Reservoir Survey for Invasive and Native Aquatic Plants Species within the Pat Harrison Waterway District

Nelumbo lutea at Turkey Creek

A Report to the Pat Harrison Waterways District

Wilfredo Robles, John D. Madsen, and Victor L. Maddox
GeoResources Institute and Department of Plant and Soil Sciences
Mississippi State University
Box 9652
Mississippi State, MS 39762-9652
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Introduction

Invasive aquatic plants have been responsible for a variety of problems in water bodies worldwide. The introduction and growth of invasive aquatic plant species may impede boat traffic, increase susceptibility to flooding, and reduce biodiversity. Management of aquatic weeds costs over $100M each year in the United States (Pimentel et al. 2005). The least expensive approach to management of nuisance plants is to prevent their introduction through education, and respond rapidly to the first detection of their introduction.

The Pat Harrison Waterway is composed of nine water parks for recreational (e. g. boating and fishing) use located along the Pascagoula River Basin. Recreational use of water bodies is an important vector in the introduction and movement of new aquatic plant species (EPA 2007). For example, fragments of aquatic plants may tangle in boat propellers, allowing its spread between and within a water body.

An aquatic plant inventory performed in 1993 found that *Najas minor* and *Chara braunii* were commonly found in two of their water parks, Archusa Creek, and Little Black Creek (Wooten 1993). To date, limited information on aquatic plants exists for these water bodies, which prohibits informed recommendations on managing these lakes. One recommendation for enhancing the fisheries within each water park is to add fertilizer to the lakes. However, lakes within the Pat Harrison Waterway are already eutrophic (high nutrient concentration, MDEQ 2006). Adding more nutrients may lead increased algal blooms, reduced water clarity, unsafe swimming conditions, increased taste and odor of the water and fish, and reduction of "ecosystem stability" (Wetzel 2001).

In 2007, GeoResources Institute at Mississippi State University was contracted to survey six water bodies administered by the Pat Harrison Waterway District and to provide recommendations of aquatic plant management. The following aquatic plant survey is intended to inventory exotic invasive and native aquatic plants as well as to make recommendations for weed management. Results from these surveys may also provide useful information for other lake recreational activities.

Methodology

Survey location description

The Pat Harrison Waterway is composed of nine man-made lakes for recreational use. All are impounded by a dam and located along the Pascagoula River Basin. Only six were surveyed (Figure 1):

Archusa Creek Water Park is a 430 acre lake located in Quitman, Clarke County, Mississippi (latitude 32.033861; longitude -88.714065). Date surveyed: July 12, 2007.

Big Creek Water Park is a 70 acre lake located in Soso, Jones County, Mississippi (latitude 31.6859; longitude -89.342373). Date surveyed: August 24, 2007.

Flint Creek Water Park is a 530 acre lake located in Wiggins, Stone County, Mississippi (latitude 30.884268; longitude -89.130147). Date surveyed: July 13, 2007.

Little Black Creek Water Park is a 516 acre lake located in Lumberton, Lamar County, Mississippi (latitude 31.088341; longitude -89.495871). Date surveyed: August 23, 2007.

Maynor Creek Water Park is a 381 acre lake located in Waynesboro, Wayne County, Mississippi (latitude 31.654393; longitude -88.716559). Date surveyed: September 12, 2007.

Turkey Creek Water Park is a 225 acre lake located in Decatur, Newton County, Mississippi (32.408868; longitude -89.161553). Date surveyed: September 12, 2007.

Secchi disk and chlorophyll *a* measurements were acquired at each water body to describe water quality. Chlorophyll *a* readings were taken using a handheld fluorometer that estimates phytoplankton biomass (Wetzel and Likens 2000). Secchi disk readings provide an estimate of water transparency (Wetzel and Likens 2000).

Aquatic vegetation surveys

One lake-wide survey at each water body was conducted using a point-intercept sampling method (Madsen 1999). Survey point locations for each water body are depicted in Figures 2-7. A summary of lake size and survey point spacing is provided in Table 1. Using ArcGIS software (ESRI 2005), a grid of points was placed over the entire lake (Figures 2-7). This information is transferred into a hand-held personal digital assistant (PDA) with GPS capability. The GPS provides geographic coordinates (latitude and longitude) information for each survey point. Once the survey point information is in the PDA, Farm Works® Farm Site Mate software is used to load survey point information and navigate sequentially to each point. Pick lists of aquatic plant species were created in the PDA prior to the survey and represents the attributes for each survey point. Aquatic plant species present at each survey point were recorded with the PDA in the following format: 1 when the species was present and 0 when the species was absent. At the end of each survey, each point provides information of aquatic plant species presence and absence as well as their geographic coordinates.

Documenting diversity and area coverage of aquatic vegetation

For each aquatic plant species, points labeled as 1 were added to obtain their total count points. The following formula was used to determine the percent (%) of aquatic plant species frequency occurrence in the survey:

% Frequency occurrence = (total points present / total points surveyed) * 100.

The estimated area covered in acres for each aquatic plant species was calculated by multiplying the total points where a particular species was found by their respective plant coverage estimator factor (PCEF) (Table 1). The PCEF is calculated by converting survey point spacing at a particular water body to acres.

Results

Lake-wide aquatic plant survey

A comparison between total points and total points surveyed is presented in Table 1. At Maynor Creek Water Park; approximately 50% of the original points were actually surveyed due to low water. A total of 29 aquatic plant species, including the two macrophytic algae *Chara* sp. and *Nitella* sp., were found among all six lakes surveyed (Table 3-7). Among the 29 species found, only four are considered invasive. Although none of these exotic invasive species are listed on the federal or state noxious weed list, a management plan should be developed that is designed to avoid further spread. The following is a brief description of each water body surveyed and further descriptive information of each exotic invasive plant and management recommendations are provided. Water quality results are described in Table 2 for each lake.

Archusa Creek Water Park. The most common species found was the macrophytic alga, *Nitella* sp., followed by the exotic *Najas minor* (Table 3, Figure 8). Neither of these species were topped out nor posed a nuisance problem at the time of the survey. Another less frequent exotic found was *Myriophyllum aquaticum* growing among dense stands of the native *Panicum hemitomon*. Both invasive aquatic species found were previously reported to the Pat Harrison Waterway District in 1989 (Eubanks 1989).

Flint Creek Water Park. The most common species found was the native *Eleocharis vivipara* (Table 4). The exotic, *Alternanthera philoxeroides* was found at the boat ramp located in the northeastern portion of the lake (Figure 9). Although this location was not part of the lake-wide survey it was reported immediately due its threat of spread facilitated by boat movement within the water body. The native, *Bacopa caroliniana* was found covering entire coves in the northwestern portion of the lake.

Turkey Creek Water Park. The most common species found were the native floating-leaved species, *Brasenia schreberi* and *Nymphaea odorata* (Table 5). The exotic submersed, *Najas minor* was found at a low frequency occurrence of 2.44 (Table 5, Figure 10).

Big Creek Water Park. The most common species found was the macrophytic alga, *Chara* sp. (Table 6). The native *Eleocharis vivipara* and the exotic *Alternanthera philoxeroides* both had a 7.8 % frequency of occurrence (Table 6, Figure 11). Most of the aquatic plant species in this lake were components of the shoreline vegetation with the exception of *Chara* sp. which composed benthic vegetation.

Maynor Creek Water Park. This lake was severely affected by the extreme drought of 2007 in the southern states. Administrative personnel of this lake indicated that the water was 8 feet below the normal level in the month of August. Consequently, most of the shoreline vegetation died due to the lack of water. Also, most survey point locations in areas with water were not reached because the area was too shallow to navigate with a boat. At the end of the survey, no aquatic vegetation was recorded although the presence of many aquatic species were previously reported (Eubanks 1989).

Little Black Creek Water Park. The most common species found was the native *Myriophyllum pinnatum* (Table 7). This species was very common and topped out in coves throughout the lake. The exotic, *Panicum repens* was commonly found on lake margins as part of shoreline vegetation (Figure 12). *Najas minor*, another invasive plant, was found at a low frequency of occurrence (Table 7).

Invasive aquatic plants description and control methods

1. *Alternanthera philoxeroides* (Mart.) Griseb.

