COLORADO RIVER RECOVERY PROGRAM Project No.: 125
FY-2010–2011 SCOPE OF WORK for
Middle Yampa smallmouth bass and northern pike

Lead Agency: Colorado State University

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Category:
_ Ongoing project
X Ongoing-revised project
_ Requested new project
_ Unsolicited proposal

Expected Funding Source:
X Annual funds
_ Capital funds
_ Other (explain)

I. Title of Proposal:
Evaluation of smallmouth bass and northern pike management in the middle Yampa River

II. Relationship to RIPRAP (March 31, 2008)
Green River Action Plan: Yampa and Little Snake rivers

III Reduce negative impacts of nonnative fishes and sport fish management activities (nonnative and sport fish management).

III.B. Implement CDOW Yampa Basin aquatic wildlife management plan and the Recovery Program's Yampa River Nonnative Fish Control Strategy. Each control activity will be evaluated for effectiveness and then continued as needed. See also III.A.2.c.1&2 under General Recovery program Support Action Plan.

III.B1..Prevent nonnative fish introduction; reduce invasion and recruitment.

III.B.1.(d)(2) Smallmouth bass

III.B.2. Control nonnative fishes via mechanical removal.

III.B.2.a. Estimate nonnative abundance, status, trends & distribution (YS I-3).

III.B.2.d. Remove and translocate northern pike from the Yampa River. See Hawkins et al 2005. (YS J-1).

III.B.2.e. Remove and translocate smallmouth bass. (YS J-1).

III. Study Background/Rationale and Hypotheses
In the Yampa River, nonnative, piscivorous, smallmouth bass *Micropterus dolomieu* and northern pike *Esox lucius* are a predatory and competitive threat to native and endangered fishes. Northern pike have occupied the river for just over 25 years and smallmouth bass have occupied the river in significant numbers only since 1992. Northern pike were stocked into the tributary Elkhead Reservoir in the late 1970's, about the same time they first occurred in the Yampa River.

In addition to Elkhead Reservoir, northern pike now occur throughout the Yampa River and portions of the middle Green River, both upstream and downstream of the Yampa River confluence, and in addition to Elkhead Reservoir they now have self-sustaining populations in Stagecoach and Catamount reservoirs where they were illegally introduced.

Smallmouth bass were extremely rare in the Yampa River until a rapid draw down of Elkhead Reservoir for dam maintenance in 1992 introduced large numbers of smallmouth bass into the Yampa River. Bass are now abundant throughout the Yampa River downstream of Elkhead Creek. The loss of fish from the reservoir was so great in 1992 that local fishermen reported a significant decline in the smallmouth bass fishery in Elkhead Reservoir immediately after the draw down. Prior to that time it appeared that smallmouth bass rarely escaped from the reservoir. In 1983 and 1984, smallmouth bass were extremely rare comprising only 0.3% of the fish community and native fish were common, comprising 68% of all fish captured in the Juniper Springs area (Wick et al.1985). In the same area in 2007, 51% of the fish community was composed of smallmouth bass and only 3% were native fish species. Smallmouth bass are also considered food-resource competitors with Colorado pikeminnow *Ptychocheilus lucius* due to their predation on small fish typically consumed by pikeminnow. The small-fish prey base has precipitously declined concurrently with the invasion of smallmouth bass and drought-related warmer water temperatures (Bestgen et al. 2007). Smallmouth bass have expanded their range into Dinosaur National Monument and pose a great threat to young endangered fishes that reside there.

Both northern pike and smallmouth bass occupy reaches designated as critical habitat for the federally endangered Colorado pikeminnow, razorback sucker *Xyrauchen texanus*, humpback chub *Gila cypha*, and bonytail *G. elegans*. Northern pike are known predators of wild Colorado pikeminnow (Hawkins unpublished data) and stocked razorback sucker and are presumed predators of humpback chub and recently reintroduced bonytail. Northern pike also pose a significant predation threat to other native species such as roundtail chub *G. robusta*, flannelmouth sucker *Catostomus latipinnis*, and bluehead sucker *C. discobolus* (Martinez 1995). Northern pike were rated the 3rd greatest nonnative species of concern by experts in the Upper Colorado River Basin based on the potential effects of pike predation on endangered and other native fishes (Hawkins and Nesler 1991). Smallmouth bass were ranked low on the list of species of concern but the ranking questionnaire was completed before their 1992 invasion into the Yampa River. The Upper Colorado River Endangered Fish Recovery Program (Recovery Program) determined that management actions to reduce abundance of nonnative piscivorous fish were necessary to recover endangered fishes in the Upper Basin. The Colorado Division of Wildlife (CDOW), a Recovery Program participant, developed an Aquatic Wildlife Management Plan for the Yampa River Basin (Yampa Aquatic Plan) that recommended managing the reach downstream of Craig, Colorado, for native and endangered fishes by removing smallmouth bass *Micropterus dolomieu*, channel catfish *Ictalurus punctatus*, and northern pike and relocating them to other waters within the Yampa Basin to provide continued sport-fishing opportunities (CDOW 1998). The Yampa Aquatic Plan also recommended lethal removal of white sucker *Catostomus commersonii* because of their potential for competition and hybridization with native and endangered suckers. Reducing the number of smallmouth bass and northern pike from critical habitat should reduce predation pressure, increase forage, and reduce the influx of both species downstream. The work described in this SOW focuses primarily on removal of smallmouth bass and northern pike and secondarily on removal of white sucker and common carp from two study sites in the Yampa River.

IV. Study Goals, Objectives, End Product:

We are implementing control measures for nonnative smallmouth bass and northern pike in the middle Yampa River and coordinating our sampling with CDOW and U.S. Fish and Wildlife Service (USFWS) who are responsible for removal of those species in other reaches. We (CSU) will be responsible for management and analysis of smallmouth bass data and CDOW will be responsible for management and analysis of northern pike data.

Smallmouth bass

The goal is to reduce the number of smallmouth bass from two study sites in the Yampa River in order to benefit native fishes and assist in the recovery of endangered fishes.

Objectives:

1. Obtain an estimate of the number of smallmouth bass in Little Yampa Canyon, Lily Park, and if possible river-wide using a mark-recapture abundance estimator. Coordinate mark-recapture sampling with CDOW and USFWS to obtain a river-wide estimate of smallmouth bass, upstream of Yampa Canyon.
2. Conduct one marking pass and eight removal passes in Little Yampa Canyon and Lily Park study reaches.
3. Calculate the proportion of juvenile and adult smallmouth bass removed from each study area based on initial population size and compare capture rates on each sample pass over time.
4. Remove large numbers of age-0 and age-1 smallmouth bass from a 12-mile treatment reach (RM100-112) in Little Yampa Canyon and Lily Park to supplement Recovery Program Project 140 (Native fish response evaluation).

