ORIGINAL

United States Department of the Interior
FISH AND WILDLIFE SERVICE
UTAH FIELD OFFICE
2369 WEST ORTON CIRCLE, SUITE 50
WEST VALLEY CITY, UTAH 84119

May 14, 2013

In Reply Refer To
FWS/R6
ES/UT
08-FA-0180

Memorandum

To: Director, Upper Colorado Region, Bureau of Reclamation
Chair, Flaming Gorge Technical Working Group, Bureau of Reclamation

From: Field Supervisor, Utah Field Office, U.S. Fish and Wildlife Service

Subject: 2013 Green River Spring and Base Flows to Assist in Recovery of the Endangered Fishes

This letter describes our recommendations for 2013 spring and base flows in Reach 2 of the Green River for discussion by the Flaming Gorge Technical Working Group (FGTWG) in development of recommendations for Flaming Gorge Dam operations. Our intent is to work with other FGTWG members to ensure consistency with the 2005 biological opinion (BO; U.S. Fish and Wildlife Service 2005) and 2006 record of decision (ROD; U.S. Department of Interior 2006), which recommend flows to protect and assist in recovery of endangered fishes.

The following recommendations are subject to forecasted and real-time May – July hydrologic conditions in the upper Green River drainage, with recognition that trade-offs of spring and base flows should be considered and used to adjust operations as deemed appropriate.

Spring-peak Research Flow

We support the Upper Colorado River Endangered Fish Recovery Program's (Recovery Program) 2013 Spring Flow Request, as explained in their February 26, 2013 letter. The primary objective as presented in their letter is to time Flaming Gorge releases and resultant floodplain connection with the presence of wild produced razorback sucker larvae. The Recovery Program's objective is consistent with the intent of the Flow and Temperature Recommendations for Endangered Fishes in the Green River Downstream of Flaming Gorge Dam (Flow Recommendations; Muth et al. 2000), the 2005 BO, and the 2006 ROD, and uses the best available science to guide Flaming Gorge operations and recovery actions in an adaptive management framework. Timing Flaming Gorge r

eleases concurrently with wild produced larvae is a major step in re-establishing a stable population of razorback sucker in the Green River basin.

The Recovery Program, in an effort to scientifically evaluate the results of operating Flaming Gorge Dam concurrent with the presence of larval razorback sucker, developed the *Study Plan to Examine the Effects of Using Larval Sucker Occurrence in the Green River as a Trigger for Flaming Gorge Dam*[1] (Larval Trigger Study Plan or LTSP). The Study Design matrix (Table 2 in the LTSP) details the range of experimental conditions the Recovery Program would like to assess, with recognition that more than one set of flow conditions of that matrix could be accomplished in a single year. Because the LTSP describes a systematic analysis for evaluating the success of operating Flaming Gorge concurrently with wild produced razorback sucker larvae, we conclude it is very important to follow its recommendations whenever possible.

The Bureau of Reclamation (Reclamation) proposes to operate peak releases conservatively and exercise the flexibility in the ROD by operating one classification lower than indicated in the forecasts. As a result, Reclamation will operate under a dry classification for the spring peak, despite both the Upper Green and Yampa River Basins being in the moderately dry classification as of the April mid-month forecast. We understand that a dry 2012 and a moderately dry 2013 have reduced much of the flexibility Reclamation has for reservoir operations.

Under this operation proposal, the LTSP advises providing flows between 8,300 and 14,000 cubic feet per second (cfs) for one to six days in order to connect floodplain habitats such as Stewart Lake, Old Charley Wash, and Above Brennan. Last year these same operational criteria were targeted and achieved (5 days above 8,300 cfs). Sampling indicated that razorback suckers were entrained into Stewart Lake, demonstrating success. However, because of operational constraints those larval fish were not returned to the river as planned, as Stewart Lake desiccated during a very dry year.

We support Reclamation targeting one to six days above 8,300 cfs under the LTSP. We believe that 2012 conditions did not fulfill the intent of the LTSP because of the desiccation of Stewart Lake, and therefore a repeat of the efforts in 2012 is warranted. In 2013, Program partners believe that Stewart Lake will remain wetted before being drained in late summer to support selenium remediation. This selenium remediation effort is consistent with endangered fish recovery. As a result of these coordinated management actions, we believe we can provide a meaningful data point for the LTSP this year.

