

LOCATOR



SCALE



LEGEND

Total Macrophyte Distribution

- SMU 5 2-7 ft
- All areas
- SMU Boundaries
- Lake Contours (ft)
- Railroad
- Road
- Highway/Interstate
- Tributaries

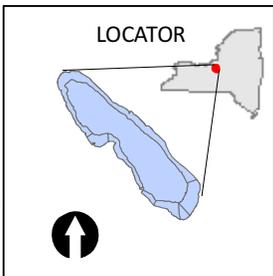
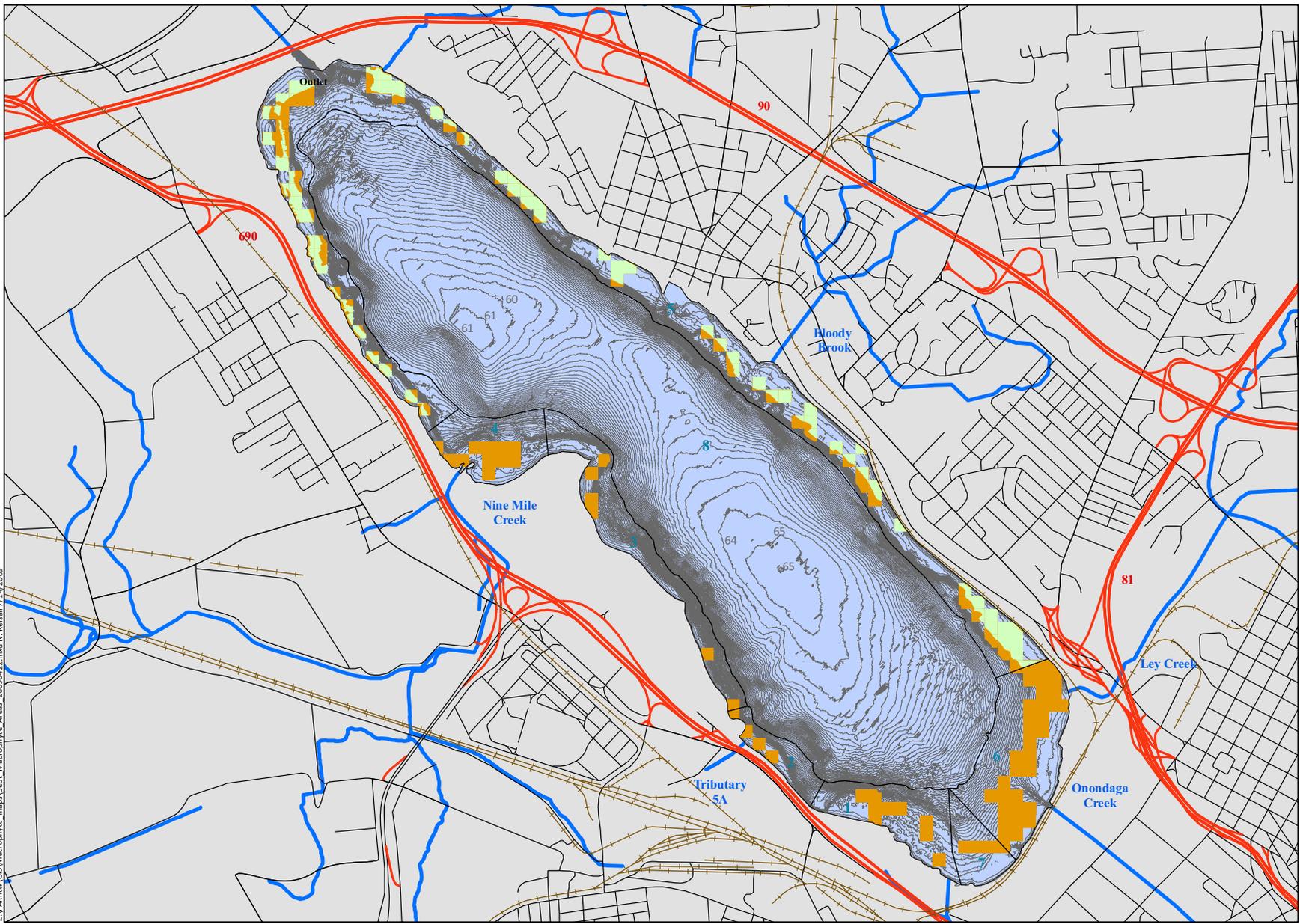
Note: The macrophyte sample grid was clipped to the 7-m depth contour. Macrophytes were sampled at the center of the grid cell.

Figure 18.
 Macrophyte distribution
 in Onondaga Lake:
 September 2008
 Honeywell Inc./PARhtw:141
 July 14, 2009



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LEGEND

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Note: The macrophyte sample grid was clipped to the 7-m depth contour. Macrophytes were sampled at the center of the grid cell.

Figure 19.
 Macrophyte distribution
 in Onondaga Lake
 for October 2008
 Honeywell Inc./PARhtw:141
 July 14, 2009

Appendix D

Suitability of Restoration in Remediation Areas for Representative Species

Suitability of Restoration in Area A for Representative Species

The technical work group evaluated the suitability of the habitat modules proposed in Remediation Area A for the representative species within each major species group to provide insight into how these species may use each area following the proposed restoration.

Remediation Area A - Habitat Modules:

- 1
- 2A
- 3A
- 4A
- 5A
- 6A
- 9B

Fish - In Remediation Area A, the lower energy and variety of submerged, emergent, and floating vegetation proposed for this area will provide suitable habitat for different life stages of all of the representative fish species. Habitat Modules 4A, 5A, and 6A will provide suitable habitat for northern pike spawning and rearing, largemouth bass adults and juveniles, pumpkinseed adults and juveniles, and golden shiner. Remediation Area A is likely to be the most suitable area for golden shiners since they prefer weedy, quiet, shallow sections of lakes. The deeper modules (3A, 2A, and 1) will provide suitable habitat for walleye, smallmouth bass, lake sturgeon, emerald shiner, and brown trout. The addition of structure to Modules 3A and 2A will improve suitability for walleye and smallmouth bass.

Plants - The lower wave energy environment, shallow water depths, and fine substrates proposed for Remediation Area A will provide a wide variety of habitats for submerged aquatic vegetation, persistent and non-persistent emergent wetland species, and floating aquatic vegetation. This area provides the best opportunity for restoration of lower energy environments within the remediation areas of the lake.

