LANDSCAPE CONSERVATION COOPERATIVES

Multi-LCC Mississippi River Basin / Gulf Hypoxia Initiative Work Groups, Tools Design & Research Forum Invitation Updated Fall 2015

On behalf of 7 Mississippi Basin LCCs:

Plains & Prairie Potholes LCC, Upper Midwest & Great Lakes LCC, Eastern Tallgrass Prairie & Big Rivers LCC, Appalachian LCC, Great Plains LCC, Gulf Coast Prairie LCC, Gulf Coast Plains & Ozarks LCC with funding from an LCC Network Grant (Multi-LCC Network Project #2013-17). See Planning Team and Participants list in Appendix for contacts.

A complete set of workshop notes and presentations is available online or upon request.
http://www.tallgrassprairielcc.org/research-projects/mississippi-river-basingulf-hypoxia-structured-decision-making-workshop-2014/

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EXECUTIVE SUMMARY

According to water quality model assessments, Midwestern states within the upper Mississippi River watershed currently contribute the greatest nutrient load to the Gulf of Mexico hypoxic zone. Recent extensive new tile drainage and reversion of Conservation Reserve Program and other grasslands to row crops in the Dakotas and Minnesota, as well as increased irrigation in central and southwestern portions of the basin may dramatically reduce wildlife habitat across the Mississippi Basin and exacerbate nutrient loading to the Gulf of Mexico. To reduce downstream water quality impacts to fisheries in the Gulf of Mexico, the conservation community needs optimization tools that prioritize the design and configuration of actions that appeal to upstream agricultural communities.

Initiative Approach

The Mississippi River Basin / Gulf Hypoxia Initiative (MRB/GHI), spearheaded by the seven LCCs, is undertaking a strategic and transparent process to create an integrated framework that supports planning, design, configuration, and delivery of wildlife conservation practices within the watershed.

This framework consists of multiple quantitative objectives representing three interests (i.e., wildlife, water quality, agriculture), a tiered set of conservation strategies to achieve those objectives within five production agriculture systems, and a modeling approach to determine where to best implement those actions within four key ecological systems of the Mississippi River Basin. Additional scenario planning for landscape change could provide forecast and adaptation strategies over a range of time scales across key portions of this landscape in response to ecological or economic drivers.

The initiative plans to use this framework to address collaborative needs that will:

- Enhance organizational capacity
- Avoid duplication of effort
- Streamline prioritization
- Align the work of multiple agencies and organizations

This effort is intended to be complementary to related on-going efforts, like the Gulf of Mexico Hypoxia Task Force, Mississippi River Basin Initiative, and state nutrient reduction initiatives, but with an added emphasis on the ecological and social values of wildlife habitat.

Workshop Process

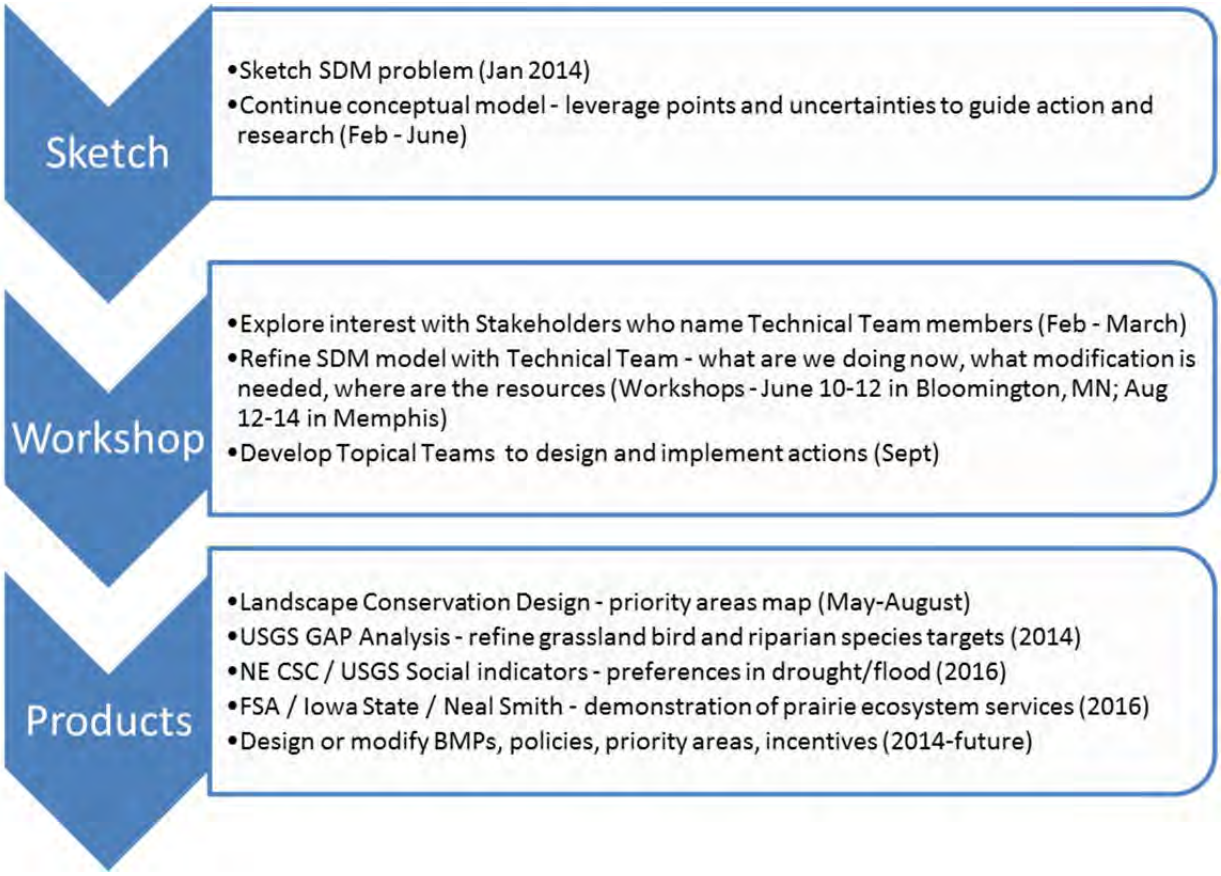
To begin developing the framework, the MRB/GH Corridor Initiative Planning Team held three Structured Decision Making (SDM) workshops, culminating in Memphis, TN, on August 12-14, 2014, with an expanded set of 50 stakeholders to continue refining this framework (see participant list and agenda in the appendix).

Specific goals of the series of workshops were to:

1) Convene a group of participants representing the primary interests in the intersection of fish and wildlife corridors, water quality, sustainable agriculture, and watershed management to develop shared objectives, metrics and strategic approaches.

2) Gain a common understanding of available tools available to achieve those objectives, as well as the science and policy gaps that create barriers or opportunities for implementation.
3) Develop a plan for how to combine the objectives and available tools to design a landscape that provides multiple ecosystem benefits.

The overall process for stakeholder engagement includes the steps described below:



Structured Decision Making (SDM) - SDM provides a systematic process to outline and evaluate transparent decisions where there may be multiple objectives, many potential actions, and uncertainty that makes decision making difficult. The process of SDM consists of a series of steps that effectively breaks a decision problem down into its component parts and then reassembles those parts in a framework that allows a decision-maker to assess various choices in terms of their values, while accounting for trade-offs between values and uncertainty in predicted outcomes. In general, the process consists of specifying the decision problem, stating measurable objectives (i.e. outcomes of interest), generating alternative actions or choices to meet those objectives and finally an assessment of the alternatives in terms of their effect on the objectives.

In addition to staff of the seven LCCs, members of the Planning Team and Workshop Participants identified themselves with the following agencies and organizations:

Organizations:

- Agricultural Watershed Institute
- American Bird Conservancy
- Bill McGuire Conservation, LLC
- Bluestem Communications
- Ducks Unlimited
- Enviroscapes Ecological Consulting
- Fishers & Farmers Fish Habitat Partnership
- Gulf Hypoxia Task Force
- High Branch Conservation
- Illinois Council on Best Management Practices
- Intertribal Agricultural Council
- KGregg Consulting
- Lower Mississippi River Committee
- Lower Mississippi River Sub-basin Committee on Hypoxia
- Lower Mississippi Valley Joint Venture
- Massachusetts Audubon
- Midwest Conservation Biomass Alliance
- Mississippi Interstate Cooperative Resource Association
- Mississippi River Network
- National Audubon Society
- National Wildlife Federation
- Natural Land Institute
- Oak Ridge National Laboratory
- Ohio River Fish Habitat Partnership
- Practical Farmers of Iowa
- Prairie Island Indian Community
- Rainwater Basin Joint Venture
- The Conservation Fund
- The Nature Conservancy
- Upper Mississippi / Great Lakes Joint Venture
- Vermont Center for Ecostudies
- Waupaca Biological Field Station
- Wildlife Management Institute

Universities:

- Louisiana University Marine Consortium
- Mississippi State University
- Missouri Department of Conservation
- Ohio State University
- Purdue University
- University of Illinois / Illinois Natural History Survey
- University of Iowa
- University of Minnesota
- University of Nebraska - Omaha
- University Wisconsin – Madison

State agencies:

- Illinois Department of Natural Resources
- Indiana Department of Natural Resources
- Minnesota Department of Natural Resources
- Minnesota Pollution Control Agency
- Nebraska Game & Parks Commission
- Tennessee Wildlife Resources Agency

Federal agencies:

- Army Corps of Engineers
- Department of Energy
- Department of Transportation
- EPA (OWOW, ORISE Hypoxia Team)
- U.S. Fish & Wildlife Service (Contaminants, Ecological Services, Fisheries, Gulf Restoration, HAPET, Migratory Birds, Private Lands, Refuges, Science Applications)
- USDA Farm Service Agency
- USDA Forest Service
- U.S. Geological Survey (NAWQA, Hypoxia Task Force, GAP, NE Climate Science Center, SC Climate Science Center, UMESC)
- National Park Service
- NOAA (HTF)
- USDA (Farm Service Agency, NIFA, NRCS - AR, IN, TN, MRBI)

Overview of SDM Components for the MRB/GH Initiative

***Decision problem* –** The group defined the decision space by describing the perceived problem as the following question:

> *How and where to best design and implement conservation delivery (habitat and species management) throughout the Mississippi River Basin in a way that benefits terrestrial and aquatic wildlife populations, while simultaneously reducing the contribution of nutrients to Gulf hypoxia and balancing agricultural interests.*

***Spatial scale* -** The spatial scale of the assessment will be focused on the entire Mississippi River Basin, including the Missouri portion of the basin south of the James River Valley to the Mississippi Delta. Initially, the initiative is focusing on a subset of watersheds at the HUC 8 level that are the most likely highest contributors of nutrients to the Gulf of Mexico.

***Time scale* -** The choice of a strategy (i.e. portfolio of actions at specific locations or subwatersheds) should take place within the next two years; however implementation of a more adaptive strategy may take decades. The time frame for performance measures may vary depending on the factors being measured. A single year's economic return or population response may not reflect long-term trends. For example, crop production may be evaluated annually whereas productivity, ecosystem services, climate impacts and costs for equipment and leases may extend up to 10 years or more.

***Geography and context* -** Recognizing that there are likely to be differences across the Mississippi River Basin in the strategies based on the ecological and the agricultural production settings, the group outlined four ecological systems and five agricultural production systems to organize conceptual models and actions.

Four Ecological Systems (Focal Habitats) - To further represent the fish and wildlife objectives, the group identified four priority ecological systems (Focal Habitats) across the landscape:

1) Modified headwaters in agricultural working lands;
2) Prairies, grasslands and savannas in uplands;
3) Forested riparian zones in mid-sized streams and smaller rivers; and
4) Bottomland hardwoods and floodplains along the mainstem and larger rivers.

Five Agricultural Production Systems - The group identified five major agricultural production systems in the Mississippi Basin to use in organizing distinctive sets of conservation practices:

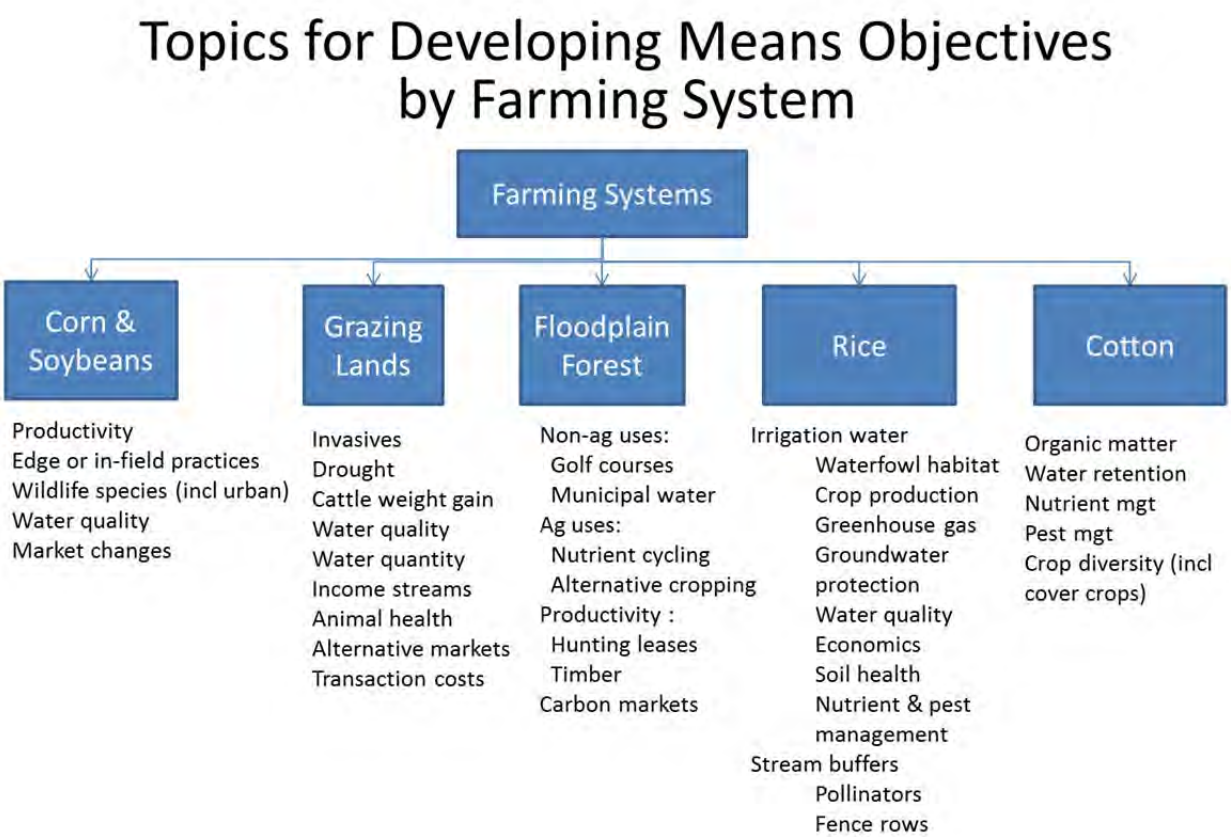
1) Corn and soybeans;
2) Grazing lands;
3) Floodplain forest;
4) Rice; and

5) Cotton.

Objectives – The group identified the following set of Fundamental Objectives:

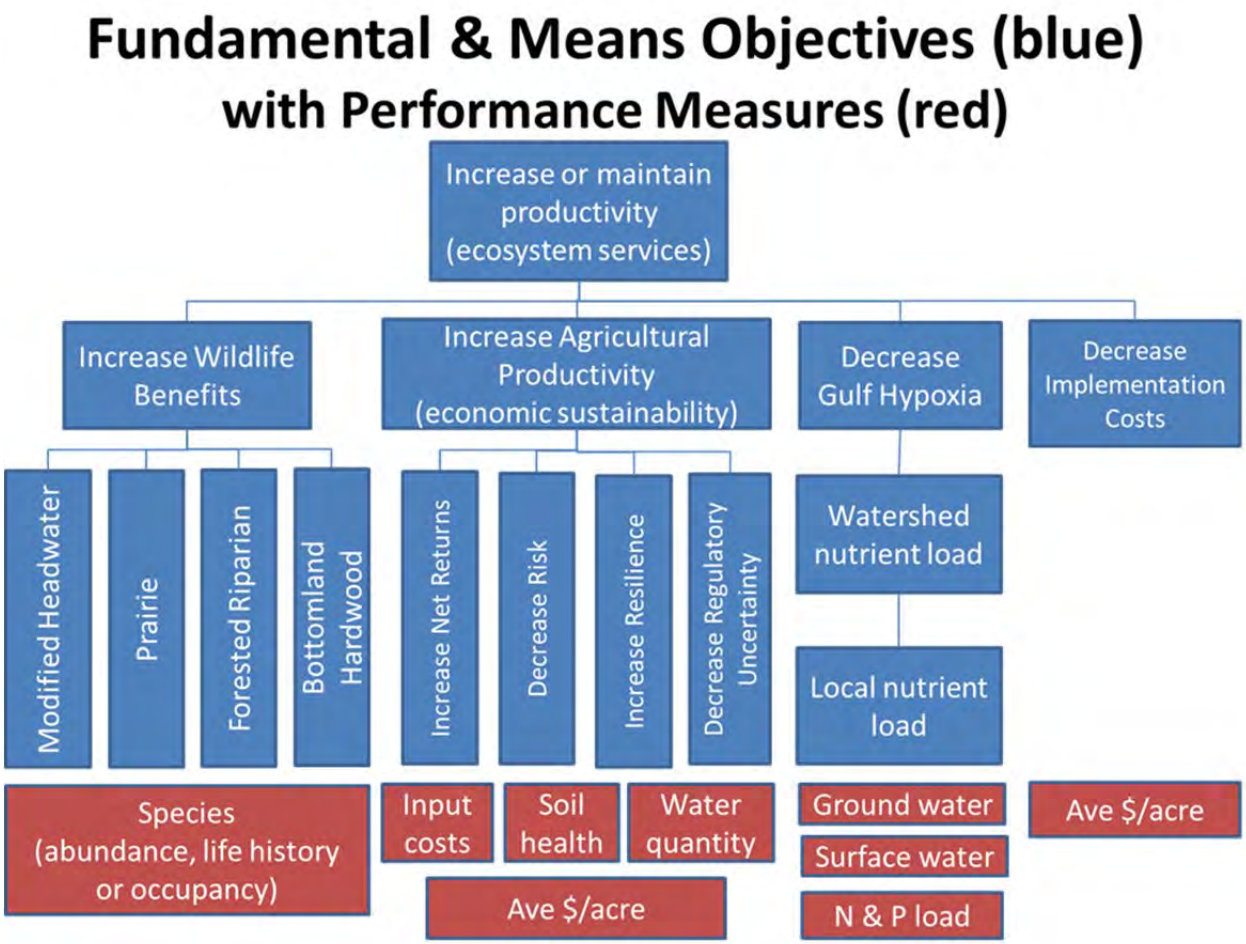
- Increase wildlife benefits (i.e., populations)
- Increase agricultural productivity
- Decrease Gulf hypoxia (i.e., local and downstream nutrient loading)
- Decrease implementation costs

The group outlined a set of topics in each of these five farming systems that may be used to further develop detailed means objectives that represent producer interests in each of these five farming systems.

