

## 2023 Proposal Form for NorthWestern Energy (NWE) Project 2188 TAC Funds

Project 2188 (Madison-Missouri River) License Protection, Mitigation and Enhancement (PM&E) projects are required to offset impacts to river resources from the continued operation of one or more of NWE's nine hydro developments (Hebgen, Madison, Hauser, Holter, Black Eagle, Rainbow, Cochrane, Ryan and Morony Dams). PM&E projects need to be prioritized toward in-river or on-the-ground measures that directly benefit fisheries and/or wildlife populations and their habitats:

**Priority 1:** 2188 License projects which meet License Article requirements and PM&E for fisheries or wildlife populations or their habitats within the main stem Madison River (Hebgen Reservoir to Three Forks) or Missouri River (Hauser Reservoir to Fort Peck Reservoir)

**Priority 2:** 2188 License projects which meet License Article requirements and PM&E for fisheries or wildlife populations or their habitats in primary tributaries or on adjacent lands and, in doing so, provide PM&E for Madison River (Hebgen Reservoir to Three Forks) or Missouri River (Hauser Reservoir to Fort Peck Reservoir) resources.

**Priority 3:** 2188 License PM&E projects which meet License Article requirements by providing scientific or other tangible PM&E benefits to Madison-Missouri River fisheries or wildlife populations or their habitats. These projects must be located in the greater Missouri River drainage upstream from Fort Peck Reservoir, but not necessarily located on the main stem Madison River or Missouri River or their adjacent lands or primary tributaries.

### All TAC project proposals must include the following information:

Project Title: Blue Sucker Bomb <sup>14</sup>C Age Validation

Date: November 2, 2022

Explain how this Project addresses a specific Project 2188 License Article(s):

Article 417: 1) Protect and provide for the recovery of Threatened and Endangered species and other species of special concern in the Missouri River downstream of Morony Dam.

Provide justification for Priority 1, 2 or 3 (above) that you selected:

This study will address knowledge gaps related to episodic recruitment of a population of blue suckers that inhabit the Missouri River (Priority 1) and tributaries such as the Marias River, Teton River, and Judith River (Priority 2).

Project Sponsor (submitted by): Luke Holmquist, Biologist, FWP

Location of Proposed Project:

Narrative; Missouri River from Morony Dam to Fort Peck Reservoir; Lower Marias River (Below Tiber Dam); Lower Teton River

Geocode (in decimal degrees ex 46.89743)

Site: Morony Dam	Lat: 47.58159	Lon: -111.05972
Site: Tiber Dam	Lat: 47.58159	Lon: -111.09705
Site: Fort Peck Headwaters	Lat: 47.55384	Lon: -107.92449

Total Project Cost: \$25,000

**TAC Funds (Cost-Share) Requested for Project: \$25,000**

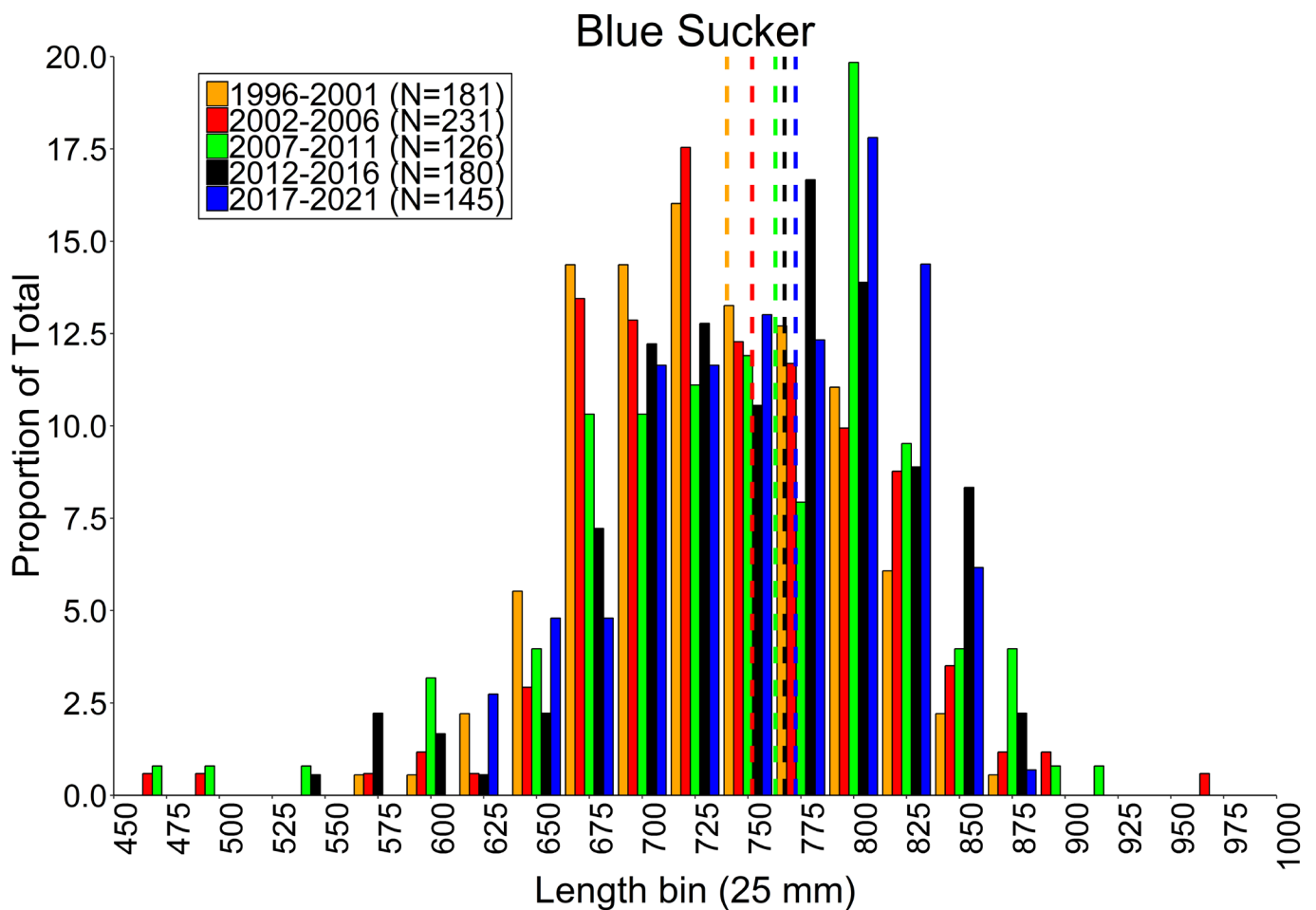
I. Introduction; brief statement of project to be completed with pertinent background information.

