COORDINATED RESPONSE EFFORTS TO THE RED SWAMP CRAYFISH INVASION IN MICHIGAN

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HOW SHOULD WE MANAGE A NEW, POTENTIALLY DESTRUCTIVE NON-NATIVE SPECIES?

- DO NOTHING
- STUDY IT
  - MIGHT LEARN SOMETHING
    - DOES IT HAVE A WEAKNESS? (E.G. JUDAS FISH)
    - WON’T HELP IF A PROBLEM ARISES (I.E. SPREAD)
- IMMEDIATELY ATTEMPT TO ERADICATE
  - WON’T LEARN MUCH
    - MOST TREATMENTS DON’T WORK EVERYWHERE
    - BANDAID ON AN OPEN WOUND
    - MIGHT HELP IF SPECIES SPREADS/FOUND ELSEWHERE
- SOME COMBINATION OF THE TWO
RED SWAMP CRAYFISH

- ONE OF THE MOST INVASIVE SPECIES WORLDWIDE
  - FOUND IN >100 COUNTRIES
- BURROWING BEHAVIOR IS DANGEROUS
  - DAMS, DYKES, WETLANDS
RED SWAMP CRAYFISH INTRODUCTIONS IN THE U.S.

- FOOD WEB EFFECTS ARE NOT PARTICULARLY WELL KNOWN
  - TROPHIC STATE
  - AMPHIBIANS
  - OTHER CRAYFISH

TIMELINE OF RED SWAMP CRAYFISH IN MICHIGAN

• 2013
  • JUL: REPORTS OF RED SWAMP CRAYFISH CARCASSES AT SEVERAL POPULAR FISHING LOCATIONS (LAKE MACATAWA)

• 2014-2016
  • STATEWIDE SURVEY OF MICHIGAN STREAMS
  • RISK ASSESSMENT OF POTENTIAL RSC PATHWAYS
    • RISKS PROMINENT IN SE MICHIGAN
STATEWIDE SURVEY IN 2014-2015 FOUND NO RED SWAMP CRAYFISH

• SAMPLED >900 STREAM SEGMENTS THROUGHOUT UPPER AND LOWER PENINSULA
  • SAMPLED STREAMS ALMOST EXCLUSIVELY
TIMELINE OF RED SWAMP CRAYFISH IN MICHIGAN

• 2017
  • JUL 17: REPORTS OF RED SWAMP CRAYFISH AT SUNSET LAKE (NEAR KALAMAZOO, MI)
  • JUL 19-22: REPORTS OF RSC AT SEVERAL LOCATIONS IN SE MICHIGAN
    • MOST AROUND NOVI
  • AUG: PROJECT START
MEDIA COVERAGE

'S mini-lobsters' have Michigan on alert after invasive, Louisiana crawfish found in waters

Invasive crayfish reported in 2 bodies of water in Michigan

Tiny lobsters of doom: Why this invasive crayfish is bad news
IMPLEMENTATION OF A COMPREHENSIVE RED SWAMP CRAYFISH RESPONSE PLAN

GOALS:

1) DETERMINE DISTRIBUTIONAL OF RSC

2) IMPLEMENT AND EVALUATE AN EARLY DETECTION STRATEGY

3) DETERMINE THE SOURCE OF RED SWAMP CRAYFISH INFESTATIONS

4) COLLECT BASELINE BIOLOGICAL AND PHYSICAL INFORMATION

5) IMPLEMENT AND EVALUATE CONTROL MEASURES
1) DETERMINE THE DISTRIBUTIONAL EXTENT OF RSC

- TRAPPING
- EDNA
- VISUAL INSPECTION
FINDINGS:
1) DISTRIBUTIONAL EXTENT

• THREE EPICENTERS (FOUND IN 35 WATERBODIES)
  • SUNSET LAKE
  • NOVI
  • FARMINGTON HILLS

• MOST ARE SMALL PONDS
  • GOLF COURSES
  • HOTELS/RESTAURANTS
  • PRIVATE RESIDENCES/APARTMENTS
DISTRIBUTIONAL EXTENT
DISTRIBUTIONAL EXTENT

• CHALLENGE

• INFESTED WATERBODIES A MIX OF PUBLIC AND PRIVATE OWNERSHIP
  • HOTELS, RESTAURANTS, GOLF COURSES
  • RETENTION PONDS
• SOMEWHAT LIMITED TOOLS FOR DETECTION
  • EDNA
  • TRAPS
  • PUBLIC

Novi/Farmington Hills epicenter
VERY VERY SMALL WATERBODIES

- HAVE TO BE ON THE GROUND TO DETERMINE SAMPLING CONDITIONS
2) IMPLEMENT AND EVALUATE AN EARLY DETECTION STRATEGY

• WHAT ARE OUR DETECTION PROBABILITIES?
  • EDNA (SCRIBNER LAB) (185 SITES, 4 SITES RESAMPLED)
  • TRAPPING (189 SITES, 29 SITES RESAMPLED)
  • BOTH (63 LOCATIONS)
• OUTREACH
HOW DOES EDNA AND TRAPPING COMPARE?

