

Invasive Crayfish Update:

Michigan Research and Control Collaborative & Great Lakes
Invasive Crayfish Collaborative

*Interagency collaboration & momentum bridging the gap between management
and research...and leading to real progress on-the-ground and in the burrows*



Great Lakes Panel on Aquatic
Nuisance Species – June 1, 2022

Photo credit: MSU

Invasive Crayfish in the Great Lakes Basin

- Identified as global threat and impacts are documented worldwide
- Priority for all jurisdictions as identified by Great Lakes St. Lawrence Sea Way Governors and Premiers
- “AIS Least Wanted List” & regulated species by state and/or provinces
 - Yabby crayfish, Marbled crayfish, Rusty crayfish, Red swamp crayfish
- Documented introductions or establishments of invasive crayfish in all Great Lakes states
- Documented economic costs and benefits to prevention and intervention

Do schools and golf courses represent emerging pathways for crayfish invasions?

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Preventing the Spread of Invasive Species: Economic Benefits of Intervention Guided by Ecological Predictions

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Abstract: Preventing the invasion of freshwater aquatic species is the surest way to reduce their impacts, but it is also often expensive. Hence, the most efficient prevention programs will rely on accurate predictions of sites most at risk of becoming invaded and concentrate resources at those sites. Using data from Vilas County, Wisconsin (U.S.A.), collected in the 1970s, we constructed a predictive occurrence model for rusty crayfish (*Orconectes rusticus*) and applied it to an independent data set of 48 Vilas County lakes to predict which of these were most likely to become invaded between 1975 and 2005. We nested this invasion model within an economic framework to determine whether targeted management, derived from our quantitative predictions

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A global meta-analysis of the ecological impacts of nonnative crayfish

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Abstract. Nonnative crayfish have been widely introduced and are a major threat to freshwater biodiversity and ecosystem functioning. Despite documentation of the ecological effects of nonnative crayfish from >3 decades of case studies, no comprehensive synthesis has been done to test quantitatively for their general or species-specific effects on recipient ecosystems. We provide the first global meta-analysis of the ecological effects of nonnative crayfish under experimental settings to compare effects



Critical Limitations for Addressing Invasive Crayfish

- Limited options available for eradication and control
 - Existing options can be challenging to permit
 - Most effective methods have non-target impacts
- Organisms in Trade (OIT) continue to pose threats
 - Live food markets, pet stores, online sales, biological supply
- Need for resource managers, research entities, NGOs, and public to collaborate
 - GLRI has been critical for advancing priorities
 - Techniques and strategies developed in Michigan have basin-wide implications



Live Crawfish Value Pack 100 lb FedEx/UPS	Live Crawfish Value Pack 120 lb FedEx/UPS	Live Crawfish Value Pack 150 lb FedEx/UPS
<ul style="list-style-type: none">• Field Run \$474.99• Select \$499.99	<ul style="list-style-type: none">• Field Run \$564.99• Select \$599.99	<ul style="list-style-type: none">• Field Run \$709.99• Select \$749.99



Phase I	Develop management response plan template for invasive crayfish infestations <ul style="list-style-type: none">• Red swamp crayfish infestations in Michigan as case study• Implement plan using adaptive management principles	Michigan Research and Control Collaborative (<i>MI DNR, MI EGLE, Michigan State University, USGS, Auburn University</i>)
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Three-phased, structured approach to address invasive crayfish concerns in the Great Lakes Basin

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Phase II	Increase collaboration to address critical life-history uncertainties and inform development and evaluation of novel response tools <ul style="list-style-type: none">• Increase capacity with partners to address local concerns while reducing broadly relevant information gaps• Create critical response tools that will be relevant for invasive crayfish infestations to slow rates of invasion, increase chances of eradication, and reduce management costs	Michigan Research and Control Collaborative, Great Lakes Invasive Crayfish Collaborative (<i>Illinois-Indiana Sea Grant and Illinois Natural History Survey</i>)

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<p>Phase III</p>	<p>Expand geographic scope and develop action-oriented plan to strategically address invasive crayfish along the invasion curve (i.e., prevention → eradication)</p> <ul style="list-style-type: none"> • Engage AIS community to identify and address risks and barriers for invasive crayfish control, share results, seek feedback and involvement, and develop and implement basin-wide strategic plan • Interstate project focused on assessing risk from the live trades and prioritize future surveillance 	<p>Michigan Research and Control Collaborative, Great Lakes Invasive Crayfish Collaborative, ... and you?</p>

Draft FY20 Strategy: Interim Goals (Phase II)

DRAFT FY20 STRATEGY
TO PREVENT INVASIVE CRAYFISH IMPACTS TO
THE GREAT LAKES BASIN



Photo: National Park Service

Contributors:
Auburn University
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Michigan Department of Environment, Great Lakes and Energy
Michigan Department of Natural Resources
Michigan State University
U.S. Fish and Wildlife Service
U.S. Geological Survey

- Facilitate increased communication, efficient transfer of information among basin stakeholders
- Prevent new introductions to the basin and unregulated movement within the basin
- Enhance ability to detect new introductions
- Develop, evaluate, and implement control strategies
 - Local and metapopulation scales
 - Short-term and long-term

Michigan Red Swamp Crayfish Response

- 2013: Reports of Red Swamp Crayfish carcasses. No live specimens found during follow-up monitoring
- 2014-2016: Statewide surveys and pathway assessment
- 2017: First documentation of live RSC in Michigan; development of response plan
- 2018-current: Develop, implement, and evaluate response strategies