The shallow water limits of Module 2A (approximately 7 to 9 ft) will provide habitat for submerged aquatic vegetation. A large area of Module 3A is proposed in Remediation Area A; this habitat includes representative submerged aquatic vegetation for species such as coontail, sago pondweed, tapegrass, and elodea (*Elodea canadensis*), as well as other pond weeds and submerged aquatics common in the lake. The sandy substrate proposed in this area will be suitable for each of these species. The shallower water depths in Modules 5A and 6A will provide habitat for non-persistent and persistent emergent wetland species, respectively. Representative non-persistent emergents that should be found in Module 5A are pickerel weed, arrow arum (*Peltandra virginica*), arrowhead (*Sagittaria latifolia*), water plantain (*Alisma*

subcordatum), and water smartweed (*Polygonum amphibium*). The shallower water depth zone in the large area of Module 6A proposed off-shore in Remediation Area A will not only provide habitat for persistent emergent vegetation, but will also reduce wave energy for the areas of floating aquatic wetland vegetation (Module 4A) proposed in the adjacent near shore area. Representative plant species that may be found in the persistent emergent wetland area (Module 6A) include cattail (*Typha latifolia* and *T. angustifolia*), soft-stem bulrush (*Scirpus tabernaemontani*), river bulrush (*Scirpus fluviatilis*), burreed (*Sparganium eurycarpum*), willow-weed (*Justicia americana*), water-willow (*Decodon verticillatus*), and sedge.

Nearshore of Module 6A, areas of slightly deeper Module 4A (floating aquatic zone) are proposed. With the lower wave energy of Remediation Area A, protection afforded by the off-shore Module 6A area, and proposed fine substrates, this is the best location to provide habitat for floating aquatic species. This is a habitat currently lacking in the lake environment. The deeper water in Module 4A would also protect the proposed off shore Module 6A area from being invaded by *Phragmites*. A deeper water trench is also proposed along the shoreline to further limit *Phragmites* encroachment. Although some of the free-floating duckweeds (*Lemna minor*, *Lemna trisulca*, and *Spirodela polyrhiza*) may occur in the floating aquatic zone (Module 4A), the representative rooted floating aquatics targeted for this area are white water lily, yellow pond lily (*Nuphar lutea*), and American pondweed. Submerged aquatic species will likely occur in this zone as well.

The wetlands at the mouth of Ninemile Creek have been included within the boundary of the Habitat Plan due to their location directly adjacent to the lake shoreline and the mouth of the Ninemile Creek. Removal of *Phragmites* in the two spits adjoining the mouth of Ninemile Creek would be necessary to establish a productive area of emergent wetland (Module 6A). Forested wetlands (Module 9B) are proposed along the shore to increase the amount of existing forested wetland and to help reduce the threat of *Phragmites* extending into the Module 6A area. Silver maple American elm, and black willow, which are common in the existing forested wetland, are targeted for this area.

Benthic Macroinvertebrates - The lower energy habitats proposed for Remediation Area A will create diverse and suitable habitat for lentic species of all the representative invertebrate orders. Suitable habitat for most of these species will be located within the shallower habitat modules (3A, 4A, 5A, and 6A), although Module 2A may be suitable for some dragonfly, caddisfly, true fly (*Diptera*), and mayfly species. The addition of structure (plants, logs, etc.) to any of these modules will increase the habitat diversity and provide additional habitat for some species, especially crayfish. Habitat Module 1 will provide suitable habitat for amphipods and true flies.

Mammals- In Remediation Area A, the combination of habitat requirements for the representative species (e.g., low energy areas, emergent vegetation, trees or other cover along the shoreline) makes for the best location within the lake for the creation of suitable habitat for

the representative mammal species. Suitable habitat for beaver, mink, muskrat and otter will be created by application of habitat module 4A, 5A, and 6A. The addition of structures to any of these modules would improve the habitat suitability for mink. The proximity to Ninemile Creek further enhances the suitability of these areas for mink and otter which can use the tributary as a travel corridor. The deeper offshore modules will provide suitable habitat for otter (Modules 2A and 3A) as well as mink and beaver (Module 3A). The addition of structure to Module 3A will provide suitable habitat for muskrat.

Habitat Module 9B along the shoreline at the mouth of the creek could potentially provide habitat for Indiana bat.

Reptiles and Amphibians - The representative reptile species, musk turtle, painted turtle, snapping turtle, and northern water snake prefer lower energy environments with shallow water and access to cover or some type of structure. Shallow water modules (3A, 4A, 5A, 6A) in Remediation Area A will provide suitable habitat conditions for each of these representative species. Module 4A (floating aquatics) in Remediation Area A would provide areas of cover for escape and feeding for the painted turtle and northern water snake as well as nesting areas for musk turtle. Musk turtle also may find suitable nesting habitat in Modules 6A and 5A. Snapping turtle would benefit most from the natural transition from lake to emergent (Modules 5A and 6A) and upland wetland (Module 9B) areas within and adjacent to Remediation Area A. Habitat would be most suitable for egg deposition in these areas, and the species would be well concealed within the wetland vegetation. The three shallowest modules (4A, 5A, and 6A) also would provide suitable habitat for hibernation and feeding for the four representative reptile species.

The representative amphibian species (red spotted newt, mudpuppy, spotted salamander, green frog (*Rana clamitans melanota*), leopard frog (*Rana pipiens-s. utricularius*), and wood frog (*Rana sylvatica*), generally prefer shallow water environments. Mudpuppy will also use deeper areas (Modules 2A and 3A), but will nest in water less than 3 ft deep. The shallow areas (Modules 4A, 5A, and 6A) will provide suitable habitat for all of the representative species, and provide a smooth transition from the lake to terrestrial areas. In addition, the calm waters and soft substrate of these modules (4A, 5A and 6A) would also provide suitable foraging and hibernating areas for red-spotted newt, green frog, leopard frog, and wood frog. Red-spotted newt and spotted salamander spend their adult stages terrestrially, and Module 9B in the adjacent area will provide cover and suitable habitat.

Birds - Remediation Area A will provide breeding and/or foraging areas for each of the representative bird species.

