

## Conservation Guidelines for Michigan Lakes

Appendix 1.—Plants that are nearly always (>99% probability) found in Michigan lacustrine habitats. Table adapted from Herman et al. (2001). PHYS = physiognomy, C = coefficient of conservatism<sup>1</sup>, M = monocotyledon, D = dicotyledon, S/FL = submergent or floating leaf plant<sup>2</sup>, F = fern or ally, Nt = native taxa, Ad = adventive taxa, A = annual, B = biennial, P = perennial. Michigan status indicated as follows: \*—non-indigenous, (T)—threatened, (En)—endangered, (Ep)—extirpated, (Ex)—extinct, (Sc)—special concern. Parenthetical scientific names indicate former names.

Common name	Scientific name	PHYS	C	M/D	S/FL
Acanthus Family	Acanthaceae				
Water-willow (T)	<i>Justicia americana</i>	Nt P-Forb	9	D	
Water-plantain Family	Alismataceae			M	
Water-plantain	<i>Alisma plantago-aquatica</i>	Nt P-Forb	1	M	Y
Dwarf burhead (En)	<i>Echinodorus tenellus (E. parvulus)</i>	Nt P-Forb	10	M	Y
Short-beaked arrowhead	<i>Sagittaria brevirostra</i>	Nt P-Forb	10	M	Y
Arum-leaved arrowhead	<i>Sagittaria cuneata</i>	Nt P-Forb	6	M	Y
Grass-leaved arrowhead	<i>Sagittaria graminea</i>	Nt P-Forb	10	M	Y
Common arrowhead	<i>Sagittaria latifolia</i>	Nt P-Forb	1	M	Y
Arrowhead (T)	<i>Sagittaria montevidensis</i> ( <i>Lophotocarpus calycinus</i> )	Nt A-Forb	8	M	Y
Stiff arrowhead	<i>Sagittaria rigida</i>	Nt P-Forb	6	M	Y
Amaranth Family	Amaranthaceae			D	
Water-hemp	<i>Amaranthus tuberculatus</i>	Nt A-Forb	6	D	
Cashew Family	Anacardiaceae			D	
Poison sumac	<i>Toxicodendron vernix</i>	Nt Shrub	6	D	
Carrot or Parsley Family	Apiaceae			D	
Angelica	<i>Angelica atropurpurea</i>	Nt P-Forb	6	D	
Water-parsnip (T)	<i>Berula erecta (B. pusilla)</i>	Nt P-Forb	10	D	
Water hemlock	<i>Cicuta bulbifera</i>	Nt P-Forb	5	D	
Water hemlock	<i>Cicuta maculata</i>	Nt B-Forb	4	D	
Hemlock parsley	<i>Conioselinum chinense</i>	Nt P-Forb	10	D	
Water-pennywort	<i>Hydrocotyle americana</i>	Nt P-Forb	6	D	
Water-pennywort	<i>Hydrocotyle umbellata</i>	Nt P-Forb	10	D	
Cowbane	<i>Oxypolis rigidior</i>	Nt P-Forb	6	D	
Water-parsnip	<i>Sium suave</i>	Nt P-Forb	5	D	Y
Holly Family	Aquifoliaceae			D	
Mountain holly	<i>Nemopanthus mucronatus</i>	Nt Shrub	7	D	
Arum Family	Araceae			M	
Sweet-flag	<i>Acorus calamus</i>	Nt P-Forb	6	M	
Wild calla	<i>Calla palustris</i>	Nt P-Forb	10	M	
Arrow-arum	<i>Peltandra virginica</i>	Nt P-Forb	6	M	
Skunk-cabbage	<i>Symplocarpus foetidus</i>	Nt P-Forb	6	M	
Milkweed Family	Asclepiadaceae			D	
Swamp milkweed	<i>Asclepias incarnata</i>	Nt P-Forb	6	D	
Aster or Daisy Family	Asteraceae (Compositae)			D	
Northern bog-aster	<i>Aster borealis</i>	Nt P-Forb	9	D	
Smooth swamp aster	<i>Aster firmus (A. lucidulus)</i>	Nt P-Forb	4	D	
Bog aster	<i>Aster nemoralis</i>	Nt P-Forb	10	D	
Swamp aster	<i>Aster puniceus (A. lucidulus)</i>	Nt P-Forb	5	D	
Small salt-marsh aster *	<i>Aster subulatus</i>	Ad A-Forb	*	D	
Nodding bur-marigold	<i>Bidens cernuus</i>	Nt A-Forb	3	D	
Purple-stemmed tickseed	<i>Bidens connatus</i>	Nt A-Forb	5	D	
Tall swamp-marigold	<i>Bidens coronatus</i>	Nt A-Forb	7	D	
Swamp-thistle	<i>Cirsium muticum</i>	Nt B-Forb	6	D	

## Appendix 1.–Continued.

Common name	Scientific name	PHYS	C	M/D	S/FL
Common cosmos *	<i>Cosmos bipinnatus</i>	Ad A-Forb	*	D	
Orange cosmos *	<i>Cosmos sulphureus</i>	Ad A-Forb	*	D	
Yerba-de-tajo	<i>Eclipta prostrata</i>	Nt A-Forb	4	D	
Hollow Joe-pye-weed (T)	<i>Eupatorium fistulosum</i>	Nt P-Forb	10	D	
Joe-pye-weed	<i>Eupatorium maculatum</i>	Nt P-Forb	4	D	
Water marigold	<i>Megalodonta beckii (Bidens b.)</i>	Nt P-Forb	10	D	Y
Butterfly-dock *	<i>Petasites hybridus</i>	Ad P-Forb	*	D	
Sweet coltsfoot (T)	<i>Petasites sagittatus</i>	Nt P-Forb	10	D	
Black-eyed susan (Sc)	<i>Rudbeckia fulgida (R. sullivantii)</i>	Nt P-Forb	9	D	
Houghton's goldenrod (T)	<i>Solidago houghtonii</i>	Nt P-Forb	10	D	
Ohio goldenrod	<i>Solidago ohioensis</i>	Nt P-Forb	8	D	
Swamp goldenrod	<i>Solidago patula</i>	Nt P-Forb	6	D	
Riddell's goldenrod	<i>Solidago riddellii</i>	Nt P-Forb	6	D	
Bog goldenrod	<i>Solidago uliginosa</i>	Nt P-Forb	4	D	
Birch Family	Betulaceae			D	
Tag alder	<i>Alnus rugosa</i>	Nt Shrub	5	D	
Bog birch	<i>Betula pumila</i>	Nt Shrub	8	D	
Fern Family	Blechnaceae			F	
Netted chain-fern (Ep)	<i>Woodwardia areolata</i>	Nt Fern	10	F	
Virginia chain-fern	<i>Woodwardia virginica</i>	Nt Fern	10	F	
Borage Family	Boraginaceae			D	
Forget-me-not	<i>Myosotis laxa</i>	Nt P-Forb	6	D	
Small forget-me-not *	<i>Myosotis laxa</i>	Ad P-Forb	*	D	
Mustard Family	Brassicaceae (Cruciferae)			D	
Lake cress (T)	<i>Armoracia lacustris (A. aquatica)</i>	Nt P-Forb	8	D	Y
Northern winter cress	<i>Barbarea orthoceras</i>	Nt B-Forb	10	D	
Spring cress	<i>Cardamine bulbosa</i>	Nt P-Forb	4	D	
Cuckoo flower	<i>Cardamine pratensis</i>	Nt P-Forb	10	D	
Watercress *	<i>Nasturtium officinale</i>	Ad P-Grass	*	D	
Yellow cress	<i>Rorippa palustris</i>	Nt A-Forb	1	D	
Creeping yellow cress *	<i>Rorippa sylvestris</i>	Ad P-Forb	*	D	
Awlwort (En)	<i>Subularia aquatica</i>	Nt A-Forb	10	D	Y
Flowering-rush Family	Butomaceae			M	
Fowering-rush *	<i>Butomus umbellatus</i>	Ad P-Forb	*	M	
Water-starwort Family	Callitricheaceae			D	
Autumnal water-starwort (Sc)	<i>Callitriche hermaphroditica</i>	Nt A-Forb	9	D	Y
Large water-starwort (T)	<i>Callitriche heterophylla</i>	Nt A-Forb	9	D	Y
Water-starwort	<i>Callitriche verna (C. palustris)</i>	Nt P-Forb	6	D	Y
Bellflower Family	Campanulaceae			D	
Marsh bellflower	<i>Campanula aparinoides</i>	Nt P-Forb	7	D	
Marsh bellflower	<i>Campanula aparinoides ssp. uliginosa</i>	Nt P-Forb	7	D	
Cardinal flower	<i>Lobelia cardinalis</i>	Nt P-Forb	7	D	
Water lobelia	<i>Lobelia dortmanna</i>	Nt P-Forb	10	D	Y
Bog lobelia	<i>Lobelia kalmii</i>	Nt P-Forb	10	D	
Honeysuckle Family	Caprifoliaceae			D	
Swamp fly honeysuckle	<i>Lonicera oblongifolia</i>	Nt Shrub	8	D	
Pink Family	Caryophyllaceae			D	
Sant spurry *	<i>Spergularia marina</i>	Ad A-Forb	*	D	
Northern stitchwort	<i>Stellaria borealis</i>	Nt P-Forb	10	D	
Starwort (Sc)	<i>Stellaria longipes</i>	Nt P-Forb	10	D	

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Appendix 1.–Continued.

Common name	Scientific name	PHYS	C	M/D	S/FL
Hornwort Family	Ceratophyllaceae				D
Coontail	<i>Ceratophyllum demersum</i>	Nt P-Forb	1	D	Y
Spiny hornwort	<i>Ceratophyllum echinatum</i>	Nt P-Forb	10	D	Y
Goosefoot Family	Chenopodiaceae				D
Coast blight *	<i>Chenopodium rubrum</i>	Ad A-Forb	*	D	
Glasswort *	<i>Salicornia europaea</i>	Ad A-Forb	*	D	
Sedge Family	Cyperaceae				M
Bulrush	<i>Bolboschoenus fluviatilis (Scirpus f.)</i>	Nt P-Sedge	6	M	
Bulrush*	<i>Bolboschoenus maritimus</i>				
	<i>(Scirpus paludosus)</i>	Ad P-Sedge	*	M	
Sedge*	<i>Carex acutiformis</i>	Ad P-Sedge	*	M	
Winged sedge	<i>Carex alata</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex aquatilis</i>	Nt P-Sedge	7	M	
Sedge	<i>Carex arcta</i>	Nt P-Sedge	8	M	
Sedge	<i>Carex atherodes</i>	Nt P-Sedge	5	M	
Sedge	<i>Carex bebbii</i>	Nt P-Sedge	4	M	
Sedge	<i>Carex buxbaumii</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex canescens</i>	Nt P-Sedge	8	M	
Sedge	<i>Carex chordorrhiza</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex comosa</i>	Nt P-Sedge	5	M	
Sedge (T)	<i>Carex crus-corvi</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex cryptolepis</i>	Nt P-Sedge	10	M	
Log sedge (Ep)	<i>Carex decomposita</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex diandra</i>	Nt P-Sedge	8	M	
Sedge	<i>Carex disperma</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex echinata (cephalantha/angustior)</i>	Nt P-Sedge	6	M	
Sedge	<i>Carex emoryi</i>	Nt P-Sedge	7	M	
Sedge	<i>Carex exilis</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex flava</i>	Nt P-Sedge	4	M	
Sedge	<i>Carex folliculata</i>	Nt P-Sedge	10	M	
Frank's sedge (Sc)	<i>Carex frankii</i>	Nt P-Sedge	4	M	
Sedge	<i>Carex gynocrates</i>	Nt P-Sedge	10	M	
Hayden's sedge (Ep)	<i>Carex haydenii</i>	Nt P-Sedge	8	M	
Sedge (En)	<i>Carex heleonastes</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex hyalinolepis</i>	Nt P-Sedge	4	M	
Sedge	<i>Carex hystericina</i>	Nt P-Sedge	2	M	
Sedge	<i>Carex interior</i>	Nt P-Sedge	3	M	
Sedge	<i>Carex lacustris</i>	Nt P-Sedge	6	M	
Sedge	<i>Carex laevivaginata</i>	Nt P-Sedge	8	M	
Sedge	<i>Carex lasiocarpa</i>	Nt P-Sedge	8	M	
Sedge	<i>Carex lenticularis</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex leptalea</i>	Nt P-Sedge	5	M	
Bog sedge	<i>Carex limosa</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex livida</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex longii</i>	Nt P-Sedge	6	M	
Sedge	<i>Carex lupulina</i>	Nt P-Sedge	4	M	
Sedge	<i>Carex lurida</i>	Nt P-Sedge	3	M	
Sedge	<i>Carex michauxiana</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex muskingumensis</i>	Nt P-Sedge	6	M	
Black sedge (En)	<i>Carex nigra</i>	Nt P-Sedge	7	M	
Sedge	<i>Carex oligosperma</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex pauciflora</i>	Nt P-Sedge	10	M	