Northern pike

The goal is to reduce the number of northern pike from two study sites in the Yampa River in order to benefit native fishes and assist in the recovery of endangered fishes. Coordinate mark-recapture sampling with CDOW and USFWS to obtain a river-wide estimate of northern pike upstream of Yampa Canyon (Primarily accomplished by CDOW Project 98a and supplemented by this Project (#125).

Objective:

Conduct one marking pass and eight removal passes for northern pike from the Little Yampa Canyon and Lily Park study reaches to support Project 98a.

Other species

The goal is to reduce the number of other nonnative species from two study sites in the Yampa River in order to benefit native fishes and assist in the recovery of endangered fishes.

Objectives:

1. Remove centrarchids, black bullhead, and stickleback on all sample occasions in all areas of the two study sites on the Yampa River.
2. Remove white sucker, white sucker hybrids, and common carp in Lily Park and the lower 12-miles of Little Yampa Canyon to develop baseline data on the effort required to reduce their numbers.
3. Evaluate whether there is a change in relative abundance of common carp, white sucker and white sucker hybrids over time and between control and treatment reaches by

comparing CPUE of the two species from 1-mile fish-community samples in treatment and control reaches.

V. Study area:

Our research will focus on two study reaches in the Yampa River, Colorado, a 24-mile reach in Little Yampa Canyon which is from Round Bottom (RM 124) to about 1-mile upstream of Government Bridge (RM 100) and a 5-mile reach at Lily Park from Cross Mountain Canyon (RM 55.3) to the Little Snake River confluence (RM 50.3). Starting in 2009, we will expand sampling at Lily Park an additional 2.7 miles downstream to the boundary of Dinosaur National Monument (RM 47).

Sampling Dates

From April through mid-July, during runoff, we will sample for smallmouth bass with boat electrofishing. Sampling typically starts in mid-April depending on water levels and temperatures are efficient for electrofishing. Both northern pike and smallmouth bass are susceptible to electrofishing when they occupy shallow shoreline and flooded off-channel habitats. Spring runoff sampling is preferred to other seasons because adults are more susceptible to electrofishing capture from shallow shorelines, higher flows allow safer navigation, and lower water temperatures allow successful transport of live fish. As discharge declines and water clears, young smallmouth bass become more susceptible to capture. During base flow water levels from mid-July through August, we will remove primarily age-0 bass from Lily Park and the lower 12-miles of the Little Yampa Canyon reach. Removing age-0 smallmouth bass only in the 12-mile treatment reach in Little Yampa Canyon maintains the Control-Treatment study design originally designated in 2004 in coordination with the native fish response evaluation by Project 140.

V. Study Methods/Approach

Sampling protocol— Each year, we will remove smallmouth bass from each study site on multiple occasions in an attempt to reduce their number or size structure. Fish will be captured with boat electrofishing from April through mid-July when flow is sufficient (>1000 cfs) to navigate the river with 17-ft. aluminum, Jon-boats fitted with outboard jet motors. Both shorelines will be sampled concurrently with two electrofishing boats using pulsed –DC current. Sampling will occur in a downstream direction covering about 6 miles per day until the entire reach is sampled. Other sampling gear types such as backpack shocker, seine, trammel net, or fyke nets may also be used (Table 1). A third boat will be used to assist with processing and transporting live fish. Electrofishing effort will be obtained from a timer on each electrofishing unit. Each reach will be sampled on multiple occasions each year with an interval of 4–10 days between occasions. Fish $\geq$100 mm TL will be marked with a numbered Floy tag and released on one sample occasion each year to serve as a mark for annual abundance estimates. Prior to 2009, fish were marked on the first sample pass and removed on all subsequent passes. Starting in 2009, the marking pass may occur later in the year (around the third pass) in order to synchronize the marking pass with agencies working in other reaches. We will coordinate with CDOW and USFWS to determine when the marking pass will occur in all reaches. On all sample occasions prior to or after the marking pass, smallmouth bass and northern pike will be removed from the river. For a description of the sampling protocol used in previous years see Hawkins et al. (2009a).

We will process fish every ½-mile. Fish that are returned to the river will be Floy tagged and released within the ½-mile section from which they were captured. Backwater and flooded tributary mouth areas will be sampled by electrofishing boat, fyke net, or block-and-shock techniques described by Nesler (1995). To determine spawning locations and timing of smallmouth bass reproduction, we will note guarding males moving off nests and reproductive condition of fish. Young bass will be removed from active nests and nest sites physically disrupted.

Removal effort— We will attempt to maximize the number of removal occasions each year based on time and resources. Based on an average capture probability of 11% from 2004 to 2007 (Hawkins et al. 2009a) we estimate that it will require eight removal passes to remove 60% of the smallmouth bass in each study reach if we consider the population closed to immigration and recruitment. This estimate was derived from the formula,
$n = \log (1-R) / \log (1-p)$ where:

n = number of removal occasions
R = percent of fish removed (60%)
p = capture probability (11%, estimated from prior years).

Removal evaluation— Each year we will estimate the abundance and capture probability of smallmouth bass at each site and river-wide using mark-recapture methods. We will calculate catch per unit effort (CPUE) for adult smallmouth bass for each sample occasion and obtain an average CPUE for all sample occasions each year. We will determine removal effectiveness primarily by examining changes in annual abundance of juvenile (100-199mm TL) and adult ($\geq$200 mm TL) smallmouth bass in each reach. We will calculate two other annual measures of removal effectiveness: removal rate and recapture rate. Removal rate measures the proportion of fish removed in relation to the abundance estimate and recapture rate measures the percent of tagged fish recaptured during removal.

