Executive Summary

Natural Resources Board policy requires that natural resources management decisions be based on sound science. The Department of Natural Resources has undertaken a biennial process to integrate research needs across the agency and to formulate a Biennial Research Agenda that addresses its highest priority science needs. Seven Research Themes provide an organizing framework for more detailed planning to address a broad range of management questions. Priority Research Focus Areas identified under each theme provide a snapshot of research already being conducted by the department, for the department, or by the department's partners, and provide guidance for prioritizing future investments. These focus areas provide a "big picture," integrated perspective of agency priorities. Staff, program managers, and the Research Review Team will use this framework to evaluate new and emerging needs, opportunities, and proposals and to ensure research informs short- and long-term management and policy decisions.

Contents

Background, Content, and Organization
- Why a Biennial Research Agenda? 2
- What Does This Biennial Research Agenda Include? 2
- Moving Forward 4

Themes and Priority Focus Area
- Theme: *Research to Manage & Sustain Ecosystems* 5
- Theme: *Research to Manage & Sustain Populations* 8
- Theme: *Research to Address Pollutants/Stressors & Protect Human Health* 10
- Theme: *Research to Support Adaptation to Change* 13
- Theme: *Research to Understand Social & Economic Values* 15
- Theme: *Research to Improve Assessment, Monitoring, & Modeling* 17
- Theme: *Research to Ensure a Solid Science Foundation* 19

Appendices
- A – Development of Biennial Research Agenda 20
- B – Implementation Process for Reviewing and Approving Proposed Research 21
- C – Generalized Model for Program Review of Proposed Research 22
- D – Division of Forestry Research Priority Setting Process 23
- E – Division of Forestry Research Priority Criteria 24
- F – Division of Forestry Research Themes and Priorities 26
- G – Division of Land Priority Setting Process and Criteria 27
- H – Division of Land Research Themes and Priorities 29
- I – Monitoring and Research Priorities from the Groundwater Coordinating Council's Current Joint Solicitation 31
- J – Water Quality Board and Watershed Bureau Recommendations for Priorities 34
- K – Bureau of Fisheries Management and Bureau of Science Services Integrated Research Prioritization for FY 2013–15 40
- L – Lake Michigan Fisheries Team Research Prioritization for FY 2013-15 45

Background, Content, and Organization

Why a Biennial Research Agenda?

Natural Resources Board policy requires that Wisconsin's natural resources management decisions be based on sound science[1]. Key actions that serve as building blocks for this foundation include:

- conducting applied research and acquiring original knowledge
- analyzing new information and emerging technologies
- synthesizing information for policy and management decisions
- applying the scientific method to the solution of environmental and natural resource problems
- providing science-based support services for management programs department-wide
- collaborating with agencies and academic institutions in Wisconsin and around the world

Just as businesses rely on research to produce and deliver effective products to target markets for the lowest possible cost, natural resources managers rely on researchers for information on effective management techniques, sustainable harvest regulations, successful habitat protection, and much more. Thus, department scientists work closely with management programs and external customers to help the agency and its partners develop novel management approaches and understand the ramifications of alternative decision choices. In short, ongoing research should build upon a continually advancing field of knowledge, refine management approaches and techniques, and allow the agency to improve continually and adapt as environmental conditions and human needs change.

Because the department's business needs are diverse, the range of research and science support also is necessarily diverse. To ensure the sound design, careful analysis, and informed interpretation required for research results to be reliable, credible, and defensible, the Bureau of Science Services is charged with providing a centralized focus for agency research and science support services. Manual Code 8104.1 outlines a biennial process for integrating research needs across all divisions (See Appendix A). The resulting Biennial Research Agenda, presented here, ***provides the framework needed to address the highest priority science needs of the agency to inform management, policy, and fiscal decisions***.

What Does This Biennial Research Agenda Include?

Research includes a broad range of activities that apply the scientific method and principles of experimental design to produce information, develop technologies, and support the application of science. Important aims of research include: 1) the discovery and sound interpretation of new facts and relationships, 2) the synthesis of existing information, analysis of emerging concepts, and revision of accepted conclusions, and 3) the practical application of these new or revised conclusions to guide department programs. Research activities include both experimental and non-experimental and quantitative and qualitative approaches.

[1] See, for example, ss. NR 1.01(1), NR 1.02(3), NR 1.11(1), NR 1.15(3), NR 1.95(2)(d), and NR 1.98(1)(a), Wis. Administrative Code.

Efforts to integrate the applications of research and science across agency division can pose challenges. As a result, this document presents seven **Research Themes** that serve as an *organizing framework* for more detailed planning to address a broad range of management questions and maintain the agency's position as a national leader:

- Research to manage and sustain ecosystems
- Research to manage and sustain populations
- Research to address pollutants/stressors and protect human health
- Research to support adaptation to change
- Research to understand social and economic values
- Research to improve assessment, monitoring, and modeling
- Research to ensure a solid science foundation

Under each Research Theme, **Priority Research Focus Areas** identify topics that will require focused attention, additional consideration, and continued commitment. These priorities result from the integrated process, involving all department divisions, outlined in Manual Code 8104.1 and address department business needs, build upon past successes and collaborations, and attend to existing statutory and grant obligations. Like the Research Themes, these focus areas tend to be broad in scope and often cross programmatic and division lines, thus providing a "big picture" integrated perspective of agency priorities. To ensure administration of a comprehensive, centralized research program, the Priority Research Focus Areas cover:

- Research performed by staff in the Bureau of Science Services
- Research performed by staff in other department programs
- Research coordinated or contracted for by the Bureau of Science Services
- Research coordinated or contracted for by other department programs
- Research undertaken in collaboration with federal, state, and local agencies and legislative, private, and academic institutions

Thus, the Priority Research Focus Areas provide a snapshot of research already being conducted by the department, for the department, or by the department's partners. This approach allows us to ensure research is coordinated between department programs and between the department and other agencies and institutions. Descriptions of division-specific, priority-setting exercises and more detailed priority and project-specific information are included in the appendices of this agenda and are referenced throughout the Research Themes.

While these Priority Research Focus Areas provide guidance to help prioritize investments and maximize the use of fiscal resources, they likely do not capture all of the research needs that the department and its partners will consider or that may emerge over the course of the biennium. Rather, program managers and the Research Review Team will use the framework provided here to evaluate new and emerging needs, opportunities, and proposals. Implementation in this way will allow department staff and managers to align research to inform both short- and long-term management and policy decisions. These Priority Research Focus Areas also can be used as benchmarks for evaluating progress in addressing the most pressing issues the department faces and ensuring all of our efforts are based on sound science.

Moving Forward

Implementation of this Biennial Research Agenda is a shared responsibility. While all research undertaken or supported by department programs will receive Science Services review and Secretary's Office approval prior to its conduct (see processes outlined in Appendices A and B), divisions will retain internal processes for identifying needs, establishing priorities, and vetting proposals (see Appendix C). Science Services will use this agenda to prioritize staff efforts and help ensure that Science Services' assistance is made available in experimental design, data collection, statistical analysis, reliability estimation, and interpretation and presentation of results.

Department scientists will continue to forge strong partnerships with scientists working for academic institutions (including the Wisconsin Cooperative Fisheries Research Unit at UW-Stevens Point and the Wisconsin Cooperative Wildlife Research Unit at UW-Madison), federal and state agencies, local governments, non-profit conservation organizations, and private corporations. Since the Priority Research Focus Areas reflect priorities of the divisions, these can be used when engaging program partners (e.g., Groundwater Coordinating Council, Governor's Council on Forestry, Wisconsin Invasive Species Council, etc.). In working with these partners, our priorities may be adapted to meet needs beyond the department's to support broader natural resources management decisions.

Finally, to ensure that we continue to provide excellent customer service, implement collaborative approaches, maximize the use of fiscal resources, and improve research operations and outputs, implementation of this Biennial Research Agenda includes ongoing communication with programs to provide progress reports, present research results, and discuss future research directions. It also includes a Research Review Team review of implementation and formal progress reporting to agency administration and the Natural Resources Board.

Theme: Research to Manage & Sustain Ecosystems

The department is dedicated to the sustainable management and protection of the state's natural resources so that those resources continue to provide ecological, economic, and social benefits for years to come. Such management requires a "big picture" view and long-term approaches. *We will undertake research to inform decisions at meaningful spatial and temporal scales and to inform decisions that consider interactions between people and natural resources.*

Priority Research Focus: **Landscape Dynamics** – A wide variety of land-use and land management practices influence ecosystems and plant and animal populations on land and in water. There is a need to assess various agricultural practices, bioenergy production, land-use development, and conservation program implementation to better understand the influences that these activities have on populations and the long-term sustainability of forest, grassland, wetland, and aquatic ecosystems. We also need to examine how to more effectively manage natural communities at large scales for rare species and habitat specialists (e.g., young- and old-forest dependent wildlife species), as well as unique ecosystems. Large scale assessments of wildlife populations are needed to evaluate the effectiveness of on-the-ground conservation and management activities such as the Wisconsin Stop Over initiative or the abundance and distribution of predators. See Appendices F and H for forest ecosystems sand wildlife-related details. For fisheries and aquatic ecosystems, see Appendices I-K.

Priority Research Focus: **Restoration Ecology** – Restoration techniques have been developed for many terrestrial and aquatic ecosystems. There is a need to evaluate various prairie and savanna restoration techniques (e.g., burning, biomass removal, herbicide treatments) and how these techniques affect various ecosystem functions, particularly on a landscape basis. Populations of wildlife species that have been subject to restoration management (e.g., prairie chickens, sharp-tailed grouse, whooping cranes, American marten, fisher, marsh birds [via impoundment restoration]) require research to refine monitoring methods and assess population responses to restoration and population/ecosystem management activities. For lakes, questions remain related to the impacts of nutrient loading and inactivation (e.g., Solar Bees, barley straw, alum treatments) and invasive species (ranging from control techniques to native plantings). Other priorities include examining the development and performance of wetland restorations—in order to evaluate mitigation efforts— and evaluating a variety of functional benefits from restored wetlands.

Priority Research Focus: **Invasive Species** – Invasive plants, animals, and pests are taking a toll on Wisconsin's aquatic and terrestrial communities and the ecosystem functions that they support. The Wisconsin Invasive Species Council's *Statewide Strategic Plan for Invasive Species* highlights statewide priorities for prevention, early detection, rapid response, and control. In addition, *Wisconsin's Comprehensive Management Plan to Prevent Further Introductions and Control Existing Populations of Aquatic Invasive Species* describes major goals for prevention, control, and abatement of aquatic invasive species. An essential component of these plans is to develop a statewide monitoring program and a resulting evaluation process to determine the effectiveness of individual strategies included in the plans. In addition, the department annually administers nearly $4 million in aquatic invasive species control grants; accordingly, there is a need for science to support strategic investment of these dollars to effectively slow the spread of aquatic invasives.

Priority Research Focus: **Great Lakes –** Management of the Great Lakes is complex and involves multiple jurisdictions. Wisconsin´s *Great Lakes Strategy* details plans for addressing Lake Michigan's and Lake Superior's most pressing environmental issues. To do so, we need to focus at scales ranging from basins to sub-watersheds to shorelines and nearshore zones. Indicators established under the *State of the Lakes Ecosystem Conference* (SOLEC) process have been used to identify basin-wide monitoring needs. Policy guiding withdrawal of Great Lakes water is covered by the *Great Lakes Compact*. Coastal wetlands provide multiple environmental services, including their importance to the biodiversity of the state, their ability to filter water, and flood storage, fish spawning, stopover habitat for migratory birds, etc. research priorities have been identified for Wisconsin's National Estuarine Research Reserve. Additional research is needed to better characterize nearshore health (particularly in the Areas of Concern), predict and mitigate bacteria and algae problems, and understand impacts of riparian and watershed land use. The "mixing zone" concept currently used for wastewater discharge permit limits is based primarily on riverine systems. There is a need to develop large lake models to better ensure resource protection. Finally, additional work is needed to fully assess the impacts of climate change to the Great Lakes.