We request that Reclamation attempts to provide connection at targeted floodplain habitats for six consecutive days (or as many as possible). Because hydrologic conditions are in the moderately dry category, but Reclamation is operating one classification drier, we believe that operating towards a longer duration of connection is warranted. Also, we request that Reclamation work the FGTWG to determine if floodplain habitats besides Stewart Lake and Old Charley Wash can be connected during larval drift. We understand

[1] Can be found online at: http://www.coloradoriverrecovery.org/documents-publications/technical-reports/isf/larvaltriggerstudyplan.pdf

flows to connect these floodplain habitats will largely be based on Yampa flows coincident with Flaming Gorge releases.

Justification for the LTSP under the Flaming Gorge BO and ROD

The LTSP is an important document that is assisting in the consistent evaluation of how Flaming Gorge operations are benefiting razorback sucker. The LTSP and updated flow release is supported by the most recent scientific research into endangered fish ecology and floodplain management (Bestgen et al. 2011). As the Recovery Program described in the LTSP, the Bestgen et al. (2011) report synthesized long term data, evaluated the ability to operate Flaming Gorge Dam for the purpose of entraining wild razorback larvae into floodplain habitats, and created a set of conclusions and recommendations to guide future management. The Flow Recommendations recommended utilizing up-to-date research and monitoring, such as the Bestgen et al. (2011) draft report:

> "the collection of additional data on endangered fishes and their habitats should focus on the evaluation and possible modification of our recommendations by following an adaptive-management process" (Muth et al. 2000, p. 5-39);

as well as biological information to guide the onset of spring peak flow:

> "Examples of real-time and other year-specific information to be considered in determining annual patterns of releases . . .
>
> - Initial appearance of larval suckers in established reference sites in Reach 2 (e.g., Cliff Creek)" (Muth et al. 2000, p. 5-9, Table 5.3).

Similarly, the 2005 BO calls for adaptive management in implementing the proposed action (operations of Flaming Gorge Dam) (U.S. Fish and Wildlife Service 2005, p. 16) and set forth this process as a conservation measure:

> "The adaptive management process will rely on the Recovery Program for monitoring and research studies to test the outcomes of implementing the proposed action and proposing refinements to dam operations" (U.S. Fish and Wildlife Service 2005, p. 17);

and

> "[Bureau of] Reclamation, Western [Area Power Administration], and the [U.S. Fish and Wildlife] Service will use any new information collected in these studies to determine the need for management actions or modification of operations as determined appropriate" (U.S. Fish and Wildlife Service 2005, p. 17)

Therefore, we believe that the Recovery Program's 2013 Spring Flow Request and implementation of the LTSP are supported by the 2005 BO and we support Reclamation's implementation of this request. The Recovery Program has determined that a minimum of six study years are needed to meet the objectives of the LTSP. Unless otherwise specifically stipulated, this letter conveys the Service's interpretation of ESA compliance under the 2005 BO as it relates to Reclamation's future LTSP-related spring operations. We recognize that Reclamation's targeting of a biological trigger (presence

of larval razorback sucker) rather than a hydrological one (Yampa River flows) deviates from past operations and may require greater volumes of water in some years. However, we conclude that this experiment is consistent with the intent of the Flow Recommendations and will assist in the recovery of the endangered fish.

We further recognize that timing releases from Flaming Gorge Dam consistent with the Recovery Program's 2013 Spring Flow Request and the LTSP may require the hydrologic tradeoff of not meeting the 2000 Flow and Temperature Recommendations for Reach 2. Nevertheless, we support Reclamation following the Recovery Program's 2013 Spring Flow Request and LTSP, and consider that doing so will meet Reclamation's responsibility to the ROD objectives in 2013.

Operations of Stewart Lake

As previously mentioned, we believe water management for selenium remediation at Stewart Lake is consistent with endangered fish recovery. Past operations of Stewart Lake (independent of endangered fish considerations) have focused on a 'fill and drain' operation. This operation followed the general procedure of an initial intake of water into Stewart Lake with Green River spring peak flows, a complete fill of the lake with Red Fleet water, and a draining of the lake after months of inundation. This operational plan has been utilized consistently[2] and successfully over the majority of the past decade and has improved the selenium levels in Stewart Lake.

