United States Department of the Interior
Fish and Wildlife Service

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July 5, 2017

Mr. Steve Hocking, Chief
Environmental and Project Review Branch
Division of Hydropower Administration and Compliance
Federal Energy Regulatory Commission
Washington, D.C. 20426

Endangered Species Act Formal Consultation for Project No. 12514-074- Northern Indiana Public Service Company (NIPSCO), Norway-Oakdale Hydroelectric Project, Tippecanoe River, White and Carroll Counties, Indiana

Dear Mr. Hocking:

This letter transmits the U.S. Fish and Wildlife Service's (Service) Final Biological Opinion on the aforementioned project. The transmittal includes the biological opinion and six appendices. Please feel free to contact me or Forest Clark of my staff if you have any questions.

Sincerely,

Scott E. Pruitt
Field Supervisor

Cc Brant Fisher, IDNR Aquatic Biologist
Matt Buffington, IDNR
Natalie Conlon, NIPSCO
Sean Marsan, USFWS
Bob Krska, USFWS

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Introduction

This document transmits the (U. S. Fish and Wildlife Service's (Service) biological opinion based on our review of the FERC Staff Alternative identified in the Federal Energy Regulatory Commission's (FERC) Final Environmental Assessment (EA) dated 10 November 2016. The FERC Staff Alternative prescribes operation of the Norway-Oakdale Hydroelectric Complex operated by Northern Indiana Public Service Company (NIPSCO).

The Norway-Oakdale Complex comprises Norway Dam and Lake Shafer, Oakdale Dam and Lake Freeman, and the small flowing reach of the Tippecanoe River between Lake Freeman and the Norway Dam. It affects the Tippecanoe River in White, Carroll, and Tippecanoe Counties in Indiana. This biological opinion evaluates the effects of the FERC Staff Alternative on the endangered clubshell mussel (*Pleurobema clava*), fanshell mussel (*Cyprogenia stegaria*), sheepnose mussel (*Plethobasus cyphyus*), rayed bean (*Villosa fabalis*), snuffbox (*Epioblasma triquetra*) and threatened rabbitsfoot (*Quadrula cylindrica cylindrica*) mussel and rabbitsfoot Critical Habitat in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). Your 16 February 2017 request for formal consultation was received on 21 February 2017.

This biological opinion is based on information provided in the Final EA, which the FERC submitted as its biological assessment (BA), field investigations by the Service in coordination with the Indiana Department of Natural Resources (IDNR), public meetings, meetings with NIPSCO, the Shafer and Freeman Lakes Conservation Commission (SFLECC), Congressman Todd Rokita (Indiana), the office of the Lieutenant Governor (Indiana) and other sources of information. A complete administrative record of this consultation is on file at the Indiana Field Office (INFO).

I Consultation History

History of the Consultation with Reference to Section 10 Consultation with NIPSCO

The background of the consultation on this project refers back to the 2007 licensing of the Norway-Oakdale Complex and discussions with NIPSCO initiated in July 2012 to address take of listed mussels documented by the Service and the IDNR in late June and early July of that year. In addition to concurrent requests for temporary variances to NIPSCO's license (detailed below) NIPSCO began work with the Service on a Habitat Conservation Plan (HCP) under section 10(a)(1)(B) of the ESA. In October of 2013, work on the HCP was stopped when the Service determined in coordination with NIPSCO that a low effect HCP was unlikely and that section 10 was not the appropriate consultation tool. At that point, NIPSCO and the Service began a more concerted effort to identify a means of essentially avoiding take of listed mussels downstream of Oakdale Dam. The result of those efforts was the technical assistance letter (TAL) issued by the Service to NIPSCO on 13 August 2014. In their Draft and Final EAs, the FERC did not select NIPSCO's license modification proposal as the preferred alternative. NIPSCO's proposed modification is prerequisite to its permanently implementing the TAL. The FERC's decision led to a request for formal consultation when the Service did not agree with the finding of no significant impact (FONSI) and did not concur with the NLAA consequent to that finding relative to implementation of the preferred FERC Staff Alternative in the Final EA.

In a consultation letter dated 10 November 2016 the FERC concluded that the FERC Staff Alternative may affect but is not likely to adversely affect the rayed bean (*Villosa fabalis*), and snuffbox (*Epioblasma triquetra*) and will have no effect on the Indiana bat (*Myotis sodalis*) and northern long-eared bat (*Myotis septentrionalis*). The Service concurs that the FERC Staff Alternative is not likely to adversely affect (NLAA) the rayed bean and snuffbox mussels because it is unlikely that those species still occur downstream of the Oakdale/Norway Complex.[1]

5 July 2012	Service notifies NIPSCO that flows out of Oakdale Dam may have dropped to as low as 15 cfs causing a large mussel kill in the Tippecanoe River downstream of Oakdale Dam.
10 July 2012	Service letter to NIPSCO (CC to the FERC) advising it of the listed mussels downstream of Oakdale Dam and its potential liability under the ESA in the absence of a minimum flow (200 cfs) out of Oakdale Dam.
11 July 2012	Letter from Congressman Tod Rokita (Indiana) requesting the Service evaluate other alternatives to protecting mussels downstream of Oakdale Dam.
17 July 2012	Letter from Senator Dan Coats (Indiana) notifying the Service of a meeting request by SFLECC. Specifically, a meeting of SFLECC, the Service, NIPSCO, local government, and a representative from the Senator's office.
23 July 2012	Meeting of SFLECC, NIPSCO, the Service, Congressman Tod Rokita, and representatives of Senator Dan Coats in Senator Coats' Indianapolis Offices.
3 August 2012	NIPSCO files a temporary variance request for Article 403 with the FERC to allow NIPSCO to implement the Service's Option 1 in our 10 July 2012 letter, which is to avoid take of listed mussels by maintaining a minimum 200 cfs release out of Oakdale Dam.

1 Only weathered dead or sub-fossil rayed bean and snuffbox mussels have been found in the Tippecanoe River downstream of Oakdale Dam in more than a decade.

8 August 2012	The FERC issues a public notice relevant to NIPSCO's request for a variance to Article 403.
16 August 2012	The FERC requests additional information from NIPSCO on implementation and background of the Service recommended minimum 200 cfs release from Oakdale Dam.
27 August 2012	Service letter to NIPSCO (CC to the FERC) responding to NIPSCO's email request precipitated by the FERC's query concerning the origin of the 200 cfs minimum flow recommended by the Service.
7 September 2012	NIPSCO requests a time extension from the FERC to modify the definition of "abnormal river conditions" under Article 405, the original definition having addressed only high-flow and not low-flow conditions (the FERC grants extension on 6 November 2012).
13 September 2012	The FERC requests Service concurrence that a temporary variance to NIPSCO's license allowing it to maintain 200 cfs flow out of Oakdale Dam until 1 December 2012 is not likely to adversely affect (NLAA) listed mussels downstream of Oakdale Dam.
19 September 2012	Service letter to FERC concurring with determination that temporary variance maintaining 200 cfs flow out of Oakdale Dam until 1 December 2012 is NLAA.
4 October 2012	The FERC grants NIPSCO a temporary variance to maintain 200 cfs of flow out of Oakdale Dam (authorized from 1 July to 31 December 2012).
1 November 2012	Meeting in Bloomington, Indiana among NIPSCO, IDNR, and the Service to discuss the development of a low-effect HCP under section 10 of the ESA.
28 November 2012	NIPSCO requests an extension of the temporary variance (see 3 August 2012 above) allowing NIPSCO to maintain a minimum of 200 cfs release out of Oakdale Dam.
4 February 2013	Service letter requesting abeyance of an extension of the 200 cfs temporary variance until 1 December 2013 while the Service identifies a minimum flow amount protective of mussels post-summer 2012.[2]
22 April 2013	The FERC grants NIPSCO's request to extend the temporary variance until 1 December 2013.
9 July 2013	Service meeting with NIPSCO and IDNR discussing technical issues relevant to development of a low-effect HCP at IDNR offices in Bloomington, Indiana.

2 Because the summer 2012 event had already affected mussels below the 200 cfs level, the Service determined that 200 cfs would be sufficient to protect listed mussels through the winter of 2012 and 2013.

17 September 2013	NIPSCO makes a second request to the FERC under Article 405 to extend the temporary variance.
4 October 2013	The FERC grants NIPSCO's request for a time extension until 2 October 2014 to finalize a modified definition of "abnormal river conditions".
25 October 2013	The Service notifies NIPSCO that a low effect HCP is not the appropriate mechanism to address take of listed mussels downstream of Oakdale Dam (follow-up discussion 1 November 2013).
11 December 2013	NIPSCO files temporary variance request with the FERC to maintain a minimum 450 cfs flow out of Oakdale Dam to allow NIPSCO to continue to comply with the ESA and to develop a plan to address mussel impacts.
11 December 2013	Service letter to the FERC supporting NIPSCO's request for a temporary variance to their license allowing the level of the reservoirs to fall below 0.25 foot of permitted level in order to maintain a flow of 450 cfs out of Oakdale Dam; and notifying the FERC that the Service and NIPSCO were working on a long-term solution in the form of a TAL.
30 January 2014	The FERC requests additional information from NIPSCO regarding its 11 December 2013 request for a temporary variance (450 cfs).
30 January 2014	Service presentation on conserving listed mussels at NIPSCO annual "drawdown" meeting in Monticello, Indiana.
5 August 2014	Congressman Tod Rokita letter to the Service.
13 August 2014	Service issues TAL to NIPSCO (revised 21 August 2014)
14 August 2014	Service meeting with Congressman Todd Rokita, NIPSCO, and SFLECC in Indianapolis.
15 August 2014	NIPSCO files request for temporary variance under Article 403 to implement the Service 13 August 2014 TAL.
21 August 2014	Congressman Tod Rokita letter to Service requesting clarification on specific issues related to historical flow and environmental flow prescribed by Service.
21 August 2014	Service Regional Director Tom Melius letter to Congressman Rokita concerning the TAL.
22 August 2014	The FERC approves NIPSCO's request for a temporary variance.
12 September 2014	Stakeholder Public Meeting with the FERC (telephone), Service, SFLECC and IDNR in Monticello, Indiana.

15 September 2014	Freedom of Information Act (FOIA) request to the Service by SFLECC.
2 October 2014	NIPSCO submits proposed modified definition of “abnormal river conditions” to the FERC.
26 January 2015	Meeting at the USGS offices in Indianapolis with USGS, NIPSCO, and Service to discuss installation and operation of a new monitoring gauge on the Tippecanoe River at Buffalo, Indiana.
12 February 2015	The FERC issues a public notice of the availability of NIPSCO’s application to amend its license and modify the abnormal river conditions definition.
16 March 2015	Dept. of Interior “no comment” letter to the FERC.
27 March 2015	NIPSCO submits 2014 TAL Compliance Report to the Service.
13 April 2015	Service comments to the FERC on NIPSCO’s proposed amendment to its license amending the definition of “abnormal river conditions” pursuant to Articles 403 and 405.
15 April 2015	Dept. of Interior withdrawal of “no comment” letter to the FERC.
9 October 2015	FERC Draft EA and request for concurrence.
6 November 2015	Service evaluates the Draft EA, requests revisions, and notifies the FERC that the Service would not concur with a NLAA determination with respect to the FERC Staff Alternative’s effect on listed species.
16 December 2015	Meeting with Peggy Welch of the Lieutenant Governor’s staff at INFO.
6 January 2016	Meeting with Lieutenant Governor Sue Ellspermann and staff at INFO.
10 February 2016	Meeting at INFO with Peggy Welch of the Lieutenant Governor’s staff and the Jack Wittman author of the INTERA report prepared for the Indiana Finance Authority.
23 March 2016	NIPSCO submits 2015 TAL Compliance Report to the Service.
10 May 2016	Technical and public meetings of the FERC, Service, and NIPSCO in Monticello, IN.
7 June 2016	Service provides comments supplemental to the Service’s 6 November 2015 letter to the FERC primarily refuting comments submitted by the “Protest Coalition” led by SFLECC.
13 June 2016	NIPSCO letter to the FERC concerning 10 May 2016 technical and public meetings.

11 July 2016	NIPSCO letter to the FERC responding to questions and comments raised at the 10 May 2016 technical and public meetings.
17 October 2016	Service provides additional information concerning the abnormal low flow (ALF) event of 2016 and recommends that the FERC not make a FONSI with respect to their EA
Summer 2016	At the suggestion of the FERC, the Service, NIPSCO, SFLECC meet on two occasions at the Indianapolis Headquarters of NIPSCO to discuss possible solutions including an independent study of the Norway-Oakdale Complex.
27 October 2016	NIPSCO letter to the FERC requesting the temporary variance remain in place (response to 28 September 2016 letter to the FERC from SFLECC).
10 November 2016	The FERC requests concurrence with a NLAA determination for the six listed mussels and designated CH regarding the FERC Staff Alternative described in the FERC's Final EA
9 December 2016	The Service informs the FERC that it does not concur with the FERC's NLAA determination of 10 November 2016. The Service highlights data gaps and deficiencies within the EA with respect to its use as a biological assessment (BA) and that formal consultation cannot begin until the FERC addresses the deficiencies
16 February 2017	The FERC advises the Service that it will not revise the EA to address the Service's highlighted data gaps, nor will it prepare a separate BA. The FERC requests initiation of formal consultation.
27 February 2017	The Service acknowledges the FERC's request for formal consultation based on receipt of its 16 February 2017 letter on 21 February 2017, re-confirms the FERC's position not to provide additional information, and initiates formal consultation.
20 March 2017	NIPSCO submits 2016 TAL Compliance Report to the Service and FERC.

Summary of the Service's TAL

The TAL and associated Clarifications are provided as an appendix to the biological opinion (Appendix 1). Issued to NIPSCO by the Service in August 2014, it was the result of close cooperation and expenditure of significant time and resources over two years between the Service and NIPSCO. In coordination with IDNR and USGS, the Service and NIPSCO developed a mutually acceptable approach for operating the Norway-Oakdale complex while avoiding future violations of the ESA.

The TAL formalized the Service's agreement that implementation of NIPSCO's abnormal low flow (ALF) plan would avoid take of federally listed mussels and negative impacts to critical habitat. As stated in the TAL its purpose is as follows:

The purpose of this TAL is to identify dam operational measures which the Service believes will, if implemented, create conditions for ESA-listed mussels sufficiently representative of natural run-of-the-river water flow so as to eliminate take of any ESA-listed mussel or adverse modification of critical habitat (should it be designated) due to the Oakdale Dam.

The TAL plan involves two primary actions: 1) early recognition of low-flow events that will trigger the temporary cessation of power generation at the Oakdale Dam; and 2) subsequent release of water from the Oakdale Dam during low-flow events that best matches natural river flow as defined based on "linear scaling" described below. Data on natural river flows below Oakdale Dam are for practical purposes non-existent because the dams have been in place since the mid-1920s. Linear scaling in the TAL replaces an application of a less flexible minimum protective flow or ecological flow (e-flow) out of Oakdale Dam (see Petts 2009 for a discussion of e-flows). E-flows formed the basis of the Service's early temporary variance recommendations to the FERC.

The Service used the best available science and data to develop a more responsive approach to minimum flows out of Oakdale Dam during low-flow events. Linear Scaling uses upstream flows (where we have USGS gauge data) outside the influence of the dams and reservoirs to approximate what the flow would be downstream of Oakdale Dam was the Norway-Oakdale Complex not present. Linear scaling predicts that in a comparatively homogenous watershed (i.e., one without large changes in elevation, large urban areas, or major differences in land cover), which applies to the Tippecanoe watershed, flow in nested sub-watersheds scale to one another linearly. Simply put, if the above conditions prevail, a point in a river where the watershed is twice the area will have twice as much flow as a point in the river upstream where the watershed is half the area – smaller watershed, less flow.

II BIOLOGICAL OPINION

Description of Proposed Action

The FERC Staff Alternative

The proposed action is the FERC Staff Alternative copied below from the Final EA (FERC 2016).

Staff developed an alternative recommendation for the definition of abnormal river conditions for article 403 that would eliminate flow fluctuations associated with project operations during periods of low flow, while avoiding the adverse effects of drawdowns discussed herein. Staff recommends alternative language as follows:

"Abnormal high river conditions" are defined as conditions with river flows of 3,000 cubic feet per second (cfs) or higher or hourly increases in river flow of 100 cfs or greater at both project dams. Under these conditions, the licensee must at all times act to maintain the fluctuation of the reservoir surface elevation at Lake Shafer within 0.75 feet above and 0.25 feet below elevation 647.47 feet NGVD (between elevation 648.22 feet and elevation 647.22 feet) and at Lake Freeman within 0.75 feet above and 0.25 feet below elevation 612.45 feet NGVD (between elevation 613.20 feet and elevation 612.20 feet).

"Abnormal low river conditions" are defined as a 24-hour daily average of river flow of ≤ 300 cfs as measured at the USGS Winamac gage (No. 03331753) or, in the event of an equipment or

operation issue at Oakdale unrelated to weather conditions upstream, a 24-hour daily average of river flow of ≤ 570 cfs at the USGS Oakdale gage (No. 03332605). Under these conditions, the licensee must immediately cease generation at the Oakdale Development and must at all times act to maintain the reservoir surface elevation at Lake Freeman no lower than elevation 612.20 feet NGVD. The licensee must release downstream flows in accordance with the Fish and Wildlife Service's August 13, 2014 Technical Assistance Letter (TAL) and Clarifications A, B, and C to the TAL, if possible, without drawing the reservoir surface elevation of Lake Freeman below elevation 612.20 feet NGVD. Project operations may return to normal when: (a) the 24-hour daily average flow is >300 cfs at the Winamac gage; and (b) hourly flow readings at the Oakdale gage are >500 cfs.

The staff alternative language requires generation to cease and lake levels to be maintained at Lake Freeman above 612.20 feet NGVD under abnormal low flow conditions, which varies slightly from current operations under normal flow conditions. The Conservation Corporation and almost all of the stakeholders want to continue current operations under abnormal low flow conditions.

The FERC selected the FERC Staff Alternative over the alternative proposed by NIPSCO (allowing NIPSCO to implement the TAL) and over the No Action Alternative, which is the existing abnormal flow definition defining flood, but not problematic low flows.

Action Area

In 50 CFR §402.02 "action area" is defined as,

all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action." The action area is not limited to the footprint of the action and should consider the effects to the environment resulting from the action. Within a set action area, all activities that can cause measurable or detectable changes in land, air, and water or to other measurable factors that may elicit a response in the species or critical habitat are considered. The action area is not defined by the range of the species that would be impacted; rather it is defined by the impacts to the environment that would elicit a response in the species.

Therefore, the action area for the low-flow operation of the Norway-Oakdale Complex includes the geographic extent of the area that could be affected by the low-flow operation of the facilities either directly, indirectly, or through interrelated or interdependent actions.

The Service includes the Norway-Oakdale Dam complex in the action area because impacts to the mussels downstream originate there via operation of the dams and reservoirs. Listed mussels within the footprint of the dams and reservoirs; however, are presumed to have been long since extirpated. This "upstream" component of the action area begins at the downstream dam (Oakdale) and extends to the USGS Buffalo Gauge (Buffalo, Indiana), the approximate upstream influence of Lake Shafer.

The downstream component, on which the biological opinion focuses, and where the listed mussels occur, includes the approximately 18.9 river miles of the Tippecanoe River that flows between the Oakdale Dam and the confluence of the Tippecanoe River with the Wabash River near Lafayette, Indiana. Stream habitats are defined by the linear nature of streams and the constant flow of water, but differences in water depth, the composition of the stream-bed or substrate (sand, gravel, mud, etc.), the force of the flowing water, and even the vegetation along the banks result in clearly defined micro-habitats. Different species of mussels respond to these factors differently. For example, some species of mussels occupy the deep runs or in some cases even channels of rivers, but many species inhabit shallow areas along the bank or other flow refugia where the forces of the current are less (Strayer 1999).

Status of the Species and Critical Habitat

Species Descriptions

Freshwater mussels are invertebrate animals in the order Mollusca. The clubshell, fanshell, sheepnose, and rabbitsfoot mussels are all members of the family Unionidae. They share many common physical traits. All possess a bi-valve shell attached by a hinge ligament and have a muscular foot by which they can bury themselves or move along the stream bed. The interior of the shell is composed of nacre or mother-of-pearl, which varies in color among species. The mantle, a sheet of glandular tissue contacts the nacre except where muscles are attached. The mantle secretes the mussel shell and also serves as a sensory organ. Mussels have simple circulatory (single ventricle heart), respiratory (gills and mantle), excretory (liver and kidneys) and nervous (three pairs of ganglia) systems. They are filter feeders that ingest plankton and organic detritus suspended in water through their incurrent (branchial) syphons. The water moves across the gills where mucus traps food particles, which are carried to the mouth, stomach, intestine, and eventually out the anal syphon (see Pennak 1978 for a useful summary of mussel anatomy).

Although structurally simple organisms, freshwater mussels have a complex reproductive cycle. Mussels tend to grow rapidly for the first few years, and then slow appreciably at sexual maturity when energy is being diverted from growth to reproduction (Baird 2000). Time to sexual maturity varies among species, but often takes up to six years or longer (Haag and Staton 2003, Jirka and Neves 1992). The sexes are typically separate, but hermaphrodism occasionally occurs. Different species of mussels reproduce from the early spring through the fall. Males release sperm into the water, which enter the incurrent syphons of downstream females. Eggs are fertilized internally and grow inside the gills of females, which function as a brood chamber and supply oxygen to the larval mussels. Haag and Staton (2003) studied fecundity of several mussel species, which varied widely, but was in large part correlated with the size of the female. Their estimates of eggs produced per year range from 9,647 to 325,709. Sometime after fertilization depending on the breeding strategy and environmental conditions, larval mussels called glochidia are expelled into the water or directly onto host fish initiating a parasitic stage. The tiny glochidia attach themselves as parasites to the fins or gills of host fish, encyst, and after days or weeks (water temperature may affect this), metamorphose into juvenile mussels. The parasitic stage ends when the juvenile mussels drop off the host fish onto the substrate of the stream; the host fish provides the primary mechanism for dispersal of mussels. If the habitat is suitable where juvenile mussels land, they begin to grow into adults (Pennak 1978, Cummings and Mayer 1992). Few of the thousands of eggs survive the larval stage to become juvenile mussels - mortality of glochidia may exceed 99 percent (Young and Williams 1984). Transition from juvenile to adult mussel represents another large bottleneck—a single female's reproductive output can decrease from hundreds of thousands of eggs to thousands of glochidia to less than one adult offspring per year (Berg, et al. 2008).

From this point on, mussels have limited ability to move themselves, traveling primarily up and down by burrowing into the substrate and coming to the surface (Schwalb and Pusch 2007, Watters et al. 2001).

Although they can propel themselves horizontally along the stream bottom, there range is limited to a few meters unless carried by some external force (e.g., high flows). As a group, mussels vary in their longevity even within populations of the same species, but some can live 70 years or more (Haag and Rypel 2010). The listed mussels in the lower reach of the Tippecanoe River all primarily occur throughout their ranges in flowing water. The four listed species, like riverine mussels generally, are not randomly distributed across the bottom of the stream (Hastie et al. 2000). They typically occur in groups of different species known as beds or assemblages (Vaughn and Spooner 2006). Although particular species tend to occupy specific habitats (see below) mussel assemblages typically contain multiple species and assemblages containing rare (listed) species tend to be diverse (Vaughn et al. 2008).

CLUBSHELL

The following description of the clubshell mussel is taken from the 5-Year Review (USFWS 2008) and the Recovery Plan (USFWS 1994). Clubshell was listed as endangered, without critical habitat, in 1993. It is a small to medium-size mussel, up to three inches long. The periostracum (shell exterior) is yellow to brown with bright green blotchy rays. The shell nacre is typically white. The shell is wedge-shaped and the valves (shell halves) are solid, with a pointed, and fairly high umbo or beak (the prominence on each valve where shell growth begins). The clubshell has a life span of 20 years or more.

The clubshell inhabits clean, packed or loose, coarse sand and gravel in runs, often just downstream of a riffle, in medium to small rivers and streams. It cannot tolerate mud or slack water conditions. The clubshell typically burrows completely beneath the substrate two to four inches, apparently relying on water, which brings food and oxygen to percolate between the sediment particles. It is a tachytictic or short-term breeder (i.e., fertilization takes place in mid-spring and glochidia are discharged into the water in the summer of the same year). As with most mussel species, many aspects of its life history are unknown.

