

# Beaver Island Archipelago Invasive Species Control Final Report

Charlevoix County, Michigan

October 20, 2012

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# BEAVER ISLAND ARCHIPELAGO INVASIVE SPECIES TREATMENT CHARLEVOIX COUNTY, MICHIGAN

## 1.0 INTRODUCTION

A number of invasive plant species are known to be present within the Beaver Island Archipelago, which is comprised of 14 islands in northern Lake Michigan, approximately 30 miles northwest of Charlevoix, Charlevoix County, Michigan (Figure 1). In addition to long-established populations, several invasive species have been observed for the first time on the archipelago within the past three years. Some treatment of invasive species has occurred in the past, but little information about the overall distribution and density of invasive species populations was available.

To address these concerns, The Nature Conservancy contracted with Cardno JFNew to conduct a coarse-level survey of established invasive species, an early detection survey for invasive species found on nearby mainland areas, and to treat certain known invasive species populations within the archipelago. Invasive species surveys and treatment were conducted on Beaver Island, Hog Island, High Island, and Garden Island in the summer of 2012.

## 2.0 INVASIVE SPECIES SURVEYS

### 2.1 Survey Areas

#### 2.1.1 Beaver Island

From June 18 to June 29, 2012 (Phase 1) and July 16 to July 20, 2012 (Phase 2), Cardno JFNew conducted both the coarse-scale mapping of established invasive plant populations and the early detection survey on Beaver Island. The surveys, although different in scope, were conducted concurrently to make most effective use of time in the field.

Phase 1 was focused in four areas which are summarized in Table 1.

Table 1: Summary of Beaver Island Survey Areas: Phase 1

| Survey Area    | Description   | Acres       |
|----------------|---|-------------|
| Priority Areas | Intersection of public land and land identified as high quality by MNFI   | 1849        |
| Roads          | 30 feet from either side of center of all roads, minus 24-foot road width | 609         |
| Trails         | 30 feet from either side of center of all trails                          | 262         |
| Shoreline      | Area between water edge and tree line (average of 120 feet)               | 623         |
|                | <b>Total:</b>   | <b>3343</b> |

Phase 2 focused on areas selected by The Nature Conservancy following consideration of the results of the Phase 1 surveys. The phase two survey areas are summarized in Table 2.

Table 2: Summary of Beaver Island Survey Areas: Phase 2

| Survey Area  | Description   | Acres       |
|--------------|---|-------------|
| Private Land | Private land of conservation interest and/or adjacent to known invasive species populations | 594         |
| Public Land  | Public land adjacent to Priority Areas  | 2300        |
|              | <b>Total:</b>   | <b>2857</b> |

The survey areas for both phases are shown in Figure 2. In total, approximately 6200 acres was surveyed for invasive species on Beaver Island.

### 2.1.2 Hog, High, and Garden Islands

In addition to the Beaver Island surveys, Cardno JFNew conducted a coarse-level survey of invasive species on Hog and High Islands, and a survey of non-native phragmites populations on Garden Island. These surveys were conducted at the same time as the invasive species treatment (September 5 to September 12, 2012). The survey area was limited to the shorelines of Hog, High, and Garden Islands and the edge of Lake Maria on High Island, and encompassed approximately 817 total acres (Table 3).

Table 3: Summary of Hog, High, and Garden Island Survey Areas

| Survey Area   | Description                      | Acres      |
|---------------|----------------------------------|------------|
| Hog Island    | Shoreline only                   | 288        |
| High Island   | Shoreline and edge of Lake Maria | 196        |
| Garden Island | Shoreline only, phragmites only  | 333        |
|               | <b>Total:</b>                    | <b>817</b> |

## **2.2 Data Collection**

To conduct the surveys, Cardno JFNew staff walked each survey area (except roads) and recorded occurrences of invasive species using Thales Mobile Mapper and Trimble Geo XH handheld GPS units. The road surveys were conducted by driving each road slowly and recording occurrences of invasive species on field maps, which were later converted to GIS shapefiles. Cardno JFNew also worked with knowledgeable island residents to gather and confirm existing invasive species data. To establish consistency in data collection, the first half-day of surveying was conducted collaboratively with all field staff, and survey methodology was reviewed at the beginning of each field day.

The coarse-scale and early detection surveys were focused on 24 priority species identified by The Nature Conservancy prior to the survey to be present or potentially present on Beaver Island. At the time of the survey, Cardno JFNew staff also identified and recorded populations of six additional invasive species found on Beaver Island



(Table 4). The additional species were surveyed only as time and field conditions allowed; thus the survey results for these species are not necessarily comprehensive.

Table 4: List of Invasive Species Surveyed

| Common Name                 | Scientific Name                   | Species Code |
|-----------------------------|-----------------------------------|--------------|
| Black and Pale Swallowworts | <i>Vincetoxicum spp.</i>          | VN           |
| Oriental Bittersweet        | <i>Celastrus orbiculatus</i>      | OB           |
| Japanese Knotweed           | <i>Polygonum cuspidatum</i>       | JK           |
| Lombardy Poplar             | <i>Populus nigra var. italica</i> | LP           |
| Kudzu                       | <i>Pueraria lobata</i>            | KZ           |
| Japanese Barberry           | <i>Berberis thunbergii</i>        | JB           |
| White Sweet Clover          | <i>Melilotus alba</i>             | WS           |
| Bladder Campion             | <i>Silene vulgaris</i>            | BC           |
| Japanese Hedge Parsley      | <i>Torilis japonica</i>           | HP           |
| Autumn Olive                | <i>Elaeagnus umbellata</i>        | AO           |
| Sweet Woodruff              | <i>Galium odoratum</i>            | SW           |
| Bush Honeysuckles           | <i>Lonicera spp.</i>              | HS           |
| Dalmatian Toadflax          | <i>Linaria dalmatica</i>          | DT           |
| Blue Lyme Grass             | <i>Elymus arenarius glaucus</i>   | LG           |
| Baby's Breath               | <i>Gypsophila paniculata</i>      | BB           |
| Phragmites                  | <i>Phragmites australis</i>       | PH           |
| Garlic Mustard              | <i>Alliaria petiolata</i>         | GM           |
| Glossy Buckthorn            | <i>Rhamnus frangula</i>           | GB           |
| Spotted Knapweed            | <i>Centuarea maculosa</i>         | SK           |
| Scotch Pine                 | <i>Pinus sylvestris</i>           | SP           |
| Marsh Thistle               | <i>Cirsium palustre</i>           | ST           |
| Purple Loosestrife          | <i>Lythrum salicaria</i>          | PL           |
| Black Locust                | <i>Robinia pseudoacacia</i>       | BL           |
| Wild Parsnip                | <i>Pastinaca sativa</i>           | WP           |
| St. John's Wort*            | <i>Hypericum perforatum</i>       | SJ           |
| Narrow-Leaf Cattail*        | <i>Typha angustifolia</i>         | CT           |
| Crown Vetch*                | <i>Coronilla varia</i>            | CV           |
| False Baby's Breath*        | <i>Galium mollugo</i>             | FB           |
| Reed Canary Grass*          | <i>Phalaris arundinacea</i>       | RC           |
| Multiflora Rose*            | <i>Rosa multiflora</i>            | MR           |

\* Additional (non-priority) species surveyed

Using the GPS units, the locations of most invasive species occurrences were recorded with point features. Polygon features were taken for populations greater than 1 acre in size where field conditions allowed. In addition to location, the approximate area and density of each invasive species occurrence were categorized according to the protocol

accepted by the Midwest Invasive Species Information Network (MISIN). The area of each population was estimated and placed into one of the following categories:

- Individual/Few/Several
- <1000 sq ft
- 1000 sq ft – 0.5 acres
- 0.5 acres – 1.0 acres
- >1.0 acres

Also, each population was assigned one of the following density categories:

- Sparse
- Patchy
- Dense
- Monoculture

Each population was labeled according to the following protocol:

**XXYYZZ0001**

Where:

**XX** = Location (BI = Beaver Island, HO = Hog Island, HI = High Island, GI = Garden Island)

**YY** = Initials of surveyor

**ZZ** = Two-letter species code (Table 4)

**0001** = Sequential number of occurrence

## **2.3 Results**

The results of the coarse-level mapping and early detection survey are summarized in Figure 3. Data collected for each population are contained in the GIS shapefiles, which have been provided.