Priority Research Focus: **Mississippi River –** Management of the Mississippi River is complex and involves multiple jurisdictions. There is a need to continue ongoing research involving other state, federal, and university partners related to developing and interpreting results of water quality monitoring of the Mississippi, nutrient evaluations on Pool 8 backwaters, lead-related impacts on wildlife in the La Crosse River Marsh, proliferation of free-floating plant mats, cyanobacteria blooms, shifts from a vegetated to un-vegetated stable state and its effects on biota and recreational opportunities, and the effects of PFCs on river biota. Finally, additional work is needed to fully assess the impacts of climate change to ecosystems in and along the Mississippi.

Priority Research Focus: **Groundwater, Drinking Water, & Water Use –** Adequate supplies of uncontaminated groundwater are crucial not only to the health of Wisconsin citizens but also for the continued growth of agricultural production and cutting-edge industries in the state. By statutory authority, the Groundwater Coordinating Council advises and assists state agencies in the coordination of groundwater research activities and the appropriation and allocation of state funds for research. Current groundwater research needs are presented in the Council's Joint Solicitation document and, in particular, the excerpted DNR priorities (Appendix I).

Priority Research Focus: **Inland Lakes, Rivers, Streams, & Wetlands –** Understanding the condition and function of Wisconsin's inland waters and wetlands is critical to their management and protection. There are ongoing needs and projects related to understanding the interactions among biological, chemical, and physical aspects of these ecosystems. We will invest in efforts to understand statewide patterns in water clarity, habitat, and fisheries to best understand how they may be changing, the factors that contribute to change, and the scale at which various land use practices affect these important components in aquatic ecosystems. In addition, *Reversing the Loss* outlines a strategy for Wisconsin's wetlands. There is a need to build capacity to conduct wetland research: assimilative capacity of discharge to wetlands, role of wetland restoration in water quality trading, hydrologic response and function of wetlands affected by high-capacity wells. There is also a need for a monitoring and evaluation strategy to identify and quantify various ecosystem services provided by wetlands.

Priority Research Focus: **Driftless Areas –** The Driftless Area is a unique region with a landscape that is rich with ecological and economic opportunities. The department owns more than 30,000 acres in the Driftless Area, mostly in narrow strips spread along over 100 streams. In addition, the department has purchased angler access easements along dozens more streams. We are engaged in a comprehensive planning process to update the master plans that will guide future actions on these properties. We need to answer questions about how we should manage these lands based on current and anticipated future conditions/ecosystem functions, where we should focus in-stream and riparian management efforts, and what priorities are for providing additional public access to the streams. It also will be necessary to evaluate the integration of climate adaptation strategies in the planning and implementation process.

Priority Research Focus: **Dam Removal & Fish Passage –** Fish passage is often a requirement of the FERC relicensing of hydropower facilities. Dam removal and fish passage are often sought for the benefits for riverine and stream fisheries populations. These activities, however, can provide pathways for invasive species introductions. Dam removals also affect the riparian areas associated with impoundments and stream channels. Assessing benefits and risks associated with dam and fish passage locations and designs, particularly on a landscape-scale basis, will remain an active area of research.

Priority Research Focus: **White-tailed Deer & Wolves –** Deer are impacting forest regeneration and successional trends in parts of the state. The recent Deer Trustee Report highlights the need to quantify the impact of varying deer densities on forest habitat as well as other functions and to develop habitat metrics to assist in the management of Wisconsin's deer herd. Additionally, wolves have the potential to improve forest regeneration through predation or behavioral modification of white-tailed deer at a local level requiring additional research.

Theme: Research to Manage & Sustain Populations

Wisconsin is home to more than 2,640 vascular plant species, nearly 700 vertebrate species, and countless invertebrate species. The department is charged with maintaining healthy and sustainable populations of these resources. Our *Fish, Wildlife, and Habitat Management Plan* establishes goals and objectives for fish and wildlife conservation. In addition, Wisconsin's *Wildlife Action Plan* identifies Species of Greatest Conservation Need and outlines priority conservation actions to protect these species and their habitats. The *Statewide Forestry Strategy* includes ideas on how the forestry community can address major issues and priority topics. *We will undertake research to assess fish and wildlife populations, health, and habitat relationships to inform our species-specific management activities.*

Priority Research Focus: **Forest Trees** – Research is needed to assess a declining abundance and distribution of some tree species. Examples include the distribution and abundance of yellow birch, jack pine, hemlock, and white birch–species that were once common and serve important timber, aesthetic, and ecological roles.

Priority Research Focus: **White-tailed Deer** – The recent Deer Trustee Report highlighted numerous areas of research related to white-tailed deer. To improve management of white-tailed deer, research is needed on factors (including diseases like CWD and EHD) that influence the fitness, reproduction, nutrition, and mortality of deer in Wisconsin. Additional research challenges to be addressed include the spatial and temporal variability in population sizes and densities, browsing impacts on forest regeneration, and social factors influencing harvest rates and regulations.

Priority Research Focus: **Carnivores** – Research is needed to ensure sustainable management of large and medium carnivores including wolves, bears, bobcats, fishers, and otters. These populations tend to occur at relatively low densities and are sensitive to factors influencing reproduction or mortality, including harvest. The recent implementation of a wolf hunt requires research to address population biology, population monitoring (modeling), and population size estimates. In addition, research is needed to understand public attitudes regarding the management and potential expansion of wolf and bear populations (social tolerance). Black bear populations have expanded over the past 20 years. Research on factors influencing bear productivity and development of an age-at-harvest model are needed to improve our management of this species.

Priority Research Focus: **Sustainable Fisheries** – The department is responsible for ensuring sustainable fisheries for commercial, recreational, and tribal harvests. This requires a broad research program closely coordinated with federal agencies, Native American tribes (GLIFWC), and university partners. Ongoing areas of emphasis for research are outlined in the *Program Goals and Strategies for Fisheries Management and Fisheries Research* (http://intranet.dnr.state.wi.us/int/water/fhp/FMStrategicPlanFinal.pdf). Species- and project-specific details for additional needs are included in Appendices K and L.

Priority Research Focus: **Nongame Species** – Species of Greatest Conservation Need have low and/or declining populations that are in need of conservation action. They include various birds, fish, mammals, reptiles, amphibians, and invertebrates. Many research needs have been identified in the *Wildlife Action Plan*. Research is needed to support the BATLAS program, citizen-based acoustic and roost monitoring projects, and development of population viability analyses for little brown bats and greater prairie chickens. In addition, freshwater mussels are good indicators of water quality and contaminants. Mussel surveys are required for permits ranging from riprap/shore protection to road crossings to FERC licenses. We lack a coordinated, statewide effort for understanding the distribution and abundance of freshwater mussels, but recently received federal support to map an endangered mussel species.

Priority Research Focus: **Fish, Wildlife, & Plant Genetics** – There is a need for research to ensure that the way we manage fish, wildlife, and plant populations is sound from a genetics standpoint. For example, stocking northern waters with source populations from the south may be a poor investment (fish that do not survive), or may change the genetics of the system for better (e.g., faster-growing, better-surviving fish) or worse (e.g., weaker fish that cannot withstand extreme winters). The Wisconsin Cooperative Fisheries Research Unit helps us understand fisheries genetics and their implications for management. Cooperative research conducted to date and ongoing includes studies of walleye genetic integrity, impacts of supplemental stocking regimes, broodstock selection strategies, and stock/strain delineation and performance of muskellunge. Needs for technical assistance identified by DNR staff include evaluations of potential broodstock sources for a wild brook trout program, a restoration monitoring effort for coaster brook trout, an evaluation of muskellunge populations as a prerequisite to movement of adult fish, and a large-scale evaluation of the state's propagation program. Our management of wildlife resources must address similar issues. Efforts to look at the genetics of prairie chickens and badgers are underway currently. The department will continue to coordinate forest genetics and tree improvement efforts with the University of Wisconsin.

Theme: Research to Address Pollutants/Stressors & Protect Human Health

The Clean Air Act, Clean Water Act, and Resource Conservation and Recovery Act/Superfund laws have resulted in considerable progress in preventing and cleaning up pollution problems. Yet, some areas continue to be impacted by pollution. Some land-use practices contribute to nonpoint source runoff. Some pollutants have only recently been discovered in the environment and new concerns emerge as monitoring and research reveal the impacts of various stressors. Our efforts to implement a smoke management plan could be enhanced by a better understanding of the impacts of smoke from wildland fires, burn barrels, and prescribed burns. *We will undertake research to better understand the sources, transport, fate, and impacts of environmental stressors. We also will evaluate best management practices and other approaches to minimize the impacts of stressors.*

Priority Research Focus: **Nutrient Impacts to Surface Water & Groundwater** – Stormwater carries solids, nutrients, and other contaminants into receiving waters. Runoff from agricultural operations and lands remains a major source of sediments, nutrients, and pesticides. Many best management practices (BMPs) have been developed to reduce these loads, but most BMPs have yet to be implemented on a truly large-scale basis and their efficacy has not been evaluated fully. The relationship between phosphorus and water quality is an area of continued research. Implementation of the state's new phosphorus rule will require sound science for issuing permits, setting site-specific criteria, adaptive management, pollution trading, and total maximum daily load (TMDL) development, implementation, and evaluation. Additional research is needed to evaluate the impacts to air and water from CAFOs and spray irrigation systems, develop a nutrient targeting and tracking tool, understand baseline nutrient conditions of lakes, understand the factors that lead to excessive blooms of cyanobacteria and bacteria outbreaks, and evaluate the effectiveness of water quality improvement practices. The role of nitrogen in lakes, streams, and wetlands is less well known. There is a need to evaluate agricultural nitrogen BMPs, refine indices of biotic integrity to incorporate nitrogen, develop a nitrogen transport and fate model, and understand nutrient dynamics of manure and various treatment strategies. We are in need of a field-based hydrogeological method for evaluating nitrate concentrations below fields following BMPs. There is a general need for research support in revising the agency's monitoring strategy and assessment protocols for Clean Water Act reporting and documentation of success stories. The Groundwater Coordinating Council advises and assists state agencies in the coordination of groundwater research activities and the appropriation and allocation of state funds for research. Current groundwater research needs are presented in the Council's Joint Solicitation document and, in particular, the excerpted DNR priorities (Appendix I).

Priority Research Focus: **Contaminated Sediments** – The Great Lakes, the Mississippi River, and the rivers that feed them have been historically important centers of trade and industry. As cities grew around these economic hubs, river and harbor sediments were polluted by chemicals. Important fish and wildlife habitat was lost. Today, the pollution and habitat loss cause problems for fish and wildlife and diminish our ability to fully use and enjoy these rivers and lakes. Some monitoring of contaminated sediments is currently done on a limited basis and the department has produced a number of guidance documents which describe a multi-tiered approach to site assessment. Research into clean-up/restoration methods and sediment disposal options, however, remains an important priority.

Priority Research Focus: **Vapor Intrusion** – Chemicals used in commercial activities (e.g., dry cleaning chemicals, chemical degreasers, petroleum products like gasoline) are sometimes spilled or leaked into soil and groundwater. These chemicals, known as volatile organic compounds (VOCs), often become gases or vapors, which can escape from contaminated groundwater and soil and enter buildings. While we understand the risks associated with vapor intrusion and have preventative measures that can be implemented, research is needed to better understand how widespread this problem is in Wisconsin.

Priority Research Focus: **Pesticides** – All types of pesticides (insecticides, herbicides, and fungicides) have been used in Wisconsin agriculture for a long time. These pesticides can reach groundwater when spilled at storage, mixing, and loading sites, when over-applied to fields, or when improperly disposed of. Preliminary studies by DATCP show that over 35% of private wells tested contained detectable levels of herbicides or their metabolites. In addition, the state permits the application of pesticides for algae and aquatic plant control, requiring research to address efficacy and effects on non-target organisms, as well as persistence in the environment.

Priority Research Focus: **Mining Impacts** – There is a need to develop methods for predicting, assessing, and mitigating the direct and indirect impacts to air, surface water, and groundwater quality and water levels from various mining activities (industrial sand mining, ferrous mining, sulfide mining, etc.). Impacts to plant and animal populations and communities also will need to be evaluated. Finally, it will be necessary to develop scientifically based monitoring strategies for newly permitted mines.