MICHIGAN DEPARTMENT OF
NATURAL RESOURCES

Invasive crayfish found at Ottawa County Lake
Michigan Department of Natural Resources sent this bulletin at 07/13/2015 10:39 AM EDT

Press Release

FOR IMMEDIATE RELEASE
July 13, 2015

Contact: Nick Popoff, 517-284-6235 or Elyse Walter, 517-284-5839

**Invasive crayfish found at Ottawa County lake;
DNR, local partners evaluating next steps**

The Michigan Department of Natural Resources recently discovered that anglers are purchasing red swamp crayfish (a prohibited species) from food markets and using them as live bait. As part of a DNR crayfish monitoring study, a discovery of several dead red swamp crayfish recently was made in the vicinity of a popular fishing area at Lake Macatawa in Ottawa County.



It is illegal to import any live species of crayfish into Michigan for commercial bait purposes. As of this year, red swamp crayfish (*Procambarus clarkii*)

Red Swamp Crayfish Response Strategy – Bridging gap between management and research

Evaluating Risk

Prevention

- Regulatory status - Prohibited Species
- Inspections of known vectors
 - Live food markets, bait shops, biological supply
- Outreach
 - Teachers, public, anglers, etc.

Monitoring & Early Detection

- Trapping
 - eDNA
 - Public reports
 - Determine spread
- } Evaluate effectiveness

Implement Response Actions

Eradication/control

- Determine risk level of infested location
 - Use decision criteria to prioritize responses based on relative abundance and connectivity
- Identify treatment options
 - Intensive trapping, high frequency sound w. trapping, chemicals, CO2, predator control
 - Implement, evaluate, adapt
 - Develop population models to evaluate control options to maximize likelihood of eradication

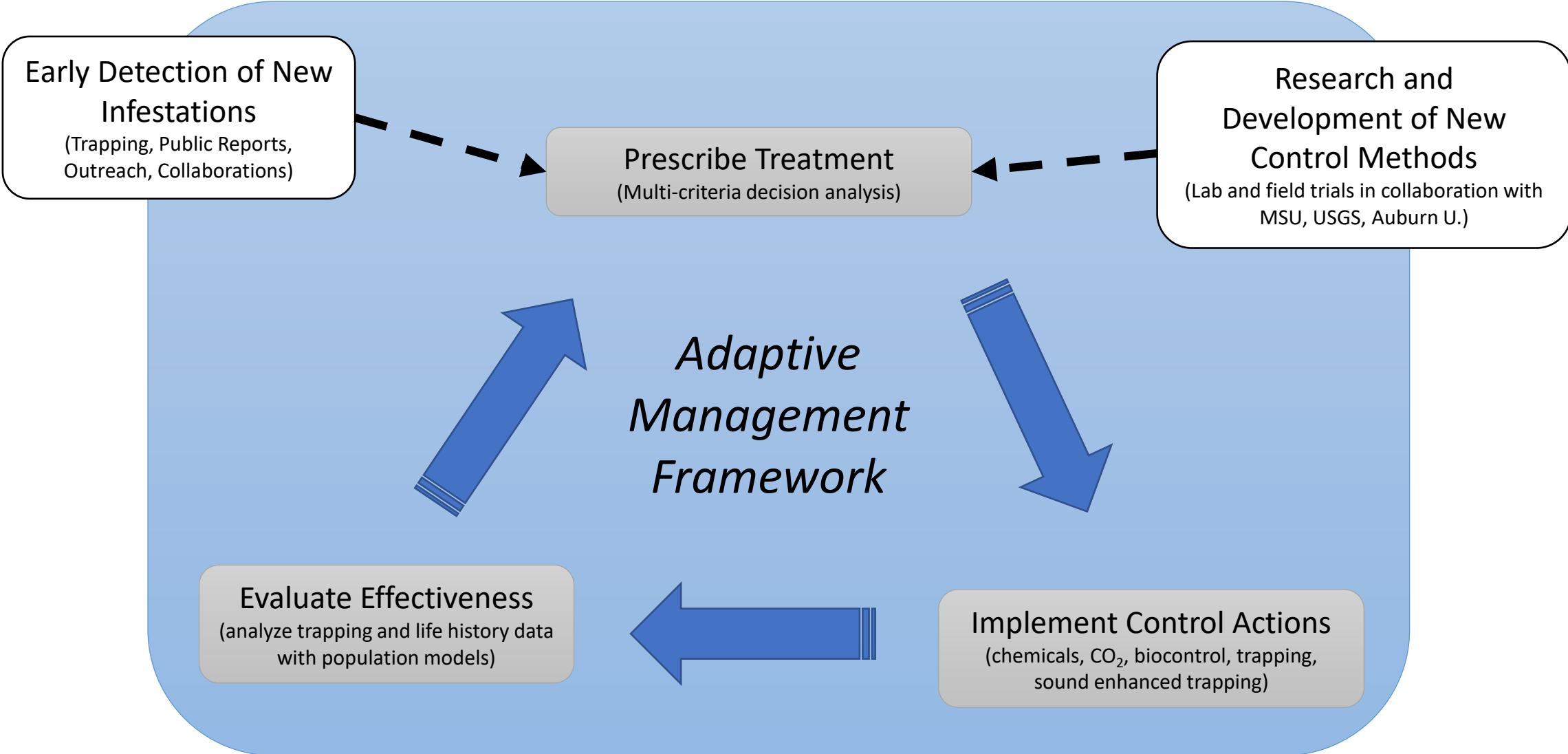
Address unknowns

- Life history – seasonality of recruitment events, life stage specific susceptibility to treatments
- Determine effectiveness of treatments
- Control options for burrows