## **3.0 INVASIVE SPECIES TREATMENT**

From September 5 to September 12, 2012, Cardno JFNew treated non-native phragmites populations along the shorelines of Beaver, Hog, High, and Garden Islands using an herbicide mix of 1% aquatic-approved imazapyr and 1% aquatic-approved glyphosate. Small or sparse populations in high-quality habitat areas were treated using the hand-wick method, and denser populations were treated by backpack spot spraying. Additionally, the populations of purple loosestrife and Japanese knotweed on Beaver Island were treated using the same methods. All treated populations were

located and recorded using Thales Mobile Mapper and Trimble Geo XH handheld GPS units (Figure 4).

## **4.0 MANAGEMENT RECOMMENDATIONS**

Based on the results of the invasive species survey and professional experience in coastal northern Michigan ecosystems, the following monitoring and/or treatment recommendations have been developed on a per species basis. Each species has been categorized as high, medium, or low priority.

### **4.1 Low Priority Species**

- Black and Pale Swallowworts. Swallowworts were not observed during the survey. However, early detection surveys should be conducted periodically to monitor for swallowwort and other new invasive species.
- Lombardy Poplar. Lombardy poplar exists in one location at a homestead west of King's Highway and in one location in the harbor area. Although it shows some evidence of spreading from the original plantings, it is not known to be invasive throughout its range and is unlikely to become a major invasive species. Plants could be treated using the cut stump and/or drill-and-fill methods.
- Kudzu. Kudzu was not observed during the survey, and occurs primarily in the southeast United States. However, early detection surveys should monitor for this species, particularly since potential long-term changes in climatic conditions may favor Kudzu and other southern species.
- Japanese Barberry. Japanese barberry was not observed during the survey. Continued monitoring for this species should occur, especially in wet to wet-mesic forest areas.
- White Sweet Clover. White sweet clover was abundant on several disturbed roadsides and beaches. However, white sweet clover is unlikely to form a monoculture that out-competes native species in high-quality habitat. Foliar herbicide applications may be used to limit its abundance.
- Bladder Campion. Bladder campion, like the above species, was frequent on disturbed roadsides and beaches, but is unlikely to form monoculture or out-compete native vegetation over large areas.
- Japanese Hedge Parsley. The only occurrence of this species was a single plant observed in a landscaped area in the township of St. James. The homeowner should be encouraged to remove the plant from his/her property.

- Sweet Woodruff. This species was not observed during the survey. However, several native *Galium* species and the similar-looking exotic false baby's breath were found on the island.
- Dalmatian Toadflax. This species was not observed during the survey, but the similar-looking plant *Linaria vulgaris* was observed in one location. Because both species have the potential to become invasive, they should be included on lists for future early detection surveys.
- Spotted Knapweed. Spotted Knapweed was abundant along disturbed roadsides and beaches. Although it has the capacity to outcompete native species in dry, open, disturbed places, it was not observed in high-quality habitats on Beaver Island except where it coexisted with native shoreline vegetation. Herbicide applications and hand-pulling may reduce populations in select areas, but efforts to eradicate this species would likely be unsuccessful.
- St. John's Wort. St. John's wort was frequent on roadsides, trails, and in forest canopy openings, but was seldom dominant and was not observed outcompeting native vegetation. Efforts to control St. John's wort through herbicide or mechanical means would likely cause more damage to native vegetation than the plant itself.
- False Baby's Breath. This species was frequent in depressions and wetlands along the shoreline. However, it is not known to be invasive throughout its range and is unlikely to become highly invasive.

#### 4.2 Medium Priority Species

- Bush Honeysuckles. Honeysuckle was observed at a few locations in yards and landscaping of residential areas. Although it does not appear to be spreading from these areas, honeysuckle can become highly invasive under a range of conditions. Homeowners should be encouraged to remove these plants from their using the cut-stump method to prevent re-sprouting.
- Blue Lyme Grass. Blue Lyme Grass was not observed during the survey, but has the potential to become highly invasive on shorelines and dunes. This species should be monitored for in future early detection surveys. Surveyors and involved residents should learn the difference between blue lyme grass and the similar-looking native wheat grass (*Elymus lanceolatus*), which occupies similar habitats.
- Glossy buckthorn. Glossy buckthorn was not observed during the survey, but has the potential to become highly invasive, particularly in groundwater-fed wetlands. This species should be monitored for in future early detection surveys. Surveyors and involved residents should learn the differences between glossy

buckthorn and somewhat similar-looking native species, including Michigan holly (*Ilex verticillata*) and choke cherry (*Prunus virginiana*).

- **Scotch Pine.** Scotch pine is abundant in certain areas of Beaver Island, and according to knowledgeable residents, has expanded dramatically in the past two decades. Scotch pine should be cut from high quality natural areas, and removed from other areas where practical to reduce its extent.
- **Marsh Thistle.** Marsh thistle was frequent in many wet areas, including depressions in shoreline and forest areas. It is listed as a noxious weed in two states, but was not found to be dominant and seems to coexist with native species on Beaver Island. Marsh thistle may be controlled in select areas by herbicide applications early in the season, or by repeated cutting of flowering stems.
- **Black Locust.** Black locust occurs on roadsides and in other disturbed areas of Beaver Island, and has the potential to spread rapidly, altering nutrient cycles and outcompeting native vegetation. Because the populations are relatively small, eradication may be possible. Foliar herbicide applications can be used on smaller individuals, but drill-and-fill herbicide applications should be used on larger trees to prevent re-sprouting.
- **Wild Parsnip.** Wild parsnip occurs in roadside ditches in a few locations on Beaver Island, and may expand to other areas. Control may be achieved by early spring herbicide applications, or by mowing the roadsides in late summer when the flowers have developed, but before going to seed. Mowing earlier in the year may increase the density of wild parsnip.
- **Crown Vetch.** Crown vetch was observed in several areas on the island, and has the potential to become invasive. Crown vetch is controlled primarily with foliar herbicide applications.
- **Reed Canary Grass.** Reed canary grass is likely the most abundant and widespread invasive species on Beaver Island, and has displaced native vegetation in many wetlands. Thus, control or eradication of this species would be very difficult, except in small, focused areas with continual maintenance treatments to remove new plants. Certain high-quality areas could be selected for reed canary grass control, then treated annually in early and late summer with a foliar herbicide application.

#### **4.3 High Priority Species**

- **Oriental Bittersweet.** Oriental bittersweet was found in a few small areas on Beaver Island. However, it has the potential to spread rapidly and smother native vegetation, including mature trees. It should be removed with foliar herbicide applications. Cut-stump treatments can be used on mature vines, and

follow-up treatments will likely be necessary to ensure all plants have been killed. As with all high priority species, oriental bittersweet should be a focus of future invasive species surveys.