The deeper water areas (Modules 1 and 2A) of this area will provide suitable foraging and feeding habitat for mallard, common goldeneye, common tern (*Sterna hirundo*), osprey (*Pandion haliaetus*), and bank swallow. Species such as spotted sandpiper, semi-palmated sandpiper, mallard, great blue heron, green heron, red-winged blackbird, and bank swallow would benefit from the foraging opportunities provided by the

soft substrate (Module 6A), while a natural transition to the forested wetland areas adjacent to Remediation Area A (Module 9B) provides perching structures for osprey, red-winged blackbird, and green heron. Wetlands (Modules 5A, 6A) in the near shore areas provide suitable nesting habitat for the common tern, mallard, common goldeneye, and red-winged blackbird. Species such as common goldeneye, mallard, kingfisher, great blue heron, and osprey would benefit from the mid-depth open water areas (Module 3A) for foraging.

Suitability of Restoration in Area B for Representative Species

Plant and animal species that will benefit from the habitat restoration proposed in Remediation Area B are discussed below. Additional benefits are provided by the proposed shoreline stabilization, which are also discussed below and in the following section.

Remediation Area B Habitat Modules:

- 1
- 2A
- 3A
- 5A

Fish - The design of the remedy in Remediation Area B limits the shallow water habitats available for representative fish species. The relatively steep slope to the deeper water habitats (Modules 2A and 1) may provide suitable habitat for adult walleye, emerald shiner, lake sturgeon, smallmouth bass, largemouth bass, and brown trout. Habitat Module 5A has been applied at two locations along the shoreline which will provide suitable habitat for golden shiner and juvenile pumpkinseed, largemouth bass, and northern pike. Module 3A will provide suitable habitat for golden shiner, pumpkinseed, largemouth bass, smallmouth bass, and northern pike adults and juveniles. Addition of structure will increase suitability of Module 3A for bass and pumpkinseed.

Plants - Limited remediation work is proposed in Remediation Area B in areas that would support vegetation. These targeted dredge areas, although slightly deeper after remediation, will provide better habitat for submerged aquatic vegetation (Module 3A) than what currently exists, because of the more suitable substrate. A narrow strip along the shore may provide habitat for non-persistent emergent wetland vegetation (Module 5A), although wave energy may limit its abundance. Common plant species targeted for these modules are detailed under the Remediation Area A plant discussion.

Stabilization efforts proposed along the shore of Remediation Area B (see below) will reduce the resuspension of Solvay waste material and would benefit many plant species. Shrub species, such as the willows (*Salix* spp.) and dogwood (*Cornus* spp.), will potentially be targeted for

those shoreline stabilization areas. The rooting ability of these species and other herbaceous plants will greatly enhance this shoreline reach.

Benthic Macroinvertebrates - The narrow areas of Module 5A and 3A along the shoreline and shallow water areas will provide suitable habitat for each representative order due to the placement of more suitable substrate. The addition of structure to Module 5A would improve the habitat suitability for crayfish.

Mammals – Remediation Area B has a relatively steep littoral zone and only a narrow area where habitat modules can be applied that provide suitable habitat for the representative mammal species. Habitat Module 5A applied at two locations along the shoreline will provide suitable habitat for mink, otter, beaver, and muskrat. The addition of structure to this module will improve the habitat suitability for mink. The deeper off-shore modules will provide suitable habitat for otter (Modules 2A and 3A), mink, and beaver (Module 3A). The addition of structure to Module 3A will provide suitable habitat for muskrat.

Reptiles and Amphibians- The shallow water modules (3A and 5A) in Remediation Area B will provide suitable habitat conditions for the representative species. Modules 3A and 5A will provide suitable habitat for musk turtle due to the cover and vegetation for foraging. Musk turtle may also find suitable nesting habitat in Module 5A. Suitable habitat for snapping turtle can be found at the natural transition from lake (Module 3A) to emergent wetlands (Module 5A) and adjacent upland habitat on WB 1-8, which is currently undergoing a remedial investigation. The species would be well concealed within the wetland vegetation. The shallow 5A Module would also provide suitable habitat for hibernation and feeding for the four representative species.

The shoreline areas of the restored Remediation Area B contain non-persistent wetlands (Module 5A) that will provide habitat for snapping turtle and other species of reptiles. The substrate is suitable for egg laying and provides cover for concealment. The abundance of vegetation within such areas also provides a sufficient food base. Many reptilian species feed on both aquatic and terrestrial resources, and the connectivity of the different habitats within Remediation Area B allows for the development of multiple food bases. The shallow waters (Module 3A), for example, will support fish, a prey of northern water snake. The area where the shoreline stabilization is currently proposed will support more terrestrial food sources for the representative reptile species.

The open water areas (Modules 2A and 3A) of Remediation Area B would provide habitat for a completely aquatic species, such as mudpuppy. The shallow water areas with a fine sand substrate (Module 5A) will support non-persistent vegetation and the representative species of amphibians. The wetlands, although they cover a relatively small area, will provide vegetation to serve as cover for breeding and tadpole development for green frog. The shoreline stabilization area of Remediation Area B and areas where Module 5A will be applied will provide beneficial cover and foraging for such species within both terrestrial and wetland areas.

Birds - Suitable habitat conditions for representative bird species in Remediation Area A are provided by Module 5A (nearshore) and Modules 2A and 3A (off-shore). Specifically, the open water habitats created by Modules 2A and 3A provide deep, mid-depth, and shallow water areas suitable for diving birds, such as osprey, common tern, common goldeneye, and kingfisher. The vegetated shoreline areas transitioning from wetland (Module 5A) to submerged macrophytes (Module 3A) provide foraging habitat for great blue heron, green heron, and sandpipers. Module 3A also would provide suitable habitat for mallards to forage and provide access to adjacent terrestrial locations for nesting.

The soft substrate in nearshore areas of Remediation Area B associated with Module 5A will provide an invertebrate food base for species such as the spotted sandpiper and semi-palmated sandpiper. The common tern and belted kingfisher could find suitable nesting areas in the herbaceous plant cover in the adjacent shoreline stabilization area or adjacent portions of WB 1-8. The steep banks at the Remediation Areas A/B border will provide nesting habitat for bank swallows and belted kingfisher.

