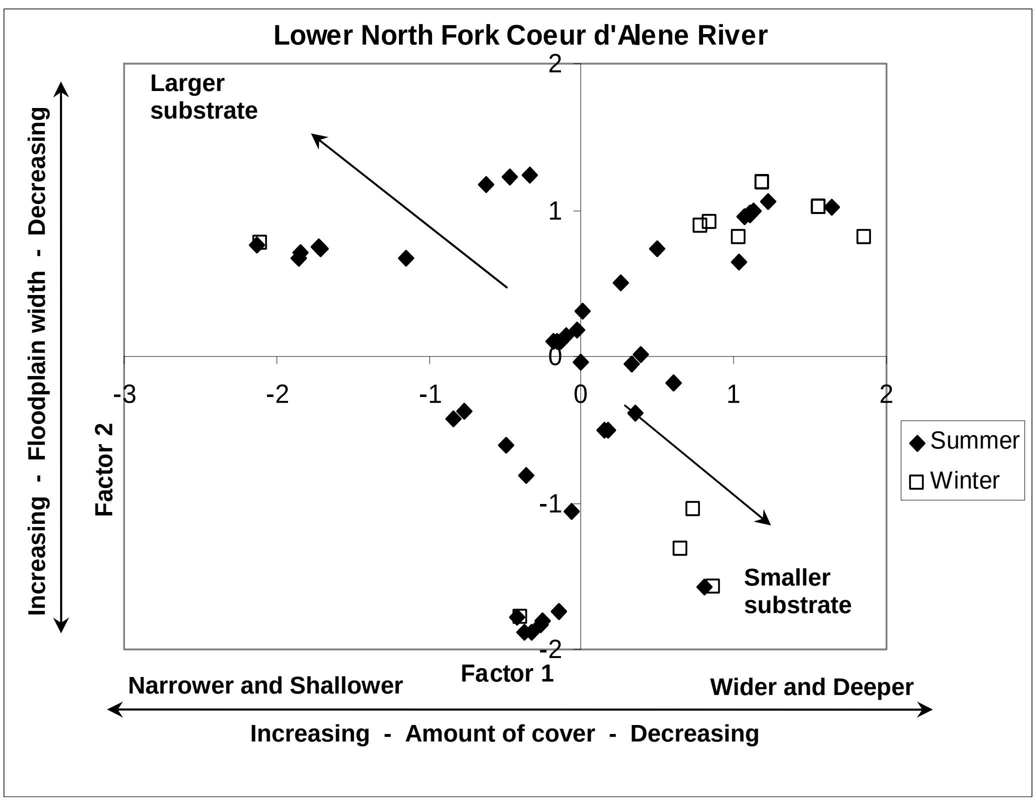


Figure 31. Principal component analysis depicting habitat conditions used by assemblages of radio tagged cutthroat trout during the summer and winter in the Coeur d'Alene and NF-lower subbasins, Idaho, between July 2003 and March 2004.

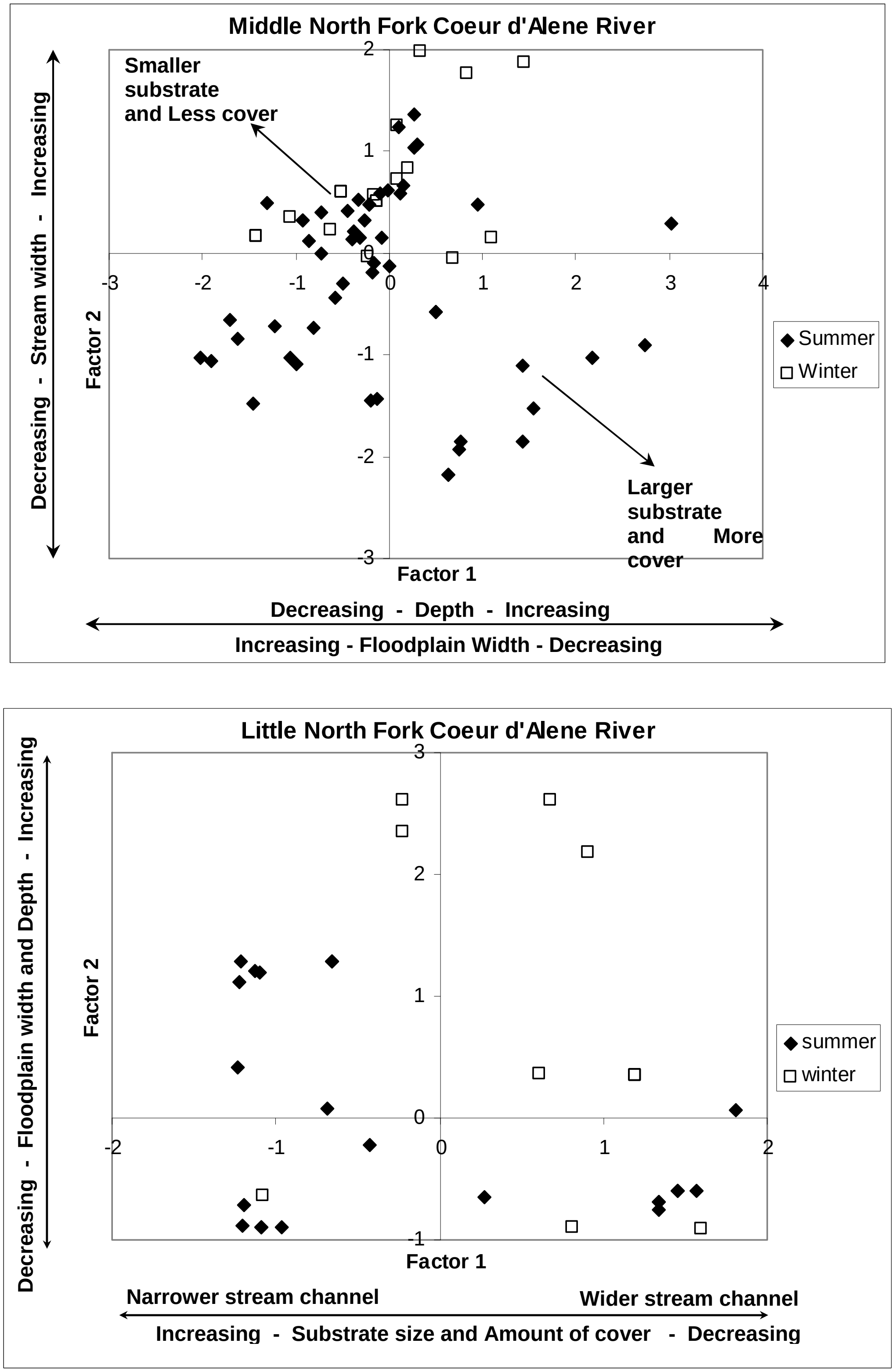
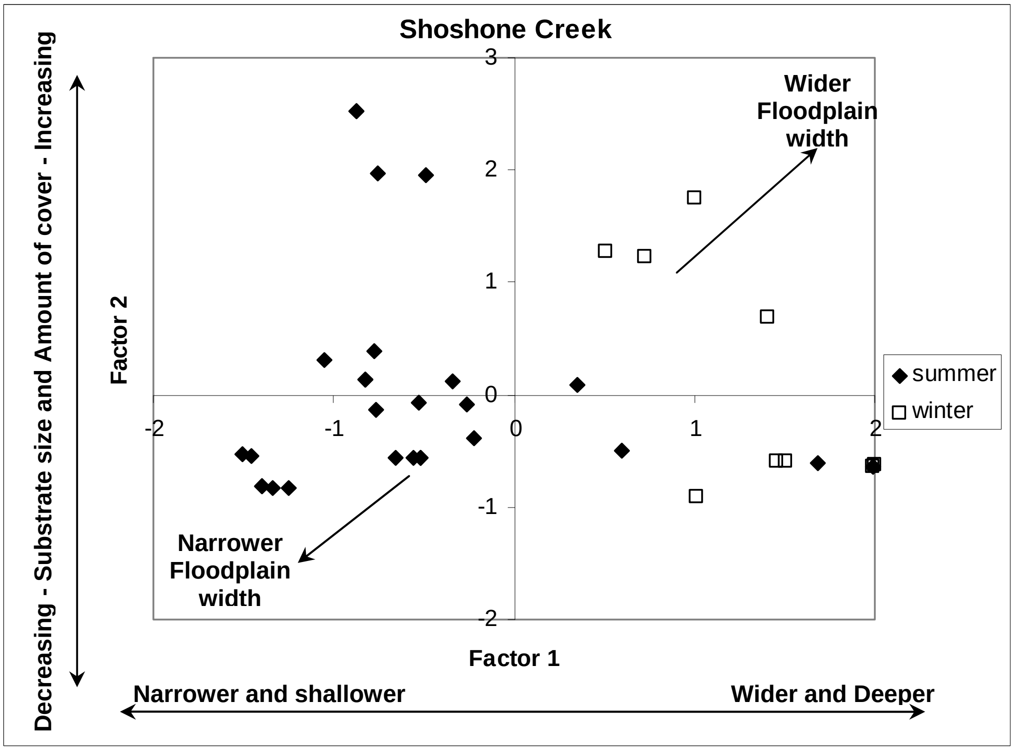


Figure 32. Principal component analysis depicting habitat conditions used by assemblages of radio tagged cutthroat trout during the summer and winter in the NF-middle and LNF subbasins, Idaho, between July 2003 and March 2004.



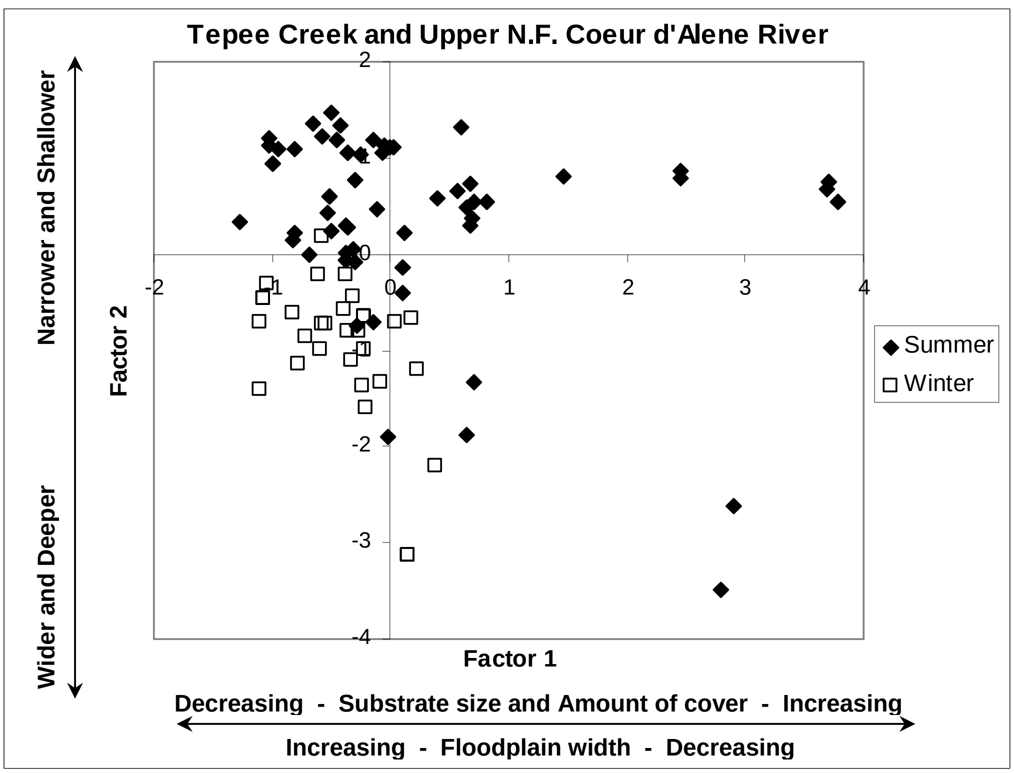


Figure 33. Principal component analysis depicting habitat conditions used by assemblages of radio tagged cutthroat trout during the summer and winter in the Shoshone, Tepee, and NF-upper subbasins, Idaho between July 2003 and March 2004.

Middle North Fork Coeur d'Alene River Fish Assemblage—Radio tagged cutthroat trout belonging to the Middle North Fork Coeur d'Alene River Fish Assemblage displayed little movement from summer to winter habitat although most changed the habitat they used between these seasons. Fish from this assemblage tended to use areas with wider floodplains that had wider stream channels, less cover, and smaller substrate sizes (Figure 32). Movement to areas with deeper depths was not prevalent.

Little North Fork Coeur d'Alene River Fish Assemblage—Most radio tagged cutthroat trout belonging to the Little North Fork Coeur d'Alene River Fish Assemblage displayed little movement from summer to winter habitat although one fish migrated 6.2 km downstream from summer to winter habitat. Changes in habitat use were prevalent between summer and winter with most fish utilizing areas with wider floodplains that had wider stream channels, greater depths, less cover, and smaller substrate sizes (Figure 32).

Shoshone Creek Fish Assemblage—Radio tagged cutthroat trout belonging to the Shoshone Creek Fish Assemblage displayed relatively large movement (~8 km) from summer to winter habitat as all fish that spent the summer in the Shoshone subbasin migrated into the North Fork Coeur d'Alene River subbasin for the winter. Habitat use was very different between the two periods as fish used areas with considerably wider floodplains that had wider stream channels and more depth (Figure 33). The substrate size and the amount of cover they utilized during the summer and winter did not appear to differ greatly.

Tepee Creek and Upper North Fork Coeur d'Alene River Fish Assemblages—Radio tagged cutthroat trout belonging to the Tepee Creek and Upper North Fork Coeur d'Alene River Fish Assemblages were grouped together as many used the same winter habitat. Fish belonging to these assemblages displayed the greatest difference between summer habitat and winter habitat use as well as the longest migrations (>15 km). Habitat use was very different between the two periods as fish used areas with considerably wider floodplains that had wider stream channels, more depth, smaller substrate sizes, and less cover (Figure 33).

Temperature

Water temperatures collected while tracking radio tagged cutthroat trout ranged from -1°C on Jan 12, 2004 to 27°C on July 30, 2003. The hottest temperatures occurred during the month of July (mean 18.8°C; range 13-27°C) and coldest temperatures occurred in January (mean 1.1°C; range -1-4°C; Figure 34). The largest range in water temperatures occurred when the warmest water temperatures were observed (June through August) whereas the least amount of variation occurred during the coldest months (November through March; Figure 34).

Changes in temperature appeared to trigger or influence movement of the radio tagged cutthroat to spawning areas and overwintering areas. Most radio tagged cutthroat trout tended to spawn when water temperatures reached 8°C (Figure 35), although spawning was observed in water ranging from 5-14°C. Movement of radio tagged cutthroat trout to winter habitat upstream of Shoshone Creek appeared to occur when temperatures dropped below 7 or 8°C (Figure 35). The lower in the watershed, the later it appeared that fish moved to winter habitat as fish in the Coeur d'Alene River and lower North Fork fish did not appear to move until temperatures dropped to around 4°C. Outside of these two periods, movement of the radio tagged cutthroat trout was minimal.

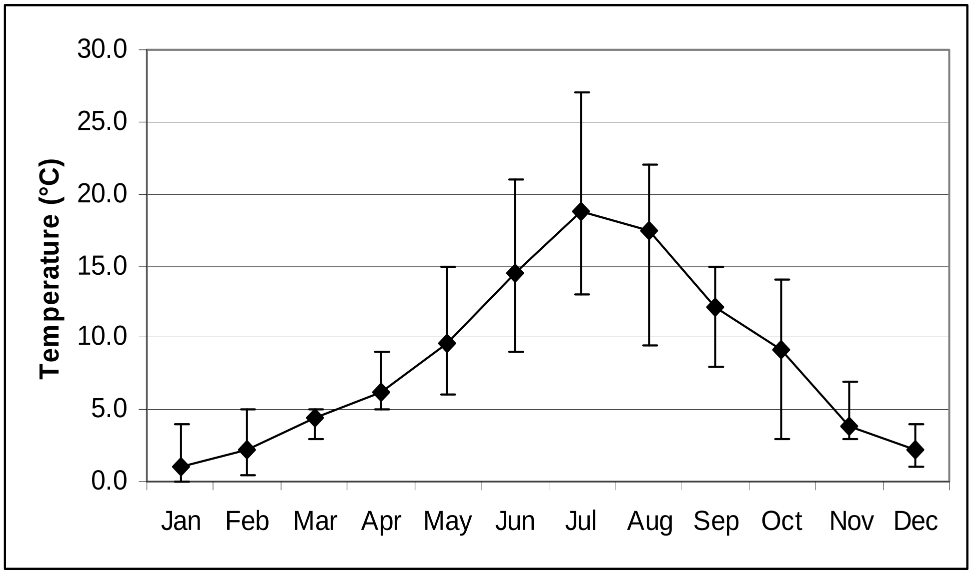


Figure 34. Monthly average temperatures recorded while tracking cutthroat trout in the North Fork Coeur d'Alene River, Idaho from May 2003 to June 2004. Vertical bars refer to the maximum and minimum temperatures recorded during each month.

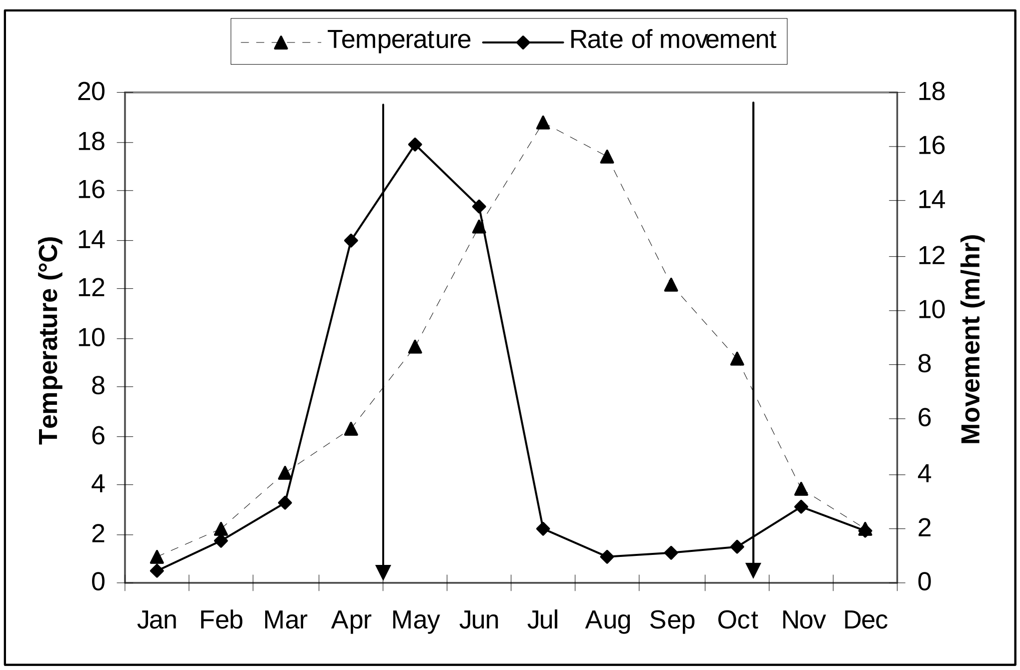


Figure 35. Monthly average water temperature at radio tagged cutthroat trout locations versus the average distance all radio tagged cutthroat trout moved in the Coeur d'Alene River, Idaho from May 2003 to June 2004. The arrow between March and April indicates when spawning began and the arrow near late October indicates when cutthroat trout first started moving to overwinter habitat.