## Appendix 1.–Continued.

Common name	Scientific name	PHYS	C	M/D	S/FL
Sedge	<i>Carex paupercula</i>	Nt P-Sedge	8	M	
Sedge	<i>Carex pellita (C. lanuginosa)</i>	Nt P-Sedge	2	M	
Sedge	<i>Carex prasina</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex pseudo-cyperus</i>	Nt P-Sedge	5	M	
Sedge	<i>Carex retrorsa</i>	Nt P-Sedge	3	M	
Sedge	<i>Carex rostrata</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex scabrata</i>	Nt P-Sedge	4	M	
Sedge	<i>Carex schweinitzii</i>	Nt P-Sedge	10	M	
Sedge (Sc)	<i>Carex squarrosa</i>	Nt P-Sedge	9	M	
Sedge	<i>Carex sterilis</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex stipata</i>	Nt P-Sedge	1	M	
Straw sedge (En)	<i>Carex straminea</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex stricta</i>	Nt P-Sedge	4	M	
Sedge	<i>Carex suberecta</i>	Nt P-Sedge	8	M	
Sedge	<i>Carex tenuiflora</i>	Nt P-Sedge	10	M	
Hairy-fruited sedge (Sc)	<i>Carex trichocarpa</i>	Nt P-Sedge	8	M	
Sedge	<i>Carex trisperma</i>	Nt P-Sedge	9	M	
Sedge	<i>Carex tuckermanii</i>	Nt P-Sedge	8	M	
Cat-tail sedge (T)	<i>Carex typhina</i>	Nt P-Sedge	9	M	
Sedge	<i>Carex utriculata</i>	Nt P-Sedge	5	M	
Sedge	<i>Carex vaginata</i>	Nt P-Sedge	10	M	
Sedge	<i>Carex vesicaria</i>	Nt P-Sedge	7	M	
Sedge	<i>Carex viridula</i>	Nt P-Sedge	4	M	
Sedge	<i>Carex vulpinoidea</i>	Nt P-Sedge	1	M	
Wiegand's sedge (T)	<i>Carex wiegandii</i>	Nt P-Sedge	9	M	
Twig-rush	<i>Cladium mariscoides</i>	Nt P-Sedge	10	M	
Umbrella sedge (Ep)	<i>Cyperus acuminatus</i>	Nt A-Sedge	6	M	
Umbrella sedge	<i>Cyperus engelmannii</i>	Nt A-Sedge	4	M	
Umbrella sedge	<i>Cyperus erythrorhizos</i>	Nt A-Sedge	6	M	
Yellow flat sedge (S)	<i>Cyperus flavescens</i>	Nt A-Sedge	5	M	
Umbrella sedge	<i>Cyperus squarrosus (C. aristatus)</i>	Nt A-Sedge	5	M	
Three-way sedge	<i>Dulichium arundinaceum</i>	Nt P-Sedge	8	M	
Spike-rush	<i>Eleocharis acicularis</i>	Nt P-Sedge	7	M	Y
Purple spike-rush (En)	<i>Eleocharis atropurpurea</i>	Nt A-Sedge	9	M	
Horsetail spike-rush (Sc)	<i>Eleocharis equisetoides</i>	Nt P-Sedge	9	M	
Spike-rush	<i>Eleocharis erythropoda</i>	Nt P-Sedge	4	M	
Small fruited spike-rush (En)	<i>Eleocharis microcarpa</i>	Nt A-Sedge	10	M	
Slender spike-rush (En)	<i>Eleocharis nitida</i>	Nt P-Sedge	10	M	
Spike-rush	<i>Eleocharis obtusa</i>	Nt A-Sedge	3	M	
Spike-rush	<i>Eleocharis olivacea</i>	Nt P-Sedge	7	M	
Spike-rush	<i>Eleocharis ovata</i>	Nt A-Sedge	8	M	
Dwarf spike-rush (T)	<i>Eleocharis parvula</i>	Nt P-Sedge	10	M	
Four-sided spike-rush	<i>Eleocharis quadrangulata</i>	Nt P-Sedge	8	M	
Spike-rush	<i>Eleocharis quinqueflora (E. pauciflora)</i>	Nt P-Sedge	10	M	
Spike rush (Ep)	<i>Eleocharis radicans</i>	Nt P-Sedge	10	M	
Spike-rush	<i>Eleocharis robbinsii</i>	Nt P-Sedge	8	M	Y
Spike-rush	<i>Eleocharis rostellata</i>	Nt P-Sedge	10	M	
Spike-rush	<i>Eleocharis smallii</i>	Nt P-Sedge	5	M	
Three-ribbed spike-rush (T)	<i>Eleocharis tricostata</i>	Nt P-Sedge	10	M	
Narrow-leaved cotton-grass	<i>Eriophorum angustifolium</i>	Nt P-Sedge	10	M	
Slender cotton-grass	<i>Eriophorum gracile</i>	Nt P-Sedge	10	M	
Cotton-grass	<i>Eriophorum spissum</i>	Nt P-Sedge	10	M	

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Common name	Scientific name	PHYS	C	M/D	S/FL
Cotton-grass	<i>Eriophorum tenellum</i>	Nt P-Sedge	10	M	
Tawny cotton-grass	<i>Eriophorum virginicum</i>	Nt P-Sedge	8	M	
Green-keeled cotton-grass	<i>Eriophorum viridi-carinatum</i>	Nt P-Sedge	8	M	
Chestnut sedge (Ep)	<i>Fimbristylis puberula</i>	Nt P-Sedge	10	M	
Umbrella-grass (T)	<i>Fuirena squarrosa (F. pumila)</i>	Nt P-Sedge	10	M	
Dwarf-bulrush (Sc)	<i>Hemicarpha micrantha (Lipocarpa m.)</i>	Nt A-Sedge	7	M	
Bald-rush	<i>Psilocarya nitens</i>	Nt A-Sedge	10	M	
Bald-rush (T)	<i>Psilocarya scirpoides</i>	Nt A-Sedge	10	M	
Bald-rush	<i>Rhynchospora alba</i>	Nt P-Sedge	6	M	
Bald-rush	<i>Rhynchospora capillacea</i>	Nt P-Sedge	10	M	
Bald-rush	<i>Rhynchospora capitellata</i>	Nt P-Sedge	6	M	
Bald-rush	<i>Rhynchospora fusca</i>	Nt P-Sedge	7	M	
Tall beak-rush (Sc)	<i>Rhynchospora macrostachya</i>	Nt P-Sedge	9	M	
Short-beaked bald-rush	<i>Rhynchospora nitens (Psilocarya n.)</i>	Nt A-Sedge	10	M	
Hardstem bulrush	<i>Schoenoplectus acutus (Scirpus a.)</i>	Nt P-Sedge	5	M	
Olney's bulrush (T)	<i>Schoenoplectus americanus (Scirpus olneyi)</i>	Nt P-Sedge	10	M	
Hall's bulrush (T)	<i>Schoenoplectus hallii (Scirpus h.)</i>	Nt A-Sedge	10	M	
Bulrush	<i>Schoenoplectus heterochaetus (Scirpus h.)</i>	Nt P-Sedge	10	M	
Three-sqaure	<i>Schoenoplectus pungens (Scirpus americanus)</i>	Nt P-Sedge	5	M	
Pursh's tufted bulrush	<i>Schoenoplectus purshianus (Scirpus p.)</i>	Nt A-Sedge	8	M	
Bulrush	<i>Schoenoplectus smithii (Scirpus s.)</i>	Nt A-Sedge	8	M	
Bulrush	<i>Schoenoplectus subterminalis (Scirpus s.)</i>	Nt P-Sedge	8	M	Y
Softstem bulrush	<i>Schoenoplectus tabernaemontani (Scirpus validus)</i>	Nt P-Sedge	4	M	
Torrey's bulrush (Sc)	<i>Schoenoplectus torreyi (Scirpus t.)</i>	Nt P-Sedge	10	M	
Bulrush	<i>Scirpus atrovirens</i>	Nt P-Sedge	3	M	
Wool-grass	<i>Scirpus cyperinus</i>	Nt P-Sedge	5	M	
Bulrush	<i>Scirpus expansus</i>	Nt P-Sedge	5	M	
Mosquito bulrush	<i>Scirpus hattorianus</i>	Nt P-Sedge	3	M	
Bulrush	<i>Scirpus microcarpus</i>	Nt P-Sedge	5	M	
Bulrush	<i>Scirpus pendulus</i>	Nt P-Sedge	3	M	
Netted nut-rush (T)	<i>Scleria reticularis</i>	Nt A-Sedge	10	M	
Nut-rush	<i>Scleria verticillata</i>	Nt A-Sedge	10	M	
Bulrush	<i>Trichophorum alpinum (Scirpus hudsonianus)</i>	Nt P-Sedge	10	M	
Bulrush	<i>Trichophorum cespitosum (Scirpus cespitosus)</i>	Nt P-Sedge	10	M	
Sundew Family	Droseraceae			D	
Sundew	<i>Drosera intermedia</i>	Nt P-Forb	8	D	
Linear-leaved sundew	<i>Drosera linearis</i>	Nt P-Forb	10	D	
Round-leaved sundew	<i>Drosera rotundifolia</i>	Nt P-Forb	6	D	
English sundew (Sc)	<i>Drosera Xanglica</i>	Nt P-Forb	10	D	
Waterwort Family	Elatinaceae			D	
Waterwort	<i>Elatine minima</i>	Nt A-Forb	10	D	Y
Horsetail Family	Equisetaceae			F	
Water horsetail	<i>Equisetum fluviatile</i>	Nt Fern Ally	7	FA	Y
Giant horsetail (Ep)	<i>Equisetum telmateia</i>	Nt Fern Ally	10	FA	
Heath Family	Ericaceae			D	
Bog rosemary	<i>Andromeda glaucophylla</i>	Nt Shrub	10	D	
Leatherleaf	<i>Chamaedaphne calyculata</i>	Nt Shrub	8	D	

## Appendix 1.–Continued.

Common name	Scientific name	PHYS	C	M/D	S/FL
Swamp-laurel	<i>Kalmia polifolia</i>	Nt Shrub	10	D	
Labrador-tea	<i>Ledum groenlandicum</i>	Nt Shrub	8	D	
Large cranberry	<i>Vaccinium macrocarpon</i>	Nt Shrub	8	D	
Small cranberry	<i>Vaccinium oxycoccos</i>	Nt Shrub	8	D	
Pipewort Family	Eriocaulaceae				M
Pipewort	<i>Eriocaulon septangulare</i>	Nt P-Forb	9	M	Y
Gentian Family	Gentianaceae				D
Panicled screw-stem (T)	<i>Bartonia paniculata</i>	Nt A-Forb	10	D	
Great Lakes gentian	<i>Gentiana rubricaulis</i>	Nt P-Forb	7	D	
Small fringed gentian	<i>Gentianopsis procera</i> ( <i>Gentiana p.</i> )	Nt A-Forb	8	D	
Buckbean	<i>Menyanthes trifoliata</i>	Nt P-Forb	8	D	
Gooseberry Family	Grossulariaceae				D
Northern black currant	<i>Ribes hudsonianum</i>	Nt Shrub	10	D	
Swamp red currant	<i>Ribes triste</i>	Nt Shrub	6	D	
St. John's-wort Family	Guttiferae				D
Northern St. John's-wort	<i>Hypericum boreale</i>	Nt P-Forb	5	D	Y
Pale St. John's-wort	<i>Hypericum ellipticum</i>	Nt P-Forb	9	D	
Marsh St. John's-wort	<i>Triadenum fraseri</i> ( <i>Hypericum f.</i> )	Nt P-Forb	6	D	
Marsh St. John's-wort	<i>Triadenum virginicum</i> ( <i>Hypericum v.</i> )	Nt P-Forb	10	D	
Water-milfoil Family	Haloragaceae				D
Alternate-leaved water-milfoil (Sc)	<i>Myriophyllum alterniflorum</i>	Nt P-Forb	10	D	Y
Spiked water-milfoil	<i>Myriophyllum exalbescens</i>	Nt P-Forb	10	D	Y
Farwell's water-milfoil (T)	<i>Myriophyllum farwellii</i>	Nt P-Forb	10	D	Y
Various-leaved water-milfoil	<i>Myriophyllum heterophyllum</i>	Nt P-Forb	6	D	Y
Eurasian water-milfoil *	<i>Myriophyllum spicatum</i>	Ad P-Forb	*	D	Y
Water-milfoil	<i>Myriophyllum tenellum</i>	Nt P-Forb	10	D	Y
Water-milfoil	<i>Myriophyllum verticillatum</i>	Nt P-Forb	6	D	Y
Mermaid weed	<i>Proserpinaca palustris</i>	Nt P-Forb	6	D	Y
Mermaid weed (E)	<i>Proserpinaca pectinata</i>	Nt P-Forb	9	D	Y
Mare's-tail Family	Hippuridaceae				
Mare's-tail	<i>Hippuris vulgaris</i>	Nt P-Forb	10	D	Y
Frog's-bit Family	Hydrocharitaceae				M
Common waterweed	<i>Elodea canadensis</i>	Nt P-Forb	1	M	Y
Slender waterweed	<i>Elodea nuttallii</i>	Nt P-Forb	5	M	Y
European frog's-bit *	<i>Hydrocharis morsus-ranae</i>	Ad P-Forb	*	M	Y
Eel grass	<i>Vallisneria americana</i>	Nt P-Forb	7	M	Y
Iris Family	Iridaceae				M
Yellow flag *	<i>Iris pseudacorus</i>	Ad P-Forb	*	M	
Wild blue flag	<i>Iris versicolor</i>	Nt P-Forb	5	M	
Southern blue flag	<i>Iris virginica</i>	Nt P-Forb	5	M	
Quillwort Family	Isoetaceae				F
Quillwort	<i>Isoetes echinospora</i>	Nt Fern Ally	8	FA	Y
Quillwort	<i>Isoetes lacustris</i>	Nt Fern Ally	8	FA	Y
Rush Family	Juncaceae				M
Sharp-fruited rush	<i>Juncus acuminatus</i>	Nt P-Forb	8	M	
Rush	<i>Juncus alpinus</i>	Nt P-Forb	5	M	
Jointed rush	<i>Juncus articulatus</i>	Nt P-Forb	3	M	
Rush	<i>Juncus balticus</i>	Nt P-Forb	4	M	
Rush	<i>Juncus brachycephalus</i>	Nt P-Forb	7	M	
Rush	<i>Juncus brevicaudatus</i>	Nt P-Forb	8	M	

Conservation Guidelines for Michigan Lakes

Appendix 1.–Continued.