This pilot project aims to investigate blue sucker population trends by collecting specimens from the Middle Missouri River. We intend to sacrifice 20 blue suckers and will estimate age using the lapillus otoliths, and then corroborate ages using bomb radiocarbon (<sup>14</sup>C) dating, known as the most accurate age validation method of fishes.

The age structure of this species has slowly been shifting to the right — a systematic shift in length toward greater sizes — over the past 25 years (Figure 1), and blue suckers less than 650 mm in length are rarely encountered. These observations suggest that recruitment is limited and population decline is occurring with an ever increasing age structure and a potentially senescent population. The construction of large dams on the mainstem Missouri River and the larger tributaries have eliminated natural recruitment of other species, such as pallid sturgeon. This recruitment bottleneck is a result of altered flow and temperature regimes, in addition to habitat fragmentation, both of which have negatively impacted important life history

strategies. Similar recruitment bottlenecks may be occurring for blue sucker in this altered ecosystem. The major dams impacting this reach include Canyon Ferry above the study area on the Missouri River (completed in 1954), Tiber Dam above the study area on the Marias River (completed in 1956), and Fort Peck Dam and Reservoir below the study area (completed in 1940).

The age structure of the population has important implications for determining if recruitment has occurred in the period following dam construction and has the potential to aid managers in identifying years where environmental conditions were suitable for recruitment to occur, even after large scale alterations to the system. Such a result could provide a framework for restoring more consistent recruitment for this species or identify future research needs. Recent studies have estimated that blue sucker aging with hard structures other than lapillus otoliths are unreliable and typically underestimate the age of the individual (Radford et al. 2021) but have yet to be validated. Bomb radiocarbon dating is a state-of-the-art method of determining accurate age of fishes that relies on an isotope of carbon ( $^{14}\text{C}$ ) that was released into the atmosphere during the testing of thermonuclear bombs in the 1950s and 1960s. This signal is incorporated into the hard structures of fishes, such as otoliths, for which an inert record of environmental  $^{14}\text{C}$  is stored. The concentration of  $^{14}\text{C}$  in the atmosphere, and subsequently in aquatic ecosystems, is therefore present in otoliths as a time-specific marker that can indicate the year class of the individual, thereby validating or refuting age estimates obtained using traditional methods of counting annuli (growth rings) in otoliths. This approach was successful in describing a great longevity for bigmouth buffalo (>100 years) with episodic recruitment patterns that can be related to habitat alterations and climate changes (Lackmann et al. 2019, 2021).



**Figure 1. Blue Sucker length distribution for 5-year periods starting in the late 1996. Mean lengths are displayed by vertical dashed lines and have incrementally increased (740 mm [1996-2001], 752 mm [2002-2006], 763 mm [2007-2011], 767 mm [2012-2016], and 772 mm [2017-2021]) over the past 26 years.**

#### References Cited

Lackmann, A. R., Andrews, A. H., Butler, M. G., Bielak-Lackmann, E. S., & Clark, M. E. (2019). Bigmouth Buffalo *Ictiobus cyprinellus* sets freshwater teleost record as improved age analysis reveals centenarian longevity. *Communications biology*, 2(1), 1-14.