During periods of low stream discharge in July and August, we will focus on removing young (age-0 and age-1) smallmouth bass from Lily Park and the lower 12-mile section of the Little Yampa Canyon study site (i.e. the original treatment reach designated in 2004). This reach is part of the control–treatment design of the native fish evaluation study (Bestgen et al. 2007). Young smallmouth bass will be captured with a 10 m-long electric seine powered by a 2000-watt generator. Other gear may include boat or backpack electrofisher, angling, seine, trap net, or cages with baited or scented attractants (Table 1). We will conduct at least three separate sampling occasions, in July and August, each about 10 days long and reaches will be sampled multiple times on each occasion. We will sample primarily shallow, low-velocity shorelines associated with backwaters, embayments, or boulders deposited from talus slopes and electrofishing effort will be recorded with a stop watch. All native and nonnative species will be handled as they are during boat electrofishing and as specified in Table 2 unless specified differently by the state collecting permit. A summary of collecting gear, fish handling, tagging, and disposition of each species is provided in Tables 1 and 2 for State of Colorado scientific collecting permit application.

Fish handling — Fish captured with boat electrofishing will be placed in a live well, measured to the nearest mm TL, and weighed to the nearest 50 gr with 5- or 10-kg, Pesola® spring scale. Fish captured with electric seine will be weighed to the nearest 0.1 gr with an electronic scale. Fish handling time will be reduced by subsampling weights of fish, except for tagged or recaptured

fish, which we will measure and weigh. All fish will be examined for tags, fin clips, pike bites, gametes, and abrasions along the ventral medial fins indicating nest cleaning. Smallmouth bass ≥100 mm TL will be tagged during the marking pass so that recaptured fish can provide information about abundance, movement, and potential escapement from translocated waters. In 2010, smallmouth bass ≥ 250–mm TL were translocated to Craig Justice Center Pond until runoff flows subsided and then bass were translocated to Elkhead Reservoir. Starting in 2011, all smallmouth bass except those released during the mark-recapture study will be euthanized with an overdose of Tricaine methanesulfonate (MS-222). A sub-sample of these fish will be preserved for further analysis of age, growth, or food-web studies. Northern pike will be translocated to Yampa State Park Headquarters' pond or as directed by CDOW. See Table 2 for sizes of each species that will be tagged, euthanized, or translocated. During mark-recapture studies, fish that are not previously tagged will be tagged with a numbered, Floy® t-bar anchor tag (model FD-94) inserted through the left musculature between pterygiophores near the posterior base of the dorsal fin. Fish that are translocated will be transported in an oxygenated live well. Tag colors and numbers will be coordinated with other agencies each year.

Endangered fishes and roundtail chub will be handled per guidelines and permits of the CDOW and the USFWS. All Colorado pikeminnow and roundtail chub will be captured, PIT tagged per Recovery Program protocol, their location recorded within 0.1 mile, and UTM coordinates recorded. We will record tag data for all recaptured fish originally tagged by other agencies. All trout species and channel catfish will be measured and released in the river. Other nonnative species captured that will be euthanized include centrarchids, black bullhead *Ameiurus exile*, walleye *Stizostedion vitreum*, brook stickleback *Culaea inconstans*, common carp *Cyprinus carpio*, white sucker, and white sucker hybrids. Handling protocol is described in Table 2. Fish that are euthanized will be buried discretely along the river. Centrarchids, black bullhead, and stickleback will be removed on all sample occasions from both study sites. Stickleback and common carp are on the state of Colorado's prohibited species list and any other species captured that is on the Colorado prohibited species list will be removed and euthanized (Table 3). Starting in 2009, we will initiate a pilot program to determine the effort involved to remove common carp, white suckers, and white sucker hybrids using electrofishing boat and electric seine. Removal of these species will occur concurrently with removal of smallmouth bass and northern pike and will be temporarily suspended if it compromises removal of smallmouth bass or northern pike. Carp and white sucker will be removed from Lily Park and a treatment reach in the lower 12-miles of Little Yampa Canyon. Fish that are removed will be measured, euthanized, and provided to CDOW researchers, kept as a voucher specimen and cataloged in the LFL collection, or disposed of by burying in remote locations along the river. We will evaluate if we are having a removal effect on white sucker by comparing their CPUE and relative abundance in the 1-mile community sampling sites in the upper 12-miles (control reach) with the lower 12 miles (treatment reach) of Little Yampa Canyon.

Fish Community (1-mile) sampling— We will monitor relative abundance of the fish community at four, 1–mile sites in Little Yampa Canyon and one, 1–mile site at Lily Park. These locations include RM 118.0–119.0 near Milk Creek, RM 112.5–113.5 near Sand Spring Gulch, RM 108.0–109.0 near Duffy Tunnel inlet, RM 104–103 near Morgan Gulch and RM 52.0–53.0 near Lily Park Bridge. Each site will be sampled at least monthly with boat electrofishing concurrently with smallmouth bass sampling. At each site we will net, count, and measure lengths and weights of all fish species.

We will assist as needed with Recovery Program or CDOW information and education efforts in the Yampa Valley. Primarily we will do this by providing information during informal contact with two important target groups: landowners near the river and anglers that fish either the river or waters that receive translocated fish.

2010 and 2011 modifications

This section describes changes in 2010 that increase adult smallmouth bass removal during their spawning period.

Background—The 2009 Nonnative Workshop described recent information about the timing and duration of smallmouth bass spawning in the Yampa River and identified conditions that maximize adult bass removal. Also described at the workshop was a strong year-class of smallmouth bass in 2007, which as 3-year-old adult fish, will comprise a large portion of the adult spawning population in 2010. Recommendations from the workshop focused on the importance of preventing the production of another large cohort in 2010 by increasing our removal efforts during the spawning period.

At the workshop, we discussed the importance of sampling during the descending limb of the hydrograph, especially based on increased catch rates (CPUE) at South Beach, Little Yampa Canyon, and lower Juniper during the nesting and spawning period (see Table 4 in Hawkins et al. 2009b). We suggest extending the sampling period in all reaches until base flow and increasing effort in reaches or sub-reaches with known spawning aggregations. This year, 2009, was the first year that smallmouth bass were sampled and removed riverwide from all reaches of the middle Yampa River. Some of those reaches were sampled for the first time but were only sampled during the pre-spawning period. We suggest sampling those areas for adult bass during the spawning period to determine if they contain spawning habitat and those area a few month after spawning to determine if they contain nursery habitat for YOY smallmouth bass.

