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A Proposal to Create an Invasive Species Research Center to Develop and Implement New Technologies to Permanently Control Aquatic Invasive Species in Minnesota

Aquatic invasive species including the Asian carp and zebra mussel are destroying Minnesota's fisheries and wildlife habitats as well as our outdoor heritage. The threat is expanding as new species such as the snakehead and quagga mussel arrive and development of tools to control them is stalled by a lack of local resources and expertise. It is not possible to protect, let alone restore or enhance, our waters in the face of this threat. Presently, Minnesota Department of Natural Resources (DNR) managers are restricted to using imperfect technologies developed at other locations for other reasons (for example, acoustic barriers were developed in England for marine power stations to stop small fishes). New ideas and technological approaches are desperately needed to develop real solutions. The College of Food, Agricultural and Natural Resources Sciences (CFANS) at the University of Minnesota is dedicated to '… solution-driven science … to make our planet productive, friendly, and sustainable …' and is both willing and able to undertake this challenge. This document outlines how CFANS will work with the College of Science and Engineering, the College of Veterinary Medicine, the DNR, and Minnesota Extension to create a new Minnesota center to meet the challenges posed by invasive species.

The Center's Objective: To develop permanent solutions to aquatic invasive species (AIS) problems in Minnesota including:

- developing and implementing new screening tools to accurately and rapidly determine the presence of invasive species including Asian and common carps, zebra mussels, the mud snail
- developing ways to control zebra mussels in local waters
- developing practical means to deter the movement of Asian carps, even in large rivers
- developing ways to control the abundance of invasive carps by improving habitat quality
- developing a practical means of eradicating at least one important aquatic invasive species
- serving as a state-of-the art source of information on the biology of invasive species and new means for their control for both citizens of the state and the DNR

Structure: Director, project manager, 5 new research assistant professors with recent PhDs and expertise in invasive species or relevant fields/technologies, 5 re-focused part-time faculty positions, 3 research associates, 7 graduate students, and 1 research professor dedicated to technology and information transfer who will work directly with the DNR. This team will incorporate all disciplines needed to prevent and control aquatic invasive species (detection, deterrence, control and eradication) while incorporating information and technology transfer so the DNR will benefit. It will position Minnesota as one of the best prepared states for aquatic nuisance species (AIS) control and a world-leader. One of the new full-time faculty positions will be dedicated to environmental DNA ('eDNA'), another to invasive carp, and another to zebra mussels: all key areas in which the state needs expertise. The scheme is flexible so a range of species can eventually be examined and controlled. The plan will require base funding from the Lessard-Sams Outdoor Heritage Council but will also seek additional external funding. It will partner with the DNR, municipal governments (watershed districts and lake associations), federal agencies, and local industries. It is possible that new businesses could also

develop from this research. The initial commitment will be for 8 years (two 4-year cycles) with a focus on 6 key activities as described below.

Approximate total costs: $1,990,000/yr PLUS $2,000,000 One-time start-up costs (rounded)

1. Development of new, reliable and useful molecular monitoring programs for AIS. Effective control of AIS requires knowing where these species are and exactly how many there are, and DNR managers currently lack this information. The center will develop, test and improve new technologies to accurately determine the distribution and abundance of both carp and zebra mussels with other species being examined in the future. Environmental DNA (eDNA; the presence of released DNA in the water—a highly sensitive measure) will be a focus and we will develop techniques and statistical models to permit the DNR to deploy it effectively. Presently eDNA is analyzed by an Indiana company and the results take months to receive and are difficult to interpret. The University has expertise that could be brought to a focus on this problem in an accountable and transparent manner. It will actively work with other eDNA research groups being developed elsewhere (ex. Army Corps of Engineers, USGS) while focusing on local concerns and exploring new techniques coming out of academic research laboratories located at the University. The University also has world-leading expertise in other biochemical tests such as pheromones (species-specific signals released by organisms) which could if assayed, be very useful in monitoring presence and abundance. This effort will be closely coordinated with the DNR and will be housed in CFANS.

Annual, ongoing needs: approx. $294K/yr
One-time setup cost: $275K

2. Develop new deterrence techniques. The University is a world leader in fish sensory physiology and bubble curtain technology (bubbler systems whose noise repels fishes). Currently, the DNR is obliged to use commercially available technologies developed elsewhere for other species which have less-than-perfect and often unproven performance. University researchers will improve barrier performance for carps while developing more practical / less expensive solutions for small tributaries and monitoring the performance of extant systems using modern, automated sensing systems. Deterrent systems for use in large rivers such as the Minnesota would also be examined in conjunction with the fish behavior group (see 3c, below). Another focus would be small affordable systems for tributaries. Model carp bubble curtain/ barriers have already been developed at the University and could be re-dedicated to Asian carp. Studies would be conducted at the University indoor lab, Saint Anthony Falls Laboratory (SAFL) and key river tributaries where such work is affordable and highly likely to be successful. Systematic improvements will then be made and new industries developed to address local issues. The new position will be a joint appointment between CFANS and the College of Science and Engineering (CSE).