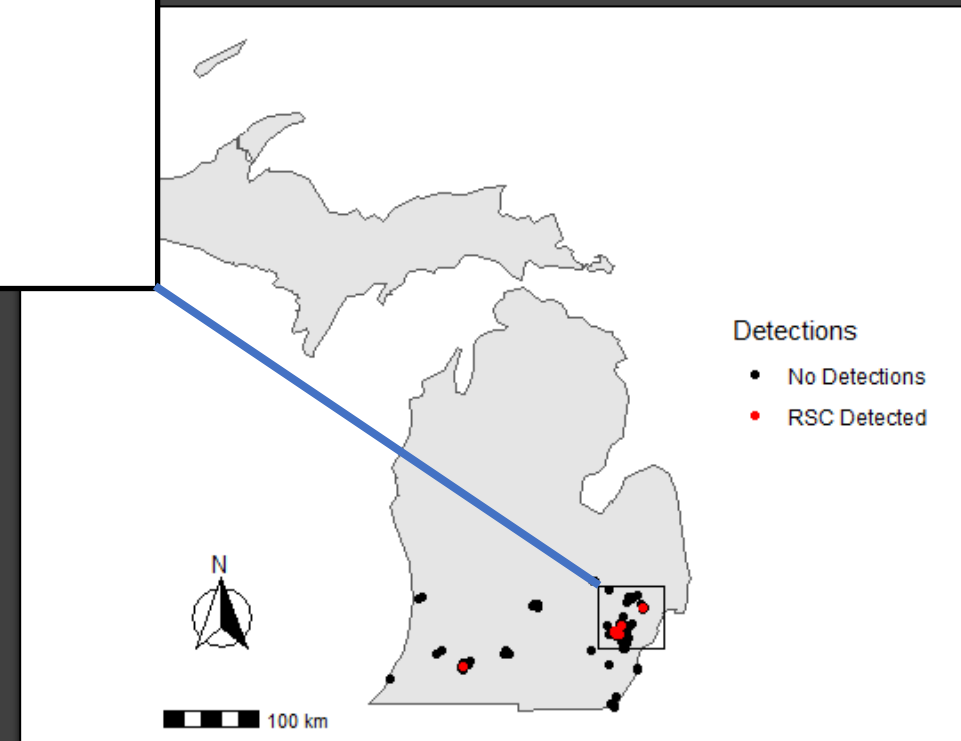
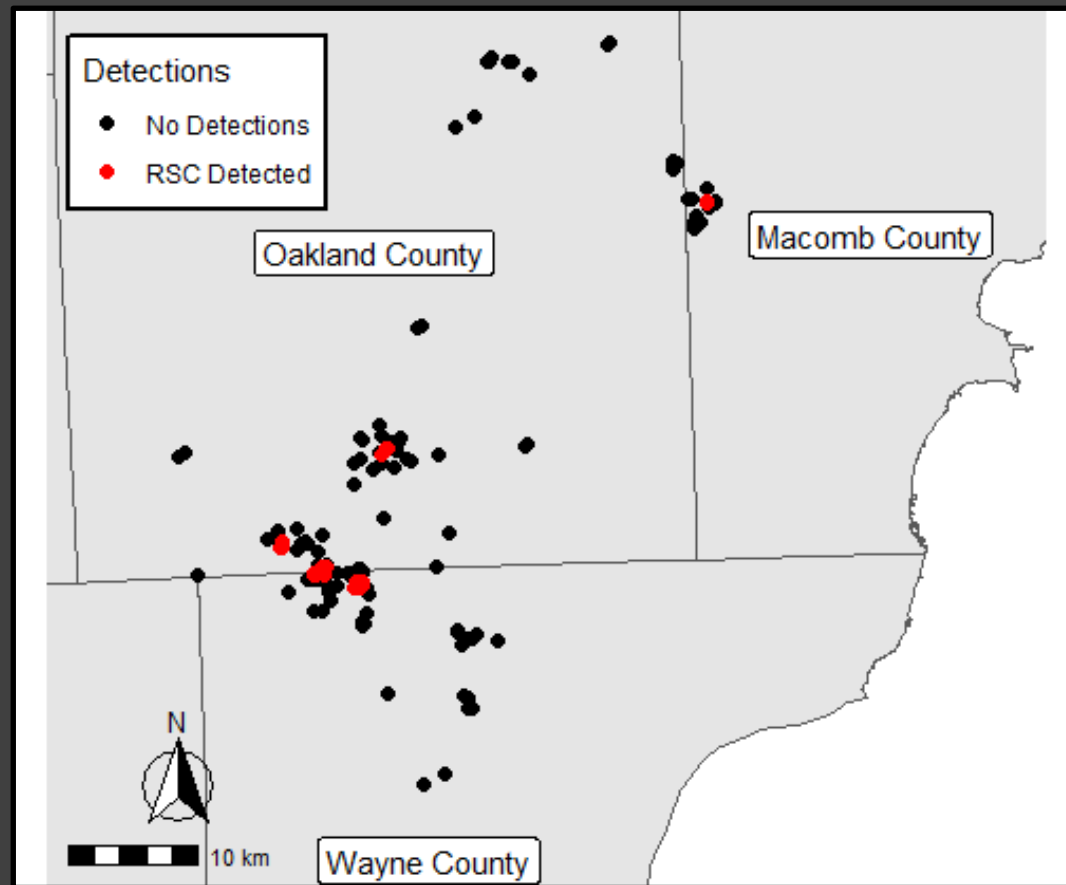
Develop partnerships

