

**FY-2018-2022 (2018-2019 portion) PROPOSED SCOPE OF WORK for: Project #: 115**

Monitoring effects of Flaming Gorge Dam releases on the Lodore and Whirlpool Canyon fish communities

Reclamation Agreement number *[if applicable & known]*: R14AP00001  
Reclamation Agreement term *[if applicable & known]*: Oct. 1, 2014 – Sep. 30, 2018

Lead Agency: Larval Fish Laboratory, CSU; Bureau of Reclamation; U.S. Fish and Wildlife Service

Jointly Submitted by: Larval Fish Laboratory, CSU; Bureau of Reclamation; U.S. Fish and Wildlife Service

Kevin R. Bestgen, Ph.D.  
Larval Fish Laboratory  
Dept. of Fish, Wildlife, and Conservation Biology  
Colorado State University  
Ft Collins, Colorado 80523  
970-491-1848/ fax 970-491-5091  
kbestgen@colostate.edu

Tildon Jones  
Vernal Colorado River Fish Project  
1380 S. 2350 W.  
U.S. Fish and Wildlife Service  
Vernal, Utah 84078  
435-789-0354/ fax 435-789-4805  
Tildon\_Jones@fws.gov

Date Last Modified: 5/23/2017 10:21:00 AM *[This field is set to update automatically.]*

Category:

- Ongoing project
- Ongoing-revised project
- Requested new project
- Unsolicited proposal

Expected Funding Source:

- Annual funds
- Capital funds
- Other (explain)

- I. Title of Proposal:  
Monitoring Effects of Flaming Gorge Dam releases on the Lodore/Whirlpool fish community
- II. Relationship to RIPRAP:  
See RIPRAP at <http://www.coloradoriverrecovery.org/documents-publications/foundational-documents/recovery-action-plan.html>  
Green River Action Plan: Mainstem  
II.D. Evaluate and revise as needed flow regimes to benefit endangered fish populations.

### III. Study Background/Rationale and Hypotheses:

In FY01, the Recovery Implementation Program (RIP) revised the RIP Recovery Action Plan to include evaluating and revising, as needed, flow recommendations for the endangered fish throughout the Upper Colorado River Basin. Flaming Gorge Flow and Temperature Recommendations (FGFTR; Muth et al. 2000) were approved by the RIP in FY01. A Record of Decision was written in 2005 and flow and temperature recommendations have been implemented in 2006. Another change in operations at Flaming Gorge Dam has resulted from implementation of the Larval Trigger Study Plan, and has effects primarily on timing and magnitude of releases in spring from Flaming Gorge Dam.

An expectation of implementation of flow and temperature recommendations was that native and endangered fishes will benefit via expanded distribution and abundance. It is also possible that new flow and temperature regimes for native endangered fishes may also enhance distribution and abundance of certain nonnative fishes. This is a major concern of managers of the Colorado River Basin, where expanding non-native fish populations are detracting from conservation efforts. Effects of full implementation of new flow and temperature regimes of the Green River downstream from Flaming Gorge Dam need to be evaluated to determine relative benefits to native and endangered fishes and other non-native elements of the fish community.

An increased emphasis was placed on non-native fish removal in this study beginning in 2005. Expanded populations of non-native fish predators have been detected since 2002 due in part, to warmer water temperatures and lower flows. The proposed non-native fish removal and native fish monitoring study is a logical extension of work conducted by Bestgen and Crist (2000), more recent sampling in 2002 to 2016 (Bestgen et al. 2006, Bestgen et al. 2007). That more recent work was conducted to evaluate changes in the fish community that occurred since 1996 in response to partial implementation of new flow recommendations and to expansion and removal of non-native predaceous fishes in the Green River. Aspects of the new flow and temperature recommendations and the Larval Trigger Study Plan that were realized since 1996 was relatively higher spring peak flows in 1997, 1999, 2011 and low and warm flows in the summer seasons from 2002 to 2007, followed by relatively high flows from 2008-2011 and 2014-16, and lower flows in 2012 and 2013. A number of changes in the fish community were observed during sampling from 2002 to 2016. Those included an expanded population of smallmouth bass *Micropterus dolomieu* in Lodore and Whirlpool canyons, and reproduction by that species in Lodore Canyon, as well as in downstream Whirlpool Canyon. We also detected upstream expansion and increased abundance of red shiner *Cyprinella lutrensis* in some years and channel catfish *Ictalurus punctatus* reductions in several years. However, in the higher and cooler water year in 2008 and 2011 resulted in delayed spawning of smallmouth bass and small size going into winter. Particularly problematic has been expansion of northern pike reproduction and abundance in Browns Park in the upstream portion of the study area, which continued in 2014, 2015, and 2016.

We also made valuable observations of native fishes during the 2002-2016 sampling. Sampling and telemetry work (Kitcheyan and Montagne 2005) revealed increased use of Lodore Canyon in summer by Colorado pikeminnow *Ptychocheilus lucius*. In 2006 and 2010, we also detected reproduction by Colorado pikeminnow in Lodore Canyon, and in 2011-2016, detected aggregations of Colorado pikeminnow in or at the mouth of Vermillion Creek in spring during

runoff. We recommend purchase a PIT tag detector to better monitor pikeminnow in Vermillion Creek into the future and included that in the 2018 budget. Seine sampling in lower Lodore Canyon in summer 2003 captured an early juvenile razorback sucker *Xyrauchen texanus* x white sucker *Catostomus commersonii* hybrid (29 mm TL), which indicated attempted reproduction by razorback suckers there in spring or early summer 2003. We detected continued presence of humpback chub *Gila cypha* in Whirlpool Canyon in 2002, 2003, and 2004, along with a relatively large population of roundtail chub *Gila robusta*, each of which has subsequently declined. Few roundtail chub have been recently observed and no suspected humpback chub have been collected in several years. We also captured (N = 16 scanned for PIT tags) or observed (N = 60) bonytail *Gila elegans* in autumn 2004 in the Green River from the Echo Park boat ramp to downstream about 11 km a short time after their stocking at Echo Park (Bestgen et al. 2008); occasional bonytail are captured that are recently stocked fish.