Common name	Scientific name	PHYS	C	M/D	S/FL
Canadian rush	<i>Juncus canadensis</i>	Nt P-Forb	6	M	
Soft-stemmed rush	<i>Juncus effusus</i>	Nt P-Forb	3	M	
Black-grass *	<i>Juncus gerardii</i>	Ad P-Forb	*	M	
Soldier rush (T)	<i>Juncus militaris</i>	Nt P-Forb	10	M	Y
Joint rush	<i>Juncus nodosus</i>	Nt P-Forb	5	M	
Brown-fruited rush	<i>Juncus pelocarpus</i>	Nt P-Forb	8	M	Y
Arrow-grass Family	Juncaginaceae			M	
Arrow-grass	<i>Scheuchzeria palustris</i>	Nt P-Forb	10	M	
Common bog arrow-grass	<i>Triglochin maritimum</i>	Nt P-Forb	8	M	
Slender bog arrow-grass	<i>Triglochin palustre</i>	Nt P-Forb	8	M	
Mint Family	Lamiaceae (Labiatae)			D	
Common water horehound	<i>Lycopus americanus</i>	Nt P-Forb	2	D	
Rough water horehound *	<i>Lycopus asper</i>	Ad P-Forb	*	D	
European water horehound *	<i>Lycopus europaeus</i>	Ad P-Forb	*	D	
Stalked water horehound	<i>Lycopus rubellus</i>	Nt P-Forb	8	D	
Northern bugle weed	<i>Lycopus uniflorus</i>	Nt P-Forb	2	D	
Bugle weed (T)	<i>Lycopus virginicus</i>	Nt P-Forb	8	D	
Peppermint *	<i>Mentha piperita</i>	Ad P-Forb	*	D	
Broad-leaved mountain mint (T)	<i>Pycnanthemum muticum</i>	Nt P-Forb	10	D	
Common skullcap	<i>Scutellaria galericulata</i>	Nt P-Forb	5	D	
Mad-dog skullcap	<i>Scutellaria lateriflora</i>	Nt P-Forb	5	D	
Woundwort	<i>Stachys palustris</i>	Nt P-Forb	5	D	
South hedge nettle	<i>Stachys tenuifolia</i>	Nt P-Forb	5	D	
Duckweed Family	Lemnaceae			M	
Small duckweed	<i>Lemna minor</i>	Nt A-Forb	5	M	Y
Star duckweed	<i>Lemna trisulca</i>	Nt A-Forb	6	M	Y
Pale duckweed (Ep)	<i>Lemna valdiviana</i>	Nt A-Forb	8	M	Y
Great duckweed	<i>Spirodela polyrhiza</i>	Nt A-Forb	6	M	Y
Common water meal	<i>Wolffia columbiana</i>	Nt A-Forb	5	M	Y
Pointed water meal (T)	<i>Wolffia papulifera</i> ( <i>W. brasiliensis</i> )	Nt P-Forb	10	M	Y
Dotted water meal	<i>Wolffia punctata</i>	Nt A-Forb	5	M	Y
Bladderwort Family	Lentibulariaceae			D	
Butterwort (Sc)	<i>Pinguicula vulgaris</i>	Nt P-Forb	10	D	
Horned bladderwort	<i>Utricularia cornuta</i>	Nt A-Forb	10	D	Y
Bog bladderwort	<i>Utricularia geminiscapa</i>	Nt P-Forb	8	D	Y
Humped bladderwort	<i>Utricularia gibba</i>	Nt P-Forb	8	D	Y
Flat-leaved bladderwort	<i>Utricularia intermedia</i>	Nt P-Forb	10	D	Y
small bladderwort	<i>Utricularia minor</i>	Nt P-Forb	10	D	Y
Purple bladderwort	<i>Utricularia purpurea</i>	Nt P-Forb	10	D	Y
Floating bladderwort (En)	<i>Utricularia radiata</i> ( <i>U. inflata</i> )	Nt A-Forb	10	D	Y
Small purple bladderwort	<i>Utricularia resupinata</i>	Nt A-Forb	10	D	Y
Zigzag bladderwort (T)	<i>Utricularia subulata</i>	Nt A-Forb	10	D	Y
Great bladderwort	<i>Utricularia vulgaris</i>	Nt P-Forb	6	D	Y
Lily Family	Liliaceae			M	
False mayflower	<i>Smilacina trifolia</i>	Nt P-Forb	10	M	
False asphodel	<i>Tofieldia glutinosa</i>	Nt P-Forb	10	M	
Clubmoss Family	Lycopodiaceae			FA	
Bog clubmoss	<i>Lycopodiella inundata</i> ( <i>Lycopodium i.</i> )	Nt Fern Ally	7	FA	
Loosestrife Family	Lythraceae			D	
Sessile tooth-cup	<i>Ammannia robusta</i>	Nt A-Forb	6	D	

Appendix 1.–Continued.

Common name	Scientific name	PHYS	C	M/D	S/FL
Whorled or swamp loosestrife	<i>Decodon verticillatus</i>	Nt Shrub	7	D	
Winged loosestrife	<i>Lythrum alatum</i>	Nt P-Forb	9	D	
Hyssop loosestrife *	<i>Lythrum hyssopifolia</i>	Ad A-Forb	*	D	
Purple loosestrife *	<i>Lythrum salicaria</i>	Ad P-Forb	*	D	
Tooth-cup (Sc)	<i>Rotala ramosior</i>	Nt A-Forb	8	D	
Mallow Family	Malvaceae			D	
Smooth rose mallow (Sc)	<i>Hibiscus laevis</i>	Nt P-Forb	7	D	
Swamp rose mallow (Sc)	<i>Hibiscus moscheutos (H. palustris)</i>	Nt P-Forb	7	D	
Marsilea Family	Marsilaceae			FA	
European water-clover *	<i>Marsilea quadrifolia</i>	Ad Fern	*	FA	Y
Melastome Family	Melastomataceae			D	
Meadow beauty (Sc)	<i>Rhexia virginica</i>	Nt P-Forb	9	D	
Bayberry Family	Myricaceae			D	
Sweet gale	<i>Myrica gale</i>	Nt Shrub	6	D	
Naiad Family	Najadaceae			M	
Slender naiad	<i>Najas flexilis</i>	Nt A-Forb	5	M	Y
Naiad	<i>Najas gracillima</i>	Nt A-Forb	8	M	Y
Southern naiad	<i>Najas guadalupensis</i>	Nt A-Forb	7	M	Y
Spiny naiad *	<i>Najas marina</i>	Ad A-Forb	*	M	Y
Naiad *	<i>Najas minor</i>	Ad A-Forb	*	M	Y
Water-lily Family	Nymphaeaceae			D	Y
Watershield	<i>Brasenia schreberi</i>	Nt P-Grass	6	D	Y
Fanwort *	<i>Cabomba caroliniana</i>	Ad P-Forb	*	D	Y
American lotus (T)	<i>Nelumbo lutea</i>	Nt P-Forb	8	D	Y
Yellow pond-lily	<i>Nuphar advena</i>	Nt P-Forb	8	D	Y
Small yellow pond-lily (En)	<i>Nuphar pumila</i>	Nt P-Forb	10	D	Y
Yellow pond-lily	<i>Nuphar variegata</i>	Nt P-Forb	7	D	Y
Sweet-scented waterlily	<i>Nymphaea odorata (N. tuberosa)</i>	Nt P-Forb	6	D	Y
Pygmy pond-lily (En)	<i>Nymphaea tetragona</i>	Nt P-Forb	10	D	Y
Olive Family	Oleaceae			D	
Pumpkin ash (T)	<i>Fraxinus profunda</i>	Nt Tree	9	D	
Evening-primrose Family	Onagraceae			D	
Cinnamon willow-herb	<i>Epilobium coloratum</i>	Nt P-Forb	3	D	
Fen willow-herb	<i>Epilobium leptophyllum</i>	Nt P-Forb	6	D	
Marsh willow-herb	<i>Epilobium palustre</i>	Nt P-Forb	10	D	
Downy willow-herb	<i>Epilobium strictum</i>	Nt P-Forb	8	D	
Seedbox (Sc)	<i>Ludwigia alternifolia</i>	Nt P-Forb	8	D	
Water-purslane	<i>Ludwigia palustris</i>	Nt P-Forb	4	D	Y
False loosestrife	<i>Ludwigia polycarpa</i>	Nt P-Forb	6	D	
Round-fruited loosestrife (T)	<i>Ludwigia sphaerocarpa</i>	Nt P-Forb	10	D	
Orchid Family	Orchidaceae			M	
Round-leaved orchis (En)	<i>Amerorchis rotundifolia (Orchis r.)</i>	Nt P-Forb	10	M	
Dragon's mouth	<i>Arethusa bulbosa</i>	Nt P-Forb	10	M	
Grass-pink	<i>Calopogon tuberosus</i>	Nt P-Forb	9	M	
White lady's-slipper (T)	<i>Cypripedium candidum</i>	Nt P-Forb	10	M	
White-fringed orchid	<i>Platanthera blephariglottis (Habenaria b.)</i>	Nt P-Forb	10	M	
Rose pogonia	<i>Pogonia ophioglossoides</i>	Nt P-Forb	10	M	
Flowering Fern Family	Osmundaceae			F	
Royal fern	<i>Osmunda regalis</i>	Nt Fern	5	F	



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Appendix 1.–Continued.

Common name	Scientific name	PHYS	C	M/D	S/FL
Plantain Family	Plantaginaceae			D	
American shore-grass (Sc)	<i>Littorella uniflora</i> var. <i>americana</i> (L. <i>americana</i> )	Nt P-Forb	10	D	Y
Heart-leaved plantain (En)	<i>Plantago cordata</i>	Nt P-Forb	10	D	
Grass Family	Poaceae (Graminae)			M	
Short-awned foxtail	<i>Alopecurus aequalis</i>	Nt P-Grass	4	M	
Marsh foxtail *	<i>Alopecurus geniculatus</i>	Ad P-Grass	*	M	
Slough grass (T)	<i>Beckmannia syzigachne</i>	Nt A-Forb	4	M	
Blue-joint grass	<i>Calamagrostis canadensis</i>	Nt P-Grass	3	M	
Barnyard grass	<i>Echinochloa muricata</i>	Nt A-Grass	1	M	
Salt-marsh cocksbur grass	<i>Echinochloa walteri</i>	Nt A-Grass	7	M	
Creeping love grass	<i>Eragrostis hypnoides</i>	Nt A-Grass	8	M	
Love grass *	<i>Eragrostis tephrosanthos</i>	Ad A-Grass	*	M	
Manna grass (Ep)	<i>Glyceria acutiflora</i>	Nt P-Grass	10	M	Y
Northern manna grass	<i>Glyceria borealis</i>	Nt P-Grass	6	M	Y
Rattlesnake grass	<i>Glyceria canadensis</i>	Nt P-Grass	8	M	Y
Reed manna grass	<i>Glyceria grandis</i>	Nt P-Grass	6	M	Y
Floating manna grass	<i>Glyceria septentrionalis</i>	Nt P-Grass	7	M	Y
Fowl manna grass	<i>Glyceria striata</i>	Nt P-Grass	4	M	Y
Cut grass	<i>Leersia oryzoides</i>	Nt P-Grass	3	M	
Sprangletop *	<i>Leptochloa fascicularis</i>	Ad A-Grass	*	M	
Muhly grass	<i>Muhlenbergia uniflora</i>	Nt P-Grass	8	M	
Panic grass	<i>Panicum lindheimeri</i>	Nt P-Grass	8	M	
Long-leaved panic grass (T)	<i>Panicum longifolium</i>	Nt P-Grass	10	M	
Panic grass	<i>Panicum spretum</i>	Nt P-Grass	9	M	
Bog bluegrass (T)	<i>Poa paludigena</i>	Nt P-Grass	10	M	
Rabbitfoot grass *	<i>Polypogon monspeliensis</i>	Ad A-Grass	*	M	
Alkali grass *	<i>Puccinellia distans</i>	Ad P-Grass	*	M	
Puccinellia	<i>Puccinellia fernaldii</i>	Nt P-Grass	6	M	
Puccinellia	<i>Puccinellia pallida</i>	Nt P-Grass	7	M	
Wild-rice (T)	<i>Zizania aquatica</i> var. <i>aquatica</i>	Nt A-Grass	9	M	Y
Wild-rice	<i>Zizania palustris</i> ( <i>Z. aquatica</i> var. <i>angustifolia</i> )	Nt A-Grass	8	M	Y
Smartweed Family	Polygonaceae			D	
Water smartweed	<i>Polygonum amphibium</i>	Nt P-Forb	6	D	Y
Tear-thumb	<i>Polygonum arifolium</i>	Nt A-Forb	7	D	Y
Water pepper	<i>Polygonum hydropiper</i>	Nt A-Forb	1	D	Y
Water pepper	<i>Polygonum hydropiperoides</i>	Nt P-Forb	5	D	Y
Smartweed	<i>Polygonum punctatum</i>	Nt A-Forb	5	D	Y
Arrow-leaved tear-thumb	<i>Polygonum sagittatum</i>	Nt A-Forb	5	D	Y
Great water dock	<i>Rumex orbiculatus</i>	Nt P-Forb	9	D	Y
Water dock	<i>Rumex verticillatus</i>	Nt P-Forb	7	D	Y
Common Fern Family	Polypodiaceae			F	
Log fern (T)	<i>Dryopteris celsa</i>	Nt Fern	10	F	
Crested shield fern	<i>Dryopteris cristata</i>	Nt Fern	6	F	
Pickrel-weed Family	Pontederiaceae			M	
Water star-grass	<i>Heteranthera dubia</i>	Nt P-Forb	6	M	Y
Pickrel-weed	<i>Pontederia cordata</i>	Nt P-Forb	8	M	
Pondweed Family	Potamogetonaceae			M	
Pondweed	<i>Potamogeton alpinus</i>	Nt P-Forb	10	M	Y
Large-leaved pondweed	<i>Potamogeton amplifolius</i>	Nt P-Forb	6	M	Y
Berchtold's pondweed	<i>Potamogeton berchtoldii</i>	Nt P-Forb	4	M	Y