- Japanese Knotweed. Japanese knotweed was found in one area along the road in the southeast part of the island. The population was treated with herbicide in 2012, but will likely require repeated follow up treatments to eradicate the population.
- Autumn Olive. Autumn olive was found in a few locations on Beaver Island, and has the potential to expand along forest edges and open areas. Some removal of autumn olive has occurred in the past; these areas should be monitored for resprouts and/or new plants. Additional populations should be removed as soon as possible using cut-stump treatments on larger individuals and foliar treatments on smaller plants.
- Baby's Breath. A few individuals of baby's breath were found on the northern end of the harbor near the lighthouse. Two plants on public land were removed by involved residents; the remaining plants are on private property. Baby's breath is highly invasive on the nearby mainland and poses a similar risk on the Beaver Island archipelago, so the homeowners should be encouraged to remove the plants on their property.
- Phragmites. Non-native phragmites occurs in many places along shorelines within the archipelago, and poses a significant threat to shoreline and wetland areas. Many of the populations have been treated previously, but multiple treatments are typically necessary to eradicate populations. Aggressive monitoring for phragmites should be a part of future invasive species surveys, keeping in mind the difference between native and non-native invasive varieties.
- Garlic Mustard. Garlic mustard was found in a few locations on Beaver Island. Garlic mustard is highly invasive on the mainland, and has potential to do the same on Beaver Island, particularly in mesic and wet-mesic forests. Known populations should be removed through early spring herbicide treatments and hand pulling in early summer. Annual treatments, occurring for several years, are necessary to exhaust the seedbank.
- Purple Loosestrife. Purple loosestrife occurs in a few wetlands on Beaver Island, and has the potential to spread through wet areas of all kinds. Some treatments have been done in the past, including in 2012 by Cardno JFNew staff, but follow up treatments and monitoring will be necessary to effectively control and eradicate the populations.
- Narrow-Leaf Cattail. Narrow-leaf cattail occurs in several areas along the shoreline and has expanded considerably in recent years. Control by hand-wicking and foliar applications should occur while the populations are still small.

- Multiflora Rose. Multiflora rose was found in a few locations on Beaver Island, and has the potential to expand rapidly. Because the populations are relatively small, they should be treated as soon as possible with a foliar herbicide application.

#### **4.4 General Management Recommendations**

- Because it is likely impossible to immediately treat all invasive species populations, the treatment of invasive species should generally follow the high-to-low prioritization of species as outlined above. This will allow effective control of the most highly invasive species, and provide the greatest ecological benefit for the amount of time, cost, and effort spent.
- For invasive species that are widespread, initial treatment areas should be focused on high quality areas and/or areas containing threatened and endangered species. Again, this will help maximize the ecological benefit per amount of effort spent.
- In addition to invasive species control, other ecosystem management measures could be implemented to improve ecological quality in habitats across the archipelago. For example, prescribed fire could be used in upland forests and bogs to help restore natural processes, improve regeneration of native vegetation, and reduce certain invasive species. Strategic reforestation of cleared areas will help reduce habitat fragmentation and potentially reduce vectors for exotic species invasion.
- Although this survey provides good baseline information on the extent of invasive species in the Beaver Island archipelago, early detection surveys of invasive species should be an ongoing effort. Working with residents, volunteers, agencies, and/or contractors, ongoing survey efforts should focus especially on species with small, expanding populations and on species that have not yet been found within the archipelago but are likely to invade. Like this survey, early detection efforts should be focused in disturbed areas that are likely to be invasion corridors, including the harbor area, the township of St. James, and along roadsides. High quality areas, especially those known to contain invasive species, should also be surveyed for new or expanding populations.
- Invasive species control, and ultimately, improving the ecological health of the archipelago, will be more successful with involvement from Beaver Island residents. Installing educational signage in public areas and/or holding seminars on invasive species identification would help improve public awareness and involvement. Volunteer workdays could also be organized to survey or remove certain invasive species.

## FIGURES

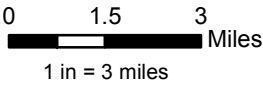




**Figure 1:**  
**Project Location Map**  
**Beaver, Garden, Hog & High Island**  
**Charlevoix County, Michigan**

October 2012  
Job No. 1205129

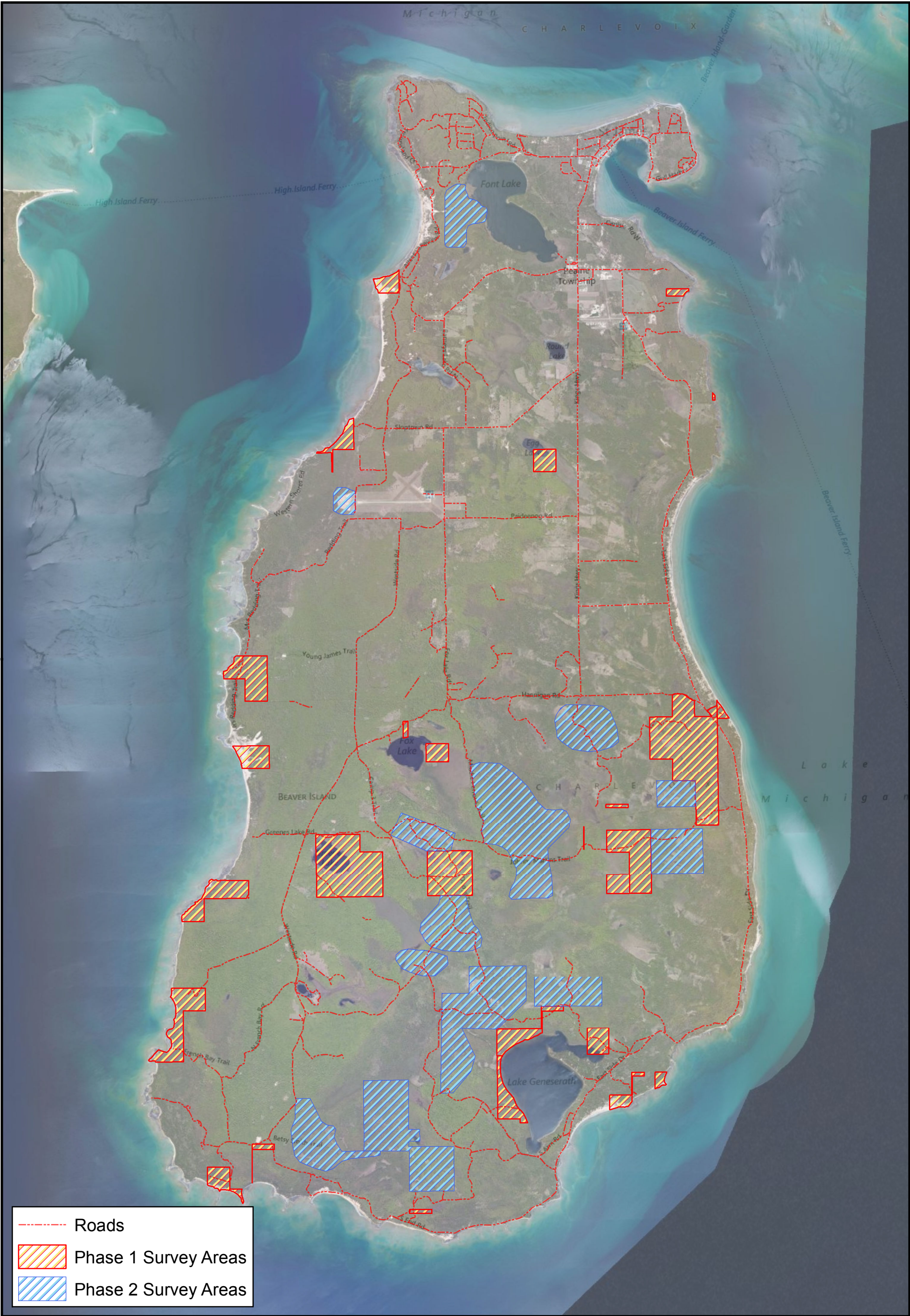
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Roads