New 2010 Task 3.5 Intensive sampling during smallmouth bass spawning —We will use current knowledge about smallmouth bass spawning ecology to focus and increase removal of smallmouth bass during the 2010 spawning period. Once temperatures reach 16^0 C, we will increase removal efforts in areas with known or potential spawning habitat. Our goal is to disrupt all stages of the spawning period, including pre-spawn nest building, spawning, and nest guarding. This activity will increase the catch and removal of adult fish, disrupt the spawning event, remove guarding males from active nests, and ultimately reduce the survival of young hatchlings. Removing spawning adults from nesting areas during the earlier nest building and spawning stages will create a sink for late spawners. Adult bass on nests are vulnerable to electrofishing gear because they are in shallow water and they have a tendency to remain and protect the nest rather than flee. Our plan is to remove spawning fish and create a void in desirable spawning habitat so that other bass can move in and be removed on subsequent sampling occasions. In that process, we will also be disrupting and decreasing the survival of the 2010 year class. Sampling effort will be directed at river sections which we have identified that contain high densities of randomly distributed spawning habitat and specific locations that contain concentrations of spawning bass (Table 4). We will focus on the reaches between South Beach and Lower Juniper (RM 135–90), because those reaches have known spawning habitat.

Additional resources — Increased removal effort will require additional people and equipment; therefore, (CSU) will work closely with CDOW to coordinate removal passes and we will receive assistance from FWS crews from Vernal and Grand Junction. During intensive sampling CSU will contribute one additional boat and one additional field technician for a total of eight people and four boats. CDOW will increase sampling in South Beach, upper and lower Maybell, and Lower Juniper prior to spawning and will contribute a total of four people and three boats during intensive sampling. FWS- Grand Junction will assist with intensive sampling for 2 weeks (June 21-25 and June 28-July 2) and provide three people, two electrofishing jet boats, and two trucks. FWS- Vernal will assist for 2 weeks (June 14-18 and June 21-25) and provide two people and one truck with a fish hauler.

All sampling will require jet boats with long-range (50-mile round trip) capability. Chase boats will be required to accompany shocking boats for handling and processing fish, especially during lower, warmer water periods. CSU will split its crew to accompany visiting crews and provide guidance regarding locations, property ownership, and sampling techniques at South Beach, Little Yampa Canyon, and lower Juniper. Maybell will be sampled by DOW crews.

Effort required to complete one pass of the South Beach, Little Yampa Canyon, and lower Juniper reaches is about 7 days. With one extra crew (in addition to the CSU crew), we could sample all three reaches within 3-4 days. We will prioritize areas to sample on future passes based on results from the previous pass. We will allow about a 3-4-day reset period before returning to resample a reach to allow spawning habitat to reset with either displaced fish or new spawners.

Prediction of spawning period —CSU will measure water temperature daily and monitor temperatures at the Maybell gage and report when temperatures are expected to reach 16^0 C. Based on the past five years, this will occur between June 1st–30th. Spawning generally starts during the last part of the descending hydrograph and ends when young bass leave the nest about the time runoff drops to base flow. Bass nests are active for 10-20 days depending on temperatures and we plan to sample intensively enough that nests, no matter when started, would be disturbed 2-5 times. Intensive sampling should start within 5 days of temperatures reaching 16^0 C and continue for approximately 4 weeks or until water levels decline to a pont that the river is un-navigable.

Spawning habitat probably occurs in all reaches but nests are often dispersed along the river and can vary in density. We propose sampling through all reaches at least once to discover and document either specific locations or sections of river where spawning areas are congregated. We will then target spawning concentrations or river sections with high densities of spawning habitat on future removal occasions. Some reaches have not been sampled during spawning and we recommend sampling those areas to determine whether spawning is occurring. We propose exploring those reaches after we have confirmed that spawning is occurring in known reaches. Areas that should be examined for potential spawning include the lower 5–10 miles of the Craig reach, the upper portion of South Beach, and the Maybell-Sunbeam reach.

2010 Yampa River sample schedule — Attached is an Excel spreadsheet with two charts that show the dates that CSU and CDOW sampled in 2009 and dates and locations that we plan to sample in 2010. The charts provide a graphic description of sampling intensity by showing the number of days required to sample a reach, the total number of passes in each reach, and the

number of days between samples. They serve as a tool for scheduling and coordinating future sampling and for visualizing the logistics required to increase sampling intensity.

In 2010, we are planning for a low to normal water year with nesting activity starting in early to mid-June but will modify the schedule based on actual flow conditions. Following the proposed schedule will increase our removal passes at South Beach from six to ten, at Lower Juniper from four to nine, and Little Yampa Canyon will remain the same, at 10 removal passes. CDOW has also increased removal passes at upper Maybell from six to seven and lower Maybell and Sunbeam from three to four. In addition, we will sample occasionally in other reaches once spawning is underway to confirm whether or not spawning occurs in those reaches. These include lower Craig, Maybell-Sunbeam, and Lily Park.

Each column across the top of the chart represents one mile of river and miles are grouped by reach, including: South Beach, Little Yampa Canyon, Lower Juniper, Upper Maybell, Lower Maybell, Sunbeam, and Lily Park. Each row represents one day during the sample season. The amount of sampling that occurred in one day is represented by a heavy outline of colored blocks. Light yellow represents CDOW and light blue represents CSU. For example, in 2009, CSU sampled on April 7 from river mile 106 to 100, on April 8 from river mile 112 to 106, and on April 9 from river mile 118 to 112. These blocks are labeled “CSU Pass 1" indicating the first pass of the Little Yampa Canyon reach.

There are two short canyon reaches that are not sampled for adult bass due to inaccessibility and hazardous conditions, including two miles in Juniper Canyon (RM 88-90) and three miles in Cross Mountain Canyon (RM 56-59). We do not recommend sampling these areas for adult bass at this time. Furthermore, there are other reaches that are not accessible at lower flows in the spring, including downstream of the Little Snake River in lower Lily Park and Sunbeam. Both are shallow sandy sections with difficult navigation at lower flows and provide little habitat for adult smallmouth bass. We recommend sampling in those two reaches only during higher flow periods. Maybell (upper and lower) is another reach that cannot be sampled during the lower end of the descending hydrograph because it contains the highest percentage of private land and requires higher flow to prevent potential trespass issues.

When sampling occurs is influenced by the work schedule of each agency. CSU works on a 10-days on, 4-days off rotation and CDOW and FWS work on a 5-days on (Monday-Friday), 2-days off schedule. During a two week period, CSU has two full days of travel and eight full days of sampling. During each week, the other agencies have two, partial days of travel and three full days of sampling with the possibility of sampling during a portion of their travel days depending on their commute time.

Based on water flows and temperatures we expect to modify the sampling schedule as the season progresses while maintaining the goal of maximizing our removal efforts. We will record the actual dates and reaches sampled each week on a sample schedule chart to identify if all reaches are being sampled on the proposed schedule and to expose any changes or issues that need attention.