Suitability of Shoreline Stabilization in Area B for Representative Species

The shoreline stabilization will occur along the entire length of the SMU 3 shoreline. However, in areas where there is capping up to the shore, the in-lake portion of the stabilization will not be required since an erosion protection layer will be required for the cap design in those near-shore areas. The shoreline stabilization approach being used in Remediation Area B will largely equate to the application of Modules 5B and 6B. Due to the coarse substrate in these modules, no wetland vegetation would be expected. However, as previously mentioned, the purpose of the shoreline stabilization is to reduce resuspension and improve water quality conditions for submerged macrophytes (Module 3) that would be expected farther offshore. In addition, other representative species that would use this area are discussed below.

Fish – The shoreline stabilization areas will provide suitable habitat for smallmouth bass spawning and juvenile walleye (with the addition of structure).

Plants - As mentioned, due to the coarse substrate, vegetation is not anticipated in this area.

Benthic Macroinvertebrates - The coarse substrate will create suitable habitat for crayfish. There will be limited suitability for mayflies and caddisflies.

Mammals – The shoreline stabilization area could provide suitable habitat for mink and otter foraging. The coarse substrate and lack of vegetation will limit the suitability of this module for muskrat and beaver.

Reptiles and Amphibians- The shoreline stabilization areas would provide habitat for the snapping turtle, which is the reptilian species most tolerant of moderate energy expected in this area and may use some of the adjacent low lying areas.

Birds – Habitat for shorebirds, such as the spotted sandpiper and semi-palmated sandpiper, will be provided by the coarse substrates proposed in the stabilization areas, which will limit vegetation and allow for optimum foraging along the shoreline.

Suitability of Restoration in Area C for Representative Species

An evaluation was made of the suitability of the habitat modules proposed in Remediation Area C for the representative species within each major species group as described below.

Remediation Area C Habitat Modules:

- 1
- 2A
- 3B
- 5B
- 6B

Fish – Proposed habitat restoration in Remediation Area C maintains deep water habitats close to shore to allow for shoreline angling. With appropriate structure added along the transition from Module 3 to Module 2, suitable habitat can be provided for bass, pumpkinseed, adult northern pike, golden shiner and adult walleye in these areas. Module 1 will provide suitable habitat for brown trout, emerald shiner, walleye, bass and lake sturgeon. Habitat Module 5B, located along the shoreline, will provide suitable habitat for smallmouth bass spawning and juvenile walleye (with the addition of structure).

Plants - Wave energy, coarse substrate, and deeper water areas proposed nearshore for boat access will limit the establishment of vegetation in portions of Remediation Area C. However, the somewhat protected cove at the mouth of Ditch A and the area southeast of the Department of Transportation turn-around will be suitable areas for submerged aquatic vegetation in Module 3B areas. The rooting ability of submerged aquatics in the shallower portions of Module 3B where a cobble substrate is proposed will limit such vegetation in these areas. As mentioned in the Remediation Area A discussion, submerged aquatic vegetation will occur in the shallower end of Module 2A. Characteristic submerged aquatic species expected in these areas are presented under the Remediation Area A plant discussion.

Benthic Macroinvertebrates - The slightly higher energy in Remediation Area C allows for application of Habitat Module 5B, which,

with slightly larger substrate, will create suitable habitat for crayfish. There will be limited suitability of this module for mayflies and caddisflies. The deeper off-shore modules (2A and 3B) will provide suitable habitat for each of the representative invertebrate orders.

Mammals - Due to the slightly higher energy in Remediation Area C, Module 5B has been applied to the shallow nearshore areas. This module could provide suitable habitat for mink and otter foraging. The larger substrate material of Module 5B compared to 5A limits the suitability of this module for muskrat and beaver. However, the use of this area by aquatic mammals will be somewhat limited because of the recreational activities, adjacent Route 690, and developed land uses, which reduces the on-shore habitat for these species.

Reptiles and Amphibians- Modules 5B and 3B would provide habitat for the snapping turtle, which is the reptilian species most tolerant of moderate energy systems and may utilize some of the terrestrial resources provided along the lakeshore in this area. Other reptilian species, such as musk turtle, painted turtle, and northern water snake, would use the semi-protected areas of Remediation Area C that may allow for species colonization.

Modules 3B, 5B, and 8A in shallow water portions and shoreline areas of Remediation Area C, will provide both aquatic and terrestrial food sources for each of the representative reptilian species. Module 3B along the shoreline area of SMU 2 will provide some vegetated cover for species such as the snapping turtle, painted turtle, and northern water snake.

Areas where Module 3B is applied in the open water areas will provide habitat for mudpuppy and snapping turtle, particularly with the addition of structure. Similarly, the deeper water areas within Module 2A will provide habitat for mudpuppy. In the transitional areas nearshore, Module 5B could potentially support snapping turtles, mudpuppy, and water snake with the addition of structure.

Birds – Remediation Area C will provide breeding and foraging areas for some of the representative bird species. Deeper water off-shore areas where Module 1 will be applied will provide foraging habitat for common goldeneye, mallard, and osprey. Modules 2A and 3B will support foraging by great blue heron, green heron, and belted kingfisher (Module 3B). The open water areas of Module 2B can provide habitat for plunge-diving birds, such as the osprey and common tern, and other diving species including the common goldeneye.

Herbaceous areas created by Module 8A in the near shore areas along the barrier wall will provide suitable nesting habitat for red-winged blackbird. The vegetative cover provides protection while maintaining a proximity to feeding areas and perching posts.

Habitat for shorebirds, such as the spotted sandpiper and semi-palmated sandpiper, will be provided from the coarser, rockier areas along the shoreline of Remediation Area C created by Module 5B which has limited vegetation and allows for optimum foraging along the shoreline.

Suitability of Restoration in Area D for Representative Species

An evaluation was made of the suitability of the habitat modules proposed in Remediation Area D for the representative species within each major species group as described below.

Remediation Area D Habitat Modules:

- 1
- 2A
- 3B
- 5B
- 6A
- 6B
- 8A
- 9B

Fish - The diversity of habitat modules in Remediation Area D provides suitable habitat for several representative fish species. Module 5B will provide suitable habitat for smallmouth bass spawning. The deeper offshore modules will provide suitable habitat for lake sturgeon, brown trout, emerald shiner, and bass (Module 2A) and smallmouth bass spawning, pumpkinseed spawning, northern pike, and walleye (Module 3B). The extensive area of Module 3 and clean substrates will greatly improve the area for these species. With the addition of structure to Module 2A, suitable habitat will be provided for walleye.

Fishing opportunities provided by the deep water areas along the shore are an important aspect of Remediation Area D. There are limited fishing opportunities on the western shore of the lake, particularly areas where fish characteristic of deeper water habitats may be reached using shore fishing techniques.