FANSHELL

The following description of the fanshell mussel is taken from the Draft 5-Year Review (USFWS 2017). The fanshell was listed as federally endangered in 1990. No critical habitat has been designated for this species. Fanshell mussels can reach up to 2.8 inches in length, and the shape of the shell is rounded, inflated (fat), with the valves thick and solid. The periostracum is a pale greenish yellow, covered with a pattern of darker green flecks or dots which may appear as rays. Numerous irregular knobs and rounded pustules which may appear in rows on the center of the valve. Numerous irregular knobs and rounded pustules, which may appear in rows on the center of the valve, cover the posterior two-thirds of the shell. Umbos are elevated and full, sculpture consists of a few indistinct ridges.

Fanshell is endemic to the Ohio River system and found in flowing water with stable substrate containing a relatively firm, clean gravel, sand, and silt mixture. Fanshell mussels are often associated with other riverine mussel species, but in many cases, diverse freshwater mussel assemblages persist where fanshell mussels do not. This species may be more sensitive to environmental change than other mussel species, or life history traits may make recovery from a disturbance less likely than with other mussels.

SHEEPNOSE

The following description of the sheepnose mussel comes primarily from the Status Assessment Report (Butler 2002). The sheepnose was listed as federally endangered in 2012. No critical habitat has been designated for this species. This medium sized mussel reaches nearly 5.5 inches in length, and the shell has an elongated ovate shape (moderately inflated). The valves are thick and solid. A row of large, broad tubercular swellings generally occurs on the center of the shell extending from the beak to the ventral margin. Beaks are high and located forward. In young animals, the periostracum can have a light yellow to yellowish brown color, which becomes darker with age. The color of the nacre is generally white, but may be pinkish to cream colored, and iridescent posteriorly.

Sheepnose primarily inhabit larger streams, but usually occur in shoal habitats with moderate to swift currents over coarse sand and gravel. Habitats with sheepnose may also have mud, cobble, and boulders. Animals in larger rivers may occur in deep runs.

RABBITSFOOT

The following information derives from the status review for this species (Butler 2005). The rabbitsfoot is a medium-sized to large mussel that reaches about six inches long. The shell shape is an elongated rectangle and moderately inflated in mature animals. The valves are solid and thick, becoming thinner posteriorly. The umbos are low, located anteriorly, and barely extend above the hinge line. Shell sculpture consists of a few large, rounded, low tubercles on the posterior slope. The periostracum is generally smooth and yellowish, greenish, or olive in color becoming darker and yellowish-brown with age. Dark green or nearly black chevrons and triangles pointed ventrally typically cover the shell. The color of the nacre is white and iridescent, often with a gray-green tinge in the umbo cavity.

The rabbitsfoot is regarded as primarily a species of the Mississippi drainage, but is also found in portions of the Lower Great Lakes Basin. The rabbitsfoot is historically associated with small- to medium-sized streams and some larger rivers in the Lower Great Lakes and Lower Mississippi River sub-basins and Ohio, Cumberland, Tennessee, White, Arkansas, and Red River basins. The rabbitsfoot usually occurs in shallow areas along the bank and adjacent runs and riffles with gravel and sand substrates where the water velocity is reduced, but it also may occur in deep runs. The rabbitsfoot seldom burrows in the substrate, but lies on its side (Fobian 2007).

RABBITSFOOT CRITICAL HABITAT

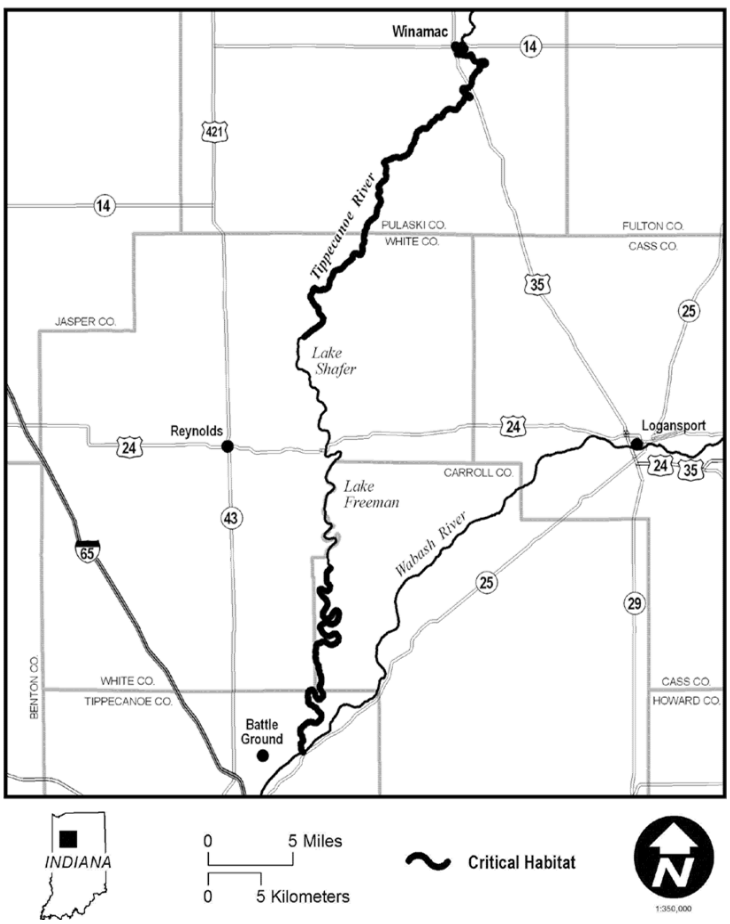
In accordance with section 3(5)(A)(i) and 4(b)(1)(A) of the Act and regulations at 50 CFR 424.12, the Service is required to identify the physical or biological features essential to the conservation of the rabbitsfoot in areas occupied at the time of listing. These generally include: (1) Space for individual and population growth and for normal behavior; (2) Food, water, air, light, minerals, or other nutritional or physiological requirements; (3) Cover or shelter; (4) Sites for breeding, reproduction, or rearing (or development) of offspring; and (5) Habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species.

Rabbitsfoot critical habitat totals approximately 1,437 river miles in 31 units (three with two subunits each) in the following rivers: Neosho, Spring (Arkansas River system),Verdigris, Black, Buffalo, Little, Ouachita, Saline, Middle Fork Little Red, Spring (White River system), South Fork Spring, Strawberry, White, St. Francis, Big Sunflower, Big Black, Paint Rock, Duck, Tennessee, Red, Ohio, Allegheny, Green,

Tippecanoe, Walhonding, Middle Branch North Fork Vermilion, North Fork Vermilion, Bear, French, Muddy, Little Darby, and Fish Creek (USFWS 2015).

Critical habitat occurs in the following counties and states: Colbert, Jackson, Madison, and Marshall Counties, **Alabama**; Arkansas, Ashley, Bradley, Clark, Cleburne, Cleveland, Drew, Fulton, Hot Spring, Independence, Izard, Jackson, Lawrence, Little River, Marion, Monroe, Newton, Ouachita, Randolph, Searcy, Sevier, Sharp, Van Buren, White, and Woodruff Counties, **Arkansas**; Massac, Pulaski, and Vermilion Counties, **Illinois**; Carroll, Pulaski, Tippecanoe, and White Counties, **Indiana**; Allen and Cherokee Counties, **Kansas**; Ballard, Edmonson, Green, Hart, Livingston, Logan, Marshall, McCracken, and Taylor Counties, **Kentucky**; Hinds, Sunflower, Tishomingo, and Warren Counties, **Mississippi**; Jasper, Madison, and Wayne Counties, **Missouri**; Coshocton, Madison, Union, and Williams Counties, **Ohio**; McCurtain and Rogers Counties, **Oklahoma**; Crawford, Erie, Mercer, and Venango Counties, **Pennsylvania**; and Hardin, Hickman, Humphreys, Marshall, Maury, Montgomery, Perry, and Robertson Counties, **Tennessee** (USFWS 2015).

In the Tippecanoe River, Critical Habitat was designated Unit RF25 covering a 47-mile reach of the River between the confluence with the Wabash River and SR 14 at the town of Winamac excluding the area between Oakdale Dam and the upstream influence of Lake Shafer (Map 1).



Map 1 - Unit RF25 rabbitsfoot critical habitat in the Tippecanoe River, Indiana.

Status and Distribution

CLUBSHELL

Historically abundant throughout the Ohio River basin, it was widespread in rivers such as the Ohio, Allegheny, Scioto, Kanawha, Little Kanawha, Licking, Kentucky, Wabash, White, Vermillion, Mississinewa, Tippecanoe, Tennessee, Green, and Salt Rivers in Illinois, Indiana, Kentucky, Michigan, Ohio, Pennsylvania, and West Virginia. Clubshell has declined drastically with a greater than 95 percent range reduction. Although a few localized populations are comparatively large (Allegheny River and French Creek and tributaries), the remaining clubshell populations exist sparsely distributed across the range of the species. Of 100 streams once known to be occupied by the clubshell, 13 extant populations in reaches of only 21 streams in the Ohio and Lake Erie drainages remain (USFWS, 2008). Of those 13, only nine, Tippecanoe (IN), Middle Branch North Fork Vermillion (IL), Green (KY), Little Darby (OH), Elk (WV), Allegheny (PA), French Creek, LeBoeuf Creek and Shenango (PA) reproduce or possibly reproduce.

FANSHELL

The historical distribution of the fanshell was limited to the Ohio River drainage. The species primarily occurred in the Ohio River its large tributaries in Pennsylvania, West Virginia, Ohio, Indiana, Illinois, Kentucky, Tennessee, Alabama and Virginia. It is estimated that there has been greater than an 80 percent decline in fanshell populations much of that in the last decade and may occupy less than 10 percent of its historic range. (http://explorer.natureserve.org/servlet/NatureServe?searchName=Cyprogenia+stegaria). The best populations of the fanshell mussel now occur in the Licking, Green, and Rolling Fork rivers in Kentucky, and in the Clinch River in Tennessee and Virginia. These populations are considered healthy with evidence of recruitment over several years or even decades, with multiple year classes present. The Rolling Fork River population is a relatively small population compared to the Licking River, Green River, and Clinch River populations (USFWS 2017). It may not be practical to assess fanshell populations with densities around the detection level. Thus, the Service may have poorly defined information about fanshell distribution and abundance even in streams where it is known to occur.

SHEEPNOSE

Historically, the sheepnose occurred throughout much of the Mississippi River system with the exception of the upper Missouri River and most lowland tributaries in the lower Mississippi. The sheepnose was historically known from 77 streams (including one canal) in 15 states in the Midwest, Northeast, and Southeast. It was last reported from some streams decades ago and has been extirpated from two-thirds of the total number of streams from which it was historically known (USFWS 2012a).

Extant populations of the sheepnose are known from 25 streams in all 14 states of historic occurrence. The 25 extant sheepnose populations occur in: streams): Alabama (Tennessee River), Illinois (Mississippi, Kankakee, Ohio, Rock Rivers), Indiana (Ohio, Tippecanoe, Eel Rivers), Iowa (Mississippi River), Kentucky (Ohio, Licking, Kentucky, Green Rivers), Minnesota (Mississippi River), Mississippi (Big Sunflower River), Missouri (Mississippi, Meramec, Bourbeuse, Osage Fork Gasconade Rivers), Ohio (Ohio, Muskingum, Walhonding Rivers), Pennsylvania (Allegheny River), Tennessee (Tennessee, Holston, Clinch, Powell, Duck Rivers), Virginia (Clinch, Powell Rivers), West Virginia (Ohio, Kanawha

Rivers, and Wisconsin (Mississippi, Chippewa, Flambeau, Wisconsin Rivers) (USFWS 2012a). Of the 25 sheepnose populations that are considered extant, nine are thought to be stable including the Tippecanoe River population, eight are considered declining, and the status of six other extant populations is unknown (USFWS 2012a).

RABBITSFOOT

Historically, the rabbitsfoot occurred in the lower Great Lakes Sub-basin and Mississippi River Basin. The rabbitsfoot was known from 137 streams in 15 states. The Service estimates that the rabbitsfoot has been extirpated from approximately 64 percent of its historical range. Because many populations are isolated, the opportunities for recruitment between populations or natural establishment of new populations are limited. In addition, most rabbitsfoot populations, like most mussel populations, exist under conditions of water quality, water quantity, and sediment impairments. The Service expects these constraints to be exacerbated by increased water demand, continued habitat degradation, and possibly climate change. Therefore, the viability of the majority of rabbitsfoot populations is uncertain (USFWS 2012b).

Extant populations of rabbitsfoot (stable or improving populations highlighted) occur in: Fish Creek (IN, OH) declining; Ohio River (IL, IN, KY, OH, PA, WV), stable; Allegheny River (PA) declining; French Creek (PA) stable; Le Boeuf Creek (PA) unknown; Muddy Creek (PA) declining; Conneautee Creek (PA) unknown; Shenango River (PA) unknown; Muskingum River (OH) declining; Walhonding River (OH) declining; Big Darby Creek (OH) declining; Little Darby Creek (OH) declining; South Fork Kentucky River (KY) declining; Green River (KY) improving; Barren River (KY) declining; Rough River (KY) declining; Wabash River (IL, IN) declining; Eel River (IN) declining; Tippecanoe River (IN) stable; North Fork Vermilion River (IL) declining; Middle Branch North Fork Vermilion River (IL) declining; East Fork Stones River (TN) declining; Red River (KY, TN) declining; Tennessee River (AL, KY, MS, TN) stable; Paint Rock River (AL) improving; Elk River (TN) declining; Bear Creek (AL, MS) declining; Duck River (TN) improving; St. Francis River (AR, MO) declining; Big Sunflower River (MS) declining; Big Black River (MS) declining; White River (AR, MO) stable; War Eagle Creek (AR) unknown; Buffalo River (AR) declining; Black River (AR, MO) declining; Current River (AR) declining; Spring River (AR) declining; South Fork Spring River (AR) declining; Strawberry River (AR) unknown; Middle Fork Little Red River (AR) stable; Verdigris River (KS, OK) unknown; Neosho River (KS, OK) declining; Spring River (KS, MO) declining; Illinois River (AR, OK) declining; Little River (AR, OK) stable; Glover River (OK) declining; Cossatot River (AR) declining; Ouachita River (AR, LA) stable; Little Missouri River (AR) declining; Saline River (AR) declining; Bayou Bartholomew (LA) declining (USFWS 2012b).

Of the 140 historical populations, 51 are extant, but only 11 (22 percent of extant populations or 8 percent of the historical populations) remain viable; 23 populations (45 percent of extant populations) show clear risk of extirpation; and 17 populations (33 percent of extant populations) show limited recruitment with little evidence of sustainability (USFWS 2012b).

Environmental Baseline

Status of the Species within the Action Area

The approximately 18.9 river miles between Oakdale Dam and the confluence of the Tippecanoe and Wabash Rivers supports populations of clubshell, fanshell, sheepnose and rabbitsfoot. Based on data in the INFO mussel database, six sites have regularly been surveyed by IDNR for mussels in the lower reach of the Tippecanoe in the last decade. These sites occur immediately downstream of Oakdale Dam (BEF08009); the upstream (BEF08010 – BEF09089) and downstream (BEF08011 – BEF09090) end of Horseshoe Bend; upstream Bicycle Bridge Road Bridge (BEF08012); upstream of Pretty Prairie Road Bridge (BEF 08013 – BEF09092); and upstream of the outlet of Moot's Creek (BEF08025 – BEF09093) (Figure 1).

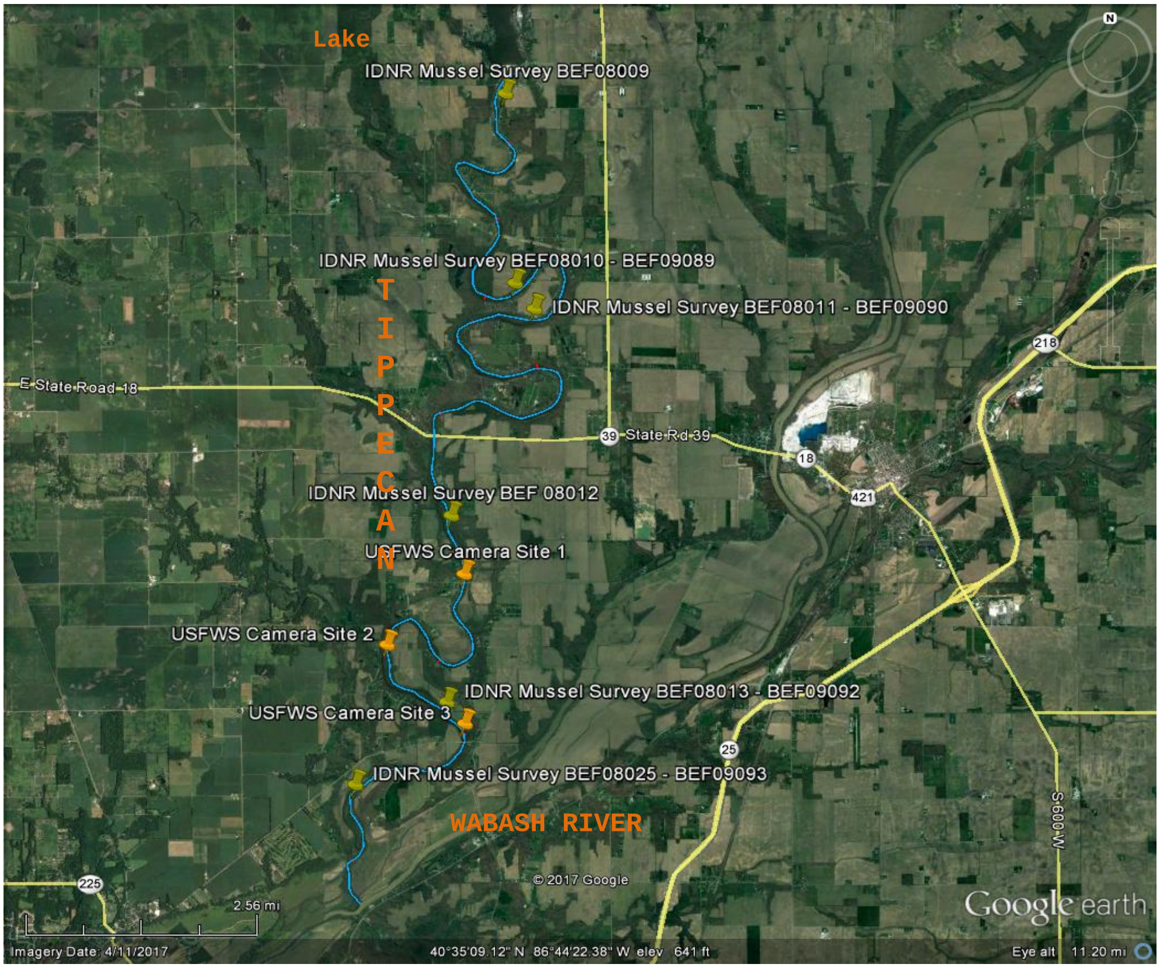


Figure 1 - Overview of mussel and vulnerable mussel habitat monitoring in the Tippecanoe River downstream of Oakdale Dam between 2009 and 2013 by IDNR and USFWS.

CLUBSHELL

In the 5-Year Review, the Service documents the Tippecanoe River downstream of Oakdale Dam as one of the nine remaining reproducing populations (USFWS 2008). Brant Fisher, IDNR Aquatic Biologist; however, believes the clubshell may no longer reproduce or reproduce at very low levels in the Tippecanoe (Brant Fisher, IDNR, pers. comm.). Live and fresh dead clubshell have been documented south of Oakdale Dam. In 2013 one live clubshell was found at Pretty Prairie Road Bridge; in 2012 two live clubshell were found near the same bridge; in 2008 one live clubshell was found in the Tippecanoe River near the mouth of Moot's Creek; and in 2005 one live and an unspecified number of fresh dead clubshell were again found near Pretty Prairie Road Bridge and the outlet of Moot's Creek. IDNR sampling in 2012 and 2009 at two locations downstream of Oakdale Dam (near Bicycle Bridge Road and Pretty Prairie Road

Bridges) did not encounter live clubshell (Fisher 2009 and Fisher 2012a unpublished data). Estimates of clubshell populations from survey data must be qualified with the knowledge that as much as 70 percent of a population may be buried below the substrate and even excavation may leave animals undetected (USFWS 2008). Understanding the size of clubshell populations is exacerbated (as is true for all mussels) when low population densities result in large margins of error because of rarity (Smith 2006). This species appears to be extant, but uncommon in the lower 18.9 miles of the Tippecanoe River and existing data suggests the clubshell population above Lake Shafer is comparable.

FANSHELL

Only 10 rivers currently support the fanshell mussel. Four populations appear healthy with evidence of multiple years of recruitment (Licking, Green, and Rolling Fork Rivers in Kentucky, and the Clinch River in Tennessee and Virginia). Some evidence of recruitment exists for the Tippecanoe River, but the population there is small compared to the four apparently stable populations (USFWS 2017). IDNR documented one live and an undisclosed number of fresh dead fanshell upstream of Pretty Prairie Road Bridge and an undisclosed number of fresh dead fanshell at Bicycle Bridge Road Bridge in 2012 (Fisher 2005, Fisher 2009, and Fisher 2012a unpublished data). In 2009, he found one fresh dead fanshell upstream of the island at the mouth of Moot’s Creek. On 22 April and 12 September 2008 he found one live and an undisclosed number of live fanshell respectively upstream of Pretty Prairie Road Bridge. He also found an undisclosed number of fresh dead fanshell the same year upstream of the island at the mouth of Moot’s Creek. In 2005 an undisclosed number of fresh dead fanshell was found by Fisher upstream of Pretty Prairie Road Bridge. Fisher characterizes the fanshell population in the lower reach of the Tippecanoe River as rare, but likely still reproducing.

SHEEPNOSE

The sheepnose occurs in highly disjunct localities in the lower two-thirds of the Tippecanoe River, a distance of about 45 river miles. Reproduction has been documented with juveniles recruiting into the population despite apparently very low overall numbers (Butler 2002; Brant Fisher, IDNR, pers. comm.). Data from IDNR lists an unspecified number of sheepnose found alive in the downstream reach. Fisher characterizes the sheepnose population in the lower Tippecanoe River as rare, but more common than clubshell or fanshell and reproducing at a low level (Brant Fisher, IDNR, pers. comm.).

RABBITSFOOT

The Service’s 2005 status assessment (Butler 2005) breaks the known populations of rabbitsfoot down into three categories: 1) sizeable stable populations (10 streams) with good evidence of recruitment; 2) small isolated populations (20 streams) with limited recruitment and doubtful viability; and 3) marginal populations (16 streams) with no evidence of recruitment and likely to be extirpated. The Tippecanoe River population falls into the first category, a sizeable and stable population. Rabbitsfoot is the most numerous of the listed species downstream of Oakdale Dam (Brant Fisher, IDNR, personal communication). Mussel surveys in the last decade south of Oakdale Dam have recorded an undisclosed number of fresh dead rabbitsfoot at Pretty Prairie Road Bridge and an undisclosed number of live rabbitsfoot at the same location in October and August respectively of 2015 (Fisher 2015).

Factors Affecting the Species Environment within the Action Area

The four listed species within the action area share a common history of impairment of the Tippecanoe River downstream of Oakdale Dam. The action under consideration in this biological opinion is the operation of the Oakdale-Norway Complex, more specifically the amount and timing of water discharged from Oakdale Dam during periods of low-flow in the River.

Separate from low-flow operation, the presence of Norway Dam, Oakdale Dam, Lake Shafer, and Lake Freeman has affected mussels and their habitat since the mid-1920s. Effects like construction of the dams and creation of the two impoundments are primarily historical. Changes in habitat from flood control management of the Complex, and development-related effects on water quality and quantity associated with the two reservoirs continue to affect the downstream reach of the River. The Norway-Oakdale Complex effectively cuts the Tippecanoe River in half creating a landscape level barrier separating the downstream and middle reaches and precluding movement of mussels and their fish hosts upstream of Oakdale Dam.

Other activities also affect mussels and their habitats in the Tippecanoe River. Approximately 87 percent of the Tippecanoe watershed is agricultural (IDEM 2001). Agriculture changes watersheds in a number of ways including: clearing of natural vegetation including riparian vegetation, extensive drainage, and withdrawal of water for irrigation. Intensive agriculture frequently degrades water quality by increasing sediment loads in streams and introducing pesticides, fertilizers and other contaminants. Confined Feeding Operation (CFO) permits are common in the counties within the watershed. Fourteen of Indiana's 92 counties have 50 or more CFO permits; these include Carroll and White Counties in the Tippecanoe River watershed. Twenty Indiana counties have 20-49 permits, including Tippecanoe County in Tippecanoe River watershed (Thompson 2008). A large percentage of the Tippecanoe River watershed has subsurface drainage feeding into numerous surface drains. Drainage contributes to the transfer of agricultural pollutants to surface waters downstream. Of the approximately 2,209 total miles of the streams in the Tippecanoe River watershed, 524 miles have been identified by the Natural Resources Conservation Service (NRCS) as being impaired by excessive amounts of sediments, nutrients, and bacteria (NRCS Undated, ca 2007). The IDNR, Division of Water maintains a yearly database of water withdrawal by county and type of use (http://www.in.gov/dnr/water/4841.htm). In 2015, Carrol County showed zero surface and groundwater withdrawals for agriculture, White County by contrast withdrew 23.16 million gallons form surface waters and 554.82 million gallons from wells, and Tippecanoe County withdrew 23.98 million gallons from surface waters and 326.15 million gallons from wells.

