FY-2016-2020 (2106-17 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

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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:
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. 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 2014 (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, 2011-2014 and low and warm flows in the summer seasons from 2002 to 2007, followed by relatively high flows from 2008-2011 and 2014, and lower flows in 2012 and 2013. A number of changes in the fish community were observed during sampling from 2002 to 2014. 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.

We also made valuable observations of native fishes during the 2002-2014 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 2011-2014, detected aggregations of Colorado pikeminnow in or at the mouth of Vermillion Creek in spring during

runoff. 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 psicivores. 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 2007-2014 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 2014 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 only occasionally when Green River flows are low and warm (conditions when pikeminnow spawning might be expected) and will be done in conjunction 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 2007-2014 to understand smallmouth bass spawning periodicity to assist with flow-related management of that species. A summary report of that work is nearly finished.

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.

Objective 7, **NEW.** Summarize data collected from 2004-2014 in a new synthesis of information. This will be similar to a report prepared in 2006 (Bestgen et al. 2006), and will discuss trends in native and invasive species abundance in the study area.

Objective 8, **NEW.** Provide a study plan and implement field investigations to better understand prospects for flow or temperature disturbances to reduce reproductive success of smallmouth bass in the Green River.

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 2014 sampling. Data will be collected in a manner that generates catch per unit effort (CPUE) metrics (fish/hour electrofishing, small-bodied fish/m^2 habitat seined, larval fish/m^3 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.

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 expnded 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 begin 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 (2002-2014 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 nearly available.

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 2014 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 2015 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.

***Summary report preparation (Task 5 below, 2016 only)*:** This item was added at the request of the Program Director's office. A summary report of fish population trends and flow and water temperature conditions was prepared in 2006 (Bestgen et al. 2006), based on sampling conducted in 1994-1996 and 2002-2004. This new report would be similar to that 2006 effort but would summarize additional findings since 2004 (through 2014) in a similar manner. We would also incorporate results from pike sampling and removal in Browns Park, and other efforts added since that time.

***Evaluate effects of flow manipulations on smallmouth bass in Lodore and Whirlpool canyons (Task 6 below, begins 2016)*:** 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 would 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 2016 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: prepare and submit annual report

Task 5: prepare summary report for data collected from 2002-2014, for FY 2016 only
Task 6: evaluate Green River flow & temperature disturbances to disadvantage smallmouth bass

Schedule: FY-2016 (Tasks 1-4)

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										

Schedule: FY-2017

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										

Task 5 would begin immediately and extend through 2016, with a draft report due 30 September 2016.
Task 6 planning for field studies would begin immediately and extend through 2016, with a draft report due with regular FR-115 sampling results.

Similar sampling schedules are envisioned for 2018-2020.

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. An added item is the data summary for years 2002-2014 with a draft report due 30 September 2016, and an assessment of flow disturbance on smallmouth bass in the Green River.

– 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 2014. Meeting costs include three nites of hotel, per diem, and mileage to travel to meetings. These include costs for two people.

Personnel: Salaries include 27% fringe rate, an estimate for 2014, 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 reduced to accommodate Program requirements. This was accomplished by not building in raises in salary between 2013 and 2014 and decreasing costs for sample identification and other analyses; budget was static from 2011-2013. Increases needed to support mandated raises for personnel and if additional funds are available, increased sample costs should be added.

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). We maintained salary costs from 2010-2013; an increase in budget for 2014 and beyond is detailed below. Fringe rates (25% in 2016) and overhead (17.5%) are figured into the per day costs for LFL items.