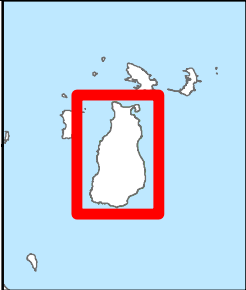
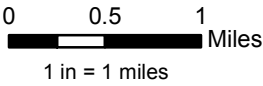
Phase 1 Survey Areas

Phase 2 Survey Areas

**Figure 2:**  
**Beaver Island Survey Areas**  
**Charlevoix County, Michigan**

**October 2012**  
**Job No. 1205129**

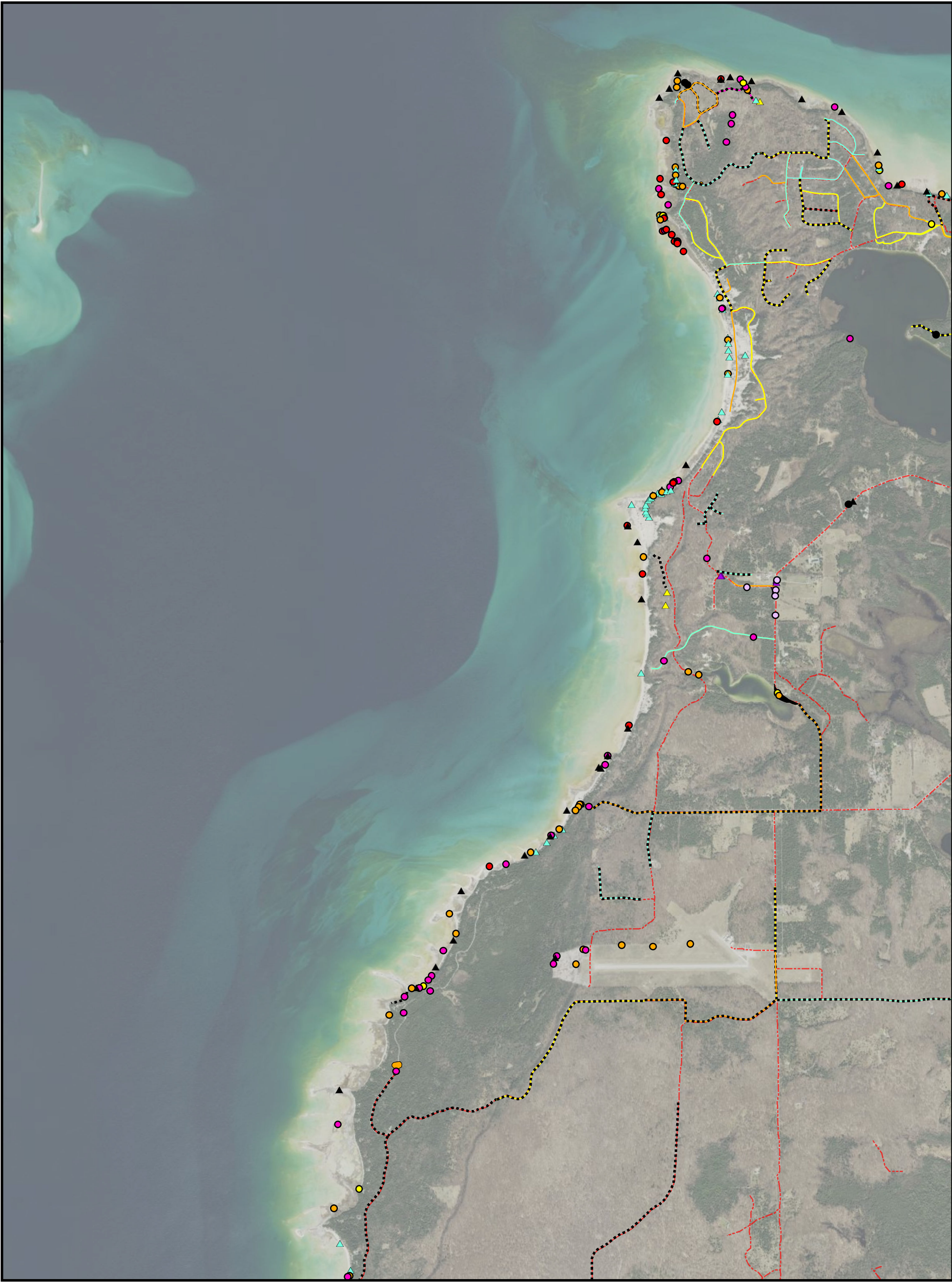
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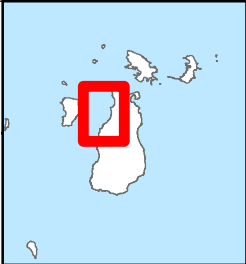
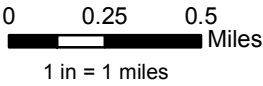


|   |  |   |  |   |   |
|---|--|---|--|---|---|
| <ul style="list-style-type: none"><li>● Phragmites australis</li><li>● Centaurea maculosa</li><li>○ Polygonum cuspidatum</li><li>● Melilotus alba</li><li>● Lythrum salicaria</li></ul> | <ul style="list-style-type: none"><li>● Elaeagnus umbellata</li><li>● Cirsium palustre</li><li>● Celastrus orbiculatus</li><li>○ Pinus sylvestris</li><li>○ Pastinaca sativa</li></ul> | <ul style="list-style-type: none"><li>▲ Gypsophila paniculata</li><li>▲ Lonicera spp.</li><li>▲ Populus nigra var. italic</li><li>▲ Alliaria petiolata</li><li>▲ Robinia pseudoacacia</li></ul> | <ul style="list-style-type: none"><li>▲ Silene vulgaris</li><li>▲ Torilis japonica</li><li>▲ Other</li></ul> | <ul style="list-style-type: none"><li>— Centaurea maculosa</li><li>— Polygonum cuspidatum</li><li>— Melilotus alba</li><li>— Cirsium palustre</li></ul> | <ul style="list-style-type: none"><li>— Celastrus orbiculatus</li><li>— Silene vulgaris</li><li>..... Other</li><li>--- Roads</li></ul> |
|---|--|---|--|---|---|