Recent work demonstrated that the most effective operation for selenium remediation would be a single fill and drain operation[3] with a total duration of inundation of about 90 days. To be consistent with past operations and to follow the most effective remediation process, UDWR's proposed 2013 operations are to allow Green River connection flows to first enter the lake, use Red Fleet water to completely fill the lake, and tentatively drain the lake on August 15 (Stewart Lake Working Group 2013). We support this proposal.

Our office believes that operating Stewart Lake for selenium remediation under this consistent operation plan will benefit endangered fish without affecting the selenium remediation efforts that have been underway for many years. We find no reason to adjust selenium remediation operations from past procedures and support the UDWR's plan to drain the lake near the end of the summer. In fact, we believe that the LTSP request to consistently connect Stewart Lake in all years will continue to provide selenium remediation benefits by providing a consistent supply of water for initial filling.

Recently, some concern has been raised about the legal and biological ramifications for entraining larval fish into Stewart Lake before selenium levels are completely remediated. However, we believe that any larval fish entrained into Stewart Lake are

---

[2] This plan has been used each year between 2003 and 2010. Historically high flows in 2011 altered operations in 2011 (no Red Fleet water needed because of large input of Green River water) and 2012 (no Red Fleet water used in order to dry the lake bed sufficiently from the 2011 flows) (Stewart Lake Working Group 2013)

[3] rather than fill and drain twice a year

more likely to survive in Stewart Lake than in the main channel habitats. We base this on continued improvement of selenium levels in Stewart Lake and years of unsuccessful recruitment of the species in main channel habitats that contain non-native predators. Although Stewart Lake selenium levels have not been completely remediated, Stewart Lake offers larval fish better habitat than the main channel because larval fish can grow more quickly and in a predator free environment[4]. While some impacts to endangered fish from selenium exposure may still occur (reduced survival, physiological abnormalities, etc.), these impacts are much less than the likely predation effects in the main channel.

As a result, we believe that entraining larval razorback sucker into Stewart Lake (via Flaming Gorge operations) and harboring them over the summer (via Stewart Lake remediation efforts) offer a net benefit to the species. While there may be some level of incidental take[5] from selenium levels in the lake, this take is covered in the 2005 BO for operation of Flaming Gorge. We would like to compliment Reclamation, the UDWR, and other partners for improving conditions of Stewart Lake and are confident complete remediation will occur in the near future.

Base Flow Request

Because of projected drier than average year conditions, we believe that base flow augmentation is a very important consideration for 2013. Base flows are important for a variety of ecological reasons, such as increased resource and habitat availability. We propose the following approach to base flow operations in 2013, which mirrors our recommended approach in 2010 and 2012. The 2010 and 2012 proposals relied on the most up-to-date research available. Biological data collected those years indicated that numbers of Colorado pikeminnow continue to improve.

Our understanding is that Reclamation will identify a Reach 1 base flow target commensurate with the April - July hydrologic condition in accordance with the ROD and the BO. The Reach 1 target will create a flow condition in Reach 2 that falls within the appropriate base flow range when coupled with projected Yampa River base flows (Muth et al. 2000). For reasons mentioned below, we request that Reclamation does not operate under a classification drier than the official base flow classification and also releases higher flows than the scheduled base flow target through September 30, 2012. We understand that Reclamation may need to release less than the base flow target through the remainder of the base flow period (October to March) to balance annual operations.

Specifically, we request that Reclamation augment the Reach 1 calculated base flow target by as much as 40%. For example, if Reclamation determines that a release of 1,100 cfs is necessary to comply with the ROD and BO, then we request that up to 1,540 cfs be released through Sept 30, 2012. This augmentation is in accordance with the

[4] UDWR is operating a weir to prevent large bodied fish from entering Stewart Lake in 2013
[5] As defined under the Endangered Species Act

Reach 2 summer - autumn seasonal flow variability recognized in the Flow Recommendations.

We believe that the Flow Recommendations intended that seasonal variability be incorporated into dam operations to assist in the recovery of the species and accommodate natural variability, but not allow for manipulation that targets a specific operational pattern. Our 2012 base flow proposal, which complies with the ROD and the BO, is consistent with the intent of the flow recommendations, is based on information gathered by the Recovery Program, and responds to current biological conditions in the Green River system.