Priority Research Focus: **Beach Pathogens** – Wisconsin's beaches provide wildlife habitat, recreation areas, and tourist destinations. Unfortunately beaches are especially vulnerable to agricultural, urban, and industrial land uses and polluted runoff, and many of our beaches are showing the effects. Real-time modeling combined with water quality monitoring has been shown to be an effective means of providing public notification, but federal BEACH Act funding for monitoring and modeling activities remains uncertain. There is a need to assist local public health agencies with model development, operation, and refinement in the face of declining funds. We will also coordinate with federal agencies, the Department of Health Services, and local public health agencies to better understand factors that affect the frequency and intensity of outbreaks and the effectiveness of various mitigation practices.

Priority Research Focus: **Harmful Blue-green Algae** – Concerns associated with blue-green algae (cyanobacteria) include discolored water, reduced light penetration, taste and odor problems, dissolved oxygen depletions during die-off, and toxin production. There are no quick or easy remedies for the control of blue-green algae once they appear in a waterbody. We will continue to invest in monitoring the occurrence of cyanobacteria in partnership with the Department of Health Services, as well as efforts to better understand factors that affect the frequency and intensity of blooms, and the effectiveness of various mitigation practices.

Priority Research Focus: **Fish & Wildlife Contaminants** – Fish and wildlife may take in pollutants from the water they live in and the food they eat. Some pollutants can build up in their tissues to levels that can be harmful to predators, including humans. Research is needed to assess the impact of toxins on wildlife and fish populations and how regulations and management can

ameliorate negative impacts to both humans and natural ecosystems. Areas requiring attention include fish and wildlife consumption advisories, mercury and PCBs in loons and bald eagles, and the effects of lead shot and tackle to fish and wildlife.

Priority Research Focus: **Emerging Pollutants –** Some pollutants have only recently been discovered in the environment. Examples include endocrine disruptors resulting from organic compound degradation, pharmaceuticals, steroids and hormones, surfactants and surfactant metabolites, flame retardants, industrial additives and agents, gasoline additives, and nanoparticles. A priority need is developing information on these compounds for evaluation of their potential threat to environmental and human health. Research is needed to develop analytical methods to measure these contaminants in water, sediment, and waste streams, to determine the occurrence of these contaminants in the environment, to characterize their sources and source pathways, to define and quantify processes that determine their transport and fate through the environment, and to identify potential ecologic effects from exposure.

Theme: Research to Support Adaptation to Change

Environmental conditions and human needs change over time. An effective, modern, science program must continually engage in activities that enable informed responses to changes. There also is an ongoing need to identify new and emerging stressors and to understand how different stressors interact with each other. The Wisconsin Initiative on Climate Change Impacts (WICCI) identified a broad range of impacts and risks associated with Wisconsin's changing climate in its first adaptive assessment report, *Wisconsin's Changing Climate: Impacts and Adaptation.* WICCI has also discussed various approaches to adaptation. *We will undertake research to identify emerging issues, understand the synergistic effects of ecosystem stressors, and inform Wisconsin's responses to a changing climate.*

Priority Research Focus: **Forest & Forestry Impacts –** Research to evaluate the synergistic impact of changing environmental conditions related to climate (e.g., changes in susceptibility to wildfires), invasive species, changing land cover, deer populations, diseases, pests, and various land uses will provide key information on how to manage forests for both short- and long-term sustainability. Sustainable management of our forests, both now and into the future, will be important to maintaining an economically viable forest industry while at the same time providing numerous ecological and social benefits to Wisconsin's citizens (Appendices D-F).

Priority Research Focus: **Fisheries & Wildlife Impacts –** There is a need to refine our models to better understand the synergistic effects of climate change and other stressors (e.g., diseases, invasive species, habitat loss, etc.) on the functioning of aquatic and terrestrial ecosystems. Research assessing the climate vulnerabilities associated with trout and cisco distributions, interactions between walleye and smallmouth bass, impacts on boreal forest and snow-dependent wildlife species—as well as key game species like white-tailed deer and ruffed grouse—are priorities in order to develop proactive management for future conditions.

Priority Research Focus: **Water Resources Impacts –** The WICCI Water Resources and Stormwater working groups have identified a wide range of research needs related to understanding impacts to water resources and water-related infrastructure. Examples of needs include increased monitoring of inland beaches, development of prediction tools for blue-green algae blooms, identification, mapping, and prioritization of potentially restorable wetlands in floodplain areas, evaluation of the effects of elevated water temperatures and extreme events on water quality, and identification of potential pathways for invasive species migrations under changing climate regimes. It would also be helpful to evaluate synergistic effects of climate change and changes in impervious surfaces on groundwater and surface water ecosystems. Finally, additional work is needed to fully assess the impacts of climate change on the Great Lakes and Mississippi River.

Priority Research Focus: **Adaptation Strategies –** Adapting our approach to manage Wisconsin's ecosystems under future conditions will require research to identify likely scenarios, assess risks and vulnerabilities, and understand synergistic factors. A broad suite of regulatory definitions (e.g., What is a 100-year flood? Where is the ordinary high water mark?) and management concerns (e.g., ecosystem susceptibility to forest fires) are affected by changes in climate and the factors that need to be considered when adapting. Research outcomes will focus on the development of adaptation strategies to manage natural resources under changing conditions. To assess strategies we will need to use adaptive management approaches that link research and management in a feedback loop. Doing so will allow us to assess the effectiveness of adaptation strategies under future conditions and modify strategies to reflect management failures and successes.

Theme: Research to Understand Social & Economic Values

Some of the most challenging decisions in natural resources management stem from the relationship between people and the environment. It is not surprising then that the public's awareness, knowledge, perceptions, attitudes, beliefs, motivations, and behaviors strongly influence management decision making and the success of many management activities. Social science research and economic analysis can help department managers and policy makers identify relationships between our diverse constituencies and the state's natural resources and can assist us in measuring customer satisfaction. *We will undertake research to understand our stakeholders' awareness, knowledge, attitudes, motivations, and behaviors, identify and address economic concerns, and assess customer satisfaction.*

Priority Research Focus: **Resource Valuation & Ecosystem Services** – Economic theory predicts that the optimal allocation of a private good occurs in a competitive market environment, assuming property rights are well-defined/enforceable, transaction costs are low, private rates of discount mirror social rates, and external economic impacts are absent. When it comes to natural resources, however, these assumptions often break down due to the public good aspects of the resources. In addition, resource management is greatly affected by socio-political issues that arise when the use of resources by one constituency collides with the needs of another. As such, the department can benefit from efforts to assess the value of resources in particular contexts. An understanding of the market and non-market values of natural resources (ecosystem services) can aid decisions at the field, business, and landscape level, and can also be a helpful indicator of how selected management prescriptions are performing (e.g., water quality impacts on land values, effects of wetland condition on public's valuation of wetlands, health benefits of ample outdoor opportunities). Understanding the full context for market structures/trends would better support the department's sustainable forestry approach.

Priority Research Focus: **Policy & Planning Processes** – Recent changes in state law have created an economic impact assessment (EIA) requirement for administrative rule proposals. Department guidance for implementing these provisions has been developed and is now being used by rule drafters. It will be helpful to evaluate the analytical processes and resulting products and assess the ways in which these are used in decision making (e.g., there are questions about the effect of the timing of public input opportunities on the outcomes of the analyses). Methods exist for developing cost and benefit estimates, but rule drafters would most immediately benefit from further guidance on how to account for health and similar benefits resulting from cleaner air, safer water, and recreational amenities.

Priority Research Focus: **Stakeholder Awareness & Knowledge** – Successful natural resources management requires a knowledgeable and informed citizenry. To successfully implement regulatory programs, it is often helpful to understand how aware the regulated community is of regulations, particularly new regulations. Such an understanding is essential to a full assessment of compliance behaviors. In addition, a baseline assessment of environmental and conservation awareness, knowledge, attitudes, and motivations among Wisconsin students at various grade levels could inform the department's outreach and education programs.

Priority Research Focus: **Customer Satisfaction & Behavior** – There remains a need to assess the social carrying capacity (social tolerance) of wildlife species that may conflict with human interests when their populations become over abundant (e.g., white-tail deer, wolves, and bears). There is a desire to assess recreational use of state-owned lands (especially wildlife areas), measure visitor satisfaction, and understand stakeholder preferences for fisheries and aquatic resources use. It would be helpful to know what factors (perceptions, beliefs, attitudes, and motivations) affect the choices of private forest landowners and the way they are currently managing their properties (behaviors). It also will be necessary to understand angler, hunter, and trapper behavioral changes and levels of satisfaction as regulations and season structures are refined. Of particular interest are those species (e.g., bears, bobcats) for which participants are likely to have high success rates but low probabilities of participation (long wait times).

Priority Research Focus: **Public Outreach & Social Engagement (Social Marketing)** – Social Science research can help department managers and policy makers identify relationships between our diverse constituencies and the state's natural resources. We need to continually evaluate our outreach programs and education efforts to ensure that they are reaching their target audiences and result in needed behavioral changes. Understanding stakeholder knowledge, attitudes, motivations, and behaviors, can inform the development of an effective communication strategy for Farm Bill conservation programming. Research into public attitudes toward wetlands can help improve communication with the public about wetland health, function, and values.

Priority Research Focus: **Fire Suppression & Fire Management** – Fire landscape is a new component of fire suppression efforts in Wisconsin. The ability to accurately predict fire behavior conditions leads to efficient use of resources. Research is needed to accurately predict fire threats by forest cover and age classes across Wisconsin with resulting information incorporated into national fire risk mapping efforts (LandFire). There is also a need to identify alternative management options for prescribed burning on both public and private lands. The goal of this research is to develop alternatives for the timing and frequency of prescribed burns and to assess the effectiveness of prescribed burning in meeting management objectives in both forests and grassland systems while reducing the risk of spread. This information will also address options to mitigate air quality concerns and potential burning regulations as they relate to the release of airborne particulates from prescribed burn management.

Theme: Research to Improve Assessment, Monitoring, & Modeling

Sound natural resources management requires continuous monitoring of environmental conditions, plant and animal populations, and management systems. Federal agencies, like the U.S. EPA and U.S. Geological Survey, work in partnership with states to assess and monitor various resources, often providing funding to support our research. In addition, the department is committed to continually improving its operations. *We will undertake research to develop and refine assessment and monitoring approaches and to improve our modeling capabilities.*

Priority Research Focus: **White-tailed Deer Population Monitoring** – Research is needed to improve white-tailed deer monitoring, both spatially and temporally. Alternative means of monitoring the deer herd from traditional age and harvest data need to be explored. New methods or metrics to monitor the impacts of deer on forests and agricultural crops at various densities and to link those metrics to management actions has been recommended as a future management tool by Wisconsin's Deer Trustee. New approaches to harvest management such as e-registration will need to be evaluated.

Priority Research Focus: **Furbearer Population Monitoring** – Sustainable furbearer harvest regulations require an accurate and reliable assessment of populations. Research is needed to evaluate the feasibility of using age-at-harvest models for Wisconsin's furbearer populations. In addition, there is a need to evaluate the population metrics and models used to derive annual population estimates with research to develop new monitoring approaches for Wisconsin's furbearer populations.

Priority Research Focus: **Fish Population Modeling & Regulation Monitoring** – Sustainable harvest regulations and season structures require an accurate and reliable assessment of populations. We will focus research on the assessment and evaluation of population models and responses to management prescriptions.

Priority Research Focus: **Landfill Organic Stability** –The science and technology governing the achievement of organic stability in landfills encompasses a wide range of methods, including innovations that are not practiced routinely in waste management system design and operation in Wisconsin. When the landfill organic stability rule was adopted in 2006, the Natural Resources Board directed the department to convene a panel of independent experts to conduct a statewide review of the effectiveness of this rule and to recommend ways to improve the efficiency and effectiveness of the rule. It will be important for the department to review the panel's findings and recommendations.

Priority Research Focus: **Biological Criteria and Designated Uses** – Water quality standards rely heavily on chemical parameters that may or may not have biological relevance. Research is needed to support revisions to water quality standards, especially in the area of nutrients and biological response to nutrient and habitat impairments (e.g., NR 102, 104, 105, 217).

Priority Research Focus: **Baseline Assessment & Monitoring –** There is a need to assess and refine surface water sampling and field protocols and to develop a broad scale standardized approach to monitoring the health of rivers, streams, lakes, and wetlands through comparing data/results yielded from multiple monitoring approaches that have been implemented historically in Wisconsin. We can also improve consistency and statistical rigor in our assessments for Clean Water Act integrated reporting. Wisconsin is in a position to provide key leadership for development and implementation of U.S. EPA's national assessment of lakes, rivers, Great Lakes coastal zones, and wetlands.