**Figure 3:**  
**Sheet 1 of 4**  
**Invasive Species Locations**  
**Beaver Island**  
**Charlevoix County, Michigan**

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Job No. 1205129

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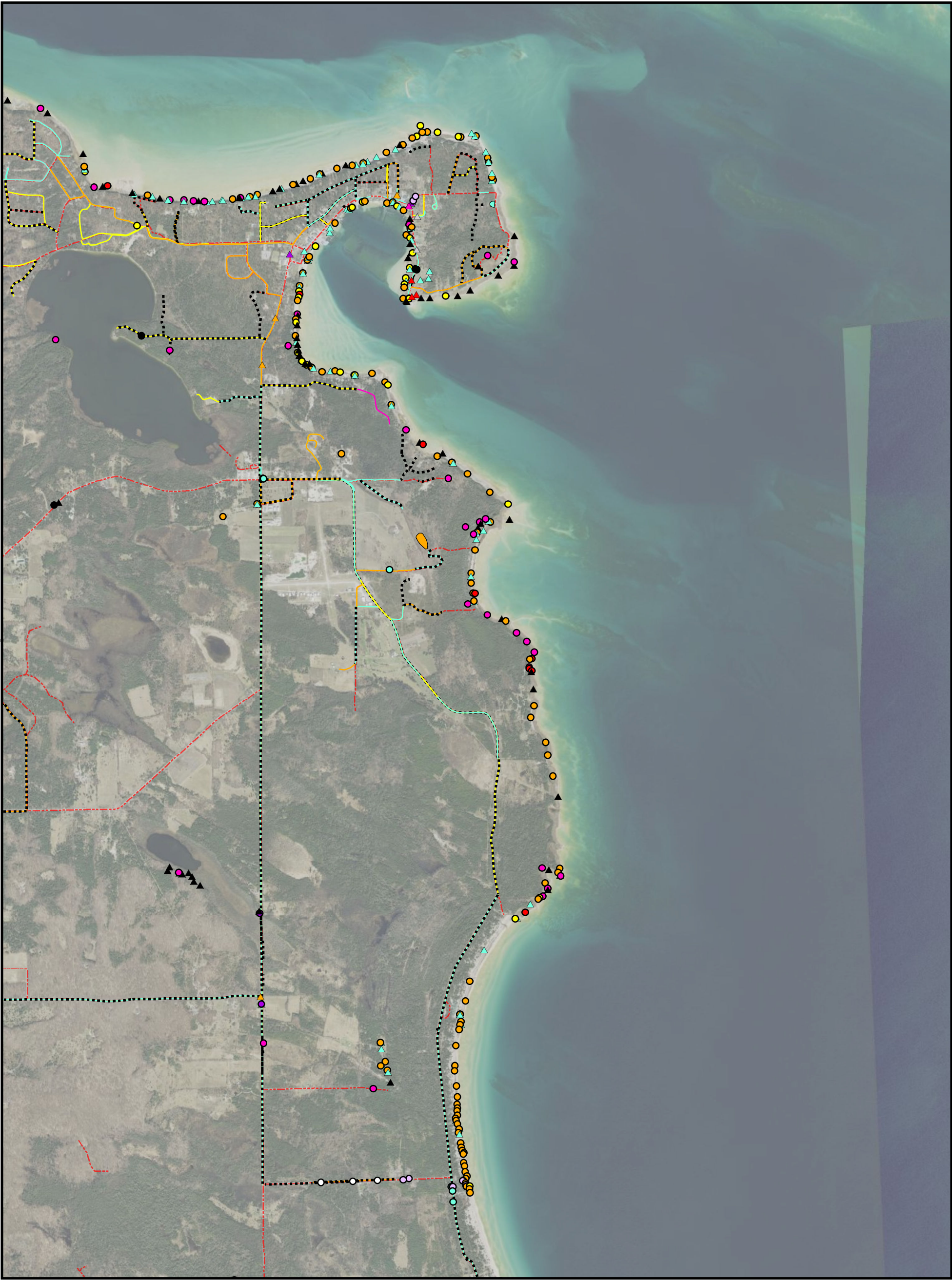


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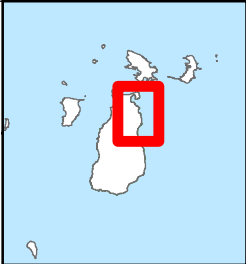
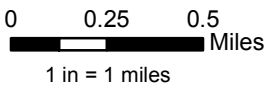


|                        |                         |                             |                    |                        |                         |
|------------------------|-------------------------|-----------------------------|--------------------|------------------------|-------------------------|
| ● Phragmites australis | ● Elaeagnus umbellata   | ▲ Gypsophila paniculata     | ▲ Silene vulgaris  | — Centaurea maculosa   | — Celastrus orbiculatus |
| ● Centaurea maculosa   | ● Cirsium palustre      | ▲ Lonicera spp.             | ▲ Torilis japonica | — Polygonum cuspidatum | — Silene vulgaris       |
| ○ Polygonum cuspidatum | ● Celastrus orbiculatus | ▲ Populus nigra var. italic | ▲ Other            | — Melilotus alba       | ..... Other             |
| ● Melilotus alba       | ○ Pinus sylvestris      | ▲ Alliaria petiolata        |                    | — Cirsium palustre     | --- Roads               |
| ● Lythrum salicaria    | ○ Pastinaca sativa      | ▲ Robinia pseudoacacia      |                    |                        |                         |

**Figure 3:**  
**Sheet 2 of 4**  
**Invasive Species Locations**  
**Beaver Island**  
**Charlevoix County, Michigan**

**October 2012**  
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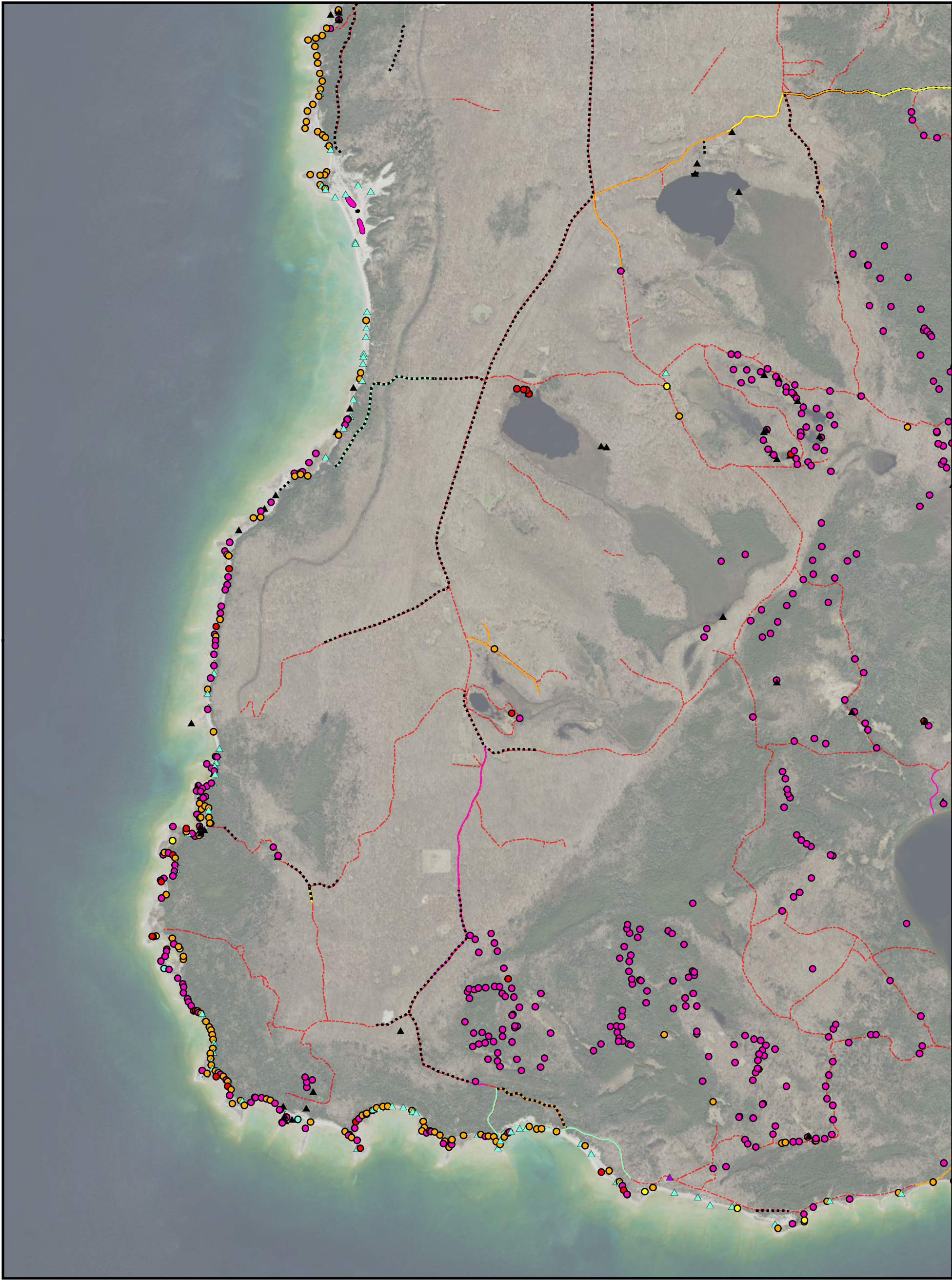
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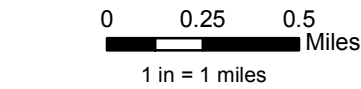
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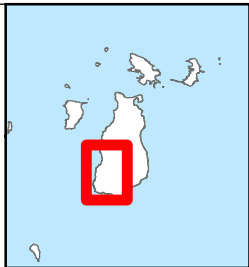
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| <ul style="list-style-type: none"><li>● <i>Phragmites australis</i></li><li>● <i>Centaurea maculosa</i></li><li>○ <i>Polygonum cuspidatum</i></li><li>● <i>Melilotus alba</i></li><li>● <i>Lythrum salicaria</i></li></ul> | <ul style="list-style-type: none"><li>● <i>Elaeagnus umbellata</i></li><li>● <i>Cirsium palustre</i></li><li>○ <i>Pinus sylvestris</i></li><li>○ <i>Pastinaca sativa</i></li></ul> | <ul style="list-style-type: none"><li>▲ <i>Gypsophila paniculata</i></li><li>▲ <i>Lonicera</i> spp.</li><li>▲ <i>Populus nigra</i> var. <i>italic</i></li><li>▲ <i>Alliaria petiolata</i></li><li>▲ <i>Robinia pseudoacacia</i></li></ul> | <ul style="list-style-type: none"><li>▲ <i>Silene vulgaris</i></li><li>▲ <i>Torilis japonica</i></li><li>▲ Other</li></ul> | <ul style="list-style-type: none"><li>— <i>Centaurea maculosa</i></li><li>— <i>Polygonum cuspidatum</i></li><li>— <i>Melilotus alba</i></li><li>— <i>Cirsium palustre</i></li></ul> | <ul style="list-style-type: none"><li>— <i>Celastrus orbiculatus</i></li><li>— <i>Silene vulgaris</i></li><li>..... Other</li><li>--- Roads</li></ul> |
|--|--|---|--|---|---|