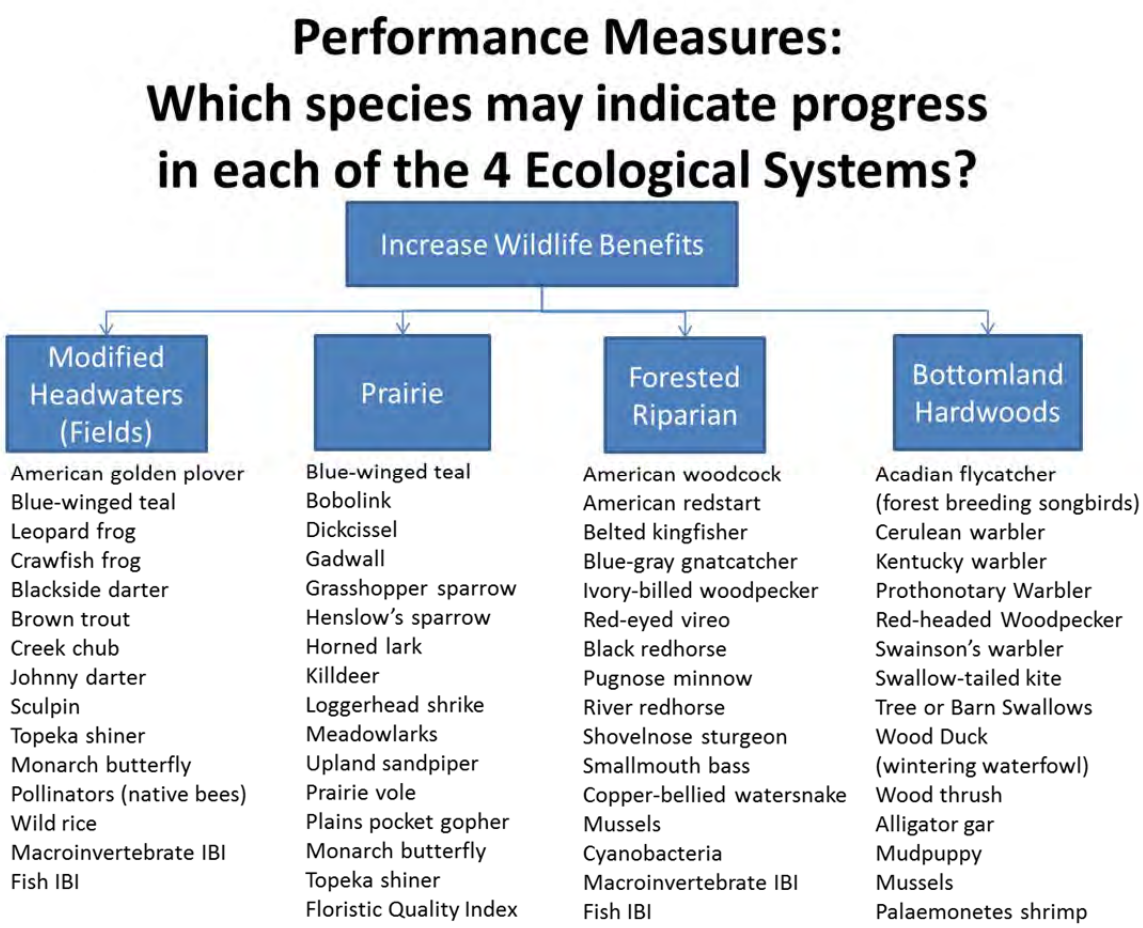


Performance Measures – How will we know if we are achieving objectives? A set of metrics would be created for the lowest level of Means Objectives to evaluate the effects of Alternative Actions.

A summary of the Fundamental and Means Objectives representing the hierarchy of management outcomes of interest and their potential relationships is represented in this diagram.



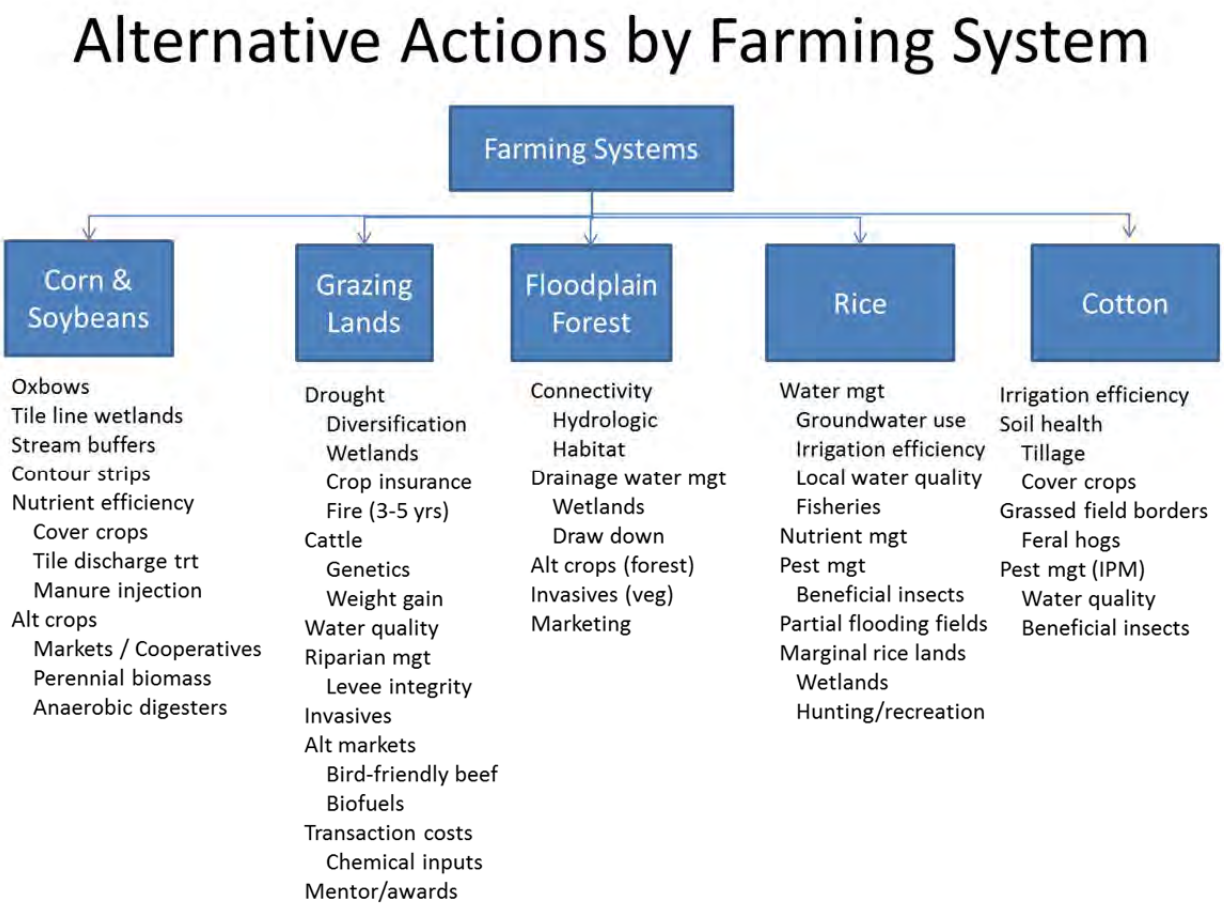
Focal Species - The group generated a preliminary list of focal species for conservation design and evaluation of the impacts of conservation actions on these four ecological systems (focal habitats).



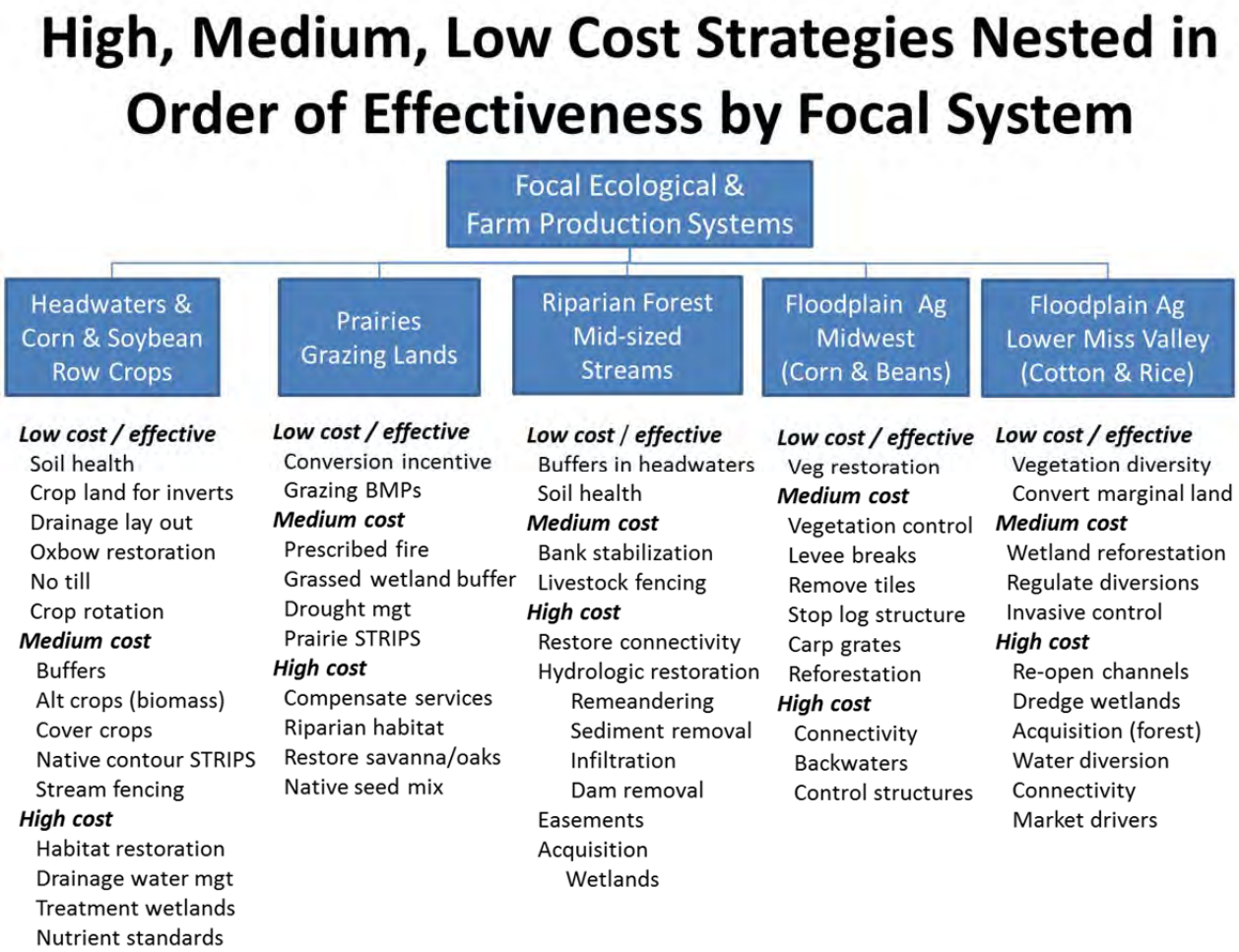
Influence Diagrams (Conceptual Models) – Influence diagrams are conceptual models for representing the main components of the problem and developing an understanding of how a particular action, or drivers, may influence each of the objectives. Patterns in these relationships can point to high value "levers" to pull in achieving objectives. They can also help in identifying important uncertainties and quantifying metrics for the objectives.

Draft diagrams were developed for each of the four focal Ecological Systems and are presented in the workshop report. These components and relationships will require further refinement.

Alternative Actions – Using the five Agricultural Production Systems identified above, the group then examined the conceptual models linking actions to the objectives through key ecosystem processes and identified a tiered set of actions that could be taken to influence desired outcomes. While this effort is focused mainly on wildlife-related management actions, the team did list a much broader set of actions that could potentially be taken, including both traditional and emerging practices.

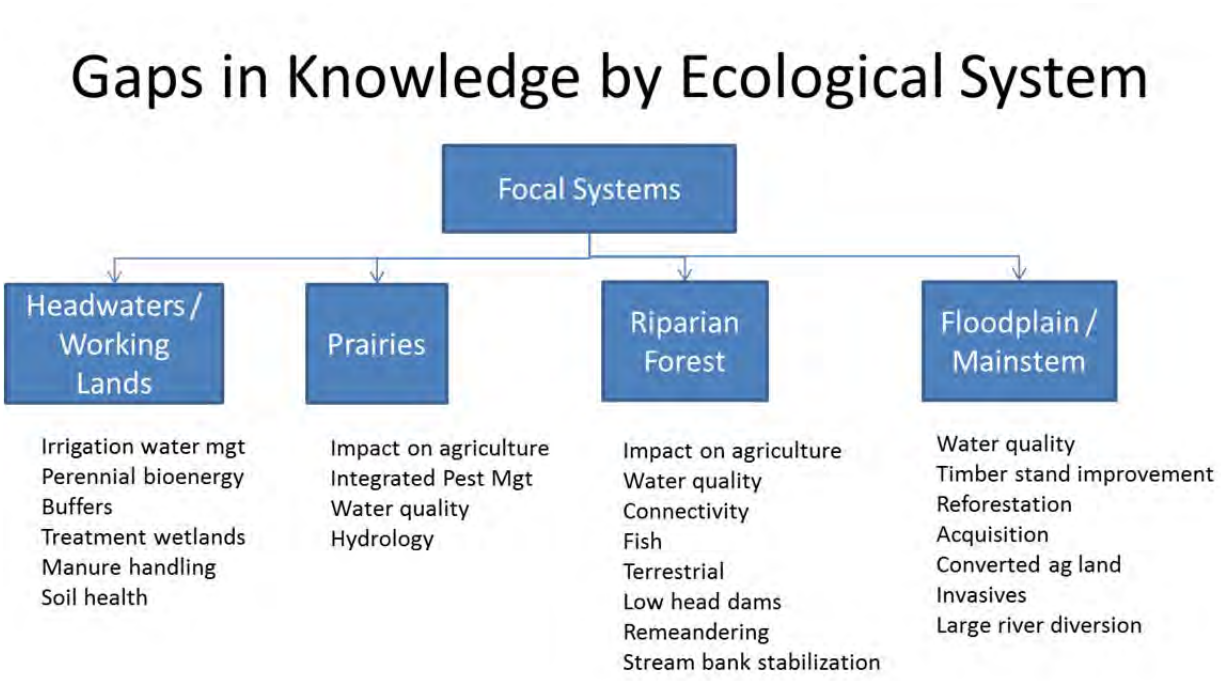


Strategy Generation - The group also worked through an exercise to consider multi-action strategies that could potentially be applied within the ecological systems at different scales, subdivided to reflect geographic differences in application of conservation practices. These alternatives were organized into a series of strategies by combining actions that are typically deployed together and grouped according to implementation cost.

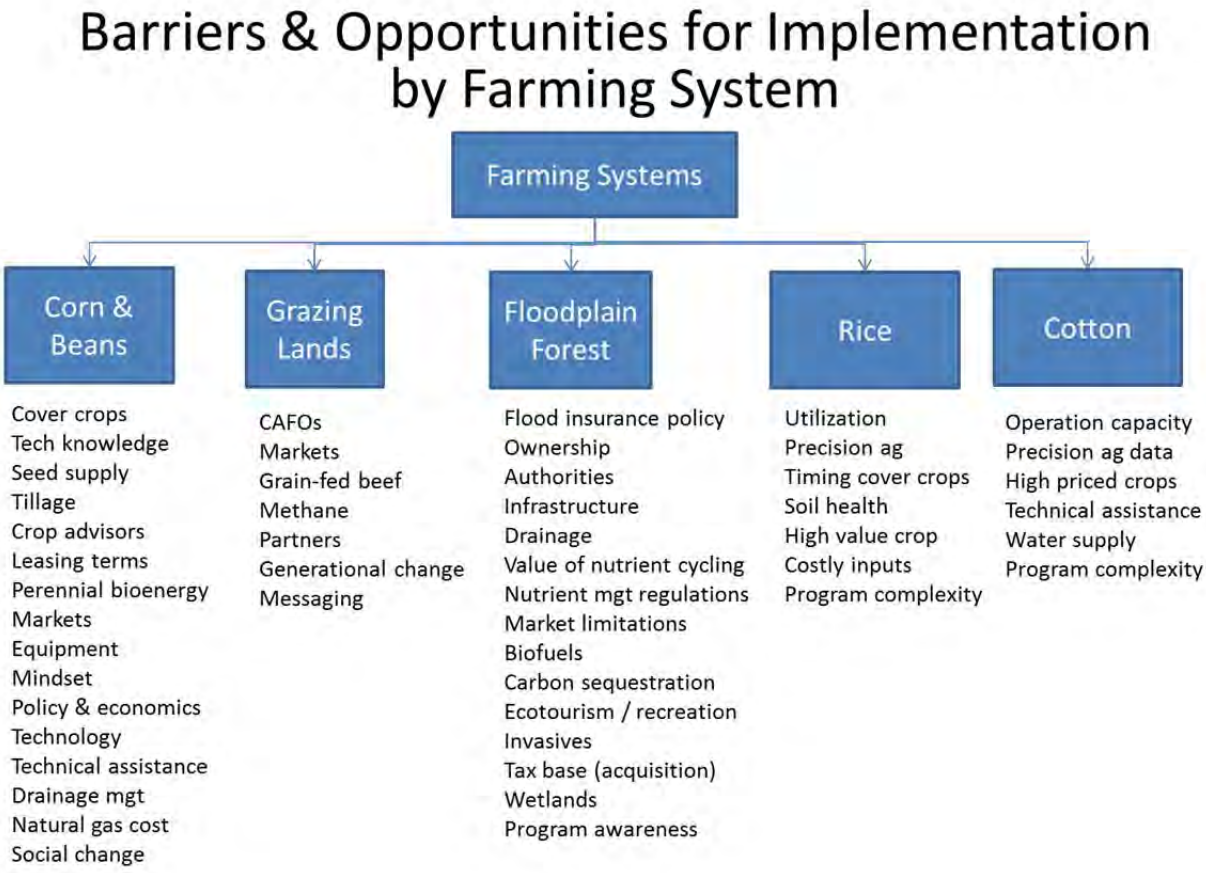


Examining Trade-Offs – Actions differentially impact objectives. Trade-offs between actions with opposing effects may be necessary. Choices may differ according to stakeholder values and environmental conditions such as climate extremes. Optimization tools can be structured very simply (e.g., swing weights) or may be very complex (e.g., dynamic optimization). Such tools will be constructed in future steps within the Mississippi Basin / Gulf Hypoxia Initiative.

Science Needs – The group began to identify areas of scientific uncertainty that require further research within each of the four Ecological Systems.



Barriers and Opportunities for Implementation – The group listed a series of potential barriers to implementing conservation practices within each of the five Farming Systems. These constraints may be used to rate strategies for feasibility or to identify opportunities for taking action to overcome barriers.



Collaboration & Outreach – Implementation of conservation practices will require a strategic marketing and communications approach with consistent messaging across participating agencies and organizations, including use of strategic planning (modeling), policy and infrastructure changes, and resource allocation among programs and activities.

Audiences who may conduct or be affected by actions include agricultural producers or land managers, corporations and private entities (agribusiness), and consumers of agricultural products as drivers of adoption. Venues for delivering conservation messages may include: extension services, celebrities / organizations, conservation delivery networks (e.g., Joint Ventures), agency programs, NGOs (policy changes), and state nutrient management strategies. The group then identified a preliminary list of high performing watershed organizations and other programs that are implementing conservation successfully and where pilot approaches may be tested.

Further refinement of the approach **-** There is still considerable work to be done on crafting this decision structure into something more explicit and specific. Next steps in the process include:

1. *Peer review of this decision support framework* - Present and get feedback on the preliminary decision structure mostly focusing on the decision problem statement, the objectives and the quantitative metrics for those objectives. How could this approach be beneficial for others?

2. *Narrow the list of strategies for further evaluation* - Be more specific about the scope of the alternatives that we are going to consider. Again, we are mainly focusing on wildlife management alternatives that could have simultaneous benefits for both agricultural production and water quality (e.g., Gulf hypoxia).

3. *Simplify the conceptual models* – Determine which components we can model given the alternatives and objectives. These models have a lot of detail that might not be necessary to predicting the desired consequences of different actions. We should revise these models to be more reflective of what we can reasonably do and the detail we need to work through this problem.

4. *Develop descriptive or predictive models* - Determine how to go about modeling the expected outcomes for different actions. This will have some influence on the types of metrics we can use and the complexity of the models we need. Currently, we have not yet determined how much effort modeling or predicting consequences will require.

5. *Develop an optimization tool* - Put the pieces developed above together to form a Landscape Conservation Design, which may include a spatial analysis.

6. *Implementation of the results* - There needs to be some discussion about how these results will be used once everything is put together. Will it simply be a communication tool? Could we use it to coordinate something larger? How do regulatory authorities fit into this problem? Are there other constraints we haven't thought of?