An ongoing understanding of shifts in distribution and abundance patterns of non-native predaceous fishes and native/endangered fishes associated with Flaming Gorge operations will provide managers with information necessary to assess effects of full implementation of new flow and temperature recommendations. Of particular interest are continued assessment of recent changes in distribution and abundance of predaceous species such as smallmouth bass, northern pike, and other native fishes. This study provides important non-native fish removal activities, as well as information to describe the response of native fishes to removal of smallmouth bass and other non-native piscivores. This adds information to a continued management process (along with other ongoing studies downstream) that addresses uncertainties in flow and temperature recommendations that may affect the fish community (Muth et al. 2000).

#### IV. Study Goals, Objectives, End Product:

**Goal:** Remove non-native fishes and determine if changes in Green River flow and thermal regimes are associated with changes in distribution and abundance patterns of native and nonnative fishes in Browns Park, Lodore and Whirlpool canyons, and Island-Rainbow Park.

Objective 1. Remove non-native fishes and determine if shifts in distribution and abundance of large-bodied fishes have occurred in Lodore Canyon and Whirlpool Canyon by comparing the results of shoreline electrofishing and trammel net surveys with the results of previous studies, particularly Bestgen and Crist (2000), Bestgen et al. (2007) and results of the 2007-2016 sampling.

Objective 2. Remove non-native fishes and determine if shifts in the distribution and abundance of small-bodied fishes have occurred in Brown's Park, Lodore and Whirlpool canyons, and Island-Rainbow Park by comparing results of low-velocity, nearshore seining with the results of previous studies, particularly Bestgen and Crist (2000), Bestgen et al. (2007), and results of the 2002 to 2016 sampling.

Objective 3. Determine if Colorado pikeminnow spawn in the Green River upstream from the Yampa River confluence by sampling with drift nets in lower Lodore Canyon, and by summer sampling to determine presence of ripe adults. Drift net sampling will be done occasionally when Green River flows are low and warm (conditions when pikeminnow spawning might be expected) and will be done coordinated with drift-net sampling in the Yampa River (project 22f).

Objective 4. Analyze hydrological records as recorded by the USGS at their gaging station (09234500) near Greendale, Utah, to compare differences in current and historical operations.

Objective 5. Analyze temperature records of the Green River through Browns Park, Lodore Canyon, and Whirlpool Canyon to compare differences in current and historical operations. This activity has been expanded with more thermographs in other locations to further document warming and mixing patterns of the Green River, especially downstream of the Yampa River.

Objective 6. Continue to analyze past otolith samples and those collected in 2007-2016 to understand smallmouth bass spawning periodicity to assist with flow-related management of that species. A summary report of that work was finished in 2016 (Bestgen and Hill 2016).

Objective 7. Based on results of objectives 1–6, determine physical effects of new operations and subsequent effects on the fish community of the Green River downstream of Flaming Gorge Dam.

End Product: Remove non-native fishes and assessment of effects of non-native fish removal and effects of new flow and temperature regimes based on the fish community response.

## V. Study area

In general, the fish community of the Green River will be sampled between the Swinging Bridge in Brown's Park and the lower end of Rainbow Park in Dinosaur National Monument. Additional northern pike sampling in upstream reaches will also be conducted but specific areas dependent on habitat availability. Specific reaches and gear include:

**Boat, raft or seine sampling for small-bodied fishes and northern pike:** Beginning upstream near Red Creek in Brown's Park and extending downstream through Island-Rainbow Park.

**Raft-based electrofishing and trammel-netting:** Lodore Canyon: Entire Canyon, which consists of four contiguous, 5-mile reaches and; Whirlpool Canyon: Entire Canyon, which consists of 2 contiguous, 5-mile reaches.

## VI. Study Methods/Approach

Sampling methods will be patterned closely after those used in 2002 to 2016 sampling. Data will be collected in a manner that generates catch per unit effort (CPUE) metrics (fish/hour electrofishing, small-bodied fish/m<sup>2</sup> habitat seined, larval fish/m<sup>3</sup> water, fish/hour trammel-netting) with associated variance estimates to enable within-study, and annual comparative statistical analyses. Additional sampling techniques (e.g., angling, hoop nets) will be used on an experimental basis. Flow data collected by USGS and temperature data (U. S. Fish and Wildlife Service) at several of its gauging stations on the Green and Yampa rivers will be used to address Objectives 4 and 5.

Three sampling trips will be conducted each year. Sampling will begin in early to mid-summer and ending in autumn. We envision two sampling trips using electrofishing and a third trip using

primarily netting gear. Seine sampling will occur on all trips. The two electrofishing trips will be 5-days in length and utilize a 7-8 person crew; netting trips will have similar requirements.

**Large-bodied fishes; Electrofishing:** Two electrofishing rafts will simultaneously sample the left and right shoreline. Each two-person crew (one boat operator and one netter) will collect all fish. Each 5-mile reach will be sampled in segments, usually about 1-2 miles each. At the lower end of each section all fish will be enumerated as an adult or sub-adult (based on pre-determined total length ranges per species) and electrofishing effort will be recorded. Rare fish (T&E species) will be weighed, measured, and PIT-tagged. Thus, mean CPUE/trip/reach will be generated from the section samples.