**Figure 3:**  
**Sheet 3 of 4**  
**Invasive Species Locations**  
**Beaver Island**  
**Charlevoix County, Michigan**

**October 2012**  
**Job No. 1205129**



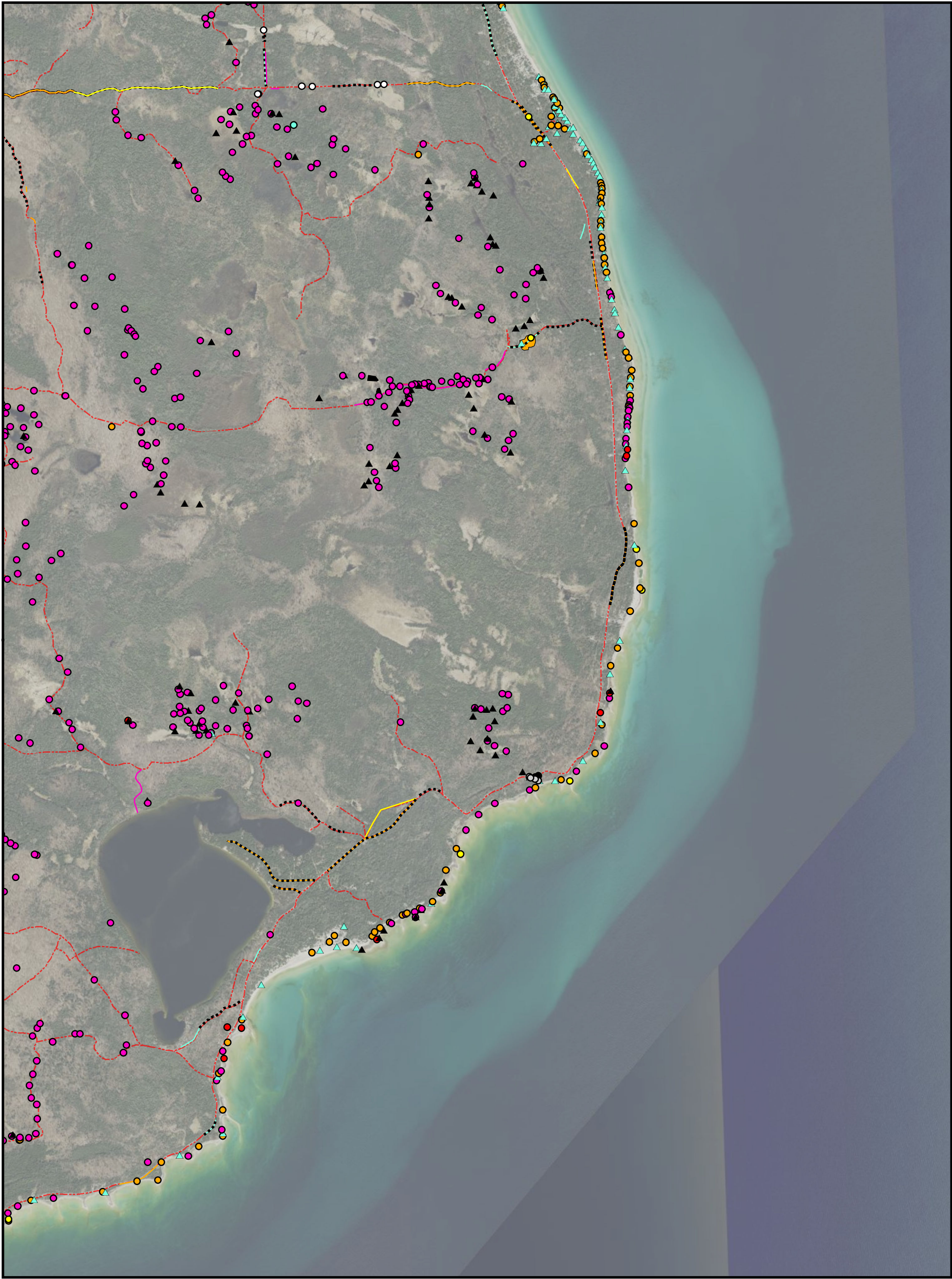
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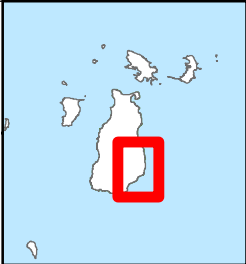
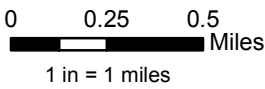


|   |  |   |  |   |   |
|---|--|---|--|---|---|
| <ul style="list-style-type: none"><li>● Phragmites australis</li><li>● Centaurea maculosa</li><li>○ Polygonum cuspidatum</li><li>● Melilotus alba</li><li>● Lythrum salicaria</li></ul> | <ul style="list-style-type: none"><li>● Elaeagnus umbellata</li><li>● Cirsium palustre</li><li>● Celastrus orbiculatus</li><li>○ Pinus sylvestris</li><li>○ Pastinaca sativa</li></ul> | <ul style="list-style-type: none"><li>▲ Gypsophila paniculata</li><li>▲ Lonicera spp.</li><li>▲ Populus nigra var. italic</li><li>▲ Alliaria petiolata</li><li>▲ Robinia pseudoacacia</li></ul> | <ul style="list-style-type: none"><li>▲ Silene vulgaris</li><li>▲ Torilis japonica</li><li>▲ Other</li></ul> | <ul style="list-style-type: none"><li>— Centaurea maculosa</li><li>— Polygonum cuspidatum</li><li>— Melilotus alba</li><li>— Cirsium palustre</li></ul> | <ul style="list-style-type: none"><li>— Celastrus orbiculatus</li><li>— Silene vulgaris</li><li>..... Other</li><li>--- Roads</li></ul> |
|---|--|---|--|---|---|