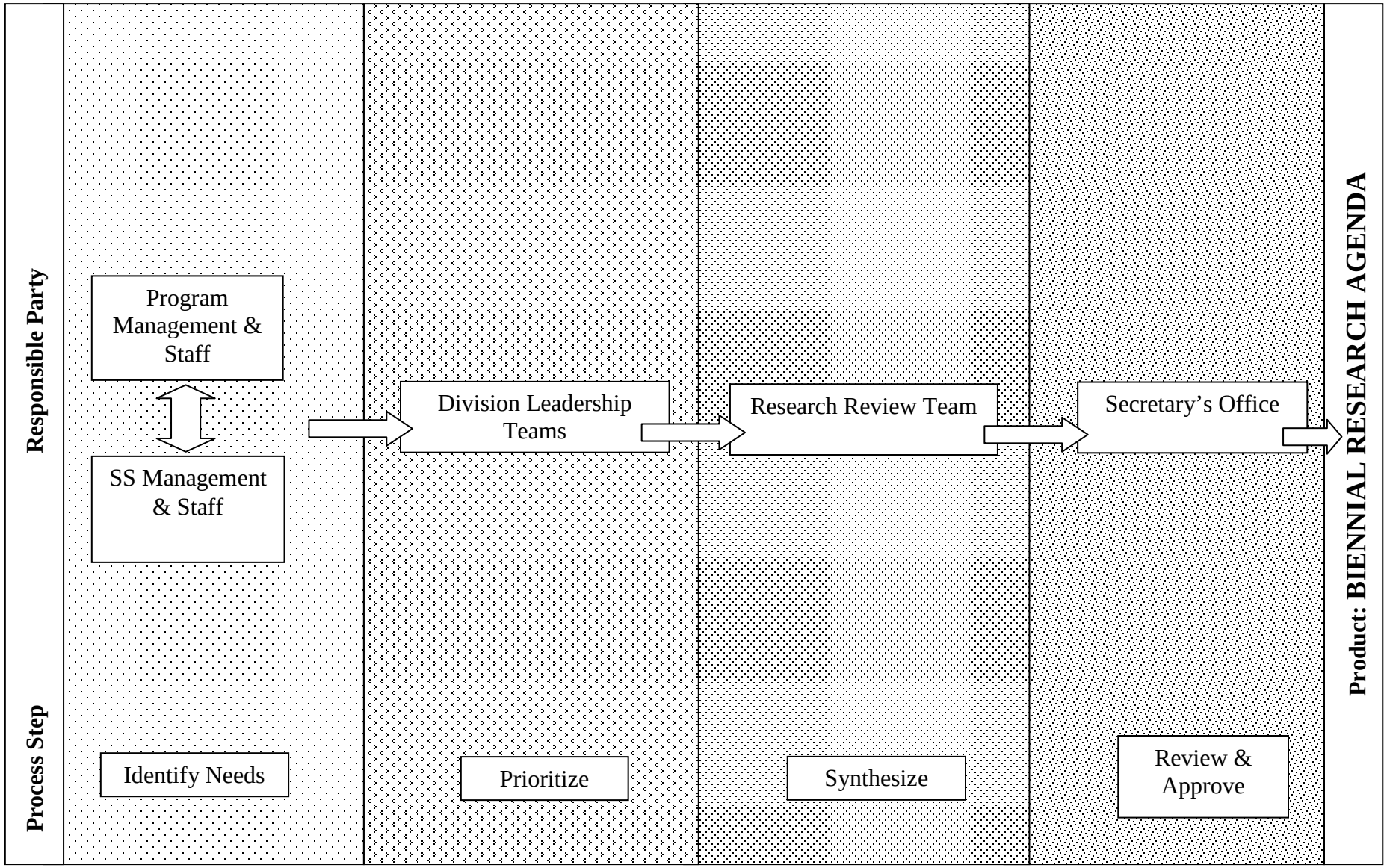
Theme: Research to Ensure a Solid Science Foundation

An effective, modern, science program must take strength from the past and use it to face challenges that lie ahead. Changes often occur incrementally and can go largely unnoticed. The analysis of long-term datasets often provides insights to and a better understanding of current phenomenon. In addition, new issues and challenges continually arise. While many research efforts require narrowly focused approaches, proactive identification of issues before and as they emerge relies on a broad view of disciplines and their overlaps. An approach that considers both is needed to ensure the department is well prepared to base management decisions on sound science. *We will undertake research to document progress and accomplishments, remain efficient and effective, and advance our management goals.*

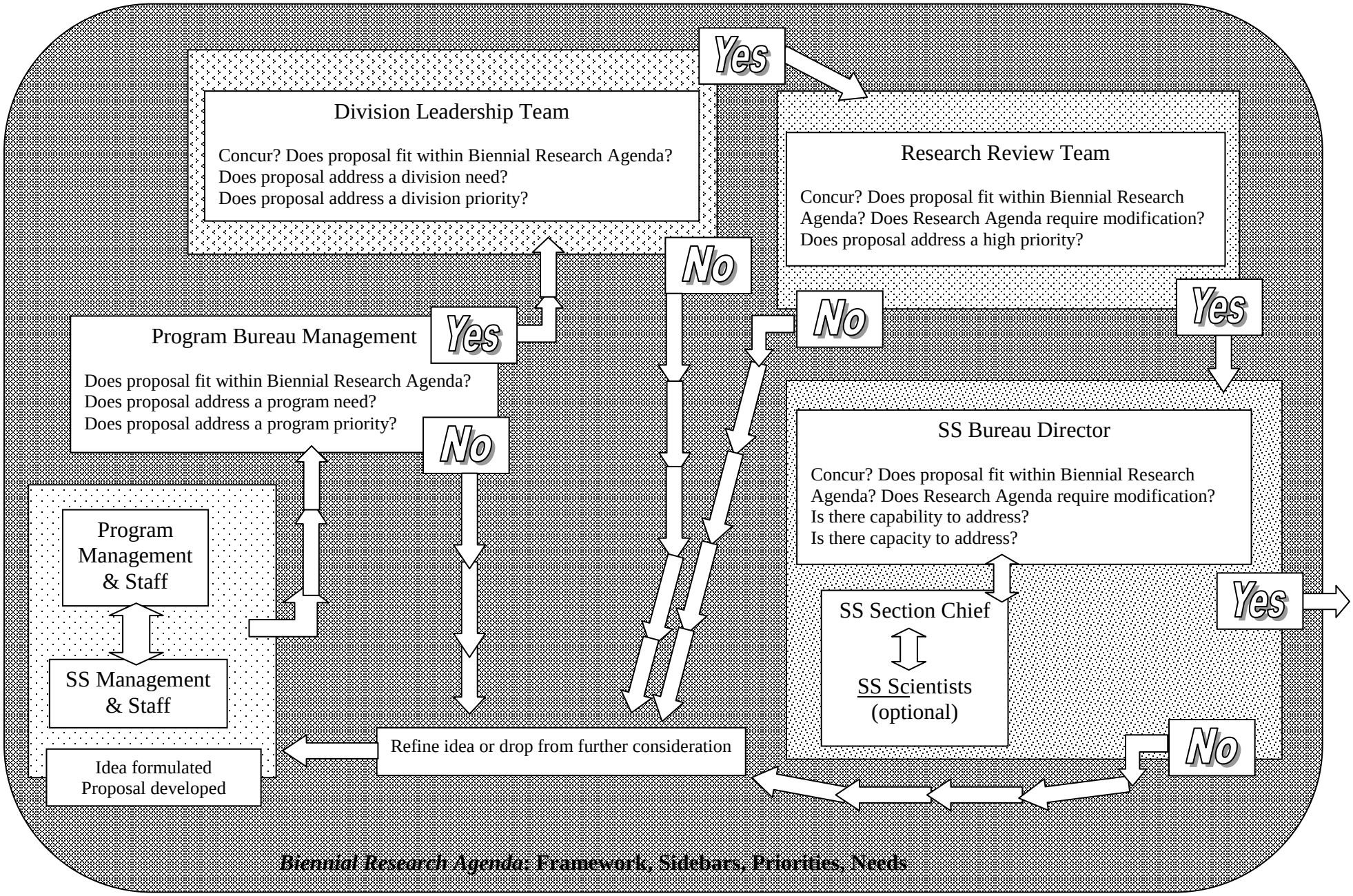
Priority Research Focus: **Long-term Monitoring & Foundational Science** – Investment in long-term data is critical for detecting change over time and for understanding the factors that have led to change. Natural systems may change significantly over a period of 10, 20, or 50 years or more. For example, long-term silvicultural research is a foundation for sustainable management of forest ecosystems. Such studies provide critical information used to assess the impact of various management strategies on tree species composition, quality, size, successional trends, and economic value over time. Without long-term research we would be unable to determine the best management approach for a future desired condition. Similarly, we have invested in long-term creel data collection and fisheries population studies at the Escanaba Lake Research Station since 1946. The resulting dataset has allowed us to answer unanticipated questions (fish scales collected over the years have been used to evaluate the effects of stocking practices on the genetics of the walleye population). Only through a 20-year study of southwestern streams were we poised to tease out the effects of floods and droughts on fish populations from the "normal" year-to-year variation that occurs in year class recruitment and survival. Similarly, data from 50 years of deer population monitoring is used to understand current population trends. We also contribute to broader-scale and national efforts (e.g., sentinel lakes for mercury, NSF-funded North Temperate Long-Term Ecological Research study lakes in Dane and Vilas counties, and the Long-term Resource Monitoring Program on the Upper Mississippi River). Finally, it is important that our scientists remain abreast of the progress in their respective fields and that we have a pool of in-house expertise that can be tapped for baseline information, training, and technical assistance. Scientists' individual research programs facilitate the maintenance of this type of expertise. For example, by maintaining a master fish distribution database and compiling relevant information for each species in a single location, we enable fisheries professionals and the public to have a basic understanding of the distribution and state of the science for all fish species in Wisconsin.

Priority Research Focus: **Emerging Issues** – Over the years, it has been important for Science Services to deploy staff as major issues affecting our agency's mission have emerged. Examples over the past couple of decades have included: mercury contamination from atmosphere to waters, chronic wasting disease, acid rain, biomass fuel utilization, eutrophication, emerald ash borer, aquatic invasive species and VHS, and climate change. Future challenges are yet unknown, but a key role for Science Services is to work with the management programs and external partners to identify emerging management challenges. Once those challenges are identified Science Service researchers develop collaborative research efforts to address those challenges to inform management and policy decision-making within the agency in a timely manner.