Temperature extremes that we believed had the potential to influence cutthroat trout survival were observed in both the winter (<0°C) and summer (>22°C). During winter, water temperatures dropped below 0°C for a short period (observed only in January) upstream of Prichard Creek. Ice covered the river in places during January although no frazil or anchor ice was observed. None of the radio tagged fish died during any winter months. Few thermographs were left in the river during the winter to thoroughly evaluate water temperatures and whether the radio tagged fish were selecting habitat based on temperature. During winter, several fish in the Coeur d'Alene River subbasin were located in off channel habitat that had water temperatures 2-3°C warmer than the main river.

We thoroughly evaluated water temperatures during the warmest time of the year (July 22 to July 31, 2003). During this period, maximum water temperatures exceeded 20°C in the main river and stream channels except in streams where the watershed size decreased to approximately <15,000 ha (Figure 36). In the entire North Fork Coeur d'Alene River downstream of Tepee Creek, maximum water temperatures exceeded 22°C. The warmest water temperatures (25-28°C) occurred from approximately 5 km above Shoshone Creek to approximately 8 km below Prichard Creek. Moving downstream from this area, water temperatures cooled to the point where once the Coeur d'Alene River was reached water temperatures never exceeded 22°C (Figures 36 and 37). This same cooling pattern from Prichard Creek downstream to the Coeur d'Alene River was also observed during 2004 (Figure 37). The decline in water temperature was observed moving downstream from Prichard Creek coincides with an increase in the width of the floodplain (Table 27). This same pattern was also observed in the Little North Fork Coeur d'Alene River where temperatures decreased and floodplain width increased moving downstream (Figure 36 and 38).

When tracking cutthroat trout during this warmest time period, every fish was located in areas where water temperature in the main river or stream channel exceeded 20°C except for one fish that occurred near the mouth of Prichard Creek (Figure 36). Forty-two percent of the radio tagged fish occurred in areas where water temperature in the main river or stream channel exceeded 22°C and 7% occurred in areas where water temperature in the main river or stream channel exceeded 25°C. While tracking fish during the warmest period of the year, we observed dead rainbow trout, mountain whitefish, and torrent sculpin in the river; however, none of our radio tagged fish appeared to have died from natural causes during this time.

During this warm period, we observed several patterns of movement and/or habitat use that radio tagged fish appeared to utilize to help them survive through the warm water temperatures we observed. Only two of the fish appeared to make long migrations (>7 km) to reach areas with more suitable water temperatures. Both of these fish made downstream migrations in mid to late July when water temperatures where they were located exceed approximately 21°C. These fish migrated from areas where water temperatures eventually exceeded 23-25°C to areas where water temperatures stayed below 21°C. The remainder of the radio tagged fish stayed in the same general area throughout the entire summer although many made short movements (<3 km) to areas with cooler temperatures.

In the Tepee Creek watershed and upper and middle sections of the North Fork, six different radio tagged fish (33% of radio tagged fish in this area) were observed holding near the mouth of tributary streams during the warmest time of the year. Most of these streams were approximately 5°C cooler than the temperatures in the main river. When measuring temperatures around these stream mouths, a small pocket of cooler water occurred where it entered the main channel, but quickly dissipated as it moved out into the current.

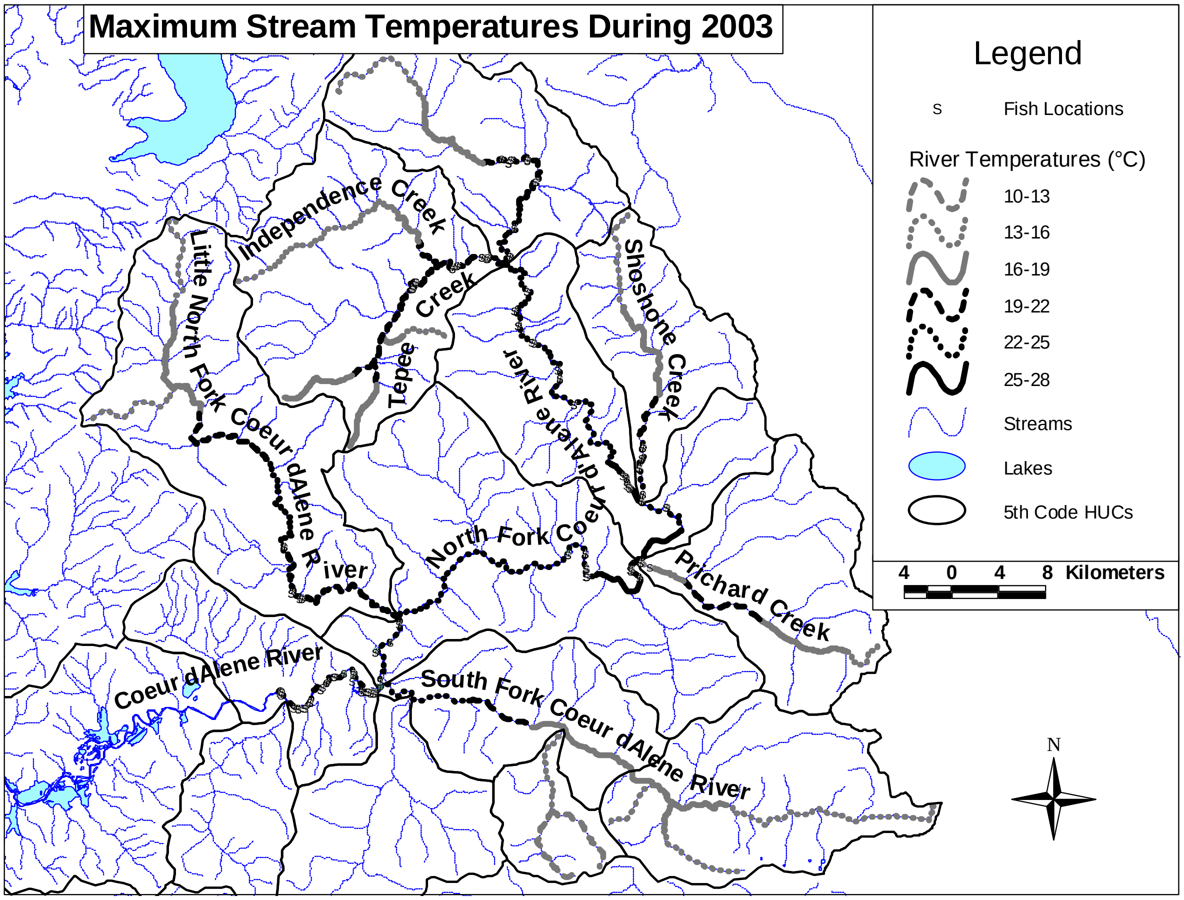
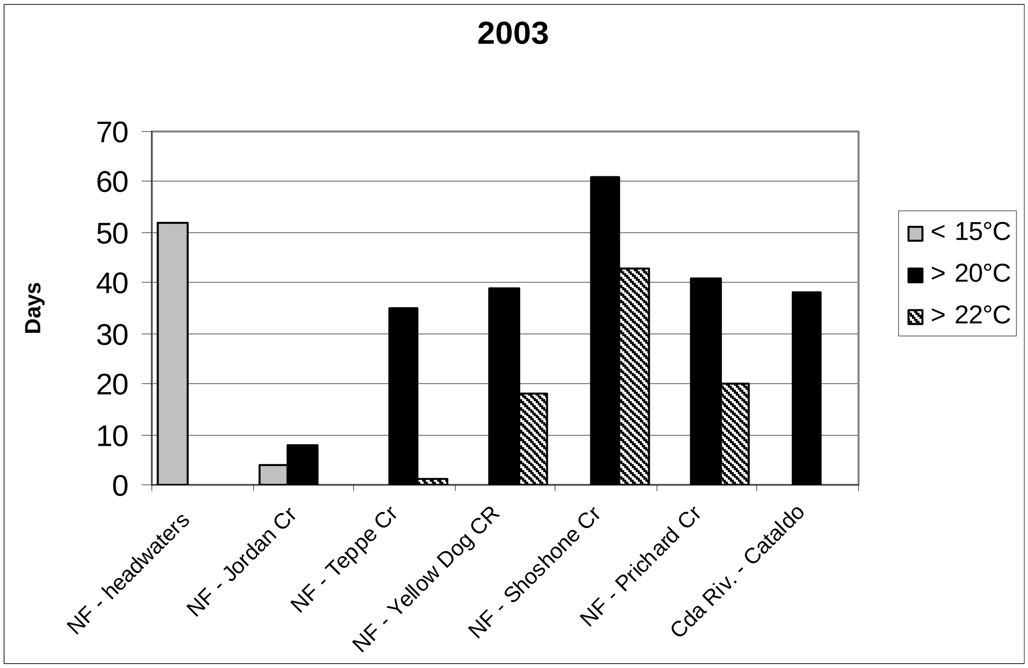


Figure 36. Maximum water temperatures and locations of radio tagged cutthroat trout in rivers and major tributaries in the Coeur d'Alene River basin, Idaho, from July 14 to August 15, 2003.



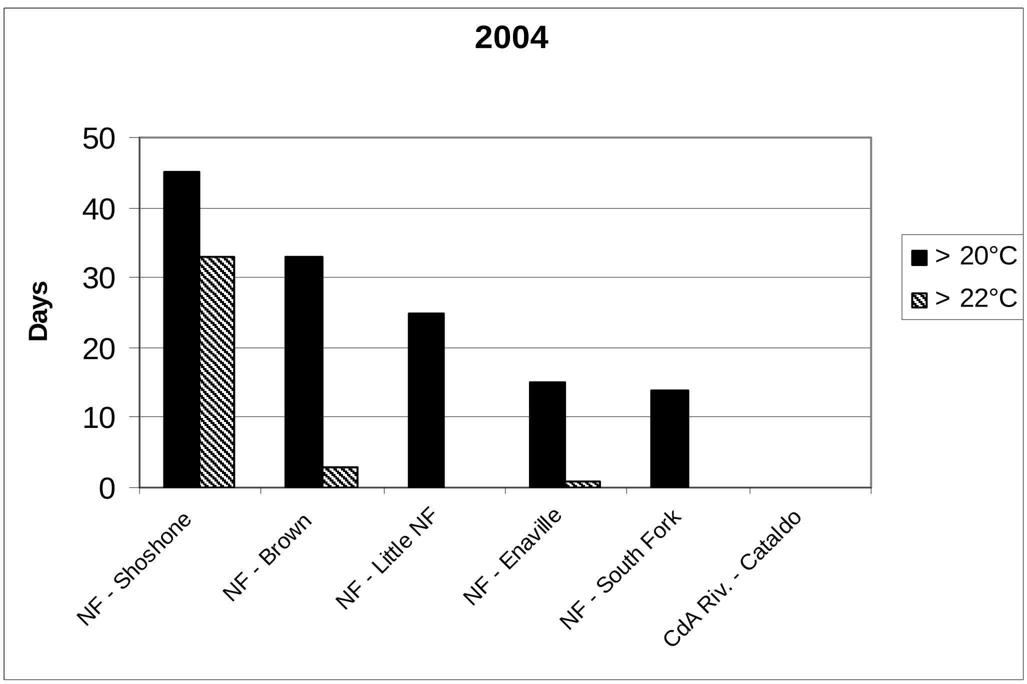


Figure 37. Number of days daily maximum temperatures were <15°C, >20°C and >22°C during July and August at selected sites within the Coeur d'Alene (CdA) and North Fork Coeur d'Alene (NF) rivers, Idaho during 2003 and 2004.

Table 27. Valley width and number of days daily maximum temperatures were >20°C during July and August at thermograph sites within the Coeur d'Alene and North Fork Coeur d'Alene (NF) rivers, Idaho during 2003 and 2004.

Thermograph Area	Valley Width (m)	Day >20°C 2003	2004
NF - Jordan	222	8	—
NF - Tepee	431	35	—
NF - Yellow Dog	205	39	—
NF - Shoshone	228	61	45
NF - Prichard	442	41	—
NF - Browns	1206	—	33
NF - Little NF	759	—	25
NF - South Fork	1119	—	14
CDA - Cataldo	2500	38	0

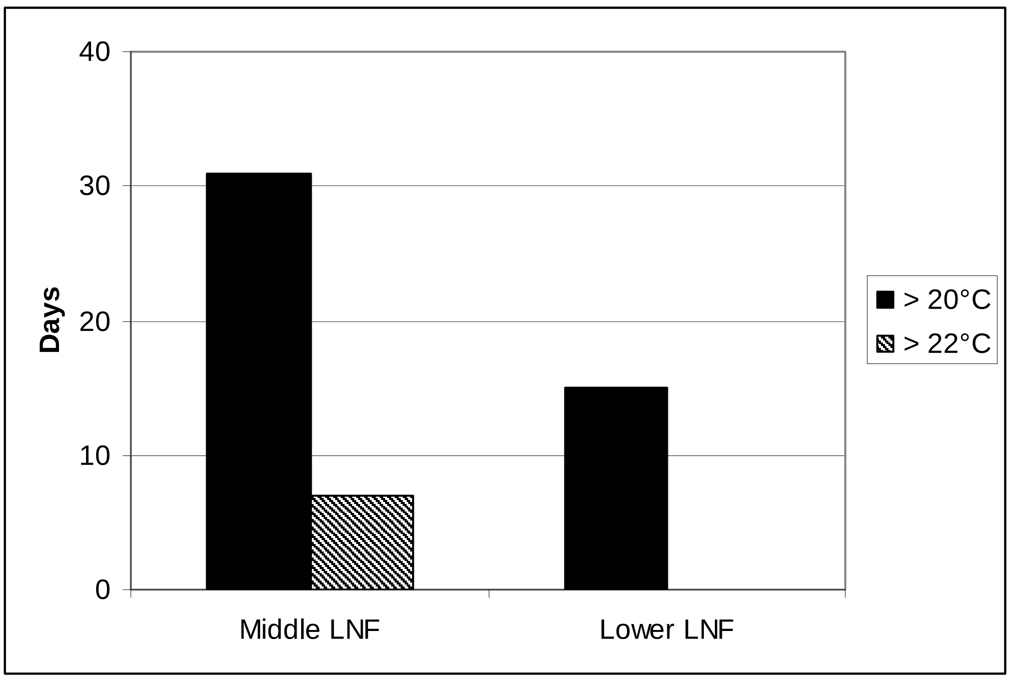


Figure 38. The number of days the daily maximum temperatures were >20°C and >22°C during July and August at selected thermograph sites within the Little North Fork Coeur d'Alene River (LNF), Idaho, during 2003.

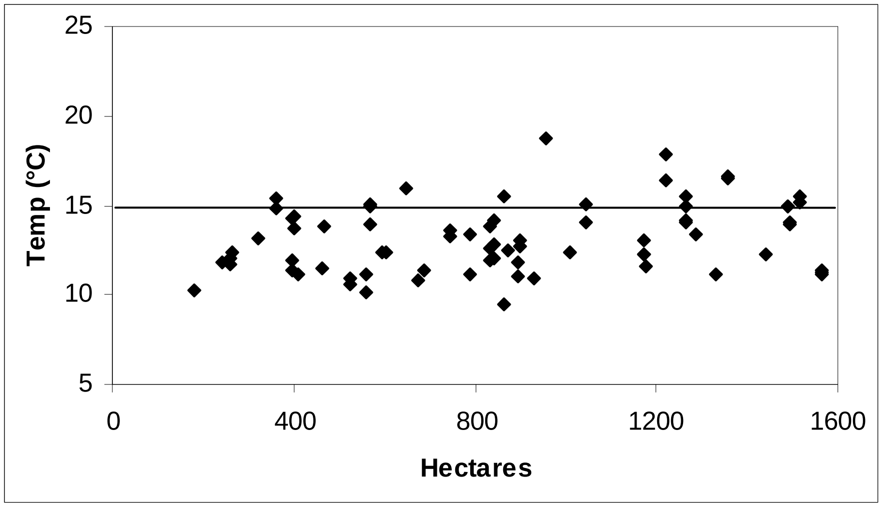
The larger the main stream channel and the swifter the current the more quickly cold water dissipated. In Tepee Creek, two fish were located at the mouths of streams that drained approximately 500 ha, whereas in the main North Fork Coeur d'Alene River fish were located only at the mouths of stream that drained >2,000 ha. When tracking these radio tagged fish at the mouths of the smaller tributaries (500 ha) we typically observed one to three cutthroat trout holding in the cooler water. At the mouths of the larger tributaries (>2,000 ha) 5 to 10 fish were often observed holding in the cooler water.

Thermograph data collected during 1998-2004 showed that the maximum weekly average maximum temperatures (MWMT) seldom exceeded 15°C in streams with watersheds <1,600 ha in size (Figure 39). Streams with watersheds >1,600 ha exceeded 15°C MWMT in a majority of cases (Figure 39). Tributaries lower in elevation (mouths <730 m) tended to have warmer temperatures and exceed these rules.

The only tributary radio tagged fish moved into was Shoshone Creek, which has a watershed size of approximately 17,400 ha. One fish moved into Shoshone Creek during mid-July when the temperature in the main North Fork began to exceed 25°C. Three other radio tagged fish moved in during June when the main river temperature began to exceed 16-17°C and remained there until the main river's maximum temperature dropped below 19°C in late August. Maximum temperatures in the lower 1 km of Shoshone Creek were approximately 3°C cooler than the North Fork. Shoshone Creek also cooled significantly more at night than the North Fork, as the average daily temperature during the hottest day of the year was 5°C cooler in Shoshone Creek than in the North Fork (Figure 40). When snorkeling pools in Shoshone Creek that our radio tagged fish used, we typically observed 10 to 30 other trout with the radio tagged fish.

Maximum water temperatures near the mouth of Prichard Creek (25,000 ha in size) did not reach 16°C, whereas maximum temperatures in the North Fork exceeded 25°C (Figure 40). Water in Prichard Creek flowed intermittently for approximately 14 km before resurfacing for the last 1.2 km. None of the radio tagged fish moved into this tributary during the summer, although one fish stayed in this tributary throughout the entire study except during winter. When snorkeling the pool where this fish stayed, we typically would see one or two other cutthroat trout with it. We also snorkeled the mouth of Prichard Creek during 2004 and observed 42 cutthroat trout and 5 rainbow trout within 7 m of where creek entered the main river.

Another strategy the radio tagged fish used to avoid the warmer temperatures of the main river was to move into side channels. Four of the radio tagged fish utilized side channels in July with three of them occurring in the NF-lower subbasin. Fifty percent of all radio tagged fish that utilized the NF-lower subbasin during late July/early August were located in side channels. All of these side channels were at least 4°C cooler than the main river. During summer, the three side channels in the lower North Fork did not have surface flows entering from above. Consequently, the majority of the water entering them came subsurface. The other side channel received a substantial amount of cooler water from a tributary stream. In the two side channels with the shallowest water (<1 m) 10-20 other cutthroat trout were often observed in close proximity to the radio tagged fish. The two other side channels (both in NF-lower subbasin) had depths of 2.5 to 3.0 m. When snorkeling these side channels, in approximately 70 m of length over 500 salmonids (cutthroat trout, rainbow trout, and mountain whitefish) were observed with the radio tagged fish, with approximately 10% of them being cutthroat trout.