**Figure 3:**  
**Sheet 4 of 4**  
**Invasive Species Locations**  
**Beaver Island**  
**Charlevoix County, Michigan**

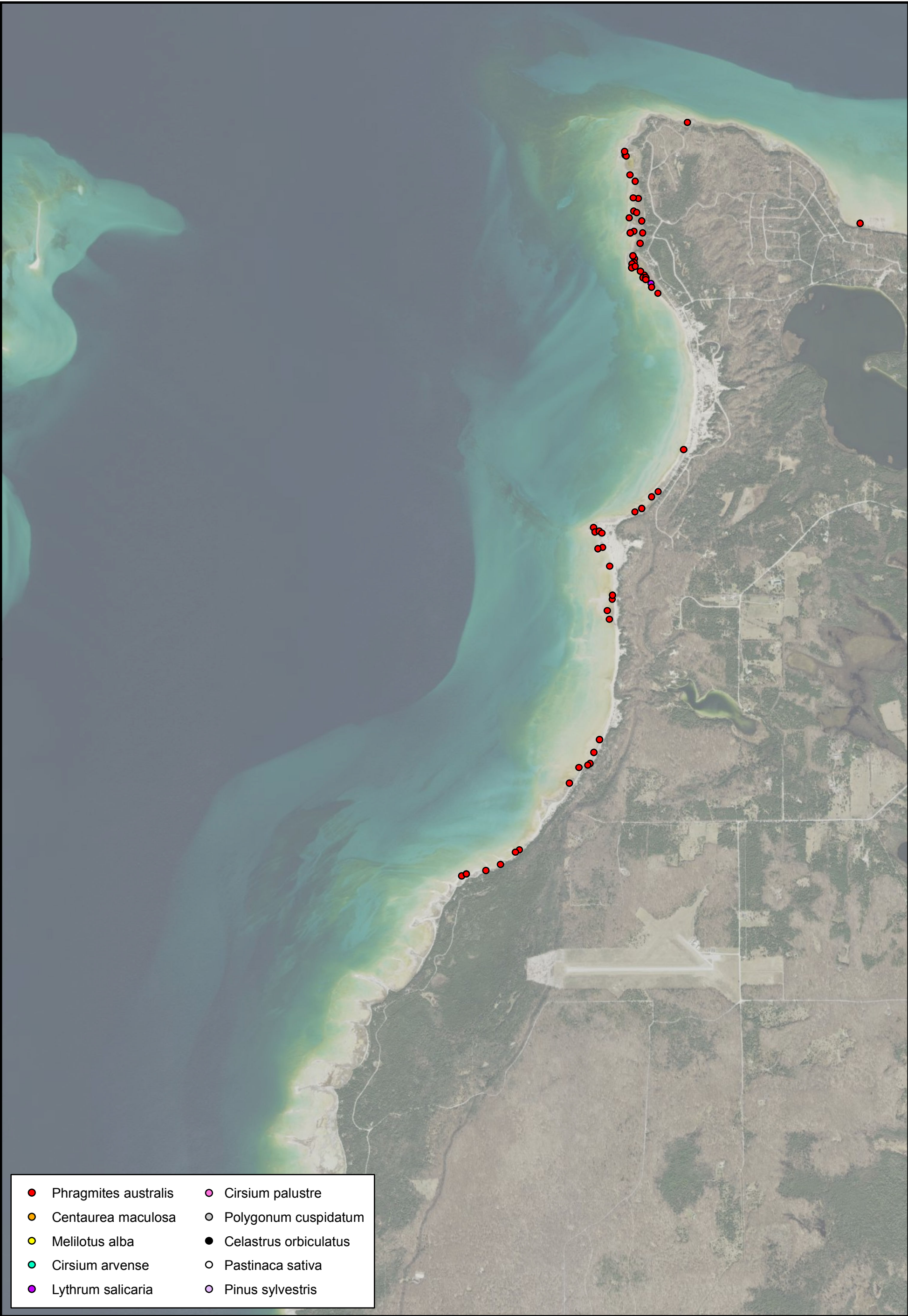
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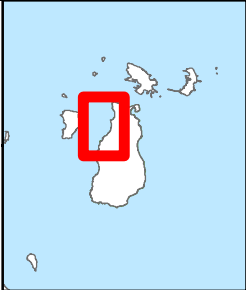


**Figure 4a:**  
**Sheet 1 of 4**  
**Invasive Species Treatment Areas**  
**Beaver Island**  
**Charlevoix County, Michigan**

**October 2012**  
**Job No. 1205129**

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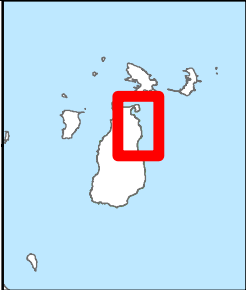
- |                        |                         |
|------------------------|-------------------------|
| ● Phragmites australis | ● Cirsium palustre      |
| ● Centaurea maculosa   | ● Polygonum cuspidatum  |
| ● Melilotus alba       | ● Celastrus orbiculatus |
| ● Cirsium arvense      | ● Pastinaca sativa      |
| ● Lythrum salicaria    | ● Pinus sylvestris      |

**Figure 4a:**  
**Sheet 2 of 4**  
**Invasive Species Treatment Areas**  
**Beaver Island**  
**Charlevoix County, Michigan**

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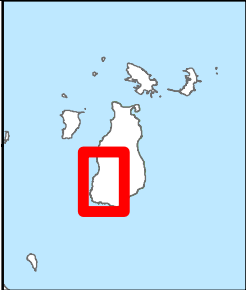


**Figure 4a:**  
**Sheet 3 of 4**  
**Invasive Species Treatment Areas**  
**Beaver Island**  
**Charlevoix County, Michigan**

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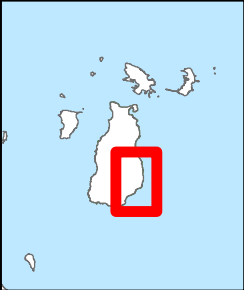




**Figure 4a:**  
**Sheet 4 of 4**  
**Invasive Species Treatment Areas**  
**Beaver Island**  
**Charlevoix County, Michigan**