- Research community and agencies to develop control options
- Suppliers for prevention
- CISMAs and Tribes for outreach, monitoring, and response
- Regulatory agencies for permitting

Implement Response Actions Using Adaptive Management Approach

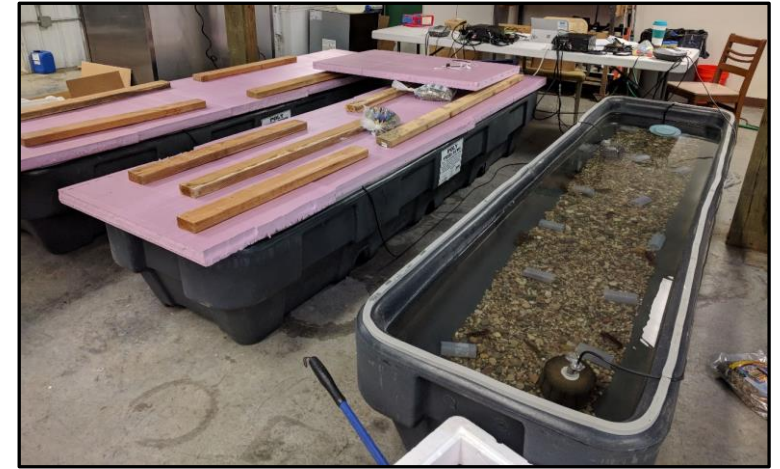


Michigan Red Swamp Crayfish Detections



Accomplishments since 2017

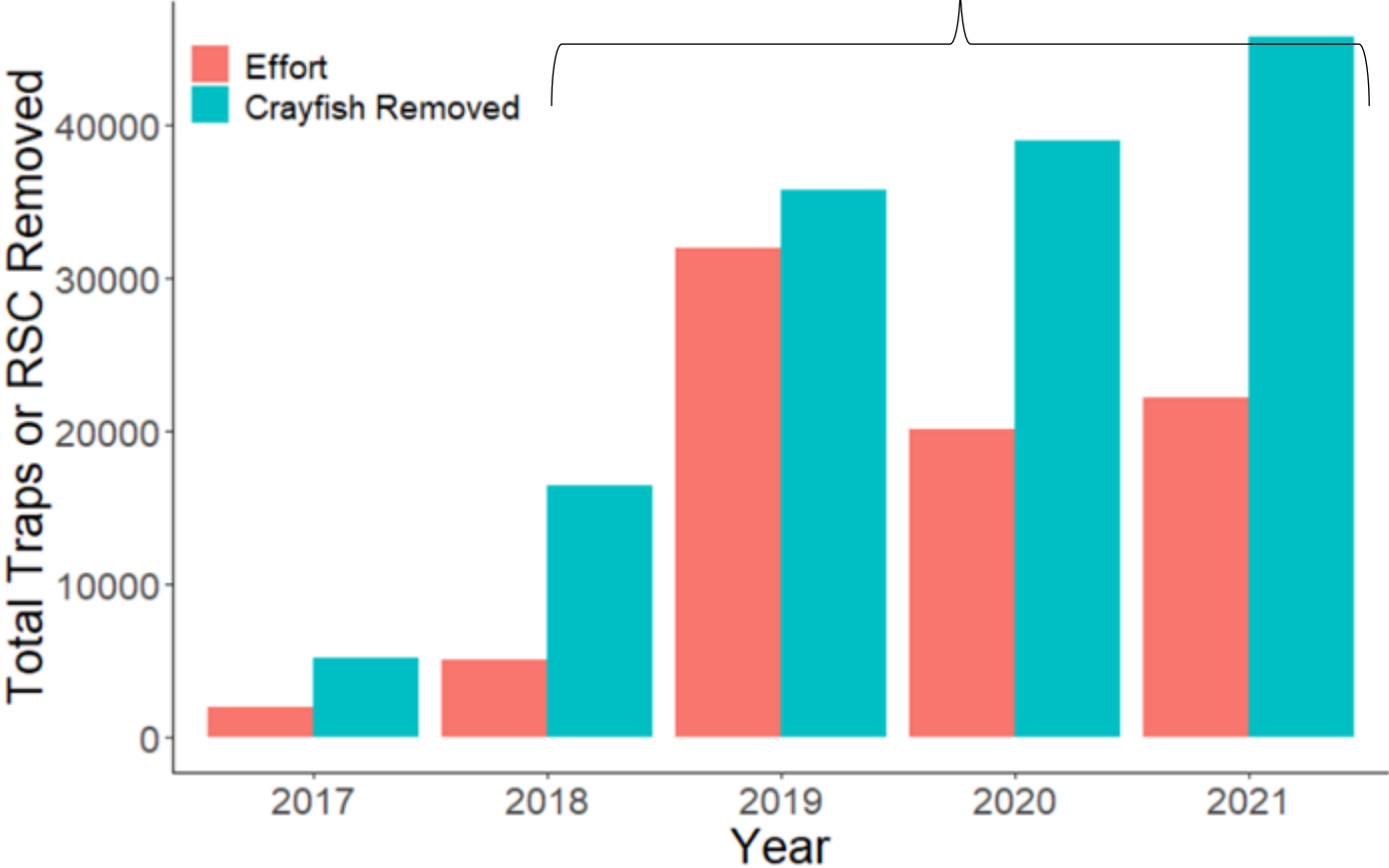
- Outreach programs
- Early detection
 - eDNA, trapping, public reports
- Intensive trapping for control
- Novel methods developed and evaluated
 - CO2 (lab, pond trials, field treatment in 2018)
 - Pyrethrin (lab testing in 2019 and field treatment in 2021)
 - Biocontrol at MSU (lab)
 - Sound to enhance trapping effectiveness (lab and field)
 - Telemetry- infested ponds in Michigan and AU experimental research station
- Pathway inspections and enforcement actions
- Publications to communicate the advancements of the science