Alligatorweed
Photo by Ryan M. Wersal

Description – Commonly known as alligatorweed, it is an herbaceous perennial which is commonly found along shorelines. It has opposite simple linear leaves with a whitish inflorescence growing from leaf axils. Its growth form is emergent attached to the sediment. Stems can creep over the water, produce adventitious root and anchor in the sediment which consequentially facilitates its spread. A distinctive morphological characteristic is having a hollow stem which provides buoyancy. Alligatorweed has been implicated in the reduction of light penetration in the water column adversely affecting native submersed plant growth (Cronk and Fennessy 2001). See Table 8 for plant locations and its geographic coordinates.

Control Methods – The use of biological and chemical control in an integrated management approach has been recommended for alligatorweed (Durden et al. 1975). The most effective biocontrol agent is the flea beetle, *Agasicles hygrophila* which is well established in southern states. However, biocontrol alone is not a long term solution and should be alternated with chemical control. Currently, alligatorweed is not widespread in Flint and Big Creek and is mainly located at boat ramps and small coves. This means that chemical control using spot treatments of herbicides is the most reliable control method. The herbicide 2, 4-D at a rate of 2 quarts of product per acre foliar applied has been recommended for alligatorweed control (Durden et al. 1975, Table 9 and 10). In the state of Florida, an application of 2, 4-D per acre costs $98.50 (Mossler and Langeland 2006). It is important to know that 2, 4-D does not have restrictions for recreational use (e. g. swimming) which is good for this water body (Table 9).

2. *Myriophyllum aquaticum* (Vell.) Verdc.

Parrotfeather
Photo by Ryan M. Wersal.
Description – Commonly know as parrotfeather, is a submersed plant attached to the sediment and able to emerge from the water. This characteristic facilitates its growth providing better light interception and gas exchange. Leaves are dissected, featherlike and arranged in whorls around the stem with a distinctive grayish green color. Emergent portions can creep over the water, produce adventitious roots and anchor in the sediment which consequentially facilitates its spread. Parrotfeather has been implicated in providing refuge for mosquito breeding, and chokes water bodies limiting water flow (Wersal and Madsen 2007a). See Table 8 for plant locations and its geographic coordinates.

Control Methods – Biological, chemical and mechanical control are suggested alternatives for parrotfeather control. However without promising effectiveness, chemical control is the only effective measure (Wersal and Madsen 2007a). Herbicide recommendations and water use restrictions are shown in Table 9 and 10. Since populations of parrotfeather at Archusa Creek are as low as 1.39 % frequency occurrence, spot treatments with imazapyr are recommended. Although other herbicides are recommended (Table 10), imazapyr has shown excellent results in reducing plant biomass (Wersal and Madsen 2007b). Spot treatments of imazapyr should be carefully done because non-target vegetation such as grasses may be injured.

3. *Panicum repens* L.
Torpedograss
Photo by Victor L. Maddox.
Description – Commonly known as torpedograss, it is a perennial rhizomatous graminoid commonly found along shorelines. It has glabrous leaf blades (no hairs) and flowers are contained in a panicle. Stems can reach up to 2.5 feet tall and surface runners form solid colonies facilitating its establishment and spread. Torpedograss has been implicated in displacing native aquatic vegetation and infesting golf courses (Langeland and Craddock Burks 1998).

Control Methods – Control programs for torpedograss should use recommended herbicides (Table 10). In the state of Florida, an application of glyphosate costs $120.00 per acre (Mossler and Langeland 2006). Spot treatments of glyphosate in Little Black Creek should be carefully done because non target vegetation such as grasses may be injured.

Recommendations

1. Perform spot treatments with herbicides for exotic aquatic plant control. Applications must be done in spring or early summer during active plant growth for better efficacy. Repeat treatments when necessary.

2. Avoid the addition of nutrients to the water body. The trophic state of these lakes is eutrophic, meaning that the system has a high nutrient loading rate. The addition of more nutrients may lead to algal blooms that consequentially promote bad odor and high turbidity in the systems. Water clarity in some of these lakes is already marginal for safe swimming, boating, or water skiing according to some state and U.S. Environmental Protection Agency standards (Madsen et al. 1999).

3. Do not add lime or fertilizer to the six water bodies. Aquatic plant assemblages at the discussed water bodies are considered diverse; composed by numerous native species and none where observed to form monotypic cultures. This means that all six water bodies may provide suitable habitat for fish spawning and shelter which consequentially sustain their populations. Aquatic plants provide habitat for fish and fish spawning. Loss of aquatic plants may lead to long-term degradation in water quality.

Table 1. Survey point intensity and plant coverage estimator factor used for each water body. PCEF = Plant coverage estimator factor.

Water body	Size (Acres)	Survey point spacing (meters)	Original total points to survey	Total points surveyed	PCEF (Acres / Point)
Archusa	430	150	72	72	5.56
Big	70	50	117	64	0.61
Flint	530	200	54	53	9.88
Little Black	516	150	89	87	5.56
Maynor	381	150	70	31	5.56
Turkey	225	100	87	82	2.47

Table 2. Water quality parameters measured at each water body.

Water body	Chlorophyll *a*	Secchi disk (meters)
Archusa	3.53	1.5
Big	7.19	0.91
Flint	4.64	1.92
Little Black	2.57	1.44
Maynor	6.59	0.63
Turkey	4.66	1.34

Table 3. Aquatic plant species present in Archusa Creek Water Park, Clarke County, MS. Growth forms are represented by: FL = floating-leaved, FF = free-floating, S = submerged, E = emergent.

Species	Common Name	Growth form	Native or Exotic	Frequency occurrence (%)	Area coverage (acres)
Nymphaea odorata	American white waterlily	FL	native	1	6
Potamogeton diversifolius	waterthread pondweed	FL	native	21	83
Myriophyllum aquaticum	parrotfeather	E/S	exotic	1	5
Panicum hemitomon	maidencane	E	native	1	5
Najas minor	brittle naiad	S	exotic	35	139
Ceratophyllum demersum	coontail	S	native	7	28
Hydrocotyle ranunculoides	floating marsh pennywort	E	native	1	6
Brasenia schreberi	watershield	FL	native	3	11
Nitella sp.	stonewort	S	native	36	145
Potamogeton pusillus	small pondweed	FL	native	18	72
Eleocharis vivipara	viviparous spikerush	E/S	native	4	17
Juncus repens	lesser creeping rush	E/S	native	1	6
Juncus effusus	common rush	E	native	1	6

Table 4. Aquatic plant species present in Flint Creek Water Park, Stone County, MS. Growth forms are represented by: FL = floating-leaved, FF = free-floating, S = submerged, E = emergent. * Frequency occurrence and area coverage was not estimated because this location was not included in the lake-wide survey.

Species	Common Name	Growth form	Native or Exotic	Frequency occurrence (%)	Area coverage (acres)
Potamogeton pusillus	small pondweed	FL	native	2	10
Eleocharis vivipara	viviparous spikerush	E/S	native	21	109
Juncus repens	lesser creeping rush	E/S	native	6	30
Alternanthera philoxeroides	alligatorweed	E	exotic	*	*
Bacopa caroliniana	blue waterhyssop	E/S	native	6	30

Table 5. Aquatic plant species present in Turkey Creek Water Park, Newton County, MS. Growth forms are represented by: FL = floating-leaved, FF = free-floating, S = submerged, E = emergent.

Species	Common Name	Growth form	Native or Exotic	Frequency occurrence (%)	Area coverage (acres)
Nymphaea odorata	American white waterlily	FL	native	21	42
Potamogeton diversifolius	waterthread pondweed	FL	native	1	2
Najas minor	brittle naiad	S	exotic	2	5
Brasenia schreberi	watershield	FL	native	18	37
Chara sp.	muskgrass	S	native	10	20
Nelumbo lutea	American lotus	FL	native	2	5

Table 6. Aquatic plant species present in Big Creek Water Park, Jones County, MS. Growth forms are represented by: FL = floating-leaved, FF = free-floating, S = submerged, E = emergent.

Species	Common Name	Growth form	Native or Exotic	Frequency occurrence (%)	Area coverage (acres)
Ludwigia peploides	floating primrose-willow	E	native	6	2
Alternathera philoxeroides	alligatorweed	E	exotic	8	3
Eleocharis vivipara	viviparous spikerush	E/S	native	8	3
Sagittaria platyphylla	delta arrowhead	E	native	3	1
Hydrolea uniflora	oneflower false fiddleleaf	E	native	2	1
Pluchea camphorata	camphor pluchea	E	native	2	1
Cephalanthus occidentalis	common buttonbush	E	native	2	1
Sacciolepis striata	American cupscale	E	native	2	1
Chara sp.	muskgrass	S	native	55	22

Table 7. Aquatic plant species present in Little Black Creek Water Park, Lamar County, MS. Growth forms are represented by: FL = floating-leaved, FF = free-floating, S = submerged, E = emergent.