Web Map Service **-** More extensive instructions are available for using the map service. To quick start, navigate to the map service at:

http://www.conservationgis.com and login using:

Username: msriver
Password: etpbr

1) Click the "Manage" tab
2) Select "Map Services"
3) In the "MississippiRiverHypoxia" folder select "MS_River_WaterQuality_PriorityZone"
4) Click the green plus sign to add the service to the map

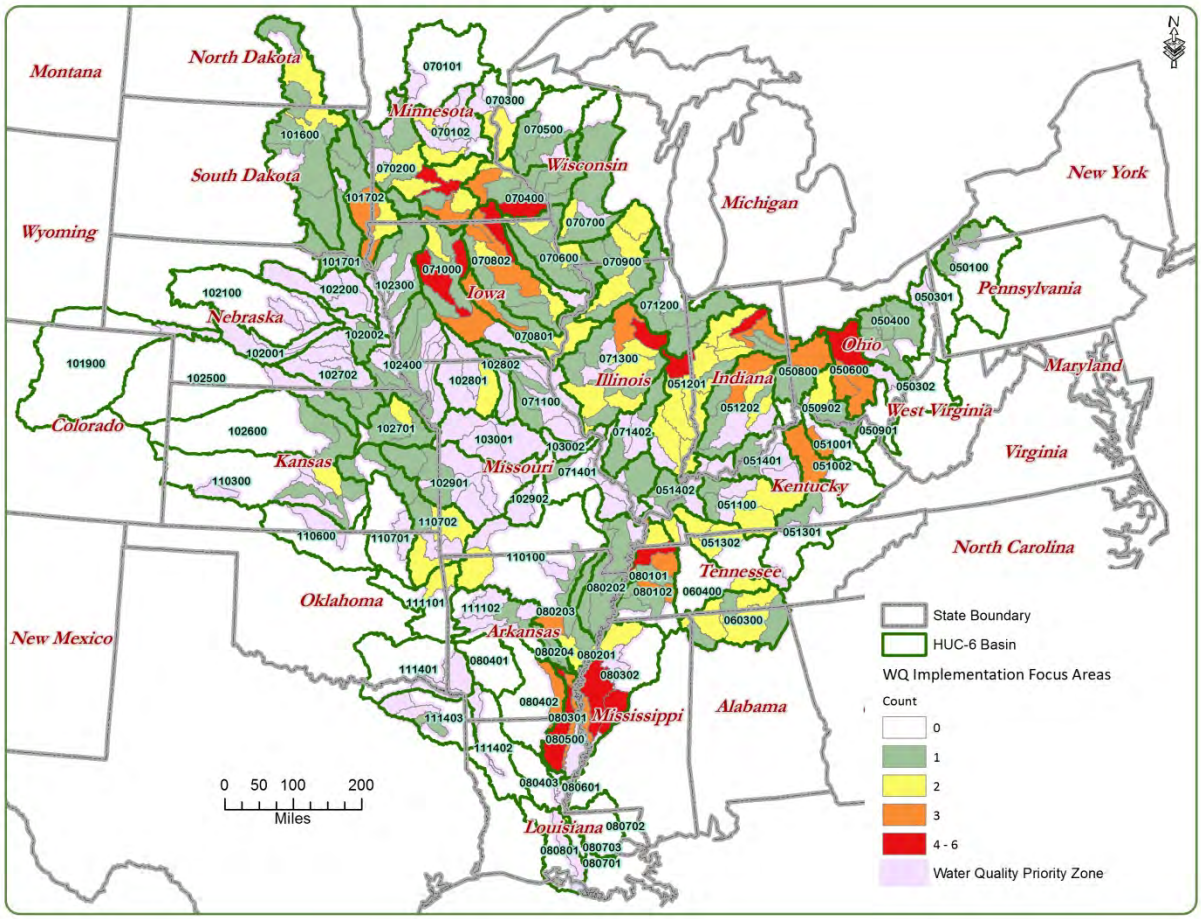


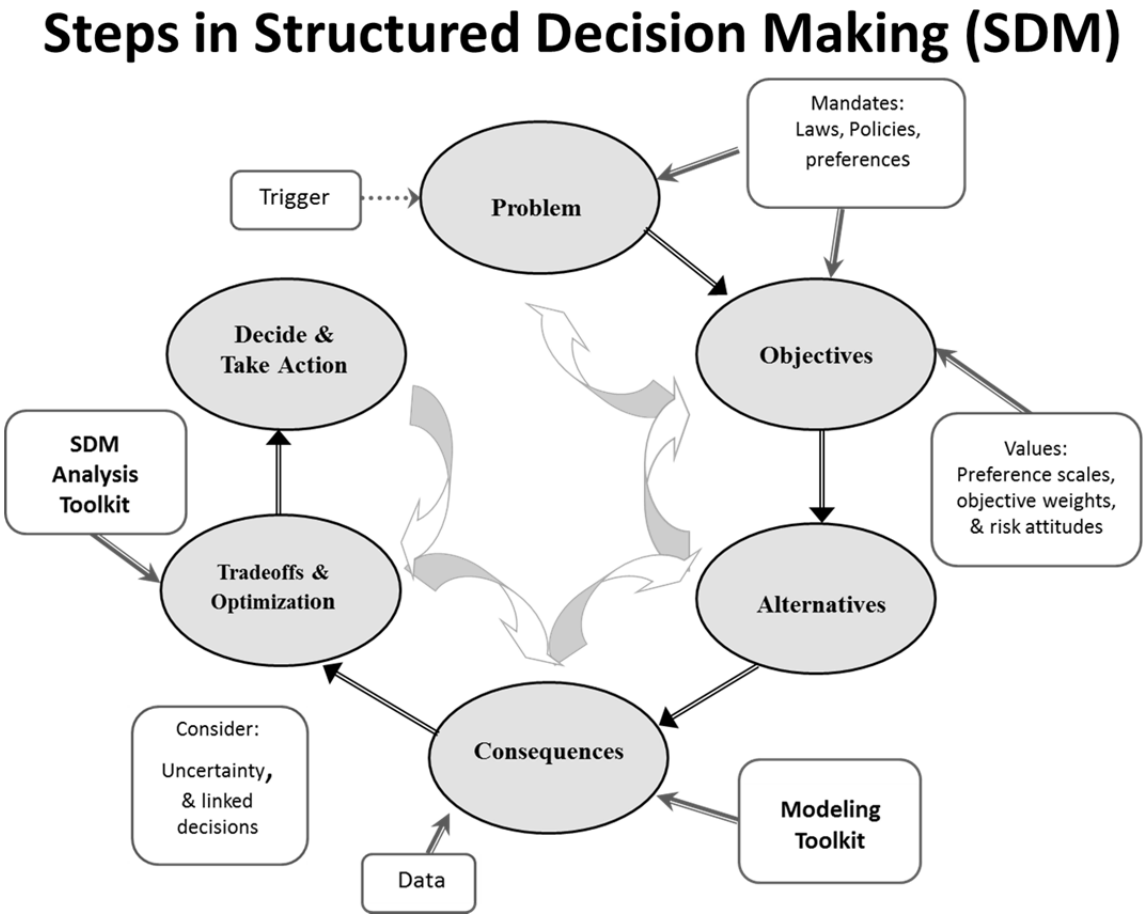
Figure 8. Preliminary map of Water Quality Implementation Focus Areas, showing number of programs with water quality implementation priorities within HUC-8 watersheds with at least 308 kg/m2/year of nitrogen loading attributed to agricultural sources in the 2002 SPARROW Mississippi/Atchafalaya River Basin Model or containing at least 39% cropland as identified in the 2013 USDA-NASS Cropland Data Layer.

MISSISSIPPI / GULF HYPOXIA INITIATIVE – WORKSHOP OUTCOMES

Funded by a multi-LCC Network Grant #2013-17, the seven LCCs hosted a Structured Decision Making (SDM) process to guide development of a Mississippi River Basin / Gulf Hypoxia Wildlife Conservation Corridor Initiative through numerous online meetings and three in person workshop events from December 2013 to September 2014 (see Planning Team, Stakeholder participant list, and Memphis Agenda in the Appendix).

1) SDM Introduction Workshop, Planning Team, January 26-27, Kansas City, MO.
2) Rapid Prototype Workshop, Planning Team, June 10-12, Bloomington, MN.
3) Implementation & Model Refinement Workshop, Stakeholders, August 12-14, Memphis, TN.

The SDM process consists of a series of steps that effectively breaks a decision problem down into its component parts and then reassembles those parts in a framework that allows a decision-maker to assess various choices in terms of their values, while accounting for trade-offs between values and uncertainty in predicted outcomes. In general, the process consists of specifying the decision problem, stating measurable objectives (i.e. outcomes of interest), generating alternative actions or choices to meet those objectives and finally an assessment of the alternatives in terms of their effect on the objectives.



Credit Jean Fitts Cochrane

Background

Historically, the Mississippi River Basin has contained prime farmland that produces high-value nutrient-hungry crops for food, fiber and fuel for both domestic and international markets. This region is also home to prairie, forest and river ecosystems that support diverse endemic plant and animal communities. However, agricultural production has displaced and removed many acres of native habitats on highly productive soils and marginal lands. Intensive land use and standard cultivation practices have led to the degradation of many aquatic systems through sediment and nutrient loading, exacerbated by channelization and tile drainage, resulting in eutrophication and impaired uses of local waters and culminating in the development of a hypoxic zone in the Gulf of Mexico.

An abbreviated hypoxia response timeline follows:

1985 – First estimate of aerial extent of the Gulf of Mexico hypoxic zone
1997 – Mississippi River/Gulf of Mexico Watershed Nutrient Task Force established
1998 – Harmful Algal Bloom and Hypoxia Research and Control Act passed an authorized plan of action to reduce, mitigate, and control hypoxia
2000 – Final Integrated Assessment of Hypoxia in the Northern Gulf of Mexico released Includes the 6 report series from NOAA research on causes, consequences, and control (http://www.nos.noaa.gov/products/pubs_hypox.html)
2001 – Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico
2008 – Gulf Hypoxia Action Plan, revision of 2001 Plan (http://www.epa.gov/msbasin)
2010 – USDA NRCS launches Mississippi River Basin Healthy Watersheds Initiative MRBI (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1167406.pdf)
2013 – Release of 5-year progress report from MR/GOM Watershed Nutrient Task Force (http://water.epa.gov/type/watersheds/named/msbasin/upload/hypoxia_reassessment_508.pdf)

Much research has been done, priorities set, and actions initiated to address local water quality and downstream hypoxia. The focus has revolved around voluntary actions by the agriculture community to manage nutrient application, runoff and downstream water quality through agricultural conservation practices such as alternative timing, rates, and methods of application and managing runoff through in-field bioreactors in tile lines, edge of field treatments such as treatment wetlands, no-till, cover crops, and other traditional and emerging BMPs. These practices collectively are designed primarily to reduce erosion and soil loss, combat nutrient loading, and maintain profitable production systems for landowners. For the most part, they provide incidental and limited fish and wildlife benefits.

However, the planning team believes that there is a conservation opportunity to complement these ongoing efforts by utilizing wildlife habitat management actions focused on priority areas identified in existing regional and national conservation plans. By aligning complimentary programs and convergent objectives, there may be opportunities to leverage the strengths of different agencies and organizations, reduce duplication of effort, and increase the efficiency of conservation delivery across critical planning areas, thereby improving habitat and reducing

nutrient loss from watersheds. This effort is designed to be complementary to the Gulf of Mexico Hypoxia Task Force, Mississippi River Basin Initiative, state nutrient reduction initiatives and related programs, by targeting wildlife habitat management actions with multiple benefits.

Decision problem – The team identified their decision problem as how to best allocate wildlife management actions throughout the Mississippi River Basin in way that reduces the contribution of nutrients to Gulf hypoxia, while simultaneously benefiting terrestrial and aquatic wildlife populations and balancing agricultural interests. The spatial scale of our assessment will be focused on the entire Mississippi River Basin, including the Missouri portion of the basin south of the James River Valley to the Mississippi delta. As for timing, the choice of a strategy (i.e. portfolio of actions at specific locations or watersheds) should take place within the next few years; however implementation of a more adaptive strategy may take decades.

As a starting point, the group agreed to focus on wildlife habitat priorities identified in previous efforts (e.g. State Wildlife Action Plans, NGO plans, federal agency initiatives) and determine where those priorities overlapped the regions with the highest watershed nutrient loads. The group initially defined these subwatersheds of interest as those with total N yields greater than 439 kg/km2/yr based on the SPARROW model (see Figure 1). However, a broader approach was also discussed that would focus on watershed-level allocations of effort across the river basin.

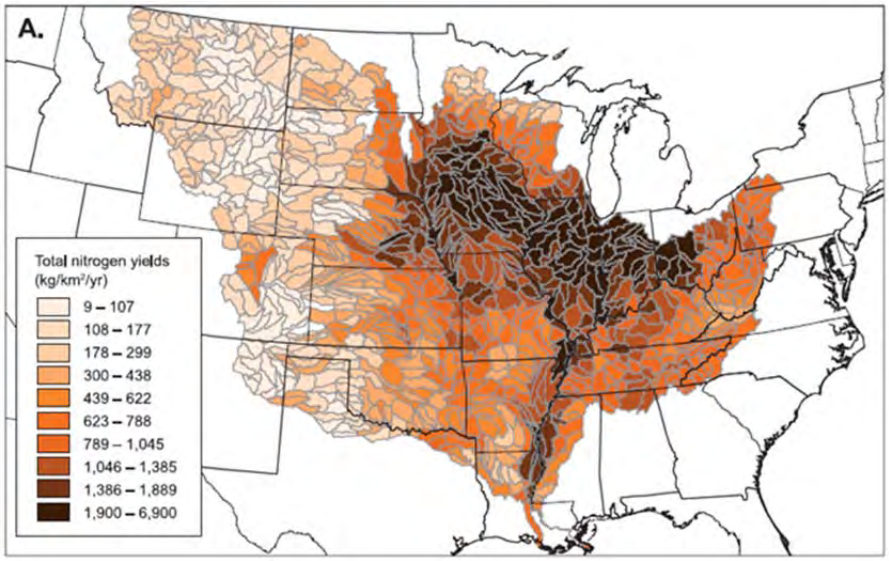


Figure 1. Total nitrogen yields from all sources grouped by 8-digit HUC for Mississippi River Basin (Figure from Robertson et al., 2009)

The group defined the decision space by describing the desired outcome:

> *How and where to best design and implement conservation delivery (habitat and species management) throughout the Mississippi River Basin in a way that benefits terrestrial and aquatic wildlife populations, while simultaneously reducing the contribution of nutrients to Gulf hypoxia and balancing agricultural interests.*

Spatial scale - The spatial scale of the assessment will be focused on the entire Mississippi River Basin, including the Missouri portion of the basin south of the James River Valley to the Mississippi Delta. Initially, the initiative is focusing on a subset of watersheds

Time scale - The choice of a strategy (i.e. portfolio of actions at specific locations or watersheds) should take place within the next two years; however implementation of a more adaptive strategy may take decades. The time frame for performance measures may vary depending on the factors being measured. For example, a single year's economic return or population response may not reflect long-term trends. Crop production may be evaluated annually whereas productivity, ecosystem services, climate impacts and costs for equipment and leases may extend up to 10 years or more.

Objectives – Fundamental objectives are those outcomes of interest that are ends in themselves, rather than a means for achieving something else. The group identified the following set of Fundamental Objectives with associated Means Objectives and Performance Measures.

Fundamental Objectives

- Increase wildlife benefits (i.e., populations and habitats)
- Increase agricultural productivity
- Decrease Gulf hypoxia (including local and downstream nutrient loading)
- Decrease implementation costs

With regard to **maximizing aquatic and terrestrial wildlife objectives**, focal habitats and species were identified to make the objectives operational. To accomplish this, the group identified four systems that would represent where most wildlife species would occur and where management actions could be applied within an agricultural land use context.

Four Ecological Systems (Habitats) - To further represent the fish and wildlife objective, the group identified four priority ecological systems (habitats) across the landscape:

1) Modified headwaters in agricultural working lands;
2) Prairies, grasslands and savannas in uplands;
3) Forested riparian zones in mid-sized streams and smaller rivers; and
4) Bottomland hardwoods and floodplains along the mainstem and larger rivers.

Increasing agricultural productivity represents a component of stakeholder interest. If actions had a large negative effect on production, they may not be very easily implemented. Optimizing a landscape that considers agricultural productivity interests may look very different from one optimized for fish and wildlife conservation. Furthermore, the geographic and production context may affect applicability and interest in different conservation practices.

Five Agricultural Production Systems - The group identified five major agricultural production systems in the Mississippi Basin to organize distinctive sets of conservation practices:

1) Corn and soybeans;
2) Grazing lands;
3) Floodplain forest;
4) Rice; and
5) Cotton.

The group reviewed an example of objectives for farming system choices that had been identified by stakeholders for a similar problem and agreed that they were generally applicable in combination with additional objectives described in this workshop.

- **Increase agricultural productivity (sustainability)**
    - Increase net returns
        - Increase crop yield
        - Decrease production costs
    - Decrease risk
        - Decrease exposure to market changes
        - Decrease negative impacts of weather
    - Increase resilience
    - Decrease regulatory uncertainty

Means objectives for producers in each of these five Agricultural Production Systems may include:

- **Corn & Soybeans** – emphasized human element, marketing to get buy-in
    - Productivity
    - Time scale
    - Edge or in-field practices (in-field more likely to change producers)
    - Wildlife species, including effect on urban populations to get city buy-in
    - Messaging for water quality practices – sometimes unclear, may not have water quality benefits are promoted
    - Resilience to market changes

- **Grazing Lands**
    - Minimize invasives in grazing lands – Eastern red cedar, getting fire back
    - Maximize sustainability in terms of production
    - Minimize drought impacts – diversification
    - Daily weight gain of cattle
    - Water quality and quantity – native plants that are more drought tolerant.
    - Income streams – wildlife-friendly or natural beef, diversify income
    - Animal health
    - Alternative markets – carbon, wildlife-friendly
    - Reduced transaction costs – time and effort associated with changing production practices and management schemes.

- **Riparian and floodplain forest** – maximize productivity
    - Non-agricultural uses that may impact nutrient loading
        - Golf courses
        - Municipal water treatment
    - Agricultural uses
        - Enhancing nutrient cycling (disruption of levees)
        - Alternative cropping to convert row crop land to other uses with broader range of benefits.

- Maximize productivity (measures)
  - Annual recreational leases (hunting)
  - Long term sustainable activities – sustainable timber (yield)
- Regionally aggregate to take advantage of carbon markets for long term

- **Rice**
  - Water management as key driver with both economic and environmental aspect. Irrigation water return providing:
    - Waterfowl habitat
    - Crop production
    - Greenhouse gas
    - Groundwater protection
    - Water quality
    - Economics
    - Soil health
    - Nutrient & pest management
  - Stream buffers
    - Pollinators
    - Fence rows

- **Cotton**
  - Organic matter
  - Water retention
  - Nutrient & pest management
  - Crop diversity, including cover crops

Decreasing Gulf hypoxia was regarded as a fundamental objective. Nutrient reduction is a means to achieving a larger conservation goal of maximizing the productivity of aquatic systems from the headwaters to the Gulf. However, larger Gulf restoration goals are outside the scope of this problem. While there may be mutual interest in reducing Gulf hypoxia when working with already existing efforts, the LCCs are also interested in how nutrient amplification affects both freshwater and marine. *The value added by LCCs would be to bring additional fish and wildlife conservation perspectives and resources to this water quality problem.* Selected wildlife conservation practices that reduce Gulf hypoxia may also address eutrophication in local waters. Improving local water quality may be a means to reducing Gulf hypoxia and maximizing aquatic species benefits.

Decreasing implementation costs (or maximizing cost-effectiveness) may be considered constraints involved in making the trade-offs between the other objectives. Solutions that are cost efficient, from a conservation perspective, will guide use of limited resources on behalf of public programs and private landowners. As a means objective, cost comparisons and social acceptability can determine what kind and how many additional resources are necessary, rather than taking alternative actions off the table.