The emergent wetlands proposed along the shore of Remediation Area D will provide habitat for some fish species during the early spring high water levels. Northern pike spawning habitat will be provided in this area.

Plants- Wave energy and required coarse substrate will affect the abundance of macrophyte growth in Remediation Area D. The shallow water portions of Module 2A and those portions of Module 3B where sand and fine gravel substrates are proposed will be suitable for submerged aquatic species, as discussed under the Remediation Area A plant section. Coarse gravel substrates in Modules 5B and 6B areas will limit rooting potential for species. However, it is likely that as time passes finer grained material will occur and provide a more favorable rooting substrate for submerged aquatic vegetation. The diverse bottom elevations in Module 3 and pockets of deeper areas will

likely create places for finer substrates to occur and increase submerged aquatic vegetation.

Proposed persistent emergent wetlands (Module 6A) and forested wetlands (Module 9B) will provide tremendous opportunities for wetland plant species discussed for these modules in previous sections of this report. These wetland fringe habitats will greatly enhance the lake habitat system.

Benthic Macroinvertebrates - The diversity of habitat modules in Remediation Area D provides suitable habitat for all representative invertebrate species. The addition to structure to Modules 6B and 5B will improve the habitat suitability for crayfish.

Mammals - The diversity of habitat modules in Remediation Area D provides suitable habitat for several representative mammal species. Modules 5B and 6B will provide suitable habitat for mink and otter. The deeper offshore modules will provide suitable habitat for otter (Module 2A) and mink, otter, beaver, and muskrat (Module 3B). The habitat suitability will be enhanced once vegetation has become established in Module 3B.

The inland wetland areas (Module 9B) adjacent to Remediation Area D will provide suitable habitat for mink and beaver and potentially Indiana bat. The associated larger wetland complex (Module 6A) adjacent to Remediation Area D will provide suitable habitat for mink, otter, beaver, and muskrat. Muskrat, in particular, will use this habitat. Module 8A provides a transition from wetland to upland and will provide habitat for mink and otter (Module 8A).

Reptiles and Amphibians- Remediation Area D is a medium energy area with a shoreline shelf proposed to reduce energy within the wetlands proposed along the shoreline area. Habitat modules 3B, 5B, and 6B with coarser substrates and more wave action will limit suitable habitat for reptiles that would use the shallow areas of the lake. Northern water snakes could find suitable prey in the shoreline area adjacent to Remediation Area D, as the fish in shoreline shallows would be the optimal size for consumption. The area along the shoreline would also provide adequate cover for the northern water snake and snapping turtle while supporting a food base of benthic macroinvertebrates, plants, and frogs.

Suitable habitat for all representative reptiles will be provided by the large on-shore area of Module 6A. The persistent emergent wetlands of Module 6A will provide habitat for musk turtles, snapping turtles, painted turtles, and northern water snake. Turtles would have access to aquatic and adjacent terrestrial food sources (Modules 8A and 8B) and the wetlands (Module 6A) would provide sufficient cover for concealment. Northern water snakes would find suitable prey (small fish) within the wetland shallows. The vegetative area would also provide adequate cover for the northern water snake, while supporting a food base of aquatic invertebrates, plants, and frogs for all the reptiles listed.

Habitat Modules 3B, 5B, and 6B with coarser substrates and more wave action will limit suitable habitat for amphibians that would use the

shallow areas of the lake. The mid-depth and deep open water areas of Module 2A would support mudpuppy, particularly with the addition of structure.

Modules 6A, 8A, and 9B will provide habitat for many of the representative amphibian species. The wetlands would provide suitable habitat for concealment and foraging for red-spotted newt, leopard frog, and wood frog. Sediments composed of finer grain sizes and organic matter would provide vegetation important for concealment and egg deposition, as well as providing a gradual transition to persistent emergent wetlands for cover and foraging. The seasonal temporary pools that will be created as part of the inland wetland complex will provide suitable breeding habitat for spotted salamander and wood frog and would provide sufficient shallow areas for tadpole survival.

Birds – Remediation Area D will provide breeding and foraging areas for most of the representative bird species. Shorebirds such as the spotted sandpiper and the semi-palmated sandpiper would benefit most from the unvegetated shallow water areas of Remediation Area D provided by Module 6B which will support a benthic macroinvertebrate food source. The shallow shoreline would allow wading birds access to open shorelines and food without compromising access to more enclosed, sheltered locations.

Osprey, an obligate piscivore, would benefit from the open water habitat areas provided by Modules 1A and 2A. Other birds that often forage in open water habitats include common tern and common goldeneye. These species also would benefit from the mid-depth open water areas for foraging (Modules 1A and 2A).

The variability of habitats and the connectivity of wetlands adjacent to Remediation Area D would be beneficial to common tern and ducks, such as mallard, by providing foraging habitat within shoreline waters and wetland areas. The presence of aquatic invertebrates and small fish would support the forage base for the common tern and belted kingfisher, as well as allow perching and nesting areas among the vegetation on the fringes of wetter areas along the shoreline.

The shallow water wetland of Module 6A would provide foraging areas for great blue heron, green heron, belted kingfisher, red winged blackbird, spotted sandpiper, and the semi-palmated sandpiper. Adjacent areas of Module 9B would provide cover for nesting in bushes, thickets, and small trees for the green heron, red-winged blackbird, common goldeneye, and mallard. The common tern, and red-winged blackbird could find suitable nesting areas in the herbaceous plant cover provided by Module 8A in the near shore areas. The waterfowl nesting mounds would provide ideal habitat for nesting for the mallard, as well as protection of nests from terrestrial predators. Insect production of the wetland will provide foraging opportunities for bank swallows.

Suitability of Restoration in Area E for Representative Species

An evaluation was made of the suitability of the habitat modules proposed in Remediation Area E for the representative species within each major species group.

Remediation Area E Habitat Modules:

- 1
- 2A
- 2B
- 3B
- 5B
- 6A
- 6B
- 8B

Fish – Remediation Area E is a high energy area. The deeper offshore modules will provide suitable habitat for the lake sturgeon, brown trout, emerald shiner, pumpkinseed, northern pike, and bass (Modules 1, 2A, 2B, and 3B). Habitat Modules 2A and 2B will be most suitable for walleye with the addition of structure. The habitat suitability will be enhanced if vegetation becomes established in Module 3B. The area of Module 5B along the shoreline of this area will provide suitable habitat for smallmouth bass spawning and with added structure suitable habitat for walleye.