## Appendix 1.–Continued.

Common name	Scientific name	PHYS	C	M/D	S/FL
Waterthread pondweed (T)	<i>Potamogeton bicipulatus</i> ( <i>P. capillaceus</i> )	Nt P-Forb	10	M	Y
Alga pondweed (Sc)	<i>Potamogeton confervoides</i>	Nt P-Forb	10	M	Y
Curly-leaf pondweed *	<i>Potamogeton crispus</i>	Ad P-Forb	*	M	Y
Ribbon-leaved pondweed	<i>Potamogeton epihydrus</i>	Nt P-Forb	8	M	Y
Narrow-leaved pondweed	<i>Potamogeton filiformis</i>	Nt P-Forb	7	M	Y
Leafy pondweed	<i>Potamogeton foliosus</i>	Nt P-Forb	4	M	Y
Fries's pondweed	<i>Potamogeton friesii</i>	Nt P-Forb	6	M	Y
Pondweed	<i>Potamogeton gramineus</i>	Nt P-Forb	5	M	Y
Hill's pondweed (T)	<i>Potamogeton hillii</i>	Nt P-Forb	9	M	Y
Illinois pondweed	<i>Potamogeton illinoensis</i>	Nt P-Forb	5	M	Y
Pondweed	<i>Potamogeton natans</i>	Nt P-Forb	5	M	Y
Pondweed	<i>Potamogeton nodosus</i>	Nt P-Forb	6	M	Y
Pondweed	<i>Potamogeton oakesianus</i>	Nt P-Forb	10	M	Y
Pondweed	<i>Potamogeton obtusifolius</i>	Nt P-Forb	10	M	Y
Sago pondweed	<i>Potamogeton pectinatus</i>	Nt P-Forb	3	M	Y
Pondweed	<i>Potamogeton perfoliatus</i>	Nt P-Forb	6	M	Y
White-stemmed pondweed	<i>Potamogeton praelongus</i>	Nt P-Forb	8	M	Y
Spotted pondweed (T)	<i>Potamogeton pulcher</i>	Nt P-Forb	10	M	Y
Small pondweed	<i>Potamogeton pusillus</i>	Nt P-Forb	4	M	Y
Richardson's pondweed	<i>Potamogeton richardsonii</i>	Nt P-Forb	5	M	Y
Pondweed	<i>Potamogeton robbinsii</i>	Nt P-Forb	10	M	Y
Pondweed	<i>Potamogeton spirillus</i>	Nt P-Forb	8	M	Y
Pondweed	<i>Potamogeton strictifolius</i>	Nt P-Forb	6	M	Y
Pondweed	<i>Potamogeton vaginatus</i>	Nt P-Forb	10	M	Y
Vasey's pondweed (T)	<i>Potamogeton vaseyi</i>	Nt P-Forb	10	M	Y
Flat-stemmed pondweed	<i>Potamogeton zosteriformis</i>	Nt P-Forb	5	M	Y
Primrose Family	Primulaceae			D	
Lance-leaved loosestrife (Sc)	<i>Lysimachia hybrida</i>	Nt P-Forb	10	D	
Whorled loosestrife	<i>Lysimachia quadriflora</i>	Nt P-Forb	10	D	
Four-leaved loosestrife	<i>Lysimachia quadrifolia</i>	Nt P-Forb	8	D	
Swamp candles	<i>Lysimachia terrestris</i>	Nt P-Forb	6	D	Y
Tufted loosestrife	<i>Lysimachia thyrsoiflora</i>	Nt P-Forb	6	D	
Water-pimpernel	<i>Samolus parviflorus</i> ( <i>S. floribundus</i> )	Nt P-Forb	5	D	
Buttercup Family	Ranunculaceae			D	
Marsh marigold	<i>Caltha palustris</i>	Nt P-Forb	6	D	
Spearwort (T)	<i>Ranunculus ambigens</i>	Nt P-Forb	10	D	
Seaside crowfoot (T)	<i>Ranunculus cymbalaria</i>	Nt P-Forb	8	D	
Yellow water crowfoot	<i>Ranunculus flabellaris</i>	Nt P-Forb	10	D	Y
Lapland buttercup (T)	<i>Ranunculus lapponicus</i>	Nt P-Forb	10	D	
White water crowfoot	<i>Ranunculus longirostris</i>	Nt P-Forb	4	D	Y
Macoun's crowfoot (T)	<i>Ranunculus macounii</i>	Nt A-Forb	10	D	
Bristly crowfoot	<i>Ranunculus pensylvanicus</i>	Nt A-Forb	6	D	
Creeping buttercup	<i>Ranunculus reptans</i>	Nt P-Forb	8	D	Y
Cursed crowfoot	<i>Ranunculus sceleratus</i>	Nt A-Forb	1	D	Y
Buckthorn Family	Rhamnaceae			D	
Alder-leaved buckthorn	<i>Rhamnus alnifolia</i>	Nt Shrub	8	D	
Rose Family	Rosaceae			D	
Purple Avens	<i>Geum rivale</i>	Nt P-Forb	7	D	
Marsh cinquefoil	<i>Potentilla palustris</i>	Nt P-Forb	7	D	
Swamp rose	<i>Rosa palustris</i>	Nt Shrub	5	D	
Dwarf raspberry (En)	<i>Rubus acaulis</i>	Nt Shrub	10	D	
Spirea *	<i>Spiraea salicifolia</i>	Ad Shrub	*	D	

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Appendix 1.–Continued.

Common name	Scientific name	PHYS	C	M/D	S/FL
Madder Family	Rubiaceae				D
Buttonbush	<i>Cephalanthus occidentalis</i>	Nt Shrub	7	D	
Rough bedstraw	<i>Galium asprellum</i>	Nt P-Forb	5	D	
Short-tailed bedstraw	<i>Galium brevipes</i>	Nt P-Forb	6	D	
Bog bedstraw	<i>Galium labradoricum</i>	Nt P-Forb	8	D	
Wild madder	<i>Galium obtusum</i>	Nt P-Forb	5	D	
Marsh bedstraw	<i>Galium palustre</i>	Nt P-Forb	3	D	
Stiff bedstraw	<i>Galium tinctorium</i>	Nt P-Forb	5	D	
Ditch-grass Family	Ruppiaceae				M
Ditch grass (T)	<i>Ruppia maritima</i>	Nt P-Forb	10	M	Y
Willow Family	Salicaceae				D
Swamp cottonwood (En)	<i>Populus heterophylla</i>	Nt Tree	10	D	
Hoary willow	<i>Salix candida</i>	Nt Shrub	9	D	
Sandbar willow	<i>Salix exigua (S. interior)</i>	Nt Shrub	1	D	
Black willow	<i>Salix nigra</i>	Nt Tree	5	D	
Bog willow	<i>Salix pedicellaris</i>	Nt Shrub	8	D	
Tea-leaved willow (T)	<i>Salix planifolia</i>	Nt Shrub	10	D	
Silky willow	<i>Salix sericea</i>	Nt Shrub	6	D	
Autumn willow	<i>Salix serissima</i>	Nt Shrub	8	D	
Salvinia Family	Salviniaceae				F
Water fern	<i>Azolla caroliniana</i>	Nt Fern	10	F	Y
Water spangles *	<i>Salvinia minima</i>	Ad Fern	*	F	Y
Pitcher-plant Family	Sarraceniaceae				D
Pitcher-plant	<i>Sarracenia purpurea</i>	Nt P-Forb	10	D	
Yellow pitcher-plant (T)	<i>Sarracenia purpurea f. heterophylla</i>	Nt P-Forb	10	D	
Lizard's-tail Family	Saururaceae				D
Lizard's-tail	<i>Saururus cernuus</i>	Nt P-Forb	9	D	
Saxifrage Family	Saxifragaceae				D
Golden saxifrage	<i>Chryso-splenium americanum</i>	Nt P-Forb	6	D	
Grass-of-parnassus	<i>Parnassia glauca</i>	Nt P-Forb	8	D	
Marsh grass-of-parnassus (T)	<i>Parnassia palustris</i>	Nt P-Forb	10	D	
Grass-of-parnassus	<i>Parnassia parviflora</i>	Nt P-Forb	10	D	
Swamp saxifrage	<i>Saxifraga pensylvanica</i>	Nt P-Forb	10	D	
Snapdragon Family	Scrophulariaceae				D
Turtlehead	<i>Chelone glabra</i>	Nt P-Forb	7	D	
Red turtlehead (En)	<i>Chelone obliqua</i>	Nt P-Forb	9	D	
Golden hedge-hyssop;					
Goldenpert (T)	<i>Gratiola aurea (G. lutea)</i>	Nt P-Forb	10	D	Y
Clammy hedge-hyssop	<i>Gratiola neglecta</i>	Nt A-Forb	5	D	
Round-fruited hedge-hyssop (T)	<i>Gratiola virginiana</i>	Nt A-Forb	5	D	
Slender false pimpernel	<i>Lindernia anagallidea</i>	Nt A-Forb	8	D	
False pimpernel	<i>Lindernia dubia</i>	Nt A-Forb	4	D	
Winged monkey-flower (Ep)	<i>Mimulus alatus</i>	Nt P-Forb	9	D	
Jame's monkey-flower	<i>Mimulus glabratus var. Jamesii</i>				
	<i>(M. g. fremontii)</i>	Nt P-Forb	10	D	
Michigan monkey-flower (En)	<i>Mimulus glabratus var. michiganensis</i>	Nt P-Forb	10	D	
Western monkey-flower (Sc)	<i>Mimulus guttatus</i>	Nt P-Forb	8	D	
Musky monkey-flower	<i>Mimulus moschatus</i>	Nt P-Forb	10	D	
Monkey-flower	<i>Mimulus ringens</i>	Nt P-Forb	5	D	
Ditch stonecrop	<i>Penthorum sedoides</i>	Nt P-Forb	3	D	

Appendix 1.–Continued.