Species	Common Name	Growth form	Native or Exotic	Frequency occurrence (%)	Area coverage (acres)
Nymphaea odorata	American white waterlily	FL	native	1	6
Potamogeton diversifolius	waterthread pondweed	FL	native	4	22
Najas minor	brittle naiad	S	exotic	1	6
Ceratophyllum demersum	coontail	S	native	10	50
Myriophyllum pinnatum	cutleaf watermilfoil	S	native	54	267
Eleocharis vivipara	viviparous spikerush	E/S	native	37	183
Nitella sp.	stonewort	S	native	2	11
Brasenia schreberi	watershield	FL	native	11	56
Juncus effusus	common rush	E	native	1	6
Scirpus cyperinus	woolgrass	E	native	1	6
Utricularia macrorhiza	common bladderwort	S	native	22	111
Panicum repens	torpedograss	E	exotic	7	33
Peltandra virginica	green arrow arum	E	native	2	11
Saccharum giganteum	sugarcane plumegrass	E	native	1	6

Table 8. Geographic coordinates for exotic invasive plant species.

Species	Water body	Latitude	Longitude
Alternanthera philoxeroides	Flint Creek	30.896651	-89.123700
	Big Creek	31.685432	-89.339827
		31.686867	-89.339980
		31.686233	-89.341132
		31.681488	-89.342360
		31.681358	-89.342818
Panicum repens	Little Black Creek	31.084660	-89.486357
		31.092910	-89.485008
		31.094038	-89.492923
		31.084733	-89.494487
		31.091268	-89.497670
		31.085903	-89.503920
Myriophyllum aquaticum	Archusa Creek	32.029140	-88.711133
Najas minor	Archusa Creek	32.033117	-88.706632
		32.033167	-88.704990
		32.034400	-88.708145
		32.035923	-88.706683
		32.037140	-88.708245
		32.038530	-88.708395
		32.038525	-88.709888
		32.039792	-88.710110
		32.042493	-88.709915
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		32.042532	-88.706808
		32.043930	-88.706857
		32.045230	-88.708378
		32.046563	-88.708452
		32.047940	-88.708525
		32.048017	-88.710005
		32.036973	-88.709735
		32.035840	-88.711460
		32.035847	-88.714585
		32.034312	-88.714570
		32.031707	-88.712748
		32.031663	-88.711255
		32.030362	-88.711313
		32.024950	-88.715978
		32.027770	-88.715890
	Turkey Creek	32.417635	-89.164173
		32.411643	-89.165303
	Little Black Creek	31.087103	-89.502352

Table 9. Comparisons of herbicide costs of application and water restrictions. Adapted from MAFES (2007).

Herbicide	Water Use Restrictions			
	Days			
	Swimming	Drinking	Fish Consumption	Irrigation
2,4-D	0	21	-	21
Glyphosate	0	0	0	0
Diquat	0	1-3	0	1-5
Triclopyr	0	0	0	120
Imazapyr	0	2	0	120

Table 10. Recommended herbicide rates for target exotic aquatic plants.

Aquatic plants	**Herbicides**				
	Glyphosate	Imazapyr	2,4-D	Diquat	Triclopyr
	Rates (qt/A)				
alligatorweed	3	2	2	-	3-8
parrotfeather	2-5	1-3	2-4	8	3-8
torpedograss	3.5	2	-	-	-

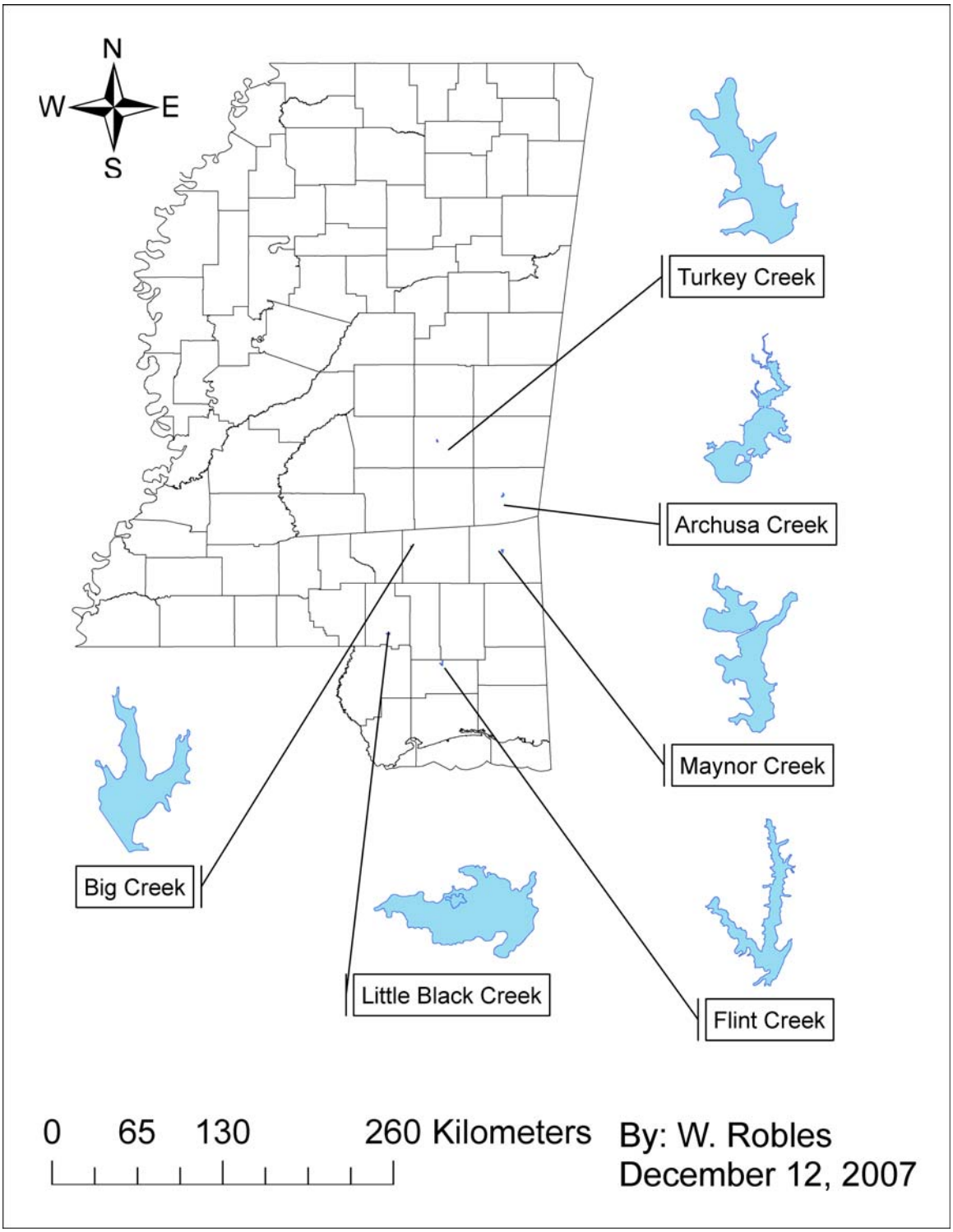

Figure 1. Reference locations of the six waterbodies surveyed within the Pat Harrison Waterway District in the state of Mississippi.