Plants - Due to the wave energy expected in this area, coarser substrate modules are proposed, which may initially slow the establishment of vegetation in portions of Remediation Area E. However, within the deeper water limits of Module 3B and in the somewhat protected areas between Module 6B and the lake shore, finer substrates are expected to accumulate over time and provide more suitable habitat for submerged aquatic vegetation over a substantial area. Characteristic submerged aquatic species expected in these areas are presented under the Remediation Area A plant discussion.

Benthic Macroinvertebrates- The proposed application of the habitat modules in Remediation Area E should result in suitable habitats to support benthic organisms. Current substrate conditions limit colonization; substrate composed of more native materials (e.g., sand and gravel) should improve habitat suitability for invertebrate colonization. Habitat Module 5B, with the addition of structure, will provide some habitat for crayfish; however, the area where this module can be applied is limited. The deeper off-shore modules will provide suitable habitat for each of the representative orders. The habitat

suitability will be enhanced if vegetation becomes established in Module 3B.

Mammals - Habitat Module 5B will provide some habitat for mink and otter; however, the area where this module can be applied is limited. The deeper off-shore modules will provide suitable habitat for the otter (Modules 2B and 3B) and mink, otter, beaver, and muskrat (Module 3B). The habitat suitability will be enhanced if vegetation becomes established in Module 3B. However, use of this area by aquatic mammals will likely be more closely related to the on-shore habitats at the mouth of Harbor Brook and the SYW-12 area. Waters near these extensive shore habitat areas will be more suitable for such species.

Reptiles and Amphibians - Habitat for several representative reptilian species will be provided by Modules 2A, 2B, 3B and 5B. Specifically, the addition of structure would provide suitable habitat for mudpuppy (Modules 2A and 2B), snapping turtle (Modules 3B and 5B) and northern water snake (Module 5B). As with mammals, reptile and amphibian use of this remediation area will be higher near the Harbor Brook and SYW-12 wetland complexes.

Birds - The deep water of Remediation Area E provided by Module 2B would support an aquatic food base for birds such as the common goldeneye and osprey. Module 3B would help break high energy waves, creating foraging habitat for ducks, such as mallards, as well as common terns, where an invertebrate community becomes established.

Habitat for wading birds, such as great blue heron and green heron, would be provided in shallow areas by Modules 3B and 5B. The common tern, belted kingfisher, and red-winged blackbird could find suitable nesting areas in the herbaceous plant cover in the near shore area of SYW-12.

The warm water discharge from the Metro facility keeps the southern portion of Onondaga Lake ice-free during the winter months. As a result, this is an important wintering area for waterfowl and foraging area for bald eagles. The habitat restoration proposed will not diminish the use of the area for these species.

Suitability of Restoration in the Harbor Brook Wetland Complex (On-shore region straddling Remediation Areas D and E)

Fish - Based on current conditions and the preliminary remediation approaches being considered, it was determined that the area near Harbor Brook, adjacent to Remediation Area E, provides the most suitable area to create spawning habitat for northern pike. The habitat modules were applied to create a large area of emergent wetland (Module 6A) that is preferred by spawning northern pike. Habitat Module 6A will also provide suitable habitat for juvenile stages of many species including bass and pumpkinseed. The transitional areas (Modules 8A and 8B) will not provide suitable habitat for any of the

representative fish species, since these habitats do not have standing water.

Plants - Nearly all the Harbor Brook area outboard of the proposed barrier wall is currently proposed to be restored to wetlands. Large expanses of persistent emergent wetlands (Module 6A) are proposed. All the emergent wetland species noted under the Remediation Area A plant discussion will be expected in this area. These areas are made suitable for emergent wetlands because of the shallow wave break areas (Module 6B) proposed off-shore.

In addition, a *Phragmites* control channel is proposed along the entire shore of the Wastebed B area to help limit the intrusion of *Phragmites* into the emergent wetland areas. This channel will be part of the wetland complex and is expected to provide suitable habitat for floating aquatic vegetation, intermixed with non-persistent emergent species (Module 5A).

The brook will be rerouted along a more sinuous path through an area of persistent emergent wetland (Module 6A). Deeper wetland areas are proposed for fish spawning enhancement and will diversify the wetland complex with non-persistent emergent and floating aquatic wetland zones. All the plant species discussed under Remediation Area A for these habitats will benefit from these changes.

Benthic Macroinvertebrates - The realigned Harbor Brook and associated wetland complex (Module 6A) will provide suitable habitat for each of the representative invertebrate groups. The transitional habitats (8A and 8B) will not provide suitable habitat for any of the invertebrate species since these habitats do not have standing water.

Mammals - The realigned Harbor Brook and associated wetland complex adjacent to Remediation Area E will provide suitable habitat for mink, otter, beaver, and muskrat. Muskrats should be significantly favored by these habitat changes. Modules 8A and 8B provide a transition from wetland to upland and will provide habitat for mink, otter, and beaver (Module 8B).

Reptiles and Amphibians- Suitable habitat for all representative reptiles will be provided by Module 6A in the low energy regime at the Harbor Brook wetland area. The wetland shallows (fishery enhancement areas) and persistent emergent wetlands of Module 6A will provide habitat for musk turtles, snapping turtles, painted turtles, and northern water snake. Turtles would have access to aquatic and adjacent terrestrial food sources (Modules 8A and 8B) and the wetlands (Module 6A) would provide sufficient cover for concealment. Northern water snakes would find suitable prey (small fish) within the wetland shallows. The vegetative area would also provide adequate cover for the northern water snake, while supporting a food base of benthic macroinvertebrates, plants, and frogs for all the reptiles listed.

Modules 6A, 8A, and 9B in the Harbor Brook wetland area will provide habitat for each of the representative amphibian species. Mudpuppy habitat would be provided by the wetland shallows (Module 6A) and by Harbor Brook during the cooler spring and fall months. The wetlands

would also provide suitable habitat for concealment and foraging for the red-spotted newt, leopard frog, and wood frog. Sediments composed of finer grain sizes and organic matter would provide vegetation important for concealment and egg deposition, as well as providing a gradual transition to persistent emergent wetlands for cover and foraging. The seasonal temporary pools that will be created as part of the inland wetland complex will provide suitable breeding habitat for the wood frog and would provide sufficient shallow areas for tadpole survival. In addition, the waterfowl nesting mounds included in this complex will provide habitat for the green frog and leopard frog.