- 63 SITES WITH BOTH SAMPLES
- EDNA ABOUT 85% ACCURATE COMPARED TO TRAPS
- CONCERNED ABOUT FALSE NEGATIVES
- TIMING OF TRAP DETECTION AND EDNA SAMPLES MAY BE PART OF ISSUE
  - RSC DISCOVERED IN TWO LOCATIONS IN 2018

<table>
<thead>
<tr>
<th>eDNA</th>
<th>Trapping</th>
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<tbody>
<tr>
<td>+</td>
<td>7</td>
</tr>
<tr>
<td>-</td>
<td>6</td>
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ARE TRAPS AN EFFECTIVE MEANS TO DETECT RED SWAMP INVASIONS?

• MANY BENEFITS TO USING TRAPS
  • INEXPENSIVE
  • EASY TO DEPLOY

• OCCUPANCY MODELING
  • CAN INFORM TRAPPING PRACTICES

• OVERALL, PREDICTED 16.8 INFESTED OR OCCUPIED SITES
  • BASED ON 2017 SAMPLES
  • OBSERVED 16 IN 2017
HOW MANY TRAPS SHOULD WE USE?

• SIX TO EIGHT
• PROBABLY DEPENDS ON ECOSYSTEM SIZE
HOW MANY TIMES SHOULD WE VISIT A SITE?

- DETECTION RATES UPWARDS OF 100%
- THREE OR FOUR TO MAXIMIZE DETECTABILITY
  - TWO IF WE WANT TO MAXIMIZE COVERAGE
LESSONS FROM EARLY DETECTION

• TRAP DETECTIBILITY IS HIGH
  • EDNA LESS SO, BUT MORE TO LEARN

• UNKNOWNS
  • EFFECTS OF ABIOTIC ENVIRONMENT (TEMPERATURE, DO)
  • SOME FALSE NEGATIVES AND POSITIVES IN EDNA
    • CONTAMINATION?
5. IMPLEMENT AND EVALUATE CONTROL MEASURES

- CONTROL MEASURES WILL BE SITE-SPECIFIC
- REQUIRE COORDINATION OF MULTIPLE INSTITUTIONS
  - MDNR
  - USGS
  - MSU
  - CISMAS
- COMBINATION OF:
  - CHEMICAL CONTROL
  - BIOLOGICAL CONTROL
  - TRAPPING
  - EXPERIMENTAL TREATMENTS
CHEMICAL CONTROL
(CO$_2$ AND CYPERMETHRIN)

- CO$_2$ EASIEST TO IMPLEMENT
- WORKING WITH USGS TO OBTAIN PROPER DOSAGE AND LETHALITY DATA ON CHEMICALS
  - PERMITTING
- WE WILL NEED PERMISSION AT SOME LOCATIONS
  - PRIVATE PONDS/WATER RETENTION
- WE SHOULD WORK WITH OWNERS/RESIDENTS AT OTHERS
  - GOLF COURSES
  - OTHER WATERS OF THE STATE
WILL CO$_2$ WORK?

- CRAYFISH FLEE PONDS TREATED WITH CO$_2$
- NEED TO ENSURE THAT FIELD APPLICATION REDUCES CHANCE OF TRANSFER TO OTHER WATERBODIES
CO₂ ADDITION EXPERIMENT

• AUG 21-24, 2018 ON SHERATON POND
  • INITIALLY PLANNED TO TREAT 3 PONDS, BUT TWO FLOODED
  • TWO CONTROL PONDS (NOT TREATED)
  • 25 DEWARS OF CO₂ (10,000LBS)
We reached CO₂ target by end of 1ˢᵗ day.
RECORDING CRAYFISH RESPONSE

- RECORDED WHERE CRAYFISH WERE ON 1-3 HOUR SHIFTS
- CRAYFISH IN WATER WERE GIGGED

![Image of crayfish recording setup with labels: Under flap, In water, Inside fence, Outside fence.]
# Crayfish Captures by Day

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<tr>
<th>Treatment</th>
<th>In Water</th>
<th>Inside Fence</th>
<th>Under Folds</th>
<th>Outside Fence</th>
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<td>6</td>
<td>68</td>
<td>3</td>
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<td>8/22/2018</td>
<td>91</td>
<td>11</td>
<td>0</td>
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<td>8/23/2018</td>
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<td>15</td>
<td>2</td>
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Mostly Burrowing
RSC hung out at water/air interface

Some RSC were narcotized
TRAP CATCHES AT CONTROL AND TREATMENT SITES
LESSONS LEARNED