New 2011 Task 3.6 Extend intensive sampling during smallmouth bass spawning (The Surge) into the base flow period.

Intensive removal of smallmouth bass during their spawning period has become known as ”The Surge”, an activity that concentrates the efforts of several agencies in reaches with spawning habitat. In 2010, the Surge started June 22nd and stopped 18 days later when flows declined to base flow levels below 1000 cfs. Flows below 1000 cfs are unsafe for navigation when using aluminum electrofishing boats. Recent work by Bestgen and Hill showed that smallmouth bass spawning continues for about 4 weeks and often for 2-3 weeks after flows decline to 1000 cfs. In order to maximize the disruption of spawning this new task in 2011 will extend The Surge beyond the 1000-cfs threshold by switching to electrofishing rafts. We will also try other gear as needed including small aluminum electrofishing boats, trammel nets, and angling over nests. This extended work will be done by CSU-LFL and CDOW crews and will focus on the same spawning reaches as The Surge. We are planning for this extended period to occur for an additional 2-3 weeks after flow declines below 1000 cfs. Fish will be shocked by two electrofishing crews with two boats, one on each side of the river. Fish will be handled as normal, except that given the logistics of remote access and unfavorable thermal conditions for keeping fish alive, all smallmouth bass and northern pike will be euthanized. A subsample of these fish will be preserved for age, growth, otolith microchemistry analysis, and forage analysis. The CDOW and CSU-LFL will each contribute two electrofishing rafts and one chase raft. CDOW will contribute four people and CSU-LFL will contribute six people to this effort. Funding for this additional work will require 2-3 weeks of salaries and travel expenses as shown in the budget for CSU in Task 3.6 of this SOW and in the budget for CDOW in the SOW for Project 98a.

New 2010 Task 4.5 Identify distribution and relative abundance of YOY smallmouth bass in the middle Yampa River —To assess the success of spawning disruption from intensive removal of spawning adult smallmouth bass and to look for high density areas of YOY smallmouth bass that indicate nearby areas of high spawning density, we will sample the middle Yampa River longitudinally from Elkhead Creek to Dinosaur National Monument (RM 147–46) including both Juniper Canyon (2 miles) and Cross Mountain Canyon (3 miles). Sampling will occur in August when YOY smallmouth bass are relatively small but are large enough to be susceptible to the sampling gear. Sampling gear will include seine, dipnet, backpack electrofisher, and electric seine. We will estimate YOY smallmouth bass abundance by their relative abundance to other species and their catch per unit effort (CPUE).

We will spend a total of three weeks sampling all reaches by spending one week in Craig and South Beach reaches, one week in Little Yampa Canyon, Lower Juniper, and Juniper Canyon, and one week in Maybell, Cross Mountain Canyon, and Lily Park. Sampling in Craig, South Beach, and Maybell will be coordinated with and may be assisted by the CDOW Area aquatic biologist and his technicians. Sampling in Little Yampa Canyon and Lily Park will coordinate and may co-occur with ongoing YOY smallmouth bass removal sampling in those two reaches. Fish will be identified in the field when possible and fish that cannot be identified in the field and voucher specimens will be euthanized and preserved for lab verification.

Smallmouth bass spawning ecology in the Yampa River
Nest location—In other river systems, smallmouth bass nests are often adjacent to some type of large cover such as a log or boulder, but nests in the Yampa River are usually exposed and not associated with large cover except when they occur near steep-cut banks. In the Yampa River, smallmouth bass nests are located in either backwaters or in other quiet (zero velocity) waters usually near shore or downstream from an obstruction that breaks the current. Nests in the

Yampa River are typically about 1-m deep, but the literature reports typical depths of 0.6–1.5 m (2-5 ft). Nests are typically circular, 25–50 cm (10 to 20 in) in diameter, with predominately small-gravel substrates which, when visible, are often darker and stand out from the surrounding, silted bottom. In portions of the Yampa River we have identified several backwaters that contain congregations of nesting smallmouth bass and several sections of river that contain high densities of nesting bass opportunistically dispersed along the shoreline among suitable habitat (Table 4). Some reaches, such as lower Craig and Maybell to Sunbeam, have not been sampled recently during the spawning period and the status of nest concentration in those areas is unknown. Often, water clarity is too poor during nesting in the Yampa River to visually detect nests. If nests are not visible, then we will determine spawning activity and nest location by observing gonad development via dissection, monitoring bass for abrasions on the anal or caudal fin indicating nest clearing, and monitoring bass capture locations that contain depth, velocity, and substrate typical of spawning habitat.

Environmental factors and timing—Spawning activity begins when temperatures reach about 16^0–18^0 C (60^0–65^0 F) which in the Yampa River can range from early to late June. Bestgen presented back-calculated hatching dates based on otolith increments at the 2009 Nonnative Workshop that support a start of spawning at 16^0 C which can vary depending on discharge volume and timing (Figure 1). Hatching date ranges from two to nine days after spawning, depending on temperatures. Optimum incubation and hatching temperatures range from 19–22^0 C (66° to 72° F) and shorten hatching time. After hatching, larvae drop into the gravel nest and they eventually emerge and remain in the nest for an additional 6–15 days. Males will often remain in the area and guard the slowly dispersing young for as long as 28 days.

Reproductive strategy—Male smallmouth bass build a nest over a period of 4–48 hours, starting primarily in the morning. There may be multiple spawning events over a single nest for several hours. Eggs are demersal and adhesive. Females may spawn over several time periods before being spent because their eggs mature at different rates. The literature reports that only about 25% of mature males nest in any given year and larger males nest earlier and often have more successful nests than smaller males. Larger males also tend to be more protective and aggressive in defense of the nest than smaller males. Males actively guard the nest and young from time of egg deposition to fry dispersal. Removing the male from a nest (typically reported in the literature by angling) often results in large losses of eggs or larvae due to predation on the young or abandonment of the nest by the male if released back to the water. However, we have observed males return to a nest after being chased away by electrofishing.

