Invasive Crayfish Collaborative
Great Lakes

Invasive Crayfish Collaborative November Meeting – Summary Notes

November 12, 2019
2:00pm – 5:00pm

The Sheraton Ann Arbor
3200 Boardwalk Dr.
Ann Arbor, MI

Facilitated by Pat Charlebois, Greg Hitzroth, and Amanda Huegelmann, Illinois-Indiana Sea Grant

2:00 Welcome and Introductions

Charlebois welcomed all members, introduced herself, and outlined the meeting agenda. She then asked other facilitators and ICC members to introduce themselves to meeting attendees. Charlebois then introduced Brian Roth of Michigan State University, the first speaker to present on their research and outreach updates.

2:15 Research & Outreach Updates

The bulk of this meeting provided time for researchers to present updates on their work. These five presenters were determined prior to the meeting: Brian Roth, Eric Larson, Reuben Keller, Cheyenne Stratton, and Lindsey Reisinger. Summaries of their presentations are as follows:

1. Brian Roth, Michigan State University
   Roth provided an update on the coordinated response efforts to the red swamp crayfish (RSC) invasion in Michigan. Following confirmed RSC reports in 2017, Michigan developed a comprehensive RSC response plan. This presentation focuses primarily on the distributional extent of RSC and efforts to implement RSC control methods.

   - Distributional extent:
     - Most surveys did not accurately show where the RSC actually are. To determine the extent of the RSC invasion, Michigan used a combination of trapping, eDNA, and visual inspection.
     - Researchers determined that RSC are found in at least three epicenters throughout the state, but they are unsure of the full extent of these invasions.
       - Most invasions are primarily in retention ponds, small ponds on golf courses, and ponds near hotels and restaurants.
       - These types of waterbodies are challenging for several reasons. First, they are a mix of private and public ownerships. It is also difficult to know where these small waterbodies are, even when looking at a relatively fine-resolution map. Lastly, these types of ponds are ubiquitous across the landscape.

- Implementing and evaluating control measures:
    - RSC management tools include trapping, chemical control, biological control, and experimental efforts, such as sound.
        - Control efforts must be site-specific, and there must be a coordinated effort from multiple institutions, such as the Michigan Department of Natural Resources, U.S. Geological Survey, Michigan State University, and Cooperative Invasive Species Management Areas (CISMAs).
    - **Trapping** is one of the easier tools to implement, but managers want to optimize trapping effort across the landscape. Effort is concentrated in certain locations based primarily on the catch per unit effort in previous years, as well as the potential connectivity of waterbodies that lead to the Great Lakes.
        - They have trapped almost 60,000 crayfish since 2017; most of those were collected in 2019. They caught the most crayfish in mid-July. Temperature influences trapping success, and there are size and sex biases in crayfish caught as well.
        - They tested five trap designs. All methods caught crayfish, but Gee minnow traps had the highest number of crayfish per trap. The size distribution indicates that the APARTs, ARTs, and juvenile traps are catching greater amounts of juvenile crayfish than other trap types.
            - Gee minnow
            - Pyramid
            - Two types of artificial refuge traps to ideally catch a broader range of crayfish sizes. Artificial refuge traps use plastic tubes meant to imitate natural shelter.
                - Standard artificial refuge trap (ART)
                - Additional partition artificial refuge trap (APARTment trap)
            - Juvenile traps, which consisted of a modified shower loofa
    - **Chemical control**
        - Carbon dioxide
            - Researchers were able to reach target carbon dioxide levels in their trials. Crayfish congregated wherever they could find low carbon dioxide levels in the water. Perhaps managers could use this method underneath ice where crayfish cannot escape.
        - Cypermethrin was newly approved for aquatic use. This chemical is very toxic for crayfish and will kill them. Managers will start using this next year.
    - **Biological control**
        - This mechanism is particularly useful where another eradication effort, such as chemical control, is not feasible. Researchers are using the optimal foraging framework to help determine the most effective predators on red swamp crayfish, which will likely have to be a combination of fish species.

        - Preliminary trials compared handling time of the crayfish to its carapace length for bluegill, green sunfish and largemouth bass.
            - Largemouth bass had the lowest handling time, but this species is not as effective at consuming small crayfish as bluegill and green sunfish are.
            - Bass are more likely to consume larger crayfish, while sunfish are more likely to consume juvenile crayfish that have not yet reproduced.
    - **Sound**
        - Researchers are interested in whether or not sound affects crayfish motility. In the lab, certain frequencies attracted crayfish more than others did. White noise attracted crayfish more than any other frequency, as did pink noise in some cases. Putting the speakers in baited traps made them trap 5 times more crayfish.
        - They tried this out in the field in attempt to shift the distribution of crayfish in two ponds.
            - The amplitude (volume) really matters. If speakers are too loud it could potentially repel crayfish. Habitat also likely plays a role in sound being able to herd crayfish.
            - There is some difficulty detecting effects of sound in the field. For example, the crayfish did move in the sound trials, but they did not necessarily go in the traps.
            - Researchers are interested in combining sound treatment with the carbon dioxide method, which might work to push crayfish with CO_2 and pull crayfish with sound to more effectively impact distribution.
- Some potential future work includes the following:
    - Manipulating temperature in a pond to allow for longer trapping time in the year.
    - Starting a telemetry experiment with Auburn University to understand the movement of crayfish.
    - Studying the life history and ecological effects of RSC.