Larval Fish Laboratory, FY2016, summary report

Tasks 5, data analysis and summary report preparation, new item

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	70	594		$41,580
Senior technician (d)	40	340		$13,600
Technician (d)	10	145		$1,450
			Total	**$56,630**

Task 6, new item, flow disturbance effects on smallmouth bass

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	44	594.1		$26,141
Senior technician (d)	44	239.8		$10,550
Technician (d)	44	153.8		$6,769
			subtotal	$43,459
Travel				
Per diem (d)	25	25.0		$625
Mileage (miles)	2000	0.5		$1,000
			subtotal	$1,625
Field supplies, seines, marking gear, tape measures, GPS units				$4,916
			Total	**$50,000**

Larval Fish Laboratory, FY2016, regular sampling

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

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	13	594.1		$7,723
Senior technician (d)	50	239.8		$11,988
Technician (d)	80	153.8		$12,306
			subtotal	$32,018
Travel				
Per diem (d)	110	25.0		$2,750
Mileage (miles)	7500	0.5		$3,750
			subtotal	$6,500
Supplies				
gas ($4/gal)	5	4.0		$20
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	2	756.0		$1,512
misc tools for repairs	5	22.0		$110
raft gear (oars, flotation, straps, cooler)	6	140.0		$840
			subtotal	$3,922
			Total	$42,440

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

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	7	594.1		$4,159
Senior technician (d)	25	239.8		$5,994
Technician (d)	50	153.8		$7,692
			Total	$17,844

Task 4, annual report preparation

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	8	594.1		$4,753
Senior technician (d)	7	239.8		$1,678
Technician (d)	7	153.8		$1,077
			subtotal	$7,508

Travel				
planning mtg	2	600.0		$1,200
			subtotal	$1,200
			Total	$8,708
		Total tasks 1-4		**$68,992**

Larval Fish Laboratory, FY2017

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

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	13	611.9		$7,955
Senior technician (d)	50	247.0		$12,348
Technician (d)	80	158.4		$12,676
			subtotal	$32,979
Travel				
Per diem (d)	110	25.0		$2,750
Mileage (miles)	7500	0.5		$3,750
			subtotal	$6,500
Supplies				
gas ($4/gal)	5	4.0		$20
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	2	756.0		$1,512
misc tools for repairs	5	22.0		$110
raft gear (oars, flotation, straps, cooler)	6	140.0		$840
			subtotal	$3,922
			Total	$43,401

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

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	7	611.9		$4,283
Senior technician (d)	25	247.0		$6,174
Technician (d)	50	158.4		$7,922
			Total	$18,380

Task 4, annual report preparation

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	8	611.9		$4,895
Senior technician (d)	7	247.0		$1,729
Technician (d)	7	158.4		$1,109
			subtotal	$7,733
Travel				
planning mtg	2	600.0		$1,200
			subtotal	$1,200
			Total	$8,933
		Total tasks 1-4		**$70,713**

Larval Fish Laboratory, FY2018

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

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	13	630.3		$8,194
Senior technician (d)	50	254.4		$12,718
Technician (d)	80	163.2		$13,056
			subtotal	$33,968
Travel				
Per diem (d)	110	25.0		$2,750
Mileage (miles)	7500	0.5		$3,750
			subtotal	$6,500
Supplies				
gas ($4/gal)	5	4.0		$20
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	2	756.0		$1,512
misc tools for repairs	5	22.0		$110

raft gear (oars, flotation, straps, cooler)	6	140.0		$840
			subtotal	$3,922
			Total	$44,390

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

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	7	630.3		$4,412
Senior technician (d)	25	254.4		$6,359
Technician (d)	50	163.2		$8,160
			Total	$18,931

Task 4, annual report preparation

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	8	630.3		$5,042
Senior technician (d)	7	254.4		$1,781
Technician (d)	7	163.2		$1,142
			subtotal	$7,965
Travel				
planning mtg	2	600.0		$1,200
			subtotal	$1,200
			Total	$9,165
		Total tasks 1-4		**$72,486**

Larval Fish Laboratory, FY2019

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

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	13	649.2		$8,440
Senior technician (d)	50	262.0		$13,100
Technician (d)	80	168.1		$13,448
			subtotal	$34,987

Travel				
Per diem (d)	110	25.0		$2,750
Mileage (miles)	7500	0.5		$3,750
			subtotal	$6,500
Supplies				
gas ($4/gal)	5	4.0		$20
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	2	756.0		$1,512
misc tools for repairs	5	22.0		$110
raft gear (oars, flotation, straps, cooler)	6	140.0		$840
			subtotal	$3,922
			Total	$45,409