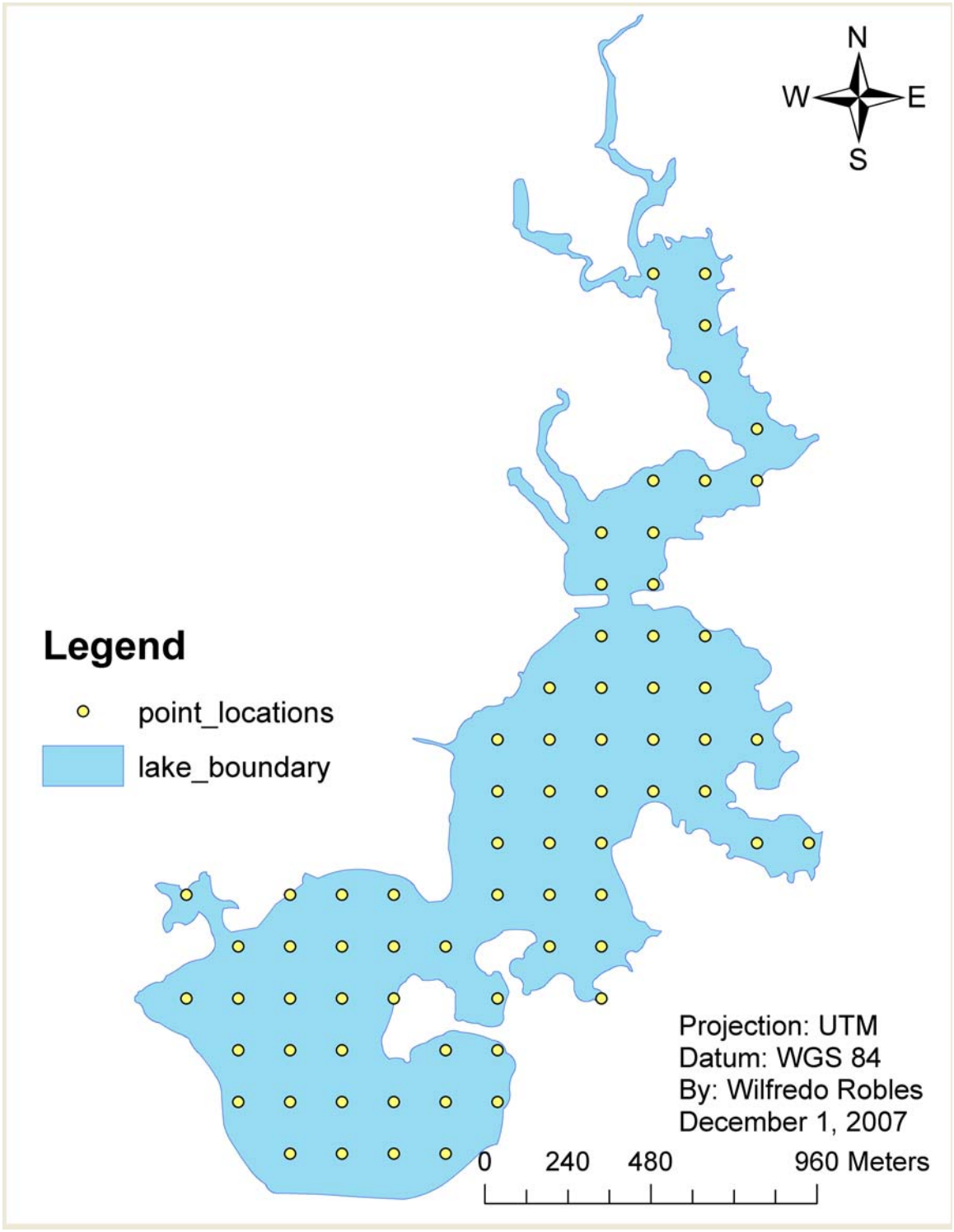

Figure 2. Point-intercept survey locations in Archusa Creek Water Park, MS.

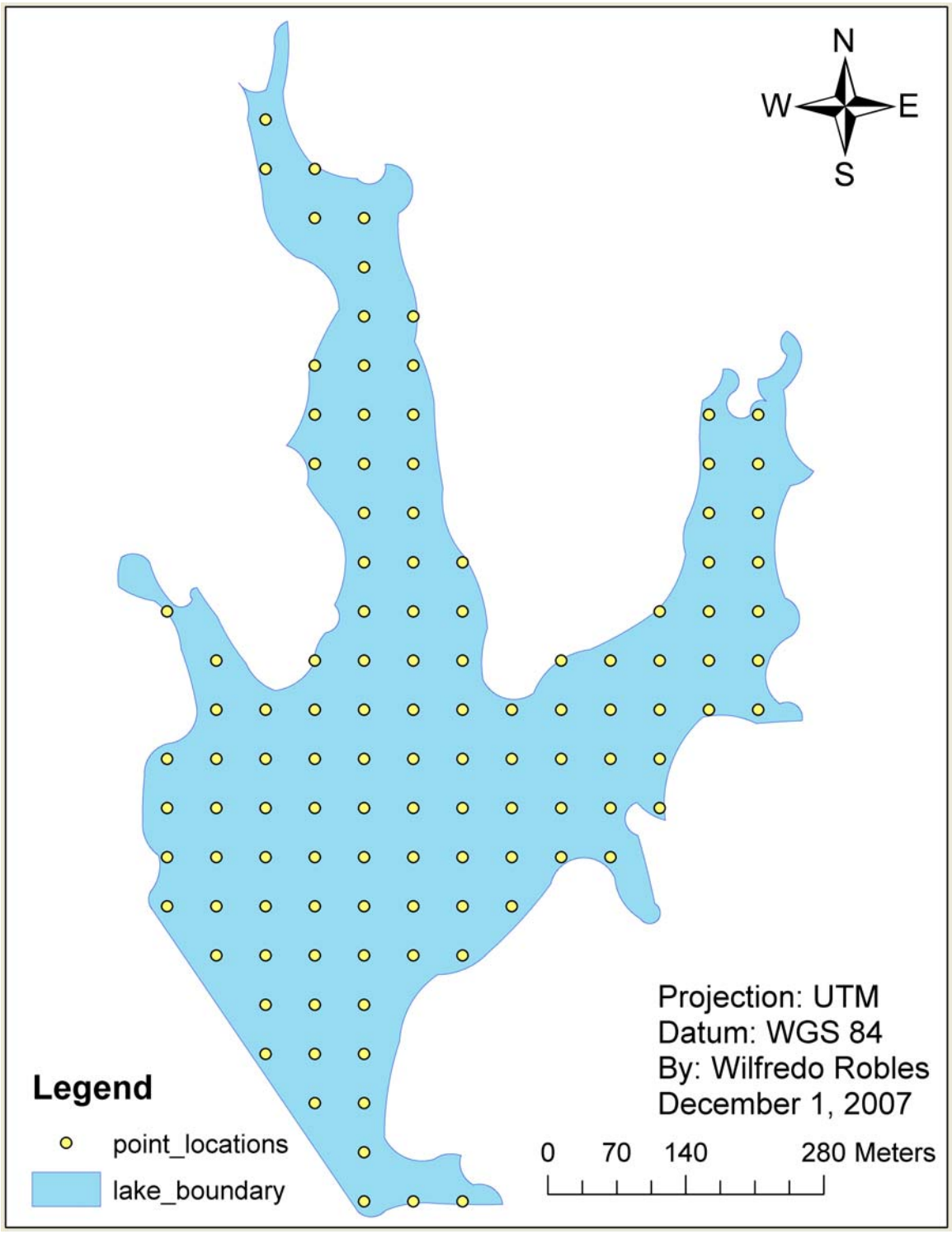

Figure 3. Point-intercept survey locations in Big Creek Water Park, MS.

