**Targeted conservation investments: A strategic decision framework for floodplain dependent fishes in the Lower Mississippi River**

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**BACKGROUND AND INTRODUCTION**

Uncertainty has long obstructed conservation planning, decision making and limited management efforts for rare species, recreational fisheries, and entire landscapes (Gregory and Long 2009; Irwin et al. 2011; Conroy and Peterson 2013). Decision makers must select management actions from a diverse candidate pool (*e.g.,* restoring habitat, protecting areas, reducing anthropogenic mortality) without certain outcomes by weighing projected biological responses and implementation costs against associated doubt (Bannot et al. 2013; Tulloch et al. 2015; Roux et al. 2016; Smith et al. *in press*). Alternative management decisions force managers to consider numerous ecological trade-offs while navigating possible social and political pressures (Irwin et al. 2011). By critically examining decision alternatives, managers can best allocate limited resources to robust actions that minimize risk or are most likely to achieve management objectives given uncertainty (Joesph et al. 2009; Linke et al. 2011; Tulloch et al. 2015).

Structured decision-making (SDM) provides a framework to assess competing management alternatives using explicit measures of uncertainties and trade-offs (Gregory and Long 2009; Conroy and Peterson 2013). Numerous conservation initiatives have recognized the utility of SDM to simplify decision making, organize strategic action, and directly compare the effects of management on multiple species under various landscape change scenarios (Peterson and Evans 2003; Gregory and Long 2009; Miller et al. 2010; Bannot et al. 2013; Robinson et al. 2016). By deconstructing decision problems for deliberation and capturing important ecological and population processes and uncertainties, SDM can identify management strategies most likely to achieve the desires of key stakeholders (Harrison and Qureshi 2000; Conroy and Peterson 2013). This transparent modeling structure translates anticipated environmental change into population and/or community responses across space and time and offers strong governance when clear objectives and decision criteria are agreed upon by an engaged stakeholder group (Bonnot et al. 2011; Smith et al. *in press*).

The Lower Mississippi River (LMR) has been largely modified to facilitate navigation and commerce which has degraded water quality, habitat heterogeneity, and fish assemblage structure (Poff et al. 1997; Humphries et al. 2002; Remo et al. 2009; Phelps et al. 2015). Today, fewer floodplain areas are inundated less frequently in channelized reaches (Shields 1995; Remo et al. 2009; Schramm et al. 2015). Although charismatic fauna (*e.g.,* Alligator Gar *Atractosteus spatula*) are commonly associated with floodplain habitats, numerous other fishes, waterfowl, and wildlife rely on the availability of these wetlands (Buckmeier et al. 2013; Opperman et al. 2017). Widespread alterations to riparian areas and disruptions to river-floodplain connectivity have been implicated in the declines of Alligator Gar and other floodplain dependent fishes (Kluender et al. 2017). Because Alligator Gar and many other fishes depend on highly connected floodplain habitats for reproduction and flow refugia (Halls and Welcomme 2004; Pease et al. 2006; Zeug and Winemiller 2008), managers are interested in reopening secondary channels and reconnecting remote floodplain areas. A SDM approach has been proposed by the Gulf Coastal Plains & Ozarks (GCPO) Landscape Conservation Cooperative to identify areas to concentrate conservation investments and effective management strategies for available floodplains.

Populations of Alligator Gar and other lotic fishes are expected to benefit from management that increases floodplain habitats in vegetated lowland areas with little canopy cover. However, fishes are just one piece in the complex floodplain connectivity and management matrix that includes waterfowl, wildlife, invasive species, agriculture, commerce, and flood control (Bayley 1995). Assessments of management strategies that require habitat acquisition and modification rarely cross the aquatic-terrestrial riparian threshold, despite the potential to impact taxa from both environments (Tockner and Ward 1999; Terrado et al. 2016). By understanding the relative responsiveness of different taxa to proposed management actions, we can describe appropriate locations and trade-offs in strategies used to inundate and reconnect floodplain habitats. Although ecological improvements are probable, management must also consider anthropogenic uses of these valuable wetland areas.

**DECISION PROBLEM**

Access to floodplains by floodplain dependent fishes is limited by anthropogenic modifications of the lower Mississippi River. Modifications, in part, were done to prevent flooding of agricultural and private lands. Land acquisition by management agencies and other organizations can potentially increase floodplain habitat if river connectivity is restored. However, resources to acquire lands are finite and if multiple acquisitions opportunities exist then a framework to identify opportunities that maximize the likelihood of achieving stakeholder objectives are needed. For example, restoration of floodplain dependent fishes, with focus on Alligator Gar, in the Lower Mississippi River by identifying priority locations for future easements and describing best management practices for new properties and those currently in the GCPO conservation portfolio.Additionally, a framework to evaluate alternative restoration and management actions of existing and future land acquisitions in the context of stakeholder objectives is needed.

**TWO “NESTED” DECISION PROBLEMS**

1. **Targeted regional conservation investments**. Bannot et al. (2013) and others demonstrate the importance of strategic conservation efforts in areas that are most likely to achieve management objectives (Rodrigues et al. 2004; Suski and Cooke 2007; Copeland et al. 2013). The allocation of resources to randomly selected easements are expected to provide few improvements to target taxa or even result in “ecological traps” that harm sensitive populations of mobile animals (Donovan and Thompson 2001; Bannot et al. 2013). This analysis would focus on the size and distribution of floodplain habitats and could help establish important regions and configurations for future easement acquisitions.
2. **Sharing the floodplain**. Numerous floodplains are actively managed for other wildlife and various anthropogenic uses (*i.e.,* agriculture, recreational hunting, flood control). Existing refuges, wildlife management areas, and duck clubs are already able to manage floodplain habitats, primarily to benefit waterfowl. By balancing the needs of other wildlife (*e.g.,* waterfowl) with the expected responses fishes, managers may be able to obtain additional value from properties currently in the GCPO conservation portfolio. This analysis would focus on the timing and duration of floodplain inundation events and could describe management that benefits fishes and other wildlife within anthropogenic constraints.

**METHODS**

We will coordinate with GCPO staff and partners to prototype an adaptive decision framework that incorporates potential future changes into current aquatic management decisions. Key to development of this prototype will be identification of a core technical advisory team consisting of planners, managers, and researchers to represent the diversity of stakeholders within the GCPO (Miller et al. 2010; Irwin et al. 2011). The core team (*i.e.,* stakeholders) will help to additionally frame the problem, define objectives and measures of performance, and identify a set of competing conservation strategies for evaluation. We will facilitate meetings of the core team and develop a set of analytical tools (*e.g.,* species distribution models) that estimate the likelihood of success for each potential conservation strategy and evaluate trade-offs among decision alternatives (Gregory and Long 2009).

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