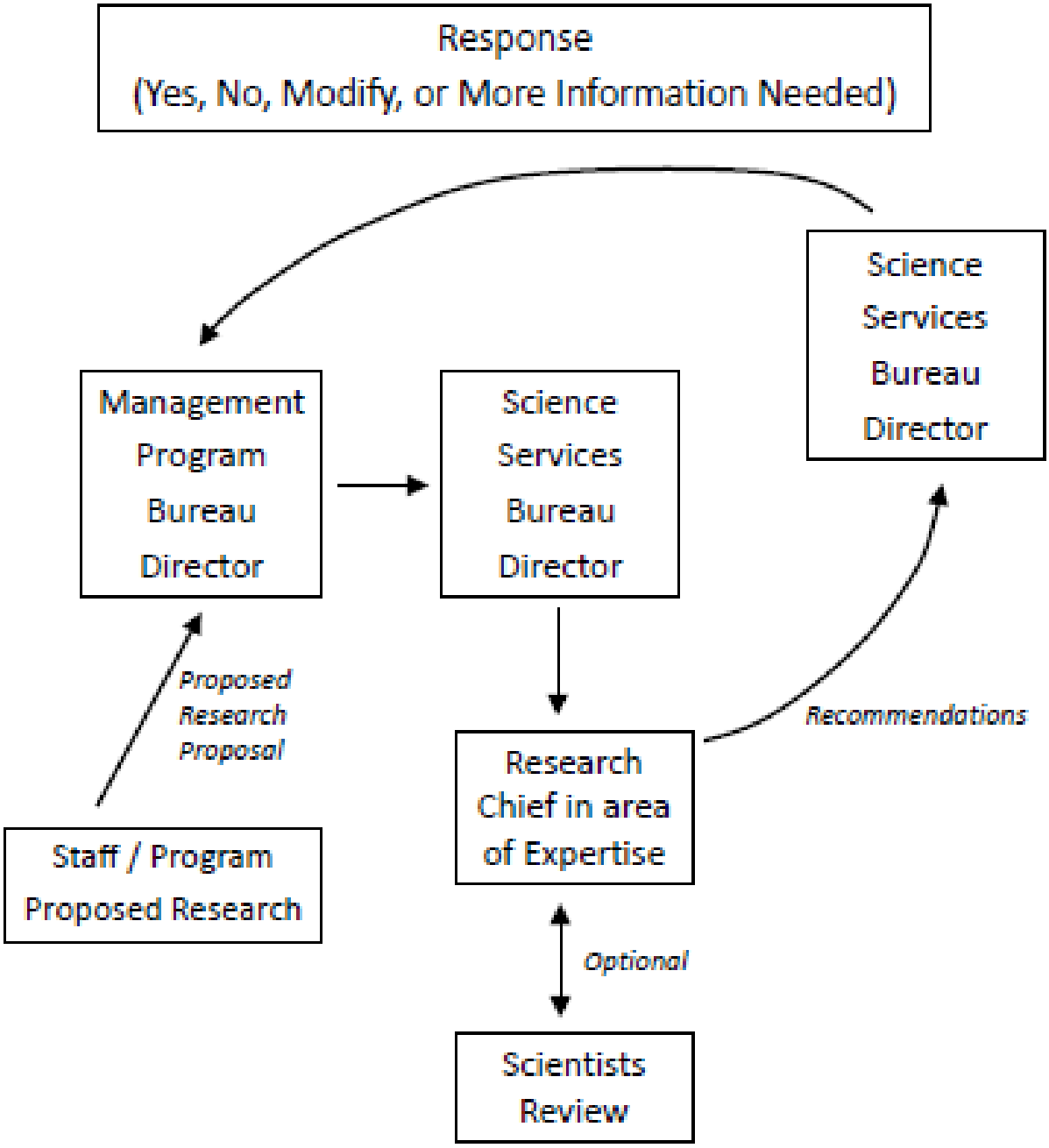
Appendix A – *Development of Biennial Research Agenda*



Appendix B. *Implementation Process for Reviewing and Approving Proposed Research*



Appendix C – *Generalized Model for Program Review of Proposed Research*



Appendix D – *Division of Forestry Research Priority Setting Process*

DNR Research Priority Setting Process Piloted with the Division of Forestry Jan-June 2011

Step 1 – (January 2011) – Identified an eight person core team of experts from FR and SS to develop the process as well as to develop a list of potential topic priorities and project priorities within each topic.

Step 2 – (February-April 2011) - Core Team members used the Statewide Forest Assessment, Strategic Forest Plan, and contacted key staff to develop a list of 22 priority topics and 66 projects to be ranked. In addition three primary prioritization criteria were developed to set a framework for evaluation of the potential topic areas and projects.

Step 3 – (April-May 2011) – Regional Forestry Leaders and Bureau Directors were asked to submit names of individuals to serve on the evaluation team. One representative from each region and two representatives from each bureau were selected to serve on the evaluation team.

Step 4 – (May 2011) - Evaluation Team Members were sent a list and brief descriptions of 22 research topic areas and 66 specific projects and invited to participate in a daylong workshop. On May 18th Core Team Members and Evaluation Team Members met at DNR's Science Operations Center to review current forest research activities, review and discuss the ranking criteria and have a presentation/discussion of priority research topics and projects. After much discussion evaluation team members were asked to rank the 22 topic areas and 66 projects using the 3 evaluation criteria and return their rankings by June 1st. (two weeks). An emphasis was reiterated throughout the workshop that evaluation team members should take a broad statewide and Division-wide perspective when ranking the priorities and should try to avoid focusing on their own area of interest or expertise.

Step 5 – (June 2011) – Summaries of the ranking results were shared with both teams on a June 6th Conference Call. Discussion about the rankings took place with the decision to make the cutoff at the twelve highest ranked topic areas . There were discussions regarding the list and the general consensus was that we used a sound process and changing the list would seem counterintuitive to the process. We ended up prioritizing the top 12 topics with a ranking of 6.5 or higher out of a maximum of 9..

Step 6 – (June 2011) – Compiled the comments we received from the evaluation team regarding the workshop and comments from our June 6th wrap-up meeting.

Step 7 – (June 2011) – Presented the process, information, comments and results to the Forestry Leadership Team for discussion and input on the final list Presented the following decision item to the Forestry Leadership Team (it was approved as presented).

Decision Item for Division of Forestry Leadership Team – Approved forest research priority topics as presented.

Appendix E - *Division of Forestry Research Priority Criteria*

Primary Prioritization Criteria

The primary prioritization criteria will be used at the May 18 workshop to identify the top 15 research priorities. Each research topic and project will be assessed against the criteria with a numerical scoring.

Criteria 1: Significance to Forestry Division

The following statements are true for high-scoring research topics under this criterion:
The research topic is closely aligned with needs identified in the Division of Forestry Strategic Direction and is very applicable to Forestry Division programs. The research helps to achieve the Division's mission of protecting and sustainably managing Wisconsin's forests. The research significantly addresses high priority issues, with minimal follow-up studies. The results of the research are timely and can inform decision-making processes for policies, strategies, and management practices.

Criteria 2: Value to Forestry Community

The following statements are true for high-scoring research topics under this criterion:
The research topic is aligned with needs identified in the Statewide Forestry Strategy and Sustainability Framework. The research is addresses a long-term priority need and will inform forest management and policy decisions for five, ten, fifteen, and more years. The results of the research are valuable to management of both public and private forests as well as across social strata. The research topic is conducive to regional collaboration.

Criteria 3: Application of Research

The following statements are true for high-scoring research topics under this criterion:
The research results are clearly applicable to forest management and policy decisions. The results of the research inform decision-making on high priority management policies, strategies, and practices. The research topic is clearly defined and addresses an issue that cannot be solved by some other method, such as changing a policy or practice.

Secondary Prioritization Criteria

The secondary prioritization criteria will be used to evaluate the top 15 research priorities by the Forestry Division, Department, and external partners to guide research decisions as funding and opportunities become available.

Criteria 1: Institutional Considerations

The following statements are true for high-scoring research topics under this criterion:
The research topic meets the needs of multiple divisions within the Department and addresses the Governor's priorities, including sustaining natural resources and creating jobs.

Criteria 2: Financial & Human Resources

The following statements are true for high-scoring research topics under this criterion:
The research topic provides a high return on investment with a relatively low cost commitment. The research results will provide needed information that justifies the use of limited funding. The research project can leverage internal and/or external resources and has a high potential for partnership opportunities. The research findings will result in a major efficiency for the Department and/or forestry community.

Criteria 3: Timing and Feasibility

The following statements are true for high-scoring research topics under this criterion:
The research topic addresses an urgent issue with high risks and significant consequences. The research need is long-standings and has become elevated in importance because of changes in policies, increased environmental impacts or partnership potential. The results of the research will proactively address research needs. The research project is logistically feasible and the there is expertise available within the Department or external partners to undertake the research. The research topic is not a focus other agencies or universities.

Appendix F – *Division of Forestry Research Themes and Priorities*

DNR Forestry Themes December 10, 2012

I. Social and Economic Values of Natural Resources
   a. Economic value of forests
   b. Industry - supply and demand for markets
   c. What affects the choices of private forest landowners and the way they are currently managing
   d. General public outreach/education

II. Ecological Sustainability
   a. Invasive non-native species are an increasing threat.
   b. Information about some aspects of forest ecosystem function is scarce.
   c. There are unresolved questions about the long-term sustainability of intensive forest harvesting for energy production ("biomass" harvesting).
   d. Some tree species are becoming increasingly less common.
   e. Climate change may affect forest composition, structure, and function.

III. Fire
   a. Fire landscape is a new component of fire suppression efforts in Wisconsin.
   b. The ability to accurately predict fire behavior conditions leads to efficient use of resources.

IV. Deer
   a. Deer are impacting forest regeneration and affecting successional trends.

Appendix G – *Division of Land Priority Setting Process and Criteria*

Process

Projects and three ranking criteria will be sent out to the Wildlife and Endangered Resources Policy Teams, and the Facilities and Lands and Parks Bureau Directors for ranking of proposed project ideas. Each member will be asked to rank the roughly 140 projects based on the three criteria provided below. This process will simply identify the top priorities. It will not result in a ranked prioritization. These research priorities are expected to have a lifespan of approximately 3- 5 years, at which time they will be revisited. The top projects will be used to develop themes which will then be incorporated into the Department's priority setting process. The secondary criteria will be used by research program managers and management program managers to implement projects as resources become available.

Ranking Directions

Please rank each project for each of the three criteria. A '1' denotes a low ranking and a '3' denotes a high priority and a '2' is a medium priority. So the highest possible ranking across all three criteria would be a '9'. Please try to use a relatively equal number of low, medium, and high rankings as you go through the projects. Some projects may rank low for one criteria and high for another criteria. Once you fill in your rankings on the spreadsheet please save and send a copy via email to Jescie Kitchell (Jessica.Kitchell@Wisconsin.gov). You will likely find that you need more information to make a decision – at this point please do the best you can with the available information keeping in mind that you should be approaching this exercise from a Land Division perspective.

Criteria 1: Significance to Land Division

The following statements are true for high-scoring research topics under this criterion:
The research topic is aligned with a critical need for planning, policy, and/or management to address current and/or future threats to populations, ecosystems, or recreational activities associated with State Properties. The research significantly addresses high priority issues. The results of the research are timely and can inform decision-making, policies, strategies, and management practices.

Criteria 2: Value to Land Division Community

The following statements are true for high-scoring research topics under this criterion: Applicability of research to address long-term priority needs of constituents, partners, and the Land Division. Projects that rank high in this category will inform Land Management Decisions for five, ten, fifteen and more years and have a direct link to a Land Division constituency. Research topics that address either socially or economically important issues of constituents will rank high.
Criteria 3: Application of Research

The following statements are true for high-scoring research topics under this criterion:
The research results are clearly applicable to land management, planning, and/or policy decisions. The results of the research inform decision-making on high priority management policies, strategies, threats, and practices either today or in the future. The research topic is clearly defined and addresses an issue that cannot be solved by some other method, such as changing a policy or practice.

Secondary Prioritization Criteria (These will be used to allocate resources during implementation)

The secondary prioritization criteria will be used to evaluate the top 20 research priorities by the Land Division, Department, and external partners to guide research decisions as funding and opportunities become available.

Criteria 1: Institutional Considerations

The following statements are true for high-scoring research topics under this criterion:
The research topic meets the needs of multiple divisions within the Department and addresses the Governor's priorities, including sustaining natural resources and creating jobs.

Criteria 2: Financial & Human Resources

The following statements are true for high-scoring research topics under this criterion:
The research topic provides a high return on investment with a relatively low cost commitment. The research results will provide needed information that justifies the use of limited funding. The research project can leverage internal and/or external resources and has a high potential for partnership opportunities. The research findings will result in a major efficiency for the Department and/or forestry community.

Criteria 3: Timing and Feasibility

The following statements are true for high-scoring research topics under this criterion:
The research topic addresses an urgent issue with high risks and significant consequences. The research need is long-standings and has become elevated in importance because of changes in policies, increased environmental impacts or partnership potential. The results of the research will proactively address research needs. The research project is logistically feasible and the there is expertise available within the Department or external partners to undertake the research. The research topic is not a focus other agencies or universities.

Appendix H – *Division of Land Research Themes and Priorities*

DNR Land Division Priority Research Themes December 10, 2012

I. Ecological Sustainability and Landscape-Scale Conservation/Management

a. Agricultural Ecosystems: Examining the Influence of Agricultural Practices, Bioenergy Production, Development Patterns, and Conservation Programs on Sustainable Wildlife Populations on Private Lands
b. Wisconsin Stopover Initiative
c. Evaluating Forest Conservation Areas
d. Monitor the effectiveness of restorations and impoundment management for secretive marshbirds and other priority wetland targets: Is our waterfowl-wetland work also working for marshbirds and other targets?
e. Estimating sharp-tailed grouse colonization and occupancy of newly created barrens habitat in the Northwest Sands.
f. Evaluating Effectiveness of Prairie and Savanna Restoration
g. Evaluating management in Natural Community Management Areas
h. Managing Landscapes for Young Forest Wildlife Specialists
i. Effect of timber management on rare species
j. Assess ecological impacts of wolves to forest regeneration and trout habitat.