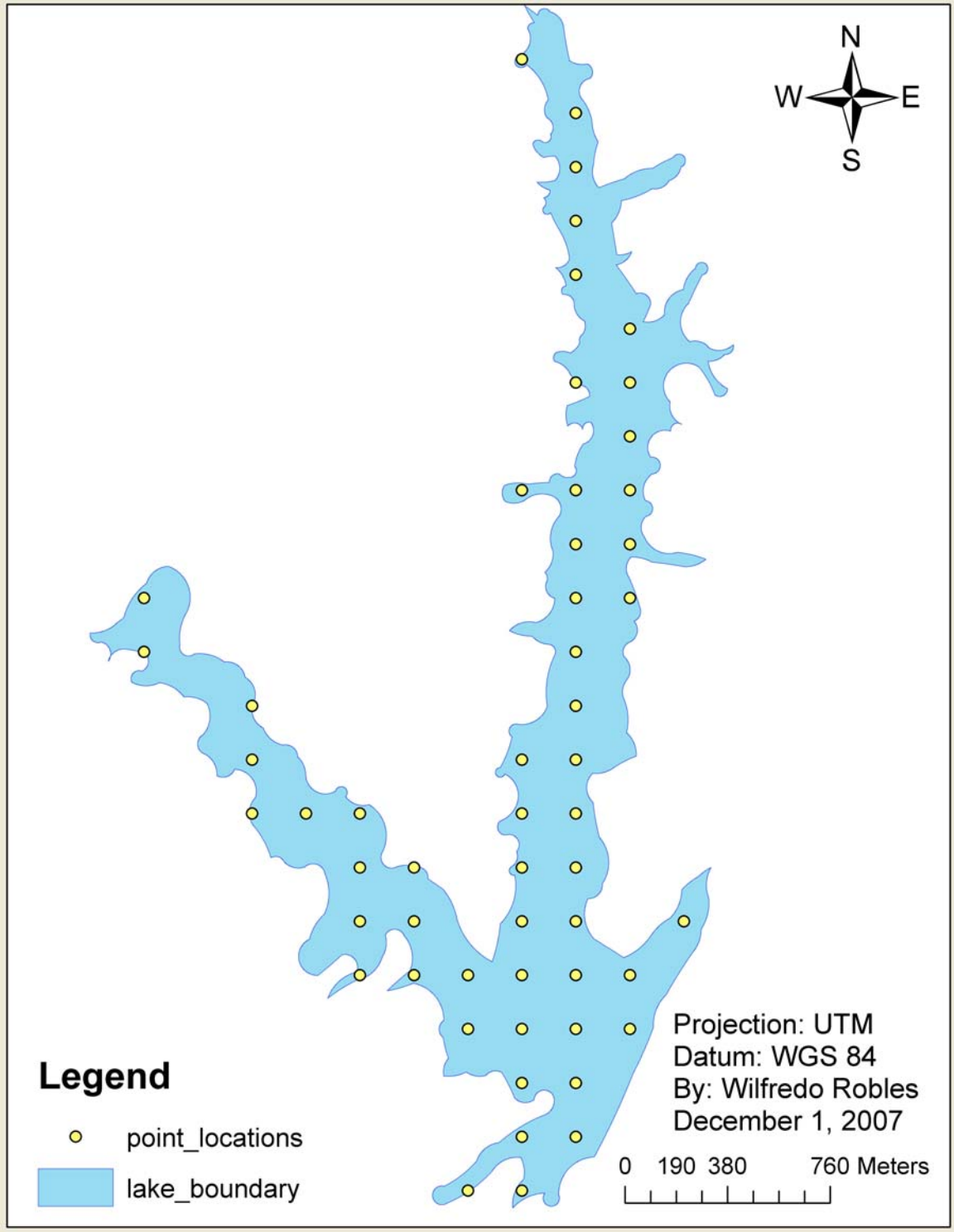

Figure 4. Point-intercept survey locations in Flint Creek Water Park, MS.

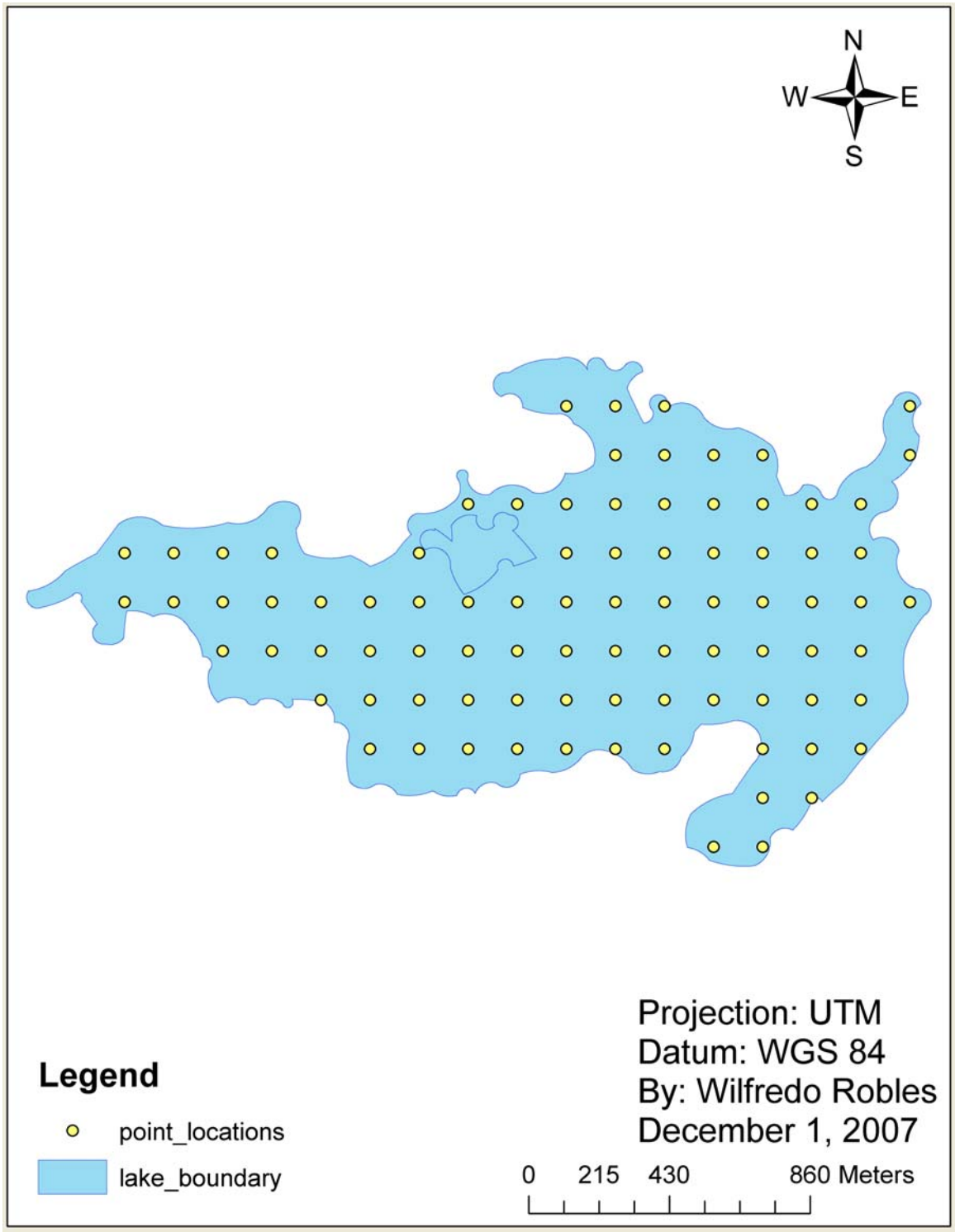

Figure 5. Point-intercept survey locations in Little Black Creek Water Park, MS.

