

**BIODIVERSITY HABITAT ASSESSMENT FOR**  
**U M a s s L o w e l l**

**IN**  
**LOWELL, MASSACHUSETTS**



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## Introduction

The University of Massachusetts Lowell (UMass Lowell) is a public university that is part of the UMass System. It is the largest university in the Merrimack Valley with over 1,000 faculty members and 18,000 students. UMass Lowell's 219 acre campus is divided into three campus clusters, the North, East and South Campuses (Figure 1). The North Campus lies on the north side of the Merrimack River. The East and South Campuses are on the south bank of the river, separated by residential urban space. The majority of the property, 170 acres, is owned outright by the Commonwealth of Massachusetts, while 49 acres are leased.

The main goals of this biological assessment are to identify priority habitat areas, identify areas for habitat improvements, and increase connectivity between campus and green space for both students and wildlife.

## Property Description

### Site Setting and Context

UMass Lowell is located in northern Middlesex County in Massachusetts (Figure 2). As the fourth largest city in Massachusetts, a dense urban landscape of Lowell surrounds the University. Each campus cluster is nestled between urban residences, commercial buildings as well as the Merrimack River. This intertwined development of the campus surrounded by open green space creates unique recreational opportunities for UMass Lowell students.

# UMass Lowell Property Boundary

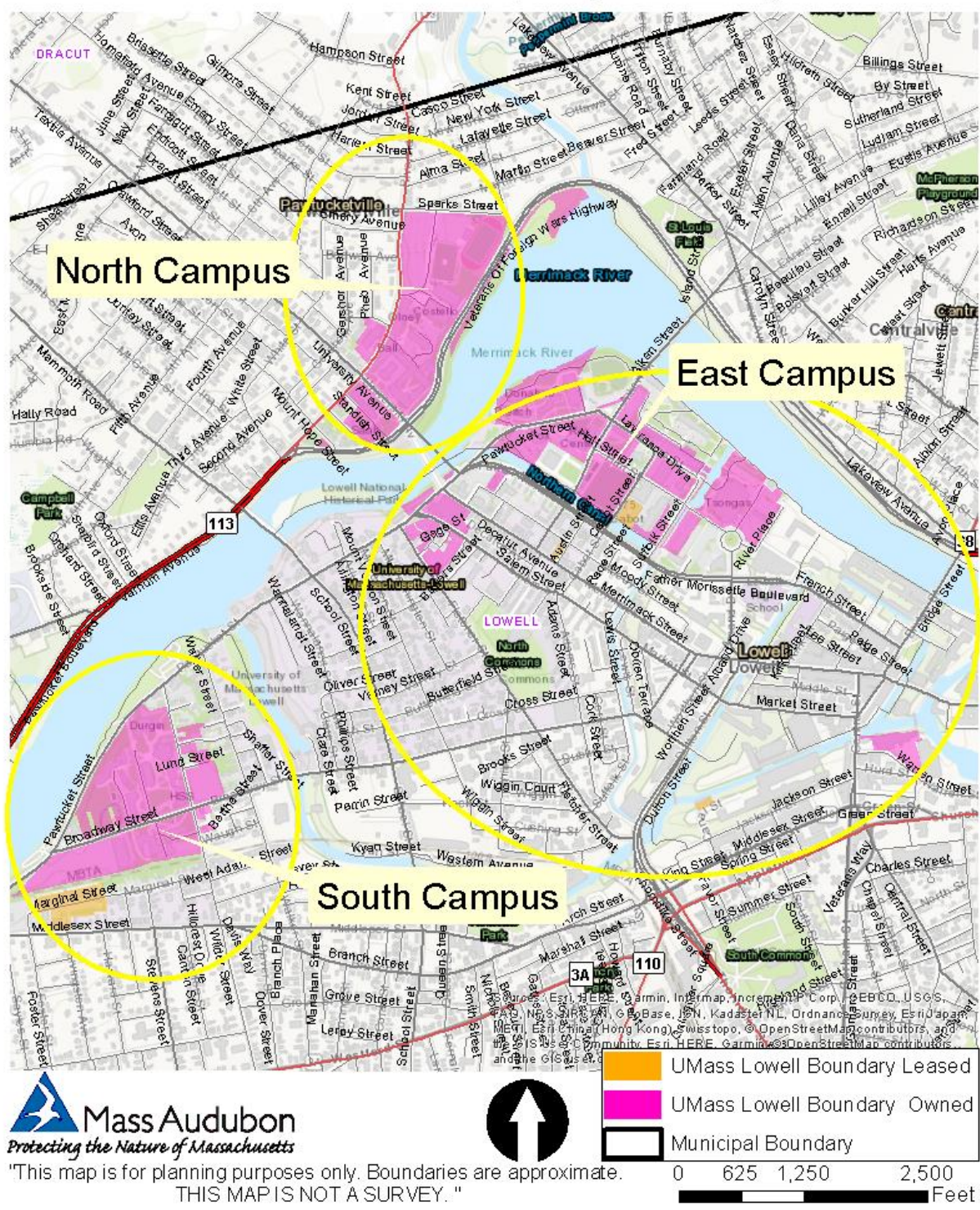


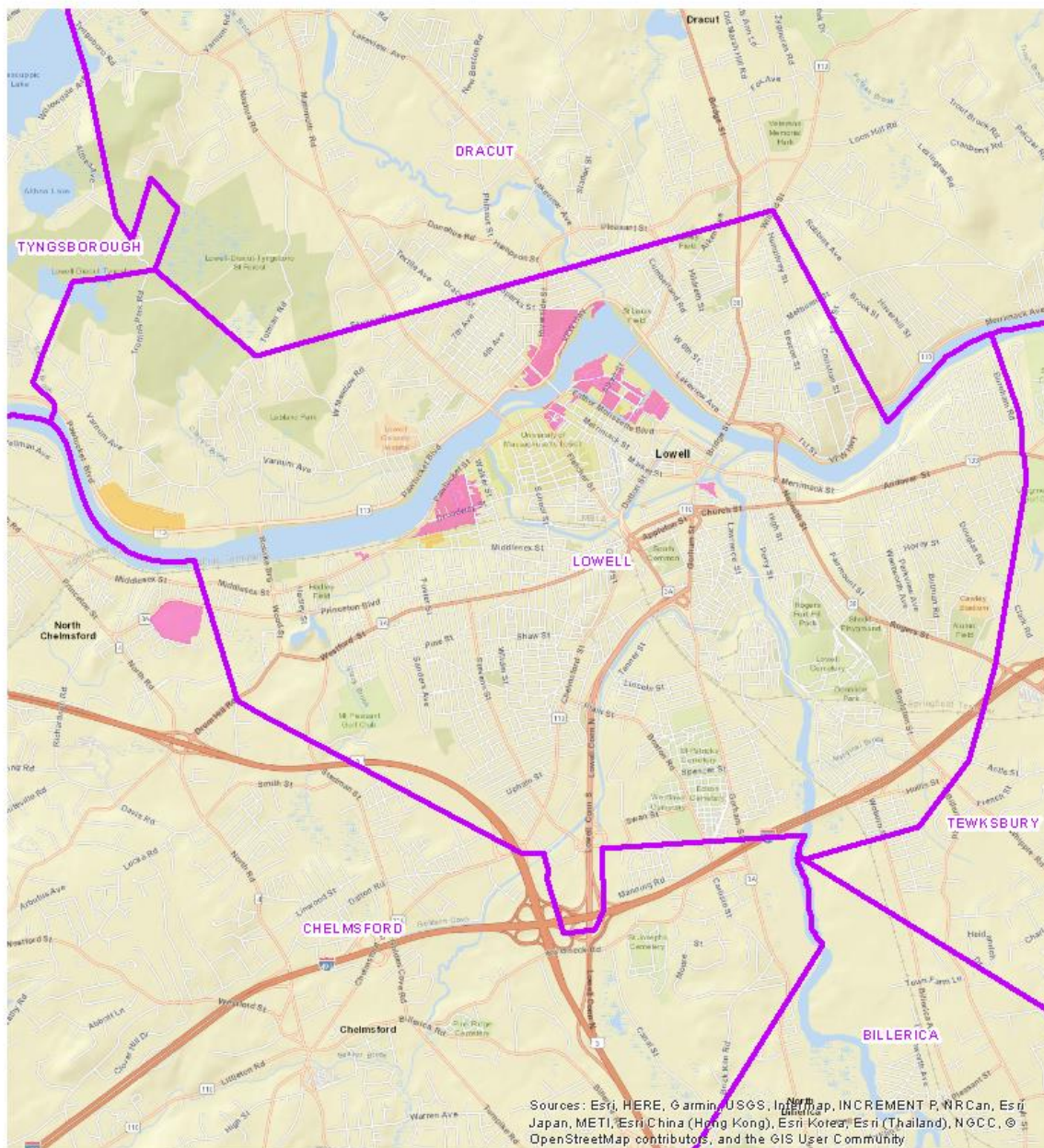
Figure 1: UMass Lowell Campus clusters

The 5.6 mile Lowell Power Canal System still transects the city landscape both on and off campus and is a designated National Historical Park managed by the National Park Service. The Lowell Waterways trail system provides community engagement and recreation within the urban area along approximately 5 miles of trails. UMass Lowell's East Campus is surrounded by these trail systems and students can easily hop on and off these trails for recreational opportunities. The North and South Campuses are slightly removed and would benefit from developing safe connections to this trail system to enhance student recreational opportunities to nearby open space as well as create safe pedestrian access ways to all clusters of campus. Any development for recreational opportunities should be balanced with preserving the greater landscape of open space. Examples include creating connecting linkages for to the Waterways trail system. This could include extensions on Pawtucket and Broadway streets for South Campus and along the VFW Highway with linkages on Aiken Street and University Avenue bridges. All new and existing trail systems should include well-defined pedestrian crossways to ensure safe use of the recreational opportunities (Figures 3 and 4).

The Merimack River and its banks are designated as priority habitat by the state Natural Heritage and Endangered Species Program due to observations of eight species that are listed within Massachusetts. Since 2004, four of these species have been observed in Lowell. Habitat improvement projects for these species should focus on maintaining and improving water quality of the river, floodplains, and surrounding wetlands; reducing erosion of the river bank due to storm water runoff and informal pathways; and restoring disturbed areas with native species.

Invasive plants are located throughout the campus and include Autumn Olive, Oriental Bittersweet, Spotted Knapweed, Japanese knotweed, common buckthorn, glossy buckthorn, burning bush, black locust, tree of heaven, and black swallowwort. Invasives are most densely located along the shoreline of the river as well as along boundaries between the campus and residential areas.

General recommendations to improve overall wildlife habitat include designating a river access trail or observation area on the east campus including educational wayside panels describing the priority habitat; treating invasive plants (e.g. Japanese knotweed and Black swallowwort) along the riverbanks and restoring with native berry producing trees and shrubs; reducing the locations on campus that are regularly mowed for student use and instead allowing sides of walkways and hills around buildings to be planted using no-mow grass and wildflower mixes to produce pollinator habitat.



"This map is for planning purposes only. Boundaries are approximate.  
THIS MAP IS NOT A SURVEY."



