

FRAS_{ps}: a planning support tool for inland fisheries management

Need Statement

MDWFP monitors the fish habitat and fishery of nearly 300 lakes >10 ac totaling about 300,000 acres distributed throughout the state (Miranda et al. 2018). In addition, miles of streams and rivers contribute to state fisheries and receive various levels of monitoring attention. The goal of MDWFP's monitoring effort is to develop management plans specific for each water body. These plans establish long-term management direction, including a vision and a protocol for management of the water body. The plan identifies management objectives and actions implemented to achieve these objectives. Objectives and actions usually address identified problems and impairments associated with fish assemblages, fish habitat, facilities, and the angling public.

Developing a management plan involves merging recent monitoring data, historical information, scientific knowledge, system-specific knowledge, expert judgement, and lay wisdom. The extent to which these six elements influence the plan varies among plans and managers. We propose to develop an interactive support system to structure and regiment the construction of management plans. The system will combine these six elements in a guided computer assisted workflow. The data input screen will steer the user through a series of options determined by stated management goals to create a management plan that outlines existing problems, objectives, management actions, implementation, monitoring protocols, and outcome evaluation. Branching logic and decision analysis will enable managers to progress through adjustable data input screens. Similar systems are in use in the medical field to arrive at diagnoses and develop health management plans for individuals (Bond et al. 2012), but the proposed support system would be the first of its kind in fisheries management and accordingly preliminary.

The system will be implemented within MDWFP's Fisheries Resources Analysis System (FRAS) online platform. The proposed planning support (FRAS_{ps}) would open in a new browser window within FRAS.

Approach

Before building this tool we will inventory possible fishery management objectives and link them to specific fisheries management problems they address, the actions required to deal with the problems, and the monitoring protocols needed to evaluate the outcome of management interventions to address the problems. This would be a preliminary inventory, not exhaustive, but would allow the system address a large percentage of fishery management problems. We have already completed some of this task by compiling from about 70 MDWFP lake management plans a database of objectives and actions applied by MDWFP staff to attain desired habitat, fish, and fisher management goals. However, we want to expand our database by conducting a nationwide review to identify how fishery problems are addressed by other state fishery agencies.

Details

In 1986 MDWFP initiated a standardized monitoring program to support inland fisheries management activities. The program included directives about how, where, when, and how much to sample, and was accompanied with software package (Fisheries Resources Analysis System – FRAS) that facilitated standardized data storage, analyses, and reporting. The monitoring guidelines and FRAS have been revised every decade to keep pace with new developments, but the backbone of the monitoring program has remained constant. During this 30-year period MDWFP has assembled a database that includes over 1,100 fish surveys in 150 lakes, and near 500 angler surveys in 75 lakes. This database has been used to develop lake-specific management plans that focus on managing lake habitat, fish populations, and the angler experience. The proposed project will expand FRAS to add a planning support tool (FRAS_{ps}) that will enable implementation of a structured approach to development of water body-

specific management plans. This project will include two separate but complementary activities:

- (1) review of management objectives and actions, and
- (2) development of FRAS_{ps}.

1. Review of Management Objectives and Actions

The objectives of this review are to: (1) update information about resource monitoring data processing protocols; and (2) expand our inventory of management actions applicable to addressing common fishery management problems.

To gather material regarding management protocols of state fisheries agencies we will follow accepted protocols for conducting narrative reviews. The general methodology begins with formation of the question or problem and objectives of the review. An initial scope of the literature is then done in order to refine the review's question or problem and objectives, identify relevant databases and search engines or lack thereof, and refine search terms and key words. Formal literature searching and gathering is then performed using the finalized search terms and keywords within relevant database and search engines. Results are screened as possibly relevant through examination of the title, abstract, and keywords. As literature is screened, criteria and selection of relevant data is formed. After searches have been exhausted, the full texts of gathered literature are examined and relevant papers retained. Data from this final reference library is extracted and synthesized.

We will deviate from these methods in criteria used for evaluation, as the material gathered (e.g., sampling and monitoring protocols, actions plans, and technical documents) are limited documents available at state level. Because of expected low availability of documents, we will also deviate from the formal literature searching and gathering steps by tiering search methods. This order of operations is as follows:

1. Systematic searches of bibliographic sources and Google Scholar.

2. Searching of state agency websites.
3. Reference scanning and relational searching of gather sources.
4. Requests for material from agency personnel.

The goal is to obtain documents from at least 50% of states within each US Fish and Wildlife Service region; 28 states overall at a minimum.

Website searching. If database searches are not successful in returning useful documents, state fisheries agencies' websites will be manually searched for relevant material. This process consists of locating websites then searching available titles. Results thus far indicate that documentation varies among states; some states have online libraries with complete reports, whereas others disseminate information regarding the results of surveys in print.

Bibliography searches. This method uses the bibliographies of relevant documents to search for other relevant resources; it is also referred to as "snowballing," "citation chasing," or "pearl growing." Relevant titles found in bibliographies will be searched via Google across the Web and documents meeting criteria will be retained.

Agency solicitation. When other methods have been exhausted, agency personnel will be contacted and asked to provide documents related to sampling procedures and fisheries management. It is expected that a significant portion of documents will be gathered this way.