2. The second presenter of this meeting was Eric Larson, University of Illinois. (51:20)
   Larson provided updates on two studies:
   - Does habitat quality explain rusty crayfish population collapse in lakes?
       - "Habitat explains patterns of population decline for an invasive crayfish" – study published in *Ecology*
   - Do crayfish carcasses produce detectable eDNA?

   Question 1: Does habitat explain patterns of population decline?

- Rusty crayfish destroy aquatic plants, thus reducing their coverage from predators. Other potential explanations for population declines include predatory pressure, parasites or diseases, and severe drought.
- To study habitat and crayfish population, monitoring takes place in 17 lakes near the University of Notre Dame Environmental Research Center in Northern Wisconsin to study lake substrate (1:01:39). Trapping occurs in late summer to early fall in the same spot every year. 12-74 traps are set per lake, depending on a few conditions.
- It appears that substrate does affect the collapse of crayfish populations.
    - Rock predicts the maximum population sizes of rusty crayfish in these lakes. Rusty crayfish prefer cobble/rocky substrate. Lakes with no rusty decline had high proportions of rocks; lakes *with* rusty decline lakes had low proportions of rocks. These results are significant.
- Rusty crayfish collapse is common but not ubiquitous. It did not happen in all the lakes. For the Great Lakes, Rusty crayfish probably are not going to decline where it is rocky, but they might in wetlands.
- Next step for this research: Can lakes recover after an invasive crayfish collapse? Low abundances of rusty crayfish might still prevent aquatic plant recovery. Macrophyte seed banks may not be adequate for plants to recover after invasive species decline.

Question 2: Do crayfish carcasses produce detectible environmental DNA?

- eDNA is very sensitive across different waterbodies, and is proven effective for detecting crayfish of low abundances. However, scientists were concerned that eDNA might be too sensitive and produce false positives.
- Larson's lab focused on red swamp crayfish because there is an existing assay for RSC eDNA. Larson's lab put RSC carcasses in mesh bags to represent microbial decay in a protected setting. They took water samples upstream, on top of the carcasses, and downstream in a system that did not have any record of RSC presence or other background eDNA that could be misinterpreted as RSC. They expected to see an eDNA spike as crayfish started breaking down, but they did not detect any eDNA in any of their samples.
- Given this result, they asked if they might have done anything wrong. Larson's lab explored the following potential issues, and it appears their study was sound and the results accurate.
    - Did they not use enough crayfish biomass? Previous studies detected one live crayfish per 100,000L of water, and their system did not approach this volume.
    - Was the assay bad? Not likely, as Larson's lab optimized it to their machines.
    - Is the mitochondrial DNA different for Chicago region crayfish? Perhaps, but DNA for these crayfish was added to the existing assay.
- They conclude that eDNA was not coming off these carcasses, and there may be a lower risk for false positives from crayfish carcasses than originally thought.

3. The third presenter was Reuben Keller, Loyola University Chicago. Keller provided an update on red swamp crayfish in the Chicago River.

- Around 2015, Keller's lab began looking into species, densities, and distribution of crayfish around the Chicago region. They found many rusty crayfish, some native species with limited distribution and small numbers, and red swamp crayfish. They found a reproducing population of RSC in the north shore channel that connects Lake Michigan and the north branch of the Chicago River. (1:28:00ish)
- Keller's lab has been working on controlling invasive populations since 2018, using baited minnow traps. They are continuing to remove crayfish for two more summers.
    - Trapping occurred at two sites (upper and lower channel) from about late June - late September, 2018. Each location had a control site where crayfish were trapped and returned to the water, and a removal site where crayfish were trapped and removed. Trapping had a significant effect of removal on catch per unit effort (CPUE) of RSC in the Chicago River in 2018.
        - Lower site:
            - Traps were set 5 meters apart
            - They saw a decline in CPUE at the removal site, and CPUE at the control site stayed the same or increased.
        - Upper site:
            - Traps were set 10 meters apart.
                - Reuben's lab wondered how close the traps must be to affect a decline in RSC. When traps are farther apart, they can cover a larger area. They found that traps 10m apart are less effective at reducing population than traps 5meters apart.
            - Relative to the control site, trapping efforts reduced population at the removal site.
    - When Reuben's lab returned to trapping sites in 2019, there was a notable difference between the control and removal sites, indicating that the first year of removal effectively decreased crayfish populations. The population this year, however, remained steady at the removal site. This second year of trapping did not make the population any lower.
- Because rusty crayfish and RSC populations overlap in this channel, and knowing that these two species compete, Keller's lab wondered if it would be helpful to leave rusty crayfish behind after removing RSC. Does returning any trapped rusty crayfish lead to a more serious decline in RSC?
    - After removing RSC and returning rusty crayfish, they found no evidence to indicate that this leads to an increased decline in RSC. Removing crayfish did not decrease red swamp crayfish CPUE over time.
- Next steps:
    - The following summers will have Keller's lab looking at increasing the area over which they are trapping.
    - While Gee minnow traps seem to work the best, they will continue to look into other trap types.