There are no large urban areas within the watershed, but there are a number of small cities/towns that discharge wastewater into the Tippecanoe River. The largest of these is Warsaw (pop. 14,472) at the upstream end of the watershed followed by Rochester (pop. 6,065) Monticello (pop. 5, 322) and Winamac (pop 2,402) (https://www.indiana-demographics.com/cities_by_population). All but Monticello, which sits on the west bank of the upstream end of Lake Freeman, are upstream of Lake Shafer and all are upstream of the action area. As one would expect, with no urban areas, industry is limited within the downstream reach of the Tippecanoe River. Based on 2013 NPDES Program pipe outfall data, there are no permitted outfalls downstream of Oakdale Dam (IDEM 2013).

Effects of the Action on Listed Mussels

The proposed action affects the listed mussels downstream of Oakdale Dam similarly although the severity of the effects may vary because of differing life history characteristics among the four species. It also negatively affects mussel habitat for all four species including critical habitat for the rabbitsfoot mussel. The proposed action (implementing the FERC Staff Alternative), which governs flow out of the Norway-Oakdale Complex will regularly result in less flow downstream of Oakdale Dam.

Background

The Norway-Oakdale Complex influences the lower Tippecanoe River, which includes habitat throughout for the four listed mussels and encompasses approximately half of the critical habitat for the rabbitsfoot mussel in Indiana. The Tippecanoe is a comparatively wide shallow river with abundant riffle and shallow run habitat. The Service and IDNR evaluated the lower 18.9 river miles by boat in July of 2013 and identified a number of these sites including the three (Camera Sites 1, 2, and 3) used in the Service's summer 2013 study (Figure 1).[3] Bathymetric data for the Tippecanoe River are not available. Based on Service observations before and after the summer of 2013, and information from IDNR, the assumption of this biological opinion is that areas vulnerable to artificial low-flows caused by the Norway-Oakdale Complex (vulnerable habitat) occur regularly throughout the lower 18.9-mile reach of the Tippecanoe River.

Prior to documentation of listed mussel mortality in 2012, the Service had an inadequate understanding of the effects on mussels of the complicated interaction between natural low-flows in the Tippecanoe River and the operation of the Norway-Oakdale Complex. The Norway-Oakdale Complex, although in place for decades, was not regulated by the FERC until 2007. The Service and IDNR commented in the 2007 Final EA that mussels would be protected by operating the dams as "instantaneous run-of-river". Article 403 of the license requires NIPSCO to operate the facility in an instantaneous run-of-river mode, which is defined as **water-in equals water-out** (FERC 2007a). The FERC's own analysis in the 2007 Final EA; however, indicates that this is "unrealistic" (FERC 2007b. The existing license identified problematic high-flows, but did not define low-flows. In essence, flooding is considered an abnormal occurrence, but drought conditions are not. The basis of NIPSCO's dam operation up until 2012 had been maintenance of lake levels within three inches of the design pool as dictated by its license. Therefore, neither NIPSCO nor the FERC recognized a problem when flows downstream of Oakdale dwindled as drought conditions continued that summer.

This inattention seems more understandable given that over longer periods (months) flows out of Oakdale Dam regularly exceed flows out of Norway Dam as would be predicted based on hydrologic practice (Gianfagna et al. 2015, Farmer and Vogel 2012, Emerson et al. 2005). That is because as watershed area increases, flow increases in most river systems (sinking streams in Karst areas would be an exception) according to a formula based on soils, land use, and other aspects of the watershed. A hyperbolic example is the Mississippi River. At its source downstream of Lake Itasca in Minnesota, the Mississippi River is 18 feet wide and can be waded – about 1,300 miles downstream, south of Cairo, Illinois, the Mississippi is

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3 In addition the IDNR Aquatic Biologist is a familiar with this reach of the river having surveyed it for fish and mussels numerous times.

more than 3,500 feet wide. Unfortunately for mussels, in the Tippecanoe River, especially during periods of low flows, Oakdale Dam, which has more watershed area than Norway Dam, regularly has lower flows because of the focus on maintenance of lake levels. This translates into less water in the downstream reach than would natural flow. This reversal can persist for several consecutive days or occur in closely spaced, but non-consecutive periods punctuated by days when Oakdale flow is greater (Appendix 2).

Mussels are aquatic organisms,that require water throughout their life cycles. Nonetheless, compared to some other aquatic organisms (most fish for example), mussels have some adaptations that allow them to be out of the water (emersed) for limited periods. Mussels; however, can begin to experience behavioral and physical changes within hours of emersion depending on a number of factors including water temperature, the amount of dissolved oxygen, and other stressors that might be affecting them (Galbraith et al. 2012). They eventually die in air. After the 2012 mussel kill in the lower Tippecanoe River, the Service began to more carefully assess flow data and gradually gain an understanding of the potential consequences of management of the Norway-Oakdale Complex. Based on a careful review of USGS gauge data, the Service hypothesized that management actions under the FERC license (and now the proposed FERC Staff Alternative) had affected habitat and caused take of mussels during low-flow conditions.

Norway-Oakdale Complex Management Prior to 2007

Drought conditions in the Tippecanoe River watershed in 1988 and 2012 were comparable. The watershed is located within Climate Divisions 1, 2 and 4 (northwest, northcentral and westcentral Indiana) with the lower reach of the River at more or less the intersection of these divisions. In 1988, Climate Divisions 1, 2 and 4 were all classified as being in “severe drought” on the Palmer Drought Severity Index (Fowler 1992). In 2012, severe or extreme drought conditions existed in northcentral and northwest Indiana (National Weather Service https://www.weather.gov/iwx/2012_drought). To evaluate the assumption that management actions under the FERC license, which determines run-of-river flows using the metric of static lake levels, have previously affected mussels, the Service requested data from NIPSCO on the levels of Lake Freeman during the drought of 1988 (M. McCutcheon, NIPSCO, personal communication). If lake levels were maintained during the 1988 drought, as they were in 2012, it is logical to conclude that flows downstream would have been curtailed in 1988 as they were in 2012 in order to accomplish lake level stability.

As Appendix 3 indicates, Lake Freeman never varied more than 0.14 inch from the design pool of 610.35 between 1 June 1988 and 29 September 1988 (dates for which data were made available by NIPSCO). Many other Indiana reservoirs approached record low levels during water years 1988 and 1989 (Fowler 1992). Based on this, lake level to establish run-of-river was in place prior to FERC licensing and likely resulted in artificially reduced flows out of Oakdale Dam in 1988 (i.e., compared to flows out of Oakdale Dam predicted by linear scaling) and during other low-flow periods prior to licensing. Mussels and mussel habitat may have been affected, but no surveys were conducted to look for dead mussels in 1988. Cummings and Berlocher (1990) surveyed the Tippecanoe River for mussels in 1987 (one year before the drought) including sites downstream of Oakdale Dam and recognized the potential consequences of the operation of the Norway-Oakdale Complex. They made this statement:

> *Sites located directly below the dams forming these impoundments supported large mussel populations, but these tended to be highly localized in a few pools. Riffles in these areas*

> *supported very few mussels, possibly because they are intermittently exposed when little water is released from the reservoirs.*

A long data record from the USGS Ora Gauge codifies that low-flows as defined in the Service TAL (≤ 300 cfs at the USGS Winamac Gauge) regularly occur in the Tippecanoe River in late summer and early autumn. Evaluating the Ora data using the TAL definition, the average length of an event was 26 days; the shortest being 2-day events in 1950 and 1975 and the four longest events including a 137-day event in 2012, a 132-day event in 1988, a 108 day-event in 1946, and 102–day event in 1966. Of the 72 years of record (1945 - 2016), low-flows as defined in the TAL have occurred in approximately 80 percent of years during the period June 1 to October 31 (Appendix 4).

The Service hypothesizes that artificially reduced flows downstream of Oakdale Dam have occurred many times since construction of the dams. The mechanism is the management of flows out of Oakdale Dam to maintain precise lake levels, as occurred in 1988 and 2012 and as would be dictated by the license requirement in the FERC Staff Alternative. The probability of mussel mortality linked to dam management likely increases with the duration of the natural low flow period (Allen et al. 2013). The conditions on the Tippecanoe River in 1988 and 2012 were unusual, occurring at approximately 20-year intervals, but less severe periods of low-flow are not uncommon. It is essential to the protection of mussels that the Norway-Oakdale System be managed to avoid even brief episodes of inadequate flow downstream.

Nature of the Effects of the FERC Staff Alternative

Restrictions in flow out of Oakdale Dam could cause take of mussels any time of year. Take and impacts to critical habitat; however, are less likely to occur in winter for a number of reasons. Low-flows as defined in the Service TAL do occur in the winter and early spring, but less commonly. Reviewing the USGS Winamac Gauge winter data (1 November to 1 June) between 2001 and 2017, only 0.04 percent of the daily average readings (in 12 separate events) were less than or equal to 300 cfs (Appendix 5). Low flow events during the winter are also less severe. The average length of low flow during this sample of winter months was 12 days (including the 35 day event in 2012). Six of the 12 events lasted no longer than 8 days. The average flow out of Winamac during the 12 low flow periods was 271 cfs. Mussels are also less active during this period and may be in deeper water, buried in the substrate, and not subject to high temperatures. The 2012 event, which occurred from 16 November to 20 December 2012, was unusual, as was the summer of 2012. The Service expects that limited take could occur even under winter conditions if flows out of Oakdale Dam were constrained during a severe low-flow winter event.

The nature of the effects of the FERC Staff Alternative on the four listed species result from the reduction in flow downstream of Oakdale Dam primarily during specific late summer low-flow events lasting from one day to weeks. Byrne and McMahon (1994) discussed the physiological and behavioral adaptations of freshwater mussels to emersion, but not specifically the negative effects of employing those adaptations. Bartsch et al. (2000) studied three mussels, which are also found in the lower Tippecanoe River to evaluate effects of emersion related to translocation and restoration of mussels. They tested air temperature (50^{o} and 77^{o} F), water temperature (five within 20 degrees of air temperature) and exposure time (15 minutes, 30 minutes, and 60 minutes) under a laboratory setting and found some stress related behavioral change (e.g., shell gaping), but high survival. Spooner et al. (2005) hypothesized that temperature/oxygen stress may not be expressed immediately. In general, data show that stress and mortality increase when low flows result in high water temperatures and decreased oxygen availability. Thermal stress on various life stages of mussels is not well understood, but in combination with other factors (e.g., low dissolved oxygen, pollutants) likely contributes to mortality or sub-lethal impacts. Low flow, thermal, stress, oxygen stress, and the effects of sediment and pollutants often occur in some combination (Rolls et al, 2012). It is difficult; however, to separate flow, temperature, and water quality effects of dams on aquatic communities (Olden and Naiman 2010).

As discussed in detail below, we have data for periods in 2012 and 2013, when flows out of Oakdale Dam were less than flows out of Norway Dam that correspond to mussels being killed. Although, 2012 is the first time the Service documented take, based on data from the USGS Ora Gauge, which has collected flow data since 1945, low flows comparable to those that corresponded to mussel kills in 2012 and 2013 have happened regularly over the last 72 years (Appendix 5). The logical conclusion is that under similar circumstances, mussels would have been killed during those events and if surveys would have been conducted, mortality would have been detected.

How the FERC Staff Alternative Affects Mussels

NORWAY-OAKDALE COMPLEX

In its Final EA and request for concurrence (and again in its denial of a request for additional information in its letter of 16 February 2017), the FERC disputes the Service's assessment that the proposed action will result in take of mussels and adverse effects on critical habitat. The basis for its position is the FERC's contention that the FERC Staff Alternative will function the same as natural flow. For the FERC's position to be credible there should be no effect on flow attributable to the Norway-Oakdale Complex. It has been understood for decades that dams have a major impact on the natural flow and aquatic communities of the streams on which they are located (Baxter 1977; Vaughn and Taylor 1999; Watters 2000, Poff and Zimmerman 2010, and Allen et al. 2013). For example, Vaughn and Taylor (1999) evaluated a tributary of the Red River in Oklahoma and Arkansas, which drains approximately the same area (2,000 sq. mi.) as the Tippecanoe River. They found that mussel species richness and abundance did not begin to recover until 14 miles downstream of the dam and didn't peak until 33 miles downstream. Moreover, relatively rare species only occurred in the reaches farthest from the dams. The 5-Year reviews or status assessments for the clubshell (USFWS 2008), fanshell (USFWS 2017), sheepnose (Butler 2002), and rabbitsfoot (Butler 2005) all recognize impoundments as contributing to the decline of these species.

The extent of the effects of dams on rivers varies based on a number of factors. They include the length of river impacted, the amount of water stored behind the dam, the type of dam, the purpose and management of the dam, and environmental conditions (climate and weather, groundwater, land use, etc.). At one end of the continuum low-head, fixed-weir dams storing minimal water in an otherwise natural landscape (native vegetation) with a wet climate and abundant groundwater would have minimal effect. At the other end, flood control dams in developed, arid climates with a complex management agenda (e.g., flood control, recreation, water supply) that store a large volume of water would have substantial effects.

Physical effects of dams on rivers include changes to upstream and downstream morphology (e.g., elimination of riffle habitat, sediment deposition, bank erosion, modified depth or shape of channel), destruction of upstream lotic habitat, and modification of periodicity, quality, and quantity of water flowing downstream. The physical effects of dams on the water and substrate of a stream in turn affect the stream biota above and below the dam.

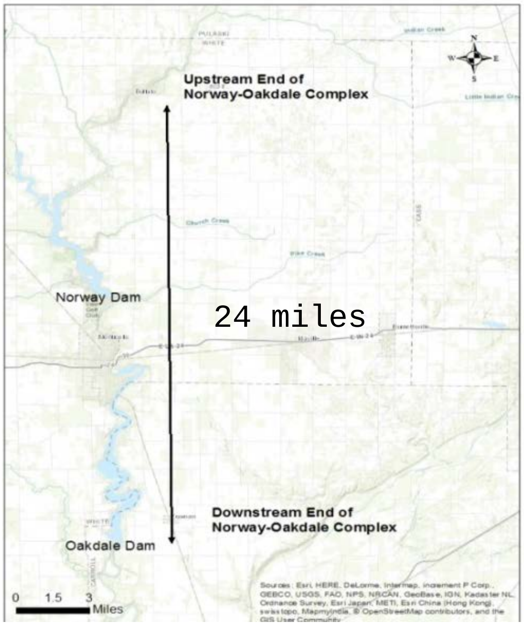
The Norway development (at licensing) included the following facilities (FERC 2007a):

- 30-foot high, 915-foot long earthen dam
- 1,291 acre reservoir (Lake Shafer) at pool elevation 647.47 feet NGVD;
- normal storage 12,920 acre feet;
- 225-foot-long, 29-foot-high concrete gravity overflow spillway with flashboards;
- 120-foot long, 30-foot-high concrete gated spillway with three 30-foot wide, 22-foot-high spillway flood gates;
- 18-foot-wide, 30-foot-high trash sluice housing, with one 8-foot-wide, 11-foot-high gate;
- 142-foot-long, 64-foot-wide powerhouse integral with the dam containing four vertical Francis turbine-generating units with a total electric output of 7.2 MW.

The Oakdale development includes the following constructed facilities:

- 58-foot high, 1,688-foot-long west earth-filled embankment having a 30-foot wide crest
- 1,547 acre reservoir (Lake Shafer) at pool elevation of 612.45 feet NGVD;
- normal storage 24,750 acre feet;
- 114-foot-long, 70-foot-wide powerhouse integral with the dam containing three vertical Francis turbine-generating units with a total electric output of 9.2 MW;
- 18-foot-wide structure containing a nonfunctional fish ladder and a gated trash sluice;
- 80-foot-long concrete gated spillway with two 30-foot wide, 22-foot-high vertical lift flood gates;
- 90-foot-long, six bay concrete gravity siphon-type auxiliary spillway.

The dams and reservoirs have an approximately 24-mile footprint (Oakdale Dam to Buffalo) within the middle Tippecanoe River; approximately 13 % of its 182 mile total length (Map 2). The temporal factor alone (the time it takes for water to traverse both dams and reservoirs) suggests that the Norway-Oakdale Complex is inconsistent with the performance of a free-flowing river. When questioned during TAL development, the USGS provided estimates from studies of the free-flowing section of the Tippecanoe upstream of Buffalo, Indiana, but could not estimate the time for water to travel through the Norway-Oakdale Complex (Donald Arvin, USGS, personal communication).



Map 2 - Norway-Oakdale Complex and environs

The term "run-of-river", although not a scientific term, generally equates with weirs and overflow dams that do not store water below the crest (Csiki and Rhoads 2010). Norway and Oakdale Dams are not small, fixed weir dams (Figure 2a) where inflows and outflows happen essentially instantaneously without human management. In contrast, Norway and Oakdale Dams are large structures with multiple outlets for water management and generation of hydroelectric energy (Figure 2b). NIPSCO maintains a staff of 11 among the two dams to manage the facilities (Mike McCutcheon, NIPSCO, personal communication).

Figure 2a – Low Fixed-weir dam allowing near instantaneous run-of-river.

Figure 2b – 58 foot high Oakdale Dam showing various discharge points (upstream Norway Dam not shown).

NIPSCO INFORMATION

NIPSCO indicates in its letter to the FERC dated 16 May 2016 (see bullets below) that a solution "…needs to take into account the operating practicalities and limitations of the Norway-Oakdale Project."

- *Whatever solution is developed must allow NIPSCO to operate within a range of elevation levels – this is critical as operating at constant elevation level is not possible.*
  - *The 2007 license order states: "With the 1920s vintage equipment at the Norway and Oakdale Dams, precise matching of dam outflow to reservoir inflow is impossible."*
  - *Inflows into Lake Freeman and Lake Shafer are diffuse and from multiple sources. As stated by FERC staff in the Final Environmental Assessment issued February 16, 2007, "Instantaneous [run-of-river] operation is unrealistic given lag times between inflow and outflow and the practicalities of operating the equipment at the developments."*

As Figure 3 (image from NIPSCO's 11 July 2016 letter to the FERC) indicates, flows out of Oakdale Dam varied considerably prior to mid-October 2015 (added vertical black line) at which time flows stabilized when NIPSCO implemented the TAL.

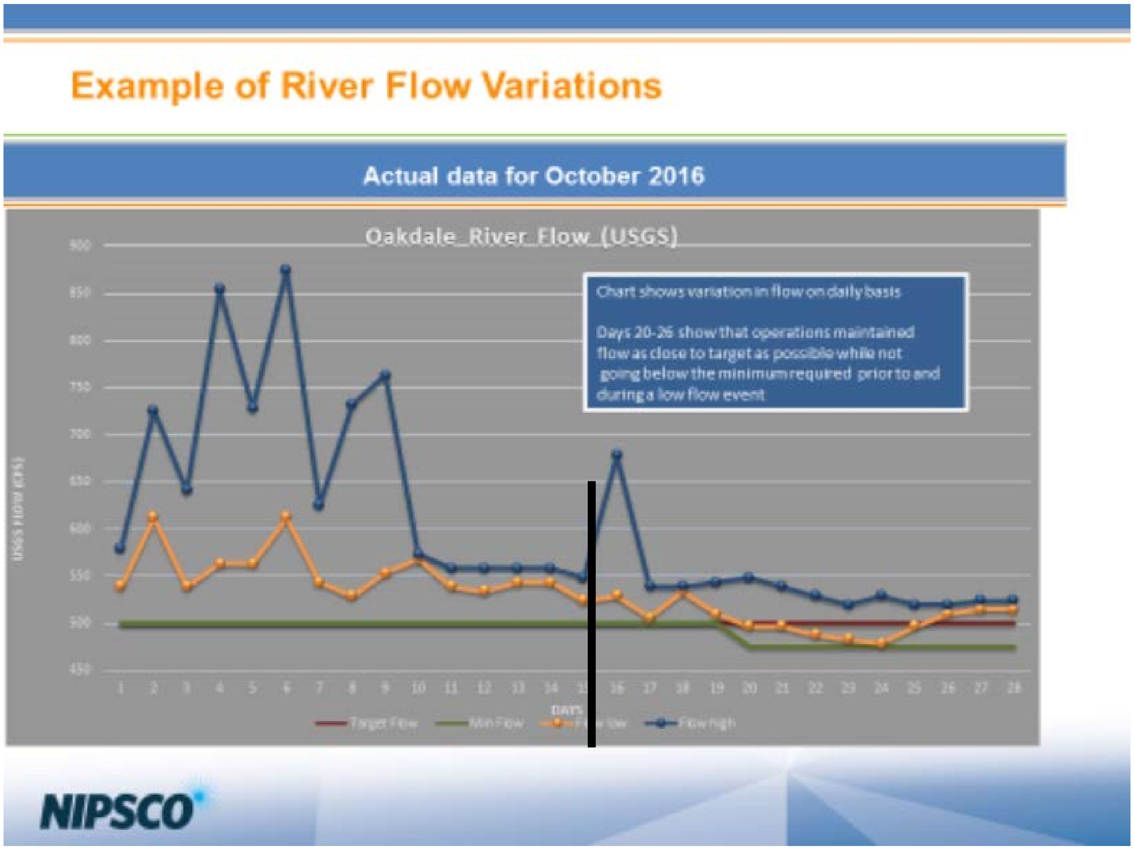


Figure 3 – NIPSCO flow management of Oakdale Dam showing the daily low (orange) and high (blue) flows before and after TAL implementation (vertical black line).

This figure shows daily variation in flow (lowest and highest) under two scenarios: a) maintaining lake level (days 1-15) and b) controlling flow through implementation of the TAL (days 16-27). It took several days for NIPSCO staff to establish procedures to effectively implement the TAL requirements. [4]

USGS DATA

For instantaneous run-of-river to be a reality, 24-hour average inflows to and outflows from the Norway-Oakdale Complex should by the FERC's definition be identical.[5] Discharge from Norway and Oakdale are rarely closely related even at a monthly scale. Appendix 2 shows the daily average discharges from the USGS Norway and Oakdale Gauges during the period when low-flows are most likely (June through October) since 2009 when data became available for both gauges. In the 27 low-flow months (five and a half years) of available data prior to implementation of the TAL in mid-August 2014, the difference between the monthly totals at Norway and Oakdale were less than 100 cfs only three times (October 2011, September 2012, and June 2014). While the total amount of monthly flow may affect the magnitude of any differences, a true run-of-river would be expected to consistently be nearly equivalent over an averaged period as long as a month. Some researchers have indicated that sub-daily flows are important

4 Note that the label on this image is incorrect and should read Actual Data for October 2015 rather than 2016.
5 Linear scaling discussed later in the BO would in fact predict a consistently higher flow out of Oakdale than out of Norway because of the larger (30 sq. mi.) watershed area of the Tippecanoe River at the Oakdale Dam.

for ecological conservation (Haas et al. 2014). Hourly flows at the Norway-Oakdale Complex can swing widely as Haas et al. found in their study of other hydroelectric facilities. The hourly variations are important for mussels (see below) but if flow becomes the governing metric (as under the TAL) rather than maintaining constant lake level, wide swings in hourly flow smooth out when hydroelectric generation is not occurring. The Service has thus primarily focused on daily average flow.

As the USGS data in Appendix 2 demonstrate, daily average flows out of Norway and Oakdale Dams are virtually never equal and the differences can be large and in opposite directions on consecutive days (or within a 24-hour period).[6] As one example, from 4 to 13 June 2009, the following daily cfs differences in flow between Norway and Oakdale were recorded -78, +161, -74, +108, -162, +81, -30, +137, -33, and +56. Of greater concern is how frequently during the summer flow out of Oakdale Dam is less than flow out of Norway Dam (see Allen et al. 2013 for a discussion of this concept). The Service looked at the data from 2009 to mid-August 2014 when the TAL was implemented. In 2009 and 2010, the daily average flows out of Oakdale were less than flows out of Norway **32** percent of the time; **39** percent in 2011; **46** percent in 2012, **59** percent in 2013, and in the first part of the summer of 2014, Oakdale flows were less than Norway **55** percent of the time.