In addition to simple enumeration, all fish will be measured and weighed in two sections (both shorelines) of each reach on each trip to characterize size structure and length/weight relationships. Non-native fishes (except salmonids) will be removed.

Descriptive statistics will be used to describe CPUE, lengths, and weights of fish and appropriate comparisons with previously collected data will be made. This sampling also plays a role in determining burbot escapement from Flaming Gorge Reservoir, and is especially important given the expanded releases in some years for implementing the Larval Trigger study plan. These data have been reported at several presentations in the recent past.

**Large-bodied fishes; Trammel netting:** Multi-filament trammel nets (23m x 1.8m; 25-cm outer mesh; 2.5-cm inner mesh) will be set at locations in Lodore and Whirlpool canyons with a main goal of sampling chubs in the genus *Gila*. Trammel nets collect a variety of species, but have been used in other studies as a primary gear type to collect native chubs in canyon-bound reaches of the Green (Chart and Lentsch 1999) and Colorado Rivers (Chart and Lentsch 2000, Valdez and Ryel 1995, McAda 2000). Trammel nets will be fished during crepuscular and nighttime hours at sites in Lodore and Whirlpool canyons. Nets will be set in low velocity habitats and along eddy lines. The number of nets set will be contingent on habitat availability and accessibility. Nets will be checked every 2 hours to reduce fish mortality.

All fish will be measured, weighed, and tagged as necessary. Dorsal and anal fin rays will be enumerated from all chubs collected. Any suspected humpback chub will be photographed, primarily for the purpose of acquainting other researchers with the chubs found in Whirlpool Canyon. Appropriate morphometric measurements (as identified in Douglas et al. 1998) will be collected. Descriptive statistics will be used to describe CPUE, lengths, and weights of fish and appropriate comparisons with data previously collected will be made. This sampling also plays a role in determining burbot escapement from Flaming Gorge Reservoir, and is especially important given the expanded releases in some years for implementing the Larval Trigger study plan.

**Large-bodied fishes; other gear types:** In addition to electrofishing and trammel netting, other sampling techniques such as angling and trap nets may be employed to evaluate their efficiency. Angling will also be used to supplement total numbers of adult Colorado pikeminnow collected and marked for movement and length/weight analyses.

***Small-bodied fishes; Seining:*** The purpose of this sampling will be to track shifts in distribution and abundance of the small-bodied nonnative (red shiner, sand shiner, fathead minnow) and native (speckled dace) cyprinids, and YOY of all other species. We will sample mostly backwaters, eddies, and shorelines; other habitat types (e.g., riffles) will be sampled as needed to detect species of interest. Two or more seine hauls will be taken in each sampled habitat and each seine haul will represent a sample. Physical measurements including area seined and habitat area will be gathered to quantify habitat dimensions and calculate CPUE. Seines used in this study will conform with the ISMP-recommended gear type. Readily identified endangered species will be measured and released alive. Other fish will be preserved in 10% buffered formalin and identified at CSU/LFL.

We will also continue to conduct analyses to understand timing and intensity of smallmouth bass reproduction in the Green River. This will be accomplished by analyzing otolith daily increments of smallmouth bass collected and preserved in ethanol during past years (2002-2016 as available). This will require analysis of several years of samples to understand effects of different flow and temperature regimes on timing and intensity of spawning. This analysis began in 2007 and results will be available as data are collected to understand the need for additional analyses. Presentations of these results have been prepared for annual meetings each year since 2008, and a summary report is available (Bestgen and Hill 2016).

***Northern pike habitat and fish sampling:*** This item was added at the request of the Program Director's office because northern pike reproduction was detected in autumn 2005 in Browns Park. The first facet of this investigation assessed habitat available for northern pike in Browns Park (from near Beaver Creek downstream of Flaming Gorge Dam downstream to Lodore boat ramp). We have continued to sample areas where northern pike are concentrated by sampling areas where age-0 pike have been captured in the past, with the intent of removal of as many pike as possible. In past years we concentrated on nearshore areas and will continue to assess nearshore and main channel habitat for presence of age-0 and adult northern pike. In 2006, we also captured smallmouth bass in Browns Park at two locations (Bestgen et al. 2007). Browns Park sampling would also be used to assess if smallmouth bass populations are expanding or remain isolated. Sampling through 2016 showed that smallmouth bass were sporadic but pike were persistent in Browns Park, but concentrated mainly in the upper Browns Park area near Beaver Creek. Continued sampling in 2018 will monitor if populations are expanding or maintaining at low levels. We think about three weeks of intensive sampling would be sufficient to survey most of the available areas; sampling effort upstream will be supplemented by Utah Division of Wildlife sampling. Timing of sampling would also be dependent on the above-referenced information and the timing of Flaming Gorge flow releases. This sampling also plays a role in determining burbot escapement from Flaming Gorge Reservoir, and is especially important given the expanded releases in some years for implementing the Larval Trigger study plan. These data have been reported at several non-native fish workshop meetings in the last few years, and details capture rates, size structure, and timing of spawning of northern pike relative to flow and water temperature patterns.

***Evaluate effects of flow manipulations on smallmouth bass in Lodore and Whirlpool canyons (Task 4 below, study plan preparation began in 2016 and is ongoing):*** This item was added at the request of the Program Director's office.