Lackmann, A. R., Kratz, B. J., Bielak-Lackmann, E. S., Jacobson, R. I., Sauer, D. J., Andrews, A. H., ... & Clark, M. E. (2021). Long-lived population demographics in a declining, vulnerable fishery—bigmouth buffalo (*Ictiobus cyprinellus*) of Jamestown Reservoir, North Dakota. *Canadian Journal of Fisheries and Aquatic Sciences*, 78(10), 1486-1496.

Radford, D. S., Lackmann, A. R., Moody-Carpenter, C. J., & Colombo, R. E. (2021). Comparison of four hard structures including otoliths for estimating age in Blue Suckers. *Transactions of the American Fisheries Society*, 150(4), 514-527.

II. Objectives; explicit statement(s) of what is intended to be accomplished.

Determine ages for 20 blue suckers from otolith sections and bomb <sup>14</sup>C dating and analyze for patterns of recruitment success or failure.

III. Methods; description of how Project objectives will be accomplished.

- Sample 20-25 blue suckers using electrofishing and trammel netting (FWP) representing as wide of a length range as possible.
- Remove lapillus and asteriscus otoliths from each individual (FWP with Dr. Lackmann advising).
- Record the whole otolith mass for each specimen (±0.0001 g).
  - Work done by Dr. Alec Lackmann (University of Minnesota, Duluth; [www.bigmouthbuffalo.org](http://www.bigmouthbuffalo.org))
- Process otoliths for traditional aging (Dr. Lackmann).
  - Use an isomet saw to cut thin cross sections (triplicate) of one otolith of each pair.
  - Mount wafers on slides and examine under compound microscope to estimate age from counting annuli.
  - Use three readers to age otoliths (blind) for independent cross section ages and corroboration of the age reading method.
- Use second otolith from each individual fish (select 15-20 fish based on lapillus otolith mass and estimated age) for bomb <sup>14</sup>C dating (Dr. Allen Andrews, University of Hawaii, Age and Longevity Research Lab; [www.astrofish.me](http://www.astrofish.me))
- Determine final ages from otolith sections and bomb <sup>14</sup>C dating and analyze for patterns of recruitment success or failure.
  - Determine if a larger sample size is needed.

IV. Schedule;

- Spring and Summer of 2023
  - FWP crew will collect otoliths from 20-25 blue suckers during monitoring work (NWE funded)
- Fall and Winter of 2023/2024
  - Age one lapillus otolith from each individual
    - Dr. Lackmann (UMN) will do the work
  - Ship second lapillus otolith to Dr. Andrews (UH) for micromilling and <sup>14</sup>C analyses
- Winter 2023/2024 and Spring of 2024
  - Dr. Andrews will extract a sample from the otolith core with a micromilling machine to generate <sup>14</sup>C values using accelerator mass spectrometry (gas-AMS), which will corroborate age reading for determination of the year-of-origin for each individual.

V. Personnel;

Project Leader: Luke Holmquist

-Dr. Allen Andrews – bomb radiocarbon aging work

-Dr. Alec Lackmann – otolith prep and traditional aging of lapillus and asteriscus otoliths

VI. Project budget must include amounts for the following:

Initial processing of otoliths (Dr. Alec Lackmann)

Weighing, cutting, mounting, photographing, and aging of up to 25 otoliths (\$200 each).....\$5,000  
-includes assistance with data analysis and manuscript writing

Bomb radiocarbon aging (Dr. Andrews)

Lab materials.....\$700

Micromilling and gas-AMS 20 otoliths (\$800 each).....\$16,000

Travel

Dr. Andrews travel to Montana for collaborative visit/presentation.....\$3,300

**TOTAL.....\$25,000**

**Total TAC funds requested: \$25,000**

VII. Deliverables; Final Report September 2024.

How will “success” for this project be monitored or demonstrated?

Ages generated from otolith sections using a well-documented method will be corroborated with measured <sup>14</sup>C values in relation to the bomb <sup>14</sup>C signal known to have occurred in freshwater systems of North America. Hatch year frequency and absence will be related to habitat, environmental conditions, and possibly climate conditions. This approach has been successful with several fishes of North America (e.g., bigmouth buffalo, alligator gar, lake trout, freshwater drum) that led to peer-reviewed publications, and we expect similar results. Results will be used to inform management decisions and future research regarding blue suckers in the Middle Missouri River.

VIII. Cultural Resources. No ground disturbance associated with this project.

IX. Water Rights. No wetland development associated with this project.