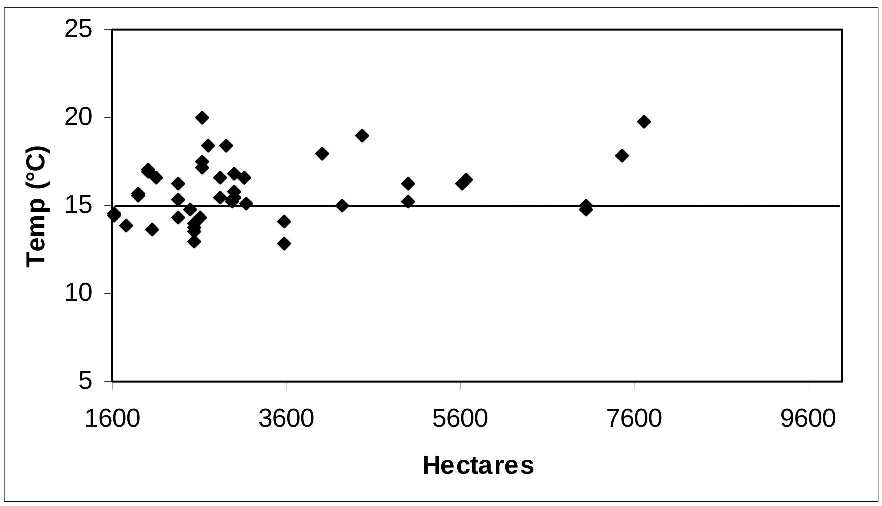


Figure 39. Maximum weekly maximum temperatures for watersheds less than 1,600 ha (top) and greater than 1,600 ha (bottom) in the North Fork Coeur d'Alene River, Idaho, 1998 through 2004.

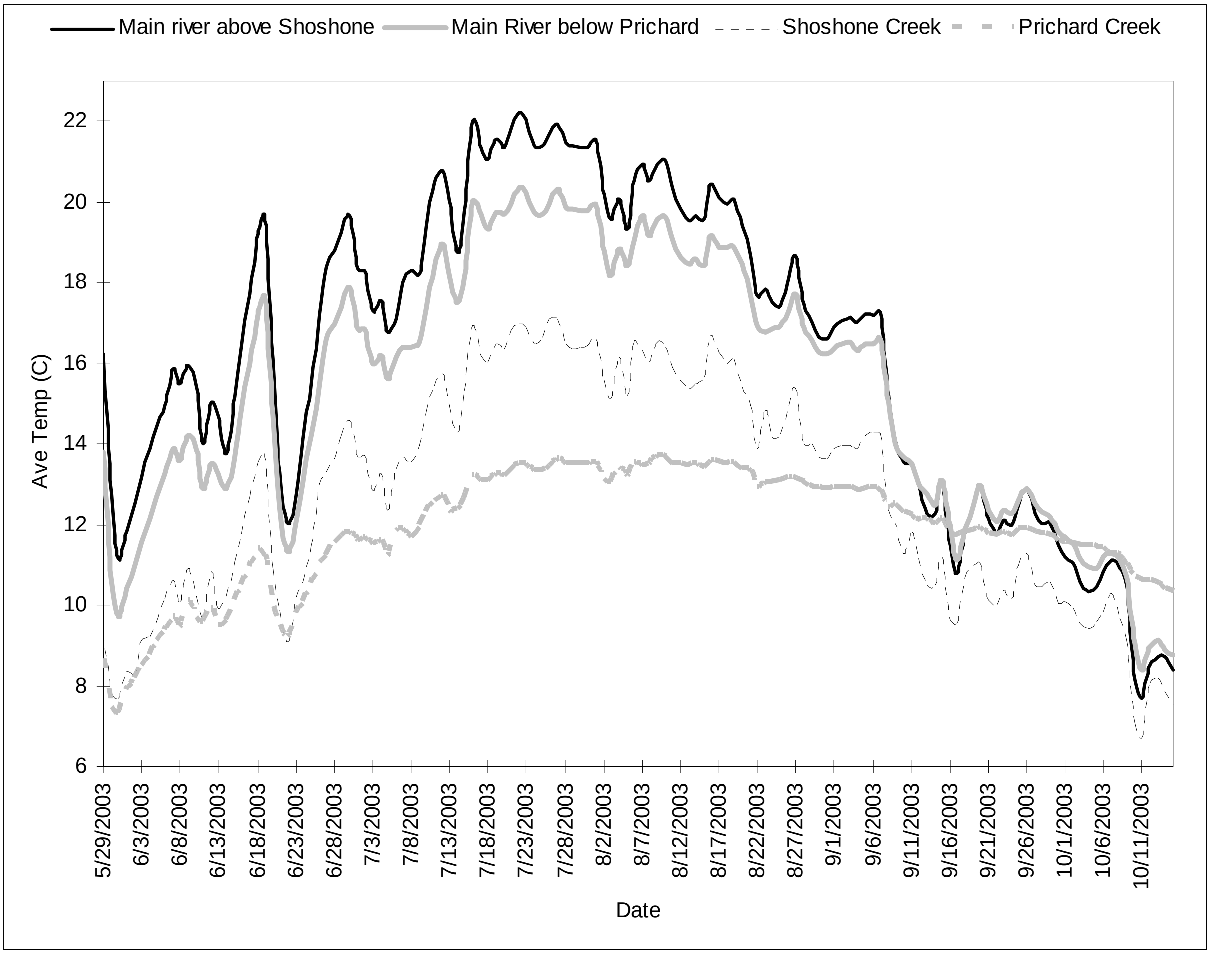


Figure 40. Average water temperatures at four monitoring sites in the North Fork Coeur d'Alene River, Idaho, May 29 through October 11, 2003. Shoshone and Prichard creeks enter the North Fork Coeur d'Alene River between the two main river sites.

During 2004, we put thermographs in these two side channels and found that during the hottest part of the year one of the side channels was approximately 4.5°C cooler than the main river and the other was approximately 9.3°C cooler than the main river (Figure 41). The fish in the colder side channel appeared healthy and were often observed actively feeding during the hottest time of the year.

Based on thermograph data, there are areas in the main river and larger stream channels where cooler pockets of water occur (3-4°C cooler) that do not appear related to tributaries or side channels. One of these areas was found in a deep pool and another was found downstream of an area where a substantial amount of subsurface flow appeared to resurface. Our inability to take temperatures with a handheld thermometer in water >1 m deep may have prevented us from documenting use of radio tagged cutthroat trout in this type of coldwater refugia area.

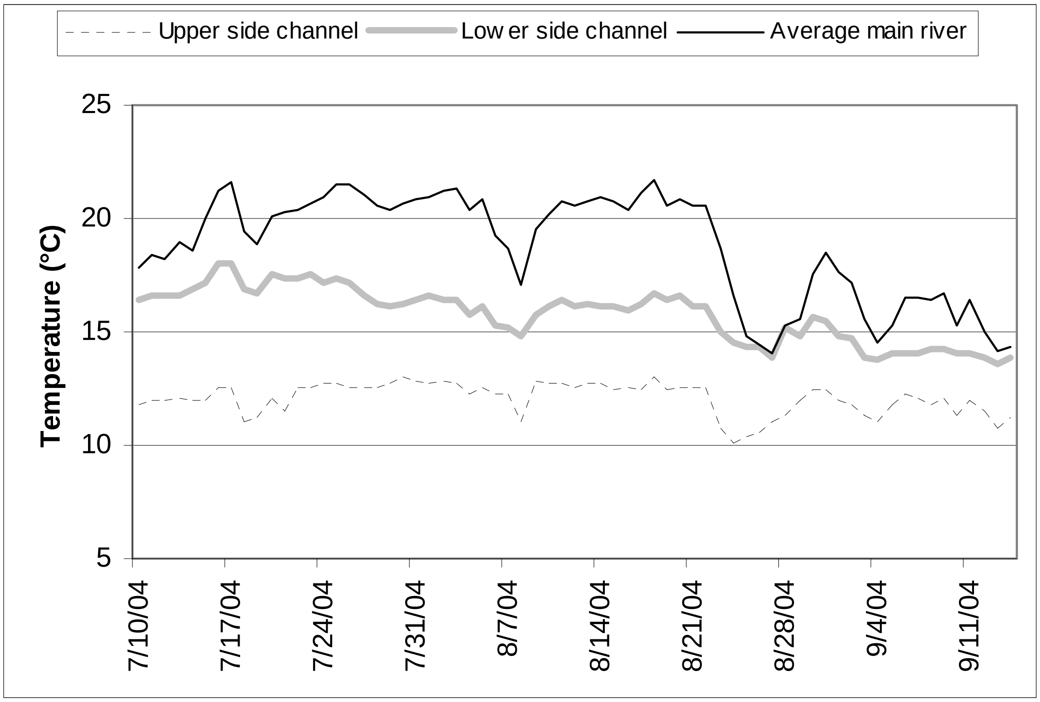


Figure 41. Maximum water temperatures in the North Fork Coeur d'Alene River, Idaho and two adjacent side channels during 2004.

Despite the warm water conditions we observed in the Coeur d'Alene River watershed during 2003, water temperatures did cool substantially at night. In the North Fork Coeur d'Alene River just upstream of Shoshone Creek (the warmest thermograph site), we found that diurnal fluctuations in daily temperatures were as great as 8.6°C when maximum temperatures occurred (Figure 42). When a maximum temperature of 26.3°C was observed during the day, it cooled down below 18°C at night. We found that radio tagged fish that did not appear to utilize areas with cold refugia (over 50% of the fish) were typically located under undercut banks, large woody debris, or boulders during the heat of the day. When we observed these fish (through snorkeling) during the hottest part of the year, they would typically be lying on the bottom, gasping significantly. We did not do any tracking at night or early morning so we were unable to verify whether these fish were more active when water temperatures were cooler. By late summer, these fish appeared to have lost weight since the spring and appeared in poorer condition than fish that utilized areas with cool water refugia.

Maximum water temperatures in the Coeur d'Alene River never reached 22°C during 2003. After June, only one radio tagged fish upstream of the South Fork Coeur d'Alene River confluence ever moved downstream into the Coeur d'Alene River. Water temperatures in July and August were 2 to 5°C cooler in the Coeur d'Alene River than occurred in the NF-lower.

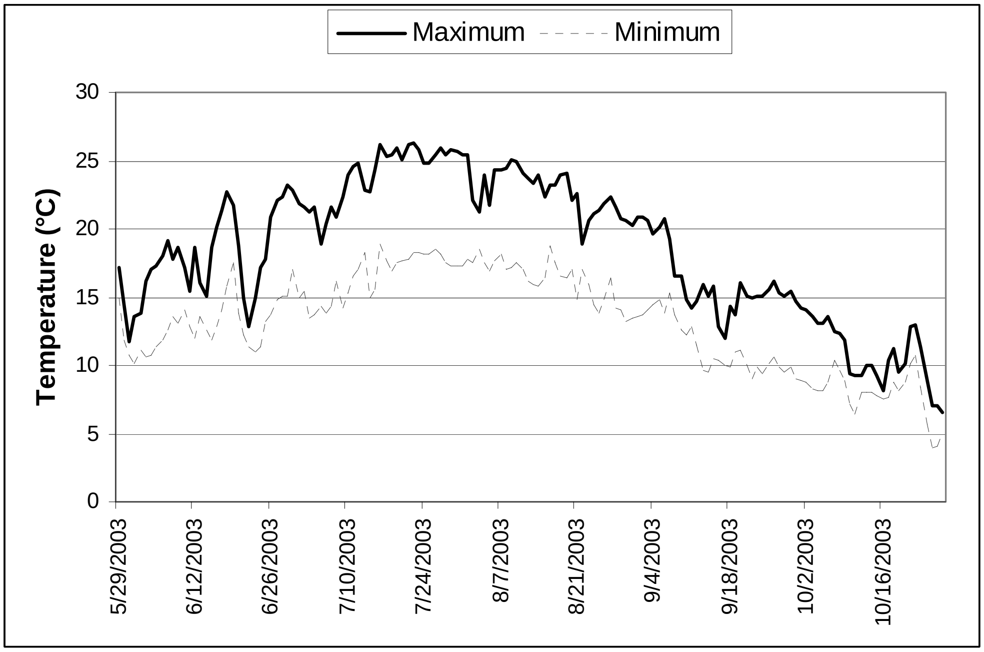


Figure 42. Maximum and minimum water temperatures recorded in the North Fork Coeur d'Alene River, Idaho, just upstream of Shoshone Creek confluence during 2003.

Post Falls Dam

The distribution of radio tagged cutthroat trout that utilized the Coeur d'Alene River did not vary considerably between high-pool and low-pool especially when focusing on the inundated segment (Figures 43 and 44). Within the inundated segment, essentially all the radio tagged fish were located in one location—a deep (~10 m) pool area at the Cataldo Mission Boat Ramp (Figures 43 and 44). Cutthroat trout were located frequently just upstream (<0.5 km) of the inundated segment but never just downstream of its boundary (Figures 43 and 44).

During the high-pool period, three different radio tagged cutthroat trout were tracked in the inundated segment, and five were tracked in segment 2 within 2.5 km of the inundated segment. During low-pool when the inundated segment becomes free flowing, seven different radio tagged cutthroat trout were tracked in the inundated segment and seven were within 2.5 km of this segment (Table 28).

Table 28. The number of radio tagged cutthroat trout that were tracked (excluding fixed-receiver data) in the inundated segment and a 2.5 km segment just upstream during high-pool (June through October 2003 and June 2004) and low-pool (November 2003 through May 2004) in the Coeur d'Alene River, Idaho.

Stage	Inundated	2.5 km Upstream
High-pool	3	5
Low-pool	7	7

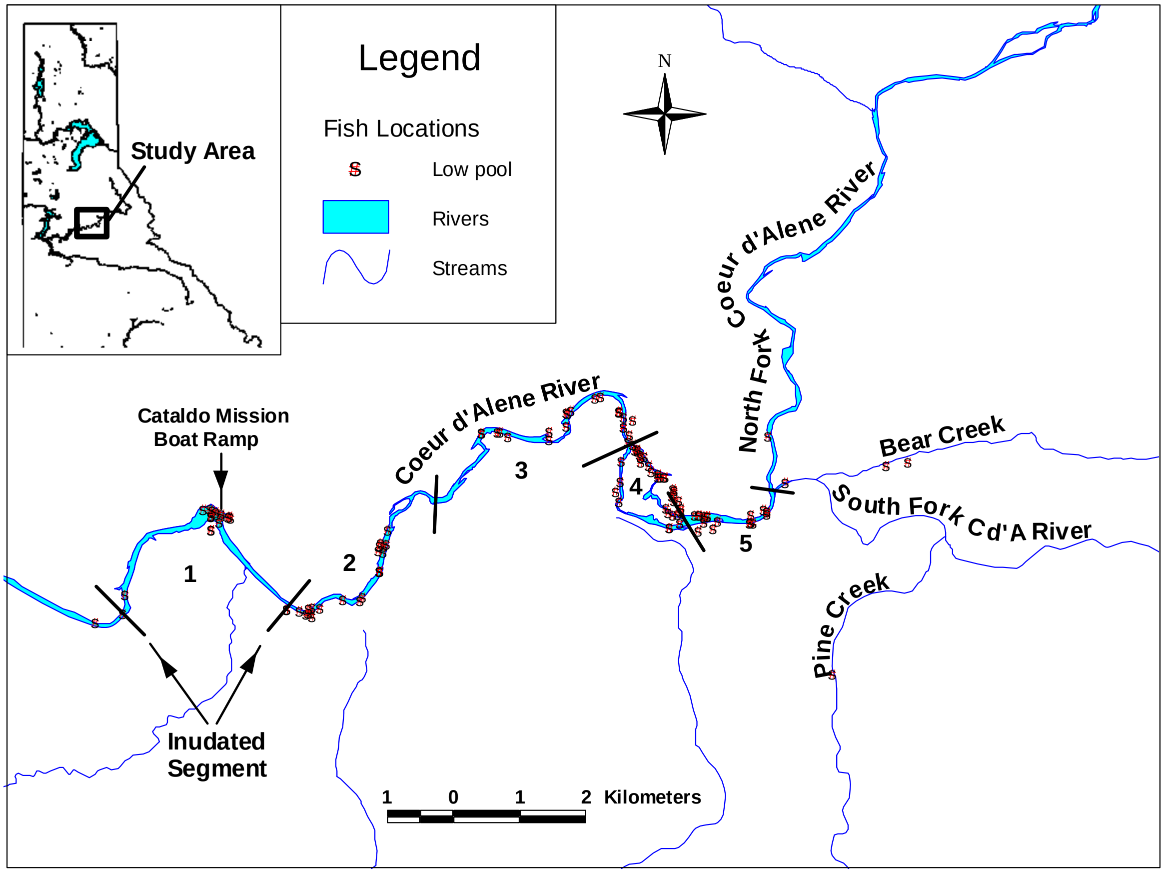


Figure 43. Locations of radio tagged cutthroat that utilized the Coeur d'Alene River, Idaho from November 2003 through May 2004.

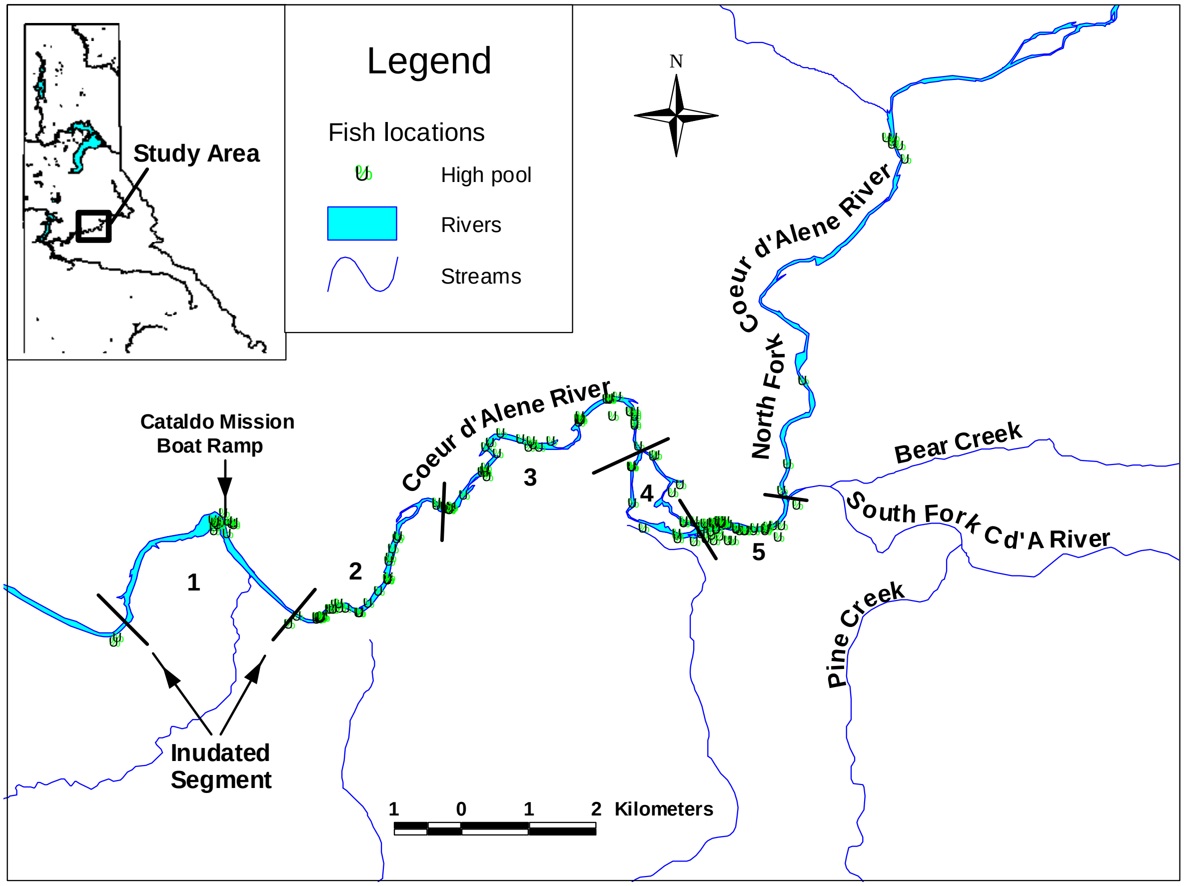


Figure 44. Locations of radio tagged cutthroat that utilized the Coeur d'Alene River, Idaho, from June through October 2003 and during June 2004.