Figure 2: Locus Map UMass Lowell

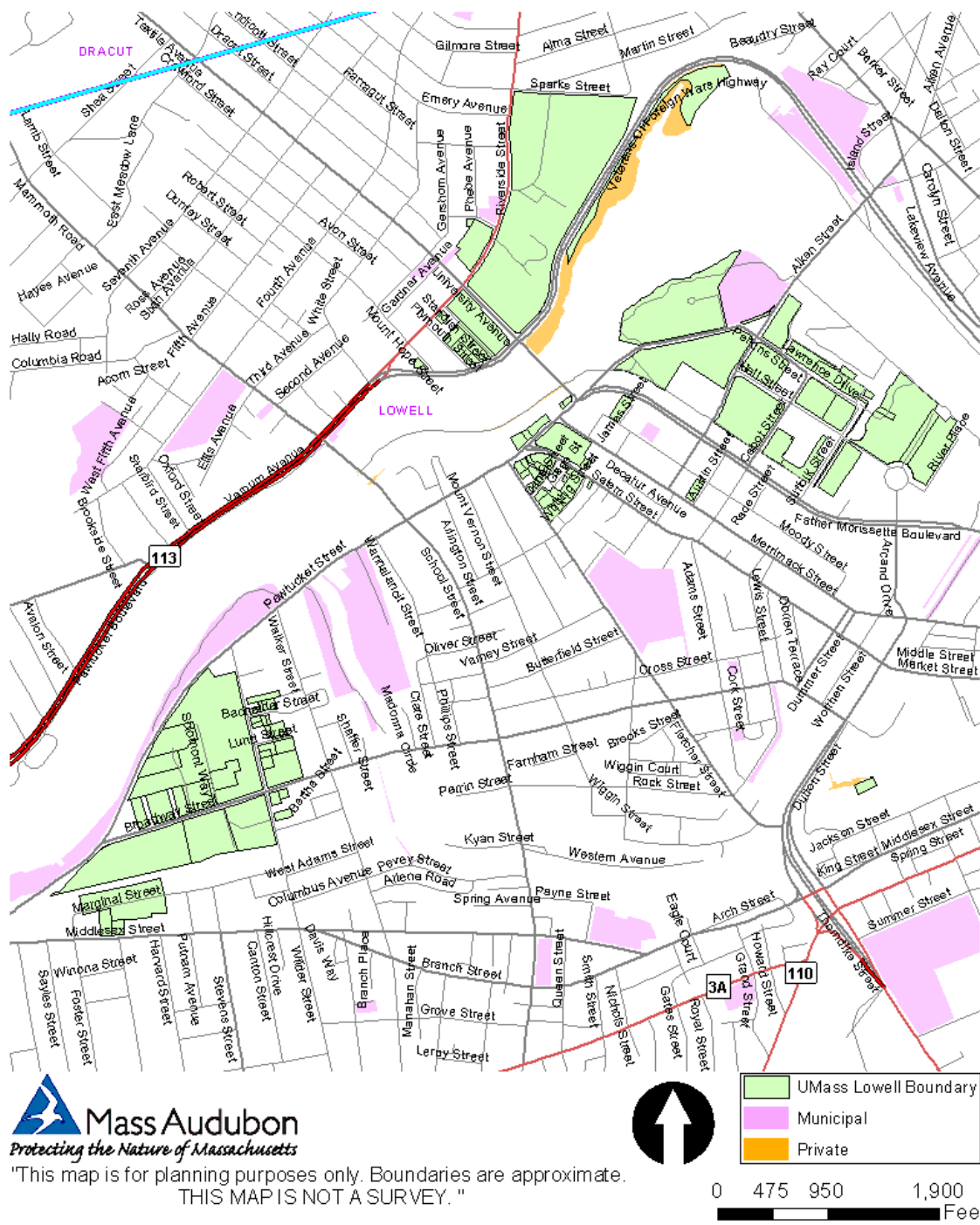


Figure 3: Open Space Areas surrounding UMass Lowell



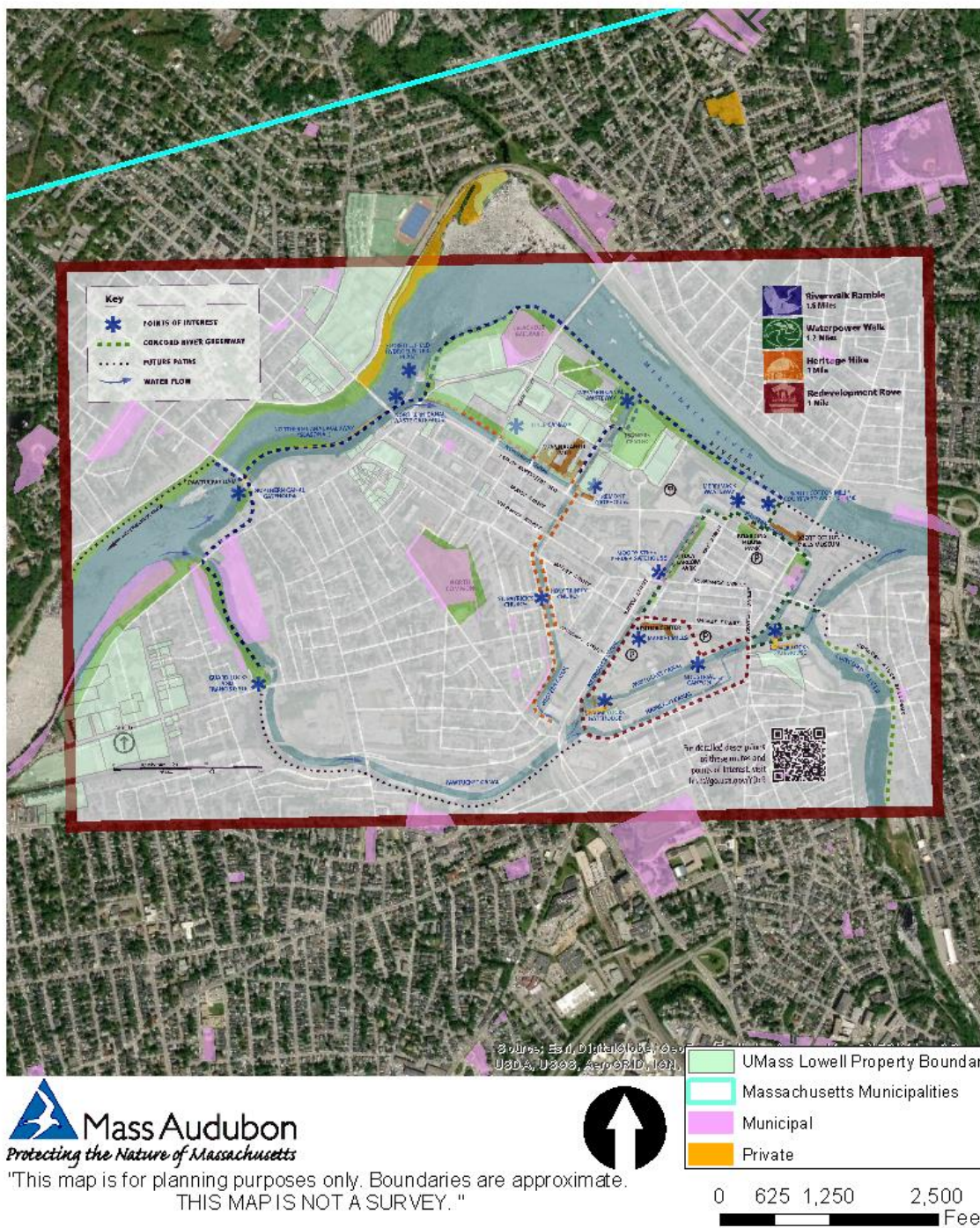


Figure 4: UMass Lowell Connectivity to surrounding Open Space

## Ecological Features

### Topography

As seen in Figure 5, the topography surrounding the UMass Lowell campus is relatively flat, the steepest areas are along the bank of the river. Due to the impermeable surfaces dominating the landscape on campus, stormwater collects from nearby properties, flows into streets and enters an underground drainage system which flows into the nearby canals and eventually into the Merrimack River. During high storm events, there is high potential for water to surge through areas and create erosion issues especially on the steeper slopes of the river embankment that are unvegetated or have low vegetation.

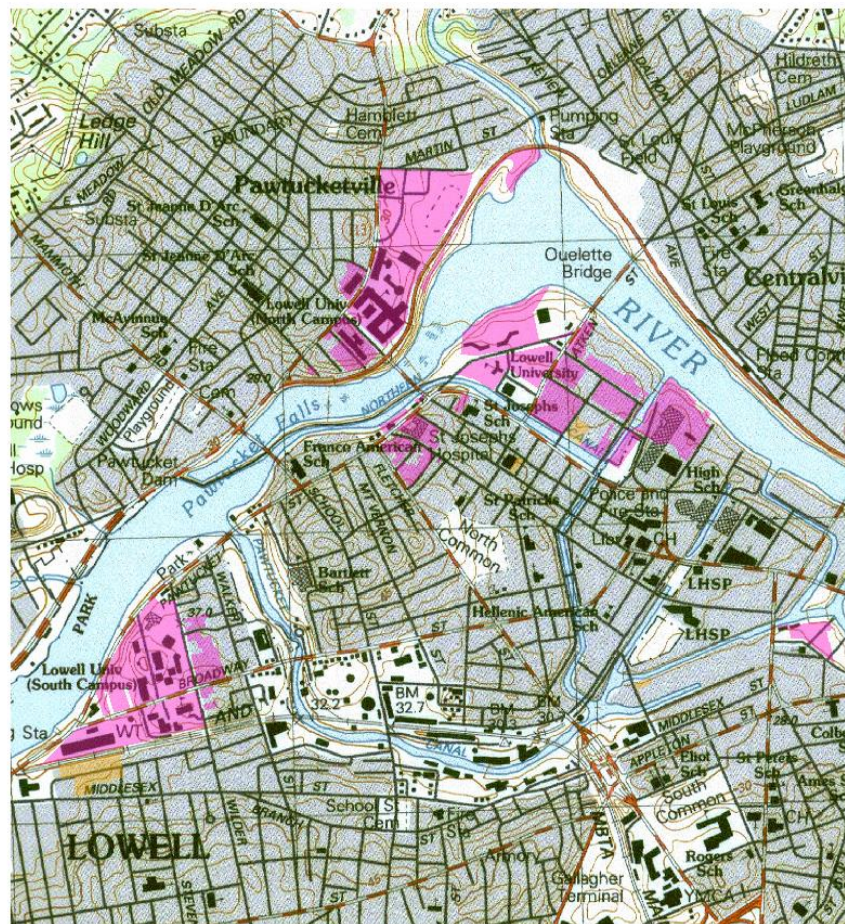


Figure 5: Topography surrounding UMass Lowell

### *Natural Communities*

Natural communities are groups of plants that tend to occur together based on conditions in the landscape as a whole. Soil composition, slope, aspect, elevation and land use history are all factors that determine the distribution of natural communities on a site.

The UMass Lowell campus is predominantly developed urban areas with mowed athletic fields, lawns, and parklands, unmowed fields, floodplain woodlands, and open water. Wildlife was predominantly observed in the floodplain woodlands and open water areas. These areas should be protected from habitat degradation as much as possible. Many of the mowed areas could become more beneficial to wildlife if they were mowed less often to encourage growth towards a wildflower meadow. An annual maintenance mowing in October would deter the development of woody vegetation as well as encourage native grasses and wildflowers to establish themselves.

The biggest threats to these areas included invasive plant species, overuse on informal pathways, and accumulation of litter. The two most aggressive invasive species seen that should be treated across campus were Japanese knotweed and black swallowwort.

Japanese Knotweed is an extremely prolific invasive plant that spreads through floating vegetation fragments and soil transportation. It was commonly seen along edges of sport fields, walkways, and along the perimeter of flooded woodlands and the canal system. Actively restoring treated areas with native berry producing trees and shrubs is a great way to reduce soil erosion from disturbance along steep slopes, improve the wildlife habitat along the river, as well as shade out invasive species that may germinate from the established seed bank on site.

Black swallowwort is a perennial vine that often invades woodlands and wet meadows. As a close relative of milkweed, these species interfere with monarch butterfly reproduction and should be removed before pollinator habitat across campus is increased.

Informal pathways were commonly seen across campuses where students and community members created access to the river. Due to the steep slopes in these areas, erosion is a major concern that will quickly degrade the existing habitat by exposing roots of established plants, create large unvegetated areas from trampling of vegetation as well as disturb habitat uses by priority species such as nesting areas for turtles. Designating a formal trail that creates access to the river and including interpretive wayside panels educating the public and student community would be a great way to minimize the creation of these informal pathways.

Litter was also observed to accumulate in particular areas, most notably along the canal trail system and washed up along the banks of the river. Annual clean ups on campus would make the area more aesthetically pleasing as well as engage students and the surrounding community in stewardship activities to maintain these green areas.

## Wildlife

Portions of the Merrimack River and its banks are mapped as Priority Habitat for Rare Species and Estimated Habitat for Rare Wildlife in the 13<sup>th</sup> edition of the Massachusetts Natural Heritage Atlas. The area is listed as priority habitat for the following Massachusetts Endangered Species Act (MESA) species: Melsheimer's Sack Bearer (*Cicinnus melsheimeri*), Tufted Hairgrass (*Deschampsia cespitosa* ssp. *Glauca*), Hairy Wild Rye (*Elymus villosus*), Blanding's Turtle (*Emydoidea blandingii*), Peregrine Falcon (*Falco peregrinus*), Cobra Clubtail (*Gomphus vastus*), New England Blazing Star (*Liatris scariosa* var. *novae-angliae*), and Umber Shadowdragon (*Neurocordulia obsoleta*). Although Blanding's Turtles, Peregrine Falcons, Cobra Clubtail, and Umber Shadowdragon (Figures 6-10) were the MESA species listed most likely to be seen on or around the UMass Lowell campus, only Peregrine Falcons were observed during my visits. See Appendix A for their MESA factsheets.

Taxonomic Group	Scientific Name	Common Name	MESA Status	Most Recent Observation
Butterfly/Moth	<i>Cicinnus melsheimeri</i>	Melsheimer's Sack Bearer	Threatened	Historic
Vascular Plant	<i>Deschampsia cespitosa</i> ssp. <i>glauca</i>	Tufted Hairgrass	Endangered	1882
Vascular Plant	<i>Elymus villosus</i>	Hairy Wild Rye	Endangered	1882
Reptile	<i>Emydoidea blandingii</i>	Blanding's Turtle	Threatened	2007
Bird	<i>Falco peregrinus</i>	Peregrine Falcon	Threatened	2017
Dragonfly/Damselfly	<i>Gomphus vastus</i>	Cobra Clubtail	Special Concern	2004
Vascular Plant	<i>Liatris scariosa</i> var. <i>novae-angliae</i>	New England Blazing Star	Special Concern	1882
Dragonfly/Damselfly	<i>Neurocordulia obsoleta</i>	Umber Shadowdragon	Special Concern	2004

Figure 6: MESA species Documented in Lowell, MA by Massachusetts Natural Heritage Endangered Species Program (NHESP)



Figure 7: *Blanding's Turtle* ©Zoo New England

Blanding's Turtles were last documented in Lowell in 2007 and were most likely using various wetlands and fields along the Merrimack River to overwinter, feed, mate and lay eggs. To reduce impacts to their habitat UMass Lowell could minimize informal and redundant trails down to the river edge around campus by installing a designated trail and observation platform for river access. Other actions include installing a wayside interpretive panel and invasive plant management along the edge of the river, with focused actions to reduce erosion as much as possible.



Figure 8: *Peregrine Falcon* ©Dorian Anderson

Even though peregrine falcons were last documented on campus in 2017 by NHESP they were actively nesting on campus during 2018 and have been documented by birders in 2019. Nesting habitat for this pair is well secured at Fox Hall and monitored by the state. To improve the quality of habitat for these birds UMass Lowell could plant berry producing trees and shrubs along the river around east campus. These restoration efforts would provide habitat for smaller birds which is the main food source for peregrine falcons. These falcons are excellent hunters and usually go after various bird species ranging in size from hummingbirds to sandhill cranes. The resident pair at UMass Lowell most likely feast regularly on starlings, pigeons, bluejays, ring-billed gulls, and mallards.



Figure 9: *Cobra Clubtail* ©John C. Abbott

Cobra Clubtails and Umber Shadowdraon (Figure 10) were last documented in Lowell in 2004 and would utilize open water areas, emergent vegetation along the river banks, decaying logs, rocks and steep river embankments to complete their lifecycle. Minimizing disturbance to the floodplain habitat around the river by having designated river access by trail, improving water quality by removing litter, restoring degraded areas with native vegetation, and creating no mow pollinator habitats are all actions that UMass could take to improve the quality of habitat for these species.



Figure 10: *Umber Shadowdragon*

The Merrimack River is a hotspot for local birding including the UMass Lowell Boathouse (South Campus) and Pawtucket Falls (East Campus). The open water areas surrounding the campus and forested floodplain forests are great stop over areas for migrating warblers and waterfowl that would use the mix of forest, edge and wetland habitats that surround the campus.

The campus also provides habitat for generalist species. Common habitat generalist mammals that are likely to occur within the UMass Lowell campus include: Virginia opossum, Eastern Gray Squirrel, Red Squirrel, Eastern chipmunk, Meadow vole, White-footed deer mouse, Eastern cottontail, Coyote, Red fox, Long-tailed weasel, Striped skunk, and White-tailed deer.