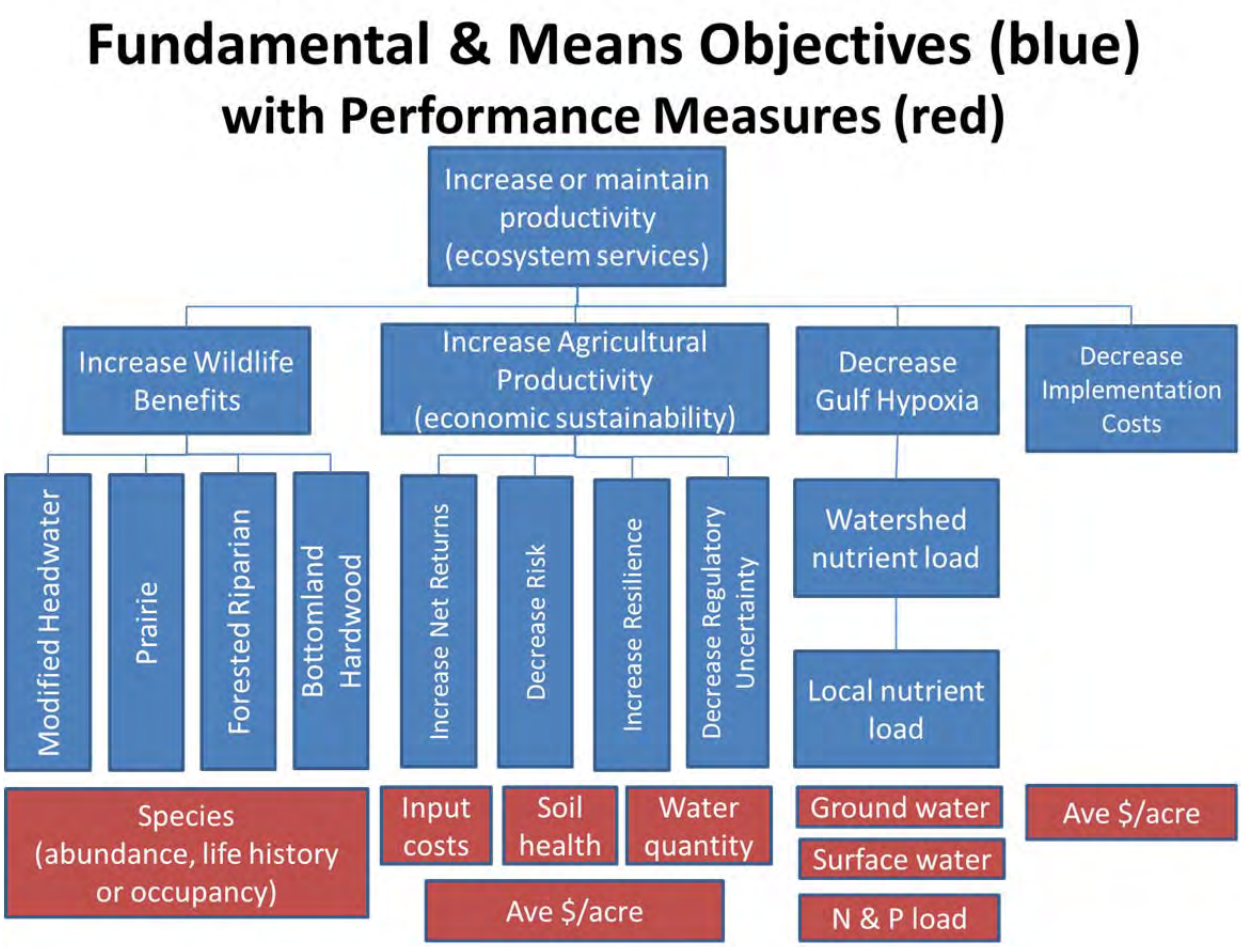


Figure 2. Fundamental and Means Objectives hierarchy representing the management outcomes of interest for the workshop planning group and their potential relationships.

Influence Diagrams (Conceptual Models) – Influence diagrams are conceptual models for representing the main components of the problem and developing an understanding of how a particular action, or drivers, may influence each of the objectives. Patterns in these relationships can point to high value "levers" to pull in achieving objectives. They can also help in identifying important uncertainties and quantifying metrics for the objectives. Draft diagrams are included for each of the four focal systems (Figures 3-7). These components and relationships will require further refinement.

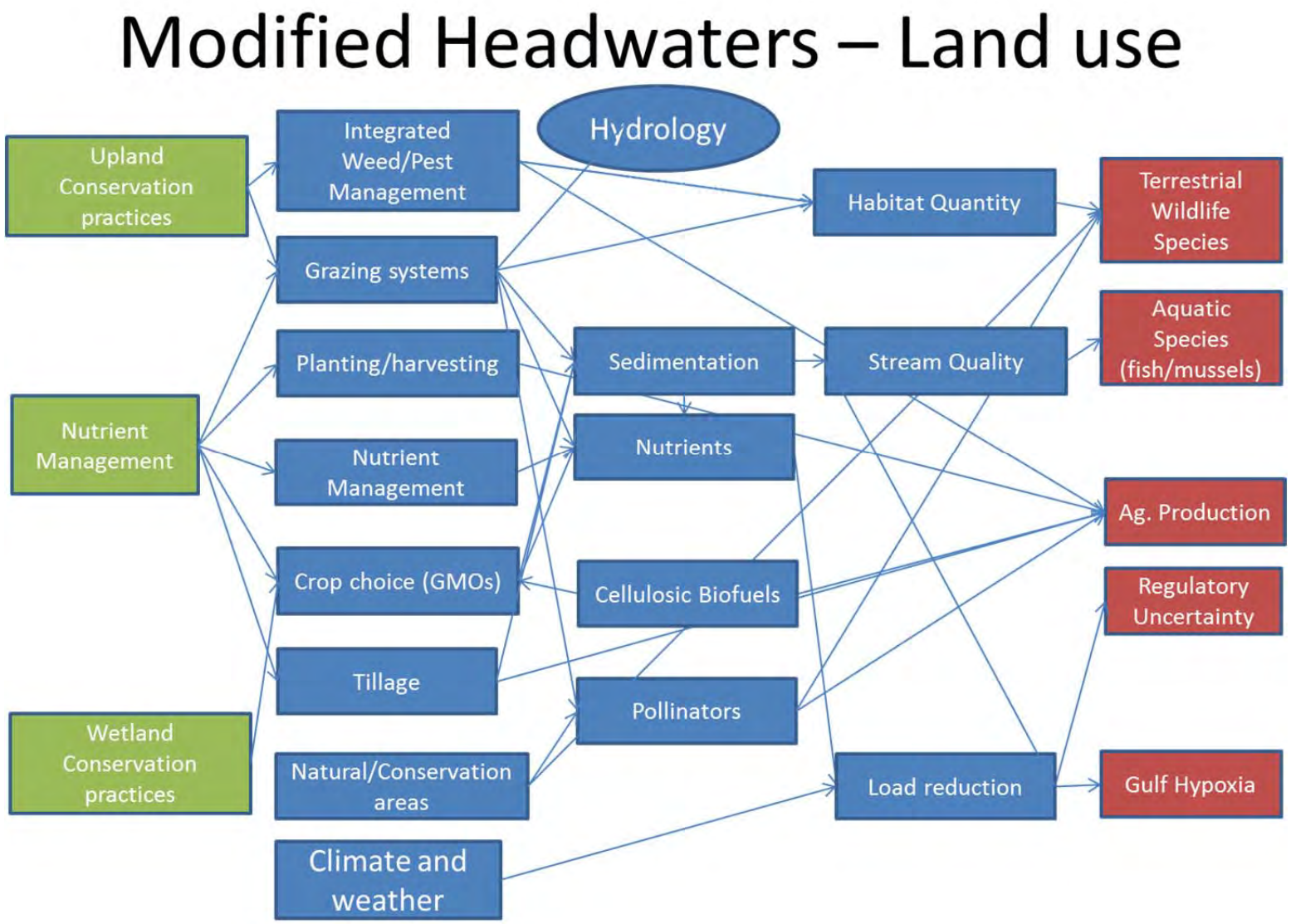


Figure 3. Draft influence diagram for land use in "modified headwaters", where green boxes represent action types, blue boxes represent system processes or uncertainties and red boxes represent fundamental objectives. The hydrology and land use models may be linked.

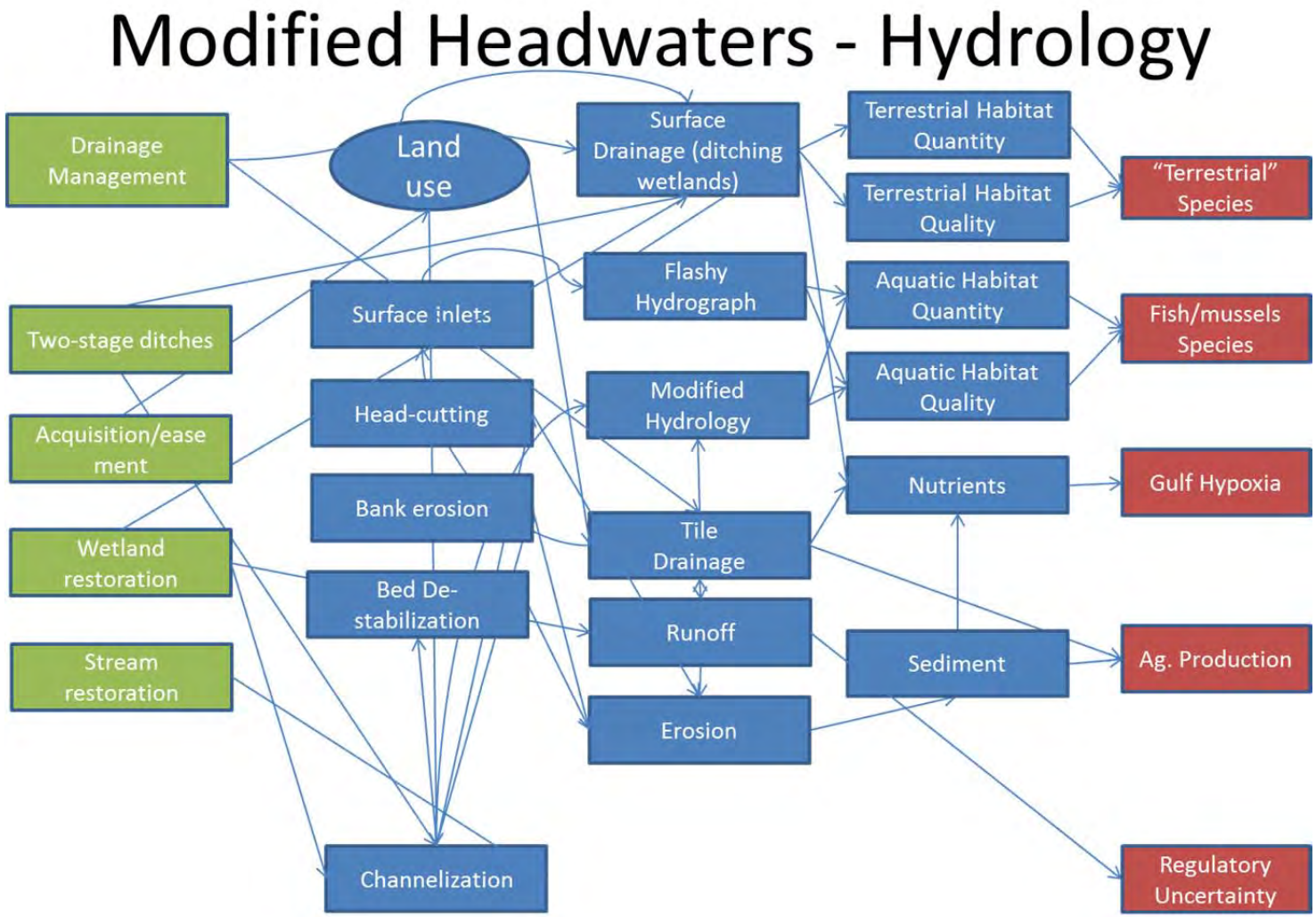


Figure 4. Draft influence diagram for hydrology in "modified headwaters" in agricultural working lands (row crops or grazing), where green boxes represent action types, blue boxes represent system processes or uncertainties and red boxes represent fundamental objectives. The hydrology and land use models may be linked.

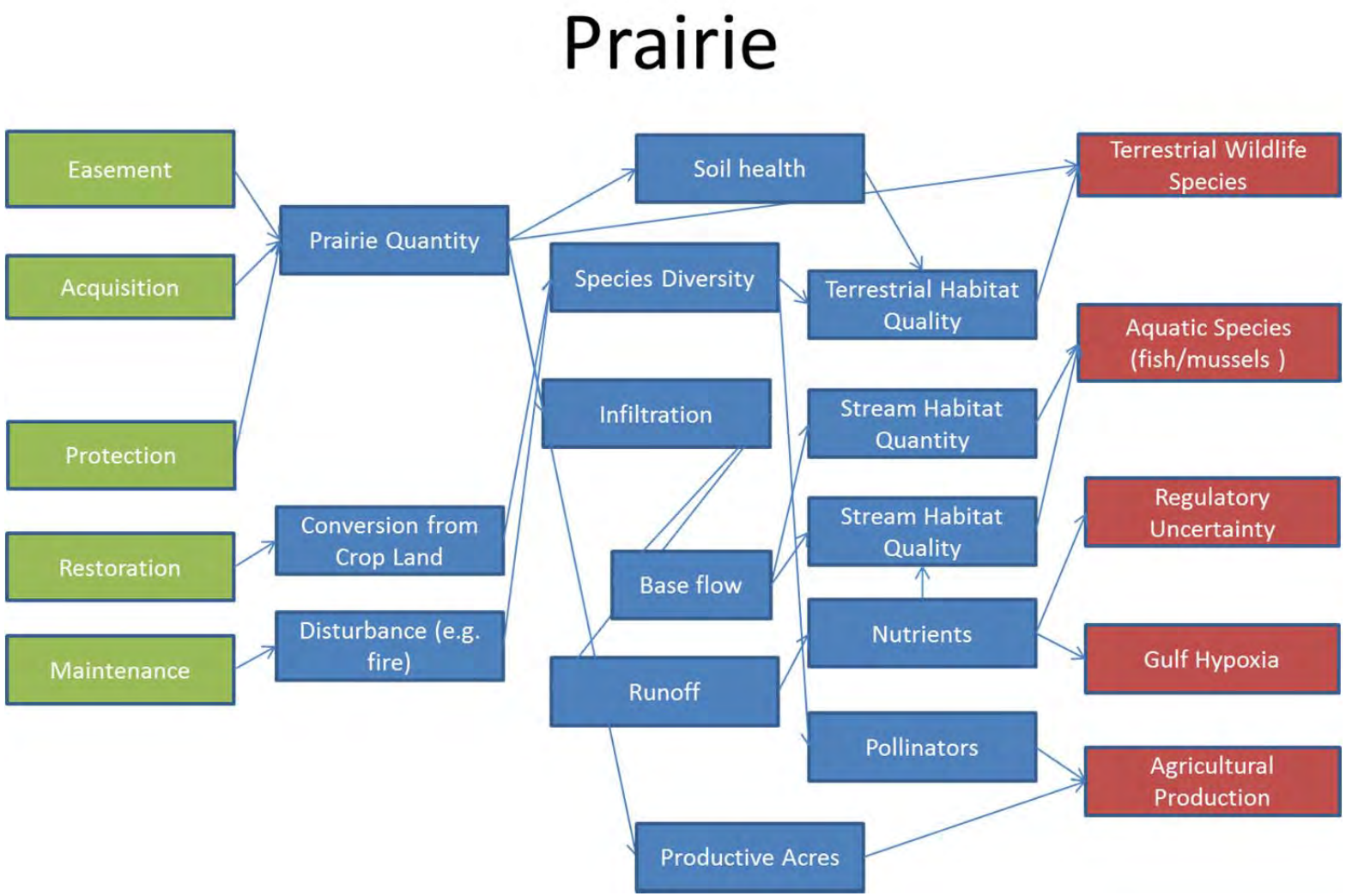


Figure 5. Draft influence diagram for prairie systems in uplands, where green boxes represent action types, blue boxes represent system processes or uncertainties and red boxes represent fundamental objectives (based on Figure 1 in Dowler, et al., 2013).

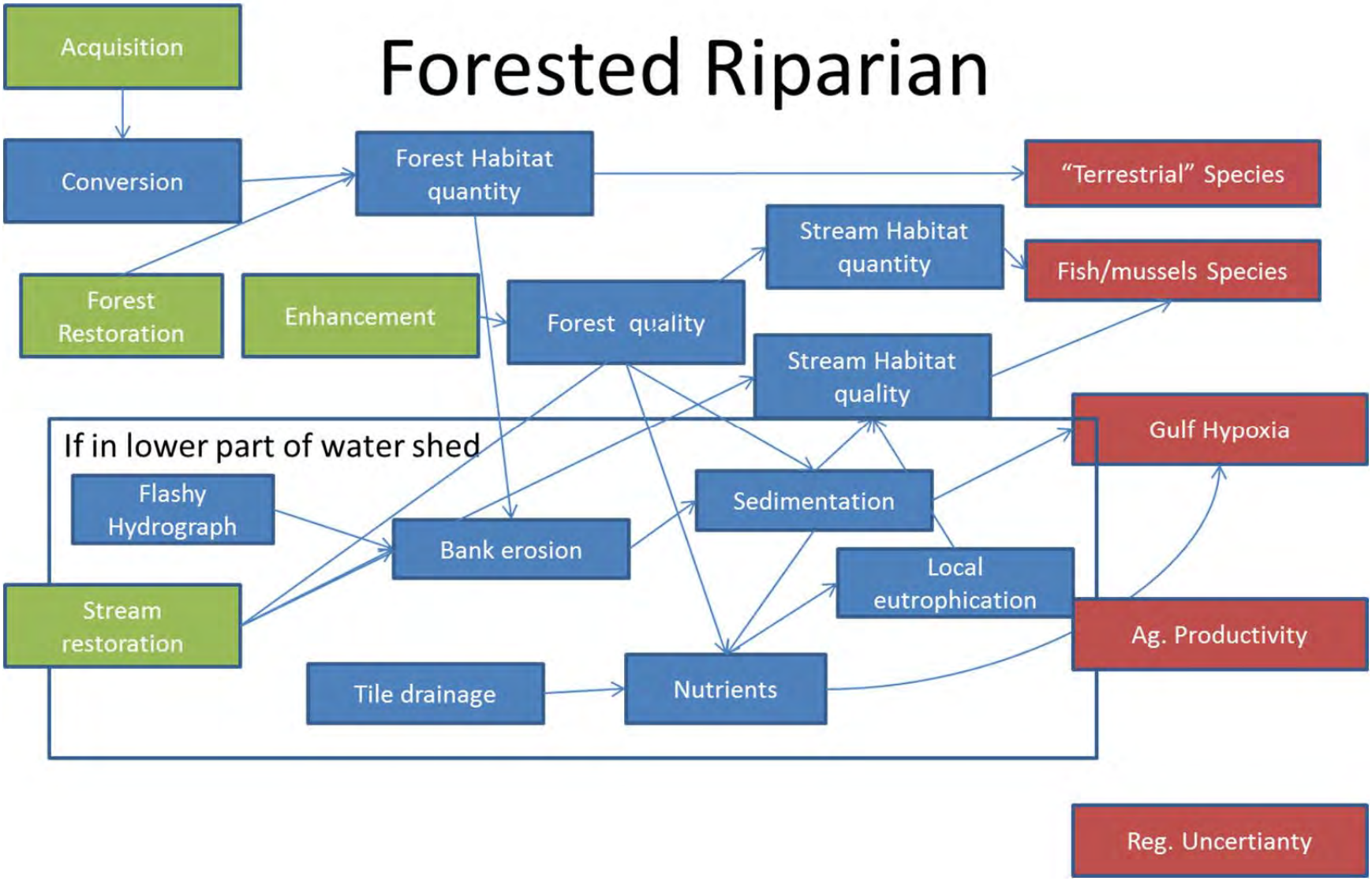


Figure 6. Draft influence diagram for forested riparian systems in small streams and mid-sized rivers, where green boxes represent action types, blue boxes represent system processes or uncertainties and red boxes represent fundamental objectives.