Common name	Scientific name	PHYS	C	M/D	S/FL
Water speedwell	<i>Veronica anagallis-aquatica</i>	Nt B-Forb	4	D	Y
Brooklime *	<i>Veronica beccabunga</i>	Ad P-Forb	*	D	
American brooklime	<i>Veronica beccabunga var. americana</i>	Nt P-Forb	10	D	
Marsh speedwell	<i>Veronica scutellata</i>	Nt P-Forb	6	D	
Bur-reed Family	Sparganiaceae				M
American bur-reed	<i>Sparganium americanum</i>	Nt P-Forb	6	M	Y
Bur-reed	<i>Sparganium androcladum</i>	Nt P-Forb	6	M	Y
Narrow-leaved bur-reed	<i>Sparganium angustifolium</i>	Nt P-Forb	10	M	Y
Green-fruited bur-reed	<i>Sparganium chlorocarpum</i>	Nt P-Forb	6	M	Y
Common bur-reed	<i>Sparganium eurycarpum</i>	Nt P-Forb	5	M	Y
Bur-reed	<i>Sparganium fluctuans</i>	Nt P-Forb	10	M	Y
Small bur-reed	<i>Sparganium minimum</i>	Nt P-Forb	8	M	Y
Cat-tail Family	Typhaceae				M
Narrow-leaved cat-tail *	<i>Typha angustifolia</i>	Ad P-Forb	*	M	
Broad-leaved cat-tail	<i>Typha latifolia</i>	Nt P-Forb	1	M	
Hybrid cat-tail *	<i>Typha xglauca</i>	Ad P-Forb	*	M	
Nettle Family	Urticaceae				D
False nettle	<i>Boehmeria cylindrica</i>	Nt P-Forb	5	D	
Valerian Family	Valerianaceae				D
Common valerian (T)	<i>Valeriana ciliata</i>	Nt P-Forb	10	D	
Vervain Family	Verbenaceae				D
Fog-fruit	<i>Phyla lanceolata</i>	Nt P-Forb	6	D	
Violet Family	Violaceae				D
Marsh violet	<i>Viola cucullata</i>	Nt P-Forb	5	D	
Northern marsh violet (T)	<i>Viola epipsila</i>	Nt P-Forb	10	D	
Lance-leaved violet	<i>Viola lanceolata</i>	Nt P-Forb	8	D	
Smooth white violet	<i>Viola macloskeyi (V. pallens)</i>	Nt P-Forb	6	D	
New England blue violet (T)	<i>Viola novae-angliae</i>	Nt P-Forb	10	D	
Yellow-eyed-grass Family	Xyridaceae				M
Yellow-eyed-grass	<i>Xyris difformis</i>	Nt P-Forb	8	M	
Yellow-eyed-grass	<i>Xyris montana</i>	Nt P-Forb	10	M	
Yellow-eyed-grass	<i>Xyris torta</i>	Nt P-Forb	10	M	
Horned Pondweed Family	Zannichelliaceae				M
Horned pondweed	<i>Zannichellia palustris</i>	Nt P-Forb	6	M	Y

<sup>1</sup> High values indicate plants that have high affinity for unaltered landscapes (Herman et al. 2001).

<sup>2</sup> Submergent and floating leaf plants listed by Voss (1972; 1985; 1996). Remaining species in this table are emergent forms or live in saturated soils.

## Conservation Guidelines for Michigan Lakes

Appendix 2.—Mollusks found in Michigan lacustrine habitats. Information compiled by Amy Harrington and Liz Hay-Chmielewski (Michigan Department of Natural Resources, Fisheries Division) from sources listed below<sup>1</sup>. Michigan status indicated as follows: \*—non-indigenous, (T)—threatened, (En)—endangered, (Ep)—extirpated, (Ex)—extinct, (Sc)—special concern.

Common name	Scientific name	Lacustrine habitat
Clams	Unionidae	
Eastern elliptio	<i>Elliptio complanata</i>	Ponds with mud or gravel bottoms
Spike	<i>Elliptio dilatata</i>	Lakes with mud or gravel bottoms
Wabash pigtoe	<i>Fusconaia flava</i>	Widespread in lakes with mud, sand, or gravel substrate.
Plain pocketbook	<i>Lampsilis cardium</i>	Lakes with mud, sand, or gravel substrate
Fatmucket	<i>Lampsilis siliquoidea</i>	Ubiquitous, in lakes with all types of substrates, tolerant of moderate pollution
Eastern pondmussel	<i>Ligumia nasuta</i>	Found in lakes and ponds in a wide range of substrates
Black sandshell	<i>Ligumia recta</i>	Lakes with sand, mud, or gravel substrate
Threehorn wartyback	<i>Obliquaria reflexa</i>	Lakes with sand, mud, or gravel substrate
Pink heelsplitter	<i>Potamilis alatus</i>	Lakes with sand, mud, or gravel substrate
Giant floater	<i>Pyganodon grandis</i>	Quiet waters in lakes
Lake floater	<i>Pyganodon lacustris</i>	
Round lake floater	<i>Pyganodon subgibbosa</i>	Natural impoundments
Purple lilliput (En)	<i>Toxolasma lividus</i>	
Lilliput	<i>Toxolasma parvum</i>	Lakes with sandy mud, mud, or fine gravel
Fawnsfoot	<i>Truncilla donaciformis</i>	Lakes with sandy mud, mud, or fine gravel
Deer toe	<i>Truncilla truncata</i>	Lakes with sandy mud, mud, or fine gravel
Paper pondshell	<i>Utterbackia imbecillis</i>	Lakes and ponds
Rayed bean (En)	<i>Villosa fabalis</i>	Lakes, apparently associated with water willow stands (Watters 1995)
Fingernail and pea clams	Sphaeriidae	Swamps, ponds, creeks
River fingernail clam	<i>Sphaerium fabale</i>	
Lake fingernail clam	<i>Musculium lacustre</i>	
Arctic fingernail clam	<i>Sphaerium nitidum</i>	
Herrington fingernail clam	<i>Sphaerium occidentale</i>	
Swamp fingernail clam	<i>Musculium partumeium</i>	
Rhomboid fingernail clam	<i>Sphaerium rhomboideum</i>	
Pond fingernail clam	<i>Musculium securis</i>	
Grooved fingernail clam	<i>Sphaerium simile</i>	
Striated fingernail clam	<i>Sphaerium striatinum</i>	
Long fingernail clam	<i>Musculium transversum</i>	
Adam pea clam	<i>Pisidium adamsi</i>	
Greater European pea clam*	<i>Pisidium amnicum</i>	
Ubiquitous pea clam	<i>Pisidium casertanum</i>	
Ridgebeak pea clam	<i>Pisidium compressum</i>	
Alpine pea clam	<i>Pisidium conventus</i>	
Ornamented pea clam	<i>Pisidium cruciatum</i>	
Greater eastern pea clam	<i>Pisidium dubium</i>	

Appendix 2.–Continued.

Common name	Scientific name	Lacustrine habitat
River pea clam	<i>Pisidium fallax</i>	
Rusty pea clam	<i>Pisidium ferrugineum</i>	
Giant northern pea clam	<i>Pisidium idahoense</i>	
Tiny pea clam	<i>Pisidium insigne</i>	
Lilljeborg pea clam	<i>Pisidium lilljeborgi</i>	
Quadrangular pea clam	<i>Pisidium milium</i>	
Shiny pea clam	<i>Pisidium nitidum</i>	
Pisidium obtusale	<i>Cyclocalyx obtusale</i>	
Perforated pea clam	<i>Pisidium punctatum</i>	
Shortended pea clam	<i>Pisidium subtruncatum</i>	
Triangular pea clam	<i>Pisidium variabile</i>	
Globular pea clam	<i>Pisidium ventricosum</i>	
Walker pea clam	<i>Pisidium walkeri</i>	
Mystery Snails	Viviparidae	
Ponderous campeloma	<i>Campeloma crassulum</i>	Lakes, buried in mud
Pointed campeloma	<i>Campeloma decisum</i>	Lakes, burrows just below surface in mud or sand
Chinese mysterysnail*	<i>Cipangopaludina chinensis malleata</i>	Muddy ponds and lakes
Japanese mysterysnail*	<i>Cipangopaludina japonica</i>	Muddy ponds and lakes
Banded mysterysnail*	<i>Viviparus georgianus</i>	Lakes with muddy substrate, frequently in vegetation
Valve Snails	Valvatidae	
Fringed valvata	<i>Valvata lewisi</i>	On vegetation in shallow water
Purplecap valvata	<i>Valvata perdepressa</i>	Large and medium-sized lakes
Mossy Valvata	<i>Valvata sincera</i>	Lakes with aquatic vegetation and over mud substrate
Threeridge valvata	<i>Valvata tricarinata</i>	Perennial lakes, in vegetation
Flanged Valvata	<i>Valvata winnebagoensis</i>	
Spire Snails	Hydrobiidae	
Mud amnicola	<i>Amnicola limosus</i>	Unpolluted perennial waters with aquatic vegetation, rough shores of the Great Lakes
Globe Siltsnail	<i>Birgella subglobosus</i>	Rare species found in large lakes, all depths, quiet water with soft silt substrate
Campeloma spire snail	<i>Cincinnatia cincinnatiensis</i>	Lakes, on mud or sand
Canadian Dusksnail	<i>Lyogyrus walkeri</i>	Perennial lakes with mud substrate and dense vegetation
Delta hydrobe	<i>Probythinella emarginata</i>	Perennial ales and ponds, on sand or mud substrate, in vegetation
Gravel Pyrg (Sp)	<i>Pyrgulopsis letsoni</i>	Recorded once under stones in a Huron River impoundment
Boreal Marstonia	<i>Pyrgulopsis lustrica</i>	Eutrophic lakes of areas with vegetation and sand or mud substrate
Looping Snails	Pomatiopsidae	
Brown Walker (Sp)	<i>Pomatiopsis cincinnatiensis</i>	
Faucet Snails	Bithyniidae	
Mud Bithynia	<i>Bithynia tentaculata</i>	Large lakes, shallow water
Horn Snails	Pleuroceridae	
Liver Elimia	<i>Elimia livescens</i>	Lakes of all sizes, usually found on rocks and stones
Sharp Hornsnail	<i>Pleurocera acuta</i>	Lakes, quiet areas

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Appendix 2.–Continued.

Common name	Scientific name	Lacustrine habitat
Pond Snails	Lymnaeidae	
Spindle lymnaea (Sp)	<i>Acella haldemani</i>	Eutrophic lakes and ponds, in reeds, depths 1-3 feet
Mammoth lymnaea	<i>Bulimnaea megasoma</i>	Large and small lakes, impoundments, vegetation, usually mud substrate
Bugle fossaria	<i>Fossaria cyclostoma</i>	
Dusky fossaria	<i>Fossaria dalli</i>	Lakes, ponds, marshes, in vegetation, various substrates
Graceful fossaria	<i>Fossaria exigua</i>	Lakes, ponds, swamps, in vegetation, mud substrate
Boreal fossaria	<i>Fossaria galbana</i>	Medium to large lakes with abundant vegetation, cold, well oxygenated water
Rock fossaria	<i>Fossaria modicella</i>	Perennial lakes, vernal ponds, in vegetation, mud substrate
Golden fossaria	<i>Fossaria obrussa</i> Similar to <i>F. modicella</i>	
Pygmy fossaria	<i>Fossaria parva</i>	Shallow water in vegetation, lakeshores, marshes, mudflats
	<i>Fossaria peninsulae</i>	
	<i>Fossaria rustica</i> Similar to <i>F. modicella</i>	
Swamp lymnaea	<i>Lymnaea stagnalis</i>	Perennial water-bodies, diverse substrate, in vegetation, on rocks
Mimic lymnaea	<i>Pseudosuccinea columella</i>	Lakes and ponds, lily pads and reeds, shorelines
Big-Eared radix	<i>Radix auricularia</i>	Lakes and ponds, frequently mud substrate
Abbreviate pondsnail	<i>Stagnicola apicina</i>	
Wrinkled marshsnail	<i>Stagnicola caperata</i>	Vernal ponds, occasionally in swamps and permanent lakes
Woodland pondsnail	<i>Stagnicola catascopium</i>	Lakes, areas exposed to waves and currents
Deepwater pondsnail (T)	<i>Stagnicola contracta</i>	Live specimens found only from Higgins Lake, in <i>Chara</i> at depths of about 33 feet
Marsh pondsnail	<i>Stagnicola elodes</i>	Various aquatic habitats, numerous in thick vegetation on mud substrates
St. Lawrence pondsnail	<i>Stagnicola emarginata</i>	Open shores of lakes with gravel or stone substrate
Flat-whorled pondsnail	<i>Stagnicola exilis</i>	
Petoskey pondsnail (En)	<i>Stagnicola petoskeyensis</i>	Found only in spring brook flowing into Lake Michigan
Coldwater pondsnail	<i>Stagnicola woodruffi</i>	Shores of large lakes
Tadpole Snails	Physidae	
Lance aplexa	<i>Aplexa elongata</i>	
Glass physa	<i>Physa skinneri</i>	
Vernal physa	<i>Physa vernalis</i>	
Pumpkin physa	<i>Physella ancillaria</i>	
Tadpole physa	<i>Physella gyrina</i>	Perennial water-bodies, temporary swamps, pollution tolerant
Pewter physa	<i>Physella heterostropha</i>	Perennial water-bodies, temporary swamps, pollution tolerant
Ashy physa	<i>Physella integra</i>	Shallow water of lakes, all substrates
Broadshoulder physa	<i>Physella parkeri</i>	