Water temperature and streamflow level each influence timing of reproduction by smallmouth bass in unregulated and regulated stream reaches of the upper Green River drainage. However, the influence of each varies depending on the level of regulation, and temperature and streamflow level, likely a surrogate for spawning habitat availability. Both are important in the regulated reach of the Green River in Lodore Canyon, and in the partially regulated reach in downstream Whirlpool Canyon. Length of the growing season and water temperatures in summer, which are inversely associated with streamflow magnitude, have strong effects on smallmouth bass length in autumn, which is an important driver of overwinter survival. Thus, the degree of stream regulation – partially to fully regulated – and associated water temperatures will affect predictions to determine timing of first reproduction and bass growth. Using that information to predict spawning times of smallmouth bass in reaches of the Green River upstream and downstream of the Yampa River, which is now known, may allow us to disadvantage reproduction and growth of invasive smallmouth bass by implementing intentional flow or temperature disturbances from Flaming Gorge Dam. Such disturbances have potential to disturb eggs in nests, displace and reduce survival of larvae, or induce nest abandonment of adult bass.

It is uncertain precisely how such a study would be implemented, and details for such are partially developed and will continue this year. We have already had discussions with the Bureau of Reclamation about how this might occur, especially related to other flow requests (e.g., Larval Trigger Study Plan) that are presently being implemented. Some ***draft and preliminary*** ideas and considerations are presented below but a more complete study plan would be offered to the Program and Biology Committee well before the field season in 2018 for evaluation.

A key part of this study may involve identifying locations of bass reproduction, including the lower ends of cutoff, low flow channels, or large backwaters in Lodore Canyon, and Whirlpool Canyon and Island Park. A key to the success of evaluations in that reach is flow conditions that are suited to making a big enough effect to create a flow disturbance. For locations such as Whirlpool Canyon, this may require moderate to low Yampa River flows, and a subsequent and relatively large flow pulse from Flaming Gorge Dam, to flow and stage levels that are substantially increased.

The level of flow increase and duration would depend on the physical attributes of backwater habitat in the system. This may require surveys, or simply observations of key areas during higher flow releases in spring in Lodore and Whirlpool canyons and Island Park. It would seem reasonable to increase flow during pulses to powerplant level (e.g. 4500 cfs) to have a large enough increase over base flows to effect habitat inundation in key spawning and nursery habitat locations, both in Lodore canyon, and in the downstream Green River.

Timing of releases should be predicted with the data described above and verified with observations. However, the precise timing to conduct such an experiment is not well established.

Certainly, flows would be post-spawning of smallmouth bass, but whether to target early spawned bass (cohort 1 or 2) is not certain. It seems as though one could target both, given the short time between initiation of spawning and the peak in the distributions of hatching dates, a period that would follow production of cohort 1 fish, typically the largest fish produced in any year, and the first portion of cohort 2, which is typically the most abundant cohort produced in any year. Targeting that time period would also reduce the chance that flow disruptions would negatively affect spawning by native fishes. This would typically occur after reproduction by most native suckers, but just prior to spawning by chubs and well before reproduction by Colorado pikeminnow. Native fishes should be less affected as well, since they typically deposit adhesive eggs in spawning gravel that is protected from higher flows. The reason smallmouth bass eggs and larvae might be negatively affected is they are not adhesive and deposited in low or zero velocity habitat. Increased velocity from a flow disturbance of sufficient magnitude may flush them away and cause mortality.

To understand the effects of such a flow disturbance action would likely involve finding and marking nests, and taking measurements of the velocity and depth characteristics around the nest area, and describing macro-habitat features of the site, including whether the nest was located in the downstream end of a secondary channel. Observations could also include finding and marking locations of newly dispersed smallmouth bass larvae that occupy low velocity areas that are typically very near channel margins. In the regulated Green River reach upstream of Lodore Canyon, we know a few locations where smallmouth bass have spawned in the past, based on capture of guarding adults on nests, or larvae, or both. These include mainly side channel backwaters, including ones just upstream of Hells Half Mile rapid (about RM 352, river right), just downstream of Wild Mountain on river left (Screaming Jay backwater), and near the Green River confluence with the Yampa River (river left). Physical factors to be measured may include the flow levels needed to make connections of side channels that do or might provide spawning habitat for smallmouth bass, and determining what flow levels might accomplish those connections. Also important would be assessing flow conditions in side channels during various levels of inundation.

Physical habitat changes with flow increases should focus on those characteristics that might change (increased velocity over the nest, reconnection of a side channel) given a certain flow increase. Thus, flows would have to be sustained for a long-enough period to have an effect in the desired reach(es), and allow investigators to measure it. A release of 2-3 days may be sufficient, and flow-stage measurements from existing data may be useful to better understand those relationships. Biological measures might include assessments of egg or larvae presence in nests, and observations of male behavior and presence on nests, at marked locations in pre and post-flooding periods. This approach could also be taken to evaluate effects of disturbance from sampling during the surge, where removal or displacement of adults might result in reduced nest success. A longer-term assessment method would also include estimates of abundance of various life stages (Project 123), and abundance of age-0 fish in autumn (Project 140 results). That Green River reach has a long history of sampling, both for smallmouth bass as well as for small-bodied species that might respond to bass removal, including native fishes and should be included in an assessment of disturbance effects designed to reduce smallmouth bass reproductive success.

Biological assessments would include measuring presence and abundance of larvae with seine samples at specific locations pre and post-flow disturbance, to assess if increased flow removed or dispersed early life stages of smallmouth bass. Placement of marked smallmouth bass early life stages in key backwaters could also be conducted to assure presence of larvae in specific locations, prior to flow manipulations. If spawning nests can be found, investigators could also make observations of those in pre and post-disturbance time periods. Drift nets may also be effective to capture dispersed early life stages of smallmouth bass. We have captured early life stages of smallmouth bass in the Green River just upstream of the Yampa River during higher flow and turbidity events caused by rain events upstream. Thus, we know larvae are dispersed and we are capable of capturing them in drift nets. Such sampling should be timed to coincide with the front edge of the flow pulse to ensure that bass are detected. Seine sampling is also conducted in the Green River in regulated and partially regulated reaches in summer and autumn. Density of smallmouth bass in backwaters in summer and autumn, between which flow disturbances might happen, could be compared to determine effects on a larger, river scale. Abundance of young bass could also be assessed in autumn, and compared to previous years where no flow disturbance was conducted.