• CRAYFISH CONGREGATED NEAR INFLOWS
• LIKELY LOWER CO2 CONCENTRATIONS
CAPTURES IN WATER AT SHERATON

Sections 1, 4, 5, and 6 are near inflows
CONCLUSIONS FROM CO$_2$

• CO$_2$ HIGH ENOUGH FOR IMPACT
• MAYBE AN EFFECT?
• NEED TO CONTROL INFLOWS
• COULD WORK UNDER ICE
CHEMICAL CONTROL (USGS)

- CYPERMETHRIN NOT APPROVED FOR AQUATIC USE!!
- EXTREMELY TOXIC, BUT LOW PERSISTENCE IN WATER
CONCLUSIONS/NEXT STEPS

• DETERMINE INVASION SOURCES
  • LIKELY MULTIPLE PATHWAYS
• TRAPPING IS A VALUABLE TOOL
  • FOR DETECTION OF INVASIONS
  • MAY BE MORE RELIABLE THAN EDNA
• TIME IS OF THE ESSENCE
  • ALL THREE EPICENTERS ARE CLOSE TO MAJOR GREAT LAKES TRIBUTARIES
STILL AN ONGOING THREAT

- JULY 2018
- >2000 LBS OF LIVE RED SWAMP CONFINSCATED AT PORT HURON/SARNIA BORDER
THANK YOU!!!

- GREAT LAKES RESTORATION INITIATIVE
- REBECCA TUCKER, HAMISH ABDULRAHMAN (AUBURN U)
- MDNR, WATERFORD FIELD OFFICE
- MDNR, PLAINWELL OFFICE
- USGS
  - UPPER MIDWEST ENVIRONMENTAL SCIENCE CENTER
  - COLUMBIA ENVIRONMENTAL RESEARCH CENTER
RISK ASSESSMENT:
HOW MIGHT RED SWAMP CRAYFISH INVADE?

• LIVE FOOD MARKETS
• PET STORES
• BAIT SHOPS
• CLASSROOM USE
RISK ASSESSMENT RESULTS: SURVEY OF RETAIL STORES

- FOCUS ON POPULATION CENTERS
  - DETROIT, GRAND RAPIDS, LANSING, JACKSON

<table>
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<tr>
<th>Store Type</th>
<th>Crayfish</th>
<th>Sold Crayfish</th>
<th>Sold <em>P. clarkii</em></th>
<th>Total (%)</th>
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<tr>
<td>Live Food</td>
<td>72</td>
<td>8</td>
<td>8</td>
<td>80 10</td>
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<td>Pet Tackle</td>
<td>17</td>
<td>13</td>
<td>0</td>
<td>25 52</td>
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<tr>
<td>Number of retailers visited</td>
<td>101</td>
<td>24</td>
<td>21</td>
<td>125 17</td>
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- Number of retailers visited
RISK ASSESSMENT RESULTS: CLASSROOM USE

Survey at Michigan Science Teachers Association meeting (2016)

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<th>Respondents</th>
<th>157 (45 counties)</th>
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<tr>
<td>Yes to crayfish use</td>
<td>17</td>
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<tr>
<td>Risky acquisition</td>
<td>8</td>
</tr>
<tr>
<td>Risky disposal</td>
<td>3</td>
</tr>
<tr>
<td>Risky acquisition and disposal</td>
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</table>

- Risky Disposal and Acquisition
- Only Risky Disposal
- Only Risky Acquisition
- Crayfish Use – No risk
- Surveyed – No use
3. DETERMINE THE SOURCE AND RELATEDNESS OF RED SWAMP CRAYFISH INFESTATIONS
“WHERE DID THEY COME FROM?”

- POPULATION GENOMICS OF POSSIBLE SOURCE POPULATIONS (W’ SCRIBNER LAB)
  - ALL INVADED SOURCES
  - WILD INVADED LOCATIONS
    - CHICAGO
    - WISCONSIN
      - SANDUSKY BAY
  - WILD SOUTHERN LOCATIONS
    - ALABAMA
    - LOUISIANA
  - COMMERCIAL SOURCES
    - LIVE FOOD MARKET BUSTS (MI) FROM LAW DIVISION
    - CAROLINA BIOLOGICAL

Older frozen samples too degraded to analyze
WHEN ARE TRAPS MOST EFFECTIVE?

- BETWEEN MID-AUGUST AND LATE OCTOBER
  - PROXY FOR TEMPERATURE?

- NEED TO INCLUDE THIS YEAR’S DATA
4. COLLECT BASELINE BIOLOGICAL AND PHYSICAL INFORMATION THAT WILL INFORM A FUTURE ASSESSMENT OF IMPACTS

- A LOT OF WORK TO DO TO DETERMINE EFFECTS IN MICHIGAN
- FUTURE METRICS
  - FECUNDITY
  - SPAWNING SEASONS
  - PREDATOR CONSUMPTION
    - CAN WE USE PREDATORS TO SUPPORT (OR LEAD) CONTROL EFFORTS?
  - BIOLOGY AND HABITAT (SUNSET LAKE)
    - MACROPHYTES
    - FISH COMMUNITY
    - WATER QUALITY