The percent of time (use) that all radio tagged cutthroat trout in the five segments of the Coeur d'Alene River spent in the inundated segment (segment 1) during high-pool (June-October) ranged from 13-18%, similar to the percent of cutthroat trout that were radio tagged there (16%). Use of the inundated segment by radio tagged cutthroat trout increased from the high-pool period to the low-pool period when it changed from a slack water to free flowing condition (Figure 45). In fact, the inundated segment was the most frequently used segment in the Coeur d'Alene River during January and February and the second most commonly used segment during November and December (Table 29). One of the fish that spent the summer in the lake migrated upstream in December to spend part of the winter in the inundated segment. From March through May, most of the radio tagged fish moved from the inundated segment, despite its free flowing nature, to other segments of the Coeur d'Alene River (Figure 45; Table 29). These results suggest that use of the inundated segment by radio tagged cutthroat trout tended to vary considerably between three different time periods (June-October, November-February, and March-May). An ANOVA showed that use of the inundated segment by the radio tagged cutthroat trout differed significantly ($p < 0.0001$) between these three periods. Pairwise comparisons using Fisher's LSD showed that use of the inundated zone differed significantly between all three periods with the highest use occurring between November and February and the lowest use occurring between March and May.

The lowest average movement rates of the radio tagged cutthroat trout were observed in the inundated segment (segment 1) during both high-pool and low-pool whereas the higher movement rates were seen in fish that utilized segment 3 (Figure 46). Movement rates of fish utilizing the inundated segment were similar during high-pool and low-pool. An ANOVA indicated that average movement rates of radio tagged fish differed significantly between the five river segments during both high-pool ($p = 0.019$) and low-pool ($p = 0.094$). Pairwise comparisons indicated that fish utilizing the inundated segment moved significantly less than fish in all other segments except one during both the high pool and low pool (Table 30).

Throughout the entire study, we tracked six different cutthroat trout that were found (during any time) within 1 km of the boundary of segment 1 and segment 2 (the slack water interface during summer). When we evaluated the movements of these six fish over the entire study, we observed a general pattern. These fish were typically located from this boundary to approximately 2.5 km upstream of it, but never just downstream of it (Figure 47). When they were tracked in segment 1 (inundated segment), it was always in the big pool next to the Cataldo Mission Boat Ramp (1.75 km downstream of the boundary). This pattern held true regardless of whether it was during high-pool or low-pool.

Table 29. The percent of time that all the radio tagged cutthroat trout spent at each of the five designated segments of the Coeur d'Alene River, Idaho on a monthly basis from May 2003 through June 2004. Refer to Figures 43-44 for the location of each segment. Shaded cells indicate which segment had the most use during each month.

Segment	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	30%	31%	2%	5%	2%	14%	13%	19%	13%	13%	24%	29%
2	10%	12%	23%	21%	18%	20%	21%	13%	24%	28%	5%	6%
3	21%	21%	11%	15%	25%	36%	30%	25%	19%	20%	20%	31%
4	22%	25%	53%	44%	33%	9%	2%	18%	19%	9%	27%	11%
5	18%	11%	11%	15%	22%	21%	33%	25%	25%	31%	24%	23%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

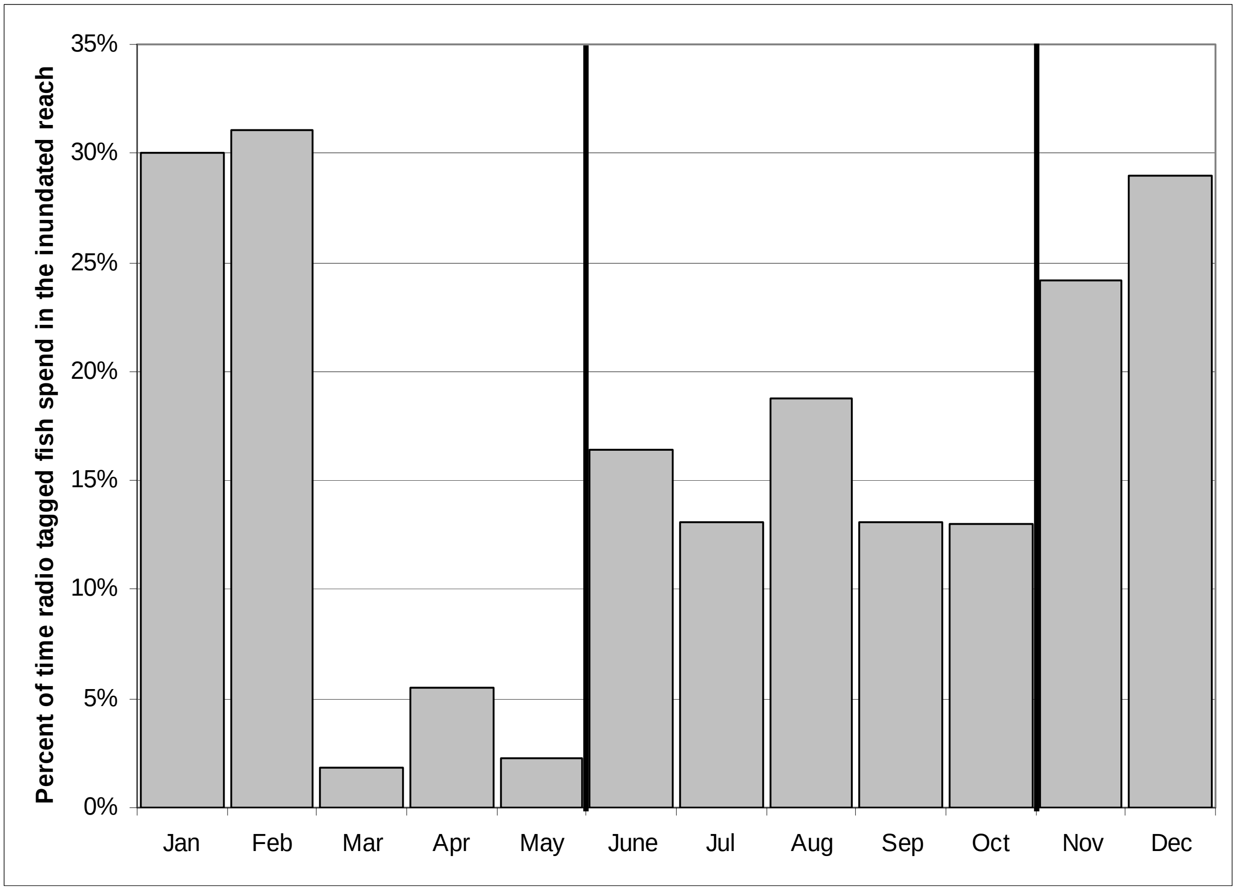


Figure 45. The percent of time that all radio tagged cutthroat trout in the five designated segments of Coeur d'Alene River, Idaho, spent in the inundated segment (segment 1) on a monthly basis from May 2003 through June 2004.

Table 30. Mean movement rates (m/hr) of radio tagged cutthroat trout (excluding fixed site data) within five segments of the Coeur d'Alene River, Idaho during high-pool (June to October 2003 and June 2004) and low-pool (November 2003 to May 2004).[a]

Period	Segment	Number of Observations	Mean Movement	90% C.I.	Letter Group
High-pool	1	11	0.15	0.11	A
	2	26	1.50	1.07	B C
	3	37	1.67	0.51	C
	4	11	0.18	0.24	A B
	5	42	0.66	0.28	B
Low-pool	1	9	0.05	0.03	A
	2	11	0.30	0.18	B
	3	12	1.86	1.21	C
	4	26	1.07	0.66	B C
	5	13	0.56	0.78	A B C

[a] Refer to Figures 43 and 44 for the location of each segment. Pairwise comparisons (Letter Group) were conducted using Fisher's Least-Significance-Difference Test with a p-value of 0.10 denoting significant differences.

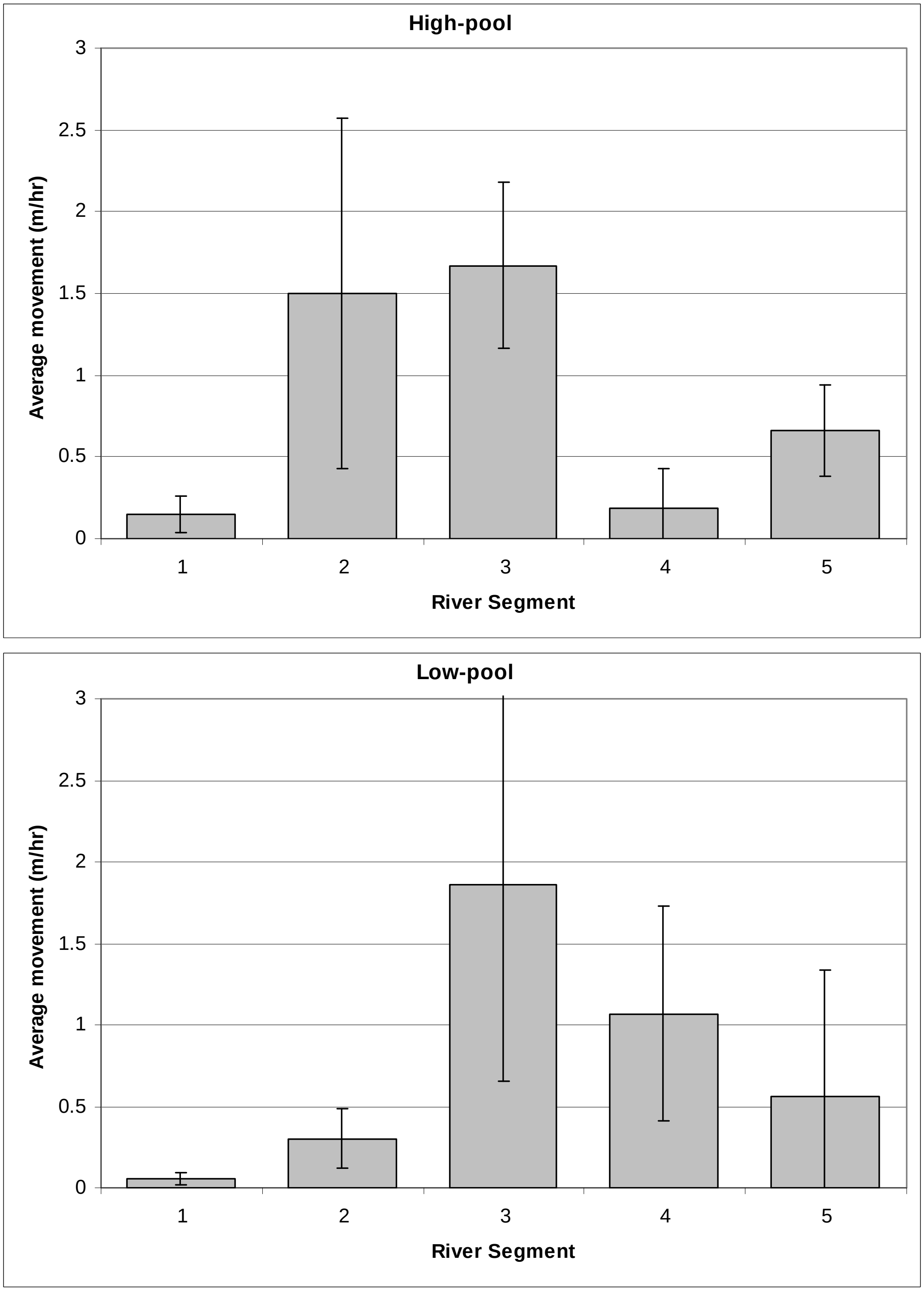


Figure 46. The average amount of movement that all radio tagged cutthroat trout displayed while utilizing segments 1-5 of the Coeur d'Alene River, Idaho, during high-pool (June to October 2003 and June 2004) and low-pool (November 2003 to May 2004).

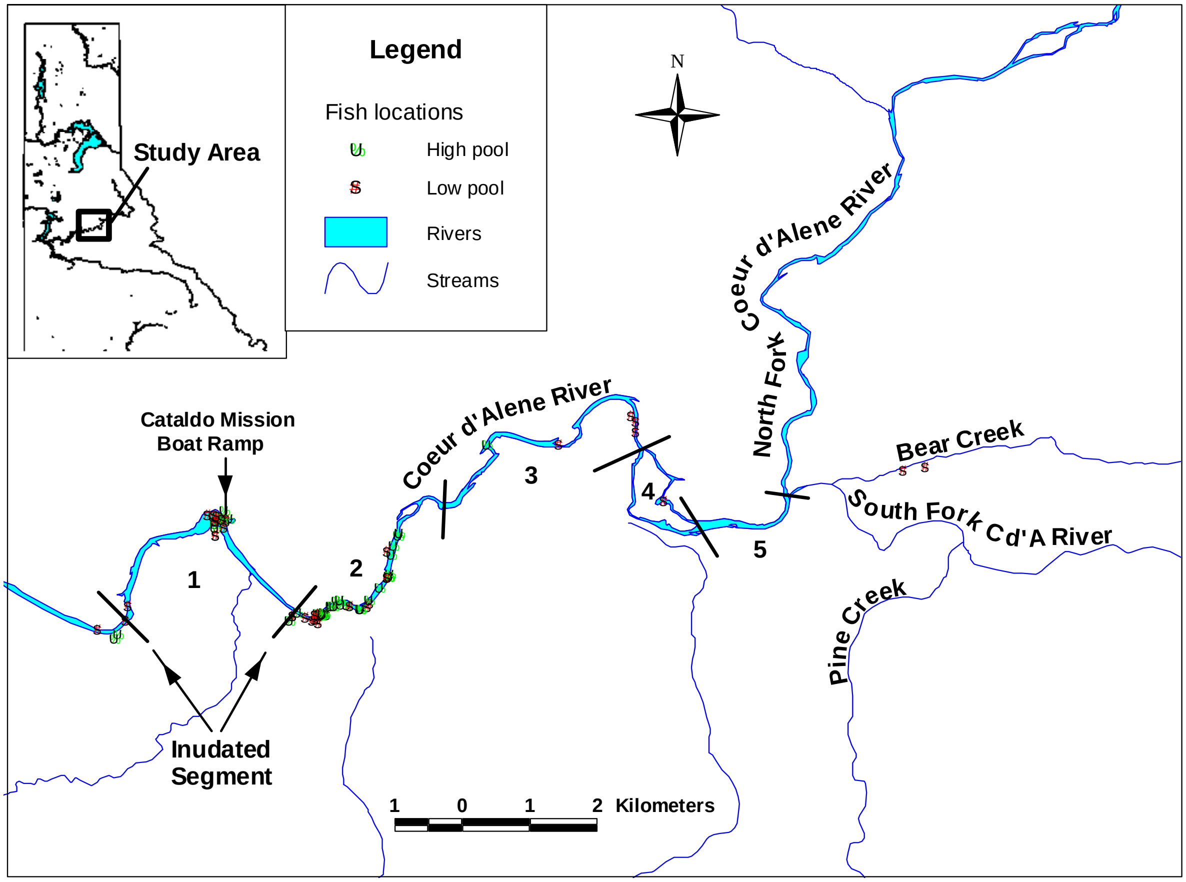


Figure 47. All locations of radio tagged cutthroat trout that were located, during any time, within 1 km of the boundary between stream segments 1 and 2, Coeur d'Alene River, Idaho, from May 2003 through June 2004.

DISCUSSION

Potential Limiting Factors

The primary goal of this study was to determine why densities of cutthroat trout ≥300 mm in length had not increased in the North Fork Coeur d'Alene River watershed (1973-2002) based on snorkel survey data (DuPont et al. In Press). Based on our research, there appear to be several factors that we believe can help explain why densities of cutthroat trout ≥300 mm have been suppressed, even while smaller fish were increasing in density since the early 1980s. We believe none of these factors alone is totally responsible for suppression of the larger cutthroat trout. Some we are only speculating on and will require further research to better evaluate this issue. However, we believe the following factors play some role in the suppression of cutthroat trout ≥300 mm in length and efforts to correct these problems should lead to improvements in this fishery.

- Noncompliance with fishing regulations.
- Degraded or loss of coldwater refugia.

- Degraded or loss of overwinter habitat.
- Degraded summer rearing habitat.

Illegal Harvest

Illegal harvest appears to be a major factor that has lead to the suppression of cutthroat trout ≥300 mm in length in the stream reaches where limited harvest is allowed. In these stream reaches, 75% (9 out of 12) of the radio tagged fish that were killed by fishermen were too small to legally keep. This illegal harvest contributed to a very high annual fishing mortality estimate (69%) for fish ≥300 mm in length in the NF-lower subbasin. These exploitation rates would certainly explain the low densities (0.01 fish/100 m^2) of cutthroat trout ≥300 that were observed while snorkeling this area prior to our study in 2002 (DuPont et al. In Press). If we add in natural mortality, the annual mortality rate for cutthroat trout ≥300 would exceed 80%; 4 out of 75 (5%) tagged fish died from predators and 2 out of 29 (7%) died shortly after spawning. With an annual mortality rate of 80%, only 4% of the fish in the NF-lower subbasin would survive more than two years after it reaches 300 mm in length. Lewynsky (1986) reported similar annual mortality rates (>80%) for cutthroat trout >200 mm in 1973, 1980, and 1981 in the North Fork Coeur d'Alene River (limited harvest area), which helps explain why the abundance of larger cutthroat trout has not increased since then. Rankel (1971) found that total annual mortality rates in excess of 70% on cutthroat trout >140 mm in the St. Joe River (largely due to overexploitation) caused the population to crash and indicated that if survival did not increase extinction was imminent. Between 60 and 80% annual mortality reduced cutthroat trout to remnant status in Kelly Creek (Ball 1971). Improvements in annual survival to >60% in Kelly Creek and about 50% in the St. Joe River resulted in 13 and 4 times more cutthroat trout, respectively, after four years (Johnson 1977). Improvements in survival were largely due to more restrictive fishing regulations and lower fishing mortality. Although the annual mortality rates in both of these systems declined by 20-40%, it is likely that fishing mortality declined by more than this but was compensated by increases in natural mortality (Johnson 1977). To reduce annual mortality rates on cutthroat trout ≥300 mm in the North Fork Coeur d'Alene River to <50% it may require a reduction in fishing mortality by 40-50%.

