### Goals and management objectives for pallid sturgeon

In 2013, the USFWS (written com., September 12, 2013 [Draft Species Objectives, p. 1]) developed the following fundamental objective for pallid sturgeon in the Missouri River:

*Fundamental Objective: Avoid jeopardizing the continued existence of the pallid sturgeon from the U.S. Army Corps of Engineers actions on the Missouri River.*

The USFWS notes that this objective is consistent with species recovery goals (U.S. Fish and Wildlife Service, 2014) but specific to Missouri River management actions.

In 2013, the USFWS also proposed the following two sub‐objectives (both measurable), which must be attained to ultimately achieve the stated “fundamental objective”. The intent of the sub‐objectives is to provide direction in the short term, provide objectives meaningful for AM, and focus efforts on the desired short term outcomes while keeping the fundamental objective in mind. Although attaining a self-sustaining population is the desired outcome of the Revised Pallid Sturgeon Recovery Plan (USFWS 2014), described below under sub-objective 2, we may be decades away from such an objective being very meaningful. If natural recruitment were achieved in 10 years, it could take 20 to 30 years before progress toward the self‐sustaining population objective could be assessed. Modeling can give projections and insights into the probability of achieving the fundamental objective under proposed and implemented actions. The two sub-objectives provide guidance for the actions, monitoring and research required to support the fundamental objective over the longer term.

*Sub‐objective 1: Increase pallid sturgeon recruitment to age 1.*

**Metrics:** primary metric is catch rates of age 0 and age 1 pallid sturgeon; secondary metrics include model-based estimates of abundance of age 0 and age 1 pallid sturgeon, and the survival of hatchery and naturally reproducing fish to age 1.

**Target:** TBD. The short‐term target is to demonstrate measurable recruitment to age 1, and hopefully increasing levels of recruitment over time. Recruitment is emphasized in sub-objective 1 since wild-spawned young-of-year (YOY) or juvenile pallid sturgeon have not been captured in the Upper Missouri River upstream of Lake Sakakawea, and have been captured only rarely in the Lower Missouri River (Jacobson et al. 2016a). Until 2015, there had been no documented captures of genetically identified, wild-spawned pallid sturgeon free embryos, larvae, or YOY in the lower river (U.S. Fish and Wildlife Service, 2014). Recent data indicate that limited recruitment is happening in the Lower Missouri River, but not at a level sufficient to maintain the population (U.S. Fish and Wildlife Service, 2014; Jacobson et al. 2016a). Multiple factors can potentially be limiting recruitment (see Appendix B, Figures B.9, B.10 and B.11).

The long‐term target for recruitment (i.e. necessary levels and frequency of recruitment over time) will be informed by the EA (Jacobson et al., 2016a) and collaborative population model (Section 4.1.2.3 and Appendix D of this plan), following the necessary monitoring, model validation, and supporting research. Defining the long term target is not critical in the near-term as the immediate priority is to establish measurable recruitment. Possible targets could include a modeled egg to age-1 survival rates sufficient to result in growth and sustainable population size.

*Sub‐objective 2: Maintain or increase numbers of pallid sturgeon* as an interim measure *until sufficient and sustained natural recruitment occurs.*

**Metric:** Population estimates for pallid sturgeon for all size and age classes, particularly for ages 2 to 3 to assess recent trends in recruitment; catch rates of all pallid sturgeon by size class (to maintain legacy data). Age classes will be estimated as an output metric of the population model that will be validated through recaptures of tagged fish. There are challenges in quantifying a population size for age 2-3 year old pallid sturgeon as there is a lot of overlap in the lengths of fish aged 2 to 5 years. Further work is required to refine population metrics, which may include estimating a population size for a subset of the length frequency distribution.

**Target:** TBD. Possible targets could include: 1) positive population growth rates (i.e., lambda (λ) > 1) of pallid sturgeon age 2 and older; 2) estimated survival rates of all size/age classes sufficient to provide a stable population of pallid sturgeon age 2 and older; and 3) acceptable probabilities of persistence and recovery over a 50 to 100 year time frame (utilizing population models). For example, the Lower Missouri Framework (USFWS and USACE 2015) described two preliminary decision criteria for halting population augmentation: 1) when population monitoring demonstrates a self-sustaining population in excess of 5000 adult fish in each management unit; and 2) when the threat of extirpation is less than 5 percent in 50 years, or as based on new criteria introduced through the Basin-wide Stocking and Augmentation Plan. The criteria recommended in USFWS and USACE (2015) are similar to those in the Revised Recovery Plan for the Pallid Sturgeon for reclassifying pallid sturgeon from endangered to threatened status (UFSWS 2014, pg. 54):

“Pallid Sturgeon will be considered for reclassification from endangered to threatened when the listing/recovery factor criteria are sufficiently addressed such that a self-sustaining genetically diverse population of 5,000 adult Pallid Sturgeon is realized and maintained within each management unit for 2 generations (20-30 years). In this context, a self-sustaining population is described as a spawning population that results in sufficient recruitment of naturally-produced Pallid Sturgeon into the adult population at levels necessary to maintain a genetically diverse wild adult population in the absence of artificial population augmentation. Metrics suggested to define a minimally sufficient population would include incremental relative stock density of stock-to-quality-sized naturally produced fish (Shuman et al. 2006) being 50-85 over each 5-year sampling period, catch-per-unit-effort data indicative of a stable or increasing population, and survival rates of naturally produced juvenile Pallid Sturgeon (age 2+) equal to or exceeding those of the adults (see Justification for Population Criteria below [in USFWS 2014] for details). Additionally, in this context a genetically diverse population is defined as one in which the effective population size (Ne) is sufficient to maintain adaptive genetic variability into the foreseeable future (Ne ≥ 500), conserve localized adaptions, and preserve rare alleles.”

In addition to the fundamental objective and associated sub-objectives, there are a set of proposed actions to be implemented on the Missouri River, which are the means of achieving the fundamental objectives and sub-objectives. The timelines for these actions serve as a backstop to ensure that the rate of implementation of management actions on the Missouri River is not hindered by an inability to learn from applied science efforts. In effect, they define necessary levels of implementation at a point in time for each hypothesis, and must be met unless the learning from applied science efforts demonstrates that the in-river actions associated with that hypothesis are unnecessary.