During visits to the campus, many bird species were heard and seen including:

Mallard  
Rock pigeon  
Killdeer  
Ring-billed gull  
Herring Gull  
Great Black-backed Gull  
Double-crested Cormorant  
Great Blue Heron  
Black-crowned Night-Heron  
Turkey Vulture  
Belted Kingfisher  
Downy Woodpecker  
Peregrine Falcon  
Blue Jay  
American Crow  
Tree Swallow  
Black-capped Chickadee  
American Robin  
Gray Catbird  
European Starling  
Cedar Waxwing  
House Sparrow  
American Goldfinch  
Ovenbird  
Common Yellowthroat  
Northern Cardinal  
Red-winged Blackbird  
Common Grackle

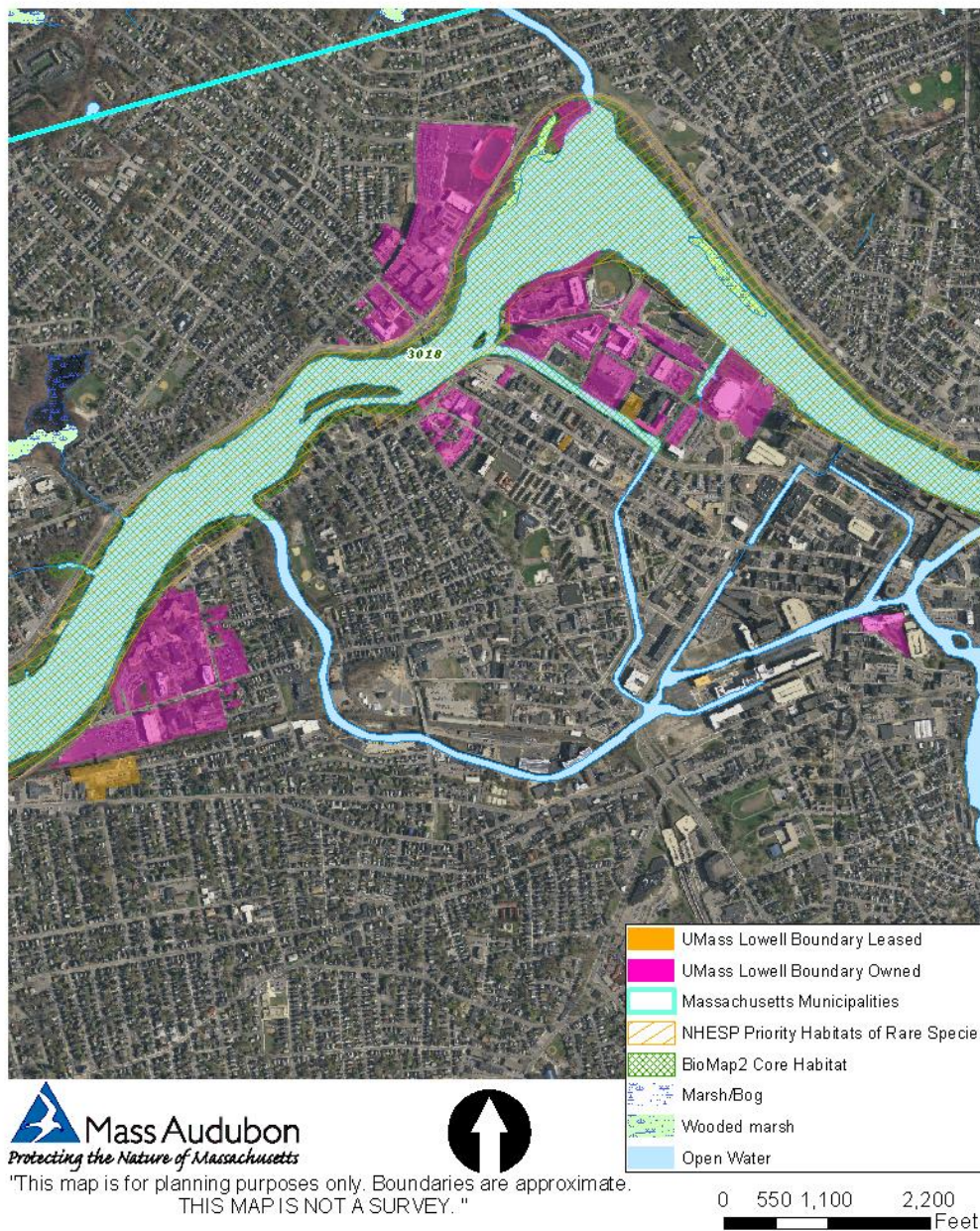


Figure 11: Wildlife habitat surrounding UMass Lowell

## Current Conditions

### *North Campus*

The North Campus lies West and North of a bend in the Merrimack River and the South and East boundaries are hugged by residences. Two open space areas lie to the east, Wannalanat Park and Lowell Heritage State Park. The Northern Canal Walkway is the closest portion of the Lowell Waterways Trails to North Campus. A trail extension from Howe Bridge North through Wannalanat Park turning South through Lowell Heritage Park and across the Aiken Street bridge would create a loop connecting the North Campus to East Campus near the Northern Canal Waste Gatehouse and Lelacheur Ballpark. During my visits a soil remediation project was underway, and seemed to be in use as a trail by pedestrians despite edging very close to the VFW highway.



Figure 12: North Campus Wildlife Habitat assessment and waypoints

### *East Campus*

The East Campus is bounded by the Merrimack River to the North and the Northern Canal to the South, the entire section of campus is surrounded by the Waterways trail system which allows students and community members to engage in direct access to areas on campus as well as nearby open space for recreational opportunities. Overall, this section of campus had the highest diversity of wildlife and recreational engagement observed. A designated trail down to the river located near the campus greenhouse would be a good location to reduce informal pathways in the area.

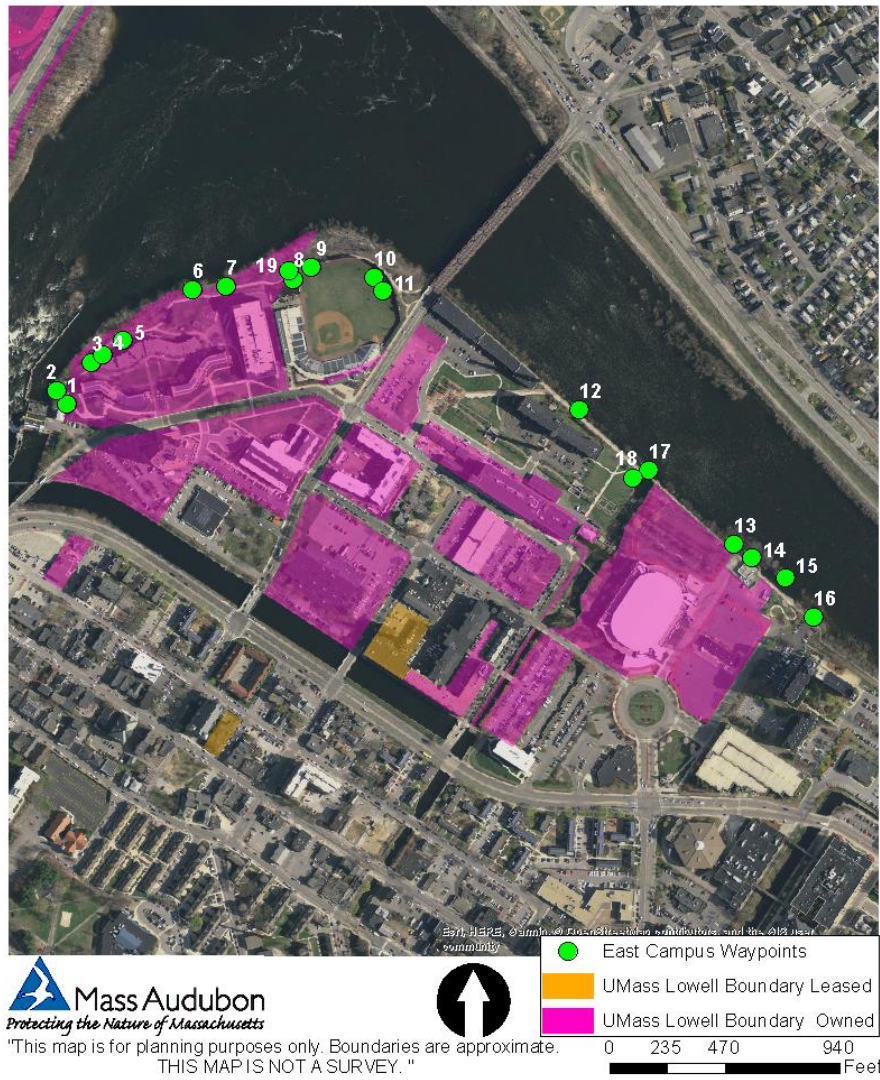


Figure 13: East Campus Wildlife Habitat assessment and waypoints

*South Campus*

The South Campus is bordered by the Merrimack River and Sheehy Memorial and Lowell Heritage State Park to the West and surrounded by residences to the East. This section of campus is the farthest away from the Waterways trail system and has the greatest opportunity to expand the trail system to include this portion of campus to access recreational opportunities.

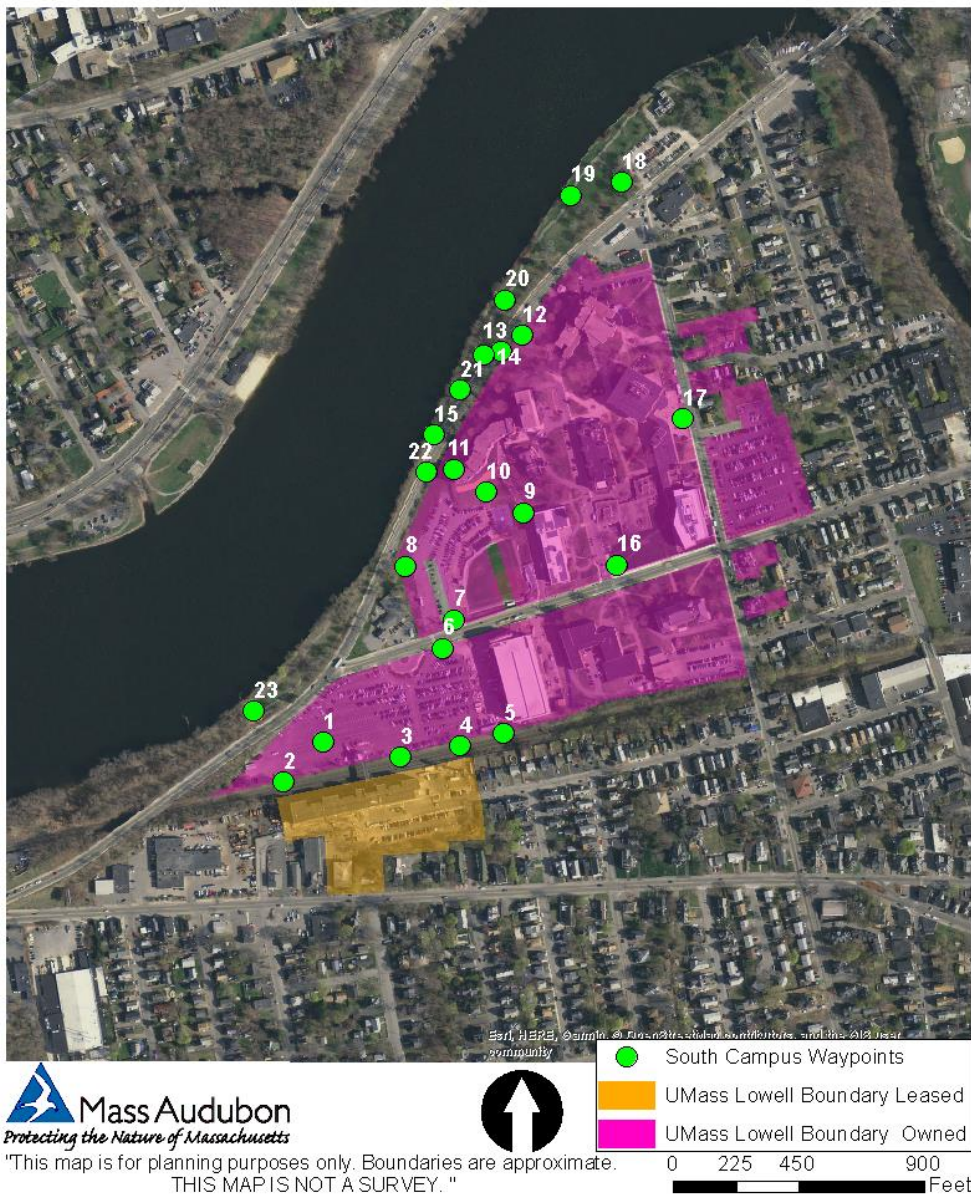


Figure 14: *South Campus Wildlife Habitat assessment and waypoints*

### *Mowed Areas*

The most abundant habitats encountered on campus were lawns, mowed athletic fields, and mowed parklands. These regularly maintained areas provide either open lawns or shaded groves for students and community members to wander on campus. Some areas on campus do need to be mowed on a regular basis. Examples include ball fields, picnic and gathering spots as well as access areas around buildings. However, many areas on campus do not need to be mowed so frequently and can be restored into wildflower meadows and provide habitat for invertebrate species. Staff would mow an edge 2-3 feet wide near parking areas, trails, and buildings leaving the greater areas of fields and slopes unmowed for the majority of the year until an annual maintenance mowing in late fall around the middle of October. Actively seeding these areas with native no-mow grass and native wildflower seed mixes would encourage the growth of pocket habitats for invertebrates.



Figure 15: ( North Campus Waypoint 2) *Example of management for unmowed areas around campus. Species observed included crown vetch, red clover, common milkweed, queen anne's lace, and chickory.*



Figure 16: *(North Campus Waypoint 3) This lawn can be restored with native plant seeds to provide habitat for invertebrates.*



Figure 17: *(North Campus Waypoint 4) Areas around buildings can be left unmowed for the majority of the year except where access is needed.*





Figure 18: (East Campus Waypoint 1) Mowed grove along trail. Plant no mow grass and native shade tolerant wildflower seed mixes.



Figure 19: (East Campus Waypoint 2) Mowed area transitions from grove to open lawn. Restore with no mow grass and wildflower seed mixes.



Figure 20: (East Campus Waypoint 5) Small mowed area that can be restored with native seed mixes or berry producing shrubs.



Figure 21: (East Campus Waypoints 8 and 18) Remove woodchips and actively restore both sides of trail with no mow grass and native wildflower mixes.



Figure 22: (East Campus Waypoint 12) Picnic area is example of area where it would be appropriate to continue to mow frequently.



Figure 23: (South Campus Waypoint 5) Small grass triangle can be mowed once a year



Figure 24: (South Campus Waypoint 6) Gravel and mulch should be minimally used around plantings. Instead a no mow grass mix would increase the quality of the habitat for invertebrates.



Figure 25: (South Campus Waypoint 10) Area between fence and road does not need to be mowed. Area to right of fence can continue to be mowed for ease of use during sporting events.



Figure 26: (South Campus Waypoint 12) Unmowed area between terraced slopes is good example of invertebrate habitat that can be created throughout campus. Invasive species should be spot treated and native wildflower and grass seeds should be used on site after annual mowing in late fall.



Figure 27: (South Campus Waypoint 17) Lawn triangle outside of Library does not need to be mowed. Should be turned into invertebrate habitat with native grass and wildflower mix.