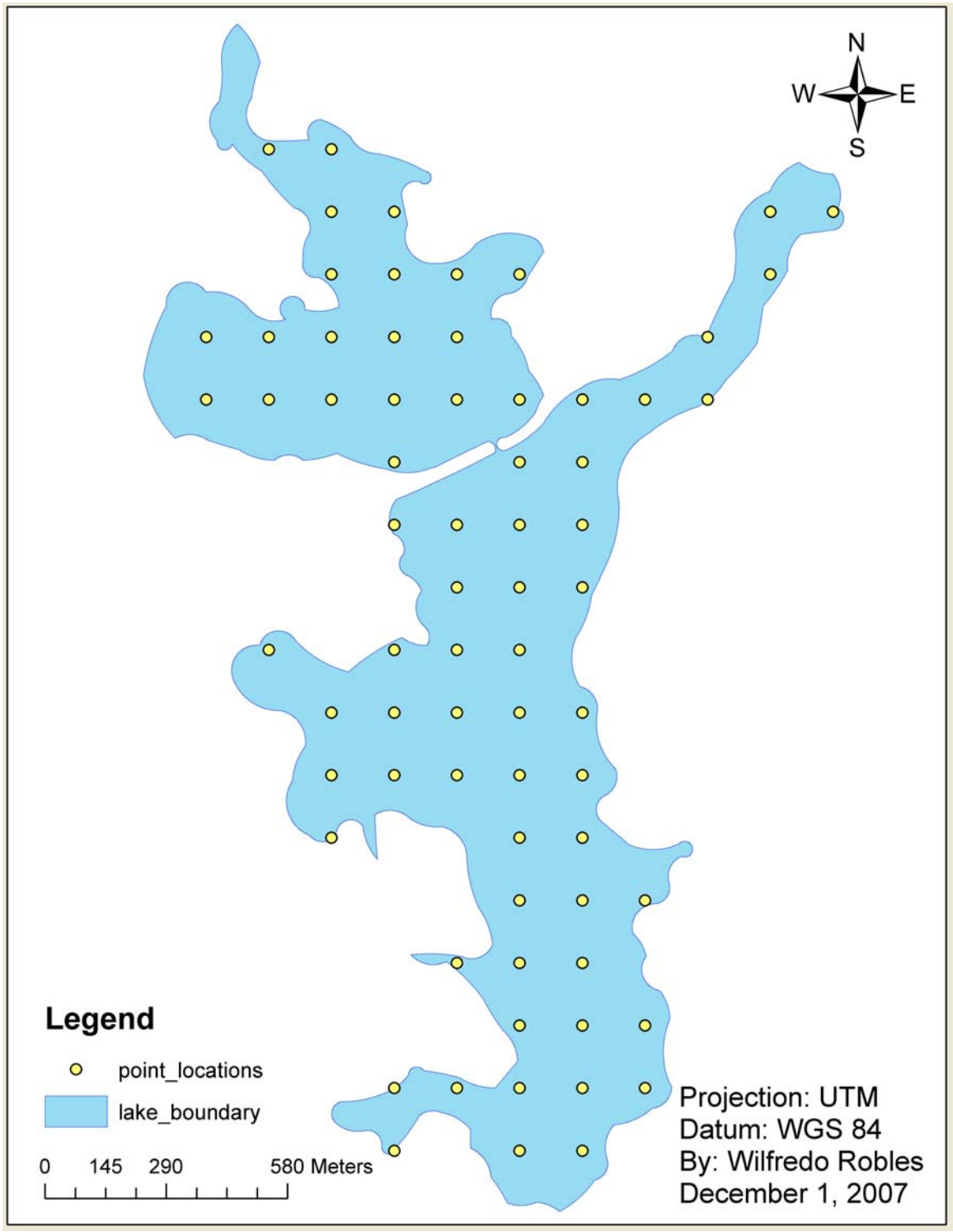

Figure 6. Point-intercept survey locations in Maynor Creek Water Park, MS.

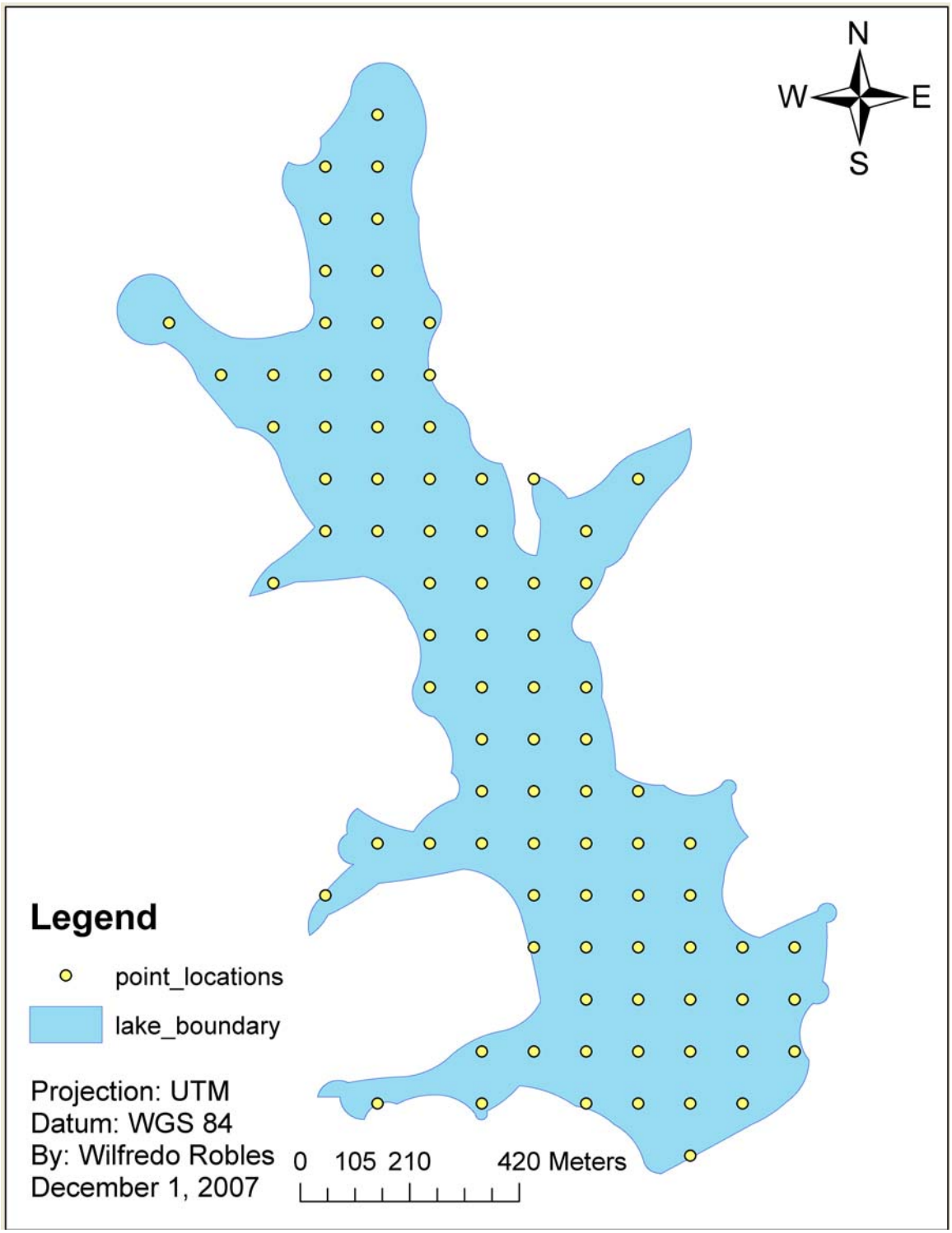

Figure 7. Point-intercept survey locations in Turkey Creek Water Park, MS.