## Appendix 2.–Continued.

Common name	Scientific name	Lacustrine habitat
Ramshorn Snails	Planorbidae	
Disc gyro	<i>Gyraulus circumstriatus</i>	Woodland ponds, marshes, thick vegetation, mud substrate
Star gyro	<i>Gyraulus crista</i>	Eutrophic ponds, dense vegetation
Flexed gyro	<i>Gyraulus deflectus</i>	Eutrophic waters, on vegetation with mud substrate
Ash gyro	<i>Gyraulus parvus</i>	Submerged vegetation in various waters with mud substrate
Two-ridge rams-horn	<i>Helisoma anceps</i>	Perennial lakes and ponds, in vegetation, various substrates
Lake Superior Rams-Horn	<i>Helisoma anceps royalense</i>	Only collected in large lakes and rivers with substrate of sand or rock, and dense vegetation
Bugle sprite	<i>Micromenetus dilatatus</i>	On sticks along banks in muddy bays, possibly only streams
Bellmouth rams-horn (Sp)	<i>Planorbella campanulata</i>	Lakes and ponds of all sizes, all substrates, usually in vegetation
Corpulent rams-horn	<i>Planorbella corpulenta</i>	Lakes of all sizes, often in exposed places, varying vegetation abundance and substrates
Acorn rams-horn (En)	<i>Planorbella multivolvis</i>	Known only from Howe Lake, Marquette County
(Sc)	<i>Planorbella smithi</i>	
Marsh rams-horn	<i>Planorbella trivolvis</i>	Lakes and ponds with mud substrate and abundant vegetation
Druid rams-horn	<i>Planorbella truncata</i>	Areas with wave action, various substrates
Thicklip rams-horn	<i>Planorbula armigera</i>	Most water-bodies, especially stagnant, with abundant vegetation
Sharp sprite	<i>Promenetus exacuus</i>	Various water-bodies with mud bottom, in submerged vegetation
Umbilicate sprite	<i>Promenetus umbilicatellus</i>	Ponds and marshes with dense vegetation and mud substrate
True Freshwater Limpets	Ancylidae	
Fragile ancylid	<i>Ferrissia fragilis</i>	Lakes and ponds, often on cattail stems
Oblong Ancylid	<i>Ferrissia parallelus</i>	Lakes, swamps, thick vegetation, on cattails, sedges, lily pads
Creeping Ancylid	<i>Ferrissia rivularis</i>	Attached to rocks and mussel shells in exposed areas of lakes
Cloche Ancylid	<i>Ferrissia walkeri</i>	
Dusky ancylid	<i>Laevapex fuscus</i>	Heavily vegetated waters, attached to vegetation

<sup>1</sup> Badra and Goforth (2002); Barnhart et al. (1998); Becker (1983); Burch (1982); Burch (1991); Burch (1994); Burch and Jung (1987); Burch et al. (1991); Clarke (1981); Fuller and Brynildson (1985); Goforth et al. (2000); Goodrich and Van Der Schalie (1939); Graf (1997); Hillegass and Hove (1997); Hove (1997); Hove and Anderson (1997); Hove et al. (1997); Hove and Kurth (1998); NatureServe Explorer (2001); O'Dee and Watters (2000); Sherman (1997); Steg and Neves (1997); Turgeon et al. (1998); Van der Schale (1936); Watters (1994); Watters (1995); Watters (1996); Watters et al. (1998a); Watters et al. (1998b); and Williams et al. (1993).



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Appendix 3.—Crayfish found in Michigan lacustrine habitats. Information compiled by Amy Harrington and Liz Hay-Chmielewski (Michigan Department of Natural Resources, Fisheries Division) from sources listed below<sup>1</sup>. Michigan status indicated as follows: \*—non-indigenous, (T)—threatened, (En)—endangered, (Ep)—extirpated, (Ex)—extinct, (Sc)—special concern.

Common name	Scientific name	Lacustrine habitat
	Cambaridae	
Devil crawfish	<i>Cambarus diogenes</i>	Wet meadows, marshes, spring-fed pools, ponds, artesian wells, lakes; terrestrial burrows
Crayfish	<i>Cambarus robustus</i>	Stony-bottomed ponds, especially alongside streams
	<i>Fallicambarus fodiens</i>	Ponds, especially temporary, and marshes, burrower
Calico crayfish	<i>Orconectes immunis</i>	Shallow, stagnant ponds with mud bottom and abundant vegetation, burrower
Northern clearwater crayfish	<i>Orconectes propinquus</i>	Clear, stony ponds and lakes
Virile crayfish	<i>Orconectes virilis</i>	Stony lakes, deep water (9–30 feet)
White River crayfish	<i>Procambarus acutus acutus</i>	Most lakes, ponds, and swamps, secondary burrower
Rusty Crayfish*	<i>Orconectes rusticus</i>	Lakes and rivers

<sup>1</sup> Crandall (2000); Creaser (1930); Crocker and Barr (1968); Hobbs (1989); and Pearse (1910).

Appendix 4.—Fish found in Michigan lacustrine habitats. Information compiled by Schneider (2002), Amy Harrington, Liz Hay-Chmielewski, and Richard O’Neal (Michigan Department of Natural Resources, Fisheries Division) from sources listed below<sup>1</sup>. Michigan status indicated as follows: \*—non-indigenous, (T)—threatened, (En)—Endangered, (Ep)—Extirpated, (Ex)—extinct, (Sc)—special concern.

Common name	Scientific name	Lacustrine habitat
Lampreys	Petromyzontidae	
Chestnut lamprey	<i>Ichthyomyzon castaneus</i>	Primarily in streams, possibly impoundments.
Northern brook lamprey	<i>Ichthyomyzon fossor</i>	Primarily in streams, possibly impoundments.
Silver lamprey	<i>Ichthyomyzon unicuspis</i>	Sand and muck in rivers as ammocetes, in lakes as adults over a variety of bottom types.
American brook lamprey	<i>Lampetra appendix</i>	Primarily in streams, possibly impoundments.
Sea lamprey*	<i>Petromyzon marinus</i>	In large lakes and Great Lakes, primarily in deep water, spawn in streams.
Sturgeons	Acipenseridae	
Lake sturgeon (T)	<i>Acipenser fulvescens</i>	Great Lakes, large inland lakes, and rivers; In shallow lakes found at all depths, in deeper lakes found at depths of 10-60 feet over soft or muck substrate.
Paddlefishes	Polyodontidae	
Paddlefish (Ep)	<i>Polyodon spathula</i>	Primarily in large rivers with slow currents, but also impoundments and associated lakes, prefers deep water with soft bottom.
Gars	Lepisosteidae	
Spotted gar (Sc)	<i>Lepisosteus oculatus</i>	Warmwater; found in small stratified and non-stratified lakes with clear to slightly turbid water; tolerant of moderate to low dissolved oxygen; in the littoral zone at surface or mid-depths; strongly dependant on vegetation.
Longnose gar	<i>Lepisosteus osseus</i>	Warmwater; found in small stratified and non-stratified lakes with clear to slightly turbid water; tolerant of moderate to low dissolved oxygen; in the littoral zone or offshore at surface or mid-depths; prefers some vegetation.
Bowfins	Amiidae	
Bowfin	<i>Amia calva</i>	Warmwater; found in lakes and reservoirs with clear to slightly turbid water; tolerant of very low dissolved oxygen; found in the littoral zone or offshore at mid-depths or on the bottom; prefers abundant or moderate vegetation.
Mooneyes	Hiodontidae	
Mooneye (T)	<i>Hiodon tergisus</i>	Large, clear rivers and their interconnecting lakes; prefers waters lower in turbidity.

## Appendix 4.—Continued.

Common name	Scientific name	Lacustrine habitat
Freshwater eels American eel*	Anguillidae <i>Anguilla rostrata</i>	Large streams and Great Lakes, nocturnal, spend the day under rocks or logs or buried in the mud with only their snouts protruding; winter burrow into soft mud and hibernate.
Herrings Skipjack herring* Alewife*	Clupeidae <i>Alosa chrysochloris</i> <i>Alosa pseudoharengus</i>	Primarily streams, possibly in impoundments. Coolwater; large and some small lakes with clear to slightly turbid water; tolerant of moderate dissolved oxygen, pelagial at mid-depths, vegetation unimportant.
Gizzard shad	<i>Dorosoma cepedianum</i>	Warmwater; lakes and reservoirs with turbid to clear water; tolerant of moderate or low oxygen levels, found offshore at mid-depth or at the surface; prefers sparse to moderate vegetation.
70 Carps & minnows Central stoneroller Goldfish*	Cyprinidae <i>Camptostoma anomalum pullum</i> <i>Carassius auratus</i>	Primarily streams, possibly in impoundments. Warmwater; found in small lakes, ponds, and reservoirs with turbid to clear water; tolerant of very low dissolved oxygen; found in the littoral zone at various depths; prefers soft, silt, gravel, or sand substrate with abundant vegetation.
Redside dace (En) Lake chub	<i>Clinostomus elongatus</i> <i>Couesius plumbeus</i>	Primarily streams, possibly in impoundments. Coolwater, large lakes and rivers with high dissolved oxygen; clear to slightly turbid water; in littoral zone and offshore at mid-depths or near bottom; over a variety of substrates; spawning in tributary streams with rock substrate and rocky shorelines, over a variety of substrates, acid tolerant.
Spotfin shiner	<i>Cyprinella spiloptera</i>	Warmwater; found in lakes and impoundments with turbid to clear water; tolerant of moderate to low dissolved oxygen; found in the littoral zone at mid-depths, surface, or bottom; prefers gravel or sand substrate and sparse to moderate vegetation; crevice spawning or on underside of submerged logs and roots.
Common carp*	<i>Cyprinus carpio</i>	Warmwater; found in lakes and reservoirs with turbid to clear water; tolerant of very low dissolved oxygen; found in the littoral zone or offshore on the bottom or at mid-depths; substrate- soft, gravel, sand, or silt; vegetation- moderate but variable.

Appendix 4.—Continued.

Common name	Scientific name	Lacustrine habitat
Brassy minnow	<i>Hybognathus hankinsoni</i>	Coolwater; found in bogs, ponds and small lakes; tolerant of moderate to low dissolved oxygen; clear, brown and slightly turbid water; in the littoral zone at mid-depths and bottom; substrate- gravel, sand, soft, and silt; vegetation- sparse to moderate.
Striped shiner	<i>Luxilus chrysocephalus</i>	Warmwater; found in small lakes and streams with clear to slightly turbid water; found in the littoral zone at mid-depths; spawning over gravel, boulder, bedrock, or sand substrate.
Common shiner	<i>Luxilus cornutus</i>	Warmwater; small lakes, ponds, and impoundments and small high-gradient streams, with clear to slightly turbid water; tolerant of very low dissolved oxygen; found in the littoral zone at mid-depths, surface or bottom; prefers gravel substrate, can tolerate some submerged aquatic vegetation; not very tolerant of turbidity or silted waters; spawning on gravel nests of other fish, especially those at the head of a riffle; acid intolerant.
Redfin shiner	<i>Lythrurus umbratilis</i>	Primarily streams, possibly in impoundments
Silver chub (Sc)	<i>Macrhybopsis storeriana</i>	Primarily streams, possibly in impoundments, occasionally in lakes at depths less than 30 feet.
Northern pearl dace	<i>Margariscus nachtriebi</i>	Coolwater, bogs and ponds, sometimes in small lakes and reservoirs; tolerant of low dissolved oxygen; in littoral zone at mid-depths; clear to slightly turbid water, vegetation sparse or unimportant; spawning—clear water, sand or gravel substrate, weak to moderate current.
Hornyhead chub	<i>Nocomis biguttatus</i>	Primarily streams, possibly in impoundments
River chub	<i>Nocomis micropogon</i>	Primarily streams, possibly in impoundments
Golden shiner	<i>Notemigonus crysoleucas</i>	Warmwater; lakes, ponds, and impoundments with clear to slightly turbid water; tolerant of very low dissolved oxygen; in the littoral zone at mid-depths, surface or bottom; prefers abundant or moderate vegetation; tolerant of persistent turbidity and high temperature.
Bigeye chub (Ep)	<i>Notropis anoblops</i>	Primarily streams, possibly in impoundments
Pugnose shiner (Sc)	<i>Notropis anogenus</i>	Coolwater; found in small lakes with clear or brown water; tolerant of low dissolved oxygen; in the littoral zone at mid-depths; prefers moderate or abundant vegetation; intolerant of turbid or muddy waters

## Appendix 4.—Continued.

Common name	Scientific name	Lacustrine habitat
Emerald shiner	<i>Notropis atherinoides</i>	Coolwater; found in large lakes and open-large stream channels with high dissolved oxygen; range of turbidities and bottom types; offshore or in littoral zone at mid-depths or surface; substrate of little importance, avoids rooted vegetation; spawning over sand or firm mud substrate or gravel shoals.
Silverjaw minnow	<i>Notropis buccatus</i>	Primarily streams, possibly in impoundments
Ghost shiner*	<i>Notropis buchanani</i>	Primarily streams, possibly in impoundments
Ironcolor shiner (Ep)	<i>Notropis chalybaeus</i>	Primarily streams, possibly in impoundments.
Bigmouth shiner	<i>Notropis dorsalis</i>	Primarily streams, possibly in impoundments, sometimes in lakes.
Blackchin shiner	<i>Notropis heterodon</i>	Warmwater; lakes, impoundments, and quiet pools in streams and rivers with clear or slightly turbid water; tolerant of moderate to low dissolved oxygen; found in the littoral zone at mid-depths or the surface; prefers clean sand, gravel, or organic debris substrate, and moderate or dense beds of submerged aquatic vegetation; cannot tolerate turbidity, silt, or loss of aquatic vegetation; Intolerant of lake edge modifications.
Blacknose shiner	<i>Notropis heterolepis</i>	Warmwater; found in clear lakes, impoundments, and pools of small, clear, low-gradient streams; tolerant of moderate to low dissolved oxygen; in the littoral zone on bottom or at mid-depths; moderate to abundant aquatic vegetation; clean sand, gravel, marl, muck, peat, or organic debris substrate; cannot tolerate much turbidity, silt, acidity, or loss of aquatic vegetation; spawning over sandy substrate; Intolerant of lake edge modifications.
Spottail shiner	<i>Notropis hudsonius</i>	Warmwater; found in lakes and impoundments with turbid to clear water; tolerant of moderate to low dissolved oxygen; found in the littoral zone and offshore at mid-depths; substrate- firm sand and gravel; sparse to moderate vegetation; spawning over sandy shoals or gravelly riffles, near the mouths of small streams.
Silver shiner (En)	<i>Notropis photogenis</i>	Primarily streams, possibly in impoundments.
Rosyface shiner	<i>Notropis rubellus</i>	Primarily streams, possibly in impoundments; sometimes in lakes near streams.
Sand shiner	<i>Notropis stramineus</i>	Warmwater; found in lakes and impoundments with clear to turbid water; in the littoral zone at mid-depths, surface, or bottom; prefers gravel or sand substrate with sparse to moderate vegetation; tolerant of some inorganic pollutants provided substrate is not covered; spawning over clean gravel or sand substrate; in winter under ice cover along shores, not tolerant of very low dissolved oxygen.