The high mortality rates observed in cutthroat trout in the NF-lower subbasin may have wider impacts than in just this subbasin. Our movement work showed that fish from the NF-lower subbasin assemblage displayed the longest spawning migrations and potentially mix with fish from several other subbasin assemblages. As a result, loss of fish from the NF-lower subbasin could also be impacting fish densities in other subbasins.

Age and growth work conducted by Lewynsky (1986) in 1980-1981 found that after a cutthroat trout reaches 300 mm in length it grows approximately 75 mm over the next year and approximately 50 mm the second year. Based on these growth rates, very few fish would reach legal size (>406 mm) in the NF-lower subbasin, similar to what we saw in our snorkel surveys in this section of river during 2002 (DuPont et al. In Press).

The NF-lower subbasin, where the highest fishing mortality was observed, has roads paralleling both sides of the river allowing easy access for anglers. In addition, a high number of summer homes occur along this reach of stream. If individuals were intentionally harvesting undersized cutthroat trout, this would allow them to quickly harvest a fish and hide them in a vehicle. In addition, recreation float traffic during a summer weekend in this section of river often exceeds 1,500 people a day (Jack Dorrell, U.S. Forest Service, Personal Communication). Occasionally these people take a rod along with them. In our discussions with several of these floaters, many did not actually know what the regulations were, how to identify fish, or have a tape measure to know what size the fish were. Conservation officers have indicated they are observing the same thing (Craig Walker, IDFG, Personal Communication). We are uncertain what impact this type of fisherman has on the overall harvest of cutthroat trout, but because of the large number of floaters using this river, it could be substantial. Gigliotti and Taylor (1990) found that in waters with low densities of fish and high fishing effort it did not take a high amount of noncompliance (15%) to suppress a fishery. What we are observing in the NF-lower subbasin far exceeds these types of noncompliance rates.

Cutthroat trout are considered an easy fish to catch (Trotter 1987) which may be a result of evolving in unproductive waters where aggressive feeding must occur to obtain adequate food supplies (Rieman and Apperson 1989). In addition, Dwyer (1990) found that westslope cutthroat trout were the easiest to catch of three different subspecies of cutthroat trout. Lewynski (1986) found that cutthroat trout were significantly more vulnerable to angling than rainbow trout. The aggressive feeding habits that westslope cutthroat trout display would make them vulnerable to even less experienced fishermen and helps indicate why anglers are able to exploit cutthroat trout at such a high rate in sections of the Coeur d'Alene River basin.

In 1993, Schill and Kline (1995) evaluated noncompliance with the fishing regulations in the North Fork Coeur d'Alene River using random response surveys. Through this technique they determined that noncompliance with the fishing regulations (keeping fish that were too small) between Prichard Creek and Yellow Dog Creek was 5.3%. These results suggest that noncompliance was not a serious source of mortality for cutthroat trout. In the particular reach where Schill and Kline (1995) conducted their study (Prichard Creek to Yellow Dog Creek), none of our radio tagged fish were actually harvested by fisherman, also suggesting that illegal harvest is low in this area. However, our research showed that fish that utilized this reach of river for extended periods of time will move into Shoshone Creek (probably as a coldwater refugia) as water temperatures warm up in the main river. In Shoshone Creek, we found illegal harvest and annual fishing mortality (67%) to be high. We are not certain what impact this illegal harvest is having on the fishery in the main North Fork as we don't know what percent of these fish utilize Shoshone Creek. Densities of cutthroat trout ≥300 mm in this reach of the North Fork were consistently among the lowest we observed (0.04 fish/100 m^2) in the watershed through our snorkel surveys (DuPont et al. In Press). A church camp has a special use permit to use property around the mouth of Shoshone Creek and hundreds of people potentially stay there each year. Many people staying at this church camp recreate in Shoshone Creek and may indicate why we observed such high exploitation rates there. If this is occurring, a simple educational program could solve the problem. Conservation officers have also found high noncompliance by anglers camping along Shoshone Creek (Craig Walker, IDFG, Personal Communication).

Only one radio tagged fish was definitely killed by an angler in catch-and-release waters (28 fish spent more than 20 days in catch and release areas) suggesting illegal harvest is not a significant problem in these areas. These findings are supported by work conducted by Schill and Kline (1995) where they essentially found that cutthroat trout were not being illegally harvested in the catch-and-release areas. In addition, we believe that no radio tagged fish were harvested in any section of river when the entire river was closed to the harvest of cutthroat trout (between April 1 and May 29). These findings suggest that people are more apt to violate size restrictions (keep fish smaller than allowed) than they are to keep a fish when the season is closed or in a catch-and-release area. Schill and Kline (1995) also reported similar findings on the Coeur d'Alene River as people were approximately twice as likely to harvest a fish that was too small than they were to harvest a fish in a catch-and-release area or to harvest over their limit where some harvest was allowed. We believe this difference is even greater than Schill and Kline (1995) reported, as they did not account for people who thought they were compliant when in fact they were not. For example, during our work on the river, we talked to several anglers who kept illegal sized fish that they thought were big enough to keep. These fishermen did not have a tape measure, and consequently had to estimate the size of the fish they caught. Conservation officers have also noticed the same thing on the Coeur d'Alene River (Craig Walker, IDFG, Personal Communication).

In 2002, densities of cutthroat trout ≥300 mm in the main North Fork Coeur d'Alene River were approximately 10 times higher in the catch-and-release areas than the limited harvested areas (DuPont et al. In Press). Although illegal harvest does not appear to be a problem in all stream reaches, the high exploitation rates we observed in the NF-lower subbasin could be a major driving factor for the low densities we record in our snorkel surveys. The sites that we snorkel in the NF-lower subbasin comprise 46% of the area of all the sites on the main river. For that reason, when we summarize the density of cutthroat trout ≥300 mm in all sites along the main North Fork Coeur d'Alene River, the low densities in the NF-lower subbasin can make it appear densities are low in all areas when in actuality the densities were considerably higher in the catch-and-release areas.

Snorkel counts during 2003 and 2004 for the first time since 1973 showed increasing trends in densities of cutthroat trout ≥300 mm in all limited harvest areas except in the Little North Fork Coeur d'Alene River (DuPont et al. In Prep a). Changes in the fishing regulations for cutthroat trout occurred in the year 2000 and could possibly explain this increase. The regulations changed from 1 fish ≥14 inches to 2 fish with none between 8 and 16 inches. Because fishermen have the tendency to over exaggerate fish size they would be likely to harvest more fish ≥300 mm with the older regulations than the newer regulations, especially if they did not have tape measures. As indicated earlier, conservation officers have stated that many fishermen do not actually carry tape measures with them while fishing. Work by Paragamian (1982) supports this theory as most sublegal largemouth bass that were kept in a lake in Iowa were close to the legal size. Despite this, we are uncertain that the changes in the regulations are responsible for this increase in density as it was also observed in most catch-and-release areas where regulations have remained the same since 1988.

In the LNF subbasin, every fish we originally tagged in the catch-and-release area in May and June migrated downstream of Laverne Creek (into the limited harvest area) to where they spent the summer and winter. Unfortunately, our sample size was limited (four fish, two of which died) so it's unclear that this is a typical pattern. Our snorkel data support this assumption as upstream of Laverne Creek cutthroat trout ≥300 mm were rarely observed (DuPont et al. In Press). Most of the potentially better habitat (larger, deeper pools with more cover) occurred downstream of Laverne Creek and summer water temperatures were favorable for cutthroat trout (<22°C) in much of this reach. One of the four fish that spent significant time (>20 days) in the lower river was harvested (illegally—too small) by a fisherman. In addition, after our study was over an angler harvested another one of these fish (illegally—too small). The two fish that were not harvested lived in logjams where they would be difficult to catch. Although these data are limited, they suggest that exploitation may be suppressing this fishery, especially if most fish that spawn in the catch-and-release area spend the summer and winter in the limited harvest area. Densities of cutthroat trout ≥300 mm observed while snorkeling the Little North Fork Coeur d'Alene River have been consistently low (<0.1 fish/100 m^2; DuPont et al. In Press).

Concerted effort should be made to reduce fishing mortality in those reaches where we believe noncompliance is significantly increasing fishing mortality and possibly suppressing the fishery. These areas include the NF-lower, Shoshone (lower 4 miles) and LNF (downstream of Laverne Creek) subbasins. Efforts should include increasing the public's awareness of what the regulations are and the impacts noncompliance appears to be having on the fishery (post more signs and talk more with the public), as well as increasing enforcement activities. Michaelson (1983) found that where illegal harvest was suppressing a fishery in a lake it took only a year after enforcement was significantly increased to see substantial improvements in the fishery.

Coldwater Refugia

During 2003, the maximum water temperature in the main channel of the entire North Fork Coeur d'Alene River downstream of Tepee Creek exceeded 22°C with reaches around Shoshone Creek and Prichard Creek exceeding 25°C. Hunt (1992) found in the Lochsa River, Kelley Creek, North Fork Clearwater River, and the St. Joe River, some of the top cutthroat trout fisheries in northern Idaho that westslope cutthroat trout tended to avoid or move from stream reaches when maximum water temperatures exceeded approximately 22°C. Bjornn and Reiser (1991), the USEPA (2003), and Behnke (1992) also reported similar avoidances by salmonids when water temperatures reached approximately 22°C. McMahon et al. (2006) found that the preferred temperature of westslope cutthroat trout was 14.8°C. Similarly, Dwyer and Kramer (1975) reported the activity of cutthroat trout was highest at 15°C and Hickman and Raleigh (1982) stated that 12-15°C was their optimum temperature range. Bell (1986) found the upper lethal temperature for cutthroat trout to be 22.8°C and Behnke and Zarn (1976) reported that cutthroat trout would not persist where temperatures consistently exceed 22°C. Bjornn and Reiser (1991) also suggested that salmonids are placed in life threatening conditions when water temperatures exceed (23-25°C). Laboratory studies have shown that trout reduce and finally cease feeding as water temperatures rise above 22°C (Dickson and Kramer 1971). As water temperatures reach 20-21°C, other species may have a competitive advantage over cutthroat trout and may outcompete them for food and/or space (Reeves et al. 1987; DeStaso and Rahel 1994). Despite these avoidances and disadvantages when water temperatures reach approximately 22°C, cutthroat trout have been able to withstand temperatures >25°C if these maximum temperatures were short and considerable cooling occurred at night (Behnke and Zarn 1976; Bjorn and Reiser 1991; Johnstone and Rahel 2003).

We must assume that cutthroat trout tend to move from areas where water temperatures exceed approximately 22° to maximize growth and food assimilation and to compete better with other species. In addition, added growth and body fat would increase chances of survival through other stressful periods such as harsh winter periods (Shutter and Post 1990; Harig et al. 2000) and spawning (Cunjak et al. 1987). In our study, we did not observe upstream movements of cutthroat trout into areas with cooler water temperatures. In fact, what we tended to observe after spawning was a general downstream movement, approximately the opposite of what Hunt (1992) observed in other cutthroat trout rivers in northern Idaho. The difference in morphology between the Coeur d'Alene River watershed and those studied by Hunt (1992) may help explain this difference in movement. The Lochsa River, Kelley Creek, North Fork Clearwater River, and the St. Joe River all flow through V-shaped canyons with small tributaries entering throughout most of their reach. Essentially, as you move upstream the flow and channel size slowly gets smaller and smaller. The Coeur d'Alene River on the other hand has a dendritic drainage pattern where major channels branch off and then branch again causing the size of the main channel to decline quickly. For this reason, if a fish in the Coeur d'Alene River were to migrate upstream to find areas where water temperatures did not exceed 22°C it would have to move to stream reaches much smaller in size than in the rivers previously mentioned. The depth and size of the pools in many of the major tributaries that have water temperatures

<22°C are not suitable to hold large numbers of fish ≥300 mm in length. For this reason, cutthroat trout may have been forced to utilize different strategies to cope with the warm waters that we observed in the North Fork Coeur d'Alene River watershed.

None of our radio tagged fish died when water temperatures exceeded 22°C, although while tracking during this period we observed dead rainbow trout, mountain whitefish, and torrent sculpin, species that have a higher tolerance to heat than cutthroat trout (Bell 1986; Grafe 2002; USEPA 2003), that we assumed had died from temperature related stresses. Because no dead cutthroat trout were observed while tracking, and none of our radio tagged fish died during this period (2 lived in areas where the maximum temperature reached 27°C), it appears that cutthroat trout have developed strategies in this system to survive through periods when water temperatures exceeded 22°C. We found our radio tagged fish to utilize four different strategies when water temperatures exceeded 22°C. Three of these strategies involved moving to areas where coldwater refugia occurred (4-10°C cooler than what occurred in the main river channel). This included: 1) moving to the mouths of tributaries, 2) into tributaries, and 3) into side channels with coldwater upwellings. Approximately half the radio tagged fish used one of these three strategies while the other half appeared to move into shaded areas under cover such as undercut banks, large woody debris, or boulders. When we observed these fish (through snorkeling) during the hottest part of the year, they would typically be lying on the bottom, gasping significantly. By late summer, these fish appeared to have lost weight, and appeared in poorer condition than fish that utilized areas with cool water refugia.

Several large tributaries appear to have the potential to provide an abundance of coldwater refugia that could support large numbers of cutthroat trout during critically warm periods. However, Shoshone Creek was the only tributary that any radio tagged fish moved into at any time during the summer. Two migrated into this stream during the summer and three others were captured and radio tagged there. Based on previous sampling in this tributary, it appeared these fish moved into the tributary in early June. By September, all of the surviving fish in this tributary had migrated out to the main river. These movement patterns lead us to believe that these fish were utilizing the stream as a coldwater refugia. This stream has limited deep (>1 m) pools and cover making it unlikely they were utilizing the stream for habitat reasons. It also seems unlikely these fish were utilizing Shoshone Creek for forage reasons as when snorkeling Shoshone Creek we often observed 10-30 other trout near our radio tagged fish suggesting that competition for food would be high. Shoshone Creek flows into the North Fork in the area where we observed the warmest water temperatures (>27°C) leading to its importance as a coldwater refugia. Unfortunately, Shoshone Creek has been degraded from past development, road building, and logging activities, and has few pools (19%) and few areas (<7%) with depths >1 m. While snorkeling Shoshone Creek, densities of fish were very high in the few areas where ample depth and cover occurred and nearly absent in other areas. Restoration work (wood and rock placement) has occurred in Shoshone Creek in the past, which appears to be beneficial as two of the radio tagged fish were found using these areas.

Prichard Creek also entered the North Fork Coeur d'Alene River in the area where the highest temperatures were observed. None of our radio tagged fish moved into Prichard Creek during the summer even though water temperatures never exceeded 16°C (near the thermal optimum). When snorkeling large pools in Prichard Creek during the summer, few fish were seen. This apparent avoidance of this stream may be related to the elevated heavy metals that occur there (USEPA 2004), as work conducted by Woodward et al. (1997) suggest cutthroat trout will avoid waters with heavy metals concentrations actually lower than what occurs in Prichard Creek. Waters in Prichard Creek also flow subsurface for much of the area we surveyed (due to heavy bed load movement from upstream mining) except for the last 1.2 km.

This subsurface flow was likely why water temperatures were so cold in this stream, but it also reduced the amount of habitat available for fish.

Based on these findings, two of the tributaries that appeared to have the most potential to provide coldwater refugia for cutthroat trout, in an area where it was needed the most, were degraded. Restoration work that improves pool depth and quantity, cover and water quality should allow these streams to support more cutthroat trout during a critical period when water temperature in the main river may cause undue stress. This in turn could lead to improvements in the densities of cutthroat trout observed in a reach of the main river where some the lowest densities of cutthroat trout ≥300 mm were observed during our snorkel surveys (DuPont et al. In Press).

Another stretch of river that has the potential to provide ample coldwater refugia is actually the upper North Fork Coeur d'Alene River from approximately Jordan Creek upstream. Water temperatures in this stretch of stream never exceeded 22°C during our study and ample flow occurs to support a large number of fish. This section of stream is managed as catch-and-release and occurs in a mostly roadless area. However, repeated fires have left this section of river with little cover and recruitable large wood, which helps explain why few pools occur in this area. Where pools do occur in this reach, fish are very abundant (DuPont et al. In Press). Over time, recovery from these fires should lead to improvements in this habitat and increases in the overall abundance of cutthroat trout in the Coeur d'Alene River.

Numerous smaller tributaries have cool waters (22°C) although none of our radio tagged fish moved into them during the summer. The shallow depths and small size of these streams may prohibit or deter use by larger cutthroat trout. However, our work showed that in smaller sized watersheds the radio tagged fish located near the mouths of tributaries down to 500 ha in size during warm summer months. Near the mouths of these tributaries, water temperatures were around 5°C cooler than the main river. Other researchers have reported similar findings (Beschta et al 1987; Bjornn and Reiser 1991). Our tracking suggests that the larger the river is that the tributaries flow into, the less their mouths are used for coldwater refugia. Only the mouths of the largest tributaries were used in the North Fork downstream of Tepee Creek. For example, DuPont et al. (In Prep b) snorkeled where Prichard Creek enters the main river in August 2005 and observed 42 different cutthroat trout within 7 m of Prichard Creek (DuPont et al. In Prep b). The cold water flowing from smaller tributaries appears to be quickly diluted when they mix with the flows of the larger main North Fork. Maintaining maximum shade and a fully functioning floodplain along tributary streams remains an important strategy to improve coldwater refugia habitat for cutthroat trout. (Williams et al. 1997; Wissmar and Bisson 2003)

Tributaries were not the only waters that provided coldwater refugia. Radio tagged fish were tracked to four different side channels during the summer months where concentrations of fish were observed. These side channels appear to be the most important form of coldwater refugia in the NF-lower subbasin as 50% of all radio tagged fish that utilized this subbasin during late July/early August were located in side channels. Water temperatures in these side channels were 4-9°C cooler than the main river and received their cooler water from resurfacing hyporheic flows. In two different side channels where radio tagged fish were tracked, over 500 salmonids were observed in approximately a 70 m reach with approximately 10% of them being cutthroat trout. Selection of side channels by fish where groundwater or upwelling occurs has been documented for spawning (Lister et al. 1980; Bonnell 1991; Geist et al. 2002), rearing (Sheng et al. 1990; Groot and Margolis 1991; Morely et al. 2005), refuge from high flows (Bustard and Narver 1975; Peterson 1982; Nickelson et al. 1992), and overwintering (Bustard and Narver 1975; Tschanplinski and Hartman 1983; Swales and Levings 1989; Nickelson et al.