Figure 4 shows two hydrographs from the USGS Winamac Gauge, which is upstream of the influence of the Norway-Oakdale Complex, and from the USGS Norway and USGS Oakdale Gauges immediately downstream of each dam respectively. Visual inspection of the two graphs, which compare flows measured at the three gauges in the summers of 2012 and 2013, reflects the difference in flow regime among the three sites. Winamac represents the “natural flow regime” compared to flows affected by the dams and reservoirs. What is most obvious is that the magnitude of flow is different between the USGS Winamac Gauge, which has a watershed area of 942 square miles, and the USGS Norway and Oakdale Gauges, which have drainage areas of 1,760 and 1.790 square miles respectively – drainage area and flow are logically related.

Less obvious are the inconsistencies in the magnitude of flow out of Norway and Oakdale. One would expect Oakdale, with a larger watershed, to nearly always have greater flow and that the magnitude of the difference would be stable. During both summers, sometimes Norway had higher flow and sometimes Oakdale did. In addition, the rate of change (flashiness) is much different at Norway and Oakdale than at Winamac. Changes occur much more rapidly with high spikes and deep valleys measured at the USGS Norway and Oakdale Gauges. Figure 5 tracks flows at Winamac and the upstream USGS Ora Gauge (drainage area of 856 square miles), neither of which are influenced by the Norway-Oakdale Complex. Note that Winamac and Ora track each other more consistently and preserve to a greater extent the direction and magnitude of difference between their flows in both years. In contrast to flows generated out of Norway and Oakdale Dams, the graphs of the upstream Ora and Winamac Gauges reflect the flow regime under which mussel habitat developed and to which mussels and their fish hosts are adapted.

6 The Service maintains and codifies in the TAL that flows at locations where the watershed is larger (e.g., Oakdale as compared to Norway) should be a standard amount greater rather than equal.

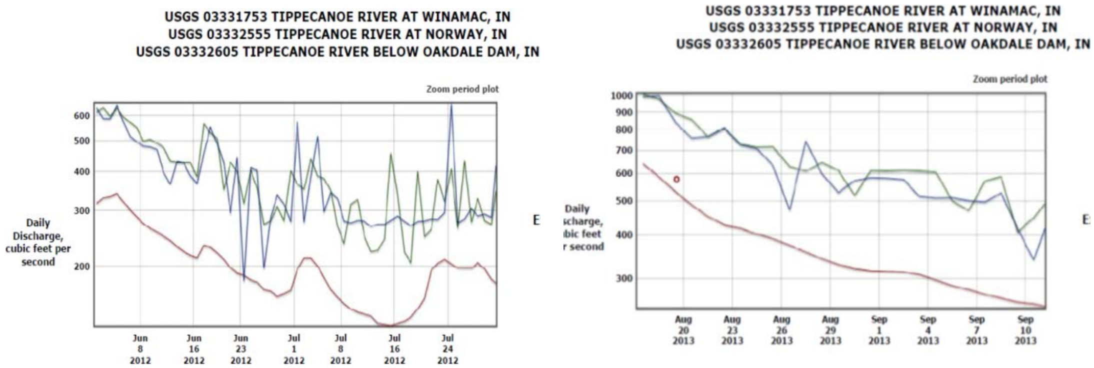


Figure 4 – Graph of flow measured at the USGS Winamac Gauge (red), Norway Gauge (green), and Oakdale Gauge (blue) in the summers of 2012 (left) and 2013 (right) – Oakdale Dam was not generating during this period.

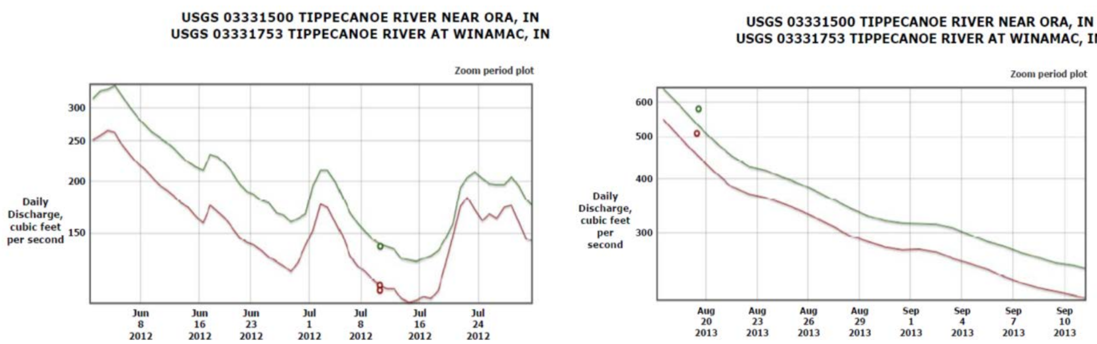


Figure 5- Graph of flow measured at the USGS Winamac Gauge (red) and USGS Ora Gauge (green) in the summers of 2012 (left) and 2013 (right).

Late summer, early autumn low-flows are not uncommon throughout the Tippecanoe River. The effect of the FERC Staff Alternative is to amplify those conditions in the lower Tippecanoe River by releasing less water out of Oakdale Dam in order to maintain stable lake levels (Tables 1 and 2). At the timescale and level of change relevant to mussels, which can be hours to days and a few inches of water, management of the Norway-Oakdale Complex under the FERC Staff Alternative will continue to result in hydrographs for Oakdale Dam inconsistent with the natural flow of the Tippecanoe River.

Mussel Kills in 2012 and 2013

The Service first began to understand the effect of management of the Norway-Oakdale Complex on mussels and mussel habitat downstream of Oakdale Dam in early July of 2012. Information reached IDNR in late June 2012 that a large mussel kill was in progress downstream of Oakdale Dam and that sections of the river were essentially de-watered. Subsequent site visits by IDNR and the Service revealed that an undetermined number of mussels had been killed including federally listed species (Fisher 2012b). The USGS Norway and Oakdale Gauge data for the period beginning on 1 June 2012 and ending on 10 July 2012 when the Service formally notified NIPSCO listed mussels were being taken downstream of Oakdale Dam reveals that natural low flows were intensified by Norway-Oakdale Complex management (Table 1).

Data for June and early July 2012 show that not only were the discharges between the two dams not equal, which is the basis for the FERC Staff Alternative's run-of-river, but for much of the time the downstream dam (Oakdale) discharged less water than did the upstream dam (Norway). The dams and reservoirs encompass the entire reach of the River between Oakdale Dam and the beginning of Lake Shafer near Buffalo. Therefore, as the data indicate, discrepancies are not an occasional glitch or gauge error, but a pattern that repeats frequently during periods of low flow; one directly attributable to the management of the Norway-Oakdale Complex under its FERC license.

Of particular importance to the mortality of mussels generally and to the take of listed mussels in 2012, were multiple times when two or more daily average discharges in a row out of Oakdale were less than out of Norway. Leading up to the 2012 mussel kill, flow out of Oakdale from 5 to 17 June was less than Norway every day but one. The deficit for the 13 day period ending on 17 June was 507 cfs. The total deficit comparing Oakdale to Norway leading up to Service action on the mussel kill was 611 cfs. Three additional two-day periods of lower flow occurred subsequent to 17 June (2 and 3 July, 5 and 6 July, and 9 and 10 July). In addition, there were large one-day deficits of over 100 cfs (21, 23, and 30 June).

Table 1 - 24-hour average flows from the beginning of June to mid-July 2012 leading up to and including the period in 2012 when federally listed species were taken downstream of Oakdale Dam.

Date	Norway Measured Discharge in CFS	Oakdale Measured Discharge in CFS	Oakdale Minus Norway Measured Discharge in CFS
6/1/2012	613	633	20
6/2/2012	633	586	-47
6/3/2012	596	585	-11
6/4/2012	632	644	12
6/5/2012	593	573	-20
6/6/2012	570	516	-54
6/7/2012	548	495	-53
6/8/2012	498	478	-20
6/9/2012	505	475	-30
6/10/2012	489	466	-23
6/11/2012	473	396	-77
6/12/2012	430	364	-66
6/13/2012	426	429	3
6/14/2012	426	425	-1
6/15/2012	426	387	-39

6/16/2012	**384**	**366**	**-18**
6/17/2012	**564**	**455**	**-109**
6/18/2012	**530**	**552**	**22**
6/19/2012	**509**	**489**	**-20**
6/20/2012	**348**	**425**	**77**
6/21/2012	**427**	**294**	**-133**
6/22/2012	**399**	**441**	**42**
6/23/2012	**315**	**179**	**-136**
6/24/2012	**405**	**410**	**5**
6/25/2012	**354**	**402**	**48**
6/26/2012	**271**	**196**	**-75**
6/27/2012	**279**	**286**	**7**
6/28/2012	**308**	**335**	**27**
6/29/2012	**279**	**314**	**35**
6/30/2012	**401**	**277**	**-124**
7/1/2012	**363**	**573**	**210**
7/2/2012	**349**	**276**	**-73**
7/3/2012	**437**	**385**	**-52**
7/4/2012	**386**	**516**	**130**
7/5/2012	**379**	**297**	**-82**
7/6/2012	**346**	**341**	**-5**
7/7/2012	**266**	**326**	**60**
7/8/2012	**235**	**278**	**43**
7/9/2012	**313**	**274**	**-39**
7/10/2012	**324**	**279**	**-45**
Total Difference			**-611**

On 2 July 2012, IDNR found a fresh dead sheepnose mussel 0.75 mile upstream of Pretty Prairie Road Bridge and on 3 July, IDNR moved two live rabbitsfoot mussels in very shallow water there to deeper water. On 10 July 2012, IDNR found fresh dead clubshell, fanshell, and rabbitsfoot mussels immediately upstream of Pretty Prairie Road Bridge. On 12 July 2012, an additional fresh dead fanshell was found upstream of Bicycle Bridge Road Bridge. It is important to understand that the 2012 mussel surveys were not extensive, but focused on two sites in one reach of the River downstream of SR 18 (about nine miles downstream of Oakdale Dam). It is the Service's position that many more listed mussels were taken in 2012 at vulnerable habitat occurring throughout the approximately 18.9 river mile reach between Oakdale Dam and the Wabash River. This take included direct mortality and harm as documented, and also likely indirect take (predation), evidence of which the Service observed about this same time on non-listed species (Lori Pruitt, USFWS, personal communication).

In response to the low flow event in the summer of 2012, in 2013 the Service initiated a study of three "vulnerable sites" downstream of Oakdale Dam using camera traps to capture hourly, time-stamped images for comparison to hourly USGS gauge readings on the Tippecanoe River. Vulnerable site selection criteria were: a) sites downstream of Oakdale Dam with shallow mussel habitat potentially vulnerable to low flows; b) areas known to support mussels and where federally listed species were known or suspected of being present; and c) sites otherwise suitable to our study design (e.g., accessible, suitable locations for cameras, etc.). The northernmost site was immediately downstream of Bicycle Road Bridge Road, the middle site was in-between Bicycle Bridge Road Bridge and Pretty Prairie Road Bridge, and the southernmost site was upstream of Pretty Prairie Road Bridge (Figure 1).

Each of the vulnerable sites was marked with a 26" length of 1" diameter PVC pipe attached with a firm spring to an approximately 2' length of metal fence post driven flush into the stream substrate. The PVC was marked at 2" intervals with half-inch wide strips of reflective tape to provide some ability to assess change during darkness. The PVC markers were positioned toward the downstream end of each vulnerable site. Camera traps (Bushnell Trophy Cam HD 8 MP) were fixed to trees at each site approximately four to six feet above the top-of-bank to ensure the cameras would not be damaged by high water. In each instance the camera was fixed downstream of the targeted area and placed so that the fields-of-view encompassed a large part of what was understood to be vulnerable habitat at each site.

During the Service's study, which lasted from mid-July to late October 2013, below normal flow conditions again occurred with August being approximately -0.7 and September -0.75 on the Palmer Drought Severity Index (see Midwest Regional Climate Center http://mrcc.isws.illinois.edu/CLIMATE/nClimDiv/STCD_monthlyChart.jsp). The Service discovered a second large mussel kill (Figure 9) during a routine check of the camera traps on 10 September 2013. Data from the USGS gauges revealed that on 28 and 29 August the difference between the daily average flow at Norway and Oakdale was - 47 cfs and -84 cfs and from 31 August through 4 September, Oakdale discharged less than Norway for five straight days. Then over the four day period from 7 September to 10 September (the day the Service was on-site) 232 cfs less water was released from Oakdale than Norway Dam (Table 2).

The Service does not know the exact date when mussels began to die, but it likely began late August or early September and was ongoing on 10 September. Although not the extreme drought event of 2012, the

2013 event highlights the vulnerability of mussels to Norway-Oakdale Complex operation during less extreme low-flow events.

Table 2 - 24-hour average flows from late August to mid-September 2013 measured at the USGS Norway and Oakdale Gauges and the differences in flow between them.

Date	Norway Measured Discharge in CFS	Oakdale Measured Discharge in CFS	Oakdale minus Norway Measured Discharge in CFS
8/19/2013	894	842	**-52**
8/20/2013	857	759	**-98**
8/21/2013	767	767	**0**
8/22/2013	810	814	**4**
8/23/2013	730	725	**-5**
8/24/2013	715	708	**-7**
8/25/2013	717	634	**-83**
8/26/2013	630	472	**-158**
8/27/2013	611	744	**133**
8/28/2013	647	600	**-47**
8/29/2013	614	530	**-84**
8/30/2013	521	573	**52**
8/31/2013	612	584	**-28**
9/1/2013	610	582	**-28**
9/2/2013	614	577	**-37**
9/3/2013	610	516	**-94**
9/4/2013	606	511	**-95**
9/5/2013	501	512	**11**
9/6/2013	471	502	**31**
9/7/2013	571	497	**-74**
9/8/2013	589	530	**-59**

9/9/2013	408	418	**10**
9/10/2013	448	339	**-109**
9/11/2013	514	457	**-57**
Total Difference			**-874**

Synergistic Effects of Emersion and other Factors on Listed Mussels

Two of the four listed species, rabbitsfoot and sheepnose frequently occur within shallow, flow refugia of rivers; rabbitsfoot may also move seasonally to shallow areas to reproduce (Fobian 2007, Butler 2002). This makes these two species particularly susceptible to emersion, increased water temperature, and increased predation during low-flow events. Shallow, slack water in addition to warming quickly during the summer can also experience depressed levels of dissolved oxygen. Negative effects on water temperature and dissolved oxygen can occur at sites that are not entirely dewatered, but where water is shallow and flow minimal. Mussels have two behavioral strategies to avoid the negative effects of dewatering, burrowing and horizontal movement; both are limited. Fobian, 2007 discussing rabbitsfoot puts mussel movement into perspective. He characterized them as “highly mobile” and observed that one mussel he watched moved **approximately 1.5 meters in just a few hours** [highlighting mine]. Moreover, mussels do not seem to possess the ability to move purposefully to deeper water; mussel “tracks” (depressions left in the substrate) often go in circles or otherwise reveal no particular end destination (Brant Fisher, IDNR, personal communication).

In experimental settings, Galbraith et al. (2015) used three dewatering rates: slow (1.6 inches of water removed/day), moderate (3.1 inches/day), and fast (2 inches/hour over 8 h) which equates to about 48 inches over a day. Images from the Service’s Camera Site 3 (Figure 6) show that a drastic change in suitability of vulnerable habitat can happen quickly, as it did on 28 August 2013 when the water fell several inches in three hours between 9:00 am and noon (the orange oval highlighting the PVC marker in these and subsequent photos is at the same location and serves as a reference point). Galbraith et al. found some differences in movement and burying among species and treatments, but many of the mussels in the experiment became stranded even at the slow dewatering rate. Different species also exhibited different stress reactions to the stranding and a number ultimately died. They conclude: “Human alteration of stream hydrology that increases dewatering rates may be a serious limiting factor for the maintenance or recovery of healthy mussel assemblages.”

Figure 6– Camera Site 3 upstream of Pretty Prairie Road Bridge at 9:00 am (left) and noon (right) on 28 August 2013, which falls between Galbraith et al.'s (2015) medium and fast rates.

Spooner, et al. (2005) studying streams in Oklahoma in combination with laboratory experiments looked at three questions: "(1) What is the best method for predicting the actual water temperatures experienced by mussel populations?; (2) What is the physiological response of freshwater mussels to a variety of water temperatures?; and (3) Can we predict the physiological responses, and thus stress levels, experienced by mussels in streams?". They found that very high water temperatures (95^{o} F), which occurred when low discharge created isolated pools of water (see Figure 9 for an example at one of the vulnerable habitat sites in the Tippecanoe River) caused significant stress prior to mussels dying. They also hypothesized that temperature/oxygen stress may not be expressed immediately, which suggests impacts from the management of the Norway-Oakdale Complex might cause harm, but not always result in proximate mussel mortality, especially during less severe events.

Metabolic activity of mussels increases as high water temperatures result in decreased solubility of oxygen in water. The combination of high water temperatures, increased need for and decreased supply of oxygen may limit the thermal tolerance of mussels (Galbraith et al. 2012). Juvenile mussels are thought to be the most sensitive life stage and two factors might make juveniles of the listed species particularly vulnerable to the FERC Staff Alternative. First, juvenile mussels drop off of the host fish over a variety of habitats, but animals less than about 5mm are easily displaced by the current (Yeager et al. 1994). Therefore they hypothesized that newly detached juveniles are more likely to remain in slow flowing areas behind boulders in riffles and long the streambank (note that Neves and Widlak (1987) found the most juveniles settled behind boulders, but comparatively few along stream banks). Juvenile mussels settling in shallow, protected areas could be disproportionately subject to the synergistic effects of artificial low flows. In addition, juvenile mussels are more sensitive to low dissolved oxygen in part because of juvenile physiology, and in part because juveniles bury in the substrate and thus live on the oxygen available in the interstitial spaces (spaces between the pieces of sand and gravel) of the sediments. Available interstitial oxygen can be much less than that in the flowing water (Sparks and Strayer 1998).

Spooner, et al. (2005) also looked at possible classification of mussels into guilds based on different thermal tolerances. They did not assess any of the listed mussels found in the Tippecanoe River, but did identify mucket (*Actinonaias ligamentina*), which occurs in the Tippecanoe River as representative of sensitive species in the streams studied in Oklahoma. Cummings and Berlocher (1990) identified mucket as common, but only at sites above the Norway-Oakdale Complex (sties 7, 8, 9). IDNR surveys in 2009 and 2012; however, found species from each guild proposed by Spooner et al. more or less equally represented downstream of Oakdale Dam. Understanding differences in tolerance to thermal stress in mussels is incomplete. In more extreme cases, where few refuges from thermal stress exist (i.e., smaller streams or during prolonged droughts) it seems likely that thermal sensitivity might affect the composition of a mussel community (Galbraith et al. 2010). The Service hypothesizes that during most low-flow events in the comparatively large Tippecanoe River, populations of thermally sensitive common species are abundant and there is sufficient habitat that those species persist (Haag and Warren 2008, Johnson, et al. 2001). Thermal stress; however, undoubtedly plays a role in mortality and sub-lethal effects on listed mussels during low-flow events in the Tippecanoe River downstream of Norway-Oakdale Complex.

Peterson et al. (2011) developed models to estimate survival and recruitment of three endangered mussels in the Apalachicola–Chattahoochee–Flint River Basin in Georgia. In part, they looked at the effectiveness of different minimum flows to conserve mussels. Simulations run with a minimum flow of 30% of the average annual discharge did not increase extinction risk when the population of the species was at least 500 animals. The populations of each of the four listed species downstream of Oakdale Dam are unknown, but the Service estimates them to range from about 1,500 to over 4,000 animals (see below). A 30% annual average discharge based on 15 years of data from the USGS Winamac Gauge equals 305 cfs, which is virtually identical to the 300 cfs (USGS Winamac Gauge) at which the TAL goes into effect (the 30% annual average at the USGS Oakdale Gauge based on seven years of data is 596 cfs – nearly 100 cfs higher than required under the TAL). In the Peterson et al. model, the probability of extinction increased no matter what the starting population when a 7Q10 minimum flow was used. The 7Q10 flow at the USGS Ora Gauge is 132 cfs – applying linear scaling, that would equate to 276 cfs at Oakdale. Their model corresponds to the Service conclusion (see previous correspondence) that 250-300 cfs is not protective of mussels in the lower reach of the Tippecanoe River.

With respect to reproduction, mussels are generally grouped into bradytictic brooders (clubshell, fanshell, sheepnose) which spawn in the summer before females brood glochidia over the winter for release in the spring; or tachytictic brooders (rabbitsfoot) which spawn in the spring and release glochidia during the same summer. The influence of temperature on the timing aspects of mussel reproduction is well documented. Watters and O'Dee, 2000; however, suggest this characterization is too simplistic and mussel reproductive activity may depend more on water temperature than season. In any case, both brooding strategies include key elements that occur over the summer (i.e., fertilization, glochidia attachment and dispersal by host fish, larval transformation, and deposition of juveniles onto the substrate) suggesting particular vulnerability to impacts on reproduction from the FERC Staff Alternative. Recruitment is subtly different from reproduction in that it tracks the addition of juvenile animals to the adult population. Lack of recruitment poses a major threat to some mussel populations. The timing of both low and high-flows contributes to recruitment, but may affect different species differently. Ries et al. (2015) evaluated effect of low flows on mussel recruitment. None of the listed species in the Tippecanoe were studied, but they found that recruitment in other mussel species that share similar life history strategies to the listed mussels in the lower Tippecanoe was poor during low flows.

Last, there may be ecosystem-level effects of even short-term dewatering of in-stream habitat. Loss and a long recovery period of macrophytes and macroinvertebrates have been tied to even short (hours long) duration dewatering events (Blinn et al. 1995). These effects may indirectly affect mussels by affecting food supplies or by affecting some poorly understood interaction among mussels and other organisms that inhabit river substrates. One interesting example is the invasive Asian clam (*Corbicula fluminea*) which is common in the lower Tippecanoe River and is particularly sensitive to dewatering (Byrne and McMahon 1994). Where this species occurs in large numbers, low flows can cause die-offs that subsequently consume dissolved oxygen in the water and produce ammonia, which is extremely toxic and especially lethal to native juvenile mussels (Spooner et al. 2005).

Mussel reproduction and recruitment depends on flows that match those under which they co-evolved with their host fishes because of the parasitic larval stage. Timing, magnitude, duration, and rate of change are all important (Allen et al. 2013). The complex interrelation among the variables must provide habitat for various mussel life history stages as needed, and for the persistence of host fish and the interaction of host fish and mussels. Mussels and host fish have adapted to the prevailing conditions over millennia. Optimum conditions do not always occur under natural flows with negative effects on that year's reproduction or recruitment and some number of the population. Where diverse and robust populations of mussels exist, optimum and adequate conditions must occur regularly compared to infrequent sub-optimal years. The Service believes the FERC Staff Alternative will maintain an imbalance causing more common occurrence of sub-optimal conditions with consequences for persistence of the listed species.

Effects of the Action on Rabbitsfoot Critical Habitat

Overview

The Service evaluated whether or not the FERC Staff Alternative would cause adverse modification of critical habitat for the rabbitsfoot mussel and ultimately concluded it would not. The following discussion summarizes that evaluation. The key factor related to such a determination is whether, with implementation of the proposed Federal action, the affected critical habitat would continue to serve its intended conservation role for the species.

Physical and Biological Features

Activities that may destroy or adversely modify critical habitat are those that alter the physical or biological features to an extent that appreciably reduces the conservation value of all critical habitat for the species. In the Final Rule designating critical habitat for the rabbitsfoot mussel, the Service grouped the primary threats rabbitsfoot critical habitat into nine categories. The Final Rule indicates that Unit RF25 (Tippecanoe River) may require special management considerations or protection (USFWS 2015). **W**ithin the areas designated as Critical Habitat, the physical or biological features essential to the conservation of the rabbitsfoot consist of five components (USFWS 2012b). Below is a brief characterization of each of these components below Oakdale Dam:

(1) Geomorphically stable river channels and banks (channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation) with habitats that support a diversity of freshwater mussel and native fish (such as stable riffles, sometimes with runs, and mid-channel island habitats that provide flow refuges consisting of gravel and sand substrates with low to moderate amounts of fine sediment and attached filamentous algae).