Birds - The shallow water wetland of Module 6A and banks of the realigned Harbor Brook would provide foraging areas for the great blue heron, green heron, belted kingfisher, red winged blackbird, spotted sandpiper, and the semi-palmated sandpiper. The common tern and red-winged blackbird could find suitable nesting areas in the herbaceous plant cover provided by Module 8A in the near shore areas. The waterfowl nesting mounds would provide ideal habitat for nesting for the mallard, as well as protection of nests from terrestrial predators. Insect production of the wetland will provide foraging opportunities for bank swallows.

Appendix E

Master List of Plants

Introduction

The following is a master list of plants that are targeted for use in the restoration of wetland and upland habitats in and around Onondaga Lake. There are separate lists for different vegetation types/habitat modules. As indicated, these habitat types are generally defined by hydrological conditions. Nearly all the plants are native species. The plants are listed alphabetically by scientific name, with nomenclature according to Mitchell and Tucker (1997).

**Wetland Woody Vegetation
(Module 9B, Water at Surface to 1 Foot Below Surface)**

Common Name	Scientific Name
TREES	
Box elder	<i>Acer negundo</i>
Red maple	<i>Acer rubrum</i>
Silver maple	<i>Acer saccharinum</i>
Black gum	<i>Nyssa sylvatica</i>
American sycamore	<i>Platanus occidentalis</i>
Eastern cottonwood	<i>Populus deltoides</i>
Trembling aspen	<i>Populus tremuloides</i>
Swamp white oak	<i>Quercus bicolor</i>
Bur oak	<i>Quercus macrocarpa</i>
Pin oak	<i>Quercus palustris</i>
Black willow	<i>Salix nigra</i>
Northern white cedar	<i>Thuja occidentalis</i>
American elm	<i>Ulmus americana</i>
SHRUBS	
Speckled alder	<i>Alnus rugosa</i>
Canada serviceberry	<i>Amelanchier canadensis</i>
Black chokeberry	<i>Aronia melanocarpa</i>
Musclewood	<i>Carpinus caroliniana</i>
Buttonbush	<i>Cephalanthus occidentalis</i>
Silky dogwood	<i>Cornus amomum</i>
Gray dogwood	<i>Cornus foemina</i>
Red-osier dogwood	<i>Cornus sericea</i>
Witch-hazel	<i>Hamamelis virginiana</i>
Winterberry	<i>Ilex verticillata</i>
Common spicebush	<i>Lindera benzoin</i>
Northern bayberry	<i>Myrica pensylvanica</i>
Mountain holly	<i>Nemopanthus mucronatus</i>
Peach-leaf willow	<i>Salix amygdaloides</i>
Pussy willow	<i>Salix discolor</i>
Shining willow	<i>Salix lucida</i>
Basket willow	<i>Salix purpurea</i>
Black elderberry	<i>Sambucus canadensis</i>
Meadowsweet	<i>Spiraea alba/latifolia</i>

**Wetland Woody Vegetation
(Module 9B, Water at Surface to 1 Foot Below Surface)
(Continued)**

Common Name	Scientific Name
Highbush blueberry	<i>Vaccinium corymbosum</i>
Southern arrowwood	<i>Viburnum dentatum</i>
Nannyberry	<i>Viburnum lentago</i>
Withe-rod	<i>Viburnum nudum</i>

^a. Scientific names according to Mitchell and Tucker (1997) "*Revised Checklist of New York State Plants.*"

**Northeast Wetland Seed Mix
(Modules 6A and 9A, Wetland Edges, Saturated Soils)**

Common Name	Scientific Name
Redtop	<i>Agrostis gigantea</i>
Autumn bent	<i>Agrostis perennans</i>
Swamp milkweed	<i>Asclepias incarnata</i>
New England aster	<i>Aster novae-angliae</i>
Beggar-ticks	<i>Bidens cernua</i>
Nodding beggar-ticks	<i>Bidens cernua</i>
Cosmos sedge	<i>Carex comosa</i>
Lake sedge	<i>Carex lacustris</i>
Blunt broom sedge	<i>Carex scoparia</i>
Fox sedge	<i>Carex vulpinoidea</i>
Creeping spikerush	<i>Eleocharis obtusa</i>
Virginia wild rye	<i>Elymus virginicus</i>
Joe-pye-weed	<i>Eupatorium maculatum</i>
Boneset	<i>Eupatorium perfoliatum</i>
Grass-leaf goldenrod	<i>Euthamia graminifolia</i>
Fowl mannagrass	<i>Glyceria striata</i>
Blue flag	<i>Iris versicolor</i>
Soft rush	<i>Juncus effusus</i>
Path rush	<i>Juncus tenuis</i>
Common monkeyflower	<i>Mimulus ringens</i>
Smooth panic grass	<i>Panicum dichotomiflorum</i>
Fowl bluegrass	<i>Poa pratensis</i>
Marsh smartweed	<i>Polygonum hydropiperoides</i>
Pennsylvania smartweed	<i>Polygonum pennsylvanicum</i>
Green bulrush	<i>Scirpus atrovirens</i>
Woolgrass	<i>Scirpus cyperinus</i>
Leafy bulrush	<i>Scirpus polyphyllus</i>

**Northeast Wetland Seed Mix
(Modules 6A and 9A, Wetland Edges, Saturated Soils)
(Continued)**

Common Name	Scientific Name
Annual rye	<i>Secale cereale</i>
Wrinkled goldenrod	<i>Solidago rugosa</i>
Eastern burreed	<i>Sparganium americanum</i>
Broad-leaf cattail	<i>Typha latifolia</i>
Blue vervain	<i>Verbena hastata</i>

^a. Scientific names according to Mitchell and Tucker (1997) "Revised Checklist of New York State Plants."