VII. Task Description and Schedule

Task 1	Oct-Jan	Prepare and present results at three annual Recovery Program meetings: nonnative workshop, nonnative summit workshop, and Researcher's Meeting.
Task 2	Feb- Mar	Contact landowners and obtain permission for property access for sampling. Attend agency and public meetings. Hire and train field crew; purchase, prepare, and fabricate equipment.
Task 3	Apr - Jul	Yampa River sampling in Critical Habitat. Capture, remove and translocate northern pike.
Task 3.5		Increase removal sampling intensity during

		spawning.
Task 3.6	Jul	Extend intensive sampling during smallmouth bass spawning into the base flow period.
Task 3.7	May	Purchase and install new ETS electrofishing unit
Task 4	Jul- Aug	Capture and remove YOY and yearling smallmouth bass from treatment sites.
Task 4.5	Aug	Identify distribution and relative abundance of YOY smallmouth bass through middle Yampa River.
Task 5	Aug - Oct	Equipment maintenance. Data entry and analysis. Prepare Recovery Program annual progress report. Interaction and data sharing with DOW aquatic researchers.

VIII. Deliverables, Due Dates, and Budget by Fiscal Year (FY-2010 and FY-2011)

Deliverables/Due Dates:

Recovery Program Annual Report: Nov 11, 2010
Nov 11, 2011

Corrected 2010 Budget –Corrections highlighted, Hawkins 2/24/10

FY-2010 Budget by Task (see footnotes for details)

Task 1:	Biologist-Researcher IV (1340/week-5 wks)	6700
	Biologists-Researcher II (750/week- 5 wks)	3750
	Laptop computer for meeting presentations and field house use	1400
	Travel-Lodging ($80/night x 2 nights/trip x 3 people x 3 trips)	1440
	Travel-Per diem ($39/day x 3 days/trip x 3 people x 3 trips)	1053
	Truck mileage ($0.37/mile x 500 miles/trip x 3 trips)	555
	Total Task 1	14898
Task 2:	Biologist-Researcher IV (1340/week-1 wks)	1340
	Biologist-Researcher II (750/week- 1 wks)	750
	Travel-Lodging ($80/night x 3 nights x 2 people)	480
	Travel-Per Diem ($39/day x 4 days x 2 people)	312
	Truck mileage ($0.37/mile x 750 miles)	278
	Total Task 1	3160
Task 3:	Biologist-Researcher IV (1340/week x 15.3 wks)	20478
	Biologist-Researcher II (2 x 750/week x 16 wks)	24000
	Technicians (4 x 623/week x 16 wks)	39872
	Travel-Lodging-rental house ($1000/month x 4 months)	4000
	Travel-Per diem ($20/day x 10 days/trip x 7 people x 7 trips)	9800
	Wireless broadband internet connection	828
	Truck Insurance and motor pool fees ($380 annually X 4 trucks)	1520
	Truck mileage *1-ton fish hauler ($0.48/mile x 900 miles/trip x 7 trips)	3024
	Truck mileage 3/4 ton people hauler ($0.37/mile x 900 miles /trip x 7 trips)	2331
	Truck mileage 1-ton people hauler ($0.59/mile x 900 miles /trip x 7 trips)	3717
	Replacement outboard motor jet unit *	2100
	Boat gas ($1900/boat/season x 3 boats)	5700

	2-stroke oil for boat motor (20 gallons X $27/gallon)	540
	Annual boat repair and maintenance ($1200/boat x 3 boats)	3600
	Field supplies (net handles, nets, boots, first aid, electrical safety gloves, tools batteries)	800
	Fish transport supplies (compressed O2 bottles, O2 regulator, salts)	300
	Services (welding, boat rigging, field equipment repair)	500
	Total Task 3	123110
Task 3.5:	Technician 623/week x 8 wks)	4984
	Travel-Per diem ($20/day x 10 days/trip 3 trips)	600
	Boat gas and oil ($500/week x 4 wks)	2000
	Modify old boat to update to new electrofishing standards	500
	Boat and equipment maintenance and repair	500
	Total Task 3.5	8584
Task 4	Biologist-Researcher IV (1340/week x 4 wks)	5360
	Biologist-Researcher II (2 x 750/week x 4 wks)	6000
	Technicians (3 x 623/week x 4 wks)	7476
	Travel-Lodging-rental house ($1000/month x 1 month)	1000
	Travel-per Diem ($20/day x 10 days/trip x 6 people x 4 trips)	4800
	Truck mileage -3/4 ton people hauler ($0.37/mile x 900 miles /trip x 4 trips)	1332
	Truck mileage -1-ton people hauler ($0.59/mile x 900 miles /trip x 4 trips)	2124
	Backpack electrofisher * (Smith Root LR 24 and accessories)	10000
	Electric seine repair and maintenance	400
	Field supplies (net handles, nets, boots, first aid, electrical safety gloves, tools batteries, generator gas)	822
	Total Task 4	39314
Task 4.5	Technicians (2 x 625/week X 6 weeks)	7500
	Biologist-Researcher II (750/week x 3 wks)	2250
	Travel-per Diem ($20/day x 15 days x 3 people)	900
	Truck mileage - ($0.37/mile x 700 miles /trip x 3 trips).	777
	Total Task 4.5.	11427
Task 5	Biologist-Researcher IV (1340/week-6 wks)	8040
	Biologist-Researcher II (2 x 750/week- 8 wks)	12000
	Research Scientist (2 weeks)	3600
	Travel-Lodging ($80/night x 3 nights x 2 people)	480
	Travel-Per diem ($39/day x 3 days x 2 people)	234
	Truck mileage ($0.37/mile x 500 miles /truck)	185
	Total Task 5	24539
	Sub-total	225032
	CSU Overhead rate to BOR (17.5%)	39381
	TOTAL (2010)	264413

FY-2011 Budget by Task (see footnotes for details) Modified to add Task 3.6- extended Surge sampling