**October 2012**  
**Job No. 1205129**

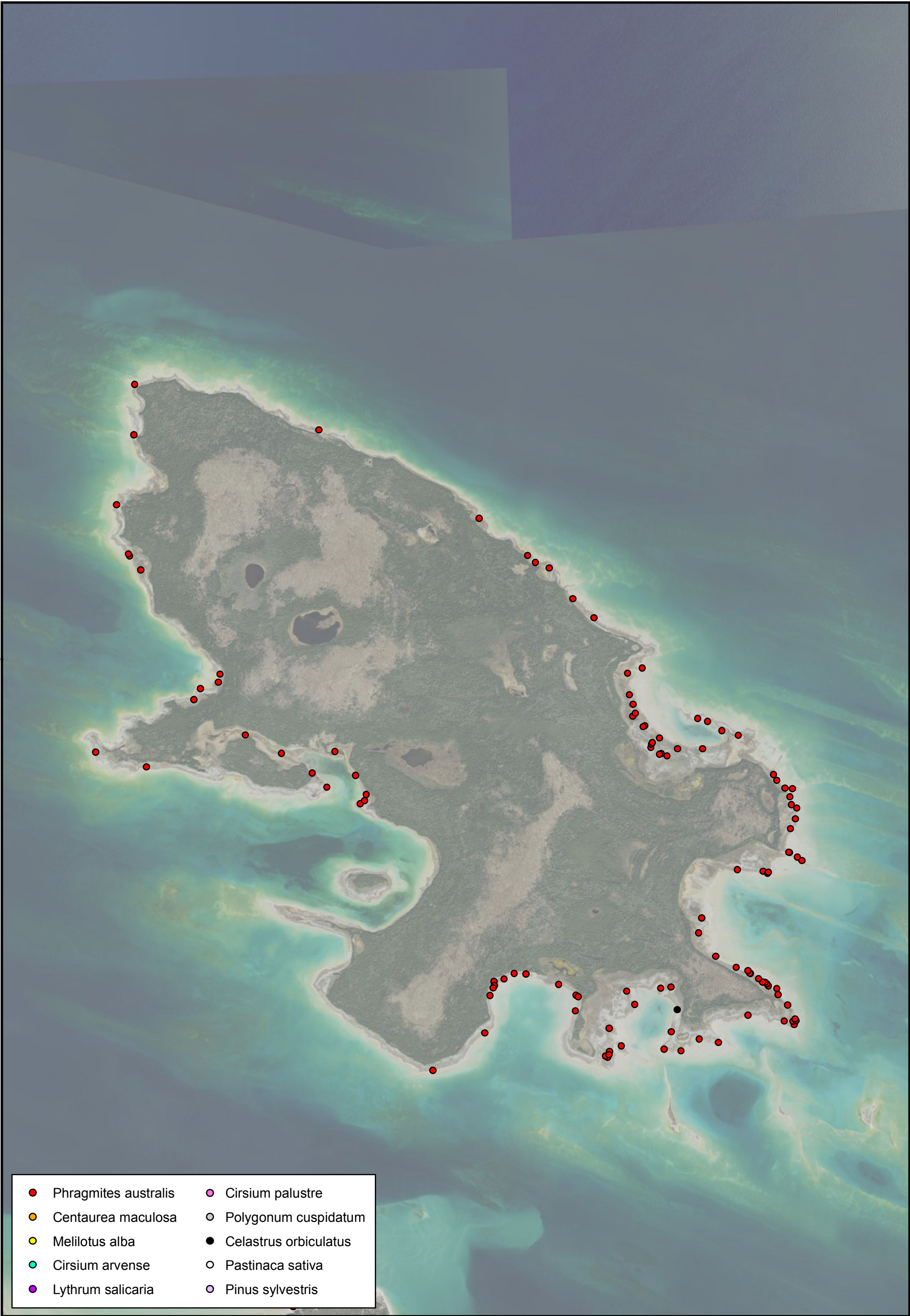
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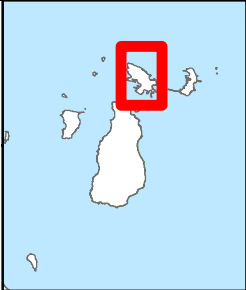


**Figure 4b:**  
**Invasive Species Treatment Areas**  
**Garden Island**  
**Charlevoix County, Michigan**

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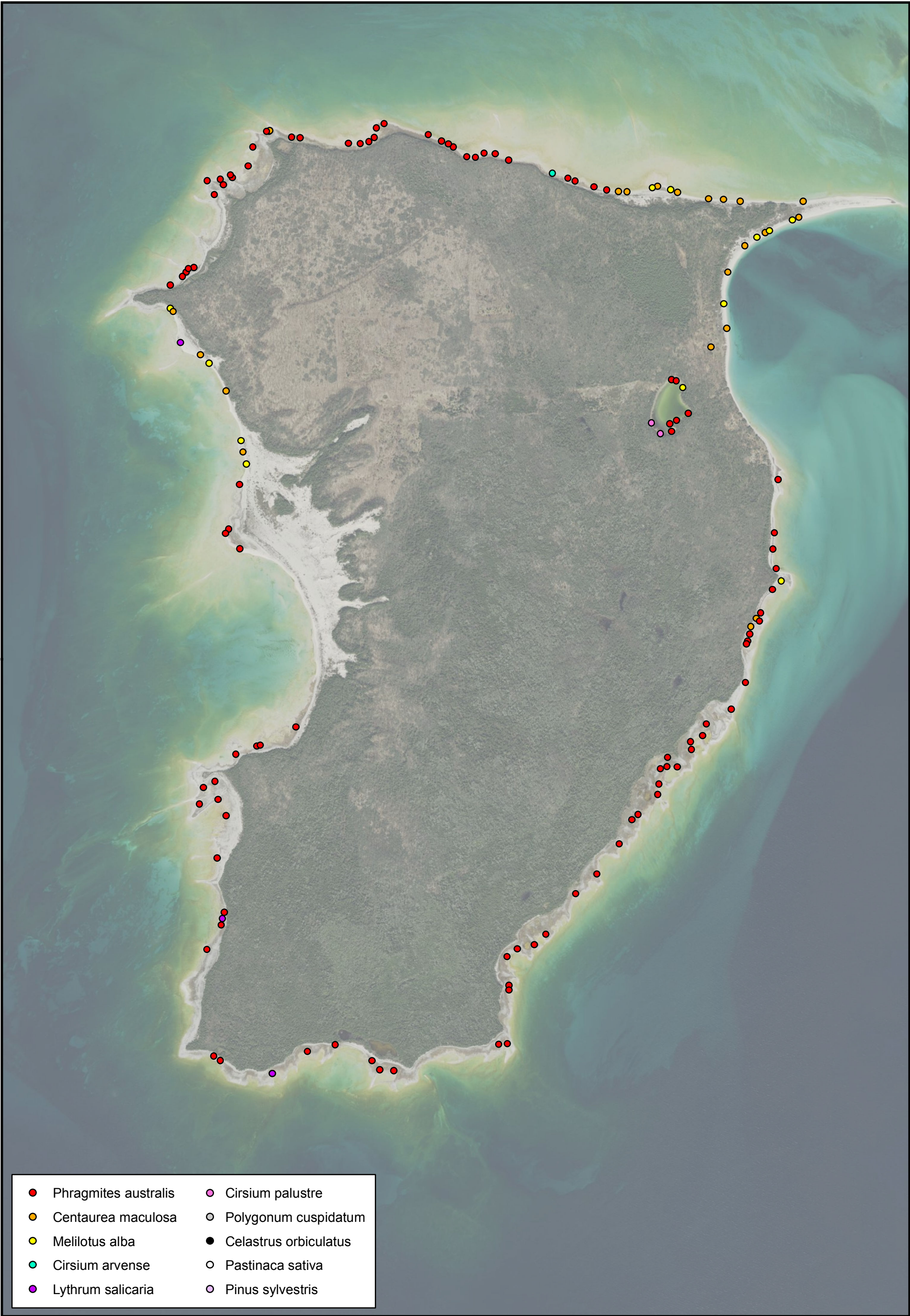
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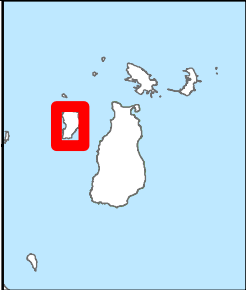


**Figure 4c:**  
**Invasive Species Treatment Areas**  
**High Island**  
**Charlevoix County, Michigan**

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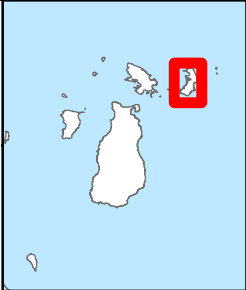


**Figure 4d:**  
**Invasive Species Treatment Areas**  
**Hog Island**  
**Charlevoix County, Michigan**

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