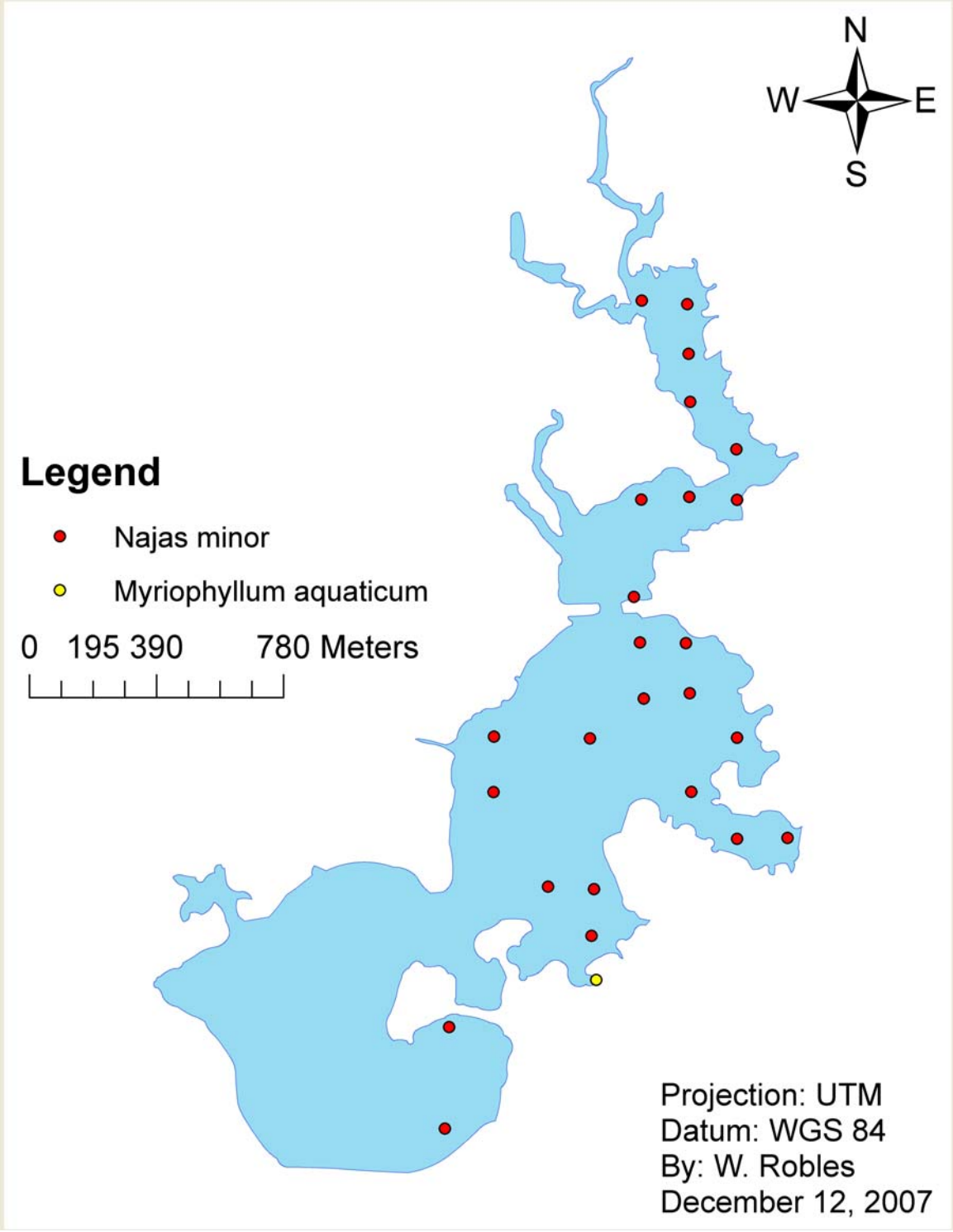

Figure 8. Locations of exotic invasive plant species in Archusa Creek

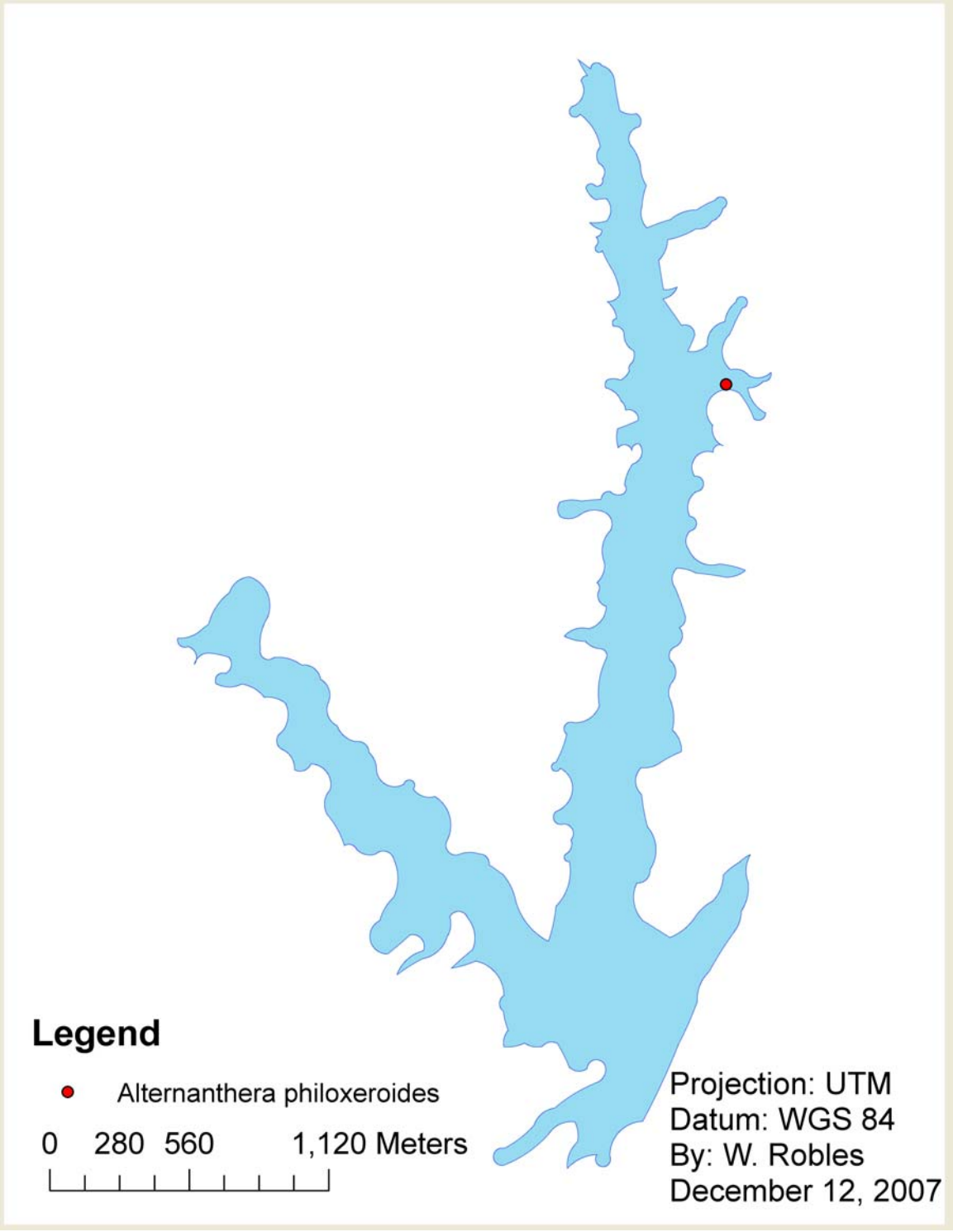

Figure 9. Locations of exotic invasive plant species in Flint Creek

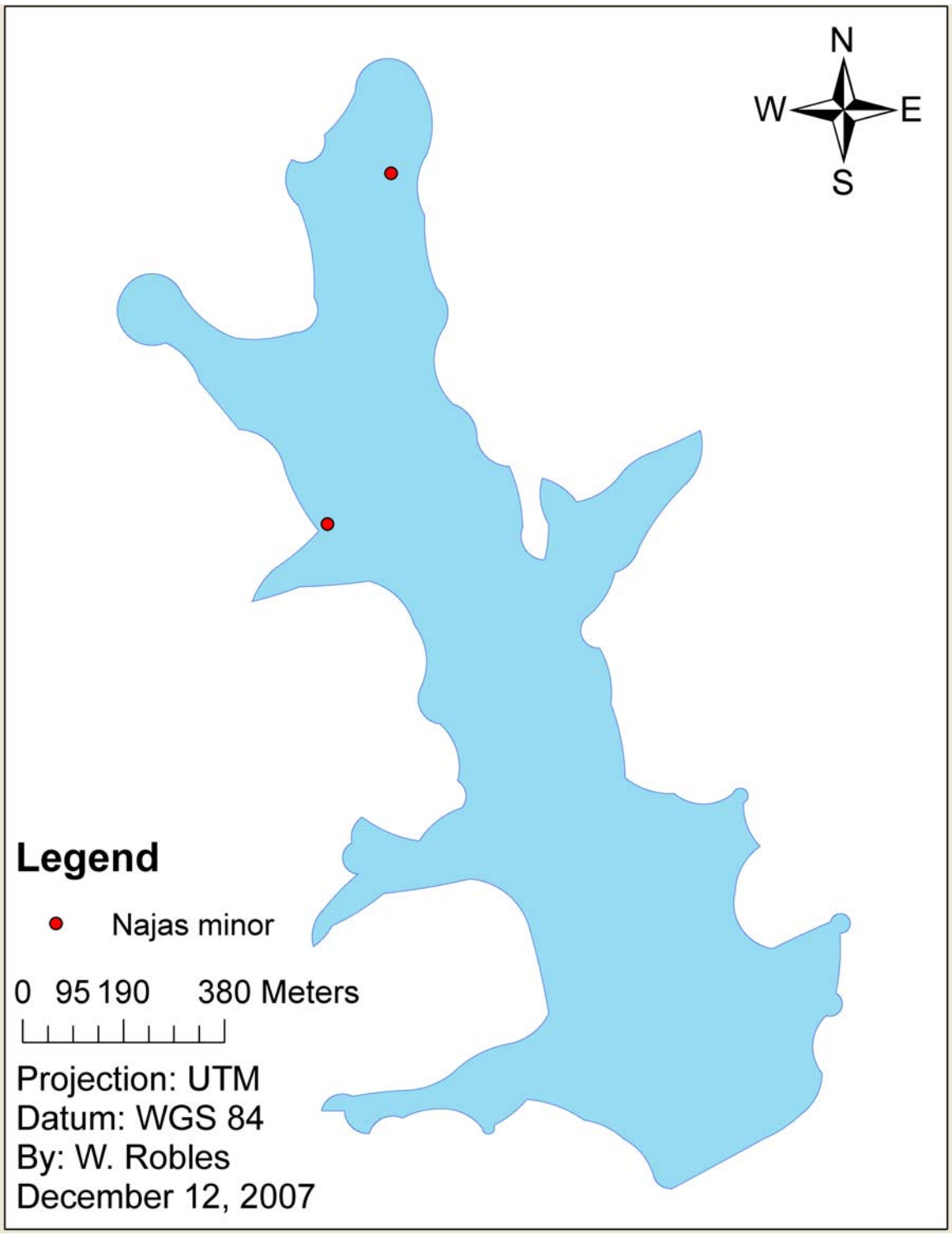

Figure 10. Locations of exotic invasive plant species in Turkey Creek