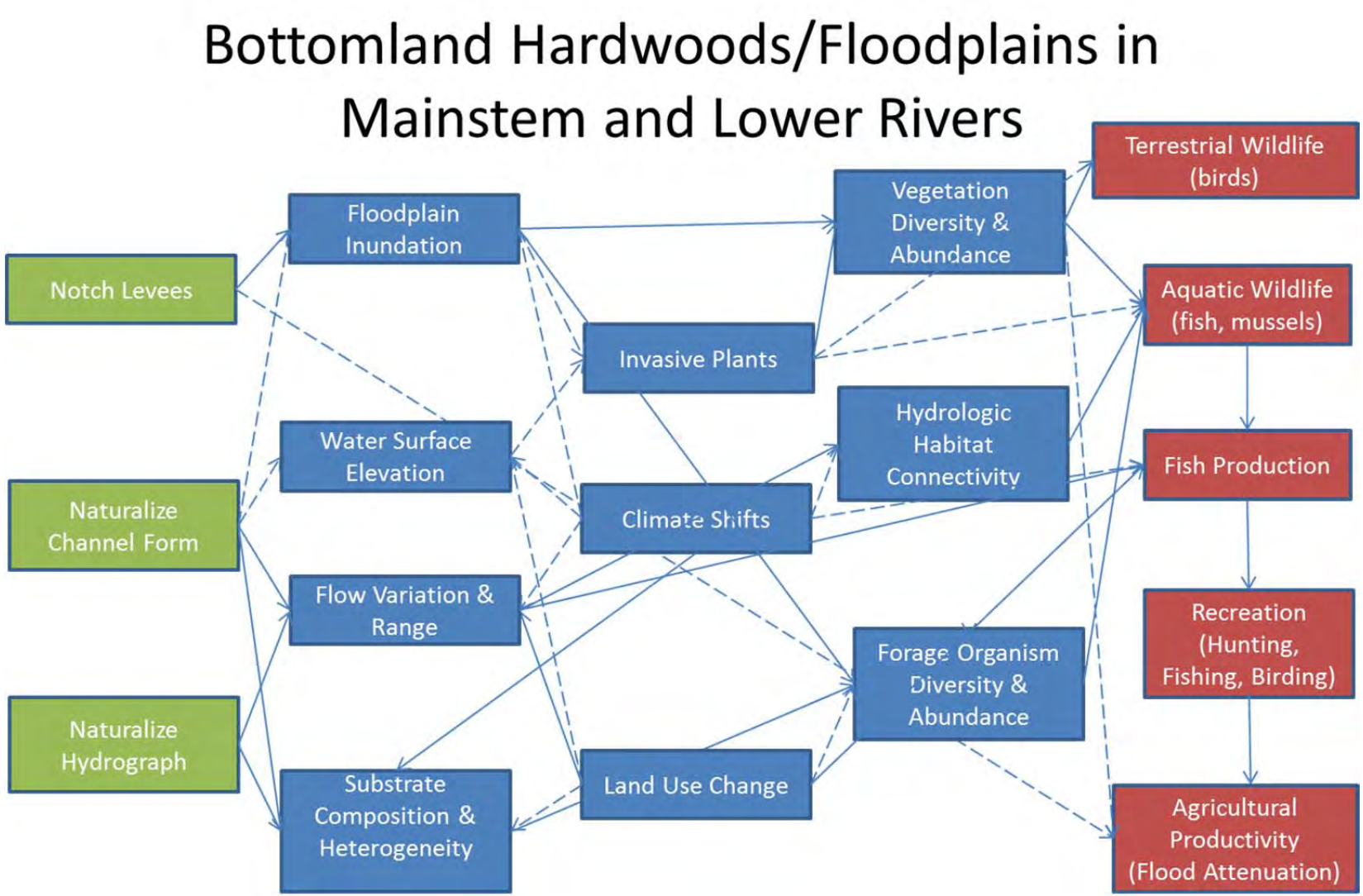


Figure 7. Draft influence diagram for bottomland hardwood / floodplain systems in mainstem and large rivers, where green boxes represent action types, blue boxes represent system processes or uncertainties and red boxes represent fundamental objectives (based on Figure 2 in Casper et al., 2009). Note, this diagram was developed post-workshop and is not yet consistent with the SDM framework.

Performance Measures - Using the influence diagrams as a starting point, quantitative measures can be developed for predicting the impact of a particular action or strategy in terms of the objectives (Table 1).

Desirable properties for performance measures are:

- Unambiguous – clear relationship between management action and consequences
- Comprehensive – covers range of possible responses to management action
- Direct – indicates actual achievement of outcomes
- Operational – feasible with available resources (time, equipment, staff)
- Understandable – communicates to key audiences

Table 1. Potential metrics for measuring impact of Actions on the Fundamental Objectives and Constraints.

Objectives	Measures	Source
Wildlife benefits	• Total abundance; Energy value; Biodiversity index • Nest success • Occupancy (presence/absence) • Abundance • Biotic integrity index Metric probably aggregated across watersheds or landscape	JV Models; existing data or other models; expert opinion; state agencies
Gulf Hypoxia	Total N and/or P yielded across watersheds	SWAT and SPARROW models
Impacts to producers	Annual revenue; long term average annual revenue; crop yield; $ needed to incentivize implementation; number of additional regs.	USDA ERS, FSA, Cooperative Extension Service, etc.
Conservation costs	Annual dollar amount spent on action; time value of money	Conservation groups, university economists, state agencies, etc.

Metrics for Wildlife Benefits

Metrics to evaluate population objectives need to be operationalized so that they may be either modeled or monitored (e.g., bird counts, fish Index of Biotic Integrity). The planning team discussed occupancy of certain species as a measure of the benefit for wildlife.

The group identified several species for each system type (see Objectives, Figure 2) according to the following criteria:

- Sensitivity to drivers / stressors
- Floodplain connectivity
- Sensitive to climate change
- Susceptible to high nutrient loads
- Response to cropland production
- Capacity to monitor population levels over long time frames (e.g., birds on BBS routes)
- Life history requiring a water-upland interface (e.g., shorebirds, dickcissel)
- Large ranges, widely dispersed and/or migratory
- Flagship species with interest for agricultural producers (private lands)

Species could be used for:

1) Predicting benefits from conservation practices for conservation design; and
2) As monitoring metrics to determine success in achieving the objectives (might pick a subset).

Focal Species – Species would be selected to match the conservation objectives and actions in these systems. A list of potential representative species for designing and monitoring actions within each of the four Ecological Systems (Focal Habitats), developed through the workshop and online input, are as follows. Species listed in alphabetical order by taxon with ratio of online respondents indicating appropriate to not appropriate, where available. Species with no ratio indicated below were suggested by respondents and so not evaluated by others. Comments about individual species from online respondents are included below. (^{SSp} - US FWS has selected species as a Surrogate Species)

<u>Modified headwaters in fields or borders</u>

Birds:

- American golden plover (staging area concentrated in east-central Illinois and west-central Indiana) – 6:1
- Blue-winged teal – 6:1

Amphibians:

- Leopard frog
- Crawfish frog (distribution and abundance is too narrow and low. Do best in large grassland/wetland landscapes and not necessarily within working agricultural landscapes. Highly tied to crawfish burrows.) – 5:1

Fish (Index of Biotic Integrity / fIBI, where available):

- Blackside darter^{SSp}
- Brown trout
- Creek chub
- Johnny darter
- Sculpin – 6:2
- Topeka shiner^{SSp}

Terrestrial insects:

- Monarch butterfly^{SSp} – 24:1

- Pollinators (e.g., native bees)

Aquatic Macroinvertebrates - Index of Biotic Integrity (mIBI), where available

- Stoneflies
- Limnephilid caddisflies
- Freshwater mussels

Plants:

- Wild Rice (northern basin)

<u>Prairie</u>

Birds:

- Blue-winged teal[SSp] (prairie nesting waterfowl species with long-term intensive monitoring already in place through Waterfowl Breeding Population and Habitat Survey)
- Bobolink[SSp] – 27:1
- Dickcissel (indicator of field-scale health, a la "Healthy Farm Index")
- Gadwall (prairie nesting waterfowl species)
- Grasshopper sparrow[SSp] (tends to occupy grass stands that are less dense with less litter layer. Although this is less ideal for water quality, it may be more a more appropriate indicator for BMPs in some grazing systems.)
- Henslow's sparrow[SSp] - 26:0
- Horned lark
- Killdeer (easily seen, widespread breeding species that is easily monitored and responds well to preservation of ephemeral ponds, filter strips, moderate to lightly grazed pastures)
- Loggerhead shrike
- Mallard[SSp] (prairie nesting waterfowl species)
- Marbled godwit
- Eastern & Western meadowlarks[SSp] (indicators of field-scale health, a la "Healthy Farm Index")
- Northern bobwhite (working lands component of prairie systems)
- Northern pintail (prairie nesting waterfowl species)
- Prairie chicken (high priority target but of such limited distribution to not be a widely useful indicator. could cover this habitat type, in reality its distribution is quite limited, and misses a lot of the region that the Gulf project is dealing with.) – 23:2
- Sedge wren
- Upland sandpiper[SSp]
- Short-eared owl

Mammals:

- Prairie vole
- Plains pocket gopher
- Richardson's ground squirrel

Terrestrial insects:

- Monarch butterfly[SSp] – 24:1
- Regal fritillary butterfly

Plants (high floristic quality index):

- Lead plant (*Amorpha canescens*)

- Prairie dropseed (*Sporobolus heterolepis*)
- White prairie clover (*Dalea candida*)

<u>Forested riparian in mid-sized streams</u>

Birds (incl. Waterfowl Breeding Population and Habitat Survey):

- American woodcock[SSp]
- American redstart – 8:1
- Belted kingfisher
- Blue-gray gnatcatcher
- Indigo bunting
- Ivory-billed woodpecker
- Mallard[SSp]
- Red-eyed vireo – 6:2
- Wood duck[SSp]

Mammals:

- Louisiana black bear
- Rafinesque's big-eared bat
- Southeastern Myotis bat

Fish (Index of Biotic Integrity, where available):

- Black redhorse[SSp] – 4:2
- Pallid sturgeon[SSp] – 3:3
- Pugnose minnow[SSp] – 6:0
- River redhorse[SSp]
- Shovelnose sturgeon[SSp] – 4:2
- Smallmouth bass[SSp] – 7:0
- Weed shiner[SSp]

Reptiles & Amphibians (sensitive to water quality, habitat diversity, structural complexity):

- Copper-bellied watersnake

Mussels (benthic macroinvertebrates are by far the best indicator species for determining water quality. Fish and other larger vertebrates have the ability to relocate more quickly and also adapt to local conditions more effectively.) – 14:0

Cyanobacteria – 6:1

Vascular plants (diversity) – 7:2

Physical / chemical (e.g., Qualitative Habitat Evaluation Index, where available)

<u>Bottomland hardwoods</u>

Birds

- Acadian rlycatcher – 11:1
- Barn or tree swallows
- Cerulean warbler (forest breeding songbirds/landbirds) – 12:0
- Kentucky warbler
- Mallard (migration and wintering waterfowl) – 10:3
- Prothonotary warbler (forest breeding songbirds/landbirds) – 14:0
- Red-headed woodpecker (forest breeding songbirds/landbirds) – 11:3

- Swainson's warbler
- Swallow-tailed kite
- Turkey
- Wood duck[SSp] (breeding, migration and wintering waterfowl) – 15:0
- Wood thrush[SSp]

Fish and salamanders (Index of Biotic Integrity, where available)

- Alligator gar – 11:1
- Mudpuppy
- Shovelnose sturgeon[SSp]
- Pallid sturgeon[SSp]
- Weed shiner[SSp]

Aquatic macroinvertebrates (Index of Biotic Integrity, where available)

- Palaemonetes shrimp

Mussels (may not be an appropriate indicator species if what happens in the upper reaches of the streams has more impact on mussels) – 9:4

Metrics for Gulf Hypoxia

The team discussed the cumulative Total Nitrogen or Phosphorus yield across watersheds as a reasonable metric. However, the measure that the team would use would be the total reduction of nutrient load that wildlife actions could contribute toward, rather than whether such actions would approach pre-established targets defined by water quality programs.

Metrics for Agricultural Productivity

Metrics that reflect the value of land and water management for private lands will be refined further along in the process. As a starting point, possible measures of revenue-neutral impact on agricultural productivity and profitability may include:

- Time and resource inputs (e.g., fertilizers, pesticides)
- Changes in yield relative to neighbors in surrounding area; or simply average crop yield
- Fit with current farming production systems
- Regulatory uncertainty and increase self-directed voluntary decision-making
- Market value (e.g., sustainability certification)
- Need for disaster assistance and taxpayer financial risk
- Outdoor recreation and alternative revenue generation
- Soil health
- Water quality

Metrics for Implementation Costs

This could simply be measured as the average cost per acre of applying a certain action. However, a modification could be made to include additional costs that would represent the willingness of agricultural producers to invest in a given strategy. In other words, if producers are more willing to invest in a strategy this would effectively lower the cost of that strategy. Unwillingness could then be represented as increased cost; perhaps this could be expressed as the additional financial incentive needed to influence adoption.

Alternative Actions – The team discussed whether landscape conservation design could be scalable, first looking for higher order (larger) watersheds with overlaps between water quality and wildlife, and then drilling down to create models for practices within habitat types (or systems) at the local level. The process would determine the optimal distribution or proportion of actions within watersheds. More detailed local scale implementation decisions would be best left to managers who are familiar with local receptivity to specific conservation practices. Participants listed possible Alternative Actions to consider for impacts on objectives.

Headwaters & Working Lands

Practice	Effectiveness (1-high; 5-low)			Cost (1-low; 5-high)			Combined Ranks
	Mean	Std Dev	Rank	Mean	Std Dev	Rank	
Cropland for invertebrates	3.20	1.40	3	1.67	0.71	3	6
Drainage layout for management	2.67	0.98	2	1.83	0.83	4	6
In-field prairie STRIPS	4.00		8	1.00		1	9
Soil health	3.58	1.62	5	1.75	0.75	5	10
Constructed wetlands	2.50		1	5.00		10	11
Oxbow restoration	5.00		10	1.00		2	12
Alternative crops (i.e., biomass)	3.62	0.96	6	1.92	0.76	6	12
Drainage water management	3.38	1.19	4	2.54	0.52	9	13
Buffers	3.92	1.19	7	1.92	0.49	7	14
Habitat restoration	4.42	1.16	9	2.50	0.52	8	17
Nutrient criteria	5.00		11	5.00		11	22

Practice list

- Buffers
  - Prairie strips – using native grasses and forbs in fields on slopes above 5% ("3/5" effectiveness; low cost)
- Integrated Pest Management
  - Diversified crop rotation
  - Scouting for birds, insects
  - Different herbicide groups
  - Variable cultivation practices
  - Banded versus broadcast application
  - Strip cropping
- Nutrient management
  - Precision management – 4Rs
    - Split and variable rate application

        - Manure injection
        - Treatment wetlands – at bottom of drains
        - Late spring test with side dressing
        - Treatment time
        - Soil health
        - Cover crops
        - Green manure
        - Long-term crop rotations
- Regulation
    - Buffers should be required via legislation, given the research supporting effectiveness.
    - Numeric nutrient water quality standards and their regulatory application to identify nutrient impairments at the HUC8 or smaller scale and obtain compliance - effectiveness 5; cost 5 (costs passed on to producers and consumers)
- Restoration and establishment
    - Adaptive management - improvement through monitoring and feedback.
    - Prescribed fire, invasive species, mid-contract management, 2-stage ditches
        - Prairie
        - Riparian
        - Savanna
        - Streams
        - Wetland
    - Oxbow restoration - effectiveness (5) cost (low - 1)
- Soil health
    - Adaptive nutrient management
    - Crop rotations (see Davis et al. 2012 PlosOne)
    - Cover crops, late summer aerial seeding
    - Crop diversification (3 crops)
        - Perennial biofuels
        - Hay
    - No-till with cover crops
    - Reduced fallow periods
    - Reduced tillage with long-term rotation
    - Organic agricultural practices to achieve comprehensive and sustainable improvements to soil health. This includes adoption of no-till techniques.
- Water management
    - Constructed wetlands placed between crops and river systems will reduce suspended sediments and other contaminants (high value, high initial cost).
    - Drainage water – incorporated with tile line management (not just herring-bone tile).
    - Exclude cattle from streams or regulate crossings.
    - Instream biogeochemical processes - removal of tile drains or diverting tile drain water into treatment wetlands; increased channel-floodplain connectivity; sediment capture ponds with implemented sediment removal activities, so that

accumulated sediment is placed back on the source lands; water table management; ditch management.
    - Irrigation water
    - Residue management
    - Soil health as part of water management

- **Prairie & Savanna**
    - Grazing (other practices apply to lands grazed and not grazed)
        - Delayed haying
        - Delayed grazing, intensity and duration
            - To improve bird nest success
            - Rotational grazing to promote grass species diversity, cover and structure for wildlife.
        - BMPs for grazing
            - Fencing and watering systems for cattle
    - Protection
        - Fee title and easements – for last remaining jewels of intact prairie
            - Perpetual, number of years, short-term agreements
        - Support ranchers and producers to keep them on the land, using it as working land as more likely to stay in condition that could benefit wildlife.
        - Grassed banks – NGOs or entities that own significant expanse of grassland that is loaned or rented as a "drought reserve" to help ranchers get through difficult years without overgrazing their property.
    - Restoration (creeks, streams, wetlands)
        - Restore hydrology or topography – plugging drains, keep wetlands for drought resilience
        - Native or wildlife-friendly riparian buffers
    - Prescribed fire
    - Invasives control
        - Weed species encroachment (fire, grazing, mechanical, chemical), especially important in non-grazed areas.
    - Forb component in grasslands
        - Native seed mixes, locally sourced.
        - Judicious use of herbicides important for wildlife, especially pollinators.
        - Manage intensive grazing – can bring forbs back without having to seed them.
    - Pest management
    - Nutrient management
        - Patch-burn-grazing for soil health – rotate grass use through time
    - Retain savanna structure - particular management of structure with some trees, but not taking over
        - Timber stand improvement
        - Fire
        - Grazing
    - Patch size and connectivity

        - Benefits wildlife
        - Reduced costs of management

- **Riparian Small & Mid-sized Streams**
    - Need everyone else to do their job keeping sediment and water on land before riparian areas.
    - Buffers
        - Native
        - Woody
        - Vegetated
        - Saturated to protect groundwater
    - Connectivity - terrestrial and aquatic
        - State or practice? Connecting wetlands to riparian areas to stream, but also remeandering stream system. Also addressed terrestrial patches in juxtaposition to water. Depends on species of wildlife.
    - Low-head dam removal
    - Remeandering
    - Stage or natural restoration of streams
        - Remove sediment to recreate what was there prior to channelization.
        - Stream bank stabilization, especially using native materials adjacent to stream.

- **Floodplains / Mainstem Large Rivers**
    - Timber Stand Improvement
    - Desired future conditions of floodplain forests for wildlife
    - Prescribed Fire
    - Mechanical disturbance (disking, mowing)
    - Chemical disturbance (pesticide, herbicide)
    - Restore or mimic hydrograph
    - Water level management
    - Land cover easements and restoration
        - Reforestation.
        - Farmable floodplain easements similar to WRP. Knock down levees, expand floodplain, and allow limited cropping without insurance on some years.
        - Post-flood cover - over fallow areas with cover crops to benefit soil health and wildlife.
    - Invasive control (plant, wildlife – nutria)
    - Crop management
    - Groundwater management
    - Moist soil management
    - Large-scale river diversions – in Louisiana lower basin to restore wetlands for nutrient removal and reduced loading into Gulf. Questionable science to predict benefits.
    - BMPs for forest management & harvesting (water quality runoff guidelines)

Consequences - A consequences table is used to check whether the fundamental objectives capture all of the outcomes of interest across a range of hypothetical actions and whether the table captures all of the information needed to choose a particular strategy.

Table 2. Example of a Consequences Table. The alternatives represent hypothetical actions that could become components of more complicated strategies. Further work on the MRB/GH Initiative would complete tables like this for suites of selected actions. (*Values in this table are examples only.)*

Alternatives	Objectives				
	Terrestrial Wildlife	Aquatic Wildlife	Agricultural productivity	Practice costs	Gulf hypoxia
Acquisition				$8,000/acre	high N capture
Grassed buffer	0.3			$300/acre	low N capture
CRP in block	0.8			$500/acre	high N capture
Cover crops	0.01			$20/acre	medium N capture
Compliance assistance				TBD	
Tax incentives				TBD	
Controlled drainage				TBD	
Status quo (no action)				TBD	

Another way to think about alternatives is as a combination of actions, termed a strategy. Table 3 shows an example of an example of a strategy generation table, which can be thought of as a menu of options that can be combined into a strategy.

Table 3. Example of a Strategy Generation Table for a forested riparian system.

Acquisition	Voluntary program	Forest restoration	Enhancement of existing site	Stream restoration
Fee title	None	Natural regeneration	Prescribed burning	Bank stabilization
Easement	Stewardship (5 yrs)	Planting (bare root)	Thinning	Armoring
	Agreement (10 yr)	Planting (RPM - sapling)	Invasives removal	Rock hard-points
	Agreement (20 yr)			Excavation

A strategy generation table could be used to compare combinations of actions by asking several questions, such as:

- Are there natural combinations of these practices?
- Where will combinations be cost-effective?
- How would the effect of these options change?

- Feasibility - some strategies (combinations) will not be applicable in certain areas.
- Who can implement actions?

In order to develop the prioritization model for mapping, a set of automated rules may be necessary, such as:

- What are the criteria?
- What are the options?
- What are rules for applying those options?

Draft strategy generation tables were prepared to depict suites of potential conservation actions for each of the four Focal Ecological Systems (see workshop notes for details)

Strategies / Portfolios – Rather than saying a specific action or practice is the desired alternative, the landscape design may focus on a portfolio of tools that partners could implement across a given priority watershed by describing how best to allocate that effort across the landscape. The strategies are organized by the four Ecological Systems, which may correspond directly to specific Agricultural Production Systems (e.g., prairie and grazing lands) or they may apply across multiple agricultural settings.

The group assembled suites of actions that naturally go together as a strategy and grouped them according to implementation cost. These groupings form the basis for further evaluation.