A visual examination of aerial photos from Google Earth (Figure 7a and 7b) over 33 years between 1984 and 2017 (1984, 1992, 1998, 1999, 2003, 2004, 2005, 2006, 2007, 2008, 2010, 2012, 2014, 2015, and 2017) reveals that 10 islands and six outside bends of the Tippecanoe River south of Oakdale Dam are stable with little or no recognizable change in size or position. Moreover, because the existing license addresses abnormal operating conditions (e.g., flooding or ice dam formation) by allowing only 0.5 foot of additional storage over the normal allowable deviation, flows generally matching flood events in terms of scale and timing exit Oakdale Dam and help to maintain the relatively unobstructed cobble-gravel substrate important for mussels in the downstream reach (FERC 2007).

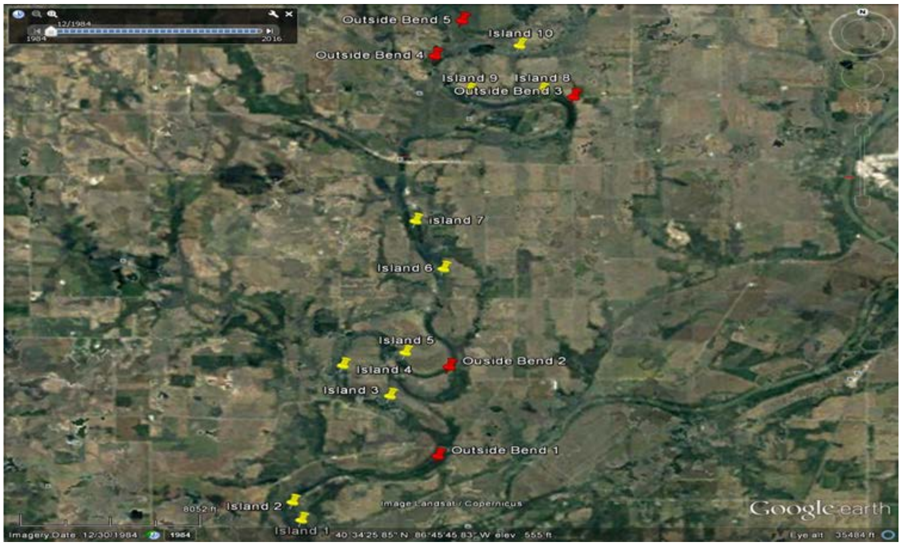


Figure 7a - Islands and outside bends visually examined from 1984 imagery.

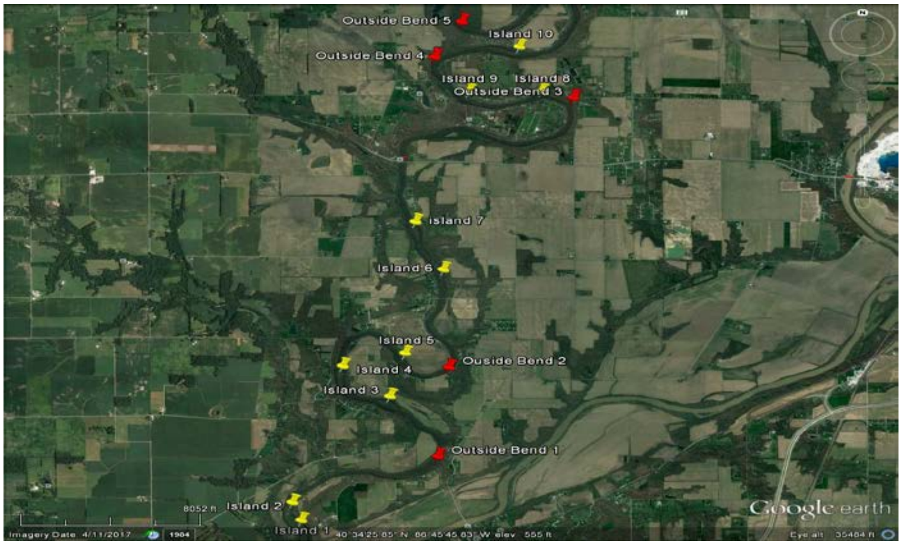


Figure 7b - Islands and outside bends visually examined from 2017 imagery.

(2) A hydrologic flow regime (the severity, frequency, duration, and seasonality of discharge over time) necessary to maintain benthic habitats where the species are found and to maintain connectivity of rivers with the floodplain, allowing the exchange of nutrients and sediment for maintenance of the mussel's and fish host's habitat, food availability, spawning habitat for native

fishes, and the ability for newly transformed juveniles to settle and become established in their habitats.

Figure 8 (a-f) is a series of photographs from Camera Site 3 (upstream of Pretty Prairie Road Bridge) that illustrate the effect of varying flows out of Oakdale Dam on rabbitsfoot critical habitat during the mussel die-off in late August and early September 2013. The photographic evidence shows fluctuation late in August with flows resulting in progressive dewatering of critical habitat through the first part of September (see Table 2 for the corresponding 24-hour average flows). The vulnerable area captured by Camera Trap 3 in 2013 is ideal habitat for rabbitsfoot (and designated critical habitat for this species).

Figure 8 (a – f) - Camera Site 3 (Pretty Prairie Road Bridge) image sequence showing the dewatering of rabbitsfoot critical habitat in late August and early September 2013.

The Service found many fresh dead mussels on 10 September 2013 at Camera Site 2 (Figure 9). Others were alive, but in very shallow water and apparently stressed (Figure 10). The camera trap at Camera Site 2 recorded the air temperature at 2:00 pm on 10 September 2013 as 93^{o} F.

All three 2013 camera sites fall within the designated rabbitsfoot critical habitat in the lower Tippecanoe River and capture the shallow habitat favored by this species. No mussel survey was conducted in September 2013, so it is impossible to conclude whether or not rabbitsfoot were taken in this event during the brief time the Service biologist was on the sites. Regardless, it is obvious that critical habitat was impacted during September 2013.

Figure 9 - Photo looking upstream from immediately upstream of the PVC Marker at Camera Site 2 showing dewatered rabbitsfoot critical habitat (and emersed mussels) on 10 September 2013.

Figure 10 – Close-up photo of partially emersed pimpleback mussel (Quadrula pustulosa pustulosa) at Camera Site 2 on 10 September 2013.

(3) Water and sediment quality (including, but not limited to, conductivity, hardness, turbidity, temperature, pH, ammonia, heavy metals, and chemical constituents) necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages.

The Norway-Oakdale Complex may have some beneficical effect by preventing some of the sediment collected in the central reach of the Tippecanoe River from affecting the downstream reach. The Shafer Freeman Lakes Environmental Conservation Corporation (SFLECC) regularly dredges sediments from the lakes (http://www.sflecc.com/newsite/?page_id=33). The Service has no information that the Norway-Oakdale Complex is directly, negatively affecting water quality other than dissolved oxygen, which is measured at the tailrace and is infrequently in violation of NIPSCO's permit (NIPSCO unpublished annual reports).

The Norway-Oakdale Complex may; however, indirectly affect water quality in the lower reach of the Tippecanoe River. It is widely acknowledged that Lakes Shafer and Freeman are directly responsible for significant development in the Monticello, Indiana area. Lake Freeman has heavy residential development around it while Lake Shafer is more commercially developed. In addition, the resort development of Indiana beach draws thousands of tourists to Lake Shafer every summer. Many residents and tourists using both lakes run motorized watercraft. It is unknown how much or specifically what contamination development and recreation on the lakes cause or how much of those contaminants might be discharged downstream through operation of the Norway-Oakdale Complex in concentrations sufficiently high to affect critical habitat.

The Service assessed point sources throughout the Tippecanoe River drainage in 2011. Biologists divided the watershed into five sections. Section 5 starts approximately at Buffalo and encompasses the watershed downstream to the confluence with the Wabash. They identified 15 point sources in Section 5. A number of the point sources are around Lakes Shafer and Freeman: Twin Lakes RSD/Big Monon Bay; Indiana Beach Resorts, Inc; Pineview Lodge and Golf Course; Landings Home Wonders Association; Twin Lakes RSD/Snow Ditch WWTP; White Oaks on the Lake WWTP; Ball Metal Beverage Container; and Monticello WWTP. During this study, only Monticello WWTP was identified as exceeding permitted levels (DMR) for heavy metals and ammonia - zinc, nickel, and copper were all exceeded (Sparks, USFWS, unpublished data). Acute toxicity from heavy metals may be unlikely at concentrations in most streams, but because mussels are in direct contact with sediments and filter large amounts of water over a long lifetime, metals can bio-accumulate in their tissues resulting in concentrations much higher than background levels. Such concentrations can result in sublethal effects on feeding, growth, and reproduction significant enough to affect mussel populations (Naimo 1995). The Service has no evidence; however, that toxic effects from lake borne contaminants have caused chronic impacts to mussels downstream of Oakdale Dam.

The Norway-Oakdale Complex does indirectly affect water temperature and dissolved oxygen (as discussed above) by creating less swiftly flowing, shallower water when flows are artificially reduced during the summer. The central section of the photograph taken at Camera Site 2 on 10 September 2013 (Figure 9) is representative of the slack, shallow water attributable to low flows that can exceed the temperature of the flowing water further out in the river. Critical habitat becomes unsuitable under these conditions because even though not entirely dewatered, high water temperatures and low dissolved oxygen can easily exceed the tolerance of mussels (Spooner et al. 2005).

(4) The occurrence of natural fish assemblages, reflected by fish species richness, relative abundance, and community composition, for each inhabited river or creek that will serve as an indication of appropriate presence and abundance of fish hosts necessary for recruitment of the and rabbitsfoot.

It is uncertain what effects management of the Norway-Oakdale Complex may have on the host fishes of the rabbitsfoot mussel downstream of Oakdale Dam. Butler, 2005 suggests rabbitsfoot may be relatively specific with respect to host fishes. In Indiana, host fish species may include: spotfin shiner (*Cyprinella spiloptera*), bigeye chub (*Hybopsis amblops*), striped shiner (*Luxilus chrysocephalus*), emerald shiner (*Notropis atherinoides*), bullhead minnow (*Pimephales vigilax*), golden redhorse (*Moxostoma erythrurum*), rainbow darter (*Etheostoma caeruleum)*, and blackstripe topminnow (*Fundulus notatus)* (Brant Fisher, IDNR, personal communication).

Fish are more vagile than mussels, but species tied to specific shallow habitats (e.g., darters to riffles) within the lower reach of the Tippecanoe could be negatively affected by the FERC Staff Alternative. Cushman (1985) discussed the mechanisms and potential effects on stream organisms of rapidly varying flows downstream of a peaking hydroelectric facility These include flow fluctuation, velocity, depth, riffle area, and wetted substrate (also see Zimmerman et al. 2010 for a more complete discussion of metrics related to changes in flows). Cushman noted that productive riffle areas may be particularly affected and that the daily range of these variables may be much different in dammed rivers than in free-flowing ones. Similarly, Aadland (1993) grouped species in Minnesota streams by habitat and found slow riffle and fast riffle habitats were preferred by adult and juvenile stages of some shiners, the juvenile stages of most darters, and the adult stage of most darters. He also found those habitats most affected by low flows.

In a particularly relevant study of an Alabama River, Travnicheck et al. (1995) evaluated fish communities before and after the implementation of a requirement that increased minimum discharge and reduced fluctuation in flows. Fish species richness about two miles below the dam doubled after implementation of the minimum flow/flow stability requirement. At a site 23 miles downstream of the dam, fish species richness was essentially the same, but more fluvial specialists were present and their abundance went from 40% to 80% of the sample. This also included increased densities of bullhead minnow and emerald shiner (potential rabbitsfoot host fish in the Tippecanoe River) and several other shiners and darters two miles downstream, and emerald shiner and several other shiners and darters 23 miles downstream.

Because many of the potential rabbitsfoot host fish inhabit shallow riverine habitats, negative effects on some host species appears inevitable. Effects could include depressed populations and perturbation of the interaction between mussels and host fish. Several viable host fish species occur in the downstream reach; however, including habitat generalists (e.g., spotfin shiner) or pool specialists (e.g. bigeye chub) that would be less affected by the FERC Staff Alternative. A reproducing population of rabbitsfoot exists with the logical conclusion that host fish persist in adequate numbers in this reach of the Tippecanoe River

(**5) Competitive or predaceous invasive (nonnative) species in quantities low enough to have minimal effect on survival of freshwater mussels.**

As discussed above, invasive aquatic species, particularly Asian clam, occur in detectable quantities downstream of the Norway-Oakdale Complex (Brant Fisher, IDNR personal communication). This species may be an important competitor with juvenile mussels for resources such as food, nutrients, and space (Neves and Widlak 1987). Strayer (1999) also thought dense populations of Asian clams could reduce habitable space for juvenile native mussels because they actively disturb sediments. In addition, he suggested the invasive species may ingest large numbers of native mussel sperm, glochidia, and newly-metamorphosed juveniles. There do not appear to be acute effects (e.g., colonization of native mussels) by zebra mussels (*Dreissena polymorpha)*. The Service has no indication that invasive species are an imminent threat to listed mussels in the lower reach of the Tippecanoe River.

In sum, the FERC Staff Alternative would result in negative effects on rabbitsfoot critical habitat; primarily the flow regime and the water and sediment quality. These affects could be acute (i.e., dewatering of critical habitat for a specific period) and chronic (e.g., making some of the critical habitat unsuitable because of repeated perturbations). Some potential exists for an acute mortality event associated with a die-off of the invasive Asian clam, but the Service cannot assess whether or not this may have occurred in the past. Oakdale Dam operation seems likely to affect rabbitsfoot host fish, but these effects do not thus far appear to have degraded critical habitat.

Species and Critical Habitat Likely to Be Affected

The clubshell, fanshell, sheepnose, rabbitsfoot and rabbitsfoot critical habitat will be adversely affected by implementation of the FERC Staff Alternative. The Service concurs that the FERC Staff Alternative is NLAA for the rayed bean and snuffbox mussels because available data indicate those two species may no longer occur downstream of the Norway-Oakdale Complex. Those two species will not be further considered in this biological opinion.

Analysis for the Effects of the Action

Beneficial Effects

The FERC Staff Alternative does contemplate problematic low flows, which signifies a positive change over the existing license. It may have some beneficial effect by codifying that generation will not occur during low flows, but because NIPSCO rarely generates power during low flows the actual benefits remain limited. Otherwise, as has been stated, the FERC Staff Alternative simply perpetuates actions in the current license requirements that have caused and will continue to cause take of mussels and negative effects to critical habitat.

Direct Effects

The direct effects of the FERC Staff Alternative are straightforward. Management of the Norway-Oakdale Complex under the FERC Staff Alternative with respect to mussels would not substantively change from that under the license granted to NIPSCO by the FERC in 2007. That license appears to have codified how the dams have operated since at least 1988. During late summer and early autumn, when flows are often naturally low, the quantity of water released from Oakdale Dam does not match what the Service has determined to best mimic the natural flow of the River (linearly scaled flow from Winamac as detailed in the TAL). As the Service has demonstrated in this biological opinion, releases out of Oakdale Dam regularly violate the current definition of run-of-river (i.e., 24-hour average water-in equals 24-hour average water-out). Further depleting natural flows during summer directly affects listed mussels, and may inordinately target sheepnose and rabbitsfoot that occur primarily in vulnerable habitats. Mortality and harm from emersion are direct effects on the mussels as is periodic disruption of the reproductive cycle because of lack of sufficient depth or flow of water. The same management approach, focused on maintaining lake levels, also directly affects rabbitsfoot critical habitat by causing rapid changes in flow and periodic dewatering.

Effects of Interrelated and Interdependent Actions

The Service has identified the following interrelated or interdependent action associated with the FERC Staff Alternative.

- Hydroelectric generation outside of the FERC Staff Alternative defined low-flows. This could negatively affect listed mussels and mussel habitat because of the large swings in flow that occur during turbine operation. Under generating conditions as currently understood by the Service; however, these effects would be insignificant. The reason for this conclusion is that changes in flow outside of low-flows would not dewater suitable habitat and the changes occur against a background of existing high flows in the River. Negative effects would occur if generation caused flows out of Oakdale Dam to drop below 500 cfs. Under the temporary variance, the TAL precludes this even outside low-flow conditions.

Indirect Effects

Indirect effects are those that are caused by the proposed action and are reasonably certain to occur, but later in time. Indirect effects caused by the FERC Staff Alternative include increased predation of listed mussels and increased human disturbance of mussels within downstream reach of the Tippecanoe River. When mussels are exposed on the streambed or water is slack or shallow, raccoons and other opportunistic predators are more likely to predate listed mussels. The Clubshell 5-Year Review states that predation could represent a significant threat to small isolated clubshell populations (USFWS 2008). The same mechanisms also apply to fanshell, sheepnose, and rabbitsfoot. When mussels are exposed they are also more vulnerable to people using the river (e.g., boating, canoeing, fishing, wading); they are more likely to encounter mussels and either accidentally or purposefully kill or harm them.

Listed Mussels Response to the Proposed Action

The listed mussels in the lower Tippecanoe River share many similarities in life history and the FERC Staff Alternative will for the most part affect them similarly. Mussel surveys conducted by IDNR and the Service in July 2012 identified affected (fresh dead or partially or wholly emersed) mussels of each of the four species, clubshell, fanshell, sheepnose, and rabbitsfoot (Fisher 2012). There are; however, some obvious and less obvious differences in the species life histories, which could affect their responses to the FERC Staff Alternative. These are discussed below.

Numbers of Animals or Populations Affected

Clubshell, fanshell, and sheepnose populations in the Tippecanoe River are known to be small, but the Service does not have a reliable population estimate. Rare mussel species, especially across a large area are difficult to assess (Smith 2006). The population of rabbitsfoot is also unknown, but apparently more robust. Based on the Service’s understanding of the mussel populations in the lower reach of the

Tippecanoe River and data from 2012, some number of each of the four listed species extant south of Oakdale Dam would be taken by implementation of the FERC Staff Alternative. The Tippecanoe River population of each species extends both upstream and downstream of the Norway-Oakdale Complex; the FERC Staff Alternative would not affect populations upstream of Oakdale Dam.

Pre-2012 operation of the Norway-Oakdale Complex appears primarily to have affected mussels and mussel habitat in concert with low flow events. Based on the long-term data set from the USGS Ora Gauge (Appendix 6), take would reoccur regularly during the summer and early autumn if the FERC Staff Alternative governs management of the facility - occurring about 8 out of 10 years. Take would be avoided only when low-flow events were absent or extremely short. In the 72 years between 1945 and 2016, data indicate that zero low-flow events as defined in the TAL occurred 14 times along with two, two-day events. Weather and climate in part dictate the severity of take as longer, more extreme low-flow events provide the conditions for greater take to occur. Those like 2012, which have occurred on an approximately 22-year cycle could have population-level impacts on the listed species downstream of Oakdale Dam.

The area of habitat downstream of Oakdale Dam was estimated by first making 23 width measurements of the lower reach in Google Earth. The average width of this section of the Tippecanoe River derived from those estimates is 271 feet.[7] The length of the lower reach was then measured in Google Earth from Oakdale Dam to the mouth of the Tippecanoe River (imagery date for both width and length measurements was 4/11/17). That measurement equaled 99,872 feet (18.9 miles). The length multiplied by the average width yields a potential habitat estimate of 621 acres. There are a number of islands in the downstream reach, which have permanent vegetation and are rarely inundated, thus not potential habitat. A Google Earth image from 1 July 2007 was used as the base map for calculating island area (an 11 April 2017 image was used as a check). The average daily flow measured at the USGS Delphi Gauge on 1 July 2007 was 759 cfs (it had been in the low 1,000s cfs the previous two days); flow measured at the USGS Winamac Gauge the same day was 368 cfs. The 1 July 2007 image represents summer flows, but flows moderately above TAL levels. This image was used to draw polygons around what appeared to be the permanent vegetation of the islands. The polygons were then transferred to the on-line program Earth Point for calculation of the areas (http://www.earthpoint.us/Shapes.aspx). Fourteen islands were identified with the following areas (in acres) from upstream to downstream (1.2, 8.9, 2.0, 0.5, 8.7, 0.71, 2.4, 2.5, 0.74, 9.2, 6.0, 1.2, 0.55, and 24) for a total of 69 acres. Thus the Service estimates the acreage of potential mussel habitat downstream of Oakdale Dam as 552 acres (see below for a comparison to French Creek in Pennsylvania). Some areas within the lower reach of the Tippecanoe River are undoubtedly not suitable for each of the four listed species, but data aren't sufficient to systematically preclude them. Therefore, the Service will assume 552 acres of suitable habitat in order to establish a reasonable baseline population estimate for the listed species.

As previously discussed mussels can occur individually or scattered in small groups on the streambed, but typically occur in assemblages or beds of many mussels of various species. The Service has little data on density of the four listed species within the lower reach of the Tippecanoe River. They are rare species; however, and their densities are undoubtedly low. During quantitative sampling of excavated 11.25 square

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7 Initially 10 measurements were visually located and the widths averaged. Then 13 additional measurements were made systematically approximately every 7,920 feet and the widths averaged. The final width is an average of the two averages (23 total measurements).

meters (45, ¼-meter square plots) of vulnerable habitat upstream of Pretty Prairie Road Bridge in 2012 one rabbitsfoot and one fanshell were found out of 194 live mussels (Fisher, IDNR, 2012, unpublished data). The average mussel density of all live mussels totaled 20.7 /m^2. Fanshell and rabbitsfoot each had a density of 0.09 /m^2. For reference, Strayer et al. (1996) studied the largest populations of the endangered dwarf wedgemussel (*Alasmidonta heterodon)* in 13 streams across multiple states. They found that all of the populations shared the characteristic of densities between 0.01 and 0.05 animals /m^2. They also documented some level of reproduction in all of the populations. Another stream, French Creek has a 1,236 square mile watershed and flows 117 miles through New York and Pennsylvania.[8] It is similar in size to the Tippecanoe River and like the Tippecanoe has a diverse mussel fauna including clubshell and rabbitsfoot mussels. Smith and Crabtree (2010) quantitatively surveyed French Creek and found clubshell at two of their nine sites with a mean density of 0.11/m^2. Rabbitsfoot was found at seven sites with a mean density of 0.07/m^2.

The Service does not have systematic quantitative surveys of the four listed mussels in the lower Tippecanoe River. The limited quantitative data available and surveys of endangered mussels in other rivers suggest a density estimate of approximately 0.09 /m^2 for each of the four species. Calculation of a population in the lower reach using 0.09; however, produces an estimate of over 127,000 animals of each species in a wetted perimeter zone between 500 cfs and 10 cfs (500 cfs is the flow at or above which mussels are minimally protected and 10 cfs represents virtually no flow in the lower reach). It is likely that more quantitative survey data, if available for the lower reach would yield a significantly lower density estimate of each of the four species.

Densities of 0.09/m^2 likely occur only at isolated sites, but not uniformly up and down the lower Tippecanoe River. If that were not the case, populations would be much stronger than considerable qualitative survey effort indicates. Some percentage of the vulnerable habitat downstream of Oakdale Dam is likely not occupied at all because of scouring flows or unsuitable substrate. Based on this, the best professional judgement of the Service in consultation with IDNR suggests a density of approximately 0.001/m^2 is the appropriate baseline estimate for the listed species across the vulnerable habitat in the lower Tippecanoe River. Fisher's multiple years of qualitative (and limited quantitative) sampling indicates that the populations of the four listed species are ordered from smallest to largest: clubshell, fanshell, sheepnose, and rabbitsfoot (Brant Fisher, IDNR, personal communication). Modifications to account for the comparative sizes of the four populations and the increased likelihood of rabbitsfoot and sheepnose to occur in vulnerable habitat result in the Service's best professional judgement of population densities: 0.001 (clubshell), 0.0013 (fanshell), 0.002 (sheepnose), and 0.003 (rabbitsfoot). Using these densities and total available habitat, we estimate total populations of the four species downstream of Oakdale Dam as: clubshell (1,414), fanshell (1,838), sheepnose (2,828), and rabbitsfoot (4,242).