Annual, ongoing needs: approx. $258K/yr

One-time setup costs: $125K

3. Develop new control techniques. The University has a deep understanding of AIS biology and control through a decade of successful work on both common carp and milfoil control. The techniques developed through the carp programs (use of radio-tagged fish to find others, robotic tracking devices, targeted netting) will be systematically deployed for Asian carp in collaboration with the DNR. A new assistant research professor will provide cutting edge expertise in zebra mussel biology and control. This invertebrate physiologist will focus on developing new chemical controls for zebra mussels and establish active links and collaborations with other centers of expertise across the world. Simultaneously, we will explore ways to improve ecosystem health (such as increasing predator abundance) to make systems more resilient to AIS while improving habitat for fish and waterfowl. Successful techniques to control the common carp, presently our most damaging invasive fish, will developed further, applied to Asian carp and made available to state biologists. Experienced faculty will be supported so they can focus on invasive carps (Sorensen) and plants (Newman) and develop meaningful programs and solutions. These four scientists will work as team and coordinate with the DNR. A central holding facility (remodeled aquaculture facility) and field support facility with 2 staff is needed for this work.

3a. Zebra mussel physiology, biology and control.

A new research assistant professor along with a postdoctoral associate and graduate student will systematically look at existing and new control strategies for zebra mussel. This individual will investigate new safe chemicals to control zebra mussel in a remodeled aquaculture center and SAFL. Collaboration with active federal and DNR labs (ex. USGS labs) will be integral to the mission. Solutions will also be provided to the technology transfer specialist for testing and use by the DNR. Staff will be available to assist with this process.

Annual, ongoing needs: approx. $333K/yr

One-time setup cost; $175K

3b. Invasive fish ecology and control.

A research assistant professor along with a graduate student will examine extant and new control strategies for invasive carps. Their emphasis will be on ecosystem balance and predators that can control AIS as well as on improving control schemes (netting, etc.) as part of sustainable, science-based integrated pest management (IPM) plans. Applied and basic studies will be conducted in rivers and lakes in cooperation with local DNR and watershed district staff.

Annual, ongoing needs: approx. $209/yr

One-time setup cost: $175K

3c. Invasive Fish behavior, physiology and control (IPM) + PROJECT ADMINISTRATION

Dr. Sorensen will continue to develop a detailed understanding of invasive fish behavior and physiology to create new species-specific attractants (pheromones) and repellants (sound), and other techniques to exert control over fishes. A postdoctoral research associate is requested to

keep this work on track as Dr. Sorensen oversees the entire project along with a project manager.

Annual, ongoing needs: approx. $277/yr
One-time setup cost: $900,000 (Aquaculture center; shared facility for all)

3d. Invasive plant control.

Invasive plants including Eurasian milfoil and curly-leaf are presently spreading across hundreds of lakes, destroying habitat for fish and wildlife. Expensive and cumbersome harvesting and nonspecific poisoning are the only control options available at present. Dr. Newman has spent over decade studying these species and discovered that some can be controlled by native insects. Along with a student he will examine extant and new control strategies for invasive plants. Special emphasis will be placed on native insects (weevils; IPM).

Annual, ongoing needs: approx. $121/yr
One-time setup expenses: $20K

4. Development of eradication technologies. Currently, there are no techniques available to eradicate any AIS (aside from poisons which kill everything)**.** An aquatic pathology team will be assembled in the College of Veterinary Medicine (Veterinary Diagnostic Laboratory) to identify species-specific pathogens from across the world that might be used to control exotic invasive species in Minnesota. We see this as our best chance for effecting permanent control. The University already has an international network in veterinary population medicine and is well positioned to perform this work. Initial efforts will focus on examining the literature for candidate viruses for both Asian carp and zebra mussel. We will then develop a science-driven solution to control these invasive species using biological controls methods. A full-time research assistant professor and postdoctoral associate will be dedicated to this important effort. Simultaneously, an extension and diagnostic expert (Nick Phelps) will expand efforts to monitor and control an exotic fish virus (VHS) that is presently found in Wisconsin and threatens to enter Minnesota. These efforts will be coordinated with state fisheries biologists and the fish culture industry.

Annual, ongoing expenses: approx. $290K
One-time setup expenses: $300K

5. Conduct formal assessment of the effectiveness of monitoring and control schemes for AIS.

Dispersal patterns of AIS and control options for them are extremely complex and not understood. This position would work actively with national and local experts as well as DNR managers to develop simulation models for exploring and evaluating alternative implementation scenarios and for predicting

outcomes years into the future. We will use simulation models as an efficient and cost-effective means of ensuring that implementation has the best chance of success (for example, by providing guidance on barrier placement)).

Annual, ongoing needs: approx. $77K/yr
One-time setup expenses:$0

6. Information and technology transfer and implementation. A full-time extension assistant professor and state specialist will actively work with the DNR and other groups to educate them and implement new ideas and technologies for AIS monitoring, deterrence and control. Ideally, this position will be split with the DNR (not budgeted here) and could be located at the University or DNR.

Annual, ongoing expenses: approx. $129K/yr
One-time setup expenses:$0

In summary, by creating a center to address these 6 objectives with a center of expertise at the University, the Minnesota State Legislature will be making a necessary, meaningful and visible contribution to controlling aquatic invasive species in the state and to protecting our valuable aquatic resources for many generations. It is important to act now as Minnesota's aquatic ecosystems (unlike those in many other states) have not been seriously compromised yet by AIS. Now is the time to act.