2. Development of FRAS_{ps}

FRAS_{ps} will rely partly on decision theory, an emerging science that addresses decision making in complex situations with high uncertainty and important consequences. Decision analysis aims to help decision makers choose between options under careful consideration of decision outcomes, uncertainty in the outcomes, and risk in decision outcomes. Structured decision making (SDM) and decision analysis, however, do not guarantee

the desired outcome, only that the best choice has been made given the information available.

The tools of decision science have been adopted in natural resource management because uncertainty of outcomes is widespread, budgets are constraining, and agencies need defensible decision making processes. Many agencies now use an SDM process to make important management decisions. The rate and level at which these decision processes have been adopted within agencies varies, but most are still in early phases. Our goal is to integrate the principles of SDM into a computer tool to facilitate the selection of management actions that have the highest likelihood of achieving management objectives.

Starting with our updated inventory of fisheries management objectives and actions that can achieve those objectives we will develop the decision support tool using open source tools like R and Shiny. The final product is intended to be a user friendly tool designed to identify, parameterize, and analyze how well management actions are likely to work. The relevant management objectives and decisions will be organized as a management plan. The system is expected to help fishery managers make effective decisions that enhance fisheries.

The development and implementation of the FRAS_{ps} decision support tool can enhance the quality and efficiency of fisheries management actions. The knowledge bases embedded in a computerized planning support system will contain the rules and logic statements that encapsulate the knowledge required for management decisions so that it generates tailored recommendations for specific problems associated with individual fisheries. FRAS_{ps} is expected to assist fisheries biologists in completing a knowledge-base, driven by rules of logic, decision making process instead of relying solely on their own knowledge, intuition, and potential personal biases. FRAS_{ps} will provide prebuilt forms to organize and store pre-processed field data and other relevant knowledge about the water body and fishery, and to document the outcome of previous management actions. The predesigned forms will help decision making by presenting the full scope

of components that should be considered in development of a management plan.

FRAS_{ps} will be organized into four planning support phases: *assessment*, *problem identification*, *management plan*, and *outcome evaluation*. It will be designed to be applied by front-line biologists with first-hand knowledge of the water body for which the management plan is being developed.

Assessment.—FRAS_{ps} will start its function for fishery assessment with a biologist's entry in an electronic assessment form. The biologist will at the onset request upload of various fish, habitat, and fishery metrics available from databases accessible by FRAS_{ps}. Some of these metrics are already processed and just need to be retrieved by FRAS_{ps}, whereas other metrics may need to be obtained after the original FRAS processes available field survey data (e.g., electrofishing, creel data files).

After existing data are imported into FRAS_{ps}, the system will prompt the user to enter additional information. This additional information may include facts about the water body not available from existing data bases, and information about the environment and fisheries that may be available only through expert judgement. Where applicable, judgements will be accompanied with an estimate from the user about the certainty of the judgement (e.g., 1, 0.95, 0.5) to be later used by FRAS_{ps} in weighing the quality of available information.

Problem identification.—After assessment information is gathered, the program will review the information to check for possible missing values and to compare with statewide standards and/or water body type (e.g., large reservoirs, small oxbow lakes) standards. Values unusually low or high (e.g., <25th, >75th percentiles) will be flagged. At this stage, and from drop down menus, the user will have the option to flag additional problems not identified by FRAS_{ps}.

For flagged problems, FRAS_{ps} will provide users with the source of the information used to flag values and clarification of why the flagged values may be problematic, and possibly references and hyperlinks for additional

reading. This would build trust in the validity, reliability and credibility of the system. It is a valuable addition that literature citations and web-based evidence are available if desired.

Management plan.—Problem-specific management objectives will be generated by the system based on problems flagged automatically and those added by the user. At this stage the user will also have the option of selecting additional objectives not automatically selected by FRAS_{ps}. The program will automatically flag potential conflicts between the objectives selected automatically and those added by the user, although the user will be able to override the flags. After the objectives are selected, potential actions to achieve the objectives will be presented to the user in menu form. Once actions are selected, the program will conduct another check to inspect for conflicts among management actions or overlap.

Management plans will summarize key data about the water body, fish, and fisheries (i.e., information gathered in *Assessment* phase). The plan will also list all problems identified automatically and added by the user (i.e., information generated in *Problem identification* phase), along with relevant background information explaining the nature of the problem and ramifications (from knowledge-base stored in FRAS_{ps}).

Outcome evaluation.—An important component of a management plan is an evaluation of the outcome of the management actions implemented. The fishery manager wants to know whether the problems in the water body have been corrected and if the actions have performed as expected. If not, adjustments to the prescribed actions may be necessary or new actions implemented. This phase of FRAS_{sp} will prescribe an evaluation protocol and schedule, with options as applicable. The evaluation will also be part of the management plan.

Outcome evaluations are also necessary to refine FRAS_{sp} knowledge base. FRAS_{sp} generates a set of actions to address management objectives based on previous performance of the action. The more we apply an action and evaluate the outcome, the better knowledge we have to help guide future

applications of the action. Thus, outcome evaluations will eventually allow MDWFP to better predict how well an action will work in a given situation.

References

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Miranda LE, Bull LA, Colvin ME, Hubbard WD, Pugh LL. 2018. Segmentation of Mississippi lakes. *Lake and Reservoir Management* 34:000-000. <https://doi.org/10.1080/10402381.2018.1481469>