Michigan's Red Swamp Crayfish Response

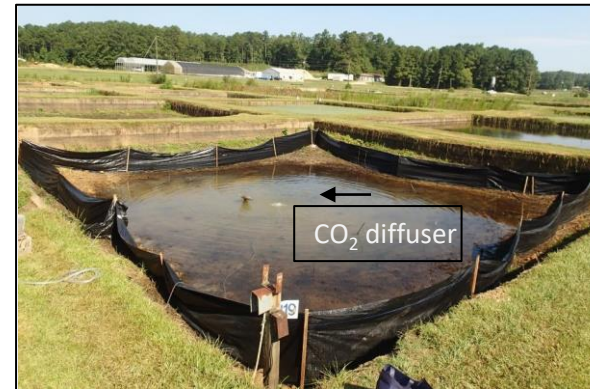
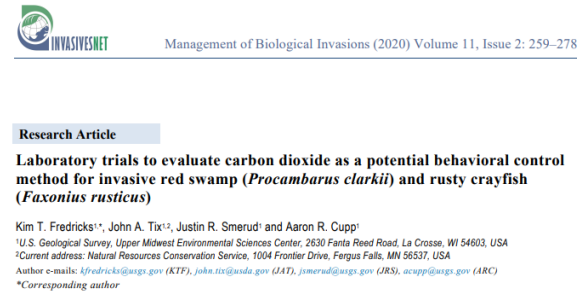
204 sites surveyed for early detection and/or control efforts

GLRI Funding



Rapid development & use of novel control methods

- Carbon dioxide (CO₂)
 - USGS lab testing: 2017/18
 - CO₂ concentration causing emergence
 - MI pond treatment: 2018
 - Target CO₂ concentration in pond achieved
 - Environmental factors may limit effectiveness of CO₂ treatment
 - AU experimental lab trials: 2018/19
 - Confirm environmental factors impact emergence
 - Temperature, inflow
- Pyrethrin
 - USGS lab testing: 2019
 - Acute lethal concentration
 - MI pond and burrow treatments: 2021
 - Treatment + Bioassay
 - Evaluation of burrow population
 - Chemical confirmation and degradation



Pyrethrin Treatment

- Received approval from USEPA and MI-EGLE for experimental use
- Conducted treatment of one MI pond in July 2021
 - Removed 1,360 red swamp crayfish
 - 1,725 removed via trapping May-July
 - ~90% reduction in trap catches post-treatment
 - 100% bioassay survival within 5 days
 - Pyrethrin concentrations at non-detect after 6 days
 - Impacts to non-target organisms limited to pond
- Conducted two pilot treatments of burrows around pond
 - Occupancy of burrows unknown seasonally
 - Females with eggs found in July and October
 - Treatments kill or significantly impact crayfish in burrows