Our rationale for requesting elevated base flows through September 30 is similar to our requests in 2008, 2009, 2010, 2011, and 2012, and is intended to accomplish two goals:

1) provide improved nursery conditions for age-0 (young-of-year) Colorado pikeminnow in Reach 2; and
2) hinder nonnative smallmouth bass in Reaches 1 and 2 by delaying their spawning time and decreasing growth of the age-0 cohort.

Goal 1: Habitat conditions for age-0 Colorado pikeminnow

Since 2000, there has been a wide range of base flow conditions in Reach 2. Many of the lower base flow years coincided with low age-0 Colorado pikeminnow catch rates as determined each autumn via Recovery Program Project 138[6] – Interagency Standardized Monitoring Program (Table 2). For example, during the summers of 2001, 2002, 2003, 2006, and 2007 base flows in Reach 2 dropped below 1,000 cfs for varying periods of time and age-0 Colorado pikeminnow catch rates were in the single digits (Badame et al. 2010, p. 8).

Contrastingly, in 2009 and 2010, Reach 2 experienced average base flows that exceeded 2,000 cfs for the second and third consecutive years, and for only the second and third time in the most recent eleven year period. Those same years, Utah Division of Wildlife Resources (UDWR) biologists reported the highest catches of age-0 pikeminnow since 1991 (Badame et al. 2010, p. 8; Table 2). We understand that there are many variables that could have contributed to the increased catch of age-0 CPM, such as numbers of spawning adults, densities of nonnative fish throughout the larval drift zone, densities of nonnatives in backwaters, productivity of backwaters, and sampling efficiency. However, we believe that the higher base flows (approximately 2,400 to 2,600 cfs) in Reach 2 in 2008, 2009, and 2010 played an important role in this increase by providing consistent high-quality backwater habitat throughout the summer growing season.

In response to our 2012 request, Reclamation augmented flows in Reach 2 before September 30th, as much as water supply allowed (Table 1). At the Jensen gauge (Reach 2) average flows decreased from approximately 1700 cfs on July 15th to 1280 on

[6] Can be found online at : http://www.coloradoriverrecovery.org/documents-publications/work-plan-documents/arpts/2012/rsch/138.pdf

September 30th. Augmented flows were highest in early summer, with releases from Flaming Gorge being approximately 1300 cfs until September 7th. From September 10th until September 30th, releases averaged approximately 1120 cfs as the water supply outlook worsened. Overall, the summer base flow period had an average flow of approximately 1443 cfs at the Jensen Gauge.

Table 1. 2012 Flows in Reach 2 of the Green River.

	Base flow period	Comparison of augmented flow throughout season	
	July 15th to Sept. 30th	July 20th to Sept. 6th	Sept. 10th to Sept. 30th
Typical Flaming Gorge releases (Reach 1)	n/a	1330 cfs	1120 cfs
Average flow at Jensen Gauge (Reach 2)	1443 cfs	1490 cfs	1280 cfs

September sampling[7] in the middle Green River, when flows were close to 1300 cfs at Jensen, demonstrated that backwater habitats were reduced in area and depth – likely due to decreased base flows (Skorupski et al. 2012, p. 3). UDWR captured 2 age-0 Colorado pikeminnow and 0 juvenile pikeminnow in backwater habitats, representing the second lowest catch rates since 1990 (Skorupski et al. 2012, p. 3 & p. 9). Contrastingly, sampling in the Yampa River in June through August of 2012 indicated that it was a relatively strong year for reproduction for Colorado pikeminnow as many larvae were captured and the spawning season was very long (Bestgen et al. 2012, p. 6). These results likely indicate that Colorado pikeminnow spawning was strong throughout the Green River basin in early summer (June and July) but as backwater habitat dried throughout the summer, young fish were forced to main channel habitats.

Predicted 2013 conditions are again drier than average, indicating that this year the FGTWG should again attempt to provide adequate base flow conditions for Colorado pikeminnow and prevent the base flows from dropping to levels not compatible with age-0 Colorado pikeminnow survival. Results from 2012 suggest that low base flows in September prematurely reduced backwater habitat quality and likely forced any juvenile or age-0 Colorado pikeminnow into the mainstem channel before the growing season ended. Maintaining consistent base flows throughout September allows young fish to reach adequate size before entering the main channel habitat.