### *Invasive Species*

The largest threat to the ecological integrity of wildlife habitat on the UMass Lowell campus is the presence of invasive plant species. Manual or mechanical treatment, such as mowing, is effective management for the open areas of sport fields, lawns and gathering spots. For dense infestations, wet areas, or particularly hard to treat species, the judicious and carefully planned use of herbicide is recommended. Dense infestations typically respond best to a foliar application applied with backpack sprayers. Cut and paint herbicide application techniques should be used in wet areas, near the river, and in areas where erosion is a concern. An outside contractor with a MA applicators license can be hired to conduct work. A local permit will be required for any vegetation management in or near wetlands.

Many common invasives were found throughout the campus such as Oriental Bittersweet, Glossy Buckthorn, Japanese Barberry, and Garlic Mustard, but the two species of highest concern are Japanese Knotweed and Black swallow-wort. Japanese Knotweed is an extremely prolific invasive plant that spreads through floating vegetation fragments and soil transportation. Black swallowwort is a perennial that often invades meadows and woodland edges. As a close relative of milkweed, black swallowwort can interfere with monarch butterfly reproduction, so should be treated around areas that are being actively restored for invertebrate habitat.



Figure 28: (North Campus Waypoint 1) Japanese Knotweed next to Cushing Field Complex



Figure 29: (North Campus Waypoint 5) Black swallow-wort growing in fence.



Figure 30: (East Campus Waypoint 3) Black swallow wort growing up fence along trail.



Figure 31: (East Campus Waypoint 6) Soil piles located near greenhouse. Japanese knotweed was found nearby and should be treated, especially if compost will be used and spread throughout campus. This area is a potential location for a river access trail and observation platform.





Figure 32: (East Campus Waypoint 10) Black swallow-wort growing among milkweed plants. Black swallow-wort should be treated to minimize negative impacts to reproductive lifecycle for monarch butterflies.



Figure 33: (East Campus Waypoint 15) Japanese knotweed along waterway should be treated so vegetation fragments will not spread along embankment. Actively restore areas by planting native berry producing shrubs to deter the regrowth of invasive species, reduce erosion issues, as well as deter re establishment of invasive species.



Figure 34 (South Campus Waypoint 2) Oriental Bittersweet growing on fence between Riverwalk Streets and catwalk. This area should be actively managed for invasive plants and restored with native berry producing shrubs. Students could watch wildlife foraging on the fruits from the catwalk.



Figure 35 (South Campus Waypoint 7) Oriental Bittersweet was commonly seen on lawn and field edge habitats around this portion of campus. Invasive plant species should be treated on edges around sports fields and restored with native berry producing shrubs. Several Fat Albert Colorado Spruce trees were also still in burlap and remained unplanted. Native species should be used for revegetation projects when possible and planted immediately to have the highest chances of survival. Planting in the spring and fall will reduce the amount of watering needed to keep the plant viable.

### *Trail Maintenance and Connectivity*

Trails and pathways are located throughout the Campus providing access to all areas of the university. Overall, the campus trails and pathways are well maintained, there were some areas that needed vegetation to be clipped back so branches were not protruding into the trail. Off campus, on surrounding green space the most common issue observed were informal pathways heading down towards the river. “Informal” pathways are typically created and maintained simply by repeated foot traffic and not reflecting any planning or trail building best practices. Such trails can lend a sense that a greenspace is not managed or monitored in any way. Such an impression can lead to illicit uses and a general appearance of neglect. Such an appearance and potential misuse can lead to a perceived lack of safety among potential users. The embankments of the river have the steepest slopes on campus and footpaths are steep, contain tripping hazards such as loose rock and soil. Trails show signs of erosion due to heavy foot traffic. These areas should be closed off with boulders, or “closed for ecological restoration” signs to allow these areas to regrow. Designating an official trail leading down to the river for access or constructing an observation platform would potentially help decrease the number of informal trails created in attempts to access the river. Including wayside interpretive panels describing the priority habitat and species of the Merrimack River would educate the public and student community to also deter the creation of these informal pathways. A soil remediation project was underway during my visit to the North Campus. This area was actively being used as a trail by many pedestrians and is a potential location for a river access trail on the North side of the campus. Mending breaks in trailside fencing will reduce use of informal pathways and installing street lights and pedestrian crossways will provide a safe connection to the new trail systems.



Figure 36: (North Campus Waypoint 6) Break in fence and informal pathway down towards the river. People were seen and heard along the embankment of the river.



Figure 37: (North Campus Waypoint 10) Soil remediation project along the VFW highway and Merrimack River. This could be a potential location for a future River Access trail along the North UMass Lowell Campus.



Figure 38: (North Campus Waypoint 11) Soil remediation project along the VFW highway and Merrimack River.





Figure 39: (East Campus Waypoint 4) Informal pathway down to river.



Figure 40: (East Campus Waypoint 7) Informal pathway down to river.



Figure 41: (East Campus Waypoint 9) Brush should be cut back from trail.



Figure 42 (South Campus Waypoint 8) this location would be a good place to connect the UMass Lowell South Campus to the Park across the street. Crosswalks should be installed for pedestrian safety.



Figure 43 (South Campus Waypoint 23) End of loop in park. Seemed to be a common area for homeless community to gather. During my visits I regularly encountered groups of 10-20 individuals. UMass should install lighting and collaborate with the city to ensure safe student access.



Figure 44 (South Campus Waypoint 13) Area behind Sheehy Hall has potential to create new campus trail that connects the campus to park across street.



Figure 45 (South Campus Waypoint 14) Potential new trail behind Sheehy Hall should follow stone wall until it gradually tapers to staircase to loop back to campus. A cross walk can be installed to connect to park across the street.

### *Encroachments*

Trash and other debris were found in the waterways near the river and around the river islands. Common debris observed included cans, cups, metal pipes, plastic bags, tires, and larger electronic items. Hosting clean up days in collaboration with students on campus, the National Park Service, and the local community would be a way to engage stewardship of the area and deter future dumping. These areas are especially important priority habitat areas for the observed listed species in Lowell. The dragonflies would regularly use exposed rocks, emergent vegetation and open water in flood plain areas, turtles would use rocks and logs for basking as well as sandy banks and island for nesting, while peregrines would use the areas around the river to hunt smaller birds for prey.



Figure 46: (East Campus Waypoint 13) Trash observed in stream.



Figure 47: (East Campus Waypoint 14) Trash observed in and around island on river.

## Management Recommendations

### Recommendations for Future Activity

The biggest threats to the biological integrity of the campus and surrounding areas included invasive plant species, overuse on informal pathways, and accumulation of litter.

The two most aggressive invasive species seen that should be treated across campus were Japanese knotweed and black swallowwort. Japanese Knotweed is an extremely prolific invasive plant that spreads through floating vegetation fragments and soil transportation. It was commonly seen along edges of sport fields, walkways, and along the perimeter of flooded woodlands and the canal system. Actively restoring treated areas with native berry producing trees and shrubs is a great way to reduce soil erosion from disturbance along steep slopes, improve the wildlife habitat along the river, as well as shade out invasive species that may germinate from the established seed bank on site. Black swallowwort is a perennial vine that often invades woodlands and wet meadows. As a close relative of milkweed, these species interfere with monarch butterfly reproduction and should be removed before pollinator habitat across campus is increased.

Informal pathways were commonly seen across campuses where students and community members created access to the river. Due to the steep slopes in these areas, erosion is a major concern that will quickly degrade the existing habitat by exposing roots of established plants, create large unvegetated

areas from trampling of vegetation as well as disturb habitat uses by priority species such as nesting areas for turtles. Designating a formal trail that creates access to the river and including interpretive wayside panels educating the public and student community would be a great way to minimize the creation of these informal pathways.

Litter was also observed to accumulate in particular areas, most notably along the canal trail system and washed up along the banks of the river. Annual clean ups on campus would make the area more aesthetically pleasing as well as engage students and the surrounding community in stewardship activities to maintain these green areas.

We recommend three management actions to control invasive plant species to enhance the habitat quality of the UMass Lowell Campus, three management actions to enhance wildlife management on the property, and six management actions to enhance the experience passive recreation.

**Invasive plant management recommendations:**

- Treat Japanese knotweed infestations near waterways, compost areas, and where soil and fill are stored
- Treat all Black swallowwort infestations, especially near areas where invertebrate habitat is being created
- Strategically treat other invasives within the property:
  - Treat invasives in edge habitat from trail system out towards river and other wetland areas

**Wildlife enhancement management recommendations:**

- Create invertebrate habitat by mowing lawn areas annually unless they need to be regularly need to be mowed such as along buildings for access, sports fields, and picnic and gathering areas
- No mow grass seed and wildflower mixes should be used on other lawn areas of campus and mowed once annually in the fall around mid October
- After treating invasive species along forest edges, areas should be actively restored with native berry producing shrubs

**Trail Maintenance, Connectivity, and Safety management recommendations:**

- Regularly trim trails so that vegetation is not on walkways
- Repair any breaks in fencing and restore damage to banks of river from informal trails
- Create designated river access trail and observation area on the East Campus with wayside interpretive panels
- Create new trail near Sheehy Hall in South Campus

- Extend Waterways Trail system to include connections on Pawtucket and Broadway Streets to South Campus as well as along the VFW highway and linkages to North Campus on Aiken Street and University Avenue Bridges
- Install and maintain crosswalks and lighting to increase student safety on all trail systems

### *Invasive Plant Remediation*

- Treat Japanese knotweed infestations near waterways, compost areas, and where soil and fill are stored
- Treat all Black swallow wort infestations, especially near areas where invertebrate habitat is being created
- Strategically treat other invasives within the property:
  - Treat invasives in edge habitat from trail system out towards river and other wetland areas

The largest threat to the ecological integrity on the UMass Lowell campus system is the presence of two invasive plant species Japanese Knotweed and Black swallow-wort. Chemical treatment for both these species is recommended due to the size of the infestations and their aggressive behavior. Japanese knotweed does not have a very high viability for its seeds but mostly spreads by rhizomes in the soil. Care should be taken to immediately treat infestations along the trails or in regularly flooded areas, if not addressed this species will easily dominate sections of the property quickly.

Control of Black swallow-wort is more difficult. Even though the current size of the infestations are small, chemical treatment is recommended. Monarch butterflies regularly lay their eggs on this species since it is related to milkweed. When this occurs, the monarch larvae are not able to complete their full life cycle. Herbicide treatment of black swallowwort usually needs to be repeated annually. The best time to treat both these species is in July or August.

Chemical or mechanical treatment is effective management for the remaining species in the interior of the property. Herbicide can be used in dense stands of invasive species where mowing is not an appropriate management action. Due to the abundance of invasive plants across the campus treatment of all infestations is not realistic. Management efforts should be focused on areas that are current and potential project sites. Since invasive plants are highly resourceful during disturbance events care should be taken to treat invasives around active project sites and deterring the spread of contaminated soil to other campus locations. Proactively managing invasive plants on the majority of the campus in this way in tandem with strategized targeted management of sensitive wetland habitats and their resource areas will greatly reduce the negative impacts invasive plants have on campus. Actively restoring areas that have been treated with native berry producing trees and shrub species is recommended to help deter regrowth of invasive species from the existing and established seed bank. Dense infestations in upland areas should be sprayed with backpack sprayers, or tanks mounted on vehicles. Cut and paint herbicide



application techniques should be used in wet areas, near the river, and in areas where erosion is a concern. An outside contractor with an herbicide applicators license should be hired to conduct the work. Local permits will be required for vegetation management in and near wetlands.

See Appendix B for more information for treatment of various species.

### *Wildlife Enhancement*

- Create invertebrate habitat by mowing lawn areas annually unless they need to be regularly mowed such as along buildings for access, sports fields, and picnic and gathering areas
- No mow grass seed and wildflower mixes should be used on other lawn areas of campus and mowed once annually in the fall ( An example would be Mesic to Dry Native Pollinator Mix by Ernst Seeds #ERNMX-105)
- After treating invasive species along forest edges, areas should be actively restored with native berry producing shrubs and or trees

Open meadow habitats can range from grass-dominated, frequently mown hayfields to infrequently mown, wildflower-dominated meadows. Each type provides habitat for a different suite of species based on plant composition, meadow size, moisture and other factors. Areas less than 10 acres in size should be managed for pollinator habitat and can be mowed annually in mid October to encourage growth of wildflower – dominated meadows. All fields need to be *disturbed* on a regular basis to avoid succession and encroachment, most often by mowing.

Mowing variables include timing, frequency, type of equipment, blade height, and fate of the mown material.

- Timing and Frequency – A field that is mown earlier in the season and more frequently in a season will tend to be dominated by grasses. A field mown once per year and later in the fall will tend to have a higher component of wildflowers. Mowing should be prohibited during bird nesting season, mid-May to mid-August. **Fields smaller than 10 acres can be mown in September or October to provide nectaring plants for invertebrates.**
- Type of equipment – Fields can be mown with a rotary deck mower. A rotary mower tends to leave clumped material which can inhibit re-sprouting in the spring and smother insect larvae.
- Blade height – Any mowing should leave roughly 6 inches of standing material to provide habitat for invertebrate larvae.
- Treatment of mown material – Smaller wildflower meadows managed for invertebrate habitat can be mown with clippings left in place.

### *Passive Recreation*

- Regularly trim trails so that vegetation is not on walkways
- Repair any breaks in fencing and restore damage to banks of river from illegal trails
- Create designated observation/ access areas to river along trail system
- Create new trail near Sheehy Hall in South Campus

- Extend Waterways Trail system to include connections on Pawtucket and Broadway Streets to South Campus as well as along the VFW highway and linkages to North Campus on Aiken Street and University Avenue Bridges
- Install and maintain crosswalks and lighting to increase student safety on all trail systems

As with any forested area UMass Lowell contains trees at all stages of their life cycle, from young saplings to declining canopy trees. These declining trees, with their soft deadwood limbs and invertebrate decomposers, provide important feeding and nesting habitat for a wide range of wildlife. However, these trees can also represent hazards to infrastructure and students due to their structural instability and can contribute to an 'unkempt' appearance. Selective removal or trimming of specific hazard trees at risk of damaging infrastructure is recommended while maintaining most interior trees in various state of growth, decline, and decay. The trails and pathways should also be routinely walked specifically after storm events so trail clearing, trimming, and repairs to wooden structures and fencing can be conducted as needed.

Currently, informal trails are a large issue on campus where the trails are close to the river. The embankments of the river have the steepest slopes on campus and footpaths are steep, contain tripping hazards such as loose rock and soil, as well as show signs of erosion due to heavy foot traffic. These areas should be closed off with boulders, or "closed for ecological restoration" signs to allow these areas to regrow. Designating an official trail down to the river or constructing an observation platform would potentially help decrease the amount of illegal trails in attempts to access the river.