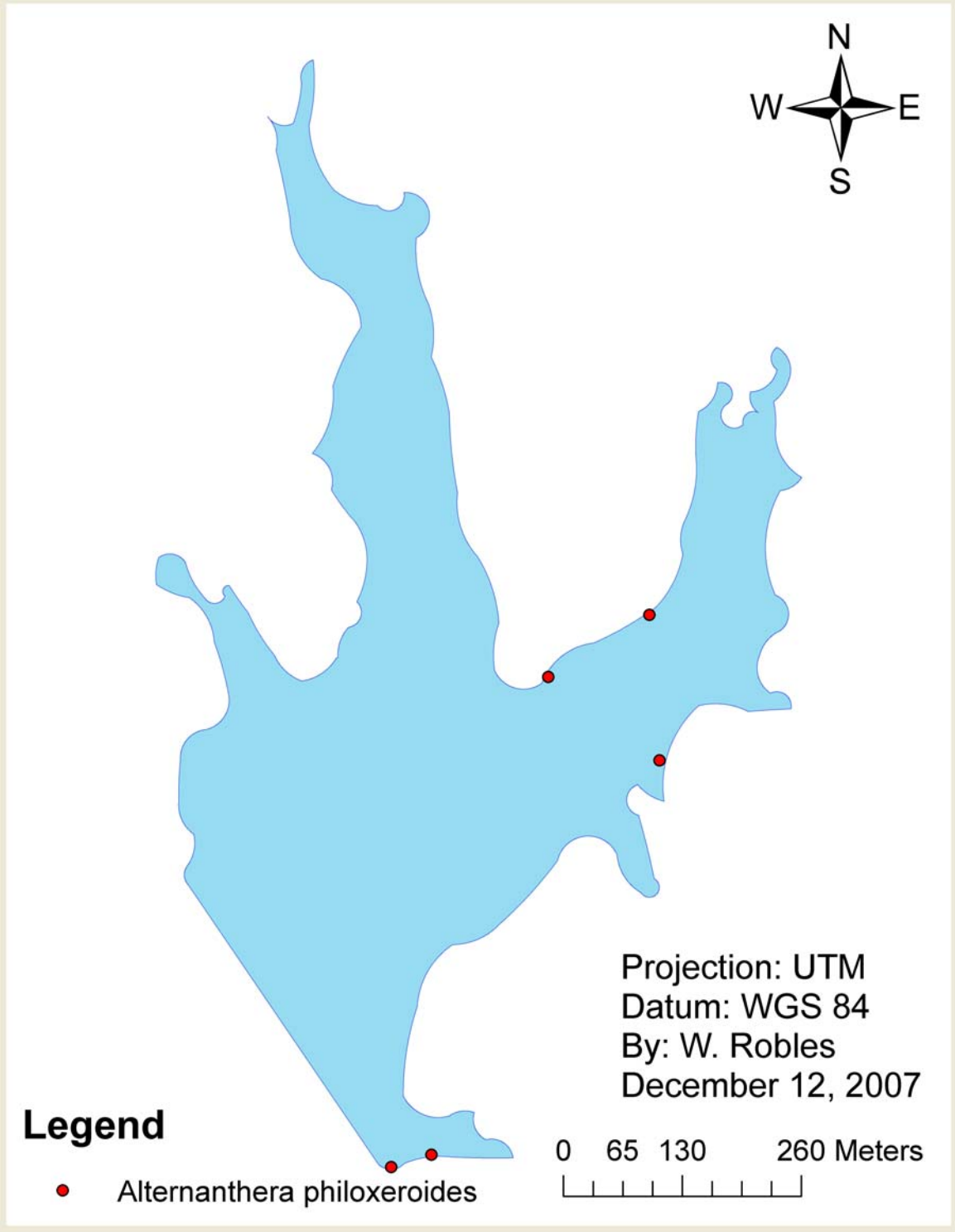

Figure 11. Locations of exotic invasive plant species in Big Creek

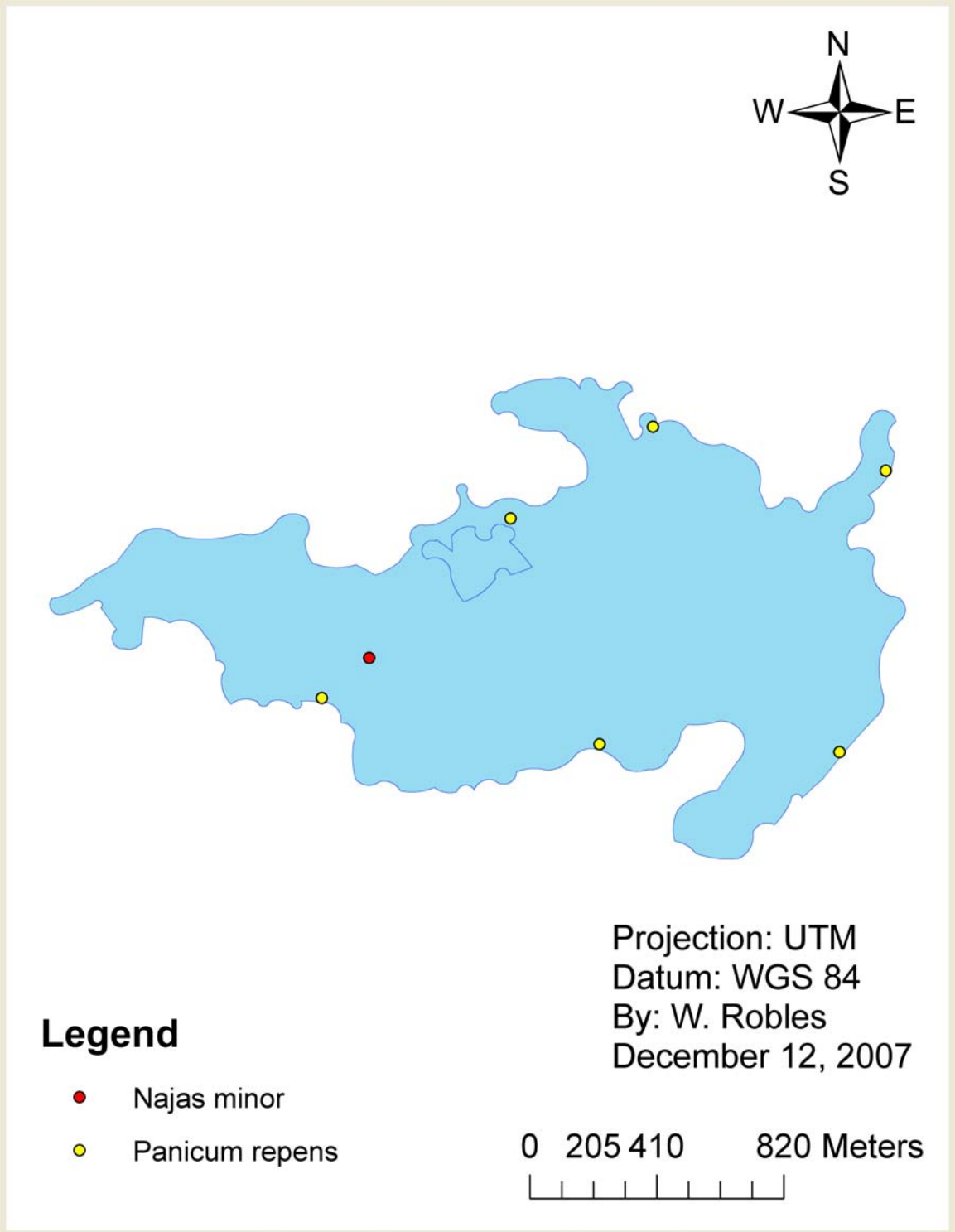

Figure 12. Locations of exotic invasive plant species in Little Black Creek

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