Department of Biosystems and Agricultural Engineering
MICHIGAN STATE UNIVERSITY

BE 487 - Spring 2022
Biosystems Design Projects

Red Swamp Crayfish Capturing Device

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InCraysive

Background

Red swamp crayfish (*Procambarus clarkii)* (Figure 1) are invasive in Michigan[2]. They:

- Are larger than native species[3]
- Affect infrastructure stability
- Have few common (aquatic) predators
- Have few natural controls
- Alter Michigan's ecosystems by
  - Outcompeting native species
  - Burrowing, threatening structural stability

Figure 1: Red swamp crayfish

Michigan's Department of Natural Resources has tried many methods to eliminate red swamp crayfish in Michigan's lakes and ponds. Chemicals have been used to eradicate RSC and different kinds of traps have been implemented (Figure 2).

Figure 2: Current trap

The current trap:

- 0.24 ft^3 volume
- 30-45 crayfish/day capacity
- 4 entry points

Wanting a more efficient technique to capture RSC, the InCraysive team has been asked to:

Design a large capacity, transportable crayfish capturing device.

Objectives

- Reduce frequency of site visits to once every 1-2 weeks
- Reduce time spent collecting crayfish by 50%
- Reduce number of traps to 3-4/pond
- Introduce 2 new stimuli

Constraints

Environmental and testing constraints include:

- Freezing of Michigan's lakes
- Seasonal lack of on-site devices
- RSC transportation requires a permit[4]

Constraints related directly to the trap design include:

- Shallow ponds: trap height < 4 ft
- Greater trap dimensions causing mobility issues
- Area < 16 ft^2
- Lack of reports on crayfish exit rates
- Risk of capturing native species restricts automated methods of disposal

Design Alternatives

Design alternatives were based on 2 essential parameters:

- Trap design
- Transportation

For the trap design, 3 changes were considered:

- Adding a lower compartment
- Enhancing stimuli
- Changing trap shape

For trap transportation, 6 methods were considered:

- Pulley system
- Rope
- RC boat
- Magnets
- Crane systems
- Drone

Research

Dog Food Experiment

- Dog food can last longer than 2 weeks in a net under water
- The smell gets stronger with time
- Bait replaced less frequently

Figure 3: Dog food, day 13

Selected Design

Trap

The selected design incorporates 3 stimuli:

- Thermal (heater)
- Auditory (speaker)
- Olfactory (dog food)

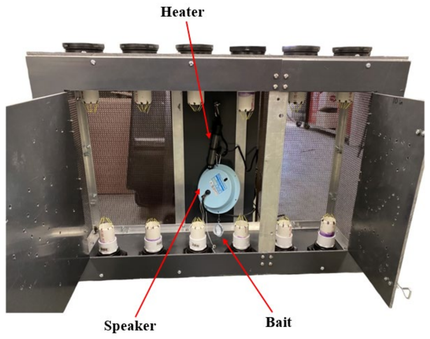

Figure 4: Internal components

From the design alternatives, the trap door component of the lower compartment addition was added to the trap. The trap doors will:

- Aid in emptying the trap
- Reduce heavy lifting to empty the trap
- Help drain water

12 soft valves with angled nylon fibers:

- Allow entry to the trap, 1.5" inside diameter
- Reduce exit of the crayfish
- Help drain water

A metallic tea bag contains the bait:

- Keeps the crayfish from eating the dog food
- Increases time bait is in the trap
- Allows dog food to slowly disperse in the water

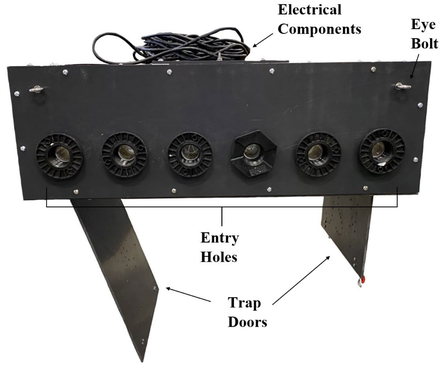

Figure 5: Final trap design (side view)

Design Parameters

Trap Parts

Entry Valves

Figure 6: PVC entry valve

Alterations to Material

- Perforate the PVC sheet trap doors
- 6, 3" holes along the bottom edge of the 2 PVC walls
- PVC sheet bottom cut to 2 doors

Table 1: Physical properties

Property	Value
Length	37 in
Width	25 in
Height	13 in
Volume	7 ft^3
Dry Weight	53 lb
In-Use Weight	65 lb

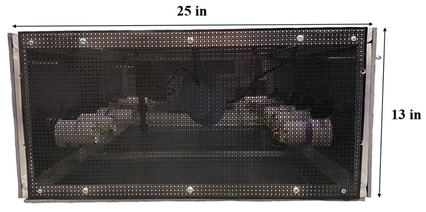

Figure 7: Final trap design (end view)

Speaker and Heater

- Electro-Voice UW-30 Speaker
- High range white noise[1]
- 12 kHz pure tone[1]
- Tetra Submersible Heater, 30-40 gal
- Increase temperature

Figure 8: Speaker

Figure 9: Heater

Economics

Trap

Table 2: Costs of materials needed per trap

Material	Subtotal
Metal tea bag	$7
Heater	$28
Miscellaneous	$59
Perforated sheet metal	$79
Bulkheads and adapters	$125
Aluminum angle and flat bar	$126
PVC tubing/sheets	$208
Speaker	$436
Total	**$1,068**

Transportation

- Crane system: $1,100
- Polypropylene rope: $74/20ft

Transportation

Recommendations

The trap will be mobilized using 2 methods:

- Rope
- Crane system

Rope pulls the trap closer to the shore and the crane lifts the trap from the water. Lifting with a crane allows the trap to be moved over a collection container. Using rope and a crane:

- Reduces heavy lifting
- Reduces labor to 1 person
- Increases mobility of the trap

Select References

1. Clements, D. (2020). *Effects of olfactory and auditory stimuli on locomotion of Procambarus clarkii*. Michigan State University. https://d.lib.msu.edu/etd/49450/datastream/OBJ/View/
2. Nagy et al. (2011, February). U.S. Fish and Wildlife Service. *Red Swamp Crayfish (Procambarus clarkii) - FWS*. Ecological Risk Screening Summary. Retrieved November 22, 2021, from https://www.fws.gov/Fisheries/ANS/erss/highrisk/Procambarus-clarkii-ERSS-revision-May2015.pdf.
3. Nathan, L. (2021). *Michigan invasive species*. *Red Swamp Crayfish*. Retrieved October 18, 2021, from https://www.michigan.gov/invasives/0,5664,7-324-68002_74188-367863--,00.html.
4. State of Michigan (n.d.) *FO-249.15 Crayfish regulations*. https://www.michigan.gov/documents/dnr/FO249-14_451665_7.pdf.