II. Population Ecology and Sustainable Ecological Modeling and Monitoring

a. Wolf Population Modeling
b. Wolf Harvest Survey
c. Develop an Age-At-Harvest Model for Black Bears in Wisconsin
d. Research on alternative systems for assessing the wolf population
e. Productivity of Black Bear in Wisconsin.
f. Population Viability Analysis Regarding Little Brown Bats
g. Evaluate and Improve Furbearer Population and Harvest Monitoring Techniques
h. BATLAS program
i. CBM Acoustic and Roost monitoring projects
j. Greater Prairie-Chicken Population Viability Analysis

III. Deer

a. Social Carrying Capacity for White-tailed Deer in Wisconsin
b. Factors Affecting the Rate of Deer Population Increase in Wisconsin
c. Factors Affecting Buck Harvest Rates
d. Deer reproduction and nutritional condition in Wisconsin
e. Assessment and Evaluation of Telecheck (eRegistration) and Alternative Options for Population Modeling

IV. Ecological Sustainability under Changing Environmental Conditions

a. Understanding the impact of changing climatic conditions and other synergistic impacts such as invasives, disease, habitat loss, etc. on Wisconsin's wildlife
b. Developing a Property Manager's Guide to Climate Adaptation Strategies
c. Monitoring Climate Impacts in Vulnerable Upland Forests

V. Communicating the Social and Economic Values of Natural Resources
a. Development of a Communications Strategy for Farm Bill Conservation Programming
b. Baseline Wildlife Conservation Knowledge of Wisconsin Students in 3rd, 6th and 12th grades
c. Assessing Recreational Use of State Wildlife Areas and Visitor Satisfaction
d. Social Carrying Capacity for Timber Wolves in Wisconsin

Appendix I – *DNR Monitoring and Research Priorities from the Groundwater Coordinating Council's Current Joint Solicitation*

The DNR has identified the following priorities for groundwater monitoring and research for FY14. These are specific ideas for projects for which state groundwater experts see an immediate need. Funding preference will be given to project proposals that address one or more of these priorities.

A. Evaluation of Fertilizer (Commercial or Waste) Management Practices for Protection of Groundwater and Drinking Water Wells.

Nitrogen and bacteria are leading causes of drinking water well contamination in Wisconsin. Viruses are an increasing concern. Research is needed to determine effective management practices and site characteristics for fertilizer application that are protective of drinking water wells and groundwater. Projects should address acute and/or chronic impacts to groundwater and may focus on one or more of the following:

- Develop and evaluate practices, decision tools, and management systems to help agricultural and other landowners cost-effectively apply fertilizers while reducing the potential for groundwater contamination
- New cost-effective analytical tools (microbial source tracking, isotopic methods, etc.)
- Occurrence of associated contaminants (pharmaceuticals, viruses, other pathogens, etc.)

B. Viruses and Other Microbial Contaminants.

Public water systems are increasingly contaminated by viruses and other microbial agents. Private wells are also at risk. Work is needed to: 1) evaluate well construction methods for susceptibility to viruses; and 2) research adenovirus genotypes, effects, routes of exposure, what people are impacted, and drinking water implications.

C. Information to Support Management of Water Use to Protect Ground and Surface Water Supplies.

To help facilitate sound water management and carry out state laws, the DNR needs additional data and information on the following topics:

- *Assessing cumulative pumping impacts and achieving sustainable water use* –The DNR is interested in developing methods to predict, evaluate, and mitigate cumulative adverse impacts of groundwater pumping on waters of the state where high capacity wells are concentrated or where surface or groundwater resources may be stressed. The purpose of this evaluation is to determine sustainable pumping levels to protect and improve our health, environment, and the economy.
- *Impacts of high capacity wells on surface waters* - Research is needed to refine our understanding of groundwater-surface water interaction (e.g. streambed conductance, stream-flow depletion, recharge area identification, assessment of irrigation practices and consumptive use coefficients for agricultural applications, evaluation of land use change impacts, as well as characterization of wetland and lake hydrology).
- Other groundwater quantity goals needing support from monitoring and research include:

- Identification of groundwater recharge areas and enhancement of natural recharge and improvement of hard-surface infiltration technologies.
- Identification of water-dependent environmentally sensitive resources (e.g. calcareous fens)
- Relationship between high groundwater use and changes in groundwater quality
- Identification of multi-aquifer wells and evaluation of their impacts on stressed aquifer systems
- Assessing how well construction requirements affect groundwater quantity
- Development of basin-scale groundwater budgets

D. Source Water Protection Tools.

Research is needed on the following topics to assist communities protect their drinking water sources.

- Hydrogeologic studies to characterize the vulnerability of municipal drinking water systems to contaminants and to find ways to manage contaminant sources
- Development of simple economic analysis tools to help communities evaluate investments in groundwater protection as compared to water treatment
- Assessment of the extent of unused wells in wellhead protection areas in need of filling and sealing through area-wide pilot projects

DNR Ongoing Needs

The DNR, the Research & Monitoring Subcommittee of the GCC, other state agency staff, and university researchers also suggest the topics listed below. While the department will give preference to proposals that meet the priorities above, the following important needs will also be considered.

Occurrence of Groundwater Contaminants – Refined information is needed about the extent, causes and forecasting of elevated nitrate, arsenic, sulfate, total dissolved solids (TDS), low pH, radium, molybdenum, VOCs from construction and demolition landfills, and other water quality problems in order to give advice to homeowners, municipalities and well drilling contractors.

Springs - DNR continues to seek updated springs inventory and flow information and better information about spring hydrology to assess impacts of high capacity wells on spring flow rates and characterize the susceptibility of certain spring types or size categories to impacts as a result of groundwater drawdown.

Health Effects of Groundwater Contaminants – Research is needed to better characterize the impact of contaminated groundwater on public health.

Emerging Groundwater Contaminants – Research is needed to determine whether certain emerging substances (pharmaceuticals, antibiotics and hormones, pesticide breakdown products, viruses, prions, and other microbial agents) pose a threat to our groundwater resource and to human health.

Evaluation of Impacts to Groundwater by Wastewater Treatment Methods - Demonstration and evaluation of techniques to measure and enhance the effectiveness of wastewater seepage cells in preventing nitrogen from entering groundwater are needed.

Protecting groundwater from impacts by stormwater infiltration - Evaluation of the impacts of stormwater infiltration practices within recharge areas is needed to assess the extent of contamination and to develop and demonstrate innovative techniques to reduce contamination.

Groundwater Monitoring and Data Analysis - Development of a process for routine analysis of currently-gathered data (Groundwater Retrieval Network, DATCP, Wisconsin Groundwater Center and others) to detect emerging trends and proactively address groundwater and drinking water contamination issues. In addition, modernization of the State Observation Well Network is needed for drought and flooding preparedness as well as land use planning.

Resource Definition – Studies are always needed to better describe the geologic, hydrogeologic and geochemical conditions that affect groundwater quality and quantity in a specific aquifer or area of the state (e.g., contaminant transport in karst areas).

Monitoring Techniques – Methodology for groundwater monitoring is constantly evolving. There is a need to evaluate new techniques to ascertain that they are effective in the field.

Appendix J – *Water Quality Board and Watershed Bureau Recommendations for Research Priorities*

Table 1. Compiled list of recommended consultation and research priority needs for the Bureau of Water Quality and Bureau of Watershed Management

PROJECT TITLE	PROJECT OBJECTIVES	PROJECT LEAD / CONTACT NAME
Phosphorus implementation (Tech consult)	Permits, site specific criteria (SSC), adaptive management (AM), pollution trading, TMDL develop/implement/evaluation/tracking. Revision of NR 102 and as intertwined w/ NR 104, 105, 217. Wisconsin River TMDL: evaluate multiple models to suggest which are useful under various scenarios. Nutrient targeting and tracking tool (aka Grid Tool): create a standardized statewide nutrient targeting and tracking tool. Great Lakes nearshore modeling, P permitting, AOC monitoring.	WQ/SS
Nitrogen reduction strategy development (Tech consult)	Evaluate agricultural nitrogen BMPs for source and surface waters. Determine breakpoints for fish/bugs vs N in surface waters. Transport & fate modeling.	WQ/SS
Biocriteria development (Tech consult)	Revise NR 102 (104, 105, 217). Interstate tools and evaluation for Mississippi River	WQ/SS
Use designation refinement (Tech consult)	Revise NR 102 (104, 105, 217).	WQ/SS
Revise monitoring strategy and WisCALM(Tech consult)	Optimize stream, river, lake, and wetland monitoring strategy through comparing data/results yielded from multiple monitoring approaches. Improve consistency and statistical rigor in assessments for CWA integrated reporting.	WQ/SS
Lakes invasives and monitoring (Tech consult)	Develop and validate Aquatic Macrophyte Community Index (AMCI). Lake transparency estimates via satellite. Sediment cores for lake planning grants. Harmful algal bloom (HAB) background, inventory, and predictions. Lake & River aquatic invasive species (AIS) (e.g., pertinent to fish passage policy). Eurasian water milfoil control	WQ/SS
Tech and ad hoc teams as appropriate	For example, lake or streams tech teams and WisCALM revision team.	WQ/SS

Frac sand mining	Initiate discussion of anticipated consequences and research to mitigate mining impacts to source waters, water levels, and indirect effects. Literature search. Develop monitoring strategy and deploy staff to collect data 2013 in high-risk areas. ($25k field component)	WQ/SS
Mineral mining impacts	Initiate discussion of anticipated consequences and research to mitigate mining impacts to source waters, water levels, and indirect effects. Literature search. Develop monitoring strategy and deploy staff to collect data 2013 in high-risk areas. ($25k field component)	WQ/SS
High-capacity well effects on source and surface water	Investigate cumulative effects of multiple wells. Assist in guidance for permitting. ($? leverage existing work).	WQ/SS
Build capacity for SS to conduct wetland research	Assimilative capacity of discharge to wetlands. Role of wetland restoration in WQ trading. Determine hydrologic response and function of wetlands affected by high-cap wells. Develop wetland monitoring and evaluation strategy.	WQ/SS
Nutrient targeting and tracking tool (aka Grid Tool)	Existing proposal available ($150k)	WQ/SS
High-cap well effects	High-cap well effects on source and surface waters (cross-listed w/ new SS work but may be collaborative opportunities outside?)	WQ/TBD
High-rate wastewater land treatement	High-rate wastewater land treatment evaluation for spray irrigation and ridge & furrow treatment systems	WQ/TBD
Permit levels for various wastes	Determine permit levels for animal, septage, biosolids, and industrial waste land spreading under various landscape scenarios	WQ/TBD
Mississippi River biocriteria and evaluation methods as part of interstate/interagency collaborations	Biological impairments in off-channel areas. Refined designations for floodplain wetlands. Assessment and biocriteria for floodplain wetlands. Monitoring, assessment, standards based upon mussels. HABs/nutrient relationships and thresholds off main channel.	WQ/TBD
Curly-leaf pondweed control	Curly-leaf pondweed control (tentatively approved). Investigate most effective control methods.	WQ/TBD
Eurasian water milfoil hand pulling efficacy	Determine the efficacy of Eurasian watermilfoil as a control option.	WQ/In collaboration with Central Sands RC&D
Shoreland useage	Promoting behavioral change on lake shorelands ($52k in hand).	WQ/TBD