1992; Morely et al. 2005). However, we are unaware of any publications that state these types of side channels are used as summer coldwater refugia for adult fish. Water temperatures in most of these study areas had temperatures in the main river that did not exceed 20°C and may explain why adult fish did not congregate in these side channels. Nonetheless, we believe that in other systems where water temperatures exceed 22°C cool side channels are important as we observed fish congregating in four different side channels during our study. Unfortunately, habitats such as these may be limited in number in the Coeur d'Alene watershed as development, dyking of the river, and road construction has lead to many side channels being cut off from the main river or eliminated altogether. These practices also have made it less likely that new side channels will form. Loss of side channel habitat has been observed in numerous rivers where development has occurred in the floodplains (Meehan 1991; Nickelson et al. 1992; Beechie et al. 1994; Roni et al. 2002; Wissmar and Bisson 2003; Morely et al. 2005). Loss of side channel habitat could have lowered the carrying capacity in the NF-lower subbasin for larger cutthroat trout. Construction of side channels has been successful in creating habitat with cooler water than the main river and has been found to be used by fish at higher levels than naturally occurring side channels (Morely et al. 2005). In less disturbed rivers, reconnecting existing off-channel habitat can also be an effective restoration technique that is less expensive and less disruptive (Roni et al. 2002). Construction and reconnection of side channel habitat could be used to improve lost side channel habitat and cool water refugia in the Coeur d'Alene River system.

Maintaining a connected, fully functioning floodplain also has more benefits than maintaining side channel habitat. Based on our stream temperature work, water temperature appeared to increase as it flowed through confined reaches (little floodplain existed) and declined when it flowed through unconfined areas with wide floodplains. For example, the highest water temperatures (27°C) were observed in the main North Fork near Shoshone and Prichard creeks, which is mostly confined by a narrowing of the valley. Approximately 8 km downstream of Prichard Creek the river enters a wide floodplain and temperatures continually decline to the point where they never reached 22°C in much of the free flowing reach of the Coeur d'Alene River. This same cooling pattern was also observed in the Little North Fork Coeur d'Alene River as temperatures decreased lower in the subbasin where a wide floodplain occurs. This same cooling pattern has been reported by others (Hauer et al. 2003; Kasahara and Wondzell 2003; Cardenas et al. 2004). The cooling process can be explained by the large volume of water that flows subsurface through floodplains (hyporheic zone). Where cooler subsurface flow mixes with surface water it causes cooling of the river. Reducing the hyporheic zone through road building, dyking, or other means can greatly reduce the amount of subsurface flow that occurs and its ability to cool the river (Brunke and Gonser 1997). Without the cooling effect that we observed in the Coeur d'Alene River system, we believe much of the lower river would frequently reach water temperatures that would not support salmonids. For this reason, future activities occurring within floodplains need to be carefully planned to ensure the floodplains maintain their fully functioning benefits.

The one reach of our study area that appears to provide the most cool water refugia is the free flowing stretch of the Coeur d'Alene River where a large functioning floodplain exists. The majority of this reach of river never had maximum temperatures exceed 22°C. However, only one of our radio tagged fish moved downstream into this reach when water temperatures began warming in the main river. For more than 70 years, everything downstream of the South Fork was toxic from heavy metal pollution and no life at all occurred in the river until 1971 (Rabe and Flaherty 1974). Based on this information, cutthroat trout probably developed life cycles that avoided this stretch of water as those that ventured downstream of the South Fork likely died. Cutthroat trout will avoid waters with heavy metal concentrations that occurred in the Coeur d'Alene River during our study as determined by lab studies (Woodward et al. 1997). These reasons may explain why cutthroat trout appear to avoid a stretch of river that has an abundance of coldwater refugia. Interestingly, every one of the radio tagged fish that utilized the Coeur d'Alene River during the summer and winter that subsequently went on spawning runs, spawned in tributaries or had to migrate through areas that had elevated heavy metals caused from past mining practices (Ott and Clark 2003; USEPA 2004). These levels were above what Woodward et al. (1997) found cutthroat trout will avoid. This observation may suggest that some type of acclimation to heavy metals occurs while rearing or migrating through areas with elevated heavy metals which would preclude an avoidance behavior to the heavy metals that occurred downstream of the South Fork. However, Woodward et al. (1997) found that in lab conditions cutthroat trout acclimated to certain heavy metals could still detect and would avoid waters with higher heavy metal concentrations. Over time, cleanup activities in the South Fork and main Coeur d'Alene rivers may decrease heavy metal levels low enough that fishes will begin utilizing this area as a coldwater refugia during periods of extreme temperature.

Power et al. (1999) suggests that coldwater refugia will extend the range of many fish species into areas where water temperatures would be too warm to exist in. Despite this, it's not certain that improvements in coldwater refugia will increase densities of cutthroat trout ≥300 mm in the Coeur d'Alene River watershed, especially since none of our radio tagged fish appeared to die from natural causes during the hottest period of the year. However, it was observed that those fish that did not utilize cool water refugia had lost a noticeable amount of weight during the summer and appeared in poorer condition than fish that utilized areas with cool water refugia. Without significant weight gains prior to winter, we would expect overwinter mortality and spawning mortality to be higher for these fish. Cunjak et al. (1987) found with brook trout that insufficient energy intake during winter coupled with depleted energy reserves from spawning resulted in higher mortality rates. One could assume the same would also occur with depleted energy stores from heat related stresses. Shutter and Post (1990) claim that smaller fish tend to be less tolerant of starvation conditions because they exhaust their energy stores sooner. Meyer and Griffith (1997) found smaller fish had lower rates of overwinter survival only when environmental conditions were more severe. Many others have also found winter to be a major period of fish mortality based largely on the severity of the winter and subsequent losses of stored energy (Reimers 1963; Paragamian 1981; Whitworth and Strange 1983). We believe that overwinter survival could be quite significant during periods of intense cold especially for those fish previously exposed to heat related stresses and weight loss. Cold winters in the St. Joe River have been followed by declines in densities of cutthroat tout (DuPont et al. In Prep b). A series of mild winters (five out of six years had above average temperatures) has occurred in the Coeur d'Alene River from 1998 to 2004 (Biological and Agricultural Engineering Department 2005) and may help explain why recent increases in densities of cutthroat trout ≥300 mm have been observed in most stream reaches where we conduct our snorkel surveys in the North Fork Coeur d'Alene River watershed.

If degraded and lost coldwater refugia is helping to suppress densities of cutthroat trout ≥ 300 mm, then we need to explain why it isn't having the same influence on the smaller fish, as their densities have been increasing over time. Several differences in habitat use and behavior of the smaller fish that can help explain these differences. First, cutthroat trout will rear up to three years in tributary habitat before out-migrating to the river (Averett 1971; Thurow et al. 1975; Horton and Mahan 1988) where they would have to withstand the warm temperatures that occur there. Second, during warm summers, smaller fish could migrate back into tributaries that may be too small to support larger fish. In addition, many larger tributaries that could support bigger fish are dominated by riffle habitat, shallow water, and little cover. These shallow systems may support only a few larger fish while the smaller fish could still utilize much of this habitat. For example, high numbers of cutthroat trout <300 mm in length were observed in Shoshone Creek in many areas where no larger fish were seen. Third, smaller fish have the ability to move into interstitial spaces in the substrate where they are protected by cover and shade and possibly cooled by subsurface flows associated with the hyporheic zone. Drake and Taylor (1996) observed in an eight-year study that in warm years a brook trout population was dominated by smaller fish. Temperatures did not appear to affect the growth of these younger fish, which they attributed to the ability of smaller fish to find suitable thermal microhabitats in the substratum probably associated with groundwater springs and groundwater flux through the hyporheic zone. Finally, our work indicates that most cutthroat trout in the Coeur d'Alene River do not spawn until they exceed 300 mm in length. Lewynsky (1986) also reported similar findings. Thus larger fish that do not utilize coldwater refugia must endure summer temperature stresses followed by winter stresses followed by spawning stresses while smaller fish would not, suggesting a higher natural mortality rate on larger fish.

Overwinter Habitat

Degraded or lost overwinter habitat that would support larger cutthroat trout could explain why the density of cutthroat trout ≥300 mm had not increased in the Coeur d'Alene River systems while densities of smaller fish had. An abundance of research has shown that smaller cutthroat trout utilize different habitat than larger fish during winter. Cutthroat trout <200 mm are typically found utilizing the voids in a stream's or river's substrate (Heifetz et al. 1986; Bjornn and Reiser 1991; Griffith and Smith 1993; Bonneau 1994; Power et al. 1999). As cutthroat trout get larger, they may not be able to use the voids in the substrate and would be forced to utilize different habitat (Bjornn and Reiser 1991). Cutthroat trout >200-300 mm have been found to utilize slow deep pools in larger river systems in the winter (Thurow 1976; Lewynsky 1986; Bjornn and Reiser 1991; Hunt 1992; Schmetterling 2001). Loss of critical pool habitat could theoretically have a large impact on a cutthroat trout fishery, especially in those systems where fish appear to congregate in only a few pools.

In our study, only one of the radio tagged cutthroat trout migrated more than 15 km from summer habitat to reach areas where they spent the winter. These overwinter areas were located throughout our study area except in the NF-upper, Shoshone, and Prichard subbasins. The widespread nature of the areas that the radio tagged cutthroat trout overwintered at suggests that there is an abundance of this critical type of habitat. Other studies on movement of westslope cutthroat trout in larger rivers in Idaho, including the St. Joe River, North Fork of the Clearwater River, Lochsa River, and Middle Fork of the Salmon River have found that cutthroat trout make extensive migrations to winter habitat, often exceeding 100 km, to where hundreds of cutthroat trout congregated in a few deep slow pools (Bjornn and Mallet 1964; Ball 1971; Rankel 1971; Johnson 1977; Bjornn and Reiser 1991; Hunt 1992). The more limited the overwinter habitat is the more congregated we would expect fish to be. Cunjak and Power (1986) suggested that aggregations of fish may be a squeezing effect of limited habitat availability. In contrast to what was observed in these Idaho rivers, congregations of less than 50 fish were typically observed where our radio tagged fish were located during winter. The one exception was in the Coeur d'Alene subbasin where over 200 cutthroat trout were observed together in one aggregation during the winter.

The differences in valley types between the Coeur d'Alene River and these other Idaho rivers may explain differences in migration patterns of larger cutthroat trout. All of these Idaho rivers except for the Coeur d'Alene River flow through confined, steep V-shaped valleys. The Coeur d'Alene River flows through relatively unconfined, moderately sloped V-shaped alluvial valleys. Our habitat use data show that radio tagged cutthroat trout tended to move to areas with wider floodplains during winter. In fact, all the radio tagged fish that utilized river reaches where confined valley types occurred (NF-upper subbasin) migrated from these areas at the onset of winter (November) to where the river valley spread out and wide floodplains occurred. Migrations of cutthroat trout in other Idaho rivers also took them to areas where the river deepened and wider floodplains occurred (Bjornn and Mallet 1964; Ball 1971; Rankel 1971; Johnson 1977; Johnson and Bjornn 1975, 1978; Bjornn and Reiser 1991; Hunt 1992). It appears the presence of a floodplain can be a key factor in winter habitat selection for many cutthroat trout populations in larger river systems. The presence of floodplains may provide several benefits. Winter rain on snow events, which are common in northern Idaho can cause increases in energy expenditure during a critical period of survival. With adjacent floodplains, cutthroat trout can move out of the main flow where they can conserve energy. Brown et al. (2001) also found brown trout to move out into floodplain areas during periods of high water discharge when coupled with ice breakup. We observed many of our radio tagged fish in the Coeur d'Alene subbasin move out of the main river into the floodplain (located in willows) during higher flows in early spring. Schmetterling (2001) also found that cutthroat trout in the Blackfoot River, Montana, which occupies an unconfined alluvial valley, moved very little (<1 km) from summer to winter habitat. Brown and Mackay (1995a) found that cutthroat trout in a low gradient, unconfined stream with abundant groundwater migrated less from summer to winter habitat than fish located in a more confined stream and less groundwater.

Another potential benefit of floodplains in providing important overwinter habitat is that they usually maintain hyporheic flows. Where subsurface flows mix with surface water, warmer temperatures often occur in the winter (Cunjack 1996; Brunke and Gonser 1997; Power et al. 1999). Others have found cutthroat trout (Brown and Mackay 1995a; Brown 1999; Power et al. 1999), as well as other salmonids (Cunjak and Power 1986; Cunjak 1996; Power et al. 1999), to locate in areas where warmer upwellings or springs occurred during the winter. Our inability to collect water temperatures at the exact fish's location during winter precluded us from actually determining whether fish were locating in areas where warmer water temperatures occurred. However, based on the cooling effect that we observed during the summer as flows enter river reaches with floodplains, we believe this same mechanism would result in a warming effect during the winter. In the Coeur d'Alene subbasin, we documented the use of off-channel areas during late winter by two radio tagged fish that were 2-3°C warmer than the main river.

The apparent benefit floodplains provide to overwinter habitat demonstrates the importance of floodplains to the cutthroat trout fishery in the Coeur d'Alene River watershed. Future activities that occur within floodplains need to be carefully planned to ensure that floodplains maintain fully functioning.

Despite the apparent abundance of overwinter habitat in the Coeur d'Alene River system, 25-50% of the fish were located in glides for much of the winter. We are unaware of any other studies that have shown larger cutthroat trout to select glide habitat during winter. Most work suggests that in larger river systems cutthroat trout almost exclusively utilize slow, deep pools during winter (Thurow 1976; Lewynsky 1986; Bjornn and Reiser 1991; Hunt 1992; Schmetterling 2001; Zurstadt and Stephan 2004). However, Brown and Mackay (1995a) and Brown (1999) found several of their radio tagged cutthroat trout utilized shallow water during winter, especially where warmer upwellings or springs occurred. Brown and Mackay (1995a) also found that radio tagged cutthroat trout in one river displayed a two stage shift in habitat use from summer to winter with the final shift being associated with anchor ice formation and resulting in larger aggregations of fish. Brown (1999) also reported radio tagged cutthroat trout moving into larger aggregations when water temperatures dropped and anchor ice formed. We did not observe anchor ice formation during our study, and the winter of 2003-4 when we conducted our study was mild (>1°C warmer than the average winter temperature). The warm winter we experienced in 2003-2004 may have alleviated the need for the radio tagged fish to move to more traditional winter habitat (deep slow pools). Air temperatures during six of the last seven winters (1998-2004) have been above average in the Coeur d'Alene watershed (warmest series of winters on record) and may help explain why during 2003 and 2004 snorkel surveys showed an increase in densities of cutthroat trout ≥300 mm throughout most subbasins for the first time (DuPont et al. In Prep a).

If increases in density are a result of mild winters, this may suggest that during colder winters, overwinter habitat may not be suitable to or abundant enough to support large numbers of cutthroat trout. Past splash damming, road building, mining, and development has resulted in straightening of the river channel and an abundance of sediment being delivered to the system over the past 100 years (Strong and Webb 1970; IDEQ 2001). This accelerated sediment delivery coupled with straightening of the river may have resulted in a loss of much of the slow deep pool habitat in North Fork Coeur d'Alene River watershed that could be important to survival of larger cutthroat trout during cold winters. Local residents have described the loss of large deep pools after major floods in the 1960s, 1970s, and 1980s (Ed Lider, U.S. Forest Service, Personal Communication). At this point this is very speculative. Evaluating how this cutthroat trout population responds after a series of average or below average temperatures during winter may reveal how suitable the overwinter habitat is in this system.

We found only one area our radio tagged fish congregated during winter: the lower 3.5 km of Tepee Creek and in the North Fork Coeur d'Alene River within 4 km of Tepee Creek. Every one of the radio tagged fish that summered in the Tepee and NF-upper subbasins overwintered in this area. The property along this section of the North Fork Coeur d'Alene River was managed by the U.S. Forest Service whereas approximately 2.3 km (66%) of where the fish overwintered in Tepee Creek was privately owned. Many of the property owners along this reach of stream have cleared the trees and brush away from the floodplain and now maintain them in lawn like conditions. Many of these stream reaches are now experiencing severe bank erosion, and appear to be losing their cover, depth, and pool habitat. Continued degradation in this area could lead to reductions of this important overwinter habitat and could be detrimental to the Tepee Creek fishery, as it appears that all the adult cutthroat trout in Tepee Creek overwinter in this area. Efforts need to be made to educate these landowners on the importance of this reach of stream to the fishery as well as working with them in improving this critical habitat.

The Coeur d'Alene subbasin has the highest percentage of deep slow pool habitat of all the subbasins we evaluated. These conditions have been characterized as good overwinter habitat for cutthroat trout (Thurow 1976; Lewynsky 1986; Bjornn and Reiser 1991; Hunt 1992; Schmetterling 2001). However, none of our radio tagged cutthroat trout that spent the summer upstream of this subbasin move downstream into this reach during winter. We are unsure if this is a learned behavior developed from over 70 years of toxic conditions that occurred there, an avoidance response to the elevated heavy metals concentrations that currently occur there, or a result of the mild winter that we observed during our study. Based on work conducted by Woodward et al. (1997) that found cutthroat trout will avoid waters with heavy metals concentrations actually lower than what occurs in Coeur d'Alene subbasin, continued work to reduce heavy metal concentrations should increase use of these waters which may be beneficial to overwinter survival especially during severe winters.

Adult Summer Rearing Habitat

Based on our work, summer rearing habitat for adult, fluvial westslope cutthroat trout could be described as pool or run habitat where water depths exceeded 1 m, although depths >2 m tended to be selected for more highly. Others have also found adult fluvial cutthroat trout to prefer deeper pool and run habitat (Schmetterling 2001; DuPont et al. In Press). The radio tagged fish in our study were associated (within 5 m) with some form of cover about 80% of the time. Where fish were not found associated with cover it was often in areas where water depth exceeded 2 m, which would make it a form of cover in itself (Bjornn and Reiser 1991). Large wood was the form of cover preferred by the radio tagged cutthroat trout. Lider (In Prep) also found in the LNF subbasin (catch and release area) that in pools and runs, abundance of larger cutthroat (>225 mm) were positively correlated with total cover with the highest densities being associated with woody debris and overhanging vegetation.

Pool and run habitat throughout the study area represented more than 45% of the habitat in all the subbasins except in the NF-upper (33%) and Shoshone (32%) subbasins. Wood-Smith and Buffington (1996) found that in managed streams (4-25 m in width) pools represented about 50% of habitat, whereas in unmanaged channels pools represented 33% of the habitat. If we evaluate only pool frequency, only two subbasins had >43% pool habitat (CDA River and Prichard). Pools represented <35% of the area in all other habitats. In addition, in most of the subbasins (NF-mid, NF-upper, Tepee, Shoshone, and Prichard), >59% of the pool and run habitats had maximum depths ≤1 m, which our data indicates cutthroat trout ≥300 mm were avoiding. The CDA River, NF-lower, and LNF subbasins were the exceptions with >60% of the pool and run habitats having maximum depths >1 m.

The abundance of cover may also be an issue for cutthroat trout ≥300 mm in the Coeur d'Alene River watershed. In only two subbasins (NF-upper and Shoshone) did we observe >16% cover in pool and run habitats, and only in one subbasin (Prichard) was large wood, which the fish showed a preference for, the dominant form of cover. The subbasins with the least amount of cover (<10%) in their pool and run habitats were the CDA River, NF-mid, and LNF subbasins. Water depth can provide an abundant form of cover in the CDA River subbasin (100% >1 m and 87% >2 m) and LNF subbasin (61% >1 m and 25% >2 m), although not in the NF-mid subbasin (35% >1 m and 8% >2 m). When we evaluated the upper LNF subbasin (catch-and-release area), we found it had much less pool and run habitat (31%) and shallower water (67% ≤ 1 m) than the lower subbasin.