Unique challenge for burrowing species

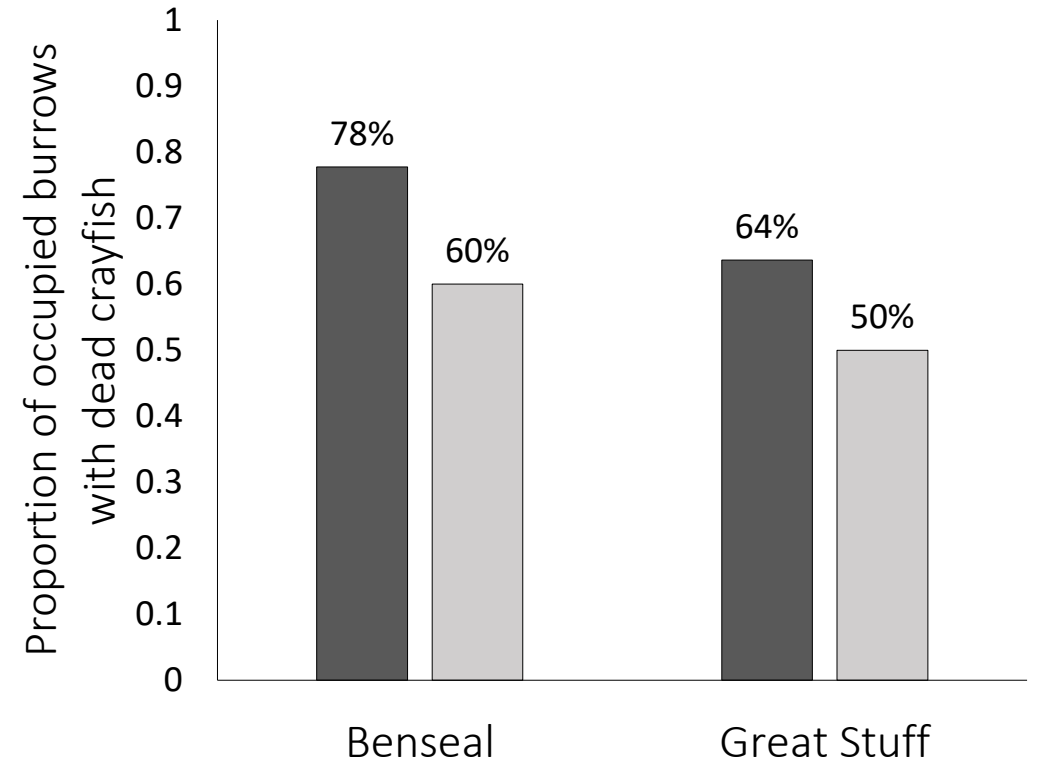
- Red swamp crayfish (RSC) will burrow underground away from ponds
- Control methods applied to ponds may not affect burrowing population
- Need to develop practical methods to control RSC in burrows
- Currently testing
 - Chemical agents
 - Physical blockers
 - CO₂ pellets



Physical Blockers



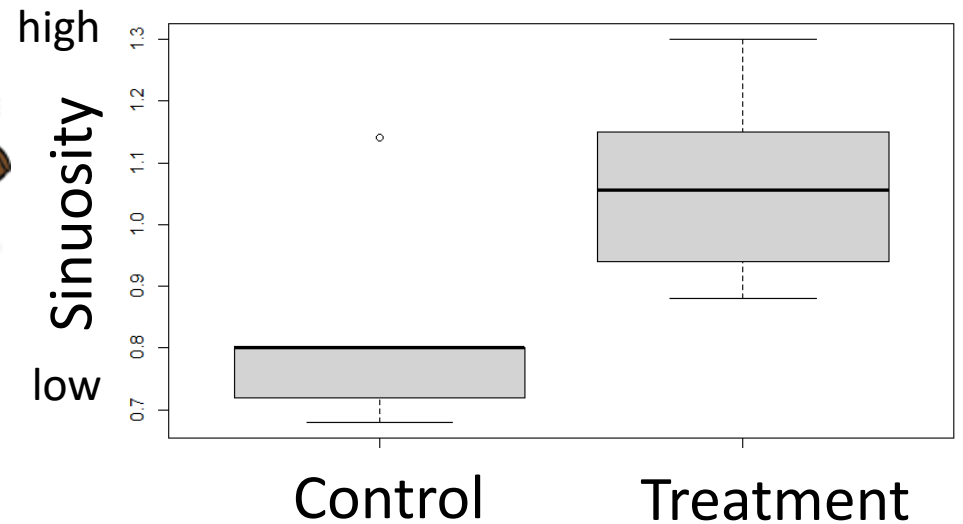
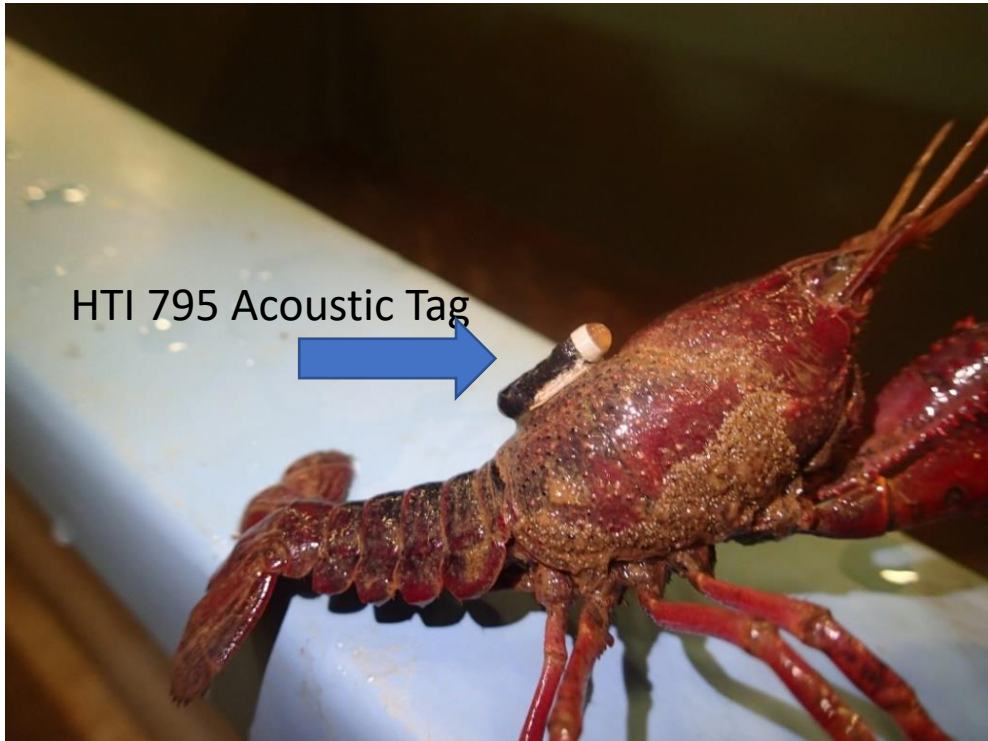
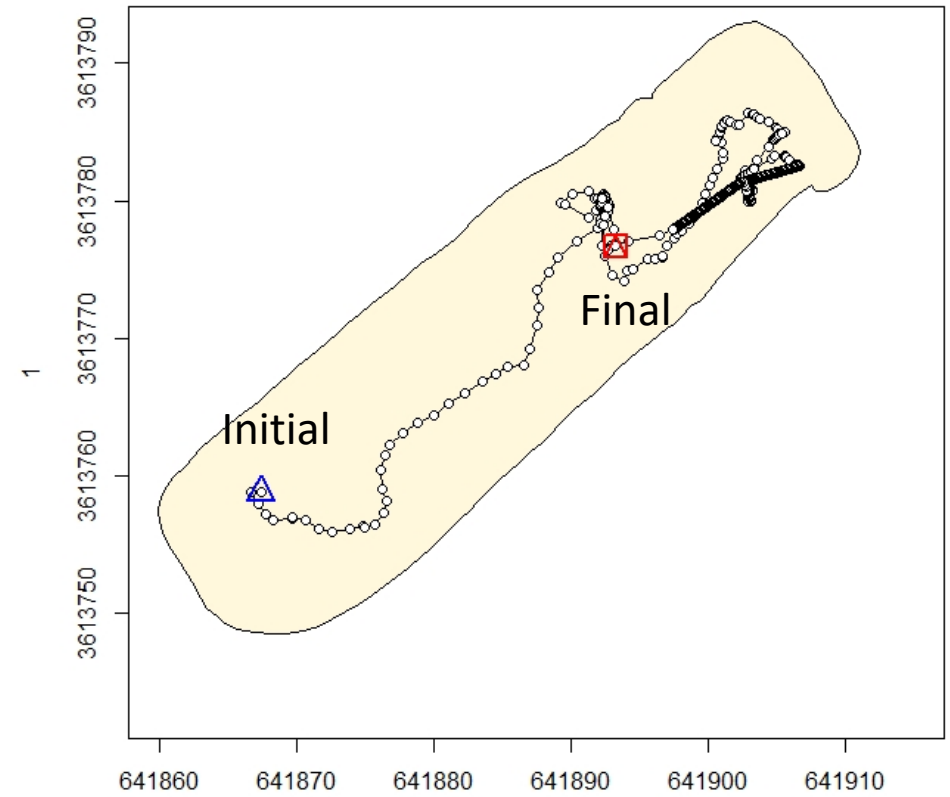
■ Did reach groundwater □ Did not reach groundwater