Samples of bass collected in autumn would also be aged to determine if any smallmouth bass survived from the time period prior to flow pulses. We would know that bass actually spawned based on observations and sampling conducted pre-disturbance. If all bass captured in autumn were produced post-disturbance, and we know bass were spawned in a pre-disturbance time period, we would know the disturbance was effective to some degree. These are preliminary ideas, which may require some ground-truthing to understand better whether they will be effective.

VII. Task Description and Schedule

Task 1: remove non-native fishes and sample main-channel fish community (large-bodied fishes)

Task 2: remove non-native fishes and sample small-bodied fish community, with pike sampling in Browns Park

Task 3: process preserved samples of small-bodied fish and conduct otolith analyses (fish from seine samples)

Task 4: conduct assessment of flow spike effects on smallmouth bass reproduction and abundance

Task 5: prepare and submit annual report

Schedule: FY-2018 (Tasks 1-5)

Task	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	x								x	x	x	x
2								x	x	x	x	x
3	x	x	x	x	x	x					x	x
4	x	x	x					x	x	x	x	x
5	x	x										

Schedule: FY-2019

Task	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	x								x	x	x	x
2								x	x	x	x	x
3	x	x	x	x	x	x					x	x
4	x	x	x					x	x	x	x	x
5	x	x										

Similar sampling schedules are envisioned for 2020-2022.

VIII. Deliverables, Due Dates, and Budget by Fiscal Year: Sampling, sample processing, and annual reporting.

– Deliverables/Due Dates: Annual Reports of field activities due to PD’s office November of each year.

– LFL Budget:

Travel: Travel costs for field work based on estimated per diem rates for Colorado State University for the area we are working in. Mileage is based on the standard rate for Motor Pool vehicles, which varies depending on age and size of the vehicle. We will use \$ 0.50 per mile for 2018. Meeting costs include three nights of hotel, per diem, and mileage to travel to meetings. These include costs for two people.

Personnel: Salaries include 24.7% fringe rate, an estimate for 2018, plus overhead. Overhead is calculated on all items (including salary plus fringe rate) at 17.5%, per our agreement with BOR.

Supplies: Supplies are used in the conduct of field sampling and lab analysis of specimens and otoliths. Containers and preservatives are to hold field specimens and to curate specimens in the lab, preservative are formalin and ethanol for preservation of samples. Camping gear includes tents, kitchen supplies for field camping, and coolers. Nets include seines and trammel nets, disposable goods that need replacements due to attrition. Fyke nets are stationary gear for pike sampling and need to be replaced due to attrition. Tools for repairs include hammers, pitons, rock bags, wrenches, and other hand tools to assist with sampling and gear repair in the field. Raft gear includes personal flotation devices, straps and other rigging for rafts, oars, frame repair or replacement, and flooring. Estimated costs based on current prices procured from various online sources (local vendors for camping supplies, NRS rafting supplies, Christiansen Inc, for net supplies, Fischer Scientific for preservatives, sample jars).

Budget notes: Costs were increased slightly to allow purchase of a BioMark PIT tag detector in FY 2018 (\$4,900) for use in Vermillion Creek, and slightly higher budgets by USFWS.

**Larval Fish Lab and USBR Fish Community Monitoring Trip Costs and Reporting (Tasks 1-4)**: five trips total, one in each of June/July, August, and September (6-day trip plus two-days of gear and trip preparation per trip) plus the additional pike habitat and sampling assessment in Browns Park, to address: Task 1 (monitor large-bodied fish), Task 2 (monitor small-bodied fish with seines, plus pike sampling and habitat assessment) and Task 3 (process seine samples and conduct otolith analyses). Fringe rates (24.7% estimated in 2018) and overhead (17.5%) are figured into the per day costs for LFL items.

Larval Fish Laboratory, FY2018

Tasks 1 and 2, sample small- and large-bodied fishes

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	13	612	\$7,956
Senior technician (d)	50	247	\$12,350
Technician (d)	90	158	\$14,220
		subtotal	\$34,526
Travel			
Per diem (d)	110	25.0	\$2,750
Mileage (miles)	7500	0.5	\$3,750
		subtotal	\$6,500
Supplies			
gas (\$3/gal)	5	3.0	\$15
sampling containers, preservative, dip nets	18	25.0	\$450
tents, field kitchen gear	3	200.0	\$600
seines, trammel nets	3	130.0	\$390
BioMark PIT detector	1	4900.0	\$4,900
misc tools for repairs	5	22.0	\$110
raft gear (oars, flotation, straps, cooler)	6	140.0	\$840
		subtotal	\$7,305
		Total	\$48,331

Task 3, process preserved fish samples and otoliths from pike and smallmouth bass

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	7	612	\$4,284
Senior technician (d)	25	247	\$6,175
Technician (d)	50	158	\$7,900
			Total \$18,359

Task 4, conduct field studies and analyses to assess flow spike effects on smallmouth bass

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	14	612	\$8,568
Senior technician (d)	55	247	\$13,585
Technician (d)	65	158	\$10,270
			Total \$32,423

Task 5, annual report preparation

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	8	612	\$4,896
Senior technician (d)	7	247	\$1,729
Technician (d)	7	158	\$1,106
			subtotal \$7,731
Travel			
planning mtg	2	800.0	\$1,600
			subtotal \$1,600
			Total \$9,331
			Total tasks 1-5 \$108,444