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

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	7	649.2		$4,544
Senior technician (d)	25	262.0		$6,550
Technician (d)	50	168.1		$8,405
			Total	$19,499

Task 4, annual report preparation

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	8	649.2		$5,194
Senior technician (d)	7	262.0		$1,834
Technician (d)	7	168.1		$1,177
			subtotal	$8,204
Travel				
planning mtg	2	600.0		$1,200
			subtotal	$1,200
			Total	$9,404

Total tasks 1-4	**$74,312**

Larval Fish Laboratory, FY2020

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

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	13	668.7		$8,693
Senior technician (d)	50	269.9		$13,493
Technician (d)	80	173.1		$13,851
			subtotal	$36,036
Travel				
Per diem (d)	110	25.0		$2,750
Mileage (miles)	7500	0.5		$3,750
			subtotal	$6,500
Supplies				
gas ($4/gal)	5	4.0		$20
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	2	756.0		$1,512
misc tools for repairs	5	22.0		$110
raft gear (oars, flotation, straps, cooler)	6	140.0		$840
			subtotal	$3,922
			Total	$46,458

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

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	7	668.7		$4,681
Senior technician (d)	25	269.9		$6,746
Technician (d)	50	173.1		$8,657
			Total	$20,084

Task 4, annual report preparation

Item				Cost
Labor	Units	Cost/unit		
Principal investigator (d)	8	668.7		$5,349
Senior technician (d)	7	269.9		$1,889
Technician (d)	7	173.1		$1,212
			subtotal	$8,450

Travel				
planning mtg	2	600.0		$1,200
			subtotal	$1,200
			Total	$9,650
		Total tasks 1-4		**$76,193**

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.

2016

Tasks 1&2 – USFWS Sample Fish Population	**Rate $/hr**	**Total hours**	**Cost**
Labor			
WG-5 Boat Operators (2)	$24.96	160	$3,994
GS-7 Fish Biologist	$28.44	120	$3,413
GS-9 Admin. Officer	$39.19	80	$3,135
GS-12 Supervisory Fish Biologist	$55.14	40	$2,206
Subtotal			**$12,747**
Travel			
Shuttle (3 trucks/trip x $150/truck x 3 trips) Lodore to Split Mountain			$1,350
Subtotal			**$1,350**
Equipment			
(2 trucks/trip x 175 mi/truck x $0.31/mi x 3 trips) Vernal to Lodore, round trip			$326
(12 gal gas/boat x 2 boats/trip x $4.00/gal x 3 trips)			$288
GSA trucks (2 trucks x 1 months)	$313	2	$626
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	$38.72	196	$7,589
Subtotal			**$9,851**
Task 1&2 Total			**$23,948**

2017

Tasks 1&2 – USFWS Sample Fish Population	**Rate $/hr**	**Total hours**	**Cost**
Labor			
WG-5 Boat Operators (2)	$25.70	160	$4,112
GS-9 Fish Biologist	$35.36	120	$4,243
GS-9 Admin. Officer	$39.98	80	$3,198
GS-12 Supervisory Fish Biologist	$56.25	40	$2,250
Subtotal			**$13,803**
Travel			
Shuttle (3 trucks/trip x $153/truck x 3 trips) Lodore to Split Mountain			$1,377
Subtotal			**$1,377**
Equipment			
(2 trucks/trip x 175 mi/truck x $0.32/mi x 3 trips) Vernal to Lodore, round trip			$336
(12 gal gas/boat x 2 boats/trip x $4.00/gal x 3 trips)			$288
GSA trucks (2 trucks x 1 months)	$320	2	$640
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	$39.74	196	$7,788
Subtotal			**$10,074**
Task 1 Total			**$25,254**