The Service estimated two additional factors to calculate take of the four listed species downstream of Oakdale Dam. First, is the amount of vulnerable habitat potentially affected by the operation of the Norway-Oakdale Complex. The Service assumes that all of the vulnerable areas, which are a subset of the 552 acres, are suitable for each of the four listed species. Precise estimates of how many of the 552 acres of potential habitat comprise vulnerable habitat (subject to the effects of the FERC Staff Alternative)

8 The assessed the aquatic habitat and estimated approximately 539 acres of riffle-run habitat in the main stem of French Creek.

would require bathymetric data for the downstream reach, which does not exist. The Service therefore looked at five available cross sections (Oakdale Boat Ramp, Upstream Horseshoe Bend, Lower Horseshoe Bend, Bicycle Bridge Road, and Pretty Prairie Bridge Road) and accompanying tables of wetted perimeter[9] at various flow rates developed by GAI for NIPSCO during the early HCP development between NIPSCO and the Service (GAI, unpublished data, 2013). Wetted perimeter, which corresponds to the shallow littoral zone (area along the river bank) is equated with vulnerable habitat.[10]

These are the best available data for characterizing the lower reach of the River. The Service averaged the wetted perimeter measurements at the five sites to estimate wetted perimeter at key flow rates. Although the GAI Table establishes wetted perimeter for flow rates up to 1,000 cfs, the Service started our analysis at 500 cfs because that is the flow, which the Service determined based on summer 2013 field work and other information, to be minimally protective of mussels in the downstream reach. Flow rates below 500 cfs are expected to cause take and negatively affect critical habitat. The bottom rate (150 cfs) corresponds to the lowest daily average flow rate measured at the USGS Oakdale Gauge during the summer 2012 low-flow event (179 cfs on 23 June). The average wetted perimeter at the four key flow rates is 217 feet at 500 cfs (baseline) 209 feet at 400 cfs, 200 feet at 300 cfs, and 170 feet at 150 cfs (Table 3).

Table 3 Wetted perimeter measured in feet at five sites downstream of Oakdale Dam and the average width of wetted perimeter at the four key flow rates.

Wetted Perimeter Width (in feet)				
CFS X-Section Sites	**500**	**400**	**300**	**150**
Boat Ramp	159	152	143	126
Upper Horseshoe	205	196	187	146
Lower Horseshoe	236	231	221	183
Bicycle Road	247	240	233	216
Pretty Prairie Road	238	228	218	180
AVERAGE	**217**	**209**	**200**	**170**

The second important factor evaluated is the year to year effect of the operation of the Norway-Oakdale Complex, which as discussed above likely varies based on the severity of natural low-flow conditions. The level of take is assumed to increase with the duration of the low-flow event as the Norway-Oakdale Complex is managed to maintain lake level. Based on the 72 year record of data from the USGS Ora and Winamac Gauges (Appendix 6) there were:

- 0 low-flow events 14 years or 19 percent of the time,

9 Wetted perimeter is a metric of the cross-sectional area of a stream channel that is covered by water.
10 There is additional vulnerable habitat associated with the shallow zones around the islands in the lower reach, but estimating a small littoral zone around the islands does not change the total take appreciably and was not calculated.

- 1–35 consecutive day events 28 years or 39 percent of the time,
- 36-70 consecutive day events 16 years or 22 percent of the time, and
- 71–100 + consecutive day events 14 years or 19 percent of the time.

The final step is to relate mussel loss at various wetted perimeters to the occurrence of low flow events. The Service makes some simplifying assumptions. First, only one type of event will occur in a given year (0 day event, 1-35 day event, 36 -70 day event, or 71 to 100 + day event). Second, mussels fully recover to occupy vulnerable habitat after each event. Third, each event has the specified probability of occurring every year regardless of the previous year. The take for clubshell will be between 0 and 436 animals each year. Based on available data, there is a 61 percent probability that low-flow events will be between 1 and 70 days resulting in a take range of 74-158 mussels.[11] The take for fanshell will be between 0 and 567 animals each year with a 61 percent probability that low-flow events will be between 1 and 70 days resulting in a take range of 96-205 mussels. The take for sheepnose will be between 0 and 872 animals each year with a 61 percent probability that low-flow events will be between 1 and 70 days resulting in a take range of 148-315 mussels. The take for rabbitsfoot will be between 0 and 1,308 animals each year with a 61 percent probability that low-flow events will be between 1 and 70 days resulting in a take range of 223-473 mussels. Table 4 shows the estimated take of each species of mussel by loss of wetted perimeter.

Table 4 Loss of wetted perimeter (vulnerable habitat) as flow rates decrease from 500 cfs to 150 cfs and associated estimated loss of each listed species.

CFS	AFFECTED HABITAT (m^2)	MUSSEL TAKE / m^2			
		Clubshell (0.001)	**Fanshell** (0.0013)	**Sheepnose** (0.002)	**Rabbitsfoot** (0.003)
500	0	0	0	0	0
400	74,227	74	96	148	223
300	157,733	158	205	315	473
150	436,085	436	567	872	1308

Sensitivity to Change / Resiliency/Recovery Rate

One aspect affecting resiliency and recovery relates to the severity of the impact. While the four listed species share many common life-history characteristics there are some key differences that influence how

11 The 61 percent probability equals the sum of the probabilities of the occurrence of a 1-35 day event and a 36 -70 day event (39 percent and 22 percent respectively).

species might be affected differently by the FERC Staff Alternative in any low flow event. Rabbitsfoot and sheepnose usually occur in shallow water (USFWS 2012, Butler 2002); the same vulnerable habitats identified by the Service in 2013 and assumed to occur throughout the lower reach of the Tippecanoe River. In addition, rabbitsfoot nearly always occurs on the surface of the streambed (USFWS 2012). Even small discontinuities in the amount or timing of flow reaching their habitat can modify it from suitable to unsuitable. Because the mussels have limited mobility, this causes stress or mortality within hours to days depending on temperature, dissolved oxygen and other variables. Clubshell and to a lesser extent fanshell and sheepnose routinely bury in the substrate (USFWS 2008). During less severe depletion of flow, this could help protect them from stress, direct mortality, or indirectly from predation (Gough et. al. 2012).

Another important factor in resiliency and recovery is starting population. As estimated above, none of the listed species likely has over 5,000 animals in the lower reach. Mussels generally have high fecundity producing tens of thousands of eggs under suitable conditions. Even a dense population of a particular species; however, would result in a small number of eggs surviving to become adult mussels (Berg et al 2008). Small, less dense populations have fewer males and females in close proximity and in the proper position within the stream to facilitate fertilization. Gates et al (2015) conclude that because mussels are slow to recover from population declines [few juveniles surviving to adulthood, relatively long time to sexual maturity, not all females reproduce every year] changes in flow can be catastrophic to mussel persistence in a stream. Thus, regular mortality of adult mussels of the listed species may result in a positive feedback loop where incremental population reduction leads a diminished ability to replenish the population after each successive take event.

It is not entirely clear why some species of mussels do well in a particular stream while other native species become extirpated or suffer severe population reductions. The USFWS (2017) concludes the environmental sensitivity of the fanshell [as one example] is still poorly known, so it is possible that previously unidentified activities could cause a precipitous decline of one or more populations of that species. It is a logical assumption that all of the listed mussels in the lower Tippecanoe River may have characteristics that make them more sensitive to change compared to more common mussel species. For reasons that remain mostly unknown, they have become threatened or endangered while other species continue to occur in comparatively large numbers in the Tippecanoe River and elsewhere.

Cumulative Effects

Cumulative effects are those effects of future State or private activities, not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to consultation. [50 CFR §402.02]. This definition applies only to section 7 analyses and should not be confused with the broader use of this term in the National Environmental Policy Act or other environmental laws.

Cumulative effects are always difficult to assess, but for mussels in the Tippecanoe River primarily relate to actions that affect the quality or quantity of water in the River. A toxic industrial spill would be an acute example. This seems unlikely given limited urban/industrial development in the downstream watershed and given that no municipalities downstream of Oakdale Dam dispose of wastewater into the River. For the most part development consists of farms and individual residences. An acute agricultural pollution event (e.g., ammonia spill) appears more likely, although it cannot be reasonably anticipated. Chronic or non-point source pollution from agriculture is a cumulative effect that will almost certainly continue to occur in the watershed. This can take the form of sediment and agricultural chemicals that reach the river attached to those sediments or more directly through the extensive drainage system in the watershed. Climate change will also affect the Tippecanoe River watershed in the coming decades. It is uncertain what the exact effects will be, but more intense storms and more severe drought periods are possible consequences (NASEM 2016).

In summary, additional stressors may exacerbate the negative effects of implementation of the FERC Staff Alternative. First, listed mussel populations in the lower Tippecanoe River will continue to be stressed (and critical habitat degraded) by non-point source pollution possibly making populations more vulnerable to depleted flows and thermal extremes caused by operation of Oakdale Dam (Pandolfo et al. 2010). Second, changes in regional climatic conditions could make low flow events more frequent or more severe. The quantity and quality of water, the quality of the substrate, and the background flow conditions in the Tippecanoe River system all affect listed mussels and critical habitat.

Conclusion

After reviewing the current status of the clubshell, fanshell, sheepnose and rabbitsfoot mussels, the environmental baseline for the action area, the effects of the proposed FERC Staff Alternative and the cumulative effects, it is the Service's biological opinion that the FERC Staff Alternative, as proposed, is not likely to jeopardize the continued existence of the clubshell, fanshell, sheepnose or rabbitsfoot mussels and is not likely to destroy or adversely modify designated critical habitat.

Clubshell, fanshell, sheepnose, and rabbitsfoot populations in the Tippecanoe River are among the last remaining of these species. Continued, regularly occurring take, even if each event takes a small number of animals could contribute to the extirpation of one or more species from the lower reach of the River. The Tippecanoe river population of clubshell is one of only 13 known populations, but at least two of those remaining are quite large. The Allegheny River population alone may have well over 1,000,000 clubshell (USFWS 2008). Fanshell mussels have fewer known populations, but three extant populations remain robust. The Green River and Licking River populations in Kentucky cover 60 and 75 miles respectively and appear to be increasing; the Clinch River population also covers over 50 miles of stream (USFWS 2017). Historically, sheepnose may have not been abundant and no large populations (see clubshell above) are known. The sheepnose; however, is comparatively widespread (25 streams) and approximately nine populations appear viable (Butler 2002). The Service lists the rabbitsfoot mussel as a Threatened species. It continues to occupy 51 streams with 11 viable populations. Jeopardize the continued existence of is defined in 50 CFR §402.02 as: to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species. Because there remain multiple viable populations of each of the four species, the Service concludes that the FERC Staff Alternative may alter the time scale of recovery but is not expected to reduce the likelihood of their survival.

Effects on critical habitat in the lower reach of the Tippecanoe River are locally important. Each event would degrade rabbitsfoot critical habitat making it temporarily unsuitable, or in a worst case scenario an ecological sink, for the species during low flow events. There are 1,437 river miles of critical habitat in multiple drainages and states (USFWS 2015). The Service interprets adverse modification of critical habitat to occur at the scale of all critical habitat designated for a species, not just that affected directly by the action. “Adverse effects to single elements or segments of critical habitat generally do not result in destruction or adverse modification unless that loss, when added to the environmental baseline, is likely to appreciably diminish the capability of the critical habitat to satisfy essential requirements of the species" (USFWS 2016). Affects to the critical habitat for rabbitsfoot mussel in the lower Tippecanoe River would not cause adverse modification of critical habitat as a whole.

III INCIDENTAL TAKE STATEMENT

Overview

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the [Service] to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the [Service] as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measure described below are non-discretionary, and must be undertaken by the FERC so that they become binding conditions of any grant or permit issued to NIPSCO, as appropriate, for the exemption in section 7(o)(2) to apply. The FERC has a continuing duty to regulate the activity covered by this incidental take statement. If the FERC (1) fails to assume and implement the terms and conditions or (2) fails to require NIPSCO to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to their license, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, NIPSCO and the FERC must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement. [50 CFR §402.14(i)(3)].

Effect of the Take

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

Amount or Extent of Take Anticipated

Implementation of the proposed FERC action would result in take at the levels described in Table 4 in the Effects of the Action section, above, and at the frequencies described in the accompanying text. This level of take would occur without implementation of the reasonable and prudent measures, which are described in the next section.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measure is necessary and appropriate to minimize impacts of incidental take of clubshell, fanshell, sheepnose and rabbitsfoot mussels.

- Minimize take of listed mussels by restoring a more natural flow regime downstream of Oakdale Dam during low-flow periods.

The FERC by virtue of granting multiple temporary variances for implementation of the TAL and its precursors and NIPSCO by successfully implementing the TAL since mid-August 2014 have demonstrated that NIPSCO can implement the TAL with minimal effects to overall operations of the facility. The Service continues to support the TAL as the best currently available approach to mimic natural flow downstream of the Norway-Oakdale Complex. As such, it will minimize mortality of listed mussels approximating what would occur naturally during low flow events.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the FERC must comply with the following terms and conditions, which implement the reasonable and prudent measure described above. These terms and conditions are non-discretionary.

- Adopt the alternative proposed by NIPSCO in its request for a license amendment and implement the Service TAL of 2014 as clarified (Appendix 1).

- Replace readings from the USGS Winamac Gauge with those from the USGS Buffalo Gauge as the key metric defined in the TAL upon authorization of the USGS Buffalo Gauge by the Service.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

- Minimize large swings in discharges (total changes > 150 cfs) and multi-directional changes within any 24-hour period out of Oakdale Dam when flows are between 525 cfs and 300 cfs at Winamac except when tied to natural events (e.g., heavy rains and resulting flood flows).

- Support IDNR and Service efforts to accomplish yearly monitoring of listed mussels downstream of Oakdale Dam.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

IV REINITIATION

This concludes formal consultation on the clubshell, fanshell, sheepnose, and rabbitsfoot mussels and rabbitsfoot mussel critical habitat outlined in the request for formal consultation. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

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August 13, 2014

Mike Finissi
Sr. VP & Chief Operating Officer of NIPSCO Operations
NIPSCO
801 E. 86th Avenue
Merrillville, IN 46410

Re: Technical Assistance Letter (TAL)

Dear Mr. Finissi:

The purpose of this TAL is to acknowledge and respond to Northern Indiana Public Service Company's (NIPSCO's) request for technical assistance dated 13 August 2014 concerning the effects of NIPSCO's Oakdale Hydro Project on Endangered Species Act (ESA)-listed species under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS or Service).

Background

The Oakdale Dam is a hydroelectricity generating facility across the Tippecanoe River constructed in the 1920s and owned by NIPSCO. It is licensed by the Federal Energy Regulatory Commission (FERC). Along with its sister dam upstream (the Norway Dam), it impounds two in-line reservoirs, Lakes Shafer and Freeman. The presence of the Oakdale Dam and Norway Dam, including various operational protocols and certain regulatory constraints on the dams, can affect the volume of water and hydrograph of the Tippecanoe River downstream of the Oakdale Dam to its confluence with the Wabash River. Occasionally, the Tippecanoe watershed experiences drought conditions, which can lead to low water flow conditions in the Tippecanoe River.

Section 9(a)(1)(B) of the ESA, 16 U.S.C.§ 1538 (a)(1)(B), and 50 C.F.R. § 17.31, protect against the unlawful "take" of an endangered species. "Take" is defined by the ESA as to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct" 16 U.S.C. § 1532(19). Section 7(a)(2) of the ESA requires federal agencies to confer with the Secretary to ensure that their actions will not jeopardize the continued existence of or destroy or adversely modify the critical habitat of an endangered or threatened species. The ESA defines critical habitat as (i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of the ESA, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of ESA section 4, upon a determination by the Secretary that such areas are essential for the conservation of the species.

There are six ESA-listed mussels in the Tippecanoe River: clubshell (*Quadrula cylindrica*), fanshell (Cyprogenia stegaria), sheepnose (*Plethobasus cyphyus*), rayed bean (*Villosa fabalis*), snuffbox (*Epioblasma triquetra),* and rabbitsfoot (*Quadrula cylindrica cylindrica*) and an extensive along with a diverse community of other unlisted mussels extant in the approximately 18-mile reach between the Oakdale Dam and the confluence of the Tippecanoe and Wabash Rivers. ESA critical habitat has also been proposed for the rabbitsfoot mussel in the Tippecanoe River and is currently under review (Figure 1).

The influence of the Oakdale Dam on the Tippecanoe River manifest in at least two important ways with respect to mussels. First, low water may expose mussel habitat to vulnerable conditions, particularly during periods of sustained low precipitation. Second, a hydrograph measured downstream of the Oakdale Dam can be much different than one measured upstream. Specifically, there are swings in the amount of flow that are more frequent than the Service would expect under "natural" conditions. Fluctuations of several hundred cfs can occur (occasionally multiple times) within a 24-hour period. ESA-listed mussels are poorly adapted to this level of instability especially during low to moderate flows.

The Indiana Department of Natural Resources, Division of Fish and Wildlife (IDNR) and the Service documented mortality of listed mussels related to low flows in the Tippecanoe River, downstream of the Oakdale Dam in 2012 and a second mussel die-off in 2013. Rapid changes in flow, whether naturally occurring or induced by man, can affect mussels by reducing available habitat, by limiting flow refuges where mussels often occur[1], by causing mussels to be dislodged and transported to less suitable or ecological sink habitat, and by contributing to sediment in the river, which can interfere with reproduction and disrupt the parasitic stage of mussels. Low flows and rapid changes in flow effects can meet the definition of take (see above) including harm and kill.

The purpose of this TAL is to identify dam operational measures which the Service believes will, if implemented, create conditions for ESA-listed mussels sufficiently representative of natural run-of-the-river water flow so as to eliminate take of any ESA-listed mussel or adverse modification of critical habitat (should it be designated) due to the Oakdale Dam.

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[1] See Strayer, David L. 1999. Use of flow refuges by unionid mussels in rivers. *Journal of the North American Benthological Society* 18:4, pp.468-476

I Key Concepts

- ***Suitable habitat*** for mussels occurs in shallow (and deep) microhabitats of rivers. Suitable, but ***vulnerable habitat*** (shoals, riffles, and other shallow habitats) under "natural" conditions exist below a generally consistent minimum elevation and provide stable habitat for mussels except during unusually dry years. Best available data indicate flows of approximately 500 cfs, as measured at the USGS Delphi gauge, roughly define the boundary between stable but vulnerable mussel habitat and ***ephemeral habitat*** that is likely downstream of the Oakdale Dam.[2]

- In addition to minimum flows, a stable flow regime during low-moderate flow is necessary to avoid take of mussels or impacts to mussel habitat.[3]

- Run-of-the-river during abnormal low flow conditions will be defined differently from run-of-the-river for the Oakdale Dam under license from FERC during normal flow conditions. During abnormal low flow ("ALF") conditions, the Oakdale Dam will be managed to achieve run-of-the-river operations that are based on a flow regime downstream of the Oakdale Dam discounting the influence of the dams and reservoirs. It is based on best available data and science looking at flows and flow regime upstream of the dams to estimate downstream flows as described more fully in Section II below.

- Linear Scaling[4] is the approach the Service and NIPSCO have used for this TAL to determine an approximation of run-of-the-river during ALF conditions. In sum, the Service and NIPSCO used Linear Scaling to predict that in a comparatively homogenous watershed (i.e., one without large changes in elevation, large urban areas, or major differences in land cover) flow in sub-watersheds scale to one another linearly. Simply put, if the above conditions prevail, a point in a river where the watershed is twice the area will have twice the flow as a point in the river upstream where the watershed is half the area (Figure 2).[5]

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[2] The recommended numbers are based on several different sets of information. The information includes: observations and data gained during and immediately after the 2012 drought by IDNR and Service biologists; records of flows from the Oakdale Dam and the USGS gauges; time-lapse images at three vulnerable sites; observations by the IDNR mussel biologist and a Service biologist on the Tippecanoe River during 2013; observations made by NiSource/NIPSCO biologists, IDNR biologists, Service biologists and others during a trial of the ALF. See NIPSCO Submittal to FERC 20140430-5304 Attachment C: US Fish & Wildlife Service Response to FERC Data Request #2

[3] These low-flow periods often correspond to "active" periods for mussels (reproduction, dispersal, etc.)

[4] See Galster, J.C., et al. 2007. Effects of urbanization on watershed hydrology: the scaling of discharge with drainage area. *Geology* 34:9, pp. 713-716; and Galster, J.C. 2007. Natural and anthropogenic influences on the scaling of discharge with drainage area for multiple watersheds. *Geosphere* 3:4, pp. 260-271.

[5] In this case we have multiple USGS gauges on the Tippecanoe River, some above the influence of the dams and some below that provide us with years of accurate flow measurements. Knowing that the watershed area at the USGS Winamac gauge is very nearly half the size of the watershed at the USGS Oakdale gauge allows use of the USGS Winamac gauge data (above the influence of the dams) to predict what the flow downstream of the dam would be were the dams and lakes not influencing that flow.

- In periods of ALF, mussel mortality is a possibility despite the implementation of the ALF operating protocols described in Section II below, however, because the run-of-the-river operations implemented during ALF conditions replicates what would be expected if the dams and resevoirs were not in place, mussel mortality by definition would not be a take because it is not caused by the applicant.

II TAL Requirements / ALF Plan

Overview of ALF Plan

The applicant and Service have developed the below-detailed set of conservative dam operating protocols (the "ALF Plan") which will be implemented during periods of ALF to protect against any take of ESA-listed mussels on the Tippecanoe River below the Oakdale Dam. The ALF Plan involves two primary actions: 1) early recognition of ALF events potentially harmful to mussels that will trigger the temporary cessation of power generation at the Oakdale Dam; and 2) subsequent release of water from the Oakdale Dam during ALF events that best matches the run-of-the- river as defined for ALF conditions based on linear scaling from the USGS Winamac gauge (USGS gauge 03331753).[6] This matching of the scaled-up USGS Winamac gauge flows will continue until the USGS Winamac gauge again reaches a 24-hour average above 300 cfs.

In addition, to avoid large fluctuations in downstream flow when mussels are especially vulnerable to such changes, NIPSCO will preclude spikes (hourly readings) below 500 cfs as measured at the USGS Oakdale gauge (USGS Gauge 03332605) from occurring at anytime during normal flows.

Initiation and Close of ALF Plan Protocols

The ALF Plan will be initiated by the onset of an ALF event, which is defined as either:

a. 24-hour daily average of ≤ 300 cfs at the USGS Winamac gauge; or
b. 24-hour daily average ≤ 600 cfs at the USGS Oakdale gauge.

NIPSCO will check the USGS calculated and published 24-hour daily average for the previous day at both the USGS Oakdale and USGS Winamac gauges and determine whether or not an ALF event has begun. If an ALF event is identified, NIPSCO will implement the ALF Plan protocols immediately.

Use of the USGS Winamac gauge to determine when an ALF event begins is expected to provide NIPSCO sufficient lead time to implement the ALF Plan protocols to avoid take of ESA-listed or proposed mussels or adverse modification of critical habitat. Monitoring of the USGS Oakdale

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[6] Should another USGS gauge or other gauge of comparable reliability be installed on the Tippecanoe River downstream of the USGS Winamac gauge and a point upstream of the influence of Norway Dam, the Service and NIPSCO can mutually agree to amend the TAL to incorporate data from that gauge to supplement or replace data from the USGS Winamac gauge.

gauge will provide for the same protection of mussels and critical habitat should a dam operation action or problem (e.g., gate stuck closed) not associated with upstream weather reduce flows downstream of the dam.

An ALF event ends when the USGS calculated 24-hour daily average is > 300 cfs as measured at the USGS Winamac gauge and hourly readings at USGS Oakdale gauge read > 500 cfs. The ALF Plan protocols need not be continued once an ALF event ends. Use of the 300 cfs 24-hour daily average at the USGS Winamac gauge to determine when an ALF event ends is expected to ensure that flows have stabilized, signaling that operations can return to normal without causing any take.

For all ALF Plan protocols, USGS calculated and published 24-hour daily averages will be used.

Implementation of ALF Protocols

Protocol 1 – Recognizing Potential ALF Conditions and Ceasing Generation

NIPSCO will monitor flows at USGS Winamac and USGS Oakdale gauges. As flow is trending downward and approaching 300 cfs or 600 cfs, respectively, NIPSCO will implement the following steps to stop any generation at the Oakdale Dam facilities:

1. NIPSCO Operations will contact NIPSCO Generation Dispatch and inform them that all Oakdale units are being taken off line to comply with the ALF Plan.

2. NIPSCO Operations will adjust flood and trash gates in combination with stopping any operating unit to maintain a steady discharge flow

3. Discharge flow will be controlled using a combination of flood and trash gates to control USGS flows per TAL requirements (see Protocol 2).

4. When the USGS Winamac gauge 24 hour daily average is > 300 cfs, NIPSCO Operations may reestablish generation and adjust downstream flows in compliance with the FERC license.

These actions are expected to help reduce the large swings in flow out of Oakdale Dam because the Service believes that engaging the turbines affects the flow through the dam.

Protocol 2 – Water Release from Oakdale Dam Matching Run-of-the-River during ALF conditions.