Appendix 4.–Continued.

Common name	Scientific name	Lacustrine habitat
Weed shiner (Ep)	<i>Notropis texanus</i>	Lakes, sloughs, and the quiet sections of medium size streams or large rivers; substrate- sand or silt, and to a lesser extent other materials, not necessarily associated with vegetation.
Mimic shiner	<i>Notropis volucellus</i>	Warmwater; found in lakes and impoundments with clear to slightly turbid water; tolerant of moderate to low dissolved oxygen; in the littoral zone at mid-depths, surface, or bottom; prefers gravel, sand, or soft substrate with moderate aquatic vegetation; aquatic vegetation necessary for spawning; acid intolerant.
Pugnose minnow (En)	<i>Opsopoeodus emiliae</i>	Warmwater; small lakes with clear to slightly turbid water; tolerant of moderate to low dissolved oxygen; in the littoral zone at mid-depths or bottom; prefers soft, gravel or sand bottom with abundant vegetation; intolerant of turbidity.
Suckermouth minnow*	<i>Phenacobius mirabilis</i>	Primarily streams, possibly in impoundments
Northern redbelly dace	<i>Phoxinus eos</i>	Coolwater; found in boggy lakes and streams with slow current and clear to slightly turbid water; tolerant of moderate to low dissolved oxygen; in littoral zone or offshore at mid-depths and bottom; detritus or silt substrate and sparse or abundant vegetation; spawning--filamentous algae needed for egg deposition.
Southern redbelly dace (En)	<i>Phoxinus erythrogaster</i>	Primarily streams, possibly in impoundments
Finescale dace	<i>Phoxinus neogaeus</i>	Coolwater; found in bog lakes and streams with neutral to slightly acidic waters, infrequent in other lakes; clear or brown water; tolerant of moderate to low dissolved oxygen; in littoral zone and offshore at mid-depths and bottom; various substrates and vegetation moderate to sparse.
Bluntnose minnow	<i>Pimephales notatus</i>	Warmwater; found in lakes, ponds, and impoundments with clear to turbid water; tolerant of very low dissolved oxygen; in the littoral zone on bottom or at mid-depths; substrate- gravel, sand, soft, or silt; vegetation- moderate, abundant, or sparse; tolerates organic and inorganic pollutants; spawning--eggs deposited on the underside of flat stones or objects, nests in sand or gravel substrate; acid intolerant.

Appendix 4.–Continued.

Common name	Scientific name	Lacustrine habitat
Fathead minnow	<i>Pimephales promelas</i>	Warmwater; found in ponds, small lakes and impoundments with brown, turbid or clear water; tolerant of very low dissolved oxygen; in the littoral zone or offshore at mid-depths or on bottom; prefers moderate to abundant vegetation; spawns on underside of objects in water 2 to 3 feet deep; prefer sand, marl, or gravel substrate; acid intolerant.
Longnose dace	<i>Rhinichthys cataractae</i>	Lakes and streams with high gradient, gravel, or boulder substrate; winter-- quiet shallow pools, or shallow flat sand and gravel-bottomed areas.
Western blacknose dace	<i>Rhinichthys obtusus</i>	Primarily streams, possibly in impoundments
Creek chub	<i>Semotilus atromaculatus</i>	Small to medium-sized streams and rivers, rare in large rivers and lakes; clear to dark brown waters; prefers silt-free to slightly turbid waters; spawning over coarse gravel runs; winter in deeper pools and runs.
Loaches *	Cobitidae	
74 Oriental weatherfish*	<i>Misgurnus anguillicaudatus</i>	Quite or slow flowing waters where it burrows into muddy substrate; tolerant of very low dissolved oxygen.
Suckers	Catostomidae	
Quillback	<i>Carpiondes cyprinus</i>	Warmwater; lakes with tributary streams, and reservoirs; in shallow, clear to turbid water; substrate- sand and gravel, and to a lesser extent silt, mud, clay, and rubble.
Longnose sucker	<i>Catostomus catostomus</i>	In the Great Lakes and tributaries for spawning; most abundant at depths less than 37 meters and infrequent at depths greater than 55 meters.
White sucker	<i>Catostomus commersonii</i>	Coolwater; large and small lakes and reservoirs with clear to turbid water; tolerant of moderate dissolved oxygen; offshore or in littoral zone near bottom, substrate- gravel, sand, or soft; vegetation- moderate to sparse.
Western creek chubsucker (En)	<i>Erimyzon claviformis</i>	Small creeks in clear, quiet waters with thick growths of submergent vegetation and a bottom type of sand or silt mixed with organic debris; spawning in riffle areas or outlets of lakes.
Lake chubsucker	<i>Erimyzon sucetta</i>	Warmwater; small lakes with clear or slightly turbid water; tolerant of moderate to low dissolved oxygen; found in the littoral zone on the bottom or at mid-depths; prefers dense vegetation over bottoms of sand or silt mixed with organic debris.
Northern hog sucker	<i>Hypentelium nigricans</i>	Primarily streams, possibly in impoundments.

Appendix 4.—Continued.

Common name	Scientific name	Lacustrine habitat
Bigmouth buffalo*	<i>Ictiobus cyprinellus</i>	Large, shallow lakes and sluggish streams; tolerant of low oxygen; substrates variable.
Black buffalo*	<i>Ictiobus niger</i>	Primarily streams, possibly in impoundments; variable substrates and turbidity.
Spotted sucker	<i>Minytrema melanops</i>	Lakes with tributary streams, and sluggish streams; turbid water; substrate-muck or sand with plant detritus, also other firm-bottomed substrates; frequents heavy vegetation.
Silver redhorse	<i>Moxostoma anisurum</i>	Streams, impoundments, and lakes; spawns in turbid waters in rivers.
River redhorse (T)	<i>Moxostoma carinatum</i>	Primarily large streams, possibly in impoundments, occasionally in lakes; intolerant of silt and pollution.
Black redhorse	<i>Moxostoma duquesnei</i>	Primarily streams, possibly in impoundments.
Golden redhorse	<i>Moxostoma erythrurum</i>	Lakes, streams, and impoundments; in the littoral zone of Lake Michigan; tolerates moderate turbidity; variable substrates.
Shorthead redhorse	<i>Moxostoma macrolepidotum</i>	Lakes, warm streams, and impoundments with clear to slightly turbid water; in the littoral zone of Lake Michigan; substrate- variable.
Greater redhorse	<i>Moxostoma valenciennesi</i>	Large lakes, possibly including the Great Lakes, medium to large rivers, and impoundments with clear water; sand, gravel, or boulder substrate.
Bullhead catfishes	Ictaluridae	
Black bullhead	<i>Ameiurus melas</i>	Warmwater; found in lakes, ponds, and reservoirs with turbid to clear water; tolerant of very low dissolved oxygen; found in the littoral zone or offshore on the bottom; prefers silt or soft substrate with moderate to abundant vegetation.
Yellow bullhead	<i>Ameiurus natalis</i>	Warmwater; lakes and reservoirs with clear to slightly turbid water; tolerant of moderate to low dissolved oxygen; found in the littoral zone and offshore on the bottom; prefers soft or silt substrate with abundant or moderate vegetation.
Brown bullhead	<i>Ameiurus nebulosus</i>	Warmwater; lakes and reservoirs with slightly turbid to clear water; tolerant of very low dissolved oxygen; found in the littoral zone or offshore on the bottom; prefers soft or silt substrate with moderate to abundant vegetation.



## Appendix 4.—Continued.

Common name	Scientific name	Lacustrine habitat
Channel catfish	<i>Ictalurus punctatus</i>	Warmwater; lakes and reservoirs with clear to turbid water; tolerant of moderate to low dissolved oxygen; found in the littoral zone or offshore at mid-depths or on bottom; prefers soft bottom with sparse to moderate vegetation.
Stonecat	<i>Noturus flavus</i>	Primarily streams, possibly in impoundments, sometimes in lakes near sand or gravel bars with wave action; spawns in lakes shallow, rocky areas of lakes under stones.
Tadpole madtom	<i>Noturus gyrinus</i>	Warmwater; found in small lakes; in the littoral zone or offshore on bottom; substrate- gravel, sand, or soft; vegetation- abundant to moderate.
Margined madtom*	<i>Noturus insignis</i>	Primarily streams, possibly in impoundments
Brindled madtom (Sc)	<i>Noturus miurus</i>	Primarily streams, possibly in impoundments, sometimes in lakes; spawns in lakes shores, beaches, and reefs, with eggs laid under stones.
Northern madtom (En)	<i>Noturus stigmosus</i>	Primarily streams, possibly in impoundments
Flathead catfish	<i>Pylodictis olivaris</i>	Lakes, large streams, and impoundments; tolerant of turbidity; hard or slightly silted substrate; prefers large logs and snags in rivers.
Pikes	Esocidae	
Grass pickerel	<i>Esox americanus vermiculatus</i>	Warmwater; small lakes, ponds and reservoirs with clear to slightly turbid water; tolerant of very low dissolved oxygen; found in the littoral zone at mid-depths; substrate- soft, gravel or sand; vegetation- abundant to moderate; intolerant of lake edge modification.
Northern pike	<i>Esox lucius</i>	Coolwater; large and small lakes and reservoirs with clear to slightly turbid water; tolerant of very low dissolved oxygen; in littoral zone and offshore at mid-depths or at surface; prefers heavy to moderate vegetation; intolerant of lake edge modification.
Muskellunge	<i>Esox masquinongy</i>	Coolwater; large and small lakes with clear to slightly turbid water; tolerant of low dissolved oxygen; in littoral zone and offshore at mid-depths or at surface; prefers heavy to moderate vegetation; spawning- optimum in soft, organic, nitrogen rich sediment with abundant deadwood.
Mudminnows	Umbridae	
Central mudminnow	<i>Umbra limi</i>	Warmwater; ponds, lakes and reservoirs with clear or brown water; tolerant of very low oxygen levels; in the littoral zone on bottom or mid-depths; prefer soft or silt substrate; vegetation- sparse to abundant; spawn in floodplain areas, on vegetation; acid tolerant.

Appendix 4.—Continued.

Common name	Scientific name	Lacustrine habitat
Smelts*	Osmeridae	
Rainbow smelt*	<i>Osmerus mordax</i>	Large and small lakes with high dissolved oxygen and clear water, pelagial at mid-depths, vegetation unimportant.
Trouts	Salmonidae	
Lake herring (T)	<i>Coregonus artedi</i>	Common in large, including the Great Lakes, and small lakes with high dissolved oxygen and clear water; pelagial at mid-depths; vegetation unimportant.
Lake whitefish	<i>Coregonus clupeaformis</i>	Coldwater; large and small lakes with clear to slightly turbid water; tolerant of moderate dissolved oxygen; pelagial mid-depths and on bottom; substrate- rock, gravel, sand or soft; vegetation- unimportant.
Bloater	<i>Coregonus hoyi</i>	Primarily Great Lakes and connected waters; at depths of 20 to 170 meters.
Deepwater cisco (Ex)	<i>Coregonus johanna</i>	Primarily Great Lakes and connected waters; at depths of 30 to 180 meters.
Kiyi (Sc)	<i>Coregonus kiyi</i>	Primarily Great Lakes and connected waters; at depths of 37 to 180 meters.
Shortnose cisco (Ex)	<i>Coregonus reighardi</i>	Primarily Great Lakes and connected waters; at depths of 37 to 110 meters.
Shortjaw cisco (T)	<i>Coregonus zenithicus</i>	Primarily Great Lakes and connected waters; at depths of 20 to 160 meters.
Pink salmon*	<i>Oncorhynchus gorbuscha</i>	Primarily Great Lakes and connected waters, near the surface; spawning in tributary streams.
Coho salmon*	<i>Oncorhynchus kisutch</i>	Primarily Great Lakes and connected waters, at surface and mid-depths, spawning in tributaries.
Rainbow trout*	<i>Oncorhynchus mykiss</i>	Coldwater; large and small lakes and reservoirs with clear water; tolerant of moderate dissolved oxygen; offshore and the littoral zone at surface and mid-depths; vegetation unimportant; turbidity intolerant; spawn in tributaries.
Chinook salmon*	<i>Oncorhynchus tshawytscha</i>	Primarily Great Lakes and connected waters, at surface and mid-depths, turbidity intolerant; spawn in tributaries.
Pygmy whitefish	<i>Prosopium coulterii</i>	Lake Superior at depths of 18 to 90 meters.
Round whitefish	<i>Prosopium cylindraceum</i>	Primarily Great Lakes and connected waters, usually at depths less than 37 meters.
Atlantic salmon*	<i>Salmo salar</i>	Primarily Great Lakes and connected waters; turbidity intolerant.
Brown trout*	<i>Salmo trutta</i>	Coldwater; large and small lakes and reservoirs with clear water; tolerant of moderate dissolved oxygen; offshore and the littoral zone at all depths; vegetation unimportant; turbidity intolerant.