Crayfish telemetry

Response of crayfish to control measures

- Push/Pull Studies: pond experiments
- Chemical Applications: Michigan field trials

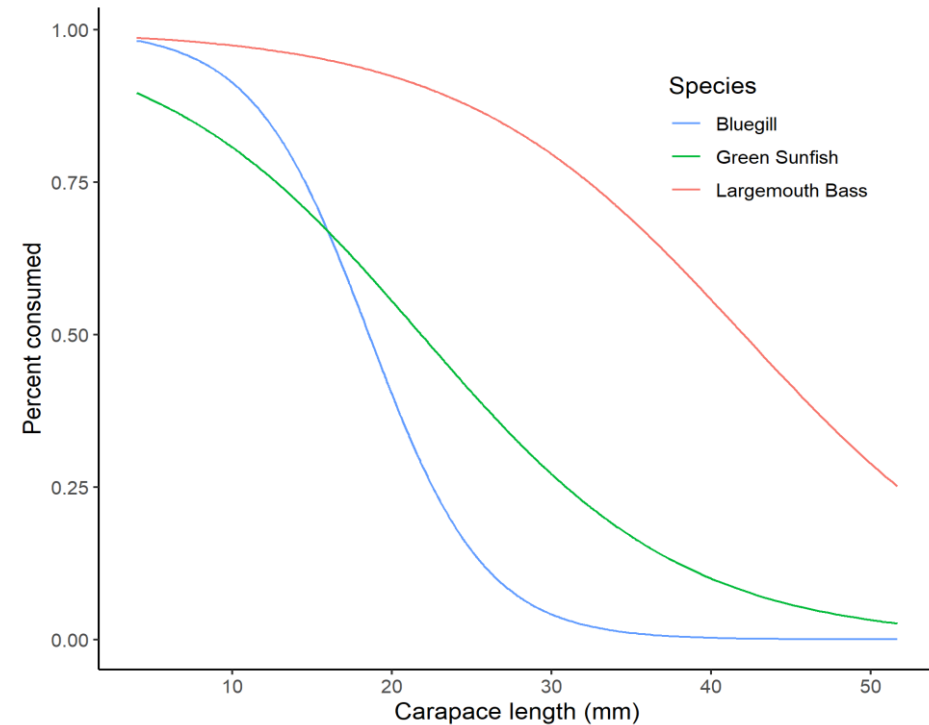


Predator Stocking for Biocontrol

- Eradication is not feasible for all infestations and need other sustainable and effective tools
- Novel option for population suppression that can also create local fishing opportunities