The proposed trail and observation platform is a wooden deck that projects 60 feet into the river. Exact location of the trail and platform will be determined in the field by a contractor, but the general location is proposed on the east campus near the greenhouse. It will have wayside interpretive panels describing the Merrimack River, the priority species, and commonly seen wildlife. It would be supported on helical piers that screw into the substrate and give extra stability while minimizing disturbance to the river embankment. Helical piers have been used in a similar project in Carlisle, Massachusetts. Details and photographs of their use are shown in Figures 48-52.

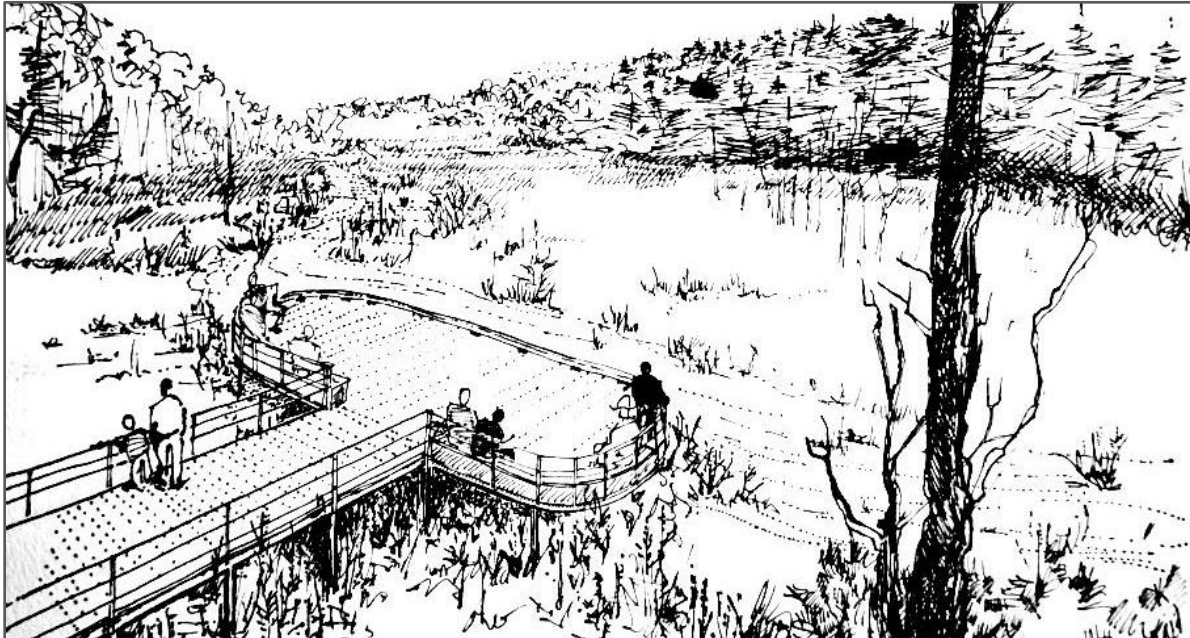


Figure 48: River access trail and observation platform concept.

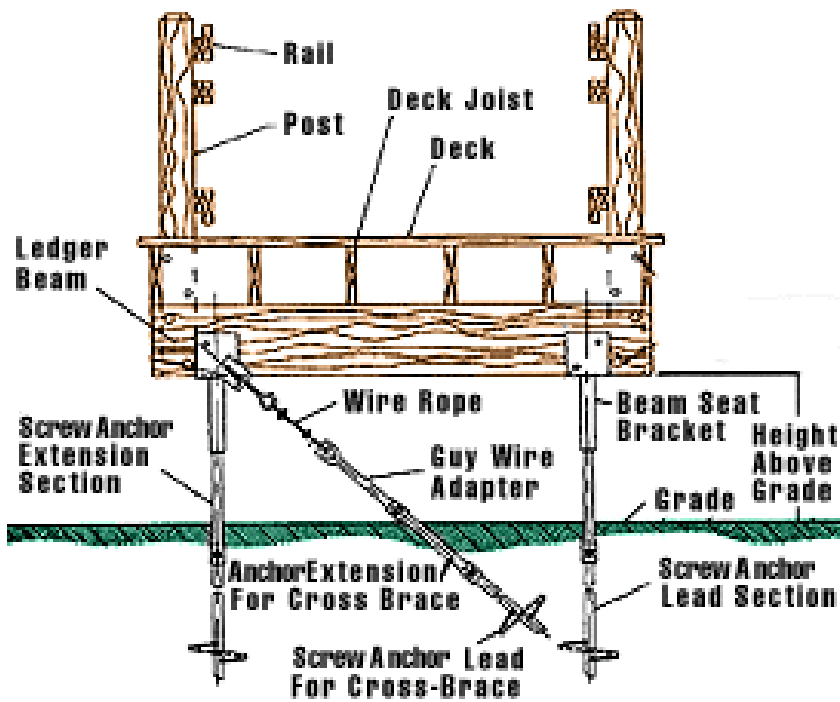


Figure 49: Detail of observation platform construction with helical piers



*Figure 50: Vegetation growing under platform in Carlisle, Mass.*



*Figure 51: Helical piers in ground with minimal disturbance, Carlisle, Mass.*



Figure 52: Example of interpretive wayside panel at Rough Meadows Wildlife Sanctuary, Rowley.

The Lowell Waterways trail system provide community engagement and recreation within the urban area along approximately 5 miles of trails. UMass Lowell's East Campus is surrounded by these trail systems and students can easily hop on and off these trails for recreational opportunities. The North and South Campuses are slightly removed and would benefit from developing safe connections to this trail system to enhance student recreational opportunities to nearby by open space as well as create safe pedestrian access ways to all clusters of campus. Any development for recreational opportunities should be balanced with preserving the greater landscape of open space. Examples include creating connecting linkages for to the Waterways trail system. This could include extensions on Pawtucket and Broadway streets for South Campus and along the VFW Highway with linkages on Aiken Street and University Avenue bridges. All new and existing trail systems should include well defined pedestrian crossways to ensure safe use of the recreational opportunities

Any programs or recreational opportunities open to the public will need to follow ADA regulations. Every recreational opportunity does not need to be ADA accessible. However, the university needs to provide people with disabilities equal opportunities to participate in programs and recreational opportunities on campus. Meaning, the university of should look at all of its trails and conservation areas and have a equal representation for the type of experience offered for that activity that is accessible to people of all abilities. Not every trail has to be accessible nor can or should be made accessible if it would fundamentally alter the experience of that activity. The university will have to communicate with the designated ADA Coordinator in Lowell for official guidance on providing equal opportunities to the public.

### Priority and Cost Estimates for Recommended Projects

Recommendation	Priority Level	Variables
Treat Japanese Knotweed	High	Volunteers, staff, contractors
Treat Black swallowwort	High	Staff or contractors
Mow less often in certain areas of campus to create pollinator habitat	High	Staff mow pollinator areas once annually in mid-October instead of regularly
Active restoration with seed mixes	High	Volunteers, staff, or contractors
Active restoration with native berry producing trees and shrubs	High	Staff, volunteers, contractor, amount of invasive species present and whether native plantings are needed
Trim vegetation along trails	High	Availability of staff, damage after storm events
Repair breaks in fencing	Medium	Availability of staff, location of breaks on or off campus
Create designated river access trail with interpretive wayside panels	Medium	Volunteers, contractor, equipment needed, permitting, materials, and staff
Install crosswalks and lighting to connect campus to green spaces	Medium	staff and contractors, costs of materials, collaboration with city
Create new trail near Sheehy Hall to extend Waterways Trail System	Low	Contractor, equipment needed
Treat other invasive species	Low (except in active project areas)	Staff or contractors

## Appendix A: MESA Species Fact Sheets



### Natural Heritage & Endangered Species Program

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Massachusetts Division of Fisheries & Wildlife

### Blanding's Turtle *Emydoidea blandingii*

State Status: **Threatened**  
Federal Status: **None**

**DESCRIPTION:** The Blanding's Turtle is a mid-sized turtle ranging between 16 and 22 cm (6-9 in.) in shell length. Its high-domed carapace (top shell) is dark and covered with pale yellow flecking. The lower shell (plastron) is yellow with large black blotches on the outer posterior corner of each scute (scale). The plastron is hinged, allowing movement; however, the shell does not close tightly. In older individuals, the entire plastron may be black. The most distinguishing feature is its long yellow throat and chin, which makes it recognizable at a distance. Males have slightly concave plastrons; females have flat plastrons. The tails of males are thicker and their cloacal opening (the common orifice of the digestive, reproductive and urinary systems) is located beyond the edge of the carapace. Hatchlings have a brown carapace and brown to black plastron, and range between 3.4 and 3.7 cm (1.3-1.5 in.) in length.

**SIMILAR SPECIES:** This species could be confused with the Eastern Box Turtle (*Terrapene carolina*). The Eastern Box Turtle can have a yellow chin, but lacks the yellow throat and neck. Box Turtles are smaller, 10-18 cm (4-7 in.) in shell length. In addition, the Box Turtle has a prominent mid-line ridge (keel) on the carapace,



Photo by Susan Speaks

which is absent on Blanding's Turtles. The Blanding's Turtle may also be confused with the Spotted Turtle. However, the Spotted Turtle is much smaller, 3.5-4.5 inches in length and has very distinct round yellow spots.

**HABITAT IN MASSACHUSETTS:** Blanding's Turtles use a variety of wetland and terrestrial habitat types. Blanding's Turtles have been observed in seasonal pools, marshes, scrub-shrub wetlands, and open uplands (Sievert et al. 2003). Habitat use appears to vary according to the individual and the amount of precipitation, with more upland utilization during dry years (Joyal et al. 2001). Wetlands are used for overwintering during their inactive season (Nov-Mar).

**RANGE:** The Blanding's Turtle is found primarily in the Great Lakes region, extending to Kansas. Several smaller, disjunct populations occur in the East: in southern Nova Scotia, in an arc extending from eastern Massachusetts through southeastern New Hampshire to southern Maine, and in the lower Hudson Valley of New

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York. These populations (with the exception of those in New Hampshire) are all listed as Threatened or Endangered at the state or provincial level.

**LIFE CYCLE & BEHAVIOR:** Blanding's Turtles overwinter in organic substrate in the deepest parts of marshes, ponds, and, occasionally, vernal pools. Some individuals overwinter under hummocks in red maple or highbush blueberry swamps. Upon emergence from overwintering, Blanding's Turtles often leave permanent wetlands and move overland to vernal pools and scrub-shrub swamps, where they feed and mate. It is during the summer months that females estivate in upland forest or along forest/field edges. At night and during periods of hot weather, Blanding's Turtles retreat to "forms." These small terrestrial shelters are found beneath leaf litter, in the grass, or under logs or brush, located up to 110 m (361 ft) from the nearest wetland. They are called "forms" because when the turtle leaves them, they retain the shape of the turtle's shell.

Blanding's Turtles are omnivores, eating both plants and animals. They eat while on land and in the water. The animals Blanding's Turtles are known to eat, either alive or as carrion, consist of pulmonate snails, crayfish, earthworms, insects, golden shiners, brown bullheads, and other small vertebrates. Vernal pools are an important source of many of these prey items. The plants that Blanding's Turtles have been known to eat include coontail, duckweed, bulrush, and sedge.

Courtship and mating takes place during the spring and early summer and typically occurs in water. Baker and Gillingham (1983) reported that in semi-natural conditions male Blanding's Turtles exhibit a variety of behaviors during mating including: chasing, mounting, chinning, gulping, swaying, violent swaying, and snorkeling. Chinning occurs after the male is mounted; if the female moves forward, the male will start gulping (taking in water and expelling it over the female's head). Gulping is typically followed by swaying and escalates to violent swaying if the female remains motionless.

Females will remain in wetland or vernal pool habitat until they begin nesting. The majority of nesting occurs in June in open areas with well-drained loamy or sandy soils, such as dirt roads, powerline right-of-ways, residential lawns, gravel pits, and early successional fields. Female Blanding's Turtles reach sexual maturity at 14-20 years of age (Congdon et al. 1993; Congdon

and van Loben Sels, 1993) and may travel great distances, often more than 1 km (3280 ft), to find appropriate nesting habitat (Grgurovic and Sievert, 2005). Females typically begin nesting during the daylight and continue the process until after dark.

Blanding's Turtles display temperature-dependent sex determination; eggs incubated below a pivotal temperature that lies between 26.5°C and 30°C (79.7-86°F) produce males, and higher temperatures produce females (Ewert and Nelson 1991). Typical clutch size ranges from 10 to 12 eggs. Hatchlings emerge in the late August and September. The typical size of a hatchling is about 3.5 cm (1.4 in.) and 10 g (0.35 oz).

**THREATS:** Blanding's Turtles are particularly vulnerable because they travel very long distances during their active season, do not reproduce until late in life (14-20 yrs), and have low nest and juvenile survivorship. These traits make them extremely sensitive to even a 1-2% increase in adult mortality. Roads are the primary cause of adult mortality. Blanding's Turtles travel to multiple wetlands throughout a single year (typically 3-6 wetlands) and adult females travel to nesting habitats, crossing roads in the process.

As this turtle is relatively difficult to study, it is not known how great a decline this species has experienced. In Massachusetts, few nesting sites are currently known and a variety of factors are attributed to this species' low numbers. Habitat loss, degradation, and fragmentation (i.e., roads) are driven by human activities such as commercial and residential expansion. Other threats include illegal collection, unnaturally inflated rates of predation in suburban and urban areas, agricultural and forestry practices, and natural succession (i.e., loss of open nesting habitat).

**MANAGEMENT RECOMMENDATIONS:** Blanding's Turtle habitat needs to be assessed and prioritized for protection based on the extent, quality, and juxtaposition of habitats and their predicted ability to support self-sustaining populations of Blanding's Turtles, using a turtle habitat model developed by UMass and NHESP records. Other considerations should include the size and lack of fragmentation of both wetland and upland habitats, and proximity and connectivity to other relatively unfragmented habitats, especially within existing protected open space.

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Given limited conservation funds, alternatives to outright purchase of conservation land are an important component to the conservation strategy. These can include Conservation Restrictions (CRs) and Agricultural Preservation Restrictions (APRs). However, these incur long-term monitoring costs. Another method of protecting large blocks of land is through the regulatory process by allowing the building of small or clustered roadside developments in conjunction with the protection of large areas of unimpacted land.

Habitat management and restoration guidelines should be developed and implemented in order to create and/or maintain consistent access to nesting habitat at key sites. This is most practical on state-owned conservation lands (i.e., DFW, DCR). However, educational materials should be made available to guide private land owners on appropriate management practices for Blanding's Turtle habitat.