1. Confirm that the 24-hour daily average at the USGS Winamac gauge is ≤ 300 cfs or the 24-hour daily average at the USGS Oakdale gauge is ≤ 600 cfs;
2. Calculate the 'run-of-the-river during ALF' discharge rate for the Oakdale Dam (1.9 times the flow of the previous 24-hour daily average flow measured at the USGS Winamac gauge);

3. Calculate maximum and minimum percent flow thresholds as specified in the TAL;

4. Adjust trash and flood gates in combination to match calculated flow;

5. Record hourly flow data at USGS Oakdale gauge and adjust trash and flood gates as needed to maintain flow within specified limits;

6. By monitoring the flows rates at USGS Winamac (24-hour daily average) and Oakdale gauges (hourly), determine when ALF period ends;

7. Then adjust flows from the NIPSCO Oakdale Dam to be in compliance with the then-current FERC license.

Flows will be maintained during ALF events as measured at the USGS Oakdale gauge that are at least 1.9 times the previous 24-hour daily average flow measured at the USGS Winamac gauge.[7]

Periodic Formal Review

The Service considers the protocols of this TAL to be preliminary in that such shall be re-evaluated after December of the first year that ALF Plan protocols are implemented. At the conclusion of that year, the Service will review implementation of the ALF Plan protocols described herein. Provided NIPSCO has complied with the requirements listed in this TAL and the process is working as expected (e.g., downstream flows are consistent with linear scaling predictions), the Service intends to subsequently issue a multi-year TAL. Upon issuance of a multi-year TAL, a formal review of the TAL will occur between the Service and NIPSCO four years from issuance, and subsequently every five years thereafter. This review will assess process, procedures, and compliance, and will use the best available data at the time of the review to evaluate the effectiveness of the ALF Plan on the federally listed mussels and their habitats downstream of the Oakdale Dam. It is the intention of the Service to reissue the TAL subsequent to the formal reviews provided the compliance record is satisfactory, mussels and their habitats (including critical habitat, should it be designated) remain protected, and NIPSCO requests reissuance. New information (e.g., delisting of species) could result in a review of the TAL in the interim.

III Compliance

Compliance with the ALF Plan will be defined as NIPSCO accomplishing each relevant item listed in (a), (b), (c), and (e) below during every ALF event and (d) below during normal flows.

[7] The previous 24-hour daily average is used because we estimate that there is on average an approximately 24-hour lag time between the USGS Winamac and Oakdale gauges. This is based on evaluation of flows during the summer of 2013 between the USGS Delphi gauge and three downstream cameras placed by the Service and NIPSCO to evaluate the impacts of various flows on mussels and mussel habitat.

a. ceasing electric power generation at the Oakdale Dam when the 24-hour daily average at the USGS Winamac gauge is $\leq$ 300 cfs or the 24-hour daily average at the USGS Oakdale gauge $\leq$ 600 cfs;
b. discharging 1.9 times the flow of the previous 24-hour daily average flow measured at the USGS Winamac gauge out of the Oakdale Dam as measured at the USGS Oakdale gauge;
c. continuing the ALF Plan protocols until the 24-hour daily average at the USGS Winamac gauge is > 300 cfs;
d. maintaining flow above 500 cfs as measured hourly at the USGS Oakdale gauge.
e. meeting all monitoring and reporting requirements (detailed below).

The Service recognizes that the ALF Plan protocols have not been previously implemented and there may be an initial period of training, calibrating equipment, etc.[8] In order to address mechanical and other challenges inherent in implementing new procedures, provisional compliance requirements may be adhered to by NIPSCO during the first ALF event.

The provisional compliance requirements are as follows:

a. Discharge from the Oakdale Dam will be a maximum of 15 percent above and 15 percent below 1.9 times the 24-hour daily average flow at the USGS Winamac gauge as measured at the USGS Oakdale gauge on Days 1 and 2. Discharge from the Oakdale Dam may exceed the target of 15 percent above 1.9 times the 24-hour daily average flow at the USGS Winamac gauge as measured at the USGS Oakdale gauge if required by operating emergencies beyond the control of NIPSCO, such as flood or abnormal high flow conditions (as defined in the FERC license), that may arise during the measurement period.
b. Discharge from the Oakdale Dam will be a maximum of 15 percent above and 10 percent below on Days 3 to 5. Discharge from the Oakdale Dam may exceed the target of 15 percent above 1.9 times the 24-hour daily average flow at the USGS Winamac gauge as measured at the USGS Oakdale gauge if required by operating emergencies beyond the control of NIPSCO, such as flood or abnormal high flow conditions (as defined in the FERC license), that may arise during the meaurement period.
c. Discharge from the Oakdale Dam will be a maximum of 15 percent above and 5 percent below for the remainder of the first ALF period. Discharge from the Oakdale Dam may exceed the target of 15 percent above 1.9 times the 24-hour daily average flow at the USGS Winamac gauge as measured at the USGS Oakdale gauge if required by operating emergencies beyond the control of NIPSCO, such as flood or abnormal high flow conditions (as defined in the FERC license), that may arise during the measurement period.

[8] Note that the Service expects NIPSCO to test the ALF Plan protocols prior to an ALF event if practical to avoid possible problems.

d. No more than three (3) spikes (hourly readings) below 500 cfs measured at the USGS Oakdale gauge can occur during the first six months after the TAL is issued.

If the first ALF event is brief (less than the five days of provisional compliance) NIPSCO may inform the Service and implement a second consecutive provisional period and still be in compliance.

If at the end of the first full ALF event (or two consecutive abbreviated periods) the provisional targets have not been met, the result will be a meeting between NIPSCO and the Service within two weeks to evaluate compliance problems. At that point, provided there are revised compliance procedures in place and both parties agree, another provisional period can be implemented during the next ALF event. If agreement cannot be reached on revised procedures, NIPSCO can temporarily remain in provisional compliance by releasing a minimum of 500 cfs from the Oakdale Dam as measured hourly at the USGS Oakdale gauge for one additional ALF event only while revised procedures are developed and a second provisional period is implemented. If agreement cannot be reached by the conclusion of the second full ALF event, NIPSCO and the Service will meet within one month and the Service will subsequently determine whether or not the TAL can remain in effect. Compliance other than during this (these) provisional period (s) will require maintaining flow within, and including, 15 percent above and 5 percent below 1.9 times the 24-hour daily average flow at the USGS Winamac gauge as measured at the USGS Oakdale gauge for every 24-hour period of every ALF event[9]. In addition, compliance will require flows be ≥ 500 cfs measured hourly at the USGS Oakdale gauge during normal river flows.The Service recognizes that third parties outside of NIPSCO's control may, from time to time, cause unanticipated water withdraws from the river downstream of the USGS Winamac gauge but upstream of the USGS Oakdale gauge, and those third party withdraws may result in flows at or below 600 cfs at the USGS Oakdale gauge notwithstanding a measured 24-hour daily average flow above 300 cfs at the USGS Winamac gauge. Compliance with the TAL does not include a requirement for NIPSCO to police third parties. Recognition of this, however, does not absolve NIPSCO of complying with the requirements of the TAL. The Service also recognizes that in the event of a flood or other operating emergency, NIPSCO will take actions necessary to protect the Oakdale Dam facilities and surrounding communities including, but not limited to, releasing water at a rate more than that specified above. The Service also recognizes that NIPSCO's existing FERC license requirements applicable to abnormal high flows do not employ a 24-hour average and therefore, NIPSCO may need to take action to release water at a rate higher than the rate specified above to comply with the requirements of Article 403 of the FERC license during abnormal high flow conditions.

[9] The Service recognizes that NIPSCO will need to rely on the USGS gauges as part of the compliance protocols. If the USGS gauges identified herein are not functioning properly or timely updates to the USGS websites are not made for any reason, the Service will not hold NIPSCO accountable for acting in good faith in accordance with data from USGS gauges. NIPSCO will use the NIPSCO gauges for compliance if it determines USGS gauges are not functioning properly. Under these circumstances, NIPSCO can also choose to coordinate with the Service.

IV Monitoring and Reporting

Monitoring

NIPSCO will monitor the USGS Winamac and USGS Oakdale gauges daily and download the USGS 24-hour daily average flows each day as defined above.

NIPSCO will also monitor the USGS Delphi gauge, NIPSCO Oakdale gauge, Freeman lake level, Dissolved O_2 levels, whether the Oakdale Dam generation is on/off, gate positions, and any changes made in operation.

The Service will oversee structured monitoring of a minimum of three sites downstream of the Oakdale Dam during the first four years of the TAL. The results of this study will be used as one component to assess the effectiveness of the TAL (ALF Plan protocols). IDNR will lead this effort in coordination with the Service and develop protocols specifically to assess federally listed mussels and any vulnerable mussel critical habitat designated downstream of the Oakdale Dam.[10]

Reporting

NIPSCO will provide an informal notice to the Service within three business days after the completion of an ALF event. In addition, NIPSCO will provide to the Service an Annual Report by 31 March of each project year detailing all of the ALF events that occurred during the prior calendar year. Reports will contain at minimum:

a. the beginning and end date of each ALF event;
b. the relevant USGS gauge readings including those used to determine the 24-hour daily averages;
c. the recorded 24-hour daily averages;
d. all measures that were implemented and when each began and ended;
e. any problems associated with implementation.
f. any deviations from ALF Plan protocols necessitated by emergency conditions as described above in this document.

By April 30 at the conclusion of each 5-Year TAL period, an in-person meeting between the Service and NIPSCO will occur to ensure that the TAL continues to be efficient and effective in avoiding take of federally listed mussels downstream of the Oakdale Dam.

V Determination

The Service has reviewed the information NIPSCO has provided regarding the presence of the aforementioned ESA-listed mussels and their habitat downstream of the Oakdale Dam, and the

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[10] Note that this is not compliance and will used by the Service and NIPSCO at the first 5-Year meeting to determine if revisions are needed to the TAL to ensure NIPSCO is avoiding take by properly implementing the TAL.

measures set forth under the ALF Plan that NIPSCO intends to implement to best avoid any potential take of such species and their habitat. Based on Service's review of this information, the ALF Plan including, measures to maintain natural run-of-the-river flows and preclude large swings in flow during low flow periods, will serve to address Service concerns with respect to take of federally-listed mussels in the Tippecanoe River downstream of the Oakdale Dam from adverse impacts associated with the Oakdale and Norway Dams. That is, compliance with the ALF Plan is anticipated to result in river conditions during ALF events sufficiently equivalent to those afforded by nature. Consequently, if operated in accordance with the ALF Plan, the Service will presume that the Oakdale Dam will not serve as a cause of any take of the downstream listed mussel population or habitat.

This office is not authorized to provide guidance in regards to the Service Office of Law Enforcement (OLE) investigative priorities involving federally listed species. However, we understand that OLE carries out its mission to protect ESA-listed species through investigation and enforcement, as well as by fostering relationships with individuals, companies, and industries that have taken effective steps to avoid take of listed species, and by encouraging others to implement measures to avoid take of listed species. It is not possible to absolve individuals or companies from liability for unpermitted takes of listed species, even if such takes occur despite the implementation of appropriate take avoidance measures. However, the Office of Law Enforcement focuses its enforcement resources on individuals and companies that take listed species without identifying and implementing all reasonable, prudent and effective measures to avoid such takes. As of this date, Bloomington Field Office concludes that the proposed project will not or is unlikely to result in take of ESA listed species and based on preliminary identification of critical habitat for rabbitsfoot mussels, would avoid adverse modification of critical habitat should it be designated for rabbitsfoot mussel. It will be necessary to evaluate this preliminary determination should designation of critical habitat occur.

Conclusion

We appreciate NIPSCO's efforts to coordinate with our office in determining what measures can be implemented to avoid take of any ESA-listed species or their habitat at the project site. Should new information become available, we request that NIPSCO promptly notify the Service. Please contact me at (812) 334-4261 or scott_pruitt@fws.gov if you have any questions.

Sincerely,

Scott E. Pruitt
Field Supervisor

Definitions

Ephemeral Habitat – for this TAL this is habitat that mussels may occupy, but that under natural run-of-the-river conditions would be exposed for periods of time in most years sufficient to kill virtually all mussels living there. Mussels may occupy this habitat opportunistically (e.g., mussels carried to higher elevation sites during high flows).

Suitable Habitat – for this TAL mussel habitat that under natural run-of-the-river conditions would remain sufficiently wet for multiple years to allow mussels to survive and permit growth, reproduction, and other aspects of mussel life history to be completed.

Vulnerable Habitat – for this TAL this is suitable mussel habitat occurring on higher elevation substrates within the Tippecanoe channel – these sites include shoals, bars, and shoreline edge. They are vulnerable because they are the first sites exposed as cfs and associated water level in the river drops. A number of the likely covered species (e.g., rayed bean, snuffbox, rabbitsfoot, and sheepnose) typically or often occupy these sites.

Figure 1 - Map of Unit RF26 of Proposed Critical Habitat for Rabbitsfoot Mussel

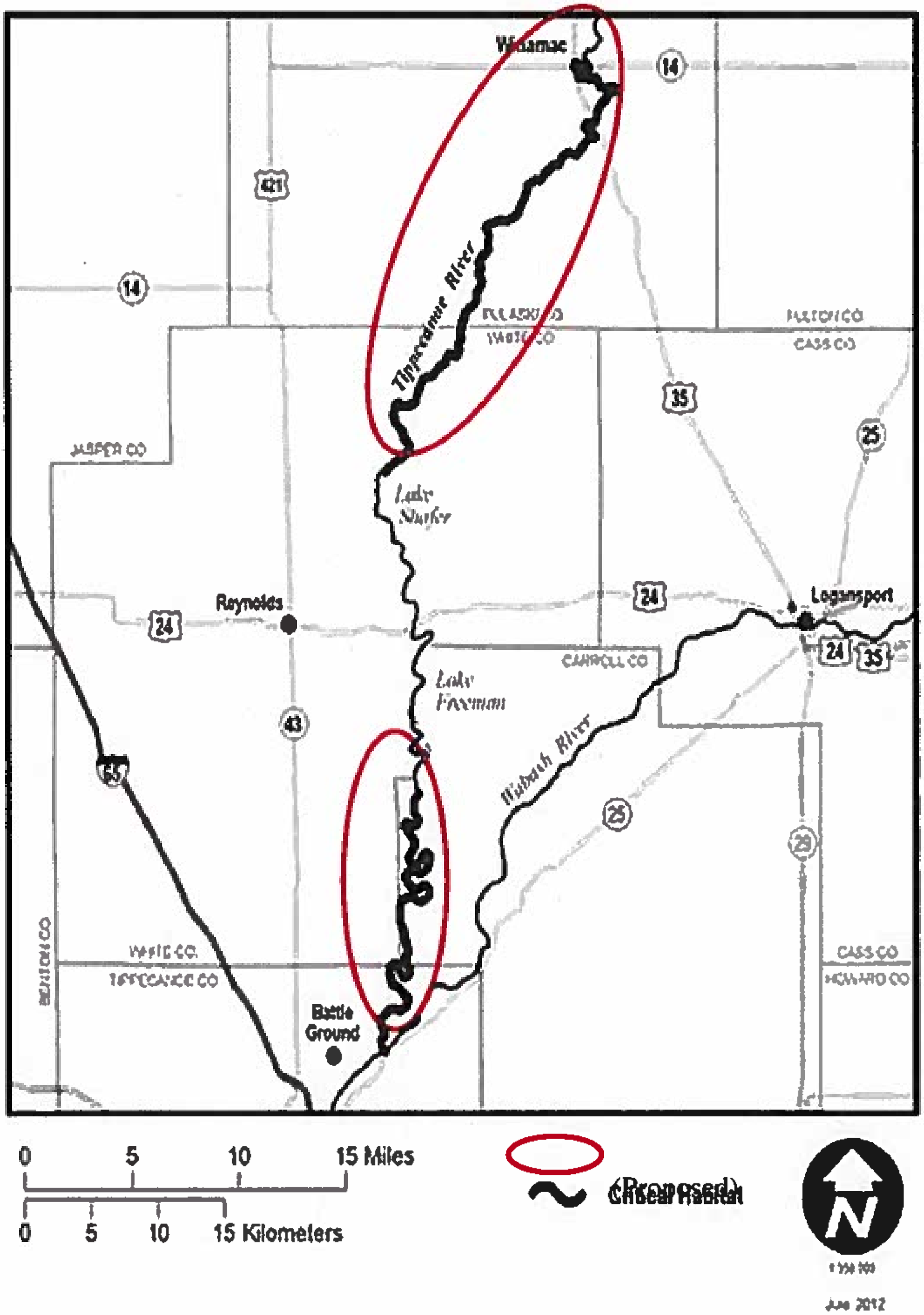
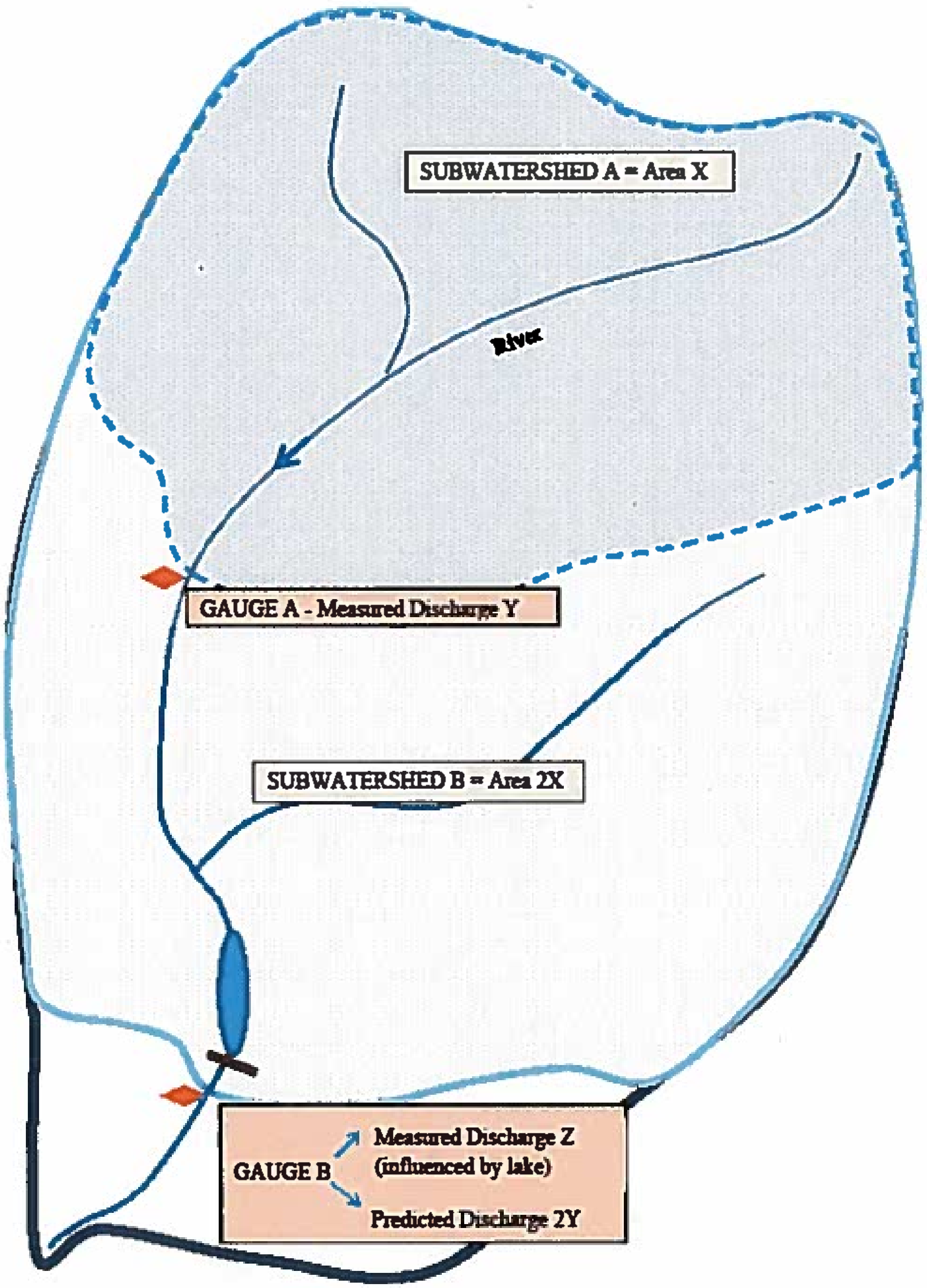


Figure 2 – Hypothetical Example of Linear Scaling



Oakdale TAL – Clarification Document A

1 TAL page 6, first paragraph after item #7 and page 7, compliance requirement "b" - minimum flow rates

Page 6 - Flows will be maintained during ALF events as measured at the USGS Oakdale gauge that are at least 1.9 times the previous 24-hour daily average flow measured at the USGS Winamac gauge.
Page 7 - b. discharging 1.9 times the flow of the previous 24-hour daily average flow.........

The Service agrees. The 2.0 was an artifact from early drafts before the exact ratio was identified. We recommend this change be formally made in the document at the one year review if still appropriate.

2 The requested clarification is that the "range' of 15% above and 5 to 15% below (TAL pages 7 and 8) is not referenced in these paragraphs. You concurred that the TAL should be interpreted to apply the range to the value calculated in these paragraphs.

The Service agrees that the 5% -15% “buffers” apply to regular and provisional implementation as appropriate. Note we are currently in the first partial ALF Event and provisional buffers apply.

3 TAL page 4. II TAL Requirements/ALF Plan, Initiation and Close of ALF Plan Protocols - use of 600 cfs at Oakdale as an ALF trigger

The ALF Plan will be initiated by the onset of an ALF event, which is defined as either:

a. 24-hour daily average of <= 300 cfs at the Winamac gauge; or
b. 24-hour daily average <= 600 cfs at the Oakdale gauge.

The requested clarification is that using 600 cfs as a trigger at the USGS Oakdale gauge to initiate an ALF event could cause a "loop" since the end of an ALF event is when Winamac is > 300 cfs and Oakdale need only be >500 cfs.

The clarification you provided is two-part. First, you confirmed that the 600 cfs at Oakdale should be interpreted as 570 cfs (1.9 x 300 cfs at Winamac). This interpretation will apply to all locations of "600 cfs" in the TAL.

The Service agrees, see previous clarification.

5 Secondly, you clarified that NIPSCO was reading the "600 at Oakdale" trigger in "b." out of context. The next two paragraphs provide narrative explaining that the Winamac gauge is the primary one and that " Use of the Winamac gauge to determine when an ALF event begins... " (emphasis added) is the requirement. "Monitoring of the USGS Oakdale gauge will provide for the same protection of mussels and critical habitat

CLARIFICATION B TO THE OAKDALE DAM TECHNICAL ASSISTANCE LETTER
Compliance Monitoring in Response to Malfunctioning Compliance Gauges

04-24-15

BACKGROUND

Compliance with the U.S. Fish and Wildlife Service (Service) technical assistance letter (TAL) relies on functioning United States Geological Survey (USGS) gauges that monitor flow in the Tippecanoe River. Section III (footnote 9) of the TAL contemplates circumstances when USGS gauges may be malfunctioning[i] or non-functional (used interchangeably hereafter) for unspecified reasons and generally discusses compliance when the USGS gauges are determined to be non-functional. The procedures outlined below are to be employed only for short periods. Additional coordination is required with the Service under this clarification to the TAL if USGS gauges used for compliance remain non-functional for more than 7 days during non-ALF conditions or after 48 hours during confirmed or suspected ALF conditions.[ii]

Although the USGS gauges are monitored and maintained in order to ensure reliability, there are various scenarios that could lead to temporary malfunctioning of one or more of the gauges. This clarification to the TAL establishes a process to identify and document incidents of gauge malfunction, and specifies actions by NIPSCO and the Service for NIPSCO to remain in compliance should these conditions arise.

Clarification B uses two criteria to establish gauge malfunction prior to implementation of the specific steps to remain in compliance during the non-functional period. Both should be documented before implementing actions under this clarification.[iii] One criterion is an observed marked inconsistency with previously recorded readings from the same gauge at approximately similar flows. The other criterion is to establish that there is some external or internal influence acting on a gauge, which could affect its reliable performance.