Most above-average Colorado pikeminnow recruitment events in the middle and lower Green River occurred when summer flows ranged from about 1,800 to 2,700 cfs (Bestgen 1997; in Muth et al. 2000). Similarly, most below-average Colorado pikeminnow recruitment events occurred when flows were below 1350 cfs. The relationship between base flow elevations and quality of nursery habitat is an information need identified in the Green River Study Plan (Green River Study Plan ad hoc group 2007) and is currently

[7] Annual monitoring for YOY Colorado pikeminnow began 17 September 2012 and was completed on 27 September 2012.

being investigated through a Recovery Program project entitled "Historical assessment of factors affecting young Colorado pikeminnow abundance and physical habitat availability in the Green River, Utah."

Table 2. Age-0 Colorado pikeminnow (CPM) standardized catch and corresponding flow conditions in Reach 2 as measured by the USGS at their Jensen, Utah gage. Green rows indicate successful Colorado pikeminnow reproduction, blue rows indicate flows exceeding the Colorado pikeminnow ecological threshold, red lines indicate years where flows were below 1000 cfs.

Year	# of age-0 Colorado pikeminnow collected	Average flow between July 15 and September 30	Years base flows dropped below 1000 cfs
2000	31	1423	
2001	8	1073	X
2002	0	876	X
2003	2	1101	X
2004	60	1367	
2005	8	1958	
2006	5	1213	X
2007	3	1122	X
2008	18	2376	
2009	325	2610	
2010	454	2244	
2011	0[8]	8660	
2012	2	1443	

Goal 2: Hinder smallmouth bass reproduction

Smallmouth bass have become a problematic nonnative species in the Upper Colorado River Basin, preying on native species & competing for resources. Understanding smallmouth bass spawning periodicity and adjusting flow releases from Flaming Gorge Dam accordingly will likely help with disruption of the species' reproduction and lead to a reduction in the overall population. Smallmouth bass spawning and recruitment is often favored by lower flows and associated warmer water temperatures (Graham and Orth 1986, Swenson et al. 2002), thus higher flows coupled with lower water temperatures may prove detrimental to smallmouth bass reproduction. Studies in other parts of the range of smallmouth bass have shown that weather-related water temperature reductions or increased flow events reduce their spawning success and number of offspring. Specifically, high flows can be associated with year-class failures (Smith et al. 2005) and may sweep eggs or fry from nursery areas (Mason et al. 1991). Reduced water temperatures often result in abandonment of spawning

[8] In 2011, the Green River and its tributaries had very wet conditions, which in some cases were the wettest on record. While these flows facilitated ecological function for floodplains and larval sucker production, they likely exceeded the ecological threshold for successful Colorado pikeminnow recruitment. Average flows during the base flow period were 8,660, which is much higher than those in years with high age-0 Colorado pikeminnow collections (approximately four times higher).

nests by the guarding male bass, after which developing eggs and just-hatched young are susceptible to predation and other mortality factors. Smallmouth bass may also be susceptible to increased turbidity or siltation which can disrupt spawning or feeding (Berkman and Rabeni 1987; Sweka and Hartman 2003). Further, smallmouth bass often inhabit regulated rivers where static, stable flow regimes provide favorable habitat and managing flows to provide a more variable flow regime may make it more difficult for this species to persist (Mims and Olden 2012).

Information from the Upper Colorado River Basin continues to indicate that higher and cooler base flows delay smallmouth bass spawning and reduce growth of the age-0 smallmouth bass cohort. The effect of flow and temperature on the onset of smallmouth bass spawning is clearly demonstrated with data collected in Lodore Canyon, Green River (Figure 1). Smallmouth bass in the Green River-Lodore Canyon study area first hatch