Prichard Creek, which may have abundant pool and run habitat (47%) flows intermittent for much of its reach with only the lower 1.2 km available to fish during summer months. Where the stream does flow on the surface, our limited snorkeling efforts only found a few cutthroat trout ≥300 mm. The apparent avoidance of this stream may be related to the elevated heavy metals that occur there (USEPA 2004). Work conducted by Woodward et al. (1997) suggests cutthroat trout will avoid waters with heavy metals concentrations actually lower than what occurs in Prichard Creek.

These results suggest that deeper pool and run habitat with abundant cover are limited in our study area except in the CDA River and NF-lower and lower LNF (downstream of Laverne Creek) subbasins. In the Shoshone, NF-upper, and the upper LNF subbasins, both the abundance of pools and runs as well as their depths are limited, whereas in the NF-mid, Tepee, and Prichard subbasins, pools and runs are more abundant but their shallow nature appears to be a problem. None of the subbasins appears to have considerable cover, especially large wood that the radio tagged cutthroat trout showed the greatest preference for. These results are not surprising as analysis of extensive stream inventory data has revealed that major declines in pool habitat, including their frequency, depth, and amount of instream wood, have occurred over the last 40 to 60 years in many Columbia River watersheds (Quigley et al. 1996; Lee et al 1997). These declines were attributed to losses in riparian vegetation, road and highway construction, timber harvest, grazing, farming, and other disturbances (Quigley et al. 1996). All these practices have impacted our study area, which we believe has resulted in a degradation of the pool and run habitat. As a result of these practices, the North Fork Coeur d'Alene River is currently a 303(d) listed stream, with excess sediment delivery as the pollutant of concern (IDEQ 2001). Excess sediment delivery has been blamed for a general shallowing of this river. Kershner et al. (2004) also found that in managed watersheds in the Columbia River basin pool depths were significantly shallower than in unmanaged watersheds. Others have found in managed streams pool quantity has declined over time (Overton et al. 1993; Overton et al. 1995; Wood-Smith and Buffington 1996; Lee et al 1997). Wood-Smith and Buffington (1996) attributed this loss of pool habitat to declines in woody debris.

Degraded habitat conditions will reduce the carrying capacity for larger cutthroat trout below what we would expect to see in a less disturbed system and is probably limiting cutthroat trout abundance in the more degraded subbasins such as the Shoshone, NF-upper, and the upper LNF subbasins. This is not to say that habitat conditions in other stream reaches within the Coeur d'Alene River watershed are not degraded and are not influencing cutthroat trout abundance. Past riparian logging, splash damming, mining, road building, and human development has certainly impacted habitat throughout the watershed. Considerable effort has been put into the Coeur d'Alene River watershed to reduce sediment delivery, increase structure and depth, and remove roads that encroached upon the floodplain (Ed Lider, U.S. Forest Service, Personnel Communication). Some of this work appears to be benefiting cutthroat trout. For example, in Shoshone Creek and Tepee Creek radio tagged cutthroat trout were commonly found using structure (large wood and rootwads) placed in the streams. The highest density of cutthroat trout ≥300 mm in all the transect snorkeled in the North Fork Coeur d'Alene River watershed were observed where habitat improvement work increased depth and cover (maximum depth increased from about 1 m to 3 m and available cover increased from about 5% to 15%; DuPont et al. In Prep b). Black cottonwood and cedar are also beginning to establish themselves in many stream reaches within the watershed, but will never reach historic levels due to riverside roads and human development. Continued projects to reduce sediment delivery and improve habitat conditions within the river should result in improvements in the cutthroat trout fishery. Areas where habitat conditions are allowed to improve and support more cutthroat trout would also make them more resilient to other forms of mortality such as illegal harvest.

Movement Patterns

Influence on Fishing Regulations

Our tracking efforts from May 2003 through June 2004 showed that following spawning cutthroat trout in the Coeur d'Alene River watershed tend to stay in one subbasin for the entire summer, fall, and winter seasons. This localized movement was consistent regardless of the size of the fish we tracked. The few exceptions were the fish from the NF-upper and Shoshone subbasins that migrated from these subbasins during the onset of winter, although none of these migrations exceeded 15 km. These types of movements are unique when compared to other cutthroat trout populations in Idaho where they will make long migrations (some in excess of 100 km) between summer and winter habitat (Bjornn and Mallet 1964; Ball 1971; Rankel 1971; Johnson 1977; Bjornn and Reiser 1991; Hunt 1992). Although unique to other cutthroat trout fisheries in Idaho, Schmetterling (2001) found this same behavior in cutthroat trout in the Blackfoot River, Montana. Our work also found that following spawning, cutthroat trout will return to the same area (often to the exact location) they utilized the previous year. Schmetterling (2001) found that in the Blackfoot River radio tagged cutthroat trout did not typically return to their prespawning locations and attributed it to mainstem habitat that was not limiting in abundance. The high frequency in which the radio tagged cutthroat trout returned to same summer locations may indicate a limited abundance of summer rearing habitat.

Limited movements by radio tagged cutthroat trout outside of spawning demonstrate the importance of considering each subbasin when designing fishing regulations. Because most spawning and associated migrations occur when the fishing season is closed, these cutthroat trout will be exposed to the same fishing regulations for most of their lives. This has benefits and disadvantages to the fishery. Fish that utilize areas managed as catch-and-release should only have to face natural mortality and possibly catch-and-release hooking mortality throughout their lives and have relatively high longevity. On the other hand, cutthroat trout that utilize areas with high fishing mortality will be exposed to that mortality for much of their lives, seriously reducing their chances for multiple years of survival. This appears to be the case for those cutthroat trout that utilize the NF-lower subbasin and helps explain the low densities of cutthroat trout that have been observed there during snorkel surveys (DuPont et al. In Press).

In northern Idaho, there has been a general pattern of placing catch-and-release areas for westslope cutthroat trout in upstream reaches of rivers and limited harvest areas in the downstream reaches. For most of these rivers, it gives a significant amount of protection to the cutthroat trout fishery when they utilize the upstream reaches during the summer and allows a limited amount of harvest as they migrate back downstream for the winter and spring. These types of regulations make sense in these watersheds. However, in the Coeur d'Alene River watershed where the cutthroat trout migrate quite differently, these types of fishing regulations do not necessarily make sense, and beg the question, why are the catch-and-release areas in the most upstream areas of the Coeur d'Alene watershed. Those individuals who wish to have the best chance at catching large, long lived fish must do the most traveling making day or afternoon trips more difficult. Conversely, those individuals who like to get away from "the grind" and want to travel will not have the opportunity to harvest fish if they camp in the upstream reaches of the watershed. The movement patterns this cutthroat trout fishery displays has the potential to provide unique opportunities that other rivers in northern Idaho may not.

Without better understanding of the movement patterns of cutthroat trout in the Coeur d'Alene River watershed, improvements could be made to the fishing regulations that would increase opportunities for anglers as well as protect areas that appear important to survival of cutthroat trout. For example, harvest is allowed in those areas where we observed the largest congregations of fish during the open fishing season, such as in some side channels in the NF-lower subbasin, at the mouths of Prichard Creek, and in lower Shoshone Creek. These fish move into these congregations during stressful times (warm water temperatures) which makes them more vulnerable to anglers at a time when they need the most protection. On the other hand, those areas that appear to receive the least amount of fishing pressure (NF-upper subbasin and LNF subbasin upstream of Lavern Creek), which should allow them to withstand some exploitation are listed as catch-and-release. In the LNF subbasin, it appears after spawning most large fish migrate downstream into the limited harvest area. This is not surprising as this stretch of river has the most pools, deepest waters, and wide floodplain. As a result, the catch-and-release area in this subbasin does not provide much protection to this cutthroat trout fishery.

Cutthroat trout in the Coeur d'Alene River watershed appear to reach sizes larger than most rivers in northern Idaho. The lower elevations, longer growing season, large floodplains, and abundance of deciduous vegetation (in the riparian zone) that occur there all contribute to increased productivity and higher growth rates for fish. Many believed that the larger cutthroat trout that occurred in the Coeur d'Alene River watershed were adfluvial fish; however, our study indicates otherwise. Our telemetry work found that cutthroat trout from 450-510 mm will remain in systems as small as Tepee and the LNF subbasins their entire lives. While tracking during late July, we once observed an untagged cutthroat trout in the Tepee Creek that we believed was between 550-580 mm in length. We also routinely talked to fisherman who reported catching cutthroat trout 550-610 mm long. Several of these fishermen backed up these claims with photographs of these fish. The vast majority of these large fish were reported being caught in catch-and-release areas. We believe that some of the best areas that could produce and support the most large cutthroat trout (>500 mm) currently allow limited harvest (allow harvest of fish >406 mm). Noncompliance coupled with high fishing pressure does not allow cutthroat trout to reach their potential in these areas. Typically, the larger the river (assuming suitable water temperatures) the larger fish it can support (Bjornn and Rieser 1991). The Coeur d'Alene subbasin has the largest watershed size, the most intact floodplain, suitable summer water temperatures, and some of the best overwinter habitat. The fish in this subbasin also almost exclusively utilized a 13 km reach of stream except during their spawning migration. Consequently, here is an example where a change in fishing regulations in a relatively short reach of river has the potential to increase the size structure of a fishery. Our telemetry work found that at least four different radio tagged fish were harvested by anglers in the Coeur d'Alene subbasin, and all four fish were too small to legally keep. Changing this reach of river to catch-and-release would provide an area with easy access where people would have a better chance of catching larger, long-lived cutthroat trout.

Making changes in fishing regulations anywhere in the Coeur d'Alene River watershed is apt to be highly controversial, especially with the amount of recreational activity that occurs there. However, we believe the movement patterns the radio tagged fish displayed would allow us to develop fishing regulations that can provide more opportunities to a diverse group of anglers than the current regulations allow. Discussions with the different angler groups should allow us to identify where catch-and-release and limited harvest opportunities can be effective throughout the entire watershed. We suggest using caution when opening catch-and-release areas to harvest as our work suggest that people are more apt to violate size restrictions than catch-and-release restrictions.

Spawning Migrations

We found that the radio tagged cutthroat trout made fast migrations, quickly spawned, and returned back to the main river, which prevented us from locating their exact spawning location. Often the fish disappeared for two or more weeks and then reappeared where they spent the previous summer. Others have also found cutthroat trout to display quick migrations and spawn over a short period (Brown and Mackay 1995b; Schmetterling 2001). Although we were not able to determine the exact spawning location of most of the fish, we did learn that they spawned in numerous tributaries throughout the entire study area. Magee et al. (1996) found that 99% of all cutthroat trout redds occurred in two tributaries in a 161 km^2 watershed and attributed it to limited juvenile rearing habitat in the basin. The broad distribution of the spawning fish in our study indicates many tributaries have suitable spawning and rearing habitat and is supported by work conducted by Dunnigan (1997) and Abbott (200). Where cutthroat trout redds were observed, the tributaries ranged in size from 2,000 to 20,000 ha in size, similar to what Schmetterling (2001) reported but much larger than reported (first and second order tributaries) by others (Rieman and Apperson 1989; Magee et al 1996). Evidence suggests that smaller resident fish are more likely to use these small tributaries for spawning (Magee et al. 1996). Schmetterling (2001) reported that the presence and accessibility of specific habitat characteristics are probably more important than the size of the stream as indicators of spawning suitability and that larger fish tended to migrate less and essentially spawn in larger system. McPhail and Murray (1979) also reported that as bull trout grow they will switch to new and larger tributaries for spawning. The large size of cutthroat trout that occur in the Coeur d'Alene River may indicate why redds were observed in larger tributaries than we originally suspected. It also indicates the importance of protecting these larger tributaries, many of which in the Coeur d'Alene River watershed have riparian road systems (IDEQ 2001). Cutthroat trout that utilize the Coeur d'Alene subbasin were found spawning in tributaries (Bear Creek, Beaver Creek, and Pine Creek) that have been degraded (eroded stream banks and limited riparian vegetation) by past development, mining, and other land use practices. Protection and enhancement of these streams may be important in maintaining and enhancing the fishery that has developed in the Coeur d'Alene subbasin.

The radio tagged cutthroat trout appeared to spread out and spawn in many different tributaries throughout the entire Coeur d'Alene River watershed. However, 41% (9 out of 22) of the radio tagged cutthroat trout that we believed spawned, spawned in the Tepee subbasin. Fish utilizing the NF-lower, NF-upper, Shoshone, and Tepee subbasins during the spring, summer, and fall all spawned in the Tepee subbasin. These findings suggest the Tepee subbasin is important to spawning to the entire Coeur d'Alene River watershed cutthroat trout fishery. Efforts to protect or improve spawning habitat in the Tepee subbasin could be important in maintaining and improving this cutthroat trout fishery. A considerable amount of restoration work ($600,000 over 5 km of stream) has occurred in Tepee Creek in the past (Ed Lider, U.S. Forest Service, Personal Communication). During our tracking efforts, we observed several cutthroat trout redds in a restored section of Tepee Creek between Trail Creek and Halsey Creek.

The radio tagged cutthroat trout that utilize the NF-lower subbasin demonstrated the longest migrations and spawned in the most widespread areas. These movements suggest that fish from many areas contribute to the population in the NF-lower subbasin, which may be helping to maintain this fishery at a low level. However, the high fishing mortality that was documented in this area may also be selecting against fish that have long spawning migrations. This could be important, as these longer migrating fish utilized overwinter habitat that we believe is less susceptible to flood events and extreme cold weather events. During extreme cold winters and winter flood events, fish utilizing the river in the lower watershed could have significantly higher survival than upstream reaches. This assumption is supported by comparing the snorkel trend data in the North Fork Coeur d'Alene River watershed between lower and upper elevation transects. In the upper elevation transects, the two lowest densities of cutthroat trout ever observed occurred after extremely cold winters whereas this was not observed in both years in the lower elevation transects (DuPont et al. In Prep b). If cold winters have less of an effect on cutthroat trout overwintering in lower elevation reaches, such as the NF-lower subbasin, these fish could be instrumental in helping to repopulate the fishery if significant declines related to extreme winter events occurred. Continued work will be required to help substantiate this, but maximizing diversity in the life cycle of any fishery is important in reducing risks that may occur from catastrophic events (Rieman and McIntyre 1993).

Snorkel Surveys

Two of the theories we set out to evaluate through this study as to why densities of cutthroat trout <300 mm had been increasing but not for cutthroat trout ≥ 300 mm were related to whether larger cutthroat migrated to areas outside of where we conducted our snorkel surveys. The locations of the snorkel transects are distributed in the North Fork Coeur d'Alene River essentially from the South Fork upstream past Tepee Creek approximately 6 km; in the Little North Fork up to approximately Deception Creek; and in Tepee Creek upstream to Independence Creek. Our telemetry work showed that large movements of cutthroat trout ≥300 mm away from where we conduct our snorkel surveys does not occur. In addition, it appears that a small portion of this cutthroat trout population displays an adfluvial life cycle (2 out of 75 radio tagged fish migrated to the lake). In fact, none of the radio tagged adfluvial fish were ever documented to use any of the stream reaches where the snorkel surveys are conducted.

The only example of where larger fish may move away from snorkel sites is when they migrate to areas that provide coldwater refugia. Large congregations of cutthroat trout were observed during the warmest period of the year in side channels, the mouths of tributaries, or in tributaries themselves. Our radio tagged fish appeared to move into these areas around mid-July and remained there through most of August. The snorkel surveys in the Coeur d'Alene watershed consistently occur during the first week of August, which often coincides with the warmest week of the year. For this reason, movement of cutthroat trout to areas of coldwater refugia could lead to lower density estimates than actually occur. If this were a significant issue, we would expect to observe higher densities during cooler years and lower densities during warmer years, which is not the case. In addition, snorkel surveys in 1973, 1980, and 1981 occurred in early July and August, and higher counts were consistently observed during August (Lewynsky 1986). Just by chance, one of the snorkel sites includes a coldwater refugia where cutthroat trout congregate, which will help in evaluating movement into and out of these areas.

Based on the movement patterns of the radio tagged fish, we do not believe migrations outside our snorkel survey areas can explain for the consistently low densities of cutthroat trout ≥300 mm observed in this system. The locations of our snorkel transects should adequately capture actual changes in densities of cutthroat trout, and consequently, we do not recommend changing or adding any new sites.

Tag Expulsion

Twenty-three of the 75 fish (31%) we put radio transmitters in expelled their tags before the study was completed (1 year period). Tag expulsion has been documented in many fish species including rainbow trout (Chisholm and Hubert 1985), channel catfish *Ictalurus punctatus* (Marty and Summerfelt 1986), African catfish *Heterobranchus longifilis* (Baras and Westerloppe 1999); hybrid striped bass *Morone saxatilis X M. chrysops* (Isely et al. 2002), and shortnose sturgeon *Acipenser brevirostrum* (Collins et al. 2002). Our radio tagged fish expelled their tags anywhere from 51 to 231 days after they were surgically planted with most (11) being expelled 120 to 160 days after implantation. Chisholm and Hubert (1985) had similar findings for rainbow trout in a controlled setting with radio tags being initially expelled 41 days after implantation. By the end of their study (175 days long) 12 of 22 (55%) rainbow trout had expelled their transmitters.

Based on our work, we caution against assuming that because a fish has stopped moving that it has died. This type of assumption can lead to erroneous estimates of mortality as well as the source of mortality. For example, Zurstadt and Stephan (2004) reported mortality signals for many of their radio tagged cutthroat trout 2-3 months after they were implanted, and attributed it to the rigors of winter. Our results suggest mortality signals could have been expelled tags, which might lead to a different conclusion.

Tag expulsion can also lead to a significant loss in the amount data collected during a study. For example, tag expulsion made it more difficult for us to evaluate cutthroat spawning behavior. For this reason, we recommend when utilizing radio telemetry to tag the fish as close to the time period of concern as possible. Our work suggests significant tag expulsion can occur as early as 2 months after being implanted.

In an effort to evaluate if any techniques could be used to reduce tag expulsion or extend the period before tags were expelled, we examined what role tag weight, fish weight, and the length of the antenna played in this process. After testing this data no significant results were obtained that suggested any of these factors play a role in whether a transmitter would be expelled from a fish or not. However, we found that those transmitters that were expelled that had full length antennae (44 cm) were not expelled as quickly as transmitters where the antennae was trimmed down to 20-30 cm in length (we trimmed many of the antennae so they did not extend past the fish's tail).

Based on our observations of recaptured fish, the radio tags were expelled from the fish through a process called transintestinal expulsion, which entails envelopment of the transmitter into the intestine, from which it would later be expelled by peristalsis through the anus (Baras and Westerloppe 1999). This is the same process in which Chisholm and Hubert (1985) found rainbow trout to expel their transmitters. One explanation for why a transmitter with a longer antenna may take longer to expel is more drag is created by a longer antenna which would restrict the peristalsis process.