Alternative wildlife corridor structures should be considered at strategic sites on existing roads. In particular, appropriate wildlife corridor structures should be considered for bridge and culvert upgrades and road-widening projects within Blanding's Turtle Habitat. Efforts should be made to inform Mass Highways of key locations where these measures would be most effective for turtle conservation.

Educational materials are being developed and distributed to the public in reference to the detrimental effects of keeping our native turtles as pets (an illegal activity that reduces reproduction in the population), releasing pet store turtles (which could spread disease), leaving cats and dogs outdoors unattended (particularly during the nesting season), feeding suburban wildlife (which increases numbers of natural predators to turtles), and driving ATVs in nesting areas from June-October. People should be encouraged, when safe to do so, to help Blanding's Turtles cross roads (always in the direction the animal was heading); however, turtles should never be transported to "better" locations. They will naturally want to return to their original location and likely need to traverse roads to do so.

Increased law enforcement is needed to protect our wild populations, particularly during the nesting season when poaching is most frequent and ATV use is common and most damaging.

Forestry Conservation Management Practice guidelines should be applied on state and private lands to avoid direct turtle mortality. Seasonal timber harvesting restrictions apply to Blanding's Turtle habitat and to stands with wetlands. Motorized vehicle access to timber harvesting sites in Blanding's Turtle habitat is restricted to times when the Blanding's Turtle is overwintering. Hand felling in wetland areas is required in order to maintain structural integrity of overwintering sites.

Finally, a statewide monitoring program is needed to track long-term population trends in Blanding's Turtles.

#### ACTIVE PERIOD

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

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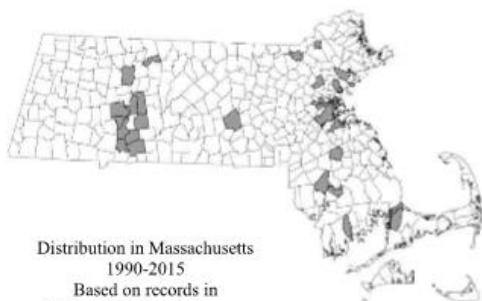
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*Massachusetts Division of Fisheries & Wildlife*

**Peregrine Falcon  
*Falco peregrinus***

State Status: **Threatened**  
Federal Status: **None**

**DESCRIPTION:** The Peregrine Falcon is the fastest bird on earth, capable of diving from great heights at speeds of up to 242 miles per hour. It is a beautiful raptor with long, pointed wings and a long, slightly rounded tail. Adults have a bluish-gray to slate-gray backside and a buffy white underside interspersed with black. Adults also possess a black crown, black moustache-like markings or "sideburns," a white throat, a dark bill with a prominent yellow fleshy base (or cere), and yellow legs and feet. Immature Peregrines have a brown backside and heavily streaked underside. Peregrines are medium-size falcons; males are slightly smaller than a crow 0.4 to 0.45 m (15 to 18 inches) in length with a wingspan of 0.9 to 1.1 m (35 to 42 inches), while females are slightly larger than a crow, reaching a length of 0.45 to 0.5 m (18 to 20 inches) with a wingspan of 1.1 to 1.2 m (42 to 48 inches).



Distribution in Massachusetts  
1990-2015  
Based on records in  
Natural Heritage Database

**SIMILAR SPECIES IN MASSACHUSETTS:** Most incorrect reports of Peregrines turn out to be Cooper's Hawks, which are in the group of raptors (birds of prey) called Accipiters. Birds in this group have long tails and short-rounded wings for dodging through the maze of branches in forest habitats. The confusion comes from their being essentially the same size as the Peregrine

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Falcon, and from the fact that adults have a blue-gray back, which is very similar to the Peregrine's, and juveniles are also brownish with a heavily streaked breast. Cooper's Hawks frequently take songbirds from backyard feeders, so they are often seen at close range in suburban yards. Peregrine Falcons would almost never be seen in these areas.

In the fall and winter, especially along the coast, smaller Merlins and larger Gyrfalcons may be confused with Peregrine Falcons.

**HABITAT IN MASSACHUSETTS:** Historical Peregrine nesting sites (eyries) within Massachusetts were located on rocky cliffs. Of the 14 historical cliff nest sites, Peregrines have returned to Mount Tom (Easthampton), Mount Sugarloaf (Deerfield), Farley Cliffs (Erving), Monument Mountain (Great Barrington), and Pettibone Falls (Chester). Peregrines also nest on the cliffs of quarries in Holyoke, West Roxbury, Saugus, Peabody, and Swampscott.

However, now Peregrines nest most frequently on man-made structures such as buildings and bridges. Peregrines are unusual among raptors in that they do not bring any materials to construct a nest. They simply find a cliff site with accumulated soil or gravel and scrape out a shallow depression in which to lay their eggs. Sometimes, they will lay their eggs in an unused nest of another species, usually a Raven, but also Red-tailed Hawk, and on one occasion an Osprey (Quincy). Since man-made structures do not have natural accumulations of soil, the female Peregrine will lay her eggs on Rock Pigeon nests and accumulated droppings, and sometimes simply on bare steel. Nest failure at such sites is high. However, the placement of a nest box or nest tray filled with a few inches of pea gravel provides an excellent nest site.

Peregrine Falcons now nest on buildings in Boston, Chelsea, Cambridge, Watertown, Lawrence, Lowell, Worcester, Amherst, and New Bedford. They nest on bridges in Charlestown, Fall River, West Springfield, and Northampton. One pair nests on a cell tower in Brockton, and the pair in Quincy originally nested on the 400-foot-tall Goliath Crane in the Quincy Shipyard, until the crane was dismantled and shipped to Romania.

**RANGE:** The Peregrine Falcon is one of the most widely distributed birds in the world, inhabiting every continent except Antarctica.

**LIFE CYCLE/BEHAVIOR:** Most Peregrine Falcons first nest at 2 or 3 years old, but a few (particularly males) will breed as one-year-old birds when they are still in their juvenile plumage. Once established, the adults will remain in the same territory year-round. Adults generally live about 10 years. The longest known life span of a Peregrine Falcon in Massachusetts was achieved by the second male to occupy the Customs House tower territory in downtown Boston. This bird lived to be 17 years old and raised 50 chicks. Although this pair nested on the Customs House in most years, they also nested on the MacCormack Post Office and Courthouse Building in Post Office Square and in the 32<sup>nd</sup> floor balcony garden of the Federal Reserve Bank. This illustrates the species' tendency to nest in the same spot year after year, but to occupy alternate nest sites within their territory in some years.

By March 1<sup>st</sup> the adult pair has chosen their nest site for the season and are spending a lot of time in and around the nest site. Four, rarely five, eggs are laid around the beginning of April and the chicks hatch in early May after a 28-day incubation. The chicks fledge (leave the nest) at about 7 weeks of age in mid-June and become independent of their parents by the beginning of August. In their first fall and winter, most of the young falcons disperse to other areas of Massachusetts, particularly along the coast, while others disperse throughout the Northeastern states where they will eventually nest. A very small number of young birds will migrate as far south as Florida, but will return to the Northeast again in the spring and never migrate south again. Peregrine Falcons that nest at high latitudes in Greenland and Labrador migrate every winter, going as far south as South America.

Peregrines are specially adapted to capture birds in flight. Their best known hunting strategy is to soar up high over their territory and wait for a bird to fly past far below. Once a target has been chosen, they do several strong wing beats to pick up speed and drop straight down into a controlled dive called a stoop. It is during this maneuver that they can attain speeds of at least 185 miles per hour and approaching 200 miles per hour by some reports. The small bird flying below does not usually even know that it has been targeted. The

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Peregrine will strike its prey hard enough to kill it and streak right past. The falcon then pulls out of its dive and catches the falling prey. It is a spectacular scene to watch and is what has made the Peregrine Falcon so prized in falconry since medieval times.

In Massachusetts, the most frequent prey species are Blue Jay, European Starling and Rock Dove (pigeon). Other common prey species include: Red-winged Blackbird, Common Grackle, American Robin, Mourning Dove, Common Flicker, Chimney Swift, House Finch, Cedar Waxwing, Woodcock, and both Black-billed and Yellow-billed Cuckoo.

**POPULATION STATUS:** In the 1930s and 1940s, there were probably about 375 nesting pairs east of the Mississippi River in the United States. Fourteen pairs nested on cliffs in Massachusetts. In 1948, the Massachusetts State Ornithologist, Archie Hagar, discovered that the pair nesting on Rattlesnake Ledge on the western shore of the Prescott Peninsula on the newly created Quabbin Reservoir had broken their eggs for no apparent reason. This observation was the first indication of the affects of the pesticide DDT. Intended for the control of agricultural insect pests, this pesticide passed up the food chain from insects through song birds to Peregrine Falcons, and other predatory species, where it became concentrated. The most significant impact to the falcons was that they laid thin-shelled eggs that broke under the weight of incubation, leaving no young to replace the adults when they eventually died. By 1966, not a single nesting pair remained in the eastern United States. The last historically active nest in Massachusetts was on Monument Mountain in Great Barrington in 1955.

With the ban of DDT in the U.S. in 1972, the stage was set for restoration efforts to begin. The Peregrine Fund, a non-profit organization originally based at Cornell University in New York, began to captive-breed and release young Peregrine Falcon chicks. Two of the earliest release sites were on a tower at Mass Audubon's Drumlin Farm in Lincoln (1975) and on the cliffs of Mount Tom in Holyoke (1976-1979). Unfortunately, none of these birds survived to breed. With the creation of the "Nongame and Endangered Species Program" in 1983, funded largely by voluntary donations on the state income tax form, Peregrine Falcon restoration became the Program's first new project. Young falcons were released on the roof of the McCormack Post Office and Court House Building in downtown Boston in 1984 and 1985. This effort led to the first modern Massachusetts nest in 1987.

Eventually, more than 6,000 captive-born Peregrine Falcon chicks were released across the country by several organizations. The number of nesting pairs continued to grow to the point that on August 25, 1999, the Peregrine Falcon was officially removed from the federal list of Endangered and Threatened Species, having skipped the status of Threatened. Surveys near the time of federal delisting documented over 2,000 nesting pairs in the U.S. (2002), over 400 in Canada (2002) and about 170 in Mexico (1995). In Massachusetts, there were 14 known territorial pairs in 2007. This was the first year that the numbers of pairs had returned to their pre-DDT levels. By 2015, this number had increased to about 30 nesting pairs. Peregrines have attempted to nest on only 6 of the 14 historic nesting cliffs, but the population increase has been driven by the significant increase in nesting opportunities on man-made structures, such as buildings and bridges.

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*Massachusetts Division of Fisheries & Wildlife*

## Cobra Clubtail *Gomphus vastus*

State Status: **Special Concern**  
Federal Status: **None**

**DESCRIPTION:** The Cobra Clubtail is a large, semi-aquatic insect in the order Odonata, suborder Anisoptera (the dragonflies). They are members of the family Gomphidae (the clubtails), a large, diverse group comprising nearly 100 species in North America. Clubtails are named for the lateral swelling at the tip of the abdomen (the seventh through ninth segments) that produces a club-like appearance. The extent of this swelling varies greatly, from extreme to non-existent, depending upon the species. The club is generally more pronounced in males than females. The purpose of the club is uncertain, but it may be used for displays or it may provide some aerodynamic benefits to the males. Clubtails are further distinguished from other dragonflies by their widely separated eyes, wing venation characteristics, and behavior. Many species are very elusive and thus poorly known.

The Cobra Clubtail is in the subgenus *Gomphurus*, a group characterized by having the broadest clubs of any of the Gomphidae. Cobra Clubtails are dark brown dragonflies with pale yellow to greenish markings on the body and bright green eyes. The top of the thorax is



Distribution in Massachusetts  
1990-2015  
Based on records in  
Natural Heritage Database



Photo © Blair Nikula

thick, pale stripes that form a rearward-facing U pattern. There are broad, pale, lateral stripes on the sides of the thorax. The pale thoracic markings are bright yellow in the young adults, but become a dull, grayish-green as the insect matures. The dark abdomen has thin, yellow markings on the tops of segments one through seven and bright yellow patches on the sides of the club. The face is dull yellowish with dark horizontal striping, and the legs are black. The sexes are similar in appearance, though the females have thicker abdomens and a less developed, though still prominent club.

Adult Cobra Clubtails range in length from 1.9 to 2.25 inches (47 mm - 57 mm), with a wingspan averaging 2.6 inches (66 mm). The fully developed nymphs average just over one inch in length (27 mm - 29.5 mm).

**SIMILAR SPECIES:** The Cobra Clubtail is one of three species in the subgenus *Gomphurus* in Massachusetts. The other two, the Midland Clubtail (*Gomphus fraternus*) and Skillet Clubtail (*G. ventricosus*) are very similar in appearance. As in most

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clubtails, the shape of the male hamules (located on the underside of the second abdominal segment) and terminal appendages, and the female vulvar laminae (located on the underside of the eighth and ninth abdominal segments) provide the most reliable means for identification. Cobra Clubtails can also be distinguished by dark cross-striping on the yellow face; Midland Clubtails and Skillet Clubtails both have unmarked yellowish faces. The Cobra Clubtail is entirely dark on the top of segment eight (Midland Clubtail has a yellow spot on the top of segment eight) and has a small pale spot on the front side of segment eight (Skillet Clubtail has a large yellow spot there).

The nymphs can be distinguished by characteristics of the palpal lobes on the labium, as per the keys in Walker (1958), Soltesz (1996), and Needham *et al.* (2000).

**HABITAT:** Cobra Clubtails inhabit large, sandy-bottomed rivers and large, wind-swept lakes. In Massachusetts, they are found along the Connecticut River. There is an historic record from the Merrimack River.

**LIFE-HISTORY/BEHAVIOR:** They have a rather long flight season with emergence beginning in early June and adults on the wing throughout the summer. The nymphs, like those of all dragonflies, are aquatic. They spend at least a year maturing, undergoing several molts during this period. They are voracious predators and feed upon a variety of aquatic life. When ready to emerge, the nymphs crawl out onto exposed rocks, emergent vegetation, partially submerged logs, or the steeper sections of river banks, where they undergo transformation to adults (a process known as “eclosion”). Exuviae have been found in numbers along stretches of the Connecticut River. Emergence generally takes place very early in the morning, presumably to reduce exposure to predation. The cast exoskeletons, known as exuviae, are identifiable to species and can be a reliable, useful means to determine the presence of a species. As soon as the freshly emerged (teneral) adults are dry and the wings have hardened sufficiently, they fly off to seek refuge in the vegetation of adjacent uplands. Here they spend several days or more feeding and maturing, before returning to their breeding habitats. Cobra Clubtails are seldom encountered during this phase of their life; it may be that they spend most of this time high in the tree tops.