- **Headwaters & Working Lands (assuming conventional corn & bean rotation)**
    - Lower cost strategy
        - Drainage tiles laid out for potential future management (option for drainage water management with minimal retrofit)
    - Medium
        - Promote buffers – wildlife, water quality, not much production benefit
    - Higher cost strategy (all of the above plus this list)
        - Promote alternative crops – biomass, bioenergy
        - Promote buffers
        - Soil health system – no till, cover crops
        - Drainage water management
        - Habitat – plant grasses and trees
        - Manage crop land to best potential for macroinvertebrates and cover

- **Prairie** – some grazed, some ungrazed, riparian
    - Lower cost strategy
        - Prescribed fire
        - Drought management plan
    - Medium
        - Grazing BMPs
            - Rotational grazing
            - Delayed haying
            - Delayed grazing

        - Native seed mix (or managing for native grasses)
    - Higher cost strategy (all of the above plus this list)
        - Prescribed fire
        - Drought management plan
        - Grazing BMPs
            - Rotational grazing
            - Delayed haying
            - Delayed grazing
        - Native seed mix (or managing for native grasses)
        - Wetland package – riparian habitat
            - Grassed or biofuel buffers
            - Manure management
        - Branding / certification for products (bird-friendly beef)
            - Work on watershed scale with landowners

- **Riparian Small & Mid-sized Streams**
    - Lower cost strategy
        - Buffer
        - Streambank stabilization
    - Medium
        - Easements
        - Dam removal
        - Streambank stabilization
        - Patch connectivity
    - Higher cost strategy (all of the above plus this list)
        - Permanent protection of buffers and wetlands (e.g., through acquisition by agencies or organizations)
        - Connectivity of wetland and stream in patch adjacent to stream
        - Remeandering (hydrologic restoration)
            - Remove dams
            - Streambank stabilization

- **Floodplain Mainstem**
    - Upper Midwest Floodplain
        - Lower cost
            - Remove all artificial drainage, leaving them in place for extreme water events
            - Moderate vegetation restoration
        - Medium
            - Connectivity
            - Stop log water control structure
            - Grate to stop invasive carp
            - Vegetation or reforestation
        - Higher cost (all of the above plus this list)
            - Connectivity

        - Backwater habitat
        - Levee breaks
        - Water control structures at upper end of floodplain
        - Vegetative control – forestry, manipulation to get natural communities, invasive control

- Lower Mississippi Valley
    - Lower cost strategy
        - Regulate diversions to retain nutrients (maintaining)
        - Wetland reforestation
        - Dredge material used to create wetlands
    - Higher cost (all of the above plus this list)
        - Expand area of big woods in reforestation (permanent protection, such as acquisition by agencies)
        - Convert marginal croplands to forest (easement)
        - Vegetation
        - Water control structures
        - Invasive wildlife management (nutria, feral swine)
        - Water diversions – add sediment to create wetlands
        - Re-open old river channels

Optimization modeling – This tool is commonly used in multi-criteria decision analysis to assess where actions will perform the best, given multiple objectives and constraints. The team discussed developing a preliminary model with pre-identified focal areas. The optimization would then be done over the focal areas. Part of the problem here is that the team may be artificially constraining themselves to areas where they perceive they can do something, but in the big picture, these areas may not provide enough insight into the problem defined in the problem statement. An additional problem is how to deal with the different scales at which different actions are implemented.

Perhaps a more fruitful and flexible approach would be to use an algorithm to allocate a range of alternative actions to all the watersheds within the basin. The actions would effectively be the amount of area within a watershed where a certain practice or strategy that could be applied. The maximum percentage of an action within a watershed would be constrained by the total area of each of the four focal systems. This would allow the team to track cumulative benefits across watershed units, while being somewhat specific about how much effort should be invested in each watershed. This approach would also help to alleviate scaling issues associated with implementation actions. The optimized landscape would serve as a guide or discussion tool to determine how actions or strategies could be implemented within the watershed, which would also alleviate the potential of being too prescriptive.

Examining Trade-Offs – Actions differentially impact objectives. Trade-offs between actions with opposing effects may be necessary. Choices may differ according to stakeholder values and environmental conditions such as climate extremes. Optimization tools can be structured very simply (e.g., swing weights) or may be very complex (e.g., dynamic optimization). Such tools will be constructed in future steps within the Mississippi Basin / Gulf Hypoxia Initiative.

Weighting Objectives - Objectives can then be weighted to reflect the degree of preference for each objective. These weights can also be used to quantitatively assess where trade-offs are made among the different objectives. For example, to achieve wildlife objectives, it may be necessary to trade off improved nutrient reduction by working outside those areas with highest nutrient loads.

Example: Weighting Objectives

	A	B	C	D	E	F	G	H	
1			Objectives						
2	Alternatives	Wildlife	Revenue	Hypoxia	Cost				
3	Delayed haying	6	3	4	8	21	5		
4	Delayed grazing	5	4	5	7	21	5.03226		
5	Rotational systems	4	5	6	5	20	4.90323		
6	Riparian wetland management	7	1	8	3	19	4.83871		
7	Managed intensive grazing	3	6	7	4	20	4.93548		
8	Fee title - prairie	2	8	3	1	14	3.80645		
9	Easements - grass	1	7	2	2	12	3.12903		
10	Prescribed fire	8	2	1	6	17	4.35484		
11		0.32258	0.290323	0.22581	0.16129				
12									
13									
14			Time-value of money						
15			Wildlife	Revenue	Hypoxia	Cost	Agency		
16		Wildlife	Best	Worst	Worst	Worst	1	10	0.3
17		Revenue	Worst	Best	Worst	Worst	2	9	0.2
18		Hypoxia	Worst	Worst	Best	Worst	3	7	0.2

Sheet1 Sheet2 Sheet3 Sheet4
Ready 140%

Uncertainty and Sensitivity Analysis (Science Needs) – The group began to identify areas of scientific uncertainty that require further research within each of the four Ecological Systems. What would it take to implement this on the landscape, applied in the best way given conditions? What information would you need to predict outcomes? What don't we know? What science is needed to fill gaps (potential research projects)?

Uncertainties may lie in three areas: condition, effectiveness, and problem solving.

- *Condition* - the landscape condition over time to understand the baseline and progress relative to implementation of our strategies. Are there practices that can't be tracked as a result of government data transparency? Is the biggest problem what data to gather or how to create a common data base?
- *Effectiveness* - more data on the effect of these practices individually and in concert across various spatial scales.
- *Problem Solving* - a problem solving logic relative to planning that optimizes across the 3 goals.

Science Needs by Four Focal Systems

- **Headwaters / Working Lands**
  - Some practices with less controversy. Cover crops most controversial regarding data on species.
    - Irrigation water management –for species
    - Perennial bioenergy –for species
    - Buffers - agriculture productivity benefit on marginal land
    - Treatment wetlands – agriculture productivity
    - Manure handling & off-site storage until properly applied – no data on all. System doesn't exist. Probably good for all 3.
    - Soil health (whole system of practices) – yes/no for species, yes for productivity and water quality.

- **Prairies & Savannas**
  - Data plus or no data or question marks. Some have data across basin, but not others.
    - Grassland restoration impact on agriculture has some data but trade-offs and different impacts on different species.
    - Integrated Pest Management – more data than gaps but will vary through Basin.
    - Most gaps in linkage with hypoxia - more confidence on wildlife and agriculture.

- **Riparian Streams**
  - Identified research needed for all on Agricultural Productivity impacts, except for buffers which takes land out of production. What farmer needs for CREP to counteract negative impact is known.
    - Fish, terrestrial, water quality studies
    - Connectivity – terrestrial and water quality, plus for aquatic species.
    - Low head dams – increases fisheries and improves water quality
    - Remeandering – fish and terrestrial, water quality.
    - Stream bank stabilization – improved water quality.

- **Floodplains / Mainstem**
  - Some predictive capability. Similar gaps in practices and effects on water quality.
    - Timber Stand Improvement (TSI), reforestation, acquired lands, converted agricultural ground. Quantitative studies on water quality.
    - Invasive control effect on water quality.
    - Large River Diversion down south.

Geospatial Services Support – The Conservation Fund (TCF) provided interactive web mapping services and mapping products as part of a process involving the Eastern Tallgrass Prairie & Big Rivers LCC and partner LCCs to develop a process to map, evaluate, and select the most strategic and cost effective places to implement the integrated strategies that protect and

enhance wildlife habitat while complementing ongoing efforts that reduce nutrient loads in the Gulf of Mexico hypoxic zone.
The data and map products developed by TCF will be shared with the LCC's (and partners) at the conclusion of the project so that it can be integrated into their Decision Support Tool system already under development and scheduled for completion in late 2014.

In addition, TCF developed a provisional process for identifying focused areas of the landscape where there is a high likelihood of significant nutrient export from agricultural lands; participated on multiple workshop planning conference calls; provided presentations via webinar to orient workshop participants and brief the ETPBR LCC Steering Committee; assisted LCC staff in developing workshop reports and communications materials; and provided staff at two workshops.

Data collection - TCF collected data and set up map services in support of two workshops and for use by participants in between and post-workshops. A basic set of data layers considered to be helpful in aiding workshop participants with orienting themselves to the primary issues was assembled into a preliminary map service in preparation for the June 2014 workshop in Minneapolis. After the June workshop we continued our data collection efforts, added datasets suggested by participants, and identified preliminary implementation focus areas. After the August 2014 workshop we finalized the mapping services and collected the remaining datasets. TCF collected close to 200 datasets pertinent to the project and organized it into six broad themes which were then packaged into individual map services (see appendix for list of data sets).

Mapping Services

- **Basemap** (Service name: MRB_Basemap): This service mainly contains boundaries (e.g. counties, LCC, Joint Venture, watersheds) for the orientation of users. Also included are a select set of layers from EPA's EnviroAtlas. The EnviroAtlas layers include such information as water use, land use, potentially restorable wetlands, and economic data aggregated to the HUC-12 scale.

- **Species** (Service name: MRB_Species): This service contains GAP distribution models for potential indicator species identified by the workgroup; breeding pair models developed by USFWS-HAPET for ducks and grassland birds; USFWS Critical Habitat data; and species ranges used in NRCS' Working Lands for Wildlife program.

- **Habitats** (Service name: MRB_Habitats): This service displays historic vegetation patterns for states where data is available; the four habitat (ecological system) types (grassland/prairie, riparian systems, floodplain/bottomland hardwoods, and agricultural lands); wetland types; and Landfire data for Biophysical Setting and Environmental Site Potential. The Environmental Site Potential dataset represents vegetation that may become established if the site were left undisturbed, whereas the Biophysical Setting represents vegetation that may have been dominant prior to settlement. Major rivers classified by drainage area are provided for reference. The agricultural lands represent the most common agricultural land uses found in the 2013 Cropland Data Layer produced by USDA's National Agricultural Statistics Service. The grassland/prairie, riparian, and

bottomland/floodplain systems were extracted from version 2.2.1 of the GAP Land Cover dataset. Based on the NatureServe Ecological Systems Classification, the GAP land cover dataset provides a wealth of information about vegetation communities by allowing users to select from six hierarchical levels of detail. The source of the wetlands data is the National Wetlands Inventory from which we extracted emergent, forested and riverine wetlands.

- **Conservation Designations** (Service name: MRB_ConservationDesignations): This service displays areas identified as conservation focus areas at the state and regional scale, as well as protected lands. Note that not all states within the Mississippi River Basin have identified focus areas.

- **Green infrastructure** (Service name: MRB_GI_Networks): This service displays green infrastructure networks designed by The Conservation Fund at the landscape and regional scale that overlap the Mississippi River Basin.

- **Water Quality Focus Areas** (Service name: MRB_WaterQuality_FocusAreas): This service displays the inputs and outputs used to identify potential implementation focus areas as well as supplementary data for additional context regarding water quality. For more information see the "Delineation of Implementation Focus Areas" section below.

Using the Web Map Service - See complete web services user guide in appendix.
Navigate to the map service at: http://www.conservationgis.com and login using:

Username: msriver
Password: etpbr

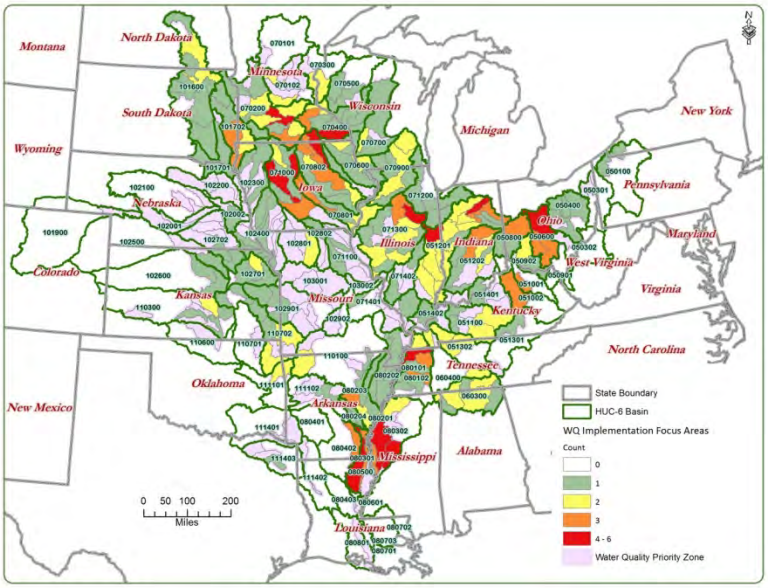
1) Click the "Manage" tab
2) Select "Map Services"
3) In the "MississippiRiverHypoxia" folder select the service that you wish to view
4) Click the green plus sign to add the service to the map
5) Usage Notes
   - Multiple services can be added to a single map.
   - In some instances, such as when initially loading the Conservation Designations service, some of the layers are "greyed-out" meaning that they are not visible at that scale. In order to make these layers visible all the user needs to do is keep zooming in until the layer name becomes black in the table of contents.

Delineation of Implementation Focus Areas
During the June 2014 Workgroup meeting in Minneapolis the group agreed that there was a need to narrow the scope of implementation from the entire Mississippi River down to a smaller set of focal areas in order to more efficiently allocate resources for implementation and help simplify modeling and future data collection.

The first step in this process was to identify the area of the Mississippi River Basin with the highest potential for nutrient export from agricultural sources (using nitrogen as the surrogate),

hereafter referred to as the "Water Quality Priority Zone" (Figure 1). Because the results from the most recent SPARROW model are somewhat dated (ca. 2002), we also considered the proportion of cropland within HUC-8 watersheds using the 2103 USDA-NASS Cropland Data Layer. This is particularly important considering the wholesale conversion of CRP lands to cropland over the past decade or so. The Water Quality Priority Zone contains any HUC-8 watershed with at least 308 kg/m2/year of nitrogen loading attributed to agricultural sources in the 2002 SPARROW Mississippi/Atchafalaya River Basin Model or containing at least 39% cropland as identified in the 2013 Cropland Data Layer. The SPARROW threshold represents the top 40th percentile of values, while the cropland proportion represents the top 20th percentile of values. These thresholds were selected somewhat arbitrarily with the goal in mind of selecting an area that was small enough to be manageable, yet large enough to contain a representative set of landscape conditions.

Within this Water Quality Priority Zone we then identified watersheds identified as implementation "priorities" by various parties and summed the total number of interests by watershed. In this instance "implementation priorities" means that the watershed has been identified as a focus for investment to improve water quality or aquatic habitat. Priority watersheds were identified from the following sources: NRCS Miss. River Basin Initiative; National Water Quality Initiative; U. of Minnesota Human Dimension Study Counties; Gulf Hypoxia Task Force State Nutrient Managements; High Tile Drainage Counties; Eastern North and South Dakota basins identified by PPP LCC staff; Midwest Fish Habitat Partnership; Cedar River Basin Initiative; USFWS Region 4/Southeast Aquatic Resources Partnership; Kansas Watershed Restoration and Protection Strategy; and EPA Regions 4 & 6.



There are at least two options for identifying implementation focus areas/landscape subsets: (1) select HUC-6 basins containing at least one HUC-8 with at least 3 aligned interests or (2) select groupings of contiguous HUC-8 watersheds with at least 3 aligned interests.

The threshold for number of aligned interests could be varied as well. Using a decision rule along these lines should represent a fairly well distributed set of conditions throughout the basin.

Figure 8. Preliminary map of Water Quality Implementation Focus Areas, showing number of programs with water quality implementation priorities within HUC-8 watersheds with at least 308 kg/m2/year of nitrogen loading attributed to agricultural sources in the 2002 SPARROW

Mississippi/Atchafalaya River Basin Model or containing at least 39% cropland as identified in the 2013 USDA-NASS Cropland Data Layer.

Barriers and Opportunities for Implementation – The group listed a series of potential barriers to implementing conservation practices within each of the five Farming Systems. These constraints may be used to rate strategies for feasibility or to identify opportunities for taking action to overcome barriers.

- **Corn & soybeans**
  - Cover crops
    - Technical knowledge
    - Seed supply
    - How to do cover crops with tillage
    - CCA education (certified crop advisors)
      - Information availability – getting information that exists into hands of right individuals.
    - Whether cover crops are feasible if leasing short-term, given that it takes more than a year to get a return.
      - Cover crops in different rotation varies.
  - Perennial bioenergy
    - Difference between whole-field versus edge and mono- versus polyculture
    - Markets, risks
    - Equipment
    - Mindset
    - Policy and economics
      - Fuel and food standards reduce renewable cellulosic.
      - Still more valuable for producer to grow corn.
    - Technology developments – on the farm and with use of cellulosic biofuels (E-85, E-15).
    - Technical understanding
      - Associated with growing and managing perennial crops sustainably.
      - Heat and power at small scale.
    - Future challenges of perennial biocrops
      - Transplanting switchgrass from place to place
    - Opportunity to rethink drainage – combine with modified drainage
      - If don't need to drain land, seize opportunity to revisit topic.
    - High cost of natural gas.
    - Social constraints – not comfortable taking on a new technology and knowledge.

- **Grazing lands**
  - CAFOs (concentrated animal feeding operations)
    - Economic incentives and market preference for grain-fed cattle. Alternative markets to change tastes.
  - Generation of methane

- Partners to work with
  - GLCI – grazing land conservation initiative
  - Partners for Conservation
- Behavioral change is generational
  - Younger generation (4-H)
  - How to measure that with congress wanting results every 4 yrs
- Consistent messaging across organizations
  - Landowner is really confused, just turns them off.

- **Floodplains**
  - Flood insurance policy
  - Ownership, authorities, COE programs (broken levee repair)
  - Owners may not want to move during narrow window of opportunity for landowner decisions.
  - Existing infrastructure – roads, utilities, schools.
  - Drainage infrastructure – ditches, pumps, tiles.
  - Uncertainty about alternative uses – real values of nutrient cycling, flood attenuation.
  - Nutrient management planning and regulation
  - Clean Water Act interpretation and enforcement is variable.
  - Market limitations – values have not been quantified for good economic picture of trade-offs on alternative floodplain uses.
    - Biofuels, carbon sequestration
    - Ecotourism, recreation
  - Invasive species
  - Tax base impact of land acquisition (varies across country)
  - Wetland restorations, especially in urban areas, have not functioned the way they were supposed to, filtration, mismatched drainage area and size of ponds (need restoration science).
  - Historic land use (ownership and community cohesion)
  - Awareness of program availability.
  - Not knowing what is happening in changing agricultural communities.

- **Rice**
  - Management operation capacity of producer to optimize practices. May be lag time between implementation and when water is used.
  - Precision agricultural data is lacking for rice & cotton. High priced crops. Reduced nitrogen use by 7% by going to RTK steering. Precision use of nitrogen. Data being collected.
    - Farmers not utilizing to extent they could.
    - Technical capacity.
    - Don’t know who owns the data or access.
  - Water supply availability
    - So farmers don’t have to pump groundwater.
    - Budgetary constraints.
  - Complexity of programs and regulations

        - Hard for individual farmers to keep up with changes. New acronyms, regulations, issues with wetlands.

- **Cotton**
    - Utilization and precision agriculture
    - Management capacity of producer
    - Timing management of cover crops
        - Source of organic matter and soil health.
        - High value crop, don't want to plant 5 days late because cover crop isn't ready to be terminated, losing value.
    - Costly
        - Expensive to raise cotton – takes a lot of inputs, number of times over the field, aerial application (also with rice). Precision with GPS getting better.
    - Complexity of programs and regulations.

Collaboration Strategy - The group also identified at least two process objectives, formulated as a Collaboration Strategy through the "Collective Impact" approach. These Process Objectives included:

- Increase involvement of the affected public (e.g., private landowners and agricultural communities)
- Increase the use of already existing frameworks and efforts (e.g., Hypoxia Task Force, State Wildlife Action Plans, NRCS MRBI, etc.)