Task 1:	Biologist-Researcher IV (1340/week-5 wks)	6700
	Biologists-Researcher II (750/week- 7 wks)	5150
	Travel-Lodging ($80/night x 2 nights/trip x 3 people x 3 trips)	1440
	Travel-Per diem ($39/day x 3 days/trip x 3 people x 3 trips)	1053
	Truck mileage ($0.37/mile x 500 miles/trip x 3 trips)	555
	Total Task 1	14898
Task 2:	Biologist-Researcher IV (1340/week-1 wks)	1340
	Biologist-Researcher II (750/week- 1 wks)	750
	Travel-Lodging ($80/night x 3 nights x 2 people)	480
	Travel-Per Diem ($39/day x 4 days x 2 people)	312
	Truck mileage ($0.37/mile x 750 miles)	278
	Total Task 1	3160
Task 3:	Biologist-Researcher IV (1340/week x 15.3 wks)	20478
	Biologist-Researcher II (2 x 750/week x 16 wks)	24000
	Technicians (4 x 623/week x 16 wks)	39872
	Travel-Lodging-rental house ($1000/month x 4 months)	4000
	Travel-Per diem ($20/day x 10 days/trip x 7 people x 7 trips)	9800
	Wireless broadband internet connection	828
	Truck Insurance and motor pool fees ($380 annually X 4 trucks)	1520
	Truck mileage *1-ton fish hauler ($0.48/mile x 900 miles/trip x 7 trips)	3024
	Truck mileage 3/4 ton people hauler ($0.37/mile x 900 miles /trip x 7 trips)	2331
	Truck mileage 1-ton people hauler ($0.59/mile x 900 miles /trip x 7 trips)	3717
	Fyke, trammel, and block nets	2100
	Boat gas ($1900/boat/season x 3 boats)	5700
	2-stroke oil for boat motor (20 gallons X $27/gallon)	540
	Annual boat repair and maintenance ($1200/boat x 3 boats)	3600
	Field supplies (net handles, nets, boots, first aid, electrical safety gloves, tools batteries)	800
	Fish transport supplies (compressed O2 bottles, O2 regulator, salts)	300
	Services (welding, boat rigging, field equipment repair)	500
	Total Task 3	123110
Task 3.5:	Technician 623/week x 8 wks)	4984
	Travel-Per diem ($20/day x 10 days/trip 3 trips)	600
	Boat gas and oil ($500/week x 4 wks)	2000
	Modify old boat to update to new electrofishing standards	500
	Boat and equipment maintenance and repair	500
	Total Task 3.5	8584
New 2011 Task		
Task 3.6:	Biologist-Researcher IV (1340/week x 2 wks)	2680
	Biologist-Researcher II (750/week x 2 wks)	1500
	Technicians (4 x 623/week x 2 wks)	4984
	Travel-Per diem ($20/day x 10 days/trip x 6 people)	1200
	Truck mileage *1-ton fish hauler ($0.48/mile x 500 miles)	240
	Truck mileage 3/4 ton people hauler ($0.37/mile x 900 miles /trip x 1 trip).	333
	Truck mileage 1-ton people hauler ($0.59/mile x 900 miles/trip x 1 trip)	531

	Total Task 3.6	11468
New 2011 Task		
Task 3.7:	ETS electrofishing Unit- Model MBS-1DP	5600
	Honda EG-6500 Generator	2200
	Total Task 3.7	7800
Task 4	Biologist-Researcher IV (1340/week x 4 wks)	5360
	Biologist-Researcher II (2 x 750/week x 4 wks)	6000
	Technicians (3 x 623/week x 4 wks)	7476
	Travel-Lodging-rental house ($1000/month x 1 month)	1000
	Travel-per Diem ($20/day x 10 days/trip x 6 people x 4 trips)	4800
	Truck mileage -3/4 ton people hauler ($0.37/mile x 900 miles /trip x 4 trips)	.1332
	Truck mileage -1-ton people hauler ($0.59/mile x 900 miles /trip x 4 trips)	..2124
	Backpack electrofisher * (Smith Root LR 24 and accessories)	10000
	Electric seine repair and maintenance	400
	Field supplies (net handles, nets, boots, first aid, electrical safety gloves, tools batteries, generator gas)	822
	Total Task 4	39314
Task 4.5	Technicians (2 x 625/week X 6 weeks)	7500
	Biologist-Researcher II (750/week x 3 wks)	2250
	Travel-per Diem ($20/day x 15 days x 3 people)	.900
	Truck mileage - ($0.37/mile x 700 miles /trip x 3 trips).	777
	Total Task 4.5.	11427
Task 5	Biologist-Researcher IV (1340/week-6 wks)	8040
	Biologist-Researcher II (2 x 750/week- 8 wks)	12000
	Research Scientist (2 weeks)	3600
	Travel-Lodging ($80/night x 3 nights x 2 people)	480
	Travel-Per diem ($39/day x 3 days x 2 people)	234
	Truck mileage ($0.37/mile x 500 miles /truck)	185
	Total Task 5	24539
	Sub-total	244300
	CSU Overhead rate to BOR (17.5%)	42753
	TOTAL (2011)	287053

Budget Footnotes:

1. Mileage rates vary depending on year of truck and size. Mileage totals 900 miles per truck/trip based on 500 miles round trip from Ft Collins to Morgan Gulch field site each sample trip plus 400 miles per truck per trip (50 miles per truck per day for 8 days for shuttles and fish hauling)
2. Boat repair includes replacement, repair, and maintenance of parts used, broken, or damaged such as: throttle, steering, motor, jet sleeves and impellers and electrofishing assemblies.
3. Backpack shocker needed to capture YOY and yearling smallmouth bass in isolated pools and other selected habitats not accessible to electric seine.

IX. Budget Summary

	CSU	FWS-Grd Jct	FWS-Vernal	Total
FY-2010	$ 264,413	$ 22,406	$ 8,160	294,979
FY-2011	$ 287,053	$ 12,606	$ 8,160	307,819

X. Reviewers: Biology Committee

XI. References

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SOW Revisions: 1/20/11- Added Task 3.6 and Budget for extending removal into base flow period. 2/14/11— Modified text to reflect new disposition policy for smallmouth bass.

Table 1—Sampling gear that may be used by CSU on the Yampa River.

Electrofishing: boat, bank, backpack, or seine.
Nets: Gill, trammel, dip, hoop, fyke, or trap; cages (i.e. minnow traps) - various lengths and mesh sizes.
Seines: various lengths and meshes.
Angling: with bait, lures or artificial flies.
Suction devices to collect larvae or young.
All gear may be baited or scented with attractants.

Table 2—Summary of handling, tagging, and disposition requirements for fish captured by CSU researchers in the Yampa River, 2009.