The following is a list of possible factors identified by NIPSCO and the Service in coordination with USGS that could affect the reliable performance of the USGS gauges in the Tippecanoe River. These are:

- ice or debris build-up under the gauge
- damage to the gauge by vandalism
- damage to the gauge by natural causes
- data transmission problems (loss of internet, delayed posting of data by USGS, offline USGS or NIPSCO website, or other documented data transmission problem that precludes or delays data from a gauge)

CLARIFICATION C TO THE OAKDALE DAM TECHNICAL ASSISTANCE LETTER

Revised Compliance when USGS Winamac Gauge Reads 264-300 cfs

07-31-15

BACKGROUND

Compliance with the U.S. Fish and Wildlife Service (Service) technical assistance letter (TAL) requires specific flow rates measured at the USGS Oakdale Gauge (Oakdale) during abnormal low flow (ALF) events, which are initiated when the USGS Winamac Gauge (Winamac) records a 24-hour average of 300 cfs or below. The TAL specifies that 24-hour average water discharge measured at Oakdale equal 1.9 x the 24-hour average flow measured at Winamac based on linear scaling between the two gauges. An artifact of defining ALF events as beginning at a 24-hour average of 300 cfs measured at Winamac is a window where compliance flows above 500 cfs are required.[1] This occurs when the 24-hour average at Winamac is between 300 cfs and 264 cfs inclusively. For example:

24-hour average at Winamac	Required 24-hour average at Oakdale
300 cfs	570 cfs
285 cfs	542 cfs
264 cfs	502 cfs

It is important that ALF events be defined so that procedures implemented under the TAL take effect before mussels are subject to take. The Service, however, has defined 500 cfs at Oakdale as the minimum flow threshold to avoid take. Therefore, flows measured at Oakdale above 500 cfs (see examples above) which would be required only under this specific circumstance are inefficient. In that circumstance, likely to occur at the beginning and end of longer or more severe ALF events, and over the course of short duration or moderate ALF events, NIPSCO will implement Clarification C.

PROCEDURES FOR COMPLIANCE WITH THE TAL WHEN THE 24-HOUR AVERAGE AT WINAMAC IS BETWEEN 264 CFS AND 300 CFS INCLUSIVELY

For that part of any ALF event when the 24-hour average flow at Winamac is between 300 cfs and 264 cfs inclusively, NIPSCO will flow water out of Oakdale Dam sufficient to meet the 500 cfs 24-hour average minimum measured at Oakdale in place of implementing the 1.9 x Winamac standard as documented in the TAL. All other TAL requirements (e.g., halting generation) will remain unchanged and must follow procedures documented in the TAL for the duration of the

[1] The Service/NIPSCO evaluation of the 2014 ALF events done as part of the TAL revealed that moderate or short duration ALF events can transpire entirely within this range.

ALF event as defined in the TAL. During an ALF event or part of any ALF event when the 24-hour average at Winamac is between 300 cfs and 264 cfs inclusively, the operating buffers of 15% above and 5% below the required minimum will be applied to the 500 cfs 24-hour average the same as if the flow were 1.9x Winamac as defined in the TAL.

PROCEDURES FOR COMPLIANCE WITH THE TAL WHEN THE 24-HOUR AVERAGE AT WINAMAC IS BELOW 264 CFS

When the 24-hour average at Winamac falls below 264 cfs, NIPSCO will follow the 1.9 x Winamac standard documented in the TAL until such time as the ALF event ends (implement non-ALF requirements) or the 24-hour average flows at Winamac are again between 264 cfs and 300 cfs inclusively (implement Clarification C).

Other factors affecting the reliability of the gauges are possible. NIPSCO must coordinate with the Service should it suspect a factor (s) not on the aforementioned list is causing gauge malfunction.

PROCEDURES FOR ALTERNATE TIPPECANOE FLOW MEASUREMENT IN ALF CONDITIONS

Step 1

Document and make a determination that USGS gauges are malfunctioning using both criteria outlined above.[iv] Specifically, document at least one 24-hour period of suspect gauge readings and verify the occurrence of one or more of the factors specified above affecting the suspect gauge (e.g., ice or debris build-up under a gauge).

Step 2

Notify the Service by phone or email that such conditions have arisen and that NIPSCO is assessing gauge reliability and may initiate alternate compliance monitoring measures, and

Step 3

Contact USGS to report suspected problems with their gauge (s).

Step 4

Begin alternative compliance monitoring following the steps outlined below beginning in the next 24-hour cycle.

Step 5

If the Winamac USGS Gauge is documented non-functional because of one or more of the factors listed in Clarification B, use Oakdale USGS Gauge as the sole gauge for compliance monitoring and, as necessary, solicit guidance from USFWS on adequate flow amounts required for compliance with the TAL

Step 6

If the Oakdale USGS Gauge is non-functional because of one or more of the factors listed in Clarification B (or both USGS Oakdale and Winamac Gauges are non-functional), use NIPSCO Oakdale Gauge for compliance, using guidance from USFWS on adequate flow required for TAL compliance; and[v] use visual observation of flow out of Oakdale Dam to support approximate minimum required flows.[vi]

Step 7

If none of the accepted gauges for compliance (USGS Oakdale and Winamac and NIPSCO Oakdale) are determined to be functional because of one or more of the factors listed in Clarification B, solicit guidance from USFWS on adequate flow amounts required for compliance with the TAL,[vii] and use visual observation of flow out of Oakdale Dam to document approximate minimum required flows; and[viii], provide compliance photos documenting approximate minimum flows to the Service via email within 15 hours of initiating compliance by visual observation of flow.

PROCEDURES FOR EXITING USE OF ALTERNATE TIPPECANOE FLOW MEASUREMENT IN ALF CONDITIONS

Step 1

NIPSCO independently evaluates the determination by documenting gauge readings consistent with known functional gauge readings at approximately similar flows, and

Step 2

NIPSCO supports its determination by confirming that the factor (s) presumed to be causing the malfunction are no longer influencing the gauge, and

Step 3

NIPSCO in consultation with USGS makes a determination that the USGS compliance gauges are again functional, and

Step 4

NIPSCO informs the Service that standard compliance measures are again being used within 24 hours, and

Step 5

Within 5 business days, provide a brief summary of the alternate compliance monitoring measures event (i.e., duration, what measures were used, problems with compliance, etc.).

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[i] Malfunctioning or non-functional for purposes of this clarification to the Oakdale TAL means either completely off-line, or based on criteria established here or other documented reasons, suspected of inaccurate readings. Conversely, functional means consistent with past readings in the absence of factors suggesting gauge failure.

[ii] Suspected is used here because depending on conditions when gauges malfunction, NIPSCO might not be able to determine with certainty whether or not ALF conditions exist.

[iii] This is to avoid misinterpreting and acting on unusual or unexpected readings that may be accurate.

[iv] If it is not feasible or necessary to document both to determine gauge malfunction, NIPSCO will explain the reasons in the subsequent report to the Service on the alternate compliance procedures.

[v] The NIPSCO Oakdale Gauge monitors flow differently from the USGS Gauges which may result in NIPSCO gauges functioning as an acceptable short-term alternative to the USGS gauges.

[vi] NIPSCO will provide reference photos of the tail race area from multiple angles at approximately 500 cfs, which will be available and used as reference images. These will include the flow in relation to a permanent marker proximate to the downstream side of the dam that facilitates estimation of 500 cfs flows.

[vii] As of the date of issuance of this clarification to the Oakdale TAL no other gauge (e.g., NIPSCO Buffalo Gauge) is approved for compliance monitoring.

[viii] NIPSCO can remain in compliance for a maximum of 72 hours using the visual observation measures discussed in this amendment without receiving confirmation from the USFWS in response to NIPSCO's required contact.

should a dam operation action or problem (e.g., gate stuck closed) not associated with upstream weather..." (emphasis added) is only in case of a problem, not to be routinely or jointly used.

Thus, the clarification is that the trigger for an ALF event is flow <= 300 cfs on a 24-hour daily average basis at Winamac unless there is a problem with the Winamac gauge or facilities at Oakdale.

The Service agrees, the interpretation outlined here above is correct.

6 During the ALF period, the 24-hour daily average flow at Oakdale must be 1.9 x Winamac (24-hour daily average), +/- the prescribed percentages. The ALF event ends when Winamac is flowing >300 cfs (24-hour daily average). Minimum flow at Oakdale outside of an ALF period is 500 cfs (hourly).

The Service makes a minor clarification here. The ALF event ends when Winamac is flowing > 300 cfs <u>and</u> the hourly flow measured at Oakdale USGS is ≥ 500 cfs. At the end of every 24-hour daily period (midnight to 11:59:59 pm), the 24-hour Winamac average is calculated. Flow as measured at the Oakdale Gauge must move quickly (technically within the hour if an ALF event has ended) to the new required flow rate – either matching run-of-the-river or non-ALF.

7 Finally, we discussed the required 500 cfs minimum (hourly) flow at Oakdale during normal flows as the subject has come up numerous times. You confirmed that the flow requirement at Oakdale during an ALF event could be more than 500 cfs (24-hour), for example when Winamac is at 299, Oakdale must be 568 csf (24-hour), plus or minus the range clarified above. The flow requirement outside of an ALF event is >=500 cfs at Oakdale (hourly). You acknowledged there is a little conservatism built into the flow rate during ALF periods as compared to normal river conditions.

Yes, this is correct. The threshold for entering and ALF event, when "natural" run-of-the-river flow is initiated, begins at 300 cfs at Winamac rather than 263 cfs at Winamac (1.9 x 263 ≈ 500 cfs) to provide some buffer around the 500 cfs minimum estimate. Therefore, readings at Winamac USGS between 300 cfs and 264 cfs, require flows at Oakdale above 500 cfs.

8 We also discussed a fairly real example of a requirement to flow 570 cfs (24 hour) at Oakdale today, assuming flow at Winamac yesterday was 300 cfs and rising such that it was the last day of the ALF event. If such were to occur, NIPSCO could be flowing, for example, 525 cfs (24-hour) at Oakdale tomorrow, using the remaining flow to help raise the lake level. You agreed that could happen, was allowable under the TAL, and actually expected that we would maintain Oakdale flows close to 500 cfs (hourly) if needed to raise the lake level after an ALF event.

The Service agrees. This is essentially the same scenario discussed above. For example, if the 24-hour average daily flow as calculated at 11:59:59 at Winamac is 400 cfs (e.g., flows rising from 250 cfs to 500 cfs over the 24-hour period), the required flow at Oakdale USGS for the next day (beginning at midnight) would be ≥ 500 cfs not 760 cfs (1.9 x 400 cfs).

Appendix 3 – Lake Freeman Level During the 1988 Drought

	OAKDALE DAM 1988 HISTORICAL DATA				
Date	Discharge	Generation	Lake Level	Target*	Difference
6/1/1988	668	3.784	610.34	610.35	0.01
6/2/1988	407	3.682	610.3	610.35	0.05
6/3/1988	688	4.852	610.35	610.35	0.00
6/4/1988	405	1.652	610.34	610.35	0.01
6/5/1988	668	5.707	610.37	610.35	-0.02
6/6/1988	488	3.75	610.35	610.35	0.00
6/7/1988	362	5.041	610.34	610.35	0.01
6/8/1988	594	4.678	610.37	610.35	-0.02
6/9/1988	360	5.115	610.32	610.35	0.03
6/10/1988	438	4.267	610.43	610.35	-0.08
6/11/1988	522	4.267	610.43	610.35	-0.08
6/12/1988	612	4.239	610.43	610.35	-0.08
6/13/1988	374	3.653	610.37	610.35	-0.02
6/14/1988	394	4.385	610.37	610.35	-0.02
6/15/1988	400	3.76	610.38	610.35	-0.03
6/16/1988	414	4.392	610.41	610.35	-0.06
6/17/1988	452	3.659	610.4	610.35	-0.05
6/18/1988	280	1.286	610.34	610.35	0.01
6/19/1988	350	3.365	610.4	610.35	-0.05
6/20/1988	588	4.419	610.37	610.35	-0.02

Appendix 6 – Low Flow Events

Winamac Predicted from Ora 1945 -2001

Year	Event #	Date Range	Event Length (days)	# Events*	Total Days	Percentage	Summers W/O Event
1945	NA	NA	NA	0	0	0	1
1946	1	7/16 to 10/31	108	1	108	71	
1947	1	8/4 to 8/25	22	1	22	14	
1948	1	8/2 to 8/3	2	3	84	55	
	2	8/6 to 8/11	6				
	3	8/17 to 10/31	76				
1949	1	8/8 to 10/5	59	1	59	39	
1950	1	10/30 to 10/31	2	1	2	1	
1951	NA	NA	NA	0	0	0	1
1952	1	9/10 to 9/14	5	1	5	3	
1953	1	7/12 to 8/3	24	2	111	73	
	2	8/6 to 10/31	87				
1954	1	8/15 to 8/16	2	2	29	19	
	2	9/6 to 10/2	27				
1955	1	6/30 to 7/4	5	4	63	41	

	2	7/13 to 7/14	2				
	3	7/26 to 7/28	3				
	4	8/14 to 10/5	53				
1956	1	8/6 to 8/14	9	2	68	45	
	2	9/3 to 10/31	59				
1957	1	8/6 to 9/21	47	3	71	47	
	2	9/25 to 10/16	22				
	3	10/21 to 10/22	2				
1958	1	6/1 to 6/7	7	1	7	5	
1959	1	8/12 to 9/27	47	1			
1960	1	9/8 to 9/12	5	3	32	21	
	2	10/3 to 10/9	7				
	3	10/12 to 10/31	20				
1961	NA	NA	NA	0	0	0	1
1962	1	7/17 to 10/20	96	2	98	64	
	2	10/30 to 10/31	2				
1963	1	6/5 to 6/7	3	3	102	67	
	2	6/22 to 7/14	23				
	3	8/17 to 10/31	76				

1964	1	6/1 to 6/14	14	3	116	76
	2	6/29 to 7/7	9			
	3	7/31 to 10/31	93			
1965	1	7/15 to 7/16	2	3	22	14
	2	7/27 to 8/9	14			
	3	8/22 to 8/27	6			
1966	1	6/27 to 7/13	17	2	119	78
	2	7/22 to 10/31	102			
1967	1	7/21 to 7/26	6	2	86	57
	2	7/29 to 10/16	80			
1968	1	8/14 to 8/15	2	4	27	18
	2	9/8 to 9/18	11			
	3	9/29 to 10/10	12			
	4	10/16 to 10/17	2			
1969	1	8/24 to 9/18	26	2	47	31
	2	9/21 to 10/11	21			
1970	1	8/9 to 8/21	13	2	22	14
	2	8/27 to 9/4	9			
1971	1	6/26 to 7/10	15	4	105	69

	2	7/17 to 9/6	52				
	3	9/11 to 9/26	16				
	4	10/1 to 10/22	22				
1972	NA	NA	NA	0	0	0	1
1973	1	9/7 to 9/29	23	2	37	24	
	2	10/18 to 10/31	14				
1974	1	8/7 to 9/12	37	2	82	54	
	2	9/17 to 10/31	45				
1975	1	10/16 to 10/17	2	1	2	1	
1976	1	8/20 to 10/6	48	2	69	45	
	2	10/11 to 10/31	21				
1977	1	6/23 to 6/29	7	2	21	14	
	2	7/25 to 8/6	14				
1978	1	7/20 to 7/24	5	2	101	66	
	2	7/28 to 10/31	96				
1979	1	7/11 to 7/30	20	3	76	50	
	2	9/3 to 10/24	52				
	3	10/28 to 10/31	4				
1980	1	7/19 to 7/27	9	2	16	11	

	2	8/4 to 8/10	7				
1981	NA	NA	NA	0	0	0	1
1982	1	8/16 to 9/20	36	3	73	48	
	2	9/23 to 10/19	27				
	3	10/22 to10/31	10				
1983	1	8/4 to 10/21	79	1	79	52	
1984	1	8/19 to 10/8	51	1	51	34	
1985	1	7/17 to 8/13	28	3	76	50	
	2	8/25 to 9/10	17				
	3	9/14 to 10/14	31				
1986	1	9/6 to 9/11	6	1	6	4	
1987	1	7/26 to 7/27	2	4	14	9	
	2	8/16 to 8/18	3				
	3	8/21 to 8/25	5				
	4	9/25 to 9/28	4				
1988	1	6/9 to 10/18	132	1	132	87	
1989	1	7/10 to 7/11	2	4	54	36	
	2	8/4 to 8/24	21				
	3	8/27 to 8/31	5				

	4	9/26 to 10/21	26				
1990	NA	NA	NA	0	0	0	1
1991	1	7/24 to 8/8	16	4	73	48	
	2	8/12 to 8/19	8				
	3	8/23 to 10/4	43				
	4	10/10 to 10/15	6				
1992	1	8/24 to 8/27	4	1	4	3	
1993	NA	NA	NA	0	0	0	1
1994	1	8/28 to 10/31	65	1	65	43	
1995	1	8/27 to 10/29	64	1	64	42	
1996	NA	NA	NA	0	0	0	1
1997	NA	NA	NA	0	0	0	1
1998	NA	NA	NA	0	0	0	1
1999	1	7/16 to 8/1	17	2	105	69	
	2	8/5 to 10/31	88				
2000	NA	NA	NA	0	0	0	1
2001	1	10/1 to 10/3	3	1	3	2	
AVG/TOT	**1.7**		**27.4**	**1.7**	**46.6**	**30.6**	**11**

Winamac Data 2002 -2016

Year	Event #	Date Range	Event Length (days)	# of Events	Total Days	Percentage	Summers W/O Event
2002	1	7/25 to 7/28	4	3	82	54	
	2	8/8 to 8/18	11				
	3	8/26 to 10/31	67				
2003	1	6/30 to 7/4	5	2	14	9	
	2	8/21 to 8/29	9				
2004	NA	NA	NA	0	0	0	1
2005	1	7/6 to 7/18	13	3	100	66	
	2	8/2 to 8/14	13				
	3	8/19 to 10/31	74				
2006	NA	NA	NA	0	0	0	1
2007	1	7/9 to 7/19	11	3	40	26	
	2	8/3 to 8/8	6				
	3	9/25 to 10/17	23				
2008	1	8/27 to 9/12	17	1	17	11	
2009	NA	NA	NA	0	0	0	1

2010	1	8/20 to 9/3	15	2	69	45	
	2	9/8 to 10/31	54				
2011	1	8/29 to 9/4	7	2	21	14	
	2	9/11 to 9/24	14				
2012	1	6/7 to 10/21	137	2	144	95	
	2	10/25 to 10/31	7				
2013	1	9/4 to 9/19	16	3	39	26	
	2	9/27 to 10/5	9				
	3	10/17 to 10/30	14				
2014	1	8/8 to 8/11	4	2	6	4	
	2	8/19 to 8/20	2				
2015	1	10/20 to 10/26	7	1	7	5	
2016	1	8/5 to 8/15	11	1	11	7	
AVG/TOT	**1.8**		**25.8**	**1.7**	**36.7**	**24.1**	**3**

* An event is defined as < 300 cfs at Winamac for at least two consecutive days with no more than one consecutive higher flow day (extrapolated from Ora data using linear scaling multiplier for Years from 1945 until 1986) for the period June 1 to October 31 each year.

6/21/1988	278	1.279	610.33	610.35	0.02
6/22/1988	379	3.797	610.46	610.35	-0.11
6/23/1988	477	4.312	610.32	610.35	0.03
6/24/1988	284	1.247	610.36	610.35	-0.01
6/25/1988	441	3.803	610.39	610.35	-0.04
6/26/1988	278	1.172	610.33	610.35	0.02
6/27/1988	283	1.173	610.36	610.35	-0.01
6/28/1988	285	1.184	610.37	610.35	-0.02
6/29/1988	372	3.607	610.43	610.35	-0.08
6/30/1988	333	3.663	610.42	610.35	-0.07
7/1/1988	443	4.298	610.32	610.35	0.03
7/2/1988	265	1.114	610.25	610.35	0.10
7/3/1988	274	1.136	610.31	610.35	0.04
7/4/1988	377	4.315	610.32	610.35	0.03
7/5/1988	374	4.334	610.23	610.35	0.12
7/6/1988	249	1.27	610.21	610.35	0.14
7/7/1988	264	1.207	610.24	610.35	0.11
7/8/1988	264	1.222	610.24	610.35	0.11
7/9/1988	266	1.198	610.26	610.35	0.09
7/10/1988	273	1.179	610.31	610.35	0.04
7/11/1988	442	4.316	610.38	610.35	-0.03
7/12/1988	278	1.193	610.33	610.35	0.02
7/13/1988	409	4.297	610.44	610.35	-0.09
7/14/1988	320	4.286	610.4	610.35	-0.05
7/15/1988	363	3.775	610.42	610.35	-0.07

7/16/1988	395	4.819	610.37	610.35	-0.02
7/17/1988	280	1.254	610.34	610.35	0.01
7/18/1988	415	3.759	610.37	610.35	-0.02
7/19/1988	274	1.254	610.31	610.35	0.04
7/20/1988	281	1.159	610.35	610.35	0.00
7/21/1988	444	3.692	610.41	610.35	-0.06
7/22/1988	350	3.669	610.41	610.35	-0.06
7/23/1988	491	3.714	610.43	610.35	-0.08
7/24/1988	266	2.546	610.25	610.35	0.10
7/25/1988	271	1.195	610.29	610.35	0.06
7/26/1988	284	1.194	610.37	610.35	-0.02
7/27/1988	278	1.186	610.33	610.35	0.02
7/28/1988	283	1.252	610.36	610.35	-0.01
7/29/1988	276	1.265	610.33	610.35	0.02
7/30/1988	281	1.232	610.32	610.35	0.03
7/31/1988	285	1.244	610.36	610.35	-0.01
8/1/1988	275	1.284	610.32	610.35	0.03
8/2/1988	269	1.267	610.27	610.35	0.08
8/3/1988	264	1.266	610.23	610.35	0.12
8/4/1988	223	1.203	610.26	610.35	0.09
8/5/1988	270	1.166	610.33	610.35	0.02
8/6/1988	491	3.667	610.44	610.35	-0.09
8/7/1988	218	0	610.42	610.35	-0.07
8/8/1988	404	4.697	610.47	610.35	-0.12
8/9/1988	375	1.22	610.43	610.35	-0.08

8/10/1988	541	5	611	610.35	-0.65
8/11/1988	220	1.081	610.29	610.35	0.06
8/12/1988	262	1.129	610.43	610.35	-0.08
8/13/1988	419	4.656	610.48	610.35	-0.13
8/14/1988	250	1.054	610.36	610.35	-0.01
8/15/1988	258	1.054	610.39	610.35	-0.04
8/16/1988	270	1.07	610.44	610.35	-0.09
8/17/1988	271	1.089	610.45	610.35	-0.10
8/18/1988	261	2.526	610.4	610.35	-0.05
8/19/1988	390	4.292	610.43	610.35	-0.08
8/20/1988	254	0.473	610.37	610.35	-0.02
8/21/1988	321	3.996	610.28	610.35	0.07
8/22/1988	239	432	610.28	610.35	0.07
8/23/1988	311	4.531	610.36	610.35	-0.01
8/24/1988	262	0.473	610.41	610.35	-0.06
8/25/1988	354	3.945	610.35	610.35	0.00
8/26/1988	268	0.407	610.26	610.35	0.09
8/27/1988	265	0.323	610.25	610.35	0.10
8/28/1988	274	0.361	610.3	610.35	0.05
8/29/1988	277	0.412	610.33	610.35	0.02
8/30/1988	279	0.441	610.34	610.35	0.01
8/31/1988	288	0.447	610.39	610.35	-0.04
9/1/1988	292	0.414	610.39	610.35	-0.04
9/2/1988	286	0.387	610.36	610.35	-0.01
9/3/1988	421	3.943	610.41	610.35	-0.06

9/4/1988	299	0.747	610.36	610.35	-0.01
9/5/1988	378	3.91	610.28	610.35	0.07
9/6/1988	244	0.377	610.32	610.35	0.03
9/7/1988	271	0.4	610.45	610.35	-0.10
9/8/1988	454	4.032	610.47	610.35	-0.12
9/9/1988	405	4.063	610.45	610.35	-0.10
9/10/1988	356	3.922	610.31	610.35	0.04
9/11/1988	260	0.374	610.38	610.35	-0.03
9/12/1988	396	3.931	610.4	610.35	-0.05
9/13/1988	270	0.361	610.44	610.35	-0.09
9/14/1988	277	0.414	610.47	610.35	-0.12
9/15/1988	274	0.458	610.45	610.35	-0.10
9/16/1988	359	5.084	610.49	610.35	-0.14
9/17/1988	418	5.132	610.38	610.35	-0.03
9/18/1988	248	0.98	610.33	610.35	0.02
9/19/1988	448	5.043	610.32	610.35	0.03
9/20/1988	245	1.024	610.33	610.35	0.02
9/21/1988	430	4.195	610.34	610.35	0.01
9/22/1988	264	3.398	610.28	610.35	0.07
9/23/1988	394	3.733	610.4	610.35	-0.05
9/24/1988	253	1.079	610.36	610.35	-0.01
9/25/1988	364	3.688	610.41	610.35	-0.06
9/26/1988	263	1.041	610.38	610.35	-0.03
9/27/1988	275	1.043	610.45	610.35	-0.10
9/28/1988	505	4.011	610.36	610.35	-0.01

9/29/1988	232	1.024	610.24	610.35	0.11

* The Oakdale/Lake Freeman FERC Operating Target is 610.35 (Normal) with an allowable range of 610.10 - 611.10.