What are the five conditions of Collective Impact success?
Collective Impact is a rigorous and specific framework for collaboration among organizations facing a complex problem affected by many inter-related factors and where large-scale solutions require broad cross-sector coordination rather than isolated intervention by individual entities. There are five conditions that, together, lead to meaningful results from aligning the activities of multiple agencies and organizations:

1. **Common Agenda:** All participants have a shared vision for change including a common understanding of the problem and a joint approach to solving it through agreed upon actions
2. **Shared Measurement:** Collecting data and measuring results consistently across all participants ensures efforts remain aligned and participants hold each other accountable
3. **Mutually Reinforcing Activities:** Participant activities must be differentiated with each entity exercising its expertise while still being coordinated through a mutually reinforcing plan of action
4. **Continuous Communication:** Consistent and open communication is needed across the many players to build trust, assure mutual objectives, and appreciate common motivation
5. **Backbone Organization:** Creating and managing collective impact requires a separate organization(s) with staff and a specific set of skills to serve as the backbone for the entire initiative and coordinate participating organizations and agencies

This structure may present a very applicable model for LCC partner relationships addressing this complex conservation problem.

Outreach & Communications – Implementation of conservation practices will require a strategic marketing and communications approach with consistent messaging across participating agencies and organizations, including use of strategic planning (modeling), policy and infrastructure changes, and resource allocation among programs and activities. Find one theme that all stakeholders can relate to such as "sustainable infrastructure." Communicate success, needs (e.g., structure, functions and connectivity), and model feedback in simple terms like a dashboard.

Audiences and messages are likely to differ across objectives (wildlife, agriculture, water quality). Audiences who may conduct or be affected by actions include agricultural producers or land managers, corporations and private entities (agribusiness), and consumers of agricultural products as drivers of adoption.

Messages may describe initiative projects, research, policy changes and resource allocation.

Venues for delivering conservation messages may include: extension services, celebrities or organization campaigns (e.g., Gulf of Mexico Alliance, Practical Farmers of Iowa, Delta Farmers Advocating Resource Management, Illinois Council on Best Management Practices), conservation delivery networks (e.g., Joint Ventures), agency programs (e.g., NRCS State Technical Committees), NGOs (for policy changes), and state nutrient management strategies.

The group then identified a preliminary list of high performing watershed organizations and other programs that are implementing conservation successfully and where pilot approaches may be tested.

Examples of high performing project areas that may be amenable to pilot approaches:

- Atchafalaya Basin, Louisiana; Vermillion Bottoms-Lower River IBA Batture Lands, LA – wetlands restoration
- National Audubon Society
- Big Darby, Ohio
- Boone River Watershed, Iowa, Cover Crops Implementation (Fishers & Farmers Partnership, TNC, Iowa Soybean Association)
- Bourbeuse/Meramec Watershed , Landowner Committees - Fishers & Farmers Partnership, Missouri Department of Conservation
- Confluence Partnership where Missouri meets Mississippi River (wetlands, habitats)
- Conservation Delivery Networks – work in Joint Ventures in lower basin
- Coordinated Agricultural Products project – CenUSA in Iowa. Louisiana State University cane production.
- Delta F.A.R.M. or Delta Farmers Advocating Resource Management – Reach Program
- Driftless Area watersheds
- Edwards Plateau (Hill Country Alliance)
- Great Lakes Water Quality Agreement

- Green Trees program for growing bioenergy crop, restoring hardwoods and carbon sequestration payments
- Gulf of Mexico Alliance
- Healthy Rivers INitiative, Wabash River, Indiana
- Iowa Department of Transportation - highway right-of-way native prairie planting
- Kankakee River, Indiana
- Kickapoo River, Wisconsin
- Lake Erie Phosphorus Task Force
- LMRCC & Army Corps work - dike notching and the ILT multi-LCC grant
- Mackinaw River Partnership, Illinois (TNC) – paired watersheds for city of Bloomington
- Midwest Conservation Biomass Alliance
- Mississippi State water quality initiative (identified in the background reading)
- MRBI – working lands and wetland restoration, use SPARROW models to prioritize watersheds, county staff pick subwatersheds
- National Great Rivers Research and Education Center (NGRREC), Alton, IL
- NBCI for examples of local groups
- NOAA/NGI Hypoxia Workshop
- Ohio Watershed in Distress Program, Ohio Department of Agriculture
- Peno Creek Watershed, Managed Grazing Implementation - Fishers & Farmers Partnership, Missouri Department of Conservation
- Prairie Plains Resource Institute in Nebraska
- Root River
- Sauk River (Stearns and Todd Counties, Minnesota)
- Tara - large estate near Vicksburg managed as hunt club
- Texas Parks & Wildlife Dept. in Edwards Plateau - Guadalupe Bass recovery
- The Horinko Group
- USFS Forest Stewardship program
- Yellow River basin in Iowa

Additional potential applications of the Landscape Conservation Design (LCD) approach based on this MRB/GHI framework include:

- Continue to develop and implement strategies to better connect up and downstream stakeholders, as well as working to best utilize existing conversation and related programs, particularly in conjunction with USDA.
- Target their actions of agencies/groups to areas of greatest priorities and leverage efforts. However, to fully benefit, the stakeholders must develop that design to work towards. Lots of tools but little design at this point.
- Irrigation tailwater recovery should be adopted widespread in the Lower Mississippi River Basin, reducing groundwater withdrawal and providing minor habitat.
- IWRM conservation design with leveed floodplain re-integrated into the hydrologic cycle through managed connections during appropriate times of year when crops are not growing. Existing ditch infrastructure can be used to move water through floodplain for greater nutrient management potential.

- Designs that involve buffer strips, constructed wetlands, removal or plugging of tile lines. Policies that provide incentives for conservation and remove incentives for intensive farming on erodable land. Remove incentives for ethanol production.
- Applications: Establishing funding criteria for grant programs.
- Uptake into state and regional plans (e.g., State Wildlife Action Plans, prairie plans)
- Habitat and natural resource management planning at smaller scales
- Prioritization / resource allocation for land purchases and program decisions
- Communication with / persuasion of stakeholders outside of the bird conservation community Educating/influencing policy decisions, office holders
- Possible end users:
    - County board members
    - Municipal planners
    - Park district commissioners
    - Grazing/haying brokers
    - Natural Resources Conservation Service (NRCS) national and state level administrators and program staff
    - Farm Service Agency (FSA) national and state level administrators and program staff
    - Public land managers and biologists (municipal, county, state, federal)
    - Land trusts
    - Boards that administer large grants (e.g. Clean Water Council, lottery funds for wildlife habitat, landowner incentive programs)
    - Sportsman organizations (e.g., Pheasants Forever, Ducks Unlimited, etc.)
    - Joint Venture staff (including NAWCA reviewers)
    - SWAP coordinators and conservation focus area teams, State wildlife directors, State natural resources board
    - Conservation NGOs
    - Large charitable foundations that support conservation
    - County extension agents, County conservation boards
    - Wind energy developers
    - Political office holders *
    - Sustainable agriculture organizations
    - Carbon credit marketeers
    - Livestock farmers
    - Agricultural associations – cattleman's, corn, etc.
    - Xerxes Society
    - Organizations doing water quality and other environmental services work
    - Soil and water conservation district offices
- Land acquisition/easement NGOs (TNC); eastern grassland coordination efforts (USFWS region 3 and partners); foundations (for prioritization of distribution of funds); FSA, NRCS; agroindustry associations; sustainability organizations; local, state, and federal decision makers; it goes on and on - probably many overlaps with long list of potential users we derived at the Midwest Landscapes Network workshop in August (see meeting notes).

- Private conservation organizations and even private landowners who are looking for options to improve the overall health of their land - and the ancillary benefits that provides.
- Agren - developed software that designs conservation practices in half the time it takes NRCS. Check out the website. FWS Private Lands could use this, NRCS, Ducks Unlimited, Trout Unlimited, etc. http://www.agrentools.com/tools
- The AppLCC has contracted with Clemson University to create a landscape plan. They are using Marxan as the base analyses model. We are also looking at using Circuitscape to assess instream and forest connectivity.
- Integrating with some new sub-field level farm financial planning tools being developed by AgSolver. Initial model runs suggest that huge areas of the Corn Belt are exceedingly unprofitable under the current systems of corn & soy production. These are low hanging fruits in terms of doing something different; an economic case could be made for doing so in addition to a conservation case.
- "Watershed Based Budgeting" from the point of view of the Nation as a whole. We need to consider all agencies in a watershed and try to minimize cross-sector conflicts. Like reducing hazards at the source, we can manage inputs through agency incentives.
- Urban watersheds and impacts due to increased infrastructure.
- The role of fire can't be underestimated in improving the overall health of some of these grassland systems. The costs to have more fire on the landscape aren't only monetary but are social and the barriers to fire need to be better understood.

Further refinement of the approach - There is still considerable work to be done on crafting this decision structure into something more explicit and specific. There are a few things that we can as next steps in the process.

1. ***Peer review of this decision support framework*** - Present and get feedback on the preliminary decision structure mostly focusing on the decision problem statement, the objectives and the quantitative metrics for those objectives. How could this approach be beneficial for others?

2. ***Narrow the list of strategies for further evaluation*** - Be more specific about the scope of the alternatives that we are going to consider. Again, we are mainly focusing on wildlife management alternatives that could have simultaneous benefits for both agricultural production and water quality (e.g., Gulf hypoxia).

3. ***Simplify the conceptual models*** – Determine which components we can model given the alternatives and objectives. These models have a lot of detail that might not be necessary to predicting the desired consequences of different actions. We should revise these models to be more reflective of what we can reasonably do and the detail we need to work through this problem.

4. ***Develop descriptive or predictive models*** - Determine how to go about modeling the expected outcomes for different actions. This will have some influence on the types of metrics we can use and the complexity of the models we need. Currently, we have not yet determined how much effort modeling or predicting consequences will require.

5. ***Develop an optimization tool*** - Put the pieces developed above together to form a Landscape Conservation Design, which may include a spatial analysis.

6. ***Implementation of the results*** - There needs to be some discussion about how these results will be used once everything is put together. Will it simply be a communication tool? Could we use it to coordinate something larger? How do regulatory authorities fit into this problem? Are there other constraints we haven't thought of?

Work Teams Refine the List of Conservation Practices (Summer 2015)

Three Work Teams were initiated in the summer of 2015 to: 1) confirm high priority agricultural conservation practices that benefit wildlife, water quality and agricultural production (ecosystem services); 2) determine species/habitat metrics that would measure impacts at the landscape scale; and 3) identify programs that implement, research or monitor these practices in targeted areas in the Mississippi basin. The teams chose to combine systems for this task as follows:

- **Uplands – Two systems combined**
  - Prairies/Grasslands Ecosystem
  - Grazing Lands Production

- **Tributaries – Three systems combined**
  - Modified Headwaters Ecosystem
  - Forested Riparian in Mid-sized Streams Ecosystem
  - Corn & Beans Production

- **Floodplains – Five systems operating initially as separate Upper and Lower Basins**
  - Bottomlands (mainstem) – Upper Basin / Lower Missouri, Upper Mississippi, Ohio Rivers
  - Bottomlands (mainstem) – Lower Basin / Mississippi Alluvial Valley
  - Floodplain Forest Production
  - Cotton Production
  - Rice Production

Fundamental Questions

Work Teams are addressing these questions, starting with a limited list of **highest priority conservation practices** (low cost, effective and/or high cost, effective) in the associated Ecological and Farm Production Systems, as indicated in online ratings in the Memphis workshop report (see figures details in the Memphis workshop report):

Design:

1) Which particular **species respond to which practices** (see list by Ecological System with Bottomlands combined)? Are there surrogate species that would be useful and appropriate to incorporate into the design or monitoring at the landscape scale?
2) Do we have current population information? Do we have **population objectives and monitoring** in place?
3) Is there **any redesign of the practices** necessary to maximize multiple benefits?

Delivery:

4) Which **programs/agencies/organizations** implement, research and/or design these practices?
5) What are the human dimensions and **socioeconomic implications** of these practices?
1) How do we **deliver this information** (when completed) to the implementing programs/agencies/organizations (contacts, meeting dates, deadlines, communications tools, etc.)?
6) What **additional resources** will you need to identify potential implementation programs for these practices?

Work Teams may find it helpful to use the practice and species spreadsheets prepared as guides for answering these questions. The ultimate goal would be to fill in/update the tables so that we have complete information for each practice and species, starting with the highest priority practices first. There is some overlap between and within the spreadsheets; the tables and organization may be modified in a way that seems best to the teams.

The Conservation Fund is handling the spatial analysis dimension of this project; as a result, you should not have to worry about that aspect of the framework. The ultimate goal of this project is to help target conservation efforts that maximize the mutual benefits of wildlife conservation and nutrient reduction; keeping this in mind, you can find below a document that lists some possible target programs where this design could be implemented.

We are seeking **broad consensus on which practices to emphasize and how to implement and monitor them** in targeted programs across the Mississippi Basin water quality implementation focus areas such as:

- Farm Bill national ranking systems
- Monarch conservation corridor (multiple programs)
- Conservation Reserve Program (CRP) Environmental Benefits Index
- Environmental Quality Incentives Program (EQIP) minimum of 5% designated for wildlife
- NRCS State Technical Committee ranking systems
- NRCS & FWS "Working Lands for Wildlife" program in Conservation Stewardship Program (CSP)
- Regional Conservation Partnership Program (RCPP) - Critical Conservation Areas for Prairie Grasslands and Mississippi River Basin
- USDA Biomass Crop Assistance Program (BCAP) to include wildlife
- States, Tribes, NGOs, and federal programs in other sectors

Resources

The following resources were provided to the Work Teams:

1) **Work Team** spreadsheet with two pages**:** (a) a preliminary listing of participants on the 10 Work Teams, one for each Ecological System and each Farm Production System; and (b) contacts for participating individuals.

2) **Team Charter** - a document containing some logistics, questions, resources, and an initial implementation program list for consideration as we move forward through this process.
3) **Species** list spreadsheet organized by the individual species identified in the Memphis Report.
4) **Conservation practices** spreadsheet organized by the individual conservation practices identified in the Memphis Report.

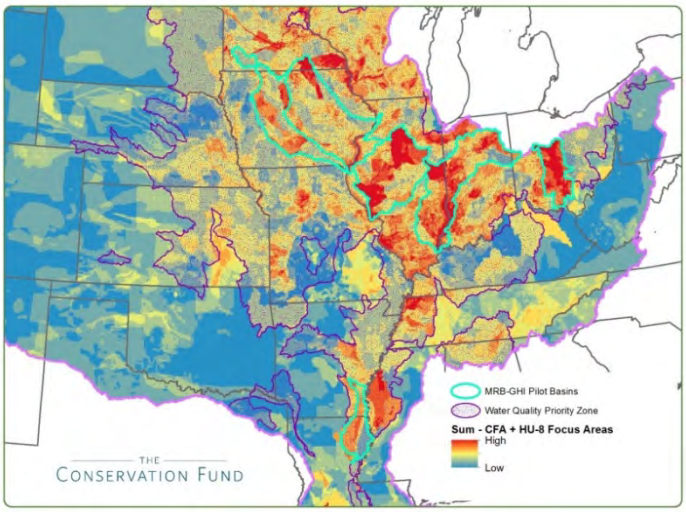
Connections for all online meetings listed above:

Audio: 866-714-8353 participant code 43553755#
Webex - http://www.mymeetings.com/nc/join.php?i=747216396&p=&t=c

Logistics

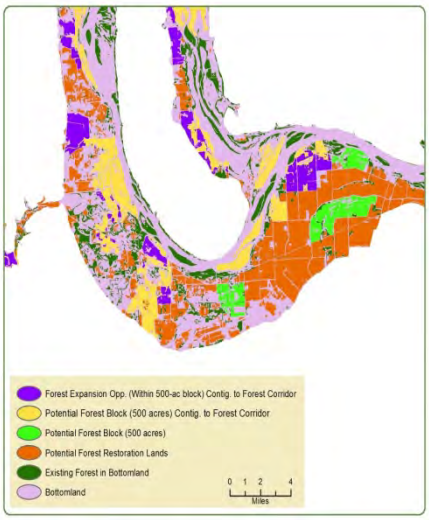
1) As was noted in the email, this is a preliminary list of the working teams. If individuals feel that **their expertise would contribute more to a different group or were missed**, they may join any (or all) of the work team calls. The process introduction will be the same for all groups.
2) There is some overlap between these ecological systems and farm production systems. Thus, it makes sense that some of the groups chose to be combined. For example, practices in the Prairie/Grasslands ecological system may be appropriate within the Corn and Soybeans farm production system, the Grazing Lands, and/or in upper Mississippi floodplains. However, the Floodplains group recommended continuing to analyze practices geographically by initially conducting the work in an Upper Basin and Lower Basin teams. Once information is generated by the teams, it will be useful to examine relationships, connectivity and influence between the practices from uplands to lowlands and from upstream to downstream.
3) Ideally, we hope to designate **one volunteer to coordinate** each team. The ETPBR LCC staff is providing facilitation support for each Work Team, using our webex and phone line.
4) Teams may use the Griffin Groups site to organize and share information. Each work team has its own sub-page, and ideally Team coordinators would post updates there to keep the wider group informed. https://griffingroups.com/groups/profile/152774/mississippi-river-basingulf-hypoxia-initiative
5) Consider a rough interim target date of **JULY 1st** with finalization by **SEPTEMBER 1st, 2015**

MRB/Gulf Hypoxia Initiative Spatial Analysis, Preparing Conservation Blueprint v1.0 – With an additional $71,400 from the ETPBR LCC, The Conservation Fund is completing an initial spatial analysis and online mapping tool for Gulf Hypoxia Conservation Blueprint v1.0 based on the framework created by participants for the landscape conservation design (see preliminary images below right).



Describing initial Priority Practices for Each System – To further refine an implementation approach, 65 scientists and managers worked in small teams to: 1) confirm which practices to emphasize; 2) identify species for design and monitoring; 3) cite current research; and 4) list key programs and policies for implementation.

The Work Teams have outlined these 14 high priority practices, which we will formulate into *Gulf Hypoxia Practice Fact Sheets* to accompany the Gulf Hypoxia Initiative Conservation Blueprint v1.0 for consideration by relevant program managers:



- *Uplands – in all priority river sub-basins(4 practices)*
  - Drought Management
  - Grassed Wetland Buffer
  - Grazing BMPs
  - Prescribed Fire
- *Tributaries/Headwaters – in all priority river sub-basins (6 practices)*
  - Cover Crops – Wheat
  - Cover Crops – Camelina
  - Drainage Water Management
  - Two-stage Ditches
  - Buffers - Field Borders & Streams
  - Prairie Biomass/Biofuels
- *Floodplains Upper Basin – Upper Mississippi, Lower Missouri, Ohio Rivers (1 practice)*
  - Hydrologic Restoration - Connectivity via Diversion
- *Floodplains Lower Basin- Mississippi Alluvial Valley(3 practices)*
  - Diversion
  - Reforestation
  - Vegetation Diversity

Please note that everything here is still in a draft stage for refinement by the Work Teams. The Griffin Group for this MRB/GHI project, including Work Team sub-pages, is online at: https://griffingroups.com/groups/profile/152774/mississippi-river-basingulf-hypoxia-initiative

MRB/GHI Practice Refinement Work Team Volunteers (as of 6/3/15)

MODIFIED HEADWATERS	PRAIRIES/GRASSLANDS	FORESTED RIPARIAN	BOTTOMLAND HARDWOODS - UPPER	BOTTOMLAND HARDWOODS - LOWER VALLEY
Wayne Anderson	Dan Lambert	Bridgett Costanzo	Kelly Srigley Werner	Bill Bartush
Lyn Kirschner	Gabe Miller	Christina Negri	Heidi Keuler	Alan Lewitus
Lisa Schulte Moore	Karen Viste-Sparkman	Melinda Knutson	John Coluccy	Dennis Figg
Mary McConnell	Michael R. North	Rebecca Kauten	John Sowl	Jeff Fore
Jane Frankenberger	Jonathan Atwood	Terry Esker	Jeff Walk	R. Edward DeWalt
Cathy Kling	Mike Ward	William Richardson	Robert Welch	John Tirpak
Ashley Kittle	Laura Paine	Jeff Kiefer	Charles Theiling	Keith McKnight
Andy Bishop	Yetta Jager	Louise Mauldin		Ronald S. Seiss
Andy Ward	Susan Rupp			Melanie Driscoll
	Heidi Keuler			

CORN AND SOYBEANS	GRAZING LANDS	FLOODPLAIN FORESTRY	RICE PRODUCTION	COTTON PRODUCTION
LaReesa Wolfenbarger	Bob Russell	Ying Ouyang	Dan Cornelius (upper - wild rice)	Bill Bartush (for SC CSC Texas contacts)
Carol Williams	Greg Hoch	Bill McGuire	Cynthia Edwards	
Robert Swanson	Jane Fitzgerald	Jane Ledwin		
Matt Schwarz	Scott Simpson	Eric Schenck		
Meg Cross	Rosalind Renfrew	Jamie Serino		
Andy Ward	Marissa Ahlering	Jeremy Peichel		
Gary Feng	Stuart Miller			

Invitation to MRB/GHI Conservation Design & Research Forum (March 2016)

Join us in preparing the next steps to maximize cross-sector benefits of conservation practices.