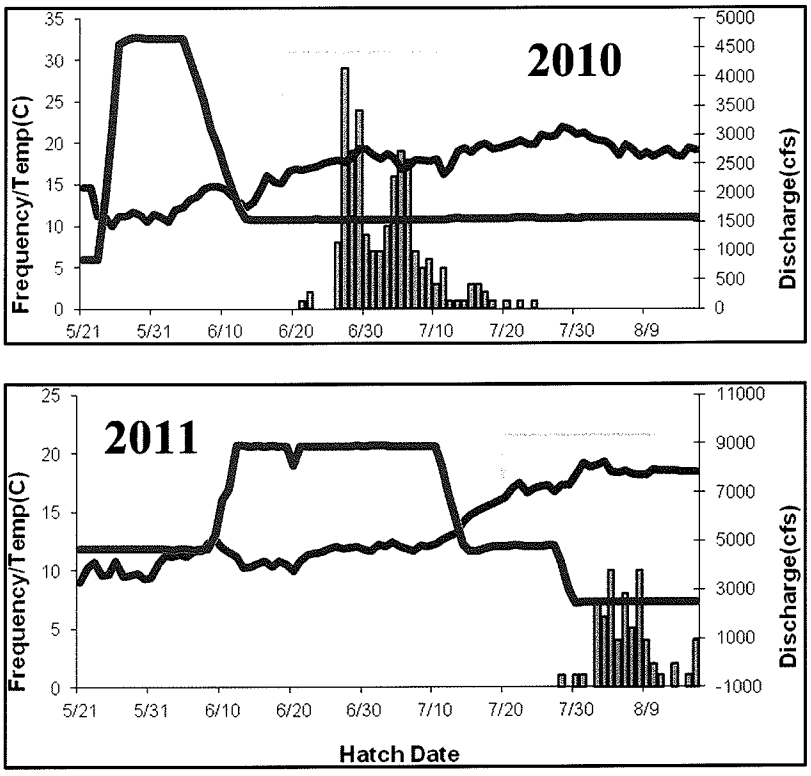

Figure 1. Comparison of flow (green), water temperature (purple), and onset of 16° C water temperature (gray arrow) in Lodore Canyon (Green River - Reach 1), 2010 & 2011. Distributions of hatching dates of, including first hatching in 2010 and 2011 and hatch duration in 2010. Bass were collected from the Green River in Lodore Canyon. Left vertical axis is the frequency of fish in histograms or water temperature; right vertical axis is Green River discharge (in cubic feet per second).

well after spring peak releases decline and just slightly after (usually within one week) mean daily water temperatures regularly exceed 16°C. During years with relatively wet or cool springtime periods (2011), smallmouth bass spawning occurred nearly three weeks later than during a year with drier, warmer conditions (2010). The same relationship has been

observed on the Yampa River. Hatching date and the extent of the reproductive season was much shorter in 2011 when high flows were relatively cool. The 2012 water temperatures suggest a relatively late initiation of hatching as well, and that is supported by capture of very few and relatively small bass in Lodore Canyon in late-July. High flows and associated cool temperatures appear to not only delay spawning but also slow the growth rates of age-0 smallmouth bass which decreases their likelihood for overwinter survival (Shuter at al. 1980; Lawrence et al. 2012).

Conclusion

In summary, we request that Reclamation:

- Time spring flow releases from Flaming Gorge to correspond with the presence of wild produced razorback sucker larvae according to the LTSP in order to improve entrainment success;
- Attempt to meet connection at Stewart Lake for 6 consecutive days and target wetlands with higher connecting flows if Yampa River flows allow;
- Work with the UDWR to operate Stewart Lake water supplies for selenium remediation efforts equivalent to the past, by filling the lake following a Green River connection and draining later in the summer; and
- Enhance summer base flows in Reach 2 of the Green River at the expense of winter base flows to continue to improve Colorado pikeminnow nursery conditions, support age-0 Colorado pikeminnow, and disadvantage smallmouth bass.

We believe that data gathered by the Recovery Program make a strong case for these proposed operations in 2013 and should benefit young life stages of endangered fish. We hope that hydrology conditions in the Upper Green and Yampa River drainages will supply sufficient water to meet these needs. Furthermore, we believe that these operations are consistent will the existing BOs for Flaming Gorge and Stewart Lake and the Flaming Gorge ROD.

We thank Reclamation for the opportunity to provide this input and look forward to participating in the Flaming Gorge Technical Working Group process. If you have any questions or concerns, please contact Kevin McAbee at 801-975-3330 ext. 143.

Literature Cited

Badame, P., K. Creighton, T. Hedrick, L. Monroe, and K. Bestgen. 2010. Young-of-the-year Colorado pikeminnow monitoring. FY 2010 Annual Project Report, Colorado River Recovery Program Project Number 138.

Berkman, H.E. and C.F. Rabeni. 1987. Effect of siltation on stream fish communities. Environmental Biology of Fishes. 18:285-294.