M.Sc. Student Samantha Strandmark

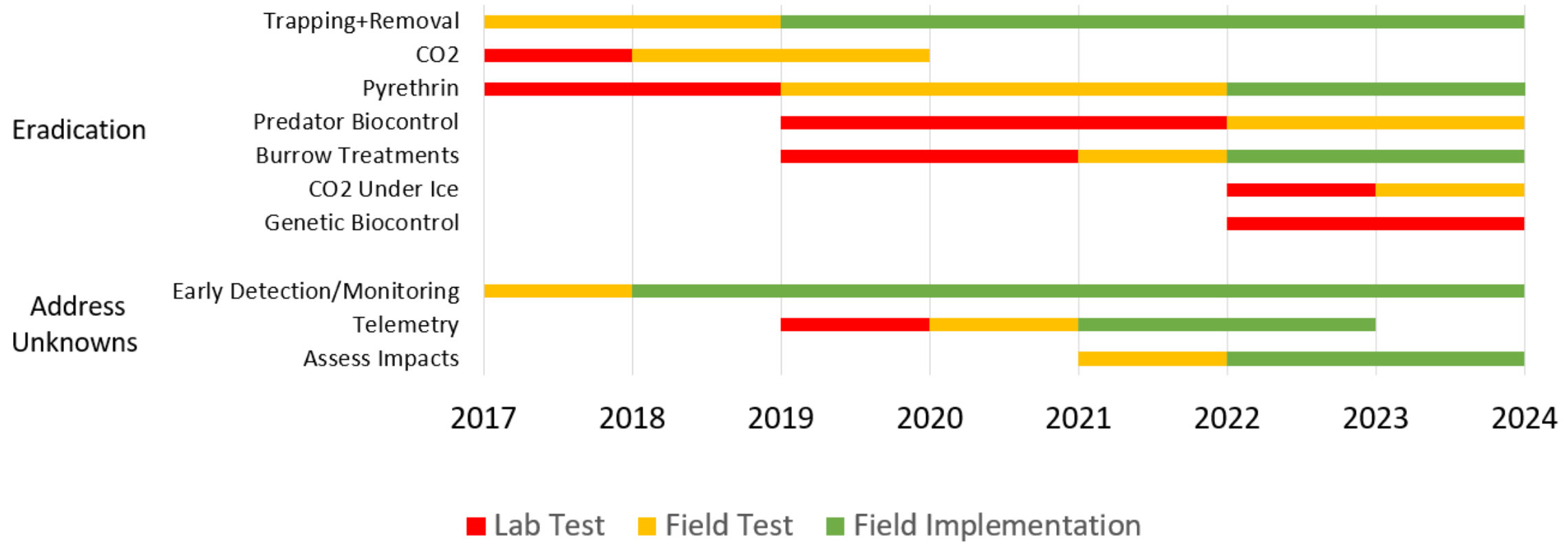


Next Steps: Enhance Adaptive Management Approach

- Evaluate and implement chemical treatments
 - Increase treatments per year
 - CO₂ under ice; prior to macrophytes; presence of young-of-year
 - Address eradication methods in burrows
 - Seasonal occupancy and treatment
 - Chemical and physical blockers
- Implement bio-controls (fish predators) and determine effectiveness
- Determine movement patterns (telemetry) to inform eradication and control
- Develop and evaluate enhanced trapping methods
 - Behaviors - sound, flow, light
- Develop and evaluate genetic bio-controls
 - e.g., neo-females
- Conduct inspections and outreach to address threats within identified pathways
 - Interjurisdictional project funded to determine highest risk pathways
- Determine ecological impacts of establishments

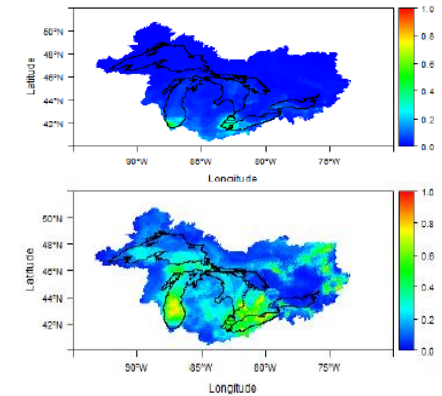


Red Swamp Crayfish Response Strategy Multi-Year Development and Implementation



Great Lakes Invasive Crayfish Collaborative (Phase II)

- Establish Great Lakes wide invasive crayfish collaborative
 - Applicable beyond GL
- Science Transfer and Information Exchange
 - Meetings, webinars, 2018 IAGLR session email group, news letters, InvasiveCrayfish.org
- Resource Creation
 - Climate matched ND STAIR crayfish in trade risk assessment
 - Member needs assessment
 - Retailer outreach tool
 - Pilot educator based community science monitoring program



Strategic Planning (Phase III)

- Preliminary Strategic Plan by USFWS FY2020
- Developing 5-year Strategic Plan
 - Foundational Work - Data collection and synthesis to outline potential outcomes
 - Visioning, goal setting, strategic planning
 - Implementation - emails, surveys, meetings
- Establishing Steering Committee



Invasive Crayfish Outreach (Phase III)

- Increasing awareness for high-risk pathways reduces risk of introductions, long-term ecological impacts and control costs
 - Organisms in Trade
 - Supply chain description
 - Regulation summaries
 - Educator and culinary user needs assessment
 - Community science engagement