Agricultural Land Use Surveys within TMDL subbasins	Phosphorus and Nitrogen are leading causes of surface water contamination (i.e., hypoxia, algae blooms) and for nutrient impaired waters in Wisconsin. Several large watersheds are currently under, or have been proposed for, TMDL's by the WI DNR	WT-Craig
Evaluation of Agricultural Waste Management Practices for Protection of Groundwater and Drinking Water Wells.	Project Summary (Describe specific project objectives and estimated project costs): Research is needed to determine effective management practices and site characteristics for manure and process wastewater application on sandy, highly permeable soils that are protective of drinking water wells and groundwater.	WT-Craig, Helmuth
Evaluation of Adaptive Management Approach to Controlling Drain Tile Effluent in Bower Creek, Brown County	Bower Creek is a major source of phosphorus in the Lower Fox TMDL area. It was also part of the East River Priority Watershed Project. Extensive monitoring was conducted over the last 20 years to determine the benefits of the BMPs cost shared by the county. Levels of phosphorus were not statistically reduced in the stream. Brown county, NRCS, and DNR staff are interested in adapting the management approach to achieve TMDL objectives in the stream. Different strategies would be implemented to control the level of phosphorus in discharge from the many drain tiles. A completely automated monitoring station was installed on the creek and this station would be re-activated to document any changes in the stream's phosphorus levels. The estimated cost for the first year is $80,000 and the cost for each following year is about $50,000.	WT-Bannerman
Design of a field-based hydrogeological method for evaluating nitrate concentrations below fields following best nitrogen management practices		WT-Craig, Helmuth
Leaf Collection as a BMP to Achieve Phosphorus Reduction Goals in Wisconsin TMDLs	As part of a TMDL many cities in Wisconsin are being required to significantly lower their annual phosphorus loads during runoff events. One important source of phosphorus is the runoff in leaves. Studies have shown the levels of phosphorus concentrations in urban runoff increases dramatically with greater tree canopy. Most cities in Wisconsin have a leaf collection program to remove the leaves, but unlike other BMPs the Department does not the ability to give the cities phosphorus reduction credit for collecting the leaves. The purpose of this study is to evaluate the phosphorus reduction achieved with different leaf collection programs and develop a tool for the cities to use to calculate a credit. The total cost of the project is estimate to be about $300,000 for the four years. Some of the funds have already been obligated by several partners, but to complete the funding requirement for this project an additional $30,000 a year is needed.	WT-Bannerman
N stabilizer technology and dairy manure	Following digestion, land application of digested manure (liquids and solids) is a common practice. After digestion, manure has reduced pathogen loads and the nutrient content and forms of nutrients are altered.	WT-Craig

Characterizing the sources of elevated groundwater nitrate in Dane County, WI		WT-Craig
Nutrient Availability of Manure (new or continuing research)	Nitrification inhibitors restrict the conversion of ammonium to nitrate, the form of N susceptible to denitrification and leaching, for a period of time. Past research using nitrification inhibitors with liquid manure have had mixed results.	WT-Craig
Impact of Polymers Used by Sand Mining Operations on Local Groundwater Quality	People living near sand mining operations have been very concerned about potential groundwater contamination problems. Polymers used in the process to recycle water on the sites have received particular attention. The purpose of this project is to conduct a literature review on the potential of polymers used at the sand mining sites to contaminate local groundwater. The cost of this one year project would be about $20,000.	WT-Bannerman, Bertolacini
Effects of CAFOs on Air Quality	This is a topic for which we receive many questions.	WT-Stoll
Effects of CAFOs on groundwater nitrates and bacteria	Groundwater monitoring near CAFO's in karst environments and also sandy porous soil areas for nitrates and E coli bacteria.	WT-Stoll
Wetland Condition: Establishing reliable indicators of condition (the wetland thermometer)	Wetland Invasive Species Management (Hydrologic (and nutrient) impacts to wetlands from:Stormwater additions, Wastewater Discharges –Paul LaLiberte's issue, Groundwater Drawdown from High Capacity Wells – Larry Lynch) and Evaluating the development and performance of wetland restorations for: Mitigation evaluation – definitely the most pressing need, Evaluating restoration techniques, Evaluating functional benefits from restored wetlands.	WT-Wetland Team
Wetland Function: Understanding the actual mechanisms and physical processes that result in performance of functions.	Understanding the role of wetlands in sustaining healthy watersheds, such as resilience in the face of climate change, Quantifying the economic value of wetland functions. Determining if there is a link between good wetland condition and public's valuation of wetlands, Social research into public attitudes toward wetlands – including how to improve communication with the public about wetland health and function.	WT-Wetland Team

Effectiveness of existing regulations to address impacts of near shore activities in lakes and rivers: Impacts of activities regulated under chapter 30, Stats.	Use a lake or stream classification system or something similar to compare like water bodies, in order to evaluate the effects of selected regulated activities on selected parameters in the near shore area. The goal of this type of study is to compare different activities and their impacts on similar types of water bodies, and the combination of those impacts, helping to understand cumulative effects of those activities. The results of these studies will provide information and data to assess effectiveness of existing regulations, support individual permit decisions, and identify appropriate conditions for general permits to ensure that regulated activities are not detrimental to the public interest. Some examples are described below:	WT-Waterway and Wetland Section
Effectiveness of existing regulations to address impacts of near shore activities in lakes and rivers: Culverts and Bridges	Study of fragmentation effects on streams by road crossings, with a focus on effects on aquatic organism passage. This study would focus on multiple parameters to evaluate the culvert structure and resulting physical and habitat changes in aquatic organisms. Study sites would be chosen with the idea that the data could be used to create a model which will be able to identify culvert and bridge crossings on a watershed level that are having the greatest impact to the resources. The results of these studies will provide information and data to prioritize culvert repair and replacement priorities for restoring stream functions, as well as assess effectiveness of existing regulations, support individual permit decisions, and identify appropriate conditions for general permits to ensure that culvert and bridge placement/replacement are not detrimental to the public interest.	WT-Waterway and Wetland Section
Effectiveness of existing regulations to address impacts of near shore activities in lakes and rivers: Water Withdrawals	Collect data and evaluate parameters to establish flow regimes (includes levels and flows) for highest priority steams in the state based on sensitivity, etc. The flow regimes could then be used to come up with a minimum standard related to the reduction of those regimes and evaluate if the alteration of regime would adversely affect stream system and services it provides to citizens. This would allow us to better evaluate and understand the cumulative effects of current water withdrawals for a variety of uses and also emergency withdrawals for agriculture due to drought. The results of these studies will provide information and data to help set an expectation of water use before requests or increased pressures due to extreme weather events. In addition, results will help assess effectiveness of existing regulations, and identify appropriate individual permit conditions to ensure that water withdrawals are not detrimental to the public interest.	WT-Waterway and Wetland Section
Effectiveness of existing regulations to address impacts of near shore activities in lakes and rivers: Piers (Docks) and wharves	Study effects of pier size and density on habitat and aquatic organisms in a novel way. Instead of trying to find similar systems that have drastically different pier placement use, conduct an artificial treatment style experiment where undeveloped water bodies on state owned land are pre-evaluated for a variety of habitat parameters artificially for the duration of the study establish different levels of pier density clusters on selected shorelines leaving other areas undeveloped. Impact to near shore aquatic organism movement and habitat use could even be documented using the latest GIS and satellite tracking techniques.	WT-Waterway and Wetland Section

Effectiveness of existing regulations to address impacts of near shore activities in lakes and rivers: Piers (Docks) and wharves	Study of pier construction methods/materials and design on near shore habitat. For Inland Lakes examining the effects of materials and design on shading; on Outlying waters examine effects of materials and design on solid piers related to near shore coastal process including littoral drift, sediment transport, and shoreline erosion.	WT-Waterway and Wetland Section

Appendix K – *Bureau of Fisheries Management and Bureau of Science Services Integrated Research Prioritization for FY 2013–15*

-February 2013-

Jonathan Hansen, Fisheries Management
&
Jennifer Hauxwell, Section Chief, Fisheries and Aquatic Science Research

Background

As part of a department wide effort carried out within each division, Fisheries Management (FM) and Science Services (SS) were tasked with working together to identify and prioritize fisheries-related research needs for the biennium beginning in FY 2013. In FY 2010, FM and SS carried out a similar research prioritization effort which was used as the basis for the current effort, however a few changes in the prioritization process were made; namely additional collaboration between FM and SS. The research needs identified in this document will be considered as SS staff initiate new projects but also for the department's external partners, particularly within the University of Wisconsin system. Generally, this document serves to summarize the prioritization process and list FM's current research priorities. However, unanticipated research needs often emerge and the FM Board may adjust priorities accordingly. Moreover, several priority projects related to various species and fisheries issues are ongoing and are not included here but are still considered high priority.

Process

Research needs were identified and ranked within the various FM teams to ensure spatial and fishery type coverage and included species teams, Lake Michigan Fisheries Team, Lake Superior work unit, and Bureau staff. After the ranked research needs were compiled across the teams, Bureau staff (Fisheries Management Section) and SS staff met to discuss the top 2-5 needs within each team and then ranked the various projects. The FM Board members independently ranked the same list. Both sets of rankings were then combined to identify three levels of research importance according to obvious breaks in the rankings: Primary, Secondary, and Tertiary.

SS staff independently created a list of research interests and needs, many of which overlapped with the needs identified by FM teams. To gauge FM interest, each Bureau staff ranked each non-overlapping item as high, medium or low priority. The scores were then averaged to create a priority score, with higher scores being higher priority.

Prioritization Results

The rankings of the top research needs identified by FM teams are shown in Table 1. Three new projects were clearly identified as top priority: the development of a lakes classification system and conducting two separate angler surveys, one re-doing a statewide angler creel survey and one describing angler sportfish preferences. Two projects were also ranked as a top priority (Fish community interactions in a changing climate and a review of the Ceded Territory walleye

harvest model), however some aspects are currently underway. Additional research that could be considered supplemental to these efforts should still be considered as a top priority for FM.

A range of other needs are listed in Table 1 all of which should be considered important questions for FM but identified as secondary or tertiary level. Additional research areas that were not included in any of the elevated rankings because of their initial low priority are included in Table 2. Finally, research interests of SS staff that weren't identified within the FM teams showed varying scores of importance to FM (Table 2). Top ranked projects included a summary of statewide panfish status and trends, testing for changes in walleye growth in the Ceded Territory, and incorporating the Northern Highland Fishery Research Lakes into a national long-term ecological monitoring program.

Incorporating the Lake Michigan Fisheries Team's (LMFT) research needs into the integrated ranking exercise was somewhat complicated. LMFT created a research needs list independent of this effort that was not prioritized and rather lengthy. Therefore individual projects were not considered in Table 1, with the exception of yellow perch survival in GB which was identified by Bureau staff. Thus researchers with interests focusing on the Great Lakes should consider LMFT's research needs which are included in Appendix L.

Summary

This prioritization effort was vital to identify fisheries-related research needs for the department and particularly effective because of the collaborative approach between FM and SS. The potential projects listed here could be led by SS staff, university faculty, FM staff or ideally, in a collaborative manner including all three groups. No matter the group, the research needs identified in this document represent important questions FM would like answered at this time. As work is initiated on these projects it will be important for researchers to communicate with the FM research liaison and SS section chief to both ensure the topic is directly applicable to FM and research efforts are not being unnecessarily duplicated. This research prioritization effort will be conducted every 2 years to stay abreast of changing management needs.

Table 1. Fisheries research needs identified by collaborative effort of FM and SS. Topics grouped by priority level. *See Appendix L for full Lake Michigan research needs list.

Project title and priority level
PRIMARY
Fisheries oriented lakes classification
Angler preferences
Statewide mail creel survey
Fish community interactions in a changing environment (bass-walleye-esocid interactions) (ONGOING)
Review current walleye harvest model in Ceded Territory (some aspects ONGOING)
SECONDARY
Evaluation of new trout regulations
Assessment of trout response to land acquisition and habitat enhancement
Evaluation of woody littoral habitat enhancement
Evaluate alternative creel methods
Walleye stocking practices evaluation: densities and pellet-reared large fingerlings
Systematic evaluation of musky stocking practices
Statewide characterization of inland trout age and growth
Economic value of Great Lakes fisheries
Bass predation on yellow perch and associated responses of juvenile walleye
Design additional trout creel surveys with emphasis on mail surveys
Yellow perch survival in GB*
Survival, movement, and dispersal of stocked sturgeon
Empirical evaluation of panfish size limits
TERTIARY
Investigate bass-bluegill associations
Black crappie sarcoma life history and transmission
Describe basic life history patterns of juvenile flathead and channel catfish
Development of standardized catfish sampling technique
Catfish exploitation evaluation
User acceptance of lead tackle ban on fishery research lakes
Shovelnose sturgeon exploitation evaluation
Update of sturgeon genetics
Declining Hg in northern sportfish
Effects of mining on aquatic resources and fisheries

Table 2. Additional fisheries management research needs not included in ranking and prioritization process. Projects generally deemed lower priority than those listed in Table 1. * indicates cross listed in Appendix L: Lake Michigan and Green Bay research needs.