- They are going to look at better ways to reduce red swamp population in this type of habitat. RSC population has retreated out of the northernmost section of the channel, and Keller's lab is looking at sediment softness or hardness as a possible partial explanation for this.
- RSC do very well in small waterbodies, but Keller's work has been almost exclusively in larger waterbodies, so they will be sampling in smaller waterbodies in Cook and Lake County to look for RSC and other species.
- Working with somebody who studies amino acid-laced baits to potentially improve trapping efforts.

3:45 Break

3:55 Research & Outreach Updates Continued

4. Cheyenne Stratton and Lindsey Reisinger, University of Florida: Using Pathogens for Biological Control of Invasive Crayfish
   - Their research focused on two main questions:
     - Does pathogen abundance and diversity differ among species and lake types?
     - Could any native, regional pathogen be a good candidate for invasive crayfish control?
   - Pathogen abundance/diversity:
     - Studying pathogens in crayfish populations of different types of northern Wisconsin lakes
       - Virile, Northern Clearwater, Rusty, and Red Swamp Crayfish
       - Sampled 18 lakes of 6 different lake types
       - Conducted brief behavioral assays, including boldness and righting responses. Then dissected the crayfish to screen for pathogens and save tissue for later study.
   - Preliminary results for pathogens and their potential for biological control:
     - Microsporidian: Spore-forming obligate parasite
       - Might be a good candidate for biological control, as microsporidians are often species-specific and cause high mortality
       - The infected rusty crayfish in this study took longer to both emerge from shelter and to right themselves
     - Psorospermium (not yet confirmed): Spore forming parasite
       - Not likely to be a good biological control because it is abundant across all populations within northern Wisconsin
       - Could look into how it affects crayfish in co-infections
     - Trematodes
       - Known to alter rusty crayfish behavior, making them bolder and more likely to be predated upon
         - Makes Virile and Clearwater Crayfish spend less time in shelter
       - Not a good candidate because of its complex life cycle, requiring multiple hosts to complete this life cycle

- Protists
  - Not a good candidate because infections did not seem to have an impact on crayfish behavior

During the last few minutes of the research and outreach updates agenda item, Charlebois asked ICC members in attendance if they had any additional updates. Nothing else was shared.

4:30 IISG Invasive Crayfish Outreach

This portion of the meeting allowed Illinois-Indiana Sea Grant to share about their current work on invasive crayfish outreach. Elizabeth (Bizzy) Berg and Greg Hitzroth of IISG provided updates on a new outreach tool and community science program they have been developing.

Hitzroth, IISG, discussed feedback on the outreach tool obtained at the previous ICC meeting and shared potential next steps.

- At the previous ICC meeting, members talked about making bait (live bait, consumers of bait) the focus for a new outreach tool. However, IISG is now considering teachers instead, as classrooms and teachers were high on the priority list discussed at last meeting. To help make the decision between the bait and teachers, Hitzroth asked for additional feedback from ICC members present at this meeting. Hitzroth also asked members for ways in which IISG might be able to collaborate on a tool that ICC members would find useful.
  - One ICC member suggested teachers because they are easy to reach – curriculum coordinators collect crayfish from the classroom.
- If the final outreach product necessitates printing, resources to do that will be included in the grant. In addition, other organizations should be able to receive electronic copies of the product to print themselves. However, IISG likely will not make the tool available for these organizations to modify.

Berg, IISG, presented on the community science program that IISG has been beginning to implement.

- This pilot program teaches educators how to trap, identify, and post pictures of crayfish to iNaturalist with their students. Teachers and their students will act as a reporting source for potential new invasive crayfish populations. This program has trained 45 teachers and outdoor educators so far.
- Next steps:
  - Helping trained educators get into the field to implement this program, then evaluating educators' experience.
  - Summarizing and providing this crayfish data to managers and scientists.
  - Expanding this program to other Great Lakes states.
- Questions to keep in mind:
  - If an early detection scenario does happen, how can we get information disseminated quickly?

- Can we provide guidance for teachers as to where they should target sampling? Currently teachers will probably sample immediately around their school, unless they can get funding for a trip somewhere else.
- Can we integrate this program into existing lesson plans and/or distribute new lesson plans?

4:50 General discussion, next steps

Charlebois introduced the last agenda item of the meeting. This is the last in-person meeting of this grant. The ICC can explore other types of meetings between now and some additional funding. Between now and end of September 2020 there will be some changes to the website, and continuing posting to the listserv, and developing the outreach tool. Charlebois then opened the meeting for final announcements or discussion.

5:00 Adjourn

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Attendance

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