## Appendix 4.—Continued.

Common name	Scientific name	Lacustrine habitat
Brook trout	<i>Salvelinus fontinalis</i>	Coldwater; small and large lakes, ponds and reservoirs with clear or brown water; high dissolved oxygen required; turbidity intolerant; acid tolerant; vegetation unimportant; turbidity intolerant.
Lake trout	<i>Salvelinus namaycush</i>	Coldwater; large and small lakes with clear water and high dissolved oxygen, pelagial at mid-depths or bottom; substrate of gravel, rock, or sand; turbidity intolerant; vegetation unimportant.
Arctic grayling (Ep)	<i>Thymallus arcticus</i>	Primarily streams and cold lakes with extensive sand and rock substrate.
Trout-perches	Percopsidae	
Trout-perch	<i>Percopsis omiscomaycus</i>	Great Lakes and connected lakes with high dissolved oxygen, clear to slightly turbid water; substrate- clean sand or fine gravel; highly intolerant of clayey silts; avoids rooted aquatic vegetation; spawning over rocks in shallows, over sand and gravel substrates in lakes.
78 Pirate perches	Aphredoderidae	
Pirate perch	<i>Aphredoderus sayanus</i>	Oxbows, overflow ponds, marshes, estuaries, pools, medium to large rivers with low gradient, less than 3ft/mi; sand or muck substrates covered with organic debris, pools bordered by emergent aquatic vegetation; clear, warm, quiet water.
Cods	Gadidae	
Burbot	<i>Lota lota</i>	Coldwater; large lakes and reservoirs with high dissolved oxygen and clear water, pelagial at mid-depths or on bottom (to 90 meters); substrate- rock, gravel, sand or soft; vegetation unimportant; may use streams for spawning.
Killifishes	Fundulidae	
Western banded killifish	<i>Fundulus diaphanous menona</i>	Coolwater; quiet backwaters at the mouths of streams and lakes, prefers clear water; tolerant of moderate to low dissolved oxygen; in the littoral zone at all depths; substrate of sand, gravel, and boulders; also found over detritus substrate where patches of submerged aquatic vegetation are present; spawning in quiet areas of weedy pools; intolerant of lake edge modification.
Starhead topminnow (Sc)	<i>Fundulus dispar</i>	Quiet shallow backwaters with clear to slightly turbid waters and an abundance of submerged plants.

Appendix 4.–Continued.

Common name	Scientific name	Lacustrine habitat
Blackstripe topminnow	<i>Fundulus notatus</i>	Warmwater; found in small lakes and impoundments with clear or slightly turbid water; tolerant of moderate to low levels of dissolved oxygen; in the littoral zone at surface or mid-depths; prefers gravel, sand, or soft substrate with moderate or abundant vegetation; spawning in vegetation or algae; winter refuge in deeper water with bottom vegetation; intolerant of lake edge modification.
Silversides	Atherinidae	
Brook silverside	<i>Labidesthes sicculus</i>	Warmwater; found in small lakes and impoundments with clear to slightly turbid water; tolerant of moderate to low dissolved oxygen; in the littoral zone or offshore at surface or mid-depths; vegetated lakes and occasionally rivers over all types of substrates with sand being the most common.
Sticklebacks	Gasterosteidae	
Brook stickleback	<i>Culaea inconstans</i>	Inhabits a wide variety of habitats, lakes, ponds and small streams; all types of substrates in moderate to dense vegetation; tolerant of low dissolved oxygen and acidity.
Threespine stickleback*	<i>Gasterosteus aculeatus</i>	
Ninespine stickleback	<i>Pungitius pungitius</i>	Mostly along the Great Lakes shorelines to depths of 110 meters, but occasionally found in inland lakes.
Sculpins	Cottidae	
Mottled sculpin	<i>Cottus bairdii</i>	Coldwater; large and small lakes and reservoirs with high to moderate dissolved oxygen and clear water; in littoral zone and offshore on the bottom; substrate- gravel and sand; vegetation unimportant, spawning-nests under logs or rock.
Slimy sculpin	<i>Cottus cognatus</i>	Cold lakes; impoundments, rivers, and streams with high dissolved oxygen; gravel or rock substrate; spawning--nest in shallow areas of lakes, gravel substrate or rock ledge,
Spoonhead sculpin (Sc)	<i>Cottus ricei</i>	Inshore shallow and deeper waters of lakes, also shallows of large muddy rivers; usually from 20-50 meters depths in Great Lakes.
Deepwater sculpin	<i>Myoxocephalus thompsonii</i>	Deep, cold water lakes, most abundant at 82-91 m depth, ranging to 366 meters; spawns in deep water.

## Appendix 4.—Continued.

Common name	Scientific name	Lacustrine habitat
Striped basses	Moronidae	
White perch*	<i>Morone americana</i>	Lakes and ponds; shallow to mid-depths, and deeper water in winter.
White bass	<i>Morone chrysops</i>	Lakes, impoundments, and large rivers with moderate currents, clear to turbid water; in the littoral zone; substrates- variable; spawning in the lower portions of rivers.
Sunfishes	Centrarchidae	
Rock bass	<i>Ambloplites rupestris</i>	Coolwater; large and small lakes and reservoirs with clear to slightly turbid water; tolerant of moderate dissolved oxygen; in littoral zone or offshore at mid-depths or near bottom; substrate- rock, gravel or sand; vegetation- moderate to sparse.
Green sunfish	<i>Lepomis cyanellus</i>	Warmwater; small lakes and reservoirs with clear to turbid water; tolerant of very low dissolved oxygen; in the littoral zone at all depths; substrate- soft, gravel, or sand; vegetation- moderate but variable.
Pumpkinseed	<i>Lepomis gibbosus</i>	Warmwater; lakes, ponds, and reservoirs with clear to slightly turbid water; tolerant of very low dissolved oxygen; in the littoral zone at mid-depths and on bottom; substrate- gravel, sand, or soft; vegetation- moderate to abundant; acid tolerant.
Warmouth	<i>Lepomis gulosus</i>	Warmwater; small lakes with clear to turbid water; tolerant of moderate to low dissolved oxygen; in the littoral zone on bottom or mid-depths; prefers soft bottom with abundant to moderate vegetation.
Orangespotted sunfish*	<i>Lepomis humilis</i>	Lakes, sluggish streams, and sloughs; found in turbid water with variable substrate, tolerant of silt and pollution; sparse to moderate vegetation.
Bluegill	<i>Lepomis macrochirus</i>	Warmwater; small and large lakes, ponds, and reservoirs with clear, brown or turbid water; tolerant of moderate to low dissolved oxygen; in the littoral zone and offshore at various depths; abundant or moderate vegetation; acid tolerant.
Redear sunfish*	<i>Lepomis microlophus</i>	Warmwater; lakes with clear water; in the littoral zone and offshore on the bottom; gravel, sand, or soft substrate with moderate vegetation.
Northern longear sunfish	<i>Lepomis peltastes</i>	Warmwater; in reservoirs and small lakes with clear to slightly turbid water; tolerant of moderate to low dissolved oxygen; in the littoral zone at mid-depths; soft, gravel, or sand substrate; moderate to high vegetation.

Appendix 4.—Continued.

Common name	Scientific name	Lacustrine habitat
Smallmouth bass	<i>Micropterus dolomieu</i>	Coolwater; large and small lakes and reservoirs with clear to slightly turbid water; tolerant of moderate dissolved oxygen; in littoral zone and offshore, near the bottom and mid-depths; rock, gravel, and sand substrate; sparse to moderate vegetation.
Largemouth bass	<i>Micropterus salmoides</i>	Warmwater; lakes and ponds with clear to turbid water; tolerant of moderate to low dissolved oxygen; in the littoral zone and offshore at various depths; abundant to moderate vegetation.
White crappie	<i>Pomoxis annularis</i>	Warmwater; in small lakes and reservoirs with slightly turbid to turbid water; tolerant of moderate to low dissolved oxygen; offshore and in the littoral zone at mid-depths; sparse to moderate vegetation.
Black crappie	<i>Pomoxis nigromaculatus</i>	Warmwater; in lakes and reservoirs with clear to turbid water; tolerant of moderate to low dissolved oxygen; offshore and in the littoral zone at mid-depths and at the surface; moderate to abundant vegetation.
Perches	Percidae	
Western sand darter	<i>Ammocrypta clara</i>	Primarily streams, possibly in impoundments.
Eastern sand darter (T)	<i>Ammocrypta pellucida</i>	Sandy bottomed areas in streams and rivers and sandy shoals in lakes
Greenside darter	<i>Etheostoma blennioides</i>	Primarily streams, possibly in impoundments, inhabits some relatively quite lakeshores; eggs attached to rocks, often among filamentous algae.
Rainbow darter	<i>Etheostoma caeruleum</i>	Primarily streams, possibly in impoundments.
Iowa darter	<i>Etheostoma exile</i>	Coolwater; small and large lakes, ponds, and reservoirs with clear to slightly turbid water; tolerant of moderate to low dissolved oxygen; in the littoral zone on the bottom; gravel, sand or soft substrate; general found with submergent vegetation, especially filamentous algae that covers stones and plants.
Fantail darter, barred	<i>Etheostoma flabellare flabellare</i>	Primarily streams, possibly in impoundments, occasionally in lakes.
Fantail darter, striped	<i>Etheostoma f. lineolatum</i>	Primarily streams, possibly in impoundments, occasionally in lakes.
Least darter	<i>Etheostoma microperca</i>	Coolwater; small lakes with clear water; tolerant of moderate to low dissolved oxygen; in the littoral zone on bottom; gravel, sand, or soft substrate; prefers abundant vegetation.

## Appendix 4.–Continued.

Common name	Scientific name	Lacustrine habitat
Johnny darter	<i>Etheostoma nigrum</i>	Coolwater; small and large lakes and reservoirs with clear, brown or slightly turbid water; tolerant of moderate to low dissolved oxygen; in the littoral zone or offshore on bottom; substrate- gravel and sand but variable; moderate but variable vegetation.
Orangethroat darter	<i>Etheostoma spectabile</i>	Primarily streams, possibly in impoundments.
Banded darter (Sc)	<i>Etheostoma zonale</i>	Primarily streams, possibly in impoundments.
Ruffe*	<i>Gymnocephalus cernuus</i>	Great Lakes and connected waters.
Yellow perch	<i>Perca flavescens</i>	Coolwater; large and small lakes, ponds, and reservoirs with clear to turbid water ; tolerant of very low dissolved oxygen; in littoral zone and offshore near bottom; gravel and sand substrate preferred but variable; moderate vegetation preferred but variable; acid tolerant.
Northern logperch	<i>Percina caprodes Semifasciata</i>	Coolwater; large and some small lakes with clear to slightly turbid water; tolerant of moderate dissolved oxygen; in littoral zone and offshore near bottom; sand, gravel, or rock substrate; sparse vegetation or unimportant; acid intolerant.
Channel darter (En)	<i>Percina copelandi</i>	Occasionally in lakes on sand and gravel beaches.
Blackside darter	<i>Percina maculate</i>	Primarily streams, possibly in impoundments.
River darter (En)	<i>Percina shumardi</i>	Primarily streams, possibly in impoundments.
Sauger (T)	<i>Sander Canadensis</i>	Large turbid rivers and lakes.
Walleye	<i>Sander vitreus</i>	Coolwater; large and small lakes and reservoirs with clear to turbid water; tolerant of moderate dissolved oxygen; in littoral zone and offshore near bottom and mid-depths; rock, gravel, sand or soft substrate; moderate to sparse vegetation.
Drums	Sciaenidae	
Freshwater drum	<i>Aplodinotus grunniens</i>	Lakes, large rivers, and impoundments with turbid to clear water; generally not in shallow, weedy areas; Great Lakes waters less than 18 meters; prefers open areas with mud substrate.
Gobies *	Gobiidae	
Round goby*	<i>Neogobius melanostomus</i>	Great Lakes and connected waters.
Tubenose goby*	<i>Proterorhinus marmoratus</i>	Great Lakes and connected waters.

<sup>1</sup> Becker (1983); Boschung et al. (1983); Brazo and Liston (1979); Etnier and Starnes (1993); Hay-Chmielewski and Whelan (1997); Jenkins and Burkhead (1993); Kallemeyn (2000); NatureServe Explorer (2001); Scott and Crossman (