Team	Project Title
Musky	Catch and release mortality: live bait (quick-set), artificial, etc.
	Fry/small fingerling stocking successes
Walleye	Periodic spawning of female walleye
	Sex ratio of large walleye fingerlings harvested from hatchery ponds.
	Survival of stocked walleye- stocking techniques
Bass	Evaluation of standardized monitoring techniques: how variable is spring electrofishing CPE and how well can it predict abundance?
	Genetic differences within and among Green Bay smallmouth bass
	Green Bay smallmouth bass movement and spawning site fidelity
	Tournament related issues with special emphasis on Green Bay smallmouth bass displacement and barotrauma associated post-release mortality
Panfish	Implications of bluegill life history variation for methods of assessing and comparing growth rates
	Evaluation and improvement of yellow perch and black crappie sampling methodologies
Trout	Survival and fitness of F1 versus F2 brook trout
	Beaver dam management and beaver impacts on trout streams
	Gill lice infection of brook trout
Catfish	Angler acceptance of restrictive catfish regulations
	Impacts of VHS policy on catfish angling participation
Sturgeon	Potential impact of gene mixing in recovering stocks
	Imprinting of fish reared and stocked from sturgeon trailers versus hatcheries
	Evaluation of streamside facilities
	Evaluation of fish passage - Upstream and downstream (especially downstream of juvenile – fingerlings)
	Impingement & entrainments survival of age 0-1; survival of juveniles age 1-6
	Shovelnose sturgeon stock range identification
Fish Health	Ranaviruses collaborative research
	Unknown viruses isolated from hatchery or wild fish
	Emerging instances of EEDv in hatcheries
Lake Superior	Bioenergetics of Chequamegon Bay/Apostle Islands
	Fishery response to Lake Superior water-level and temperature fluctuations
	Effects of sediment and nutrient transport on nearshore fishery and ecosystem
	Impact of in-stream meso-habitat shifts on fish community structure
Lake Michigan	See Appendix L
Other	Genetic description of fish imported from out-of-state for recreational stocking purposes

Table 3. Ongoing and future research interests identified by SS staff independent of FM staff. Priority score is average of relative priority rankings assigned by FM Bureau staff where High = 3, Medium = 2, and Low = 1.

PROJECT TITLE	Status	Priority Score
Statewide panfish status and trends	Ongoing	2.7
A comprehensive examination of Ceded Territory walleye growth	Future	2.5
Establishment of LTER monitoring on NHFRA lakes	Future	2.5
Fish passage/AIS cost-benefit	Ongoing	2.4
Effects of climate on stream hydrology and fish distributions	Ongoing	2.3
Propagation-related research	Ongoing	2.3
Cisco assessment and walleye-cisco interactions in Wisconsin lakes	Ongoing	2.2
Climate effects on warmwater species	Future	2.1
Conservation genetics of cisco in inland lakes of Wisconsin	Ongoing	1.9
Aquatic ecosystem responses of Pallette Lake to experimental warming	Future	1.9
Economic analysis associated with various fisheries management strategies	Future	1.8
Declining fish license sales	Potential Future	1.8
Response of SMB to mandatory harvest on Nebish Lake	Future	1.5
Effects of pollutants on fish (e.g., pharmaceuticals)	Future	1.5
Common carp management, lake restoration	Future	1.4
Disease ecology under changing environmental conditions	Potential Future	1.4
Effects of timber harvest or other disturbances on fish communities	Potential Future	1.3

Appendix L – *Lake Michigan Fisheries Team Research Prioritization for FY 2013-15*

These priority research needs were developed by the Lake Michigan Fisheries Team to encourage progress towards meeting objectives in the Lake Michigan Integrated Fisheries Management Plan (LMIFMP) and, in some cases, Lake Michigan Fish Community Objectives (FCOs) set forth by the Great Lakes Fishery Commission's Lake Michigan Committee and Technical Committee. Interested researchers should review the LMIFMP, FCOs, as well as the latest version of the *State of Lake Michigan* document for additional background information concerning these research priorities. FCOs are updated annually; copies of the most recent priority list, the FCOs, and the *State of Lake Michigan* report are available on the Great Lakes Fishery Commission's web site (www.glfc.org). The LMIFMP can be found on the DNR web site (http://dnr.wi.gov/topic/fishing/documents/lakemichigan/lmifmp2003-2013.pdf). The current list of 25 priority research questions identified by the WDNR Lake Michigan Fisheries Team are indicated below in no particular order of importance, but any innovative research project that clearly will advance the achievement of FCOs or objectives within the LMIFMP will be encouraged, even if not included on the specific list of priority research questions.

Species	Research Item	Contact
Walleye	Spawning site fidelity/genetics by area (Fox, Oconto, Peshtigo, Menominee, Sturgeon Bay). Is there a single spawning walleye population in Green Bay or are there multiple spawning populations? If there are multiple populations how do they interact?	Steve Hogler steven.hogler@wisconsin.gov 920-662-5480
Walleye	Recruitment by location & habitat (year class structure) What are the population characteristics of walleye in Green Bay? Is recruitment and year class strength the same across Green Bay or are there areas of Green Bay that contribute more to the overall abundance of walleye in the bay? What factors lead to successful recruitment?	Steve Hogler steven.hogler@wisconsin.gov 920-662-5480
Yellow Perch	Bioenergetics/diet study on pelicans. What is the diet composition of the growing population of pelicans in southern Green Bay?	Tammie Paoli tammie.paoli@wisconsin.gov 715-582-5052
Yellow Perch	Investigate parameters for automating commercial quota system. What parameters and formula would best be utilized to develop an automated commercial quota system for Green Bay yellow perch?	Tammie Paoli tammie.paoli@wisconsin.gov 715-582-5052
Smallmouth	Genetics.	Scott Hansen

Bass	What, if any, types of genetic differences exist among the Green Bay/Lake Michigan "recognized populations"?	scott.hansen@wisconsin.gov 920-746-2864
Smallmouth Bass	Spawning site fidelity/homing and general movement patterns. Potential impact of tournament relocation. What are the movement patterns of smallmouth bass in Green Bay? Are there homing tendencies? Does relocation of fish during tournaments have the potential to impact smallmouth distribution?	Scott Hansen scott.hansen@wisconsin.gov 920-746-2864
Muskellunge	Spawning/recruitment. Can we add to information already collected to help determine where are Great Lakes spotted musky spawning in Green Bay, Fox River and other tributaries, what sort of habitat is being used for spawning and are there projects that can be completed to enhance the amount spawning habitat available to musky?	Steve Hogler steven.hogler@wisconsin.gov 920-662-5480
Muskellunge	Movement of adults/telemetry. What are the seasonal movements of GLS musky in Green Bay and in the rivers?	Steve Hogler steven.hogler@wisconsin.gov 920-662-5480
Northern Pike	Population characteristics (P.E., growth, age distribution, harvest). How can we gain adequate information on the adult population of northern pike in Green Bay to affect management/regulation changes?	Tammie Paoli tammie.paoli@wisconsin.gov 715-582-5052
Northern Pike	Identifying unknown spawning habitat locations. What streams & wetlands do northern pike utilize for spawning on the east shore of Green Bay and in southern Lake Michigan? Is habitat a limiting factor? Is fish access/connectivity to potential spawning habitat in these areas adequate?	Tammie Paoli tammie.paoli@wisconsin.gov 715-582-5052
Lake Sturgeon	Movement in Green Bay, outside of rivers. Is there spawning fidelity to one river or multiple rivers for adult sturgeon? Are there movement patterns (pre- and post-spawning) that relate to staging location, recovery areas post-spawning, or seasonal movements? How long do adult sturgeon	Mike Donofrio michael.donofrio@wisconsin.gov 715-582-5050

	remain in each river? Does the amount of time in a river vary from river to river? What are the seasonal movement patterns of juvenile and adult lake sturgeon in Green Bay?	
Lake Sturgeon	Survival & outmigration rates of stocked fish. Can we assess survival and outmigration rates in the Milwaukee and Kewaunee Rivers? How can we estimate survival rates for newly stocked fish into these systems?	Brad Eggold bradley.eggold@wisconsin.gov 414-382-7921
Lake Whitefish	Multiple stock tagging (movement & mortality of Green Bay stocks). What level of movement occurs with Green Bay whitefish stocks and how do they contribute to the commercial and sport fisheries with a particular emphasis on the Menominee River spawning population?	Scott Hansen scott.hansen@wisconsin.gov 920-746-2864
Lake Whitefish	Recruitment in Green Bay and U.P. tributaries. Considering the success of the Menominee River whitefish recolonization, do other Green Bay tributaries exhibit signs of establishing reproductive populations?	Scott Hansen scott.hansen@wisconsin.gov 920-746-2864
Lake Whitefish	How to incorporate fisheries independent data into SCAA model. The current whitefish SCAA model does not include fishery independent information. Some effort has been made to include these data in the model with limited success but further efforts should be made in order to increase confidence in model output.	Scott Hansen scott.hansen@wisconsin.gov 920-746-2864
Rainbow Trout	Natural reproduction for all trout/salmon species, habitat & connectivity in streams. Is natural reproduction of steelhead occurring in Wisconsin streams (if so, where) and how much is natural reproduction contributing to the fishery? Could habitat improvement projects be implemented on any Wisconsin streams to improve natural reproduction, and if so, which streams might be good candidates for habitat projects? Also, what type of habitat improvement projects should be considered? Especially given recent	Nick Legler nicholas.legler@wisconsin.gov 920-746-5112

	concerns about predator-prey balance and stocking reductions, would an increase in steelhead natural reproduction be positive, or negative?	
Rainbow Trout	CWT use to determine survival by location stocked. Which steelhead stocking locations are most effective? Is survival better at certain locations, which locations contribute the most recruitment into the fishery, what factors may be limiting survival? What genetic strains of steelhead are contributing to the harvest?	Nick Legler nicholas.legler@wisconsin.gov 920-746-5112
Chinook Salmon Coho Salmon	CWT use to determine survival by location stocked. Which Chinook stocking locations are most effective? Is survival of stocked Chinook better at certain locations, which locations contribute the most recruitment into the fishery, and what factors may be limiting survival? What is the contribution of Green Bay stocking compared to Lake Michigan stocking efforts?	Nick Legler nicholas.legler@wisconsin.gov 920-746-5112
Chinook Salmon Coho Salmon	Timing of runs (when & where do they stage in the late summer and fall). Can we develop a sampling plan and analyze CWT information to determine when Chinook salmon begin to home back to their stocking location?	Nick Legler nicholas.legler@wisconsin.gov 920-746-5112
Brown Trout	Post-stocking survival (offshore vs. nearshore). Is offshore stocking brown trout effective in increasing survival? Does time of stocking/strain/hatchery source matter? Can we utilize CWT to answer these questions?	Tammie Paoli tammie.paoli@wisconsin.gov 715-582-5052
Brown Trout	Movements after stocking. Where and when do brown trout move after they are stocked and throughout the summer and fall? Do brown trout stocked offshore move into rivers in the fall? Can we utilize CWT to answer these questions?	Tammie Paoli tammie.paoli@wisconsin.gov 715-582-5052
Bloater Chubs Rainbow Smelt	Population estimates, life history, age, recruitment, diet. What information do we need to adequately adjust the commercial quotas for chubs and smelt?	Pradeep Hirethota pradeep.hirethota@wisconsin.gov 414-382-7928
Multiple	Tournament mortality (movement of fish,	Scott Hansen

Species	temperature issues, fizzing). The issue of fizzing and temperature related stress to fish in Green Bay, particularly smallmouth bass, has garnered some attention in recent years. Unlike most other waters in Wisconsin, conditions on Green Bay have the potential to impart additional stressors upon tournament caught fish such as barotrauma and wide temperature swings, the latent effects of which are generally unknown. Can we determine mortality as a result of these factors?	scott.hansen@wisconsin.gov 920-746-2864
Multiple Species	Economics. What is the economic value of sport and commercial fisheries in Lake Michigan and Green Bay?	Various/all
Multiple Species	Tributary studies/Connectivity. Can we identify issues with habitat and connectivity for species that are dependent on tributaries for spawning (i.e. redhorse, longnose sucker, white sucker, northern pike, lake sturgeon)?	various