We caution against using radio tags with longer antennae as work by Brown et al. (1999) and Adams et al. (1998a, 1998b) suggests that radio transmitters with antennae that are two to three times the length of the fish can reduce a fish's swimming capacity, ability to avoid predators, and growth especially where radio tags exceed 2% of the fish's body weight. Instead, we suggest utilizing techniques found by other researchers to be effective in reducing tag expulsion. Marty and Summerfelt (1986) reported that tag expulsion was significantly higher for fish where the transmitter represented 2% of its body weight versus 0.5%. Although we did not observe a significant relationship between tag expulsion and the tag to body weight of fish, the seven largest fish in our study (lowest tag to body weight ratio) did not expel their tags. Baras and Westerloppe (1999) found the type of suture material used may also influence tag expulsion with monofilament type sutures resulting in less expulsion than polyfilament types. Polyfilaments may increase the chance of infection migrating along the suture and possibly stimulate expulsion. Baras and Westerloppe (1999) also suggest that positioning the radio tag so that it reduces contact with the intestine may reduce expulsion. They recommend placing the tag closer to the tail or near large gonads or abdominal fat. We radio tagged our fish after spawning or in early spring before significant weight gain may have occurred. The lack of developed gonads or abdominal fat in many of the fish we radio tagged may have led to increased contact with the intestine and increased transintestinal expulsion. Isely et al. (2002) found that a trailing antennae may increase transmitter expulsion through rupturing of the incision. In his work, the transmitter antenna actually trailed from the back end of the incision and he believed infection around the antenna increased this type of tag expulsion. In our study, the antennae exited through a separate hole created by a needle (the shielded needle technique), not through the incision, which we believe will help reduce this type of tag expulsion.

Post Falls Dam

We conducted five different analyses on the movement of the radio tagged cutthroat trout in the Coeur d'Alene River to evaluate whether water level management at Post Falls Dam was having an influence on them. Based on these analyses, we believe radio tagged cutthroat trout were avoiding the inundated reach of the Coeur d'Alene River. This conclusion was based on findings that showed radio tagged fish were tracked throughout the Coeur d'Alene River except in the inundated reach. Radio tagged cutthroat trout were often located just upstream of the slack water interface but appeared to only move downstream of it when they were migrating through or when they relocated to a deep (~10 m) pool at the Cataldo Mission Boat Ramp. Essentially, within the 4.2 km inundated reach, the radio tagged fish were found to utilize one 200 m stretch of river near the Cataldo Mission Boat Ramp. The pool near this ramp was one of the deepest in the entire free flowing section of the Coeur d'Alene River and may be what attracted fish to this location. This same pattern of movement held true during both the high-pool and low-pool periods suggesting that lack of flow may not be the reason these cutthroat trout avoided large sections of the inundated reach.

The inundated reach can be characterized as relatively shallow (except at the Cataldo Mission Boat Ramp), with high amounts of fine sediment (imbedded substrates), little cover, and sloughing stream banks, conditions that cutthroat trout tend to avoid. It can be argued that operations from Post Falls Dam are largely responsible for these habitat conditions. Under a natural flow regime, water levels would gradually drop throughout the summer allowing free flowing conditions to occur throughout the inundated reach. These flows would help flush fine sediment downstream, maintaining clean cobbles and gravels, and productive riffle areas. In addition, as water levels slowly receded, it would allow vegetation to become established along the river, which in turn could provide areas of shade and overhead cover. Under the current operation, water levels are held up all summer long not allowing for any flushing of fine sediment. When water levels drop rapidly during the fall, it causes banks to collapse and slough in, and as the water is drawn away from the banks, cover is reduced even further. So, in essence the high amounts of fines, sloughing banks, and low amounts of cover are most likely influenced by Post Falls Dam.

Golder Associates (2005) claims that Post Falls Dam does not significantly change or affect the transport and deposition of sediments in the Coeur d'Alene River, because regulation typically does not occur when the majority of sediments are moving in the river system. We do not dispute this claim, but emphasize that fine sediments can be mobilized and deposited year round. Thus, starting around July when water levels are held up, fine sediment will begin being deposited at the slack water interface. This claim is substantiated by Golder Associates (2005) who state that a change in the river channel profile occurs between the Cataldo Mission Boat Ramp and the summer slack water interface, which appears to be a localized response to lake level management resulting in deposition of sediment in this location.

Many of the radio tagged cutthroat trout that were tracked within 1 km upstream of the inundated reach were found in shallow water (<1.5 m deep), with cobble or gravel substrates and overhead cover or undercut banks as cover. These are conditions we believe would be more prevalent in the inundated reach if water levels were not held up throughout the summer. For this reason, we believe the habitat modifications brought out by the higher summer water level help explain why the radio tagged cutthroat trout utilized only a small section of the inundated reach.

The other issue that our assessment on the movement patterns of our radio tagged cutthroat trout brought up was that during low-pool significantly more fish used the inundated reach than during high-pool. Based on our telemetry work throughout the entire Coeur d'Alene River watershed, cutthroat trout tended to move downstream to winter habitat during November, the same time fish started moving into the inundated reach. Ideally, good winter habitat is slow, deep water associated with wide floodplains. These conditions occurred near the Cataldo Mission Boat Ramp where all the radio tagged fish moved to during the winter. Consequently, these fish may not have moved to this area just because flow returned to it. However, two points need to be brought up that support that free flowing conditions were important in selecting this winter habitat. First, one radio tagged cutthroat trout moved upstream from the lake through the entire slack water reach of the Coeur d'Alene River to spend the winter at the Cataldo Mission Boat Ramp. This fish moved past miles of deep, slow water and wide floodplains to get to an area where flowing water occurred. The second point is that none of the fish that moved downstream during the winter migrated past the Cataldo Mission Boat Ramp where slack water conditions occurred. These two points suggest that free flowing water may be important when cutthroat trout are selecting winter habitat in the Coeur d'Alene River. In the St. Joe River where some fish migrate in excess of 100 km to reach winter habitat, they selected deep slow pools upstream of the inundated reach (Hunt 1992; Fredericks et al. 2002; Parametrix 2005).

Most of the radio tagged cutthroat trout that were located near the Cataldo Mission Boat Ramp from November through February migrated upstream during March. This timing coincides with that of other radio tagged cutthroat trout in the Coeur d'Alene River watershed moving upstream from wintering habitat, and consequently, we do not believe this had anything to do with operations at Post Falls Dam.

Avoidance by cutthroat trout of the inundated reach of the Coeur d'Alene River may be affected by factors such as temperature, flows, photoperiod, spawning, and food availability, which all play a role in fish movement (Hunt 1992; Hunt and Bjornn 1995; Brown et al. 1995a, 1995b; Schmetterling 2001). Movements of our radio tagged cutthroat trout were certainly influenced by these factors. Despite these confounding issues, we believe our analysis showed that the radio tagged cutthroat trout were avoiding the inundated reach largely because of operations from Post Falls Dam.

RECOMMENDATIONS

1. Make efforts to reduce illegal harvest in the NF-lower, Shoshone (lower 4 miles) and LNF (downstream of Laverne Creek) subbasins through increased education (posting more fish regulation signs and giving talks/presentations to the public) and increased enforcement.

2. Additional studies should occur to evaluate why people are illegally harvesting cutthroat trout. A better understanding of why people are illegally harvesting fish would allow us to focus efforts in manner that could have the most impact.

3. Engage in talks with locals and the fishing community on restructuring the fishing regulations to provide more diverse fishing opportunities for the public by adjusting where limited harvest and catch-and-release areas occur. Our data show that the movement patterns of cutthroat trout in this watershed provide unique opportunities in restructuring the fishing regulations.

4. Future planning and zoning activities need to be made aware of the importance of the Coeur d'Alene River floodplain in maintaining water temperatures that are suitable to cutthroat trout during both the warmest and coldest periods of the year as well as providing refuge during flood events. Future activities should not reduce or alter the hyporheic zone (subsurface flows) or restrict the natural migration of the river throughout the floodplain. These functions are vital to the long-term survival of and stability of cutthroat trout in the Coeur d'Alene River watershed.

5. Additional studies should occur in the Coeur d'Alene River watershed to understand better what the characteristics of side channels are that produce coldwater refugia and support fish during critically warm periods. A better understanding of these characteristics will allow us to reconnect lost coldwater refugia and/or construct new ones to replace those areas that have been lost due to past development and road building activities.

6. Efforts to maintain or cool water temperatures in tributaries through riparian road removal and increases in streamside shade should improve coldwater refugia at tributary mouths where fish are found to congregate during critically warm periods.

7. Maintain and/or improve recruitment of large wood through conservation of riparian areas, as cutthroat trout demonstrate an affinity for shade and habitat features created by large wood.

8. Continued efforts should be made in Shoshone Creek to improve the carrying capacity of larger cutthroat trout that utilize this stream during critically hot periods.

9. Encourage efforts to continue with reductions in heavy metal concentrations throughout the Coeur d'Alene River watershed. Reductions in heavy metal concentrations should allow cutthroat trout to move more freely throughout the watershed and utilize important habitat that currently appear to be avoided.

10. Habitat in the streams where several of our radio tagged fish spawned (Bear Creek, Beaver Creek, and Pine Creek) was degraded (eroding cut banks and limited riparian vegetation). Landowners along these streams should be made aware of their importance to cutthroat trout spawning and rearing and help encourage protection of the riparian area.

11. Efforts that have been occurring throughout the watershed to reduce sediment delivery should continue. Reductions in sediment delivery may be important in improving overwinter habitat.

12. Efforts to work with private landowners in the lower Tepee subbasin need to occur to protect, restore, and preserve the overwinter habitat that occurs there.

13. Efforts should be made to help protect the conditions of the free flowing section of the Coeur d'Alene River (South Fork to the Cataldo Mission Boat Ramp). This reach of river provides cool water during the summer; it has more pools and deeper water than anywhere in the watershed; and it has the widest and most undisturbed floodplains with the lowest gradient and the warmest winter temperatures making it ideal overwinter habitat. This section of river provides unique conditions that could increase survival of

cutthroat trout through some of the most difficult periods of their life. We believe this section of river will become more widely used as heavy metal concentrations continue to drop. Our fear is that once heavy metal concentrations declines to acceptable levels and the fishery continues to improve in this reach of river there will be efforts to develop along the floodplain (it is privately owned). The relatively undisturbed nature of this floodplain is what helps makes this reach of river the unique place it is. Efforts should be made to ensure the undisturbed nature of this floodplain is protected through habitat easements and/or land purchases. The elevated heavy metal concentrations that occur in this floodplain should make these types of easements and purchases relatively inexpensive. As these heavy metal concentrations decrease, we can expect these prices to increase.

14. The locations of our snorkel transects should adequately capture actual changes in densities of cutthroat trout, and consequently, we do not recommend changing or adding any new sites. However, it may be beneficial to conduct duplicate snorkel surveys either earlier or later in the year when water temperatures in the main river are more suitable to cutthroat trout to evaluate what influence movement to areas of coldwater refugia is having on density estimates. Periodic population estimates in the Coeur d'Alene River and possibly Shoshone Creek should also occur to evaluate changes in the fishery in these areas.

15. Relicensing of Post Falls Dam should consider loss of habitat in the free flowing section of the Coeur d'Alene River and provide mitigation either in place or by addressing limiting factors further upstream in the watershed.

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APPENDICES

Appendix A. Data sheets used when ground tracking cutthroat trout in the radio telemetry study in the Coeur d'Alene River watershed during 2003 and 2004.

Cutthroat Trout Telemetry Study - Coeur d'Alene River

Radio Frequency_____________

Species _______________ Sex__________ Weight_____ Length__________ Capture Site______________________________

Comments____

	Military	UTM Coordinates		Habitat Type			Temp	Depth (m)			Str.	Hab.	Dom.	Cover		
Date	time	N	E	Fish	Up	Dwn	(°C)	Fish	M -50	M-hab	width	length	substrate	Fish	Habitat	Comments

Habitat Type: Pool; Glide; Run; Riffle; Beaver Pond

Dominant substrate: Bed = Bedrock; Bld = boulder (> 10");
Cob = Cobble (2.5-10"); Gra = Gravel (0.25 - 2.5")
Fin = Fines (< 0.25")

Depth: Fish - depth where fish is; M-50 - max depth w/in 50 m of fish;
M-hab - max depth in habitat used by fish

Cover: UB = undercut bank; OC = Overhead cover; LS = Large substrate
LWO = submerged LOD > 4"; SWO = submerged LOD < 4"; N = none

Appendix B. Habitat data sheet used when collecting available habitat in the cutthroat telemetry study in the Coeur d'Alene River watershed, Idaho, during 2003.

COEUR D' ALENE CUTTHROAT TROUT
REACH FISH HABITAT INVENTORY

PAGE		STREAM		OBSERVER	
DATE		DISTRICT		RECORDER	
REACH		FOREST		WEATHER	

WATER TEMP		TIME		COMMENTS
WATER TEMP		TIME		
WATER TEMP		TIME		

HABITAT

HABITAT UNIT #															
CHANNEL CODE															
SIDE UNIT#															
HABITAT TYPE															
LENGTH															
WIDTH															
AVERAGE DEPTH															
MAX DEPTH															
POOL CREST DEPTH															
COMMENTS															

COVER PERCENTAGE

UNDERCUT BANK															
OVER HEAD COVER															
LARGE WOOD															
SMALL WOOD															
LARGE SUBSTRATE															

Appendix C. Sex, length, river basin the fish was captured in, capture date, last date located and the fate of radio tagged cutthroat trout tracked in the Coeur d'Alene River watershed, Idaho from May 2003 to June 2004.

Frequency	Sex	Length (mm)	River basin captured in	Capture Date	Last Date	Fate of fish
42 001	female	330	NF (lower)	05/30/03	10/25/03	expelled tag
42 002	unknown	330	Tepee Creek	06/03/03	06/20/03	predator
42 002(2)	unknown	282	L.NF CDA	10/31/03	03/18/04	expired tag
42 003	unknown	334	L.NF CDA	05/27/03	12/16/03	expired tag
42 004	unknown	338	L.NF CDA	05/15/03	06/16/03	Unknown
42 005	male	307	Prichard Creek	05/14/03	04/20/04	expired tag
42 165	male	380	NF (lower)	05/21/03	05/12/04	Unknown
42 166	female	420	NF (upper)	05/28/03	06/03/04	study complete
42 167	female	438	Tepee Creek	05/06/03	05/12/04	expired tag
42 168	unknown	428	NF (middle)	05/19/03	10/27/03	expelled tag
42 169	male	415	Shoshone Creek	06/09/03	08/25/03	expelled tag
42 169(2)	male	446	Tepee Creek	10/30/03	04/21/04	expired tag
42 170	female	370	NF (upper)	05/28/03	04/20/04	Unknown
42 171	female	349	L.NF CDA	05/29/03	05/29/03	Fisherman
42 172	male	388	NF (upper)	05/28/03	07/29/03	Fisherman
42 173	male	420	Tepee Creek	05/19/03	11/18/03	expelled tag
42 174	female	393	Tepee Creek	05/28/03	05/03/04	Unknown
42 176	unknown	313	Coeur d'Alene	05/29/03	05/19/04	Fisherman
42 177	unknown	339	Coeur d'Alene	05/29/03	03/15/04	expelled tag
42 187	unknown	328	Coeur d'Alene	05/02/03	11/19/03	expelled tag
42 191	unknown	377	Coeur d'Alene	05/29/03	10/29/03	predator
42 194	unknown	312	Coeur d'Alene	06/02/03	06/02/04	study complete
42 195	unknown	312	Coeur d'Alene	06/05/03	06/02/04	study complete
42 198	unknown	368	Coeur d'Alene	05/29/03	05/06/04	predator
42 205	male	390	L.NF CDA	05/15/03	06/16/03	surgery mortality
42 205(2)	female	376	Tepee Creek	10/30/03	06/15/04	study complete
42 206	female	401	NF (middle)	06/04/03	10/07/03	expelled tag
42 207	male	400	NF (lower)	06/06/03	06/17/03	Fisherman
42 208	female	430	Shoshone Creek	06/09/03	06/15/04	study complete
42 209	female	463	L.NF CDA	05/21/03	06/01/04	expired tag
42 210	female	377	Prichard Creek	05/14/03	12/18/03	expelled tag
42 211	female	417	NF (lower)	06/05/03	03/17/04	Unknown
42 212	female	375	NF (upper)	06/02/03	11/17/03	expelled tag
58 001	unknown	332	Tepee Creek	05/12/03	10/07/03	expelled tag
58 002	male	324	Shoshone Creek	06/09/03	08/25/03	Fisherman
58 003	male	310	NF (lower)	05/21/03	08/12/03	Fisherman
58 004	male	351	NF (middle)	05/19/03	10/07/03	expelled tag
58 004(2)	unknown	299	L.NF CDA	10/23/03	03/18/04	expired tag
58 005	unknown	331	NF (upper)	05/28/03	10/06/03	expelled tag
58 005(2)	female	343	NF (lower)	10/22/03	11/18/03	surgery mortality
58 165	female	394	Tepee Creek	05/22/03	09/16/03	expelled tag
58 166	male	368	NF (lower)	05/23/03	07/02/03	Fisherman
58 167	male	415	NF (upper)	05/28/03	05/05/04	expelled tag
58 168	male	363	NF (middle)	05/20/03	07/15/03	expelled tag
58 168(2)	male	422	L.NF CDA	10/23/03	05/17/04	expelled tag
58 169	female	407	L.NF CDA	05/27/03	06/15/04	study complete
58 170	male	450	Tepee Creek	05/06/03	10/07/03	expelled tag
58 171	male	400	NF (middle)	05/19/03	07/02/03	Fisherman
58 171(2)	female	445	NF (middle)	09/11/03	06/15/04	study complete

Appendix C. Continued.

Frequency	Sex	Length (mm)	River basin captured in	Capture Date	Last Date	Fate of fish
58 172	female	383	Prichard Creek	05/14/03	11/02/03	expelled tag
58 173	female	368	NF (upper)	06/02/03	10/07/03	expelled tag
58 174	male	464	Tepee Creek	05/28/03	06/15/04	study complete
58 175	unknown	346	Coeur d'Alene	05/29/03	07/16/03	Fisherman
58 176	unknown	338	Coeur d'Alene	05/29/03	04/15/04	expired tag
58 178	unknown	293	Coeur d'Alene	05/31/03	11/19/03	predator
58 182	unknown	288	Coeur d'Alene	06/02/03	06/16/04	study complete
58 185	unknown	299	Coeur d'Alene	05/31/03	06/02/04	study complete
58 190	unknown	325	Coeur d'Alene	05/31/03	10/10/03	Fisherman
58 191	unknown	330	Coeur d'Alene	06/02/03	02/18/04	expelled tag
58 193	unknown	415	Coeur d'Alene	05/29/03	06/15/04	study complete
58 195	unknown	341	Coeur d'Alene	06/05/03	06/02/04	study complete
58 200	unknown	386	Coeur d'Alene	06/05/03	06/11/03	Fisherman
58 203	unknown	350	Coeur d'Alene	06/02/03	12/18/03	expelled tag
58 204	unknown	355	Coeur d'Alene	06/02/03	05/12/04	study complete
58 205	male	412	NF (middle)	06/04/03	04/07/04	expelled tag
58 206	female	384	Shoshone Creek	06/09/03	09/29/03	Fisherman
58 207	female	411	NF (lower)	06/05/03	06/09/04	Fisherman
58 208	male	481	NF (middle)	05/28/03	05/17/04	Unknown
58 209	male	368	NF (middle)	05/13/03	10/07/03	expelled tag
58 210	female	502	NF (middle)	05/12/03	06/16/04	study complete
58 211	female	430	L.NF CDA	05/21/03	06/16/03	surgery mortality
58 211(2)	female	360	NF (upper)	07/01/03	09/17/03	Unknown
58 211(3)	female	425	Tepee Creek	10/30/03	06/15/04	study complete
58 212	female	380	L.NF CDA	05/16/03	08/25/03	expelled tag
58 212(2)	female	417	Tepee Creek	10/30/03	06/03/04	study complete

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