Species	**Tag type**	**Disposition**
Native-Colorado pikeminnow	RFID-PIT	measured, marked, and released at capture site
Native-roundtail chub	RFID-PIT	measured, marked and released at capture site
Native-Other species, bluehead sucker flannelmouth sucker hybrid native suckers mountain whitefish speckled dace mottled sculpin	None	measured and released at capture site
Nonnative-northern pike	Grey Floy tag	Mark Pass: All sizes measured, marked and released on first pass Removal Passes: All sizes measured, marked and moved to Yampa State Park Headquarters' pond or as directed by CDOW. Northern pike recaptured with Orange Floy tags that indicate escapees from Catamount Reservoir will be euthanized and preserved for otolith microchemistry as requested by CDOW biologist B. Atkinson.
Nonnative-smallmouth bass	Grey Floy tag	Mark Pass: If $\geq$100 mm TL then measured, marked and released, if <100 mm TL then euthanized. Removal Passes: All sizes euthanized with a sub-sample preserved and retained for additional research purposes.
Nonnatives: bluegill black crappie green sunfish largemouth bass pumpkinseed yellow perch walleye black bullhead common and grass carp burbot gizzard shad white sucker white sucker hybrids stickleback spp.	None	Common carp, white sucker, and white sucker hybrids will only be removed from the treatment reaches which include the lower 12 miles of Little Yampa Canyon and Lily Park. All other species will be measured, euthanized, and either buried or preserved for additional analysis and research.

Nonnatives: salmonids (trout) channel catfish	none	measure and release at capture site
Nonnative-Prohibited fish species per Colorado Revised Statutes-see list below.	none	measured, euthanized, and preserved

Table 3—List of Prohibited Aquatic species per Colorado Revised Statutes, Title 33, Article VII, 12, adopted by the Wildlife Commission on 01/11/07: http://wildlife.state.co.us/RulesRegs/Regulations/

1. Bowfins: Amiidae.
2. Carp of the following genera: Aristichthys; Catla; Catlocarpio; Carrassius; Cirrinus; Cyprinus; Hypophthalmichthys; Labeo; Mylopharyngodon; and Tor.
3. Catfish, Walking: *Clarias batrachus.*
4. Crayfish, Rusty: *Orconectest rusticus.*
5. Eel, Asian Swamp: *Monopterus albus.*
6. Frog, Green: *Rana clamitans.*
7. Gars: Lepistosteidae -- All species.
8. Gobies: Gobiidae.
9. Mussel, Quagga: .*Dreissena bugensis*.
10. Mussel, Zebra: *Dreissena polymorpha*.
11. New Zealand mudsnail: *Potamopyrgus antipodarum*.
12. Perch, White: *Morone americana.*
13. Piranha: Including members of the genera Serrasalmus and Pygocentrus.
14. Rudd: *Scardinius erythropthalmus.*
15. Ruffe, Eurasian: *Gymnocephalus cernuus*.
16. Snakeheads or murrels: Members of the genera Channa, Parachanna and Ophiocephalus.
17. Sticklebacks: Members of the genera Apeltes, Aulorhynchus, Gasterosteus and Pungitus.
18. Tilapia: All species.
19. Trahira: *Hoplias malabaricus*.
20. Water Fleas, Fish Hook and Spiny: *Cercopagis pengoi, Bythotrephes lomgimanus*, and *Daphnia lumholtzii*.

Table 4. Location of spawning aggregations in the middle Yampa River.

South Beach		
	Island Complex	RM 134
	Eagle Nest Bay (right)	RM 132.7
	Island Complex	RM 132
	Lower South Beach (both shorelines)	RM 124–127
Little Yampa Canyon		
	Backwater (right)	RM 122.9
	Birthday Bass Backwater (left)	RM 122.6
	Island Complex (left)	RM 121.5
	Lunch Spot Embayment (right)	RM 121.0
	Sand Spring Eddy (right)	RM 113.1
	Big Bass Backwater (left)	RM 110.5
	Vegas Backwater (right)	RM 110.2
	Boat Ramp Embayment (left)	RM 103.1
Lower Juniper		
	Embayment at Backwater (right)	RM 95.5
	Government Bridge (right)	RM 98.8
	Other locations to be discovered	
Maybell-Sunbeam		
	Island Complex (right)	RM 84.5
	Other locations to be discovered	

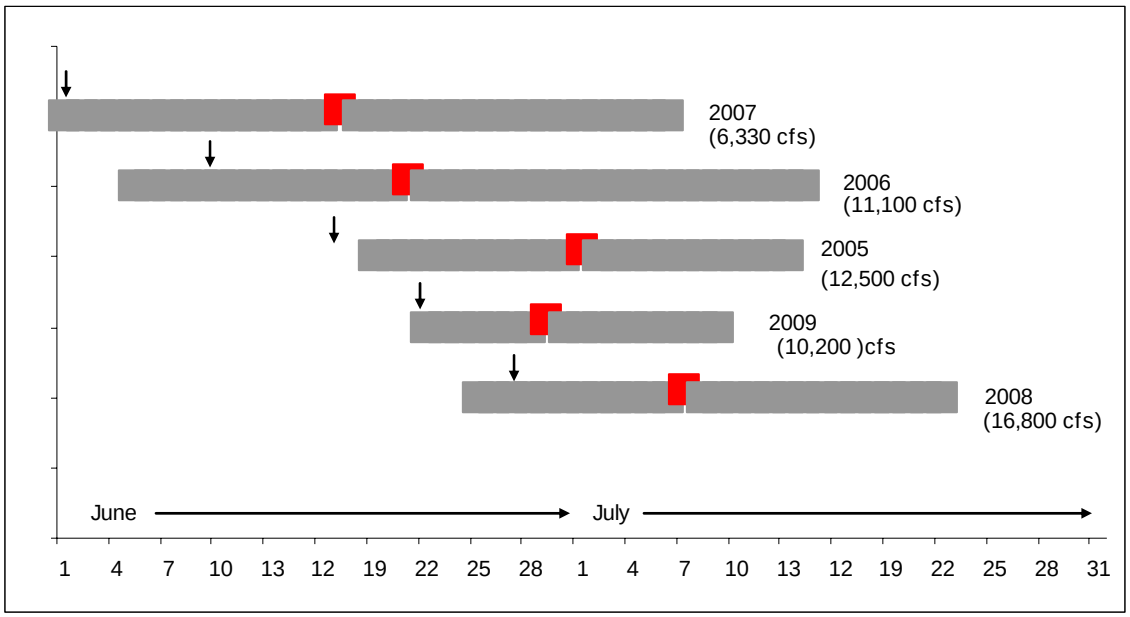

Figure 1—Estimated spawning dates for smallmouth bass in the Yampa River based on daily otolith increments. First and last dates of spawning shown by grey bars and average spawning date shown with raised dark block (in red). First occurrence of 16^0 C marked by arrow and maximum daily peak discharge for each year in parentheses. Data for 2005–2008 from Bestgen and Hill 2009 nonnative workshop presentation for Project 140. Spawning dates estimated based on 8 days prior to hatch. Dates for 2009 estimated from field observations.