Larval Fish Laboratory, FY2019

Tasks 1 and 2, sample small- and large-bodied fishes

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	13	624	\$8,115
Senior technician (d)	50	252	\$12,597
Technician (d)	90	161	\$14,504
			subtotal \$35,217
Travel			
Per diem (d)	110	25.0	\$2,750
Mileage (miles)	7500	0.5	\$3,750
			subtotal \$6,500
Supplies			
gas (\$3/gal)	5	3.0	\$15
sampling containers, preservative, dip nets	18	25.0	\$450
tents, field kitchen gear	3	200.0	\$600
seines, trammel nets	3	130.0	\$390
fyke nets	1	756.0	\$756
misc tools for repairs	5	22.0	\$110
raft gear (oars, flotation, straps, cooler)	6	140.0	\$840
			subtotal \$3,161
			Total \$44,878

Task 3, process preserved fish samples and otoliths from pike and smallmouth bass

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	7	624	\$4,370
Senior technician (d)	25	252	\$6,299
Technician (d)	50	161	\$8,058
			Total \$18,726

Task 4, conduct field studies and analyses to assess flow spike effects on smallmouth bass

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	14	624	\$8,739
Senior technician (d)	55	252	\$13,857
Technician (d)	65	161	\$10,475
			Total \$33,071

Task 5, annual report preparation

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	8	624	\$4,994
Senior technician (d)	7	252	\$1,764
Technician (d)	7	161	\$1,128
			subtotal \$7,886
Travel			
planning mtg	2	800.0	\$1,600
			subtotal \$1,600
			Total \$9,486
			Total tasks 1-5 \$106,161

Larval Fish Laboratory, FY2020

Tasks 1 and 2, sample small- and large-bodied fishes

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	13	643	\$8,359
Senior technician (d)	50	259	\$12,975
Technician (d)	90	166	\$14,940
			subtotal \$36,273

Travel			
Per diem (d)	110	25.0	\$2,750
Mileage (miles)	7500	0.5	\$3,750
			subtotal \$6,500
Supplies			
gas (\$3/gal)	5	3.0	\$15
sampling containers, preservative, dip nets	18	25.0	\$450
tents, field kitchen gear	3	200.0	\$600
seines, trammel nets	3	130.0	\$390
fyke nets	1	756.0	\$756
misc tools for repairs	5	22.0	\$110
raft gear (oars, flotation, straps, cooler)	6	140.0	\$840
			subtotal \$3,161
			Total \$45,934

Task 3, process preserved fish samples and otoliths from pike and smallmouth bass

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	7	643	\$4,501
Senior technician (d)	25	259	\$6,487
Technician (d)	50	166	\$8,300
			Total \$19,288

Task 4, conduct field studies and analyses to assess flow spike effects on smallmouth bass

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	14	643	\$9,002
Senior technician (d)	55	259	\$14,272
Technician (d)	65	166	\$10,790
			Total \$34,064

Task 5, annual report preparation

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	8	643	\$5,144
Senior technician (d)	7	259	\$1,816
Technician (d)	7	166	\$1,162
			subtotal \$8,122
Travel			
planning mtg	2	900	\$1,800
			subtotal \$1,800
			Total \$9,922
			Total tasks 1-5 \$109,208

Larval Fish Laboratory, FY2021

Tasks 1 and 2, sample small- and large-bodied fishes

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	13	662	\$8,609
Senior technician (d)	50	267	\$13,364
Technician (d)	90	171	\$15,388
			subtotal \$37,361
Travel			
Per diem (d)	110	25.0	\$2,750
Mileage (miles)	7500	0.5	\$3,750
			subtotal \$6,500
Supplies			
gas (\$3/gal)	5	3.0	\$15
sampling containers, preservative, dip nets	18	25.0	\$450
tents, field kitchen gear	3	200.0	\$600
seines, trammel nets	3	130.0	\$390
fyke nets	1	756.0	\$756

misc tools for repairs	5	22.0	\$110
raft gear (oars, flotation, straps, cooler)	6	140.0	\$840
			subtotal \$3,161
			Total \$47,022

Task 3, process preserved fish samples and otoliths from pike and smallmouth bass

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	7	662	\$4,636
Senior technician (d)	25	267	\$6,682
Technician (d)	50	171	\$8,549
			Total \$19,867

Task 4, conduct field studies and analyses to assess flow spike effects on smallmouth bass

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	14	662	\$9,272
Senior technician (d)	55	267	\$14,701
Technician (d)	65	171	\$11,113
			Total \$35,086

Task 5, annual report preparation

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	8	662	\$5,298
Senior technician (d)	7	267	\$1,871
Technician (d)	7	171	\$1,197
			subtotal \$8,366
Travel			
planning mtg	2	900	\$1,800
			subtotal \$1,800
			Total \$10,166

Total tasks 1-5 \$112,140

Larval Fish Laboratory, FY2022

Tasks 1 and 2, sample small- and large-bodied fishes

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	13	682	\$8,868
Senior technician (d)	50	275	\$13,765
Technician (d)	90	176	\$15,849
			subtotal \$38,482
Travel			
Per diem (d)	110	25.0	\$2,750
Mileage (miles)	7500	0.5	\$3,750
			subtotal \$6,500
Supplies			
gas (\$3/gal)	5	3.0	\$15
sampling containers, preservative, dip nets	18	25.0	\$450
tents, field kitchen gear	3	200.0	\$600
seines, trammel nets	3	130.0	\$390
fyke nets	1	756.0	\$756
misc tools for repairs	5	22.0	\$110
raft gear (oars, flotation, straps, cooler)	6	140.0	\$840
			subtotal \$3,161
			Total \$48,143

Task 3, process preserved fish samples and otoliths from pike and smallmouth bass

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	7	682	\$4,775
Senior technician (d)	25	275	\$6,883
Technician (d)	50	176	\$8,805
			Total \$20,463