Multi-LCC Mississippi River Basin / Gulf Hypoxia Initiative (MRB/GHI)
Conservation Design & Research Forum
Noon Tues – Noon Thurs, March 1-3, Indianapolis, IN

How did this multi-LCC initiative develop? The framework for this landscape conservation design is objective-driven across three sectors for wildlife, water quality and agriculture -- ultimately doing our part to strategically maximize the value of every conservation dollar for the Mississippi River Basin and Gulf of Mexico. An intensive year-long dialogue culminated in the Memphis workshop in August 2014, setting the stage for research and development of design tools this past year. For more information, see: http://www.tallgrassprairielcc.org/research-projects/mississippi-river-basingulf-hypoxia-structured-decision-making-workshop-2014.

What is the workshop purpose? Reconvene multi-sector participants to examine the set of high impact conservation practices, web-based spatial analysis tools, and research products to: 1) identify immediate opportunities to use these tools to target investments in conservation delivery in the Mississippi Basin; and 2) frame out next steps for research and design. The outcome will be a well-defined set of implementation actions and project proposals for action within seven LCCs.

What questions will we answer? Breakouts and group work will focus on key implementation questions organized by stages in Strategic Habitat Conservation (SHC) to determine the next steps and required resources for implementation of the multi-LCC *Gulf Hypoxia Initiative – A Corridor for Wildlife, Water & Agriculture*.

1) *Planning* -- What are the national and regional-level **program and policy barriers** to implementing these practices with designs that support efficient multi-sector outcomes?

2) *Design* -- How do we present the **spatial analysis as an accessible tool** to drive what and where to act in existing programs (NRCS State Tech Committees, FWS Partners, State SWAPs, etc)?

3) *Delivery* -- Which critical emerging practices require **demonstration sites in target watersheds** to test design and evaluate cross-sector cost and impacts?

4) *Monitoring* -- How can we integrate Mississippi **basin-level cross-sector monitoring** to: 1) examine landscape-scale impacts on all three sectors as an interdependent approach; and 2) assess how these practices support resilience to climate/land use/economic drivers?

Workshop Schedule (downtown Indianapolis meeting location):
Tues, March 1 at 1pm-5pm – Research & Tools presentations with Q&A
Wed, March 2 at 8am-5pm - Delivery Tools Design & Research Forum (brainstorming breakouts)
Thurs, March 3 at 8am-noon - Work Groups refine recommendations for implementation

Register by January 15 to indicate your interest in attending in person or online at:
https://www.surveymonkey.com/r/WG8CTB3

Conservation Design & Research Components of the multi-LCC Gulf Hypoxia Initiative

The group used a Structured Decision Making (SDM) process to create an integrated framework that supports planning, design, configuration, and delivery of high impact wildlife conservation practices within the Mississippi River Basin. This framework consists of quantitative objectives representing three interests (wildlife, water quality, and agriculture), a tiered set of **13 conservation practices** within five production agriculture systems, and an **online spatial targeting tool** to determine where best to implement those actions across areas of the Mississippi River Basin with greater water quality concerns. Additional **research on adoption and delivery of conservation practices** could lead to scenario planning that forecasts future needs for adaptation strategies in response to ecological or economic drivers.

1) **Practice Fact Sheets** – Over the past year, Work Teams drafted a concise description, similar to those for CRP, of 13 key practices identified by the conservation community as having multi-sector impacts, along with a simplified illustration of where and how the practice is applied. The next step will be to standardize these practices, so they can be more easily described to landowners and implemented by field staff. Also, standardization could lead to financial incentives such as eligibility for program enrollment or cost share at local and federal levels.

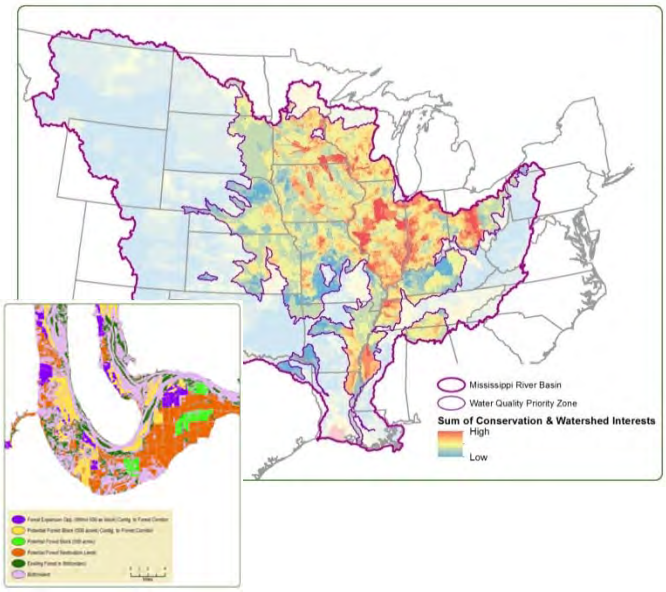
    a. *Edge of Field Practices* — located on or off row crop and grazing lands at the "edge of field" such as drainage water management, "modified" water and sediment control basins with water control structures, and constructed wetlands to catch tile and/or surface run-off from farm fields (see attached graphics). These practices tend to have limited, seasonal water quality or wildlife benefits. However the advantage of these practices is that they are acceptable within highly productive agricultural systems and are located close to the source of nutrient or sediment run-off where the concentration of the pollutant is highest.
        i. Bioenergy crops (diverse native prairie planting)
        ii. Cover Crops – Wheat
        iii. Cover Crops – Camelina
        iv. Grazing BMPs
        v. Prescribed Fire

    b. *Small Watershed & Riparian Practices* — located along streams or constructed in small watersheds (e.g. <1,000 acres). These practices provide year-round water quality and wildlife benefits if carefully designed and strategically located with the watershed at sites physically suited for detaining or slowing down run-off.
        i. Buffers - Field Borders & Streams
        ii. Drainage Water Management
        iii. Drought Management
        iv. Grassed Wetland Buffer
        v. Two-stage Ditches

    c. *Floodplain Wetland and Forest Practices* — located in the floodplains of major rivers and intended to restore or enhance large areas of wildlife habitat, particularly at sites subject to periodic flood inundation. These are large-scale, more complicated and not easily standardized, making them much more challenging to implement.
        i. Diversion – redirected flow to restore wetlands
        ii. Hydrologic Restoration – reconnection of hydrology in tributaries or rivers
        iii. Revegetation - wetland restoration and planting bottomland/floodplain forest

2) Spatial Analysis to Target Conservation Investments –This entire strategy of improving wildlife habitat and water quality is predicated on the idea of being able to better target conservation investments. This project planning system first identifies where such practices are needed and then actively pursues voluntary implementation of these practices with individual landowners in these opportunity areas.

Based on a framework of four primary ecological habitats within five farm production systems, The Conservation Fund has prepared an online GIS tool that identifies opportunity areas for implementing conservation practices in high impact areas with water quality concerns across the Mississippi Basin (example image to right).



Pre-Workshop Preparation - Online Research Webinars
Over the first few months of 2016, the LCCs will host online webinars showcasing emerging tools and research outcomes. Examples of recent research supporting the Gulf Hypoxia Initiative are listed below.

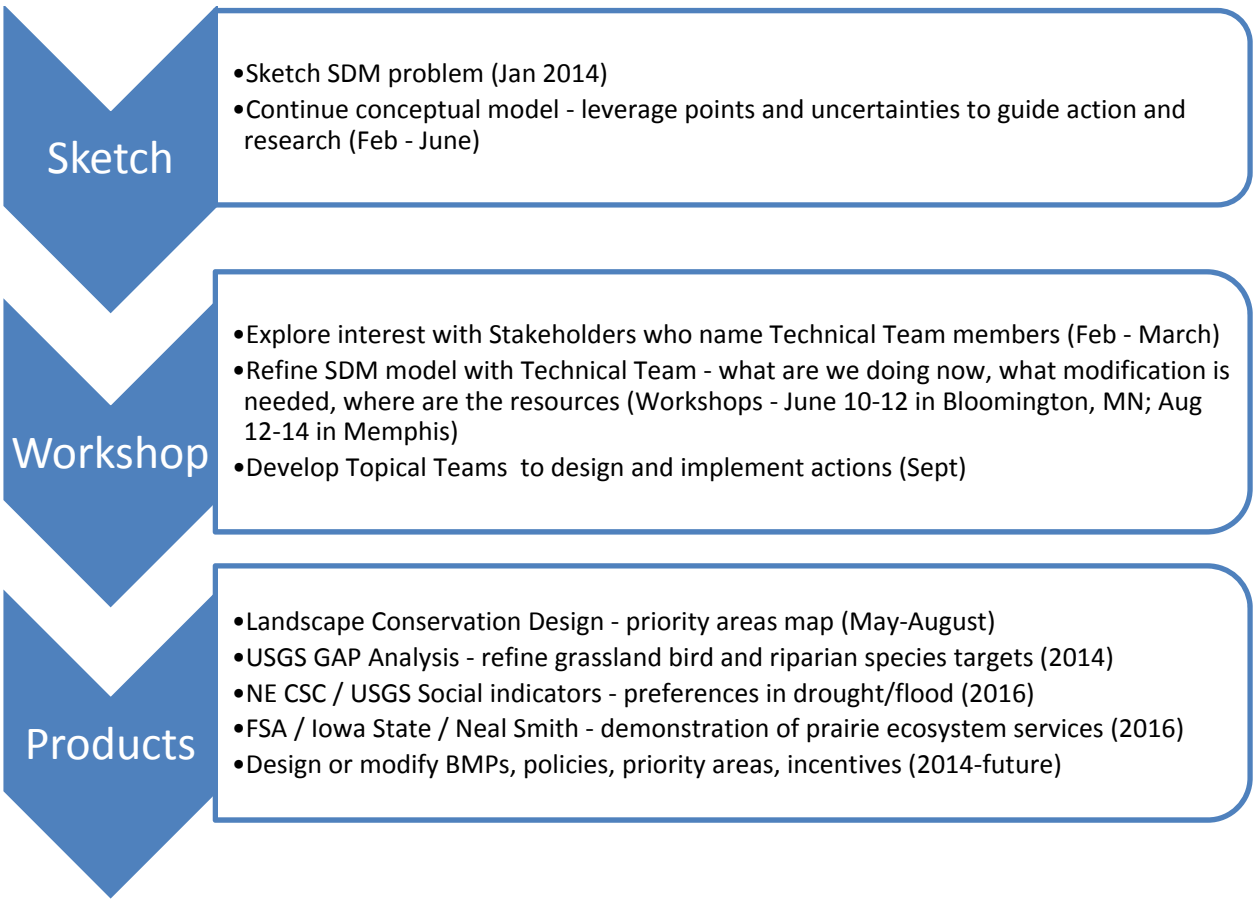
a. **Human Dimensions and Adoption of Conservation Practices**
   - Landowner preferences for conservation programs, David Fulton, Univ of Minnesota
   - Farmer & nonfarmer perceptions of Gulf hypoxia, Craig Miller, University of Illinois
   - Social drivers for adoption of practices, Linda Prokopy, Purdue University
   - Watershed modeling to detect preferences, Meghna Babbar-Sebens, Oregon State Univ
   - Midwest grassland bird conservation opportunities, Dan Lambert & Tom Will, FWS
   - Water quality trading and federal farm policy, Michelle Perez, World Resources Institute

b. **Estimated Multi-Sector Benefits**
   - Economic valuation of agricultural practices, Bonnie Keeler, Univ of Minnesota
   - Maquoketa floodplain habitat nutrient removal monitoring, William Richardson, USGS
   - Wabash floodplain estimates of nutrient removal, Jennifer Tank, Notre Dame
   - Performance metrics, surrogate species and monarchs, Ryan Drum, FWS

c. **Demonstration Projects**
   - Prairie STRIPs for water quality and wildlife, Lisa Schulte Moore, Iowa State Univ
   - Prairie biomass for biofuels and wildlife, Carol Williams, Univ Missouri
   - Monarchs and pollinators along state and federal roadsides, Brian Smith, US DOT
   - Soil health & cover crops as a driver for wildlife and water quality, Shannon Zezula, NRCS
   - Program implications for refuge planning and Gulf restoration, Robert Clevenstine, FWS

d. **Landscape-scale monitoring & modeling**
   - Multi-LCC Gulf Hypoxia Initiative & Workshop Objectives, Michael Schwartz, The Conservation Fund; Jorgen Rose, Indiana Univ
   - Hydrogeomorphic assessment for conservation planning, Mickey Heitmeyer
   - Modeling water quality impacts, Catherine L. Kling, Iowa State Univ
   - GAP analysis for bird conservation, Jack Waide, USGS

Please contact us with suggestions or questions: Gwen White, gwen_white@fws.gov, 812-212-7455.



Download a complete set of workshop materials at:
http://www.tallgrassprairielcc.org/research-projects/mississippi-river-basingulf-hypoxia-structured-decision-making-workshop-2014

Bibliography of Sources & Citations

SPARROW model Total Nitrogen Yields map from:

Robertson, D.M., G.E. Schwarz, D.A. Saad, R.B. Alexander. 2009. Incorporating Uncertainty Into the Ranking of SPARROW Model Nutrient Yields From Mississippi/Atchafalaya River Basin Watersheds. J. Am. Water Resour. Assoc. April 2009; 45(2):534-549.

Bottomland Hardwoods/ Floodplains on Mainstem and Lower Rivers System conceptual model based on Figure 2 in:

Casper, A. F., R. A. Efroymson, S. M. Davis, G. Steyer, and B. Zettle. 2009. "Improving conceptual model development: Avoiding underperformance due to project uncertainties." EMRRP Technical Notes Collection. ERDC TN-EMRRP-EBA-5. Vicksburg, MS: U.S. Army Engineer Research and Development Center. http://el.erdc.usace.army.mil/emrrp/emrrp.htm

Prairie in Uplands System conceptual model based on Figure 1 in:

Dowler, J, C. Dixon, L. Schulte-Moore, and S. Vacek. 2013. Using Structured Decision Making to Manage and Monitor Reconstructed Prairies – A Review. Notes. 28 March 2013, Neal Smith National Wildlife Refuge, Prairie City, IA.

Animal Enhancements in the Conservation Stewardship Program (NRCS Farm Bill)

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/csp/?cid=stelprdb1240690

Workshop Planning Team

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Tim Yager, Upper Mississippi NWR

Workshop and Online Input Participants

Mississippi River Basin / Gulf Hypoxia Landscape Conservation Design

- Implementation & Model Refinement Workshop, Ducks Unlimited Headquarters, Memphis, TN, August 12-14, 2014
- Online input responses, November 2014

Individuals who participated online and/or on the phone are in italics. All others were onsite in Memphis.

First	Last	Organization	Program/Expertise	City	State
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Workshop Agenda

Day 1: Tuesday, August 12, 2014 – Implementation & Collaboration

Anticipated results and output from discussions: Understanding of decision analysis models. Agreement on collaborative approach needed to advance implementation. Timeline for accomplishing further consultation and collaborative work. Agreement on technical resources (tools and staff) that will be needed and which decision makers and stakeholder viewpoints will be required in the future. Preparation for technical involvement in determining feasibility, stakeholder involvement and model refinement.

Small groups will be organized by expertise and geography to bring a range of perspectives, including geographic and stakeholder distinctions.

Time	Topic
10:00-12:00	Welcome, Workshop Process & Overview • Welcome from Ducks Unlimited (Scott Yaich, DU) • Review of workshop goals (Glen Salmon, ETPBR LCC) • Participant introductions • Overview of SDM Draft Models (Max Post van der Burg, USGS) • Spatial analysis & landscape design tools (Michael Schwartz, TCF) • Introduction to Collective Impact collaboration approach (Gwen White) • Q&A – Reflections on process to date and refinements in this workshop - Do these objectives capture the mutual interests? - What are the measurable attributes for these objectives? - What is the range of alternatives? At what scale do they operate? - What are the effects of those actions on our objectives? - What information is needed to build those relationships?
12:00 – 12:30	Lunch (bring cash to order sandwich delivered from nearby deli)
12:30 – 2:00	Programs & Actions - *Small groups based on geography (self-facilitated)* **What can we do to put more conservation on the ground in these areas?** • Which fish & wildlife conservation actions coincide with these focal areas (4 systems and geography) that also would have the most benefit for water quality and agricultural productivity? • How do scale, location and seasonality affect the opportunities to provide multiple benefits from these conservation actions?
2:00 – 3:00	Constraints & Priorities - *Small groups based on geography (self-facilitated)* **What do we need to know or do to focus implementation of these actions?** • What physical, social, jurisdictional or policy factors present constraints or incentives for implementing coordinated actions in these areas? • What could we do within these constraints? What could we do if those constraints were lifted? • Which sets of conservation actions are immediately feasible? • Which alternatives would be worth pursuing over the long-term?
3:00 – 3:30	Break – facilitators prepare draft documents for group review
3:30 – 5:00	Group Reports & Next Steps – *reconvene entire group* • Refine strategic approach to collaborative implementation. • Participant reflections on process and next steps (round robin) • Closing comments and preparation for technical work in Days 2-3
5:00 – 8:00	Adjourn for dinner at local restaurants

Day 2: Wednesday, August 13, 2014 – Objectives, Performance Measures, Actions, Science Needs

Anticipated results and output from discussions: A clear understanding and more well-defined structure of the problem, which will include a refinement of a conceptual model of how an integrated strategy is linked to the specified objectives. The goal is to refine details and ensure all perspectives are represented in the description of the opportunities for integrating and targeting actions.

Small groups will be organized by expertise in the four habitat/systems: (1) modified headwaters/working lands; (2) prairies/savannas; (3) forested riparian; and (4) bottomland hardwoods/mainstem) from a range of perspectives, including geographic and stakeholder distinctions.

Time	Topic
8:30-10:00	Implementation & Model Refinement • Review outcomes of Day 1 - Implementation Discussion • Overview of Technical Models and areas for refinement • Review and adjust process for Day 2
10:00 – 10:15	Break
10:15 – 11:30	Objectives Hierarchy – *entire group w/online connection* • Do these capture the primary Fundamental and Means Objectives? • Are there other objectives? Can we be more specific about objectives? • What are common interests? Is anything missing? • Review Influence Diagrams for relationships between objectives.
11:30 – 12:30	Lunch (bring cash to order Garibaldi's Pizza delivered from nearby)
12:30 – 1:30	Performance Measures – *entire group w/online connection* • What are the Performance Measures for these objectives? • What are the time frame(s) for measurement / assessment? • Are these the right Focal Habitats/Systems and Species? • Are they the most efficient indicators? Do they appeal to all interests? • What information will we need to estimate outcomes?
1:30 – 3:00	Alternative Actions & Consequences – *small groups in 4 focal systems* • Which actions provide multiple benefits that meet objectives within this specific Focal System? • Which sets of actions would you naturally use together as a "strategy"?
3:00 – 3:15	Break
3:15 – 4:30	Uncertainty & Sensitivity Analysis – *small groups* • Are relationships between key actions and consequences defined well? • What models or science are available? • What additional models or science are necessary?
4:30 – 5:00	Mid-point evaluation – *reconvene entire group* • Review Day 2 and preview Day 3 • Round robin of participant insights from Day 2.
5:00	Adjourn for the evening (dinner on your own)

Day 3: Thursday, August 14, 2014 – Trade-Offs, Management Portfolios & Next Steps

Anticipated results and output from discussions: Refinement of models, based on full range of perspectives from wildlife, water quality and agriculture, including human dimensions (e.g., economics, policies, values, incentives). Identification and prioritization of research needs and opportunities for short-term or long-term future actions.

Time	Topic
8:30 – 10:00	Review all SDM steps for iterative improvements • Step through all aspects of the SDM process with progress and examples. • Which models need to be further refined or constructed? • Review and adjust process for Day 3
10:00 – 10:30	Break – *small groups at tables*
10:30 – 12:00	Consequences Tables & Selection of Strategies • Examine how well Actions perform against Objectives. • Are there sets of Actions that go together naturally? • How do values of stakeholders affect weighting and trade-offs? • How will climate change affect consequences?
12:00 – 12:30	Lunch (bring cash to order sandwich delivered from nearby deli)
12:30 – 2:00	Closing comments & next steps • Next steps for continued modeling & implementation • Round robin of participant insights & individual evaluations
2:00	Adjourn & Evaluation – Thank you for your insights! Safe travels.