When mature, the males return to the water where they can be found resting on sandy stretches of shoreline, or perched on overhanging vegetation. Periodically they make flights out over the water, a foot or so above the surface, with frequent periods of hovering, presumably in search of females. Brief chases between competing males are frequent. During these patrolling flights, the male’s abdomen is tilted upward at about a 30° angle. Females generally appear at water only for a brief period when they are ready to mate and lay eggs. When a male encounters a female, he attempts to grasp the back of her head with claspers located on the end of his abdomen. If the female is receptive, she allows the male to grasp her, then curls the tip of her abdomen upward to connect with the male’s sexual organs located on the underside of the second abdominal segment, thus forming the familiar heart-shaped “wheel” typical of all Odonata — the male above, the female upside down underneath. In this position, the pair flies off to mate, generally hidden high in nearby trees where they are less vulnerable to predators. The duration of mating in Cobra Clubtails has not been recorded, but in similar-sized odonates typically ranges from several minutes to an hour or more.

Females oviposit by flying low over the water, periodically striking the surface with the tips of the abdomen to wash off the eggs. It is not known how long the eggs of Cobra Clubtails take to develop.

**RANGE:** Cobra Clubtails range throughout eastern North America from southwestern Maine, Quebec, Ontario, and Minnesota south to northern Florida, Alabama, and Texas. In New England they have been recorded from southwestern Maine, southern New Hampshire, Massachusetts, and Connecticut.

**POPULATION STATUS IN MASSACHUSETTS:** The Cobra Clubtail is listed as a Species of Special Concern in Massachusetts. As with all species listed in Massachusetts, individuals of the species are protected from take (picking, collecting, killing...) and sale under the Massachusetts Endangered Species Act. Most Massachusetts records of Cobra Clubtail are from the Connecticut River, where it seems to be one of the more common Clubtails. Most recent records are from the Sunderland-Deerfield and Turner’s Fall Pool stretches of the Connecticut River, but this may simply reflect the preponderance of field work done along that section of the river. Recent surveys of the Merrimack River have

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uncovered a population of Cobra Clubtails at several sites along that river as well.

**MANAGEMENT RECOMMENDATIONS:** As for many rare species, the exact management needs of Cobra Clubtails are not known. With most odonates water quality is critical to their well-being, and Cobra Clubtails are undoubtedly no exception. Potential threats to the water quality of the Connecticut River include industrial and agricultural pollution, sewage overflow, salt and other road contaminant run-off, and siltation from construction or erosion. The impact of the disruption of natural flooding regimes by damming and water diversion projects on Cobra Clubtails and other riverine species is unknown but may be considerable. Extensive use of the river by power boats and jet skis is a serious concern, particularly during the early summer emergence period of Cobra Clubtails (as well as several other clubtail species). Many species of clubtails, as well as other riverine odonates, eclose low over the water surface on exposed rocks, emergent or floating vegetation, or steep sections of the river bank where they may be imperiled by the wakes of high speed watercraft as well as rapidly rising water levels, which swamp delicate emerging adults. Low-level recreational use from fisherman and canoeists probably has little impact on odonate populations, but should be monitored. The upland borders of these river systems are also crucial to the well-being of odonate populations as they are critical for feeding, resting, and maturation, particularly for the teneral adults. Development of these areas should be discouraged, and the preservation of remaining undeveloped upland should be a top priority.

#### COBRA CLUBTAIL FLIGHT PERIOD

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

#### REFERENCES:

- Dunkle, S.W. 2000. *Dragonflies through Binoculars*. Oxford University Press.
- Needham, J.G., M.J. Westfall, Jr., and M.L. May. 2000. *Dragonflies of North America*. Scientific Publishers.
- Nikula, B., J.L. Ryan, and M.R. Burne. 2007. *A Field Guide to the Dragonflies and Damselflies of Massachusetts*. Massachusetts Natural Heritage and Endangered Species Program.
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*Massachusetts Division of Fisheries & Wildlife*

**Umber Shadowdragon  
*Neurocordulia obsoleta***

State Status: **Special Concern**

Federal Status: **None**

**SPECIES DESCRIPTION:** The Umber Shadowdragon (*Neurocordulia obsoleta*) is a large insect of the order Odonata and suborder Anisoptera (the dragonflies). The shadowdragons (genus *Neurocordulia*) belong to a family of dragonflies known as the emeralds (Corduliidae). Most emeralds are characterized by moderate pubescence (hairiness) on the thorax, brilliant green eyes in mature individuals, and metallic green highlights on the face, thorax and abdomen. Shadowdragons are one of the exceptions, being somber in coloration, with browns and dull yellows, and without metallic highlights or green eyes. The Umber Shadowdragon is a typical member of the genus with an overall chocolate brown coloration. The face is largely olive/brown with the lower section (labrum) dull yellow. The large eyes, which meet at the top of the head, are brown to chestnut. The brown of this insect's hairy thorax is broken only by a pair of small, yet distinct, yellow markings located on the lower middle part of each side of the thorax. The tube-shaped abdomen is brown with yellow spots on each side of segments 4 through 8 (dragonflies and damselflies have 10 segments on their abdomen). There are no lateral spots on segment 9, though segment 10 is mostly yellow in color. The hind wings have a brown, triangular spot at their bases, while the forewings have a small rectangular shaped brown marking at the base of their wings. Also, there is a row of small brown spots that extend halfway out the leading edge of each wing, ending with a larger brown spot located at the nodus (the forward midpoint of each wing). Otherwise, the wings can be mostly clear to smoky brown (especially in older individuals). The Umber Shadowdragon is a strong flier. When at rest, it hangs vertically from the branch of a tree or bush, with wings held horizontally out from the body.

Adult Umber Shadowdragons range from about 1.7 to 1.9 inches (43 to 48 mm) in length. Although male and female Umber Shadowdragons appear similar in their

coloration, the female is more heavily built with a thicker abdomen, especially at the base.

*Neurocordulia* is one of the few genera of emeralds where all of the species lack metallic green coloration and never have green eyes. The baskettails (genus *Epitheca*) completely lack these metallic highlights as well, and are similar in size and shape. However, these dragonflies generally have green eyes in mature adults and lack the rectangular spot in the forewing and the spotting in the leading edge of the wings of the Umber Shadowdragon.

The nymphs can be distinguished by characteristics of the lateral spines on segment 9 of the abdomen, as reported in keys by Soltesz (1996) and Needham *et al.* (1999).



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**SIMILAR SPECIES:** The Umber Shadowdragon's sister species, the Stygian Shadowdragon (*Neurocordulia yamaskanensis*) (the only other member of this genus to occur in Massachusetts), differs in several ways from the Umber Shadowdragon. The Stygian Shadowdragon is larger than its cousin (1.8 to 2.2 inches (45 to 55 mm)), lacks the spotting found in the leading edges of the wings of the Umber Shadowdragon, and is lighter overall in coloration. The Stygian Shadowdragon is also protected in Massachusetts and is considered a species of Special Concern.

**HISTORY/BEHAVIOR:** Shadowdragons are crepuscular, a behavioral clue that can help to identify these species. Umber Shadowdragons are on the wing from late May through early August. Shadowdragons, formerly referred to as "twilight skimmers", are unique among dragonflies for their strictly crepuscular habits. They are seen for only a short period just after sunset until dark, a window of no more than an hour. During this short time, there is a frenzy of feeding and mating as the shadowdragons try to complete the necessary life functions in an extremely abbreviated activity period. Presumably, these insects spend the rest of their time roosting in trees near their breeding habitat. Due to its unusual and elusive lifestyle, there has been little published on the life cycle of the Umber Shadowdragon. However, the life cycles of better-known species are probably similar and can help supplement our knowledge of the Umber Shadowdragon.

Dragonflies, like their cousins the damselflies (suborder Zygoptera), have two distinct life stages: an aquatic larval stage (nymph) and a flying adult stage. The nymphs of the Umber Shadowdragon spend much of their time clinging to the undersides of rocks, sticks and other debris in the water waiting for an unfortunate animal to wander within reach. Dragonfly nymphs are obligate carnivores, feeding on almost any animal of appropriate size. Prey includes a variety of aquatic insects, small fish, and tadpoles. The time it takes for full development of the nymph of the Umber Shadowdragon is not known, though for similarly sized dragonflies it usually takes about a year. The final stage of development is emergence from the aquatic larval stage to the flying adult. The nymph of the Umber Shadowdragon crawls up onto a solid structure such as a tree, rock, bridge abutment, or bank to emerge. Soon after the adult has fully emerged from its nymphal

exoskeleton (the exuviae), the insect takes its first flight. At this time, the adults are very soft and vulnerable to predators and other threats. For this reason, the dragonfly's maiden flight will take it away from the breeding habitat and into the woods where it can harden and mature in relative safety. This time of wandering is also spent feeding. Adult dragonflies may be found in fields and forest clearings where they prey upon small, aerial insects such as flies and mosquitoes. Although they disperse following emergence, adult shadowdragons are rarely seen away from the breeding site and it is unclear exactly where they spend this maturation period. It is presumed that much of this time is spent in the treetops. When the dragonfly is ready to breed, usually within a week or so, they return to the lake or river.

Breeding in Massachusetts probably occurs from mid-June through mid-July. At the breeding habitat, male Umber Shadowdragons spend much of their time swiftly patrolling the edges of the lake or river searching for females with which to mate. The patrolling flight is often very near the surface of the water and can be erratic with quick changes in direction. Following mating, oviposition occurs. Females of the genus *Neurocordulia* oviposit alone and deposit their eggs directly into the water by tapping the tip of their abdomen on its surface every few feet. While ovipositing, they fly back and forth at a very rapid rate only inches above the surface of the water.

#### UMBER SHADOWDRAGON FLIGHT PERIOD

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

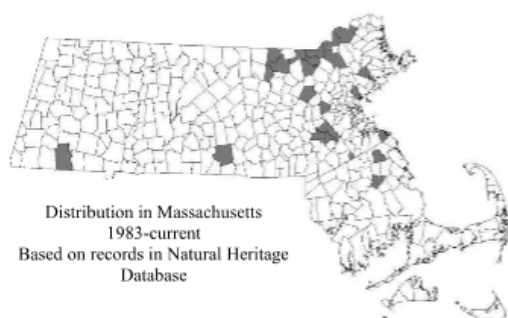
**HABITAT:** The Umber Shadowdragon is found on lakes of various sizes, and on medium to large rivers that are relatively unvegetated. They seem to do well in artificially created habitats, such as reservoirs and dammed sections of rivers, where they have been found in Massachusetts.

**RANGE:** The Umber Shadowdragon is found throughout much of the eastern United States. It is recorded from as far north as Maine, New York, and Michigan, south to Oklahoma, Louisiana and northern Florida.

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#### POPULATION STATUS IN MASSACHUSETTS:

The Umber Shadowdragon is listed as a Species of Special Concern in Massachusetts. As with all species listed in Massachusetts, individuals of the species are protected from take (picking, collecting, killing...) and sale under the Massachusetts Endangered Species Act. The species is known from a few sites in the state; however, due to its elusive nature and crepuscular habits, it is possible that populations of this dragonfly have been overlooked.

**MANAGEMENT RECOMMENDATIONS:** As for many rare species, exact needs for management of the Umber Shadowdragon are not known. As an inhabitant of lakes, ponds, and rivers which are popular recreation spots for large numbers of people, the Umber Shadowdragon may be vulnerable to overuse of these habitats. Power boats creating increased wave action could affect these dragonflies as they emerge near the surface of the water and are very vulnerable. Also, as shorelines are converted to lawns and public beaches, Umber Shadowdragons and other dragonflies have fewer places they can safely emerge. Eutrophication and aquatic plant overgrowth in lentic habitats may also be a threat to this species. Umber Shadowdragons also may be vulnerable to chemical pollution and runoff from roadways. The upland borders of their aquatic habitats are also crucial to the well-being of odonate populations as they are critical for feeding, resting, and maturation. Development of these areas should be discouraged and preservation of the remaining undeveloped upland bordering the river should be a top priority.

#### REFERENCES:

- Dunkle, S.W. 2000. *Dragonflies Through Binoculars*. Oxford University Press.
- Needham, J.G., M.J. Westfall, Jr., and M.L. May. 2000. *Dragonflies of North America*. Scientific Publishers.
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## Appendix B: Invasive Plant Management Options

### Prevent spread of existing invasives and introduction of new invasions

The primary element of a proactive prevention plan is limiting the introduction of new invasive species to individual conservation properties. Spread of existing invasives will be reduced by limiting soil disturbance and implementing restoration when soils are disturbed, by washing equipment that has been used in heavily invaded areas before moving to an un-invaded area, and by implementing practices to reduce likelihood of seed spread by individuals working on invasives control projects. Soil disturbance from plowing, tree removal, trail building, etc., should be limited and all disturbed soil should be covered with leaf litter at the very least with larger areas restored with a fast growing native seed mix. All equipment used for maintenance operations in heavily invaded areas should be cleaned (e.g. with a leaf blower) before moving to non-invaded areas; and stadd and contractors will take special care to pat down, wipe, and/or rinse clothes and shoes after working with invasive plants.

### Early Detection/Rapid Response

Any comprehensive invasive species control program must also include early detection (ED) of new invaders and rapid response (RR) to eliminate new invasions before they become well-established. ED efforts will be directed at the list of early detection species identified by the Massachusetts Invasive Plants Advisory Group (MIPAG). MIPOAG's current ED list is presented in Table 1, and updates can be found on the MIPAG website: <http://www.massnrc.org/mipag/>. Land Stewards should be trained to identify the ED species which are not yet well-known in this part of the state such as Japanese stiltgrass and mile-a-minute vine. The Commission, staff, and stewards should be prepared to collaborate on planning and implementing the rapid response element to eliminate new invasions as quickly as possible.

Table 1. Early Detection (ED) invasive plants as identified by the Massachusetts Invasive Plant Advisory Group (MIPAG).

Flowering Rush	<i>Butomus umbellatus</i>
Brazilian waterweed	<i>Egeria densa</i>
Giant Hogweed	<i>Heracleum mantegazzianum</i>
Yellow floating heart	<i>Nymphoides peltata</i>
Kudzu	<i>Pueraria montana ssp. lobata</i>
Water chestnut	<i>Trapa natans</i>
Pale swallowwort	<i>Cynanchum rossicum</i>
Tall pepperweed	<i>Lepidium latifolium</i>
Japanese stiltgrass	<i>Microstegium vimineum</i>

### Limit spread of highly noxious invaders

Special attention should be paid to particularly aggressive invaders, such as those species with wind-dispersed seeds, aggressive root suckering, allelopathic characteristics, rapid growth, and high resistance to control. Species in this category are shown in Table 2.

Table 2. Particularly aggressive invasive species.