Task 4, conduct field studies and analyses to assess flow spike effects on smallmouth bass

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	14	682	\$9,550
Senior technician (d)	55	275	\$15,142
Technician (d)	65	176	\$11,447
			Total \$36,138

Task 5, annual report preparation

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	8	682	\$5,457
Senior technician (d)	7	275	\$1,927
Technician (d)	7	176	\$1,233
			subtotal \$8,617
Travel			
planning mtg	2	900	\$1,800
			subtotal \$1,800
			Total \$10,417
		Total tasks	
		1-4	\$115,161

**USFWS, Vernal Fish Community Monitoring Trip Costs and Reporting (Tasks 1-2)** : three trips total, one in each of June/July, August, and September (5-day trip plus two-days of gear and trip preparation per trip), to address: Task 1 (monitor large-bodied fish), Task 2 (monitor small-bodied fish with seines).

<b>2018</b>			
<b>Tasks 1&amp;2 – USFWS Sample Fish Population</b>	<b>Rate \$/hr</b>	<b>Total hours</b>	<b>Cost</b>
<b>Labor</b>			
WG-5 Boat Operators (2)	\$23.16	160	\$3,706
WG-5 Boat Operators (2) OT	\$34.75	16	\$556
GS-11 Fish Biologist	\$42.37	128	\$5,423
GS-9 Admin. Officer	\$41.57	88	\$3,658
GS-12 Supervisory Fish Biologist	\$60.84	84	\$5,111
<b>Subtotal</b>			<b>\$18,454</b>
<b>Travel</b>			
Shuttle (3 trucks/trip x \$140/truck x 2 trips) Lodore to Split Mountain			\$840
Shuttle (3 trucks/trip x \$175/truck x 1 trips) Echo Park to Split Mountain			\$525
<b>Subtotal</b>			<b>\$1,365</b>
<b>Equipment</b>			
(2 trucks/trip x 300 mi/truck x \$0.33/mi x 2 trips) Vernal to Lodore, round trip			\$396
(2 trucks/trip x 167 mi/truck x \$0.33/mi x 1 trips) Vernal to Echo, round trip			\$110
(12 gal gas/boat x 2 boats/trip x \$4.00/gal x 3 trips)			\$288
GSA trucks (2 trucks x 1 months)	\$250	2	\$500
Maintenance/replacement of rafting gear (oars, repair kit supplies, raft repairs/patching, motor maintenance), sampling nets, electrofishing gear (generator maintenance, electrode replacement), safety equipment (life jackets, control pedals/mats), camping equipment (based on average annual expenses from prior years).			\$1,022
GS-8 Fish Tech maintenance work	\$43.43	196	\$8,512
<b>Subtotal</b>			<b>\$10,829</b>
<b>Task 1 Total</b>			<b>\$30,647</b>

<b>2019</b>			
<b>Tasks 1&amp;2 – USFWS Sample Fish Population</b>	<b>Rate \$/hr</b>	<b>Total hours</b>	<b>Cost</b>
<b>Labor</b>			
WG-5 Boat Operators (2)	\$23.63	160	\$3,781
WG-5 Boat Operators (2) OT	\$35.44	16	\$567
GS-11 Fish Biologist	\$43.73	128	\$5,597
GS-9 Admin. Officer	\$42.69	105	\$4,482
GS-12 Supervisory Fish Biologist	\$62.05	84	\$5,212
<b>Subtotal</b>			<b>\$19,640</b>
<b>Travel</b>			
Shuttle (3 trucks/trip x \$140/truck x 2 trips) Lodore to Split Mountain			\$858
Shuttle (3 trucks/trip x \$179/truck x 1 trips) Echo Park to Split Mountain			\$537
<b>Subtotal</b>			<b>\$1,395</b>
<b>Equipment</b>			
(2 trucks/trip x 300 mi/truck x \$0.34/mi x 2 trips) Vernal to Lodore, round trip			\$408
(2 trucks/trip x 167 mi/truck x \$0.34/mi x 1 trips) Vernal to Echo, round trip			\$114
(12 gal gas/boat x 2 boats/trip x \$4.00/gal x 3 trips)			\$288
GSA trucks (2 trucks x 1 months)	\$255	2	\$510
Maintenance/replacement of rafting gear (oars, repair kit supplies, raft repairs/patching, motor maintenance), sampling nets, electrofishing gear (generator maintenance, electrode replacement), safety equipment (life jackets, control pedals/mats), camping equipment (based on average annual expenses from prior years).			\$1,022
GS-8 Fish Tech maintenance work	\$44.29	206	\$9,124
<b>Subtotal</b>			<b>\$11,465</b>
<b>Task 1 Total</b>			<b>\$32,500</b>
<b>2020</b>			
<b>Tasks 1&amp;2 – USFWS Sample Fish Population</b>	<b>Rate \$/hr</b>	<b>Total hours</b>	<b>Cost</b>
<b>Labor</b>			
WG-5 Boat Operators (2)	\$24.10	160	\$3,856