**Shallow Emergent (Persistent) Wetland Plantings
(Module 6, Water 1 foot below surface to 1 foot deep)**

Common Name	Scientific Name
Sweetflag	<i>Acorus americanus</i>
Swamp milkweed	<i>Asclepias incarnata</i>
Lake sedge	<i>Carex lacustris</i>
Fox sedge	<i>Carex vulpinoidea</i>
Water willow	<i>Decodon verticillatus</i>
Creeping spikerush	<i>Eleocharis obtusa</i>
Spikerush	<i>Eleocharis obtusa</i>
Joe-pye-weed	<i>Eupatorium maculatum</i>
Soft rush	<i>Juncus effusus</i>
Willow weed	<i>Justicia americana</i>
Rice cutgrass	<i>Leersia oryzoides</i>
Sensitive fern	<i>Onoclea sensibilis</i>
Marsh smartweed	<i>Polygonum hydropiperoides</i>
Arrowhead	<i>Sagittaria latifolia</i>
Hard-stem bulrush	<i>Scirpus acutus</i>
Three-square	<i>Scirpus americanus</i>
Green bulrush	<i>Scirpus atrovirens</i>
Woolgrass	<i>Scirpus cyperinus</i>
Saltmarsh bulrush	<i>Scirpus robustus</i>
Soft-stem bulrush	<i>Scirpus tabernaemontani</i>
Eastern burreed	<i>Sparganium americanum</i>
Giant burreed	<i>Sparganium eurycarpum</i>
Freshwater cordgrass	<i>Spartina pectinata</i>
Narrow-leaf cattail	<i>Typha angustifolia</i>
Broad-leaf cattail	<i>Typha latifolia</i>
Blue vervain	<i>Verbena hastata</i>

^a. Scientific names according to Mitchell and Tucker (1997) "Revised Checklist of New York State Plants."

**Deep Emergent (Nonpersistent) Wetland Plantings
(Module 5, Water 1 to 2 feet deep)**

Common Name	Scientific Name
Water plantain	<i>Alisma subcordatum</i>
Arrow arum	<i>Peltandra virginica</i>
Water smartweed	<i>Polygonum amphibium</i>
Pickerel-weed	<i>Pontederia cordata</i>
Arrowhead	<i>Sagittaria latifolia</i>
Freshwater cordgrass	<i>Spartina pectinata</i>
Narrow-leaf cattail	<i>Typha angustifolia</i>
Bladderwort	<i>Utricularia vulgaris</i>
Wild rice	<i>Zizania aquatica</i>

^a. Scientific names according to Mitchell and Tucker (1997) "Revised Checklist of New York State Plants."

**Aquatic Bed
(Modules 3 and 4A, Water 1 to 4 feet deep)**

Common Name	Scientific Name
Coontail	<i>Ceratophyllum demersum</i>
Sago pondweed	<i>Coleogeton pectinatum</i>
Water weed	<i>Elodea canadensis</i>
Yellow water lily	<i>Nuphar lutea</i>
White water lily	<i>Nymphaea odorata</i>
Pondweed	<i>Potamogeton nodosus</i>
Wild celery	<i>Vallisneria americana</i>
Water stargrass	<i>Zosterella dubia</i>

^a Scientific names according to Mitchell and Tucker (1997) "*Revised Checklist of New York State Plants.*"

Salt Marsh
(Module 6A, Water 1 foot below surface to 1 foot deep)

Common Name	Scientific Name
Saltmarsh aster	<i>Aster subulatus</i>
Alkali grass	<i>Distichlis spicata</i>
Rose mallow	<i>Hibiscus moscheutos</i>
Black grass	<i>Juncus gerardii</i>
Switchgrass	<i>Panicum virgatum</i>
Saltmarsh bulrush	<i>Scirpus robustus</i>
Seaside goldenrod	<i>Solidago sempervirens</i>
Saltgrass	<i>Spartina alternifolia</i>
Salt-meadowgrass	<i>Spartina patens</i>
Freshwater cordgrass	<i>Spartina pectinata</i>

^a. Scientific names according to Mitchell and Tucker (1997) "Revised Checklist of New York State Plants."

**Upland Woody Vegetation
(Module 8B, Water at more than 1 foot below surface)**

Common Name	Scientific Name
TREES	
Red maple	<i>Acer rubrum</i>
Sugar maple	<i>Acer saccharum</i>
Yellow birch	<i>Betula alleghaniensis</i>
White birch	<i>Betula papyrifera</i>
Shagbark hickory	<i>Carya ovata</i>
American hackberry	<i>Celtis occidentalis</i>
White ash	<i>Fraxinus americana</i>
White spruce	<i>Picea glauca</i>
Red pine	<i>Pinus resinosa</i>
White pine	<i>Pinus strobus</i>
Trembling aspen	<i>Populus tremuloides</i>
Black cherry	<i>Prunus serotina</i>
White oak	<i>Quercus alba</i>
Red oak	<i>Quercus rubra</i>
Eastern hemlock	<i>Tsuga canadensis</i>
SHRUBS	
Shadbush	<i>Amelanchier canadensis</i>
Black chokeberry	<i>Aronia melanocarpa</i>
Alternate-leaf dogwood	<i>Cornus alternifolia</i>
Silky dogwood	<i>Cornus amomum</i>
Gray dogwood	<i>Cornus foemina</i>
Beaked hazelnut	<i>Corylus cornuta</i>
Witch-hazel	<i>Hamamelis virginiana</i>
Smooth sumac	<i>Rhus glabra</i>
Staghorn sumac	<i>Rhus hirta</i>
Bladdernut	<i>Staphylea trifolia</i>
Southern arrowwood	<i>Viburnum dentatum</i>
Nannyberry	<i>Viburnum lentago</i>
Highbush cranberry	<i>Viburnum opulus</i>

^a. Scientific names according to Mitchell and Tucker (1997) "Revised Checklist of New York State Plants."

**Conservation Seed Mix
(Module 8A, Uplands and Side Slopes)**

Common Name	Scientific Name
Big bluestem	<i>Andropogon gerardii</i>
Partridge pea	<i>Chamaecrista fosciculata</i>
Showy tick-trefoil	<i>Desmodium canadense</i>
Canada wild rye	<i>Elymus Canadensis</i>
Ox-eye sunflower	<i>Heliopsis helianthoides</i>
Switchgrass	<i>Panicum virgatum</i>
Black eyed Susan	<i>Rudbeckia hirta</i>
Little bluestem	<i>Schizachyrium scoparium</i>
Partridge pea	<i>Senna hebecarpa</i> (Mitchell and Tucker)
Indian grass	<i>Sorghastrum nutans</i>

^a. Scientific names according to Mitchell and Tucker (1997) “*Revised Checklist of New York State Plants.*”

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