Black swallowwort	<i>Cynanchum louiseae</i>
Japanese knotweed	<i>Fallopia japonica</i>

### Control species with recent or limited presence

Early invasions are much more easily eradicated than well-established stands of any species. Removing young woody plants before they reach a fruiting size prevents further spread, and it is critical to remove aggressively rooting species before they establish a dense underground network. Vining species are more easily removed before they tangle with native shrubs and trees.

### **Location-based Efforts**

#### Limit expansion of heavily invaded areas

An area that is completely covered in invasive species or has several species of invasive plants growing in the same location should be contained to prevent further spread of the infestation. This can be done by identifying the boundary of the heavily invaded area(s) and creating a treatment area buffer zone (e.g., 50 feet around the perimeter of infestation) for targeting management efforts. This allows conservation stewards to prevent encroachment of invasives in cleaner areas without getting overwhelmed or tackling a project that is too big for the available resources.

If highly noxious species are present in the densely invaded area extra measures may need to be taken to really prevent further spread of the infestation. Some options include increasing the treatment area to a 100 foot buffer zone or hiring outside contractors to treat the infestation chemically.

### **Treatment Methods**

Different invasive species respond to different management techniques, several of which are summarized here and detailed in Appendix B. Manual control, pulling plants by hand or with light tools such as loppers or weed wrenches, may be effective for small infestations and where volunteer capacity permits repeated effort. Large infestations and certain problematic species will require more intensive management, often involving the use of herbicides. Herbicides can only be applied by an individual duly licensed by the Department of Agricultural Resources. Because licensure requires liability insurance coverage, while volunteers could obtain this license, it is more likely that herbicide will be applied by a contracted professional. Property-specific management plans should identify infestations and recommended approaches for control. The commission, staff, and stewards should plan and budget for involvement of professionals as necessary. Table 3 provides information on species that can be managed at various times of year.

#### Disposal of removed invasives

Invasive plants that have been hand pulled or cut can be piled on site to decompose or bagged and brought to an area for invasive plant containment. The site(s) used to dump invasives should be monitored to ensure that invasive plants are not establishing themselves from the materials deposited there. Staff and volunteers should take extreme care to avoid spreading seed or other material from which plants can resprout; e.g., Japanese knotweed can sprout from any stray plant part.

*Table 3: Season-specific Management for Commonly Found Invasive Plant Species.*

Common Name	Spring	Summer	Fall
Autumn Olive	manual		chemical
Black swallowwort		chemical/manual	

Burning Bush	manual		chemical
Glossy Buckthorn	manual		chemical
Japanese knotweed		chemical	
Oriental Bittersweet	manual		chemical
Spotted knapweed		chemical/manual	
Tree-of-Heaven	manual		chemical

### Restoration

Many of our invasive species are adapted to pioneer disturbed soils. For this reason, all control efforts and general site work that results in exposed mineral soil should incorporate restoration with fast-growing native species. Small patches of exposed soil, e.g. from root wrenching a shrub, should be tamped down by foot and covered with leaf litter from on-site. Non-forested sites such as meadows, should be seeded with a grass or wild flower seed mix including annual rye (*Lolium perenne*) which can provide a quick cover to open soils and allow non-invasives time to self-germinate.

### Record-keeping

All invasive plant species management actions should be documented with a field datasheet and records kept in a central file. Information collected should include the location, date, species targeted, phenology of plant (vegetative, flowering, fruiting), type of management used (manual, mechanical, chemical), the size of the infestation and an estimate of what percent of the area was managed (See Appendix C for a sample field sheet). Recording these data allow conservation staff to track progress in management efforts, adapt tactics in future years if needed, and have a sense of the expanse of targeted invasive species.

**Foliar spray-** This method is usually applied with a type of sprayer (backpack, mist blower, or tank). The percent of solution depends on the target species, the time of year, and type of sprayer. Glyphosate will target all species while Triclopyr will only target broadleaf plants and will have minimal impact if any on grasses.

**Bloody glove-** A more intensive method of herbicide application often used in place of foliar spray when impacts to non-target species is a concern. Herbicide is applied directly to leaves and stems of target species from a soaked cotton glove worn over a rubber glove.

**Cut and paint-** The stem of the plant is cut so a cross section is showing. The outer edge of the stem is then painted in herbicide; if the stem is hollow herbicide can be injected into the hollow stem. Triclopyr or Glyphosate can be used for treatment.

**Girdling-** This method used for trees involves making a shallow cut through the bark and outer cambium tissue; the plant is slowly killed due to the inability to transport water and nutrients up the trunk. Girdling is particularly effective for species that sprout aggressively from root suckers, particularly black locust, since it seems to bypass the signal to respond to a dead main stem by sprouting from root suckers. Care must be taken not to cut too deeply into the trunk as too deep a cut can sever all phloem tissue which transports nutrients down into the roots of the plant and is necessary to transport herbicide into the roots. If the phloem is all cut, downward transport will cease and black locust will respond by sprouting aggressively from root suckers.

**Basal bark-** Herbicide is applied to the outer surface of the stem. Triclopyr is used because glyphosate will not penetrate the stem. There should not be any standing water present or moisture on the stem. The application can be made with a paint brush or backpack sprayer from the base of the stem to about 1 foot up the stem.

#### **Recommended herbicides:**

**Triclopyr-** Triclopyr is a selective herbicide that will affect broad leaf plants and will have minimal to no impact on monocots. This is due to the fact that it stimulates cell growth elongation. Since monocots grow naturally by elongating their cells it will have little to no affect where since dicots grow laterally, they burst their cell walls and cause damage to the plant when they are stimulated for cell elongation. Since this herbicide can be mixed with water or oil it can be used for foliar sprays, cut and paint, or basal bark applications. It is recommended to use this herbicide when there is a dense native grass understory surrounding a target plant.

**Glyphosate-** Glyphosate is a broad spectrum herbicide meaning it will kill most plants it is applied to. It is an amino acid inhibitor so it inhibits the growth of plants. Foliar sprays should be applied while the plant is actively growing but cut and paint applications can be done during the fall/winter months. This herbicide can be used for foliar sprays and cut and paint applications. Since water is used as the base of the solution it cannot be used for basal bark treatments because water based solutions will not penetrate the bark layer. During cut and paint treatments the herbicide will need to be applied before the cambium layer seals for it to be effective.

*Table 4. General Management Options.*

Method	Good for Volunteers?	Timing	General guidelines	Target Species
Cut and paint	Yes	Late August to November	Preferably done in the fall when woody plants are translocating energy towards roots. Can be done to all trees/ shrubs except black locust (signals root suckering). Preferred treatment for multiflora rose. If berries are present take extra precaution to not spread seed. Best when left in local area and burned in brush pile. Good for volunteers working together with staff: have volunteers cut and haul brush while licensed applicator paints herbicide.	Common Reed (stem injection) Japanese knotweed (stem injection) Burning Bush Oriental bittersweet Multiflora rose (preferred) Bush Honeysuckle (fall) Glossy buckthorn Autumn olive
Hand pull	Yes	Spring and Summer	Great for herbaceous plants with taproot and shallow root system. Best for small infestations. All trees/ shrubs can be hand-pulled when in seedling stage. Garlic mustard should be hand-pulled when second year plants start sending up seed stalk and all plant parts should be bagged and kept out of the sun (seeds can still develop if sunlight is available).	Spotted knapweed Garlic mustard All seedlings for trees and shrubs

Method	Good for Volunteers?	Timing	General guidelines	Target Species
Mechanical (weed wrench/ shovel)	Yes	Spring through Fall, although better before seed set.	Great for small shrubs/ trees. Best when done in early spring when leaves start coming out but before berries develop. Shovels can be used to dig up herbaceous plants with fibrous root systems (black swallowwort) care needs to be taken to make sure all root system is dug up. Soil should be tamped down after removal or native species planted soon after disturbance to keep additional invasives from re-colonizing area.	Japanese knotweed Burning Bush Japanese barberry Black swallowwort Autumn olive Tree of heaven
Basal bark herbicide	No	August through October	This method is best when done in late summer mid fall (Aug-Oct) when flow is towards roots. Can be performed on all trees/ shrubs.	Burning Bush Autumn olive
Biological	Yes	Dependent on insect.	This method of treatment works well for purple loosestrife. It is the least disruptive method of treatment currently available. Usually agents are released in July/ August. The affect the biological agent will have on the environment should be taken into consideration and the relative easiness of other forms of treatment. Depending on infestation size this could be a good way to treat spotted knapweed.	Purple loosestrife (preferred) Spotted knapweed (needs research)



Method	Good for Volunteers?	Timing	General guidelines	Target Species
Foliar spray herbicide	No	When leaves are out.	For trees/ shrubs best when done in the fall when flow is towards roots. Can be done any time for herbaceous plants. When spraying the least amount of herbicide at the smallest effective percentage should be used. The surrounding habitat (wetland vs upland), nesting/ breeding animals, and whether it is a necessary treatment should be considered.	All species
Girdling	If certified in chainsaw safety	Fall	A chainsaw is used to create a ~2" wide cut all around the tree between knee and waist height taking care to remove only the outer layer of cambium, then the fresh cut is painted with herbicide.	Larger trees
Bloody glove	No	When leaves are out.	A rubber glove is worn on the hand with an absorbent cotton glove over it. The cotton glove is dipped in a glyphosate solution (strength depending on target species) then used to directly apply herbicide to leaves, stems, and inflorescences of target plants. Herbicide is absorbed directly into the plant via the stem and leaves, however, breaking the stem aids in more rapid absorption.	Small patches of common reed, seedlings, etc. particularly in wetlands where impacts to non-target species is a concern.

Table 5. Species Specific Management Options.

Species	Biology	Control Recommendations		Monitoring Period
		Manual	Chemical	
Autumn Olive	Autumn Olive flowers in May-July (plants have to be at least 3 years old to flower). Seeds are produced August – November and nuts usually ripen in September. Adults produce less seed in the shade than the sun. Autumn Olive reproduces primarily by seed.	Seedlings can be hand-pulled. Bigger plants can be removed with weed wrenches. Care should be taken to get entire root system. Plants re-sprout vigorously when cut without the use of herbicide.	A foliar treatment with at 2% solution of Triclopyr or Glyphosate can be used when leaves are present. A 25% solution of Triclopyr or Glyphosate can be used for cut and paint. A 20% solution of Triclopyr is recommended for basal bark treatments.	3 years No information available on seed viability.
Black Swallowwort	Black swallowwort spreads vegetatively and by seed. It flowers in June-August. The seeds are released from August to October;	Plants can be dug up with a shovel. The entire root system would need to be removed and this method is very time consuming.	A 2% foliar spray of Glyphosate or Triclopyr is recommended before mid- July. Chemical treatment is recommended from May- June, this would be before the plants flower so there would not be a possibility of spreading seed.	6 years Seeds remain viable up to five years
Winged Euonymus (Burning Bush)	Burning Bush reproduces by seed and vegetatively.	Small plants can be hand pulled while a weed wrench will need to be used for larger plants. Care should be taken to remove entire root system.	A 2% foliar solution of glyphosate is recommended when leaves are present. A 20% solution of glyphosate or triclopyr is recommended for cut and paint and a 20% solution of triclopyr should be used for basal bark application.	5 years No information on seed banking,

Species	Biology	Control Recommendations		Monitoring Period
		Manual	Chemical	
Glossy Buckthorn	Reproduces by seed.	seedlings can be hand-pulled and larger plants can be removed with a weed wrench.	Cut and paint with a 20% solution of glyphosate or 25% triclopyr. A 2% foliar spray can be used while there are leaves. Remove dead stems if possible by mowing or lopping.	7 years Seeds remain viable for 5-7 years.
Japanese Knotweed	The majority of literature recommends spraying after flowering; this makes it harder for the plant to have enough reserves to re-sprout that year. When the plant is in flower (August) there are a lot of bees around this species; care should be taken to avoid spraying bees when present and if possible, efforts should be made to spray multiple times a year before flowering.	Due to its extensive root system hand pulling Japanese Knotweed is not recommended as an efficient form of control.	A 2% solution of Triclopyr or Glyphosate is recommended for foliar spraying and is recommended to be done soon after flowering. For cut and paint techniques a 25% solution of glyphosate or triclopyr is recommended.	4 years Seeds do not remain viable beyond one year, but rhizomes and other plant parts can sprout up to three years after treatment.
Oriental Bittersweet	The seeds are viable for several years, but can sprout from roots and runners.	Seedlings are easy to hand-pull. Bigger vines can be removed by unwinding them from their host and using a weed wrench to uproot them. This can be done year round, but use caution when berries are present.	You can foliar spray with a 2% solution of Glyphosate or Triclopyr. A 20% solution can be used for basal bark treatment. A 25% solution is recommended for cut and paint treatments, both Glyphosate or Triclopyr can be used.	5 years Seeds do not remain viable, but resprouts from roots.

Species	Biology	Control Recommendations		Monitoring Period
		Manual	Chemical	
Spotted Knapweed	Plants may contain carcinogenic compounds and skin irritation can also occur, gloves should be worn when handling	Plants can be hand pulled and bagged. Care should be taken to get entire root system and not to distribute seeds if present.	A 2% Glyphosate foliar spray can be used. Plants are most susceptible if sprayed in the late stages of flower buds (late June).	10 years Seeds can survive for 8 or more years.
Tree-of-Heaven	Tree-of-heaven flowers in May-June, and fruits starting in July. It reproduces by seed and vegetatively. Plants need to be 2 or 3 years old to produce viable seed. It re-sprouts vigorously when cut without herbicide.	Small plants can be removed by hand- pulling or using a weed wrench. Care should be taken to remove entire root system.	A 2% solution is recommended for foliar spray. Either Triclopyr or Glyphosate can be used. Triclopyr is recommended for cut and paint (30% solution) and basal bark (20% solution) treatments.	2 years Few seeds remain viable after one year.

## Appendix C: Invasive Species Treatment Record Datasheet

### Invasive Species Treatment Record

Property:

Date:

Location:

UTM (WGS84/NAD83):

Weather (include 24 hours before and after for chemical treatment)

	Current	24 hours before	24 hours after
Temp.			
Wind speed/direction			
Cloud Cover			
Precipitation			

Method:      Chemical      Manual Mechanical      Biological

Chemical

Chemical used:      % Solution Used:      Amount of solution used:

Amount of herbicide used:      Mix date:

Adjuvants/Carriers etc.:

Method of Application:

Name of applicators:

Biological

Biological control agent:      # Released:      Stage:

Mechanical/ Manual

Equipment used:

Acres/number of plants treated:      % of infested area treated:

Growth stage of target:

Target Species:

Comments:

Date current treatment mapped w/ GPS:

Efficacy notes:

Date/type of last treatment:

ATTACH MAP OF TREATMENT AREA  
or hand draw on back of this sheet