WG-5 Boat Operators (2) OT	\$36.15	16	\$578
GS-11 Fish Biologist	\$46.92	128	\$6,006
GS-9 Admin. Officer	\$44.42	80	\$3,554
GS-12 Supervisory Fish Biologist	\$63.30	124	\$7,849
<b>Subtotal</b>			<b>\$21,843</b>
<b>Travel</b>			
Shuttle (3 trucks/trip x \$146/truck x 2 trips) Lodore to Split Mountain			\$876
Shuttle (3 trucks/trip x \$182/truck x 1 trips) Echo Park to Split Mountain			\$546
<b>Subtotal</b>			<b>\$1,422</b>
<b>Equipment</b>			
(2 trucks/trip x 300 mi/truck x \$0.34/mi x 2 trips) Vernal to Lodore, round trip			\$408
(2 trucks/trip x 167 mi/truck x \$0.34/mi x 1 trips) Vernal to Echo, round trip			\$114
(12 gal gas/boat x 2 boats/trip x \$4.00/gal x 3 trips)			\$288
GSA trucks (2 trucks x 1 months)	\$260	2	\$520
Maintenance/replacement of rafting gear (oars, repair kit supplies, raft repairs/patching, motor maintenance), sampling nets, electrofishing gear (generator maintenance, electrode replacement), safety equipment (life jackets, control pedals/mats), camping equipment (based on average annual expenses from prior years).			\$1,022
GS-8 Fish Tech maintenance work	\$46.34	196	\$9,083
<b>Subtotal</b>			<b>\$11,434</b>
<b>Task 1 Total</b>			<b>\$34,699</b>
<b>2021</b>			
<b>Tasks 1&amp;2 – USFWS Sample Fish Population</b>	<b>Rate \$/hr</b>	<b>Total hours</b>	<b>Cost</b>
<b>Labor</b>			
WG-5 Boat Operators (2)	\$24.58	160	\$3,933
WG-5 Boat Operators (2) OT	\$36.87	16	\$590
GS-11 Fish Biologist	\$47.86	128	\$6,126
GS-9 Admin. Officer	\$45.61	80	\$3,649
GS-12 Supervisory Fish Biologist	\$66.37	84	\$5,575
<b>Subtotal</b>			<b>\$19,873</b>
<b>Travel</b>			

Shuttle (3 trucks/trip x \$149/truck x 2 trips) Lodore to Split Mountain			\$894
Shuttle (3 trucks/trip x \$186/truck x 1 trips) Echo Park to Split Mountain			\$558
<b>Subtotal</b>			<b>\$1,452</b>
<b>Equipment</b>			
(2 trucks/trip x 300 mi/truck x \$0.35/mi x 2 trips) Vernal to Lodore, round trip			\$420
(2 trucks/trip x 167 mi/truck x \$0.35/mi x 1 trips) Vernal to Echo, round trip			\$117
(12 gal gas/boat x 2 boats/trip x \$4.00/gal x 3 trips)			\$288
GSA trucks (2 trucks x 1 months)	\$265	2	\$530
Maintenance/replacement of rafting gear (oars, repair kit supplies, raft repairs/patching, motor maintenance), sampling nets, electrofishing gear (generator maintenance, electrode replacement), safety equipment (life jackets, control pedals/mats), camping equipment (based on average annual expenses from prior years).			\$1,022
GS-8 Fish Tech maintenance work	\$47.26	196	\$9,263
<b>Subtotal</b>			<b>\$11,640</b>
<b>Task 1 Total</b>			<b>\$32,965</b>
<b>2022</b>			
<b>Tasks 1&amp;2 – USFWS Sample Fish Population</b>	<b>Rate \$/hr</b>	<b>Total hours</b>	<b>Cost</b>
<b>Labor</b>			
WG-5 Boat Operators (2)	\$25.07	160	\$4,011
WG-5 Boat Operators (2) OT	\$37.61	16	\$602
GS-11 Fish Biologist	\$48.81	128	\$6,248
GS-9 Admin. Officer	\$46.53	80	\$3,722
GS-12 Supervisory Fish Biologist	\$67.70	84	\$5,687
<b>Subtotal</b>			<b>\$20,270</b>
<b>Travel</b>			
Shuttle (3 trucks/trip x \$152/truck x 2 trips) Lodore to Split Mountain			\$912
Shuttle (3 trucks/trip x \$189/truck x 1 trips) Echo Park to Split Mountain			\$567
<b>Subtotal</b>			<b>\$1,479</b>
<b>Equipment</b>			
(2 trucks/trip x 300 mi/truck x \$0.36/mi x 2 trips) Vernal to Lodore, round trip			\$432
(2 trucks/trip x 167 mi/truck x \$0.36/mi x 1 trips) Vernal to Echo, round trip			\$120

(12 gal gas/boat x 2 boats/trip x \$4.00/gal x 3 trips)			\$288
GSA trucks (2 trucks x 1 months)	\$271	2	\$542
Maintenance/replacement of rafting gear (oars, repair kit supplies, raft repairs/patching, motor maintenance), sampling nets, electrofishing gear (generator maintenance, electrode replacement), safety equipment (life jackets, control pedals/mats), camping equipment (based on average annual expenses from prior years).			\$1,022
GS-8 Fish Tech maintenance work	\$48.21	196	\$9,449
<b>Subtotal</b>			<b>\$11,853</b>
<b>Task 1 Total</b>			<b>\$33,602</b>

IX. Budget Summary

**FY2018-19 Budget Summary: condenses tables above**

FY 2018-19 budget

Year	LFL	USFWS	Total
FY2018	\$108,444	\$30,647	\$139,091
FY2019	\$106,161	\$32,500	\$138,661
	\$214,605	\$63,147	\$277,752

FY2018-2022 budget

Year	LFL	USFWS	Total
FY2018	\$108,444	\$30,647	\$139,091
FY2019	\$106,161	\$32,500	\$138,661
FY2020	\$109,208	\$34,699	\$143,907
FY2021	\$112,140	\$32,965	\$145,105
FY2022	\$115,161	\$33,602	\$148,763
	\$551,113	\$164,413	\$715,527

– Deliverables/Due dates: Annual Report of field activities and sampling results due to PD’s office November of each year.

X. Reviewers: Kevin McAbee, June 2015;

Doug Osmundson, U.S. Fish and Wildlife Service, Grand Junction, CO  
Kirk LaGory, Argonne National Laboratory, Argonne, IL

XI. References

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