Bestgen, K. R. 1997. Interacting effects of physical and biological factors on recruitment of age-0 Colorado squawfish. Doctoral Dissertation. Colorado State University, Fort Collins, CO.

Bestgen, K.R., G.B. Haines, and A.A. Hill. 2011. Synthesis of floodplain wetland information: timing of razorback sucker reproduction in the Green River, Utah, related to streamflow, water termperature, and floodplain wetland availability. Final Report to the Upper Colorado River Endangered Fish Recovery Program. Larval Fish Laboratory Contribution 163.

Bestgen, K.R., A. Weber, and T. Jones. 2012. Interagency Standardized Monitoring Program Assessment of Endangered Fish Reproduction in Relation to Flaming Gorge Operations in the Middle Green and Lower Yampa Rivers-Yampa and Middle Green River Assessment of Colorado Pikeminnow and Razorback Sucker Larvae. FY 2012 Annual Project Report, Colorado River Recovery Program Project Number 22f.

Graham, R.J., and D.J. Orth. 1986. Effects of temperature and streamflow on time and duration of spawning by smallmouth bass. Transactions of the American Fisheries Society. 115:693-702.

Green River Study Plan ad hoc Group. 2007. Study plan for the implementation and evaluation of flow and temperature recommendations for endangered fishes in the Green River downstream of Flaming Gorge Dam. Upper Colorado Basin Endangered Fish Recovery Program, Lakewood, CO.

Lawrence, D. J., J. D. Olden, and C. E. Torgersen. Spatiotemporal patterns and habitat associations of smallmouth bass (*Micropterus dolomieu*) invading salmon-rearing habitat. Freshwater Biology 57:1929-1946.

Mason, J. W., D. J. Graczyk, and R. A. Kerr, 1991. Effects of runoff on smallmouth bass populations in four southwestern Wisconsin streams. Pages 28-38 *in* D. C. Jackson, editor. First International Smallmouth Bass Symposium. Mississippi State University, Mississippi State.

Mims, M. C., and J. D. Olden. 2012. Life history theory predicts fish assemblage response to hydrologic regimes. Ecology 93:35-45.

Montgomery, J. C., D. H. Fickeisen, and C. D. Becker. 1980. Factors influencing smallmouth bass production in the Hanford area, Columbia River. Northwest Science 54:296-305.

Muth, R.T., L.W. Crist, K.E. LaGory, J.W. Hayse, K.R. Bestgen, T.P. Ryan, J.K. Lyons, R.A. Valdez. 2000. Flow and temperature recommendations for endangered fishes in the Green River downstream of Flaming Gorge Dam. Upper Colorado River Endangered Fish Recovery Program, Denver, CO.

Shuter, B.J., J.A. MacLean, F.E.J. Fry, and H.A. Regier. 1980. Stochastic simulation of temperature effects of first-year survival of smallmouth bass. Transactions of the American Fisheries Society 109:1-34.

Skorupski, J.A., M.J. Breen, B.J. Kiefer, and K. Creighton. 2012. Young-of-the-year Colorado pikeminnow monitoring. FY 2012 Annual Project Report, Colorado River Recovery Program Project Number 138.

Smith, S. M., J. S. Odenkirk, and S. J. Reeser. 2005. Smallmouth bass recruitment variability and its relation to stream discharge in three Virginia Rivers. North American Journal of Fisheries Management 25:1112-1121.

Sweka, J.A., and K.J. Hartman. 2003. Reduction of reactive distance and foraging success in smallmouth bass, *Micropterus dolomieu*, exposed to elevated turbidity levels. Environmental Biology of Fishes 67:341-347.

Swensen, W. A., B. J. Shuter, D. J. Orr, and G. D. Heberling. 2002. The effects of stream temperature and velocity on first-year growth and year-class abundance of smallmouth bass in the upper Mississippi River. American Fisheries Society Symposium 31:101-113.

Stewart Lake Working Group. 2013. Stewart Lake Annual Meeting Minutes (Draft).

U.S. Department of the Interior. 2006. Record of Decision on the operation of Flaming Gorge Dam Final Environmental Impact Statement. U.S. Department of the Interior, Bureau of Reclamation, Salt Lake City, Utah.

U.S. Fish and Wildlife Service. 2005. Final Biological Opinion on the operation of Flaming Gorge Dam. U.S. Fish and Wildlife Service, Denver, Colorado.