2018

Tasks 1&2 – USFWS Sample Fish Population	**Rate $/hr**	**Total hours**	**Cost**
Labor			
WG-5 Boat Operators (2)	$26.48	160	$4,237
GS-11 Fish Biologist	$42.93	120	$5,152
GS-9 Admin. Officer	$40.78	80	$3,262
GS-12 Supervisory Fish Biologist	$57.38	40	$2,295
Subtotal			**$14,946**
Travel			
Shuttle (3 trucks/trip x $156/truck x 3 trips) Lodore to Split Mountain			$1,404
Subtotal			**$1,404**
Equipment			
(2 trucks/trip x 175 mi/truck x $0.33/mi x 3 trips) Vernal to Lodore, round trip			$347
(12 gal gas/boat x 2 boats/trip x $4.00/gal x 3 trips)			$288
GSA trucks (2 trucks x 1 months)	$325	2	$650
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	$40.53	196	$7,944
Subtotal			**$10,250**
Task 1 Total			**$36,600**

2019

Tasks 1&2 – USFWS Sample Fish Population	**Rate $/hr**	**Total hours**	**Cost**
Labor			
WG-5 Boat Operators (2)	$27.27	160	$4,363
GS-11 Fish Biologist	$43.79	120	$5,255
GS-9 Admin. Officer	$41.60	80	$3,328
GS-12 Supervisory Fish Biologist	$58.52	40	$2,341
Subtotal			**$15,287**
Travel			
Shuttle (3 trucks/trip x $159/truck x 3 trips) Lodore to Split Mountain			$1,431
Subtotal			**$1,431**
Equipment			
(2 trucks/trip x 175 mi/truck x $0.34/mi x 3 trips) Vernal to Lodore, round trip			$357
(12 gal gas/boat x 2 boats/trip x $4.00/gal x 3 trips)			$288
GSA trucks (2 trucks x 1 months)	$332	2	$664
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	$41.35	196	$8,105
Subtotal			**$10,436**
Task 1 Total			**$27,154**

2020

Tasks 1&2 – USFWS Sample Fish Population	**Rate $/hr**	**Total hours**	**Cost**
Labor			
WG-5 Boat Operators (2)	$28.09	160	$4,494
GS-11 Fish Biologist	$44.67	120	$5,360
GS-9 Admin. Officer	$42.43	80	$3,394
GS-13 Project Leader	$70.66	63	$4,452
GS-12 Supervisory Fish Biologist	$59.69	40	$2,388
Subtotal			**$15,636**
Travel			
Shuttle (3 trucks/trip x $162/truck x 3 trips) Lodore to Split Mountain			$1,458
Subtotal			**$1,458**
Equipment			
(2 trucks/trip x 175 mi/truck x $0.35/mi x 3 trips) Vernal to Lodore, round trip			$368
(12 gal gas/boat x 2 boats/trip x $4.00/gal x 3 trips)			$288
GSA trucks (2 trucks x 1 months)	$338	2	$676
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	$42.17	196	$8,265
Subtotal			**$10,619**
Task 1 Total			**$27,713**

IX. Budget Summary

FY2016-17 Budget Summary: condenses tables above

Without summary report

	LFL	USFWS	total
FY16	$68,992	$23,948	$92,940
FY17	$70,713	$25,254	$95,967
FY18	$72,486	$26,600	$99,086
FY19	$74,312	$27,154	$101,466
FY20	$76,193	$27,713	$103,906
	$362,696	$130,669	$493,365

Includes Summary Report

	LFL	USFWS	total
FY16	$125,622	$23,948	$149,570
FY17	$70,713	$25,254	$95,967
FY18	$72,486	$26,600	$99,086
FY19	$74,312	$27,154	$101,466
FY20	$76,193	$27,713	$103,906
	$419,326	$130,669	$549,995

Includes summary report plus study plan and field work for bass disturbance by flows

	LFL	USFWS	total
FY16	$175,622	$23,948	$199,570
FY17	$70,713	$25,254	$95,967
FY18	$72,486	$26,600	$99,086
FY19	$74,312	$27,154	$101,466
FY20	$76,193	$27,713	$103,906
	$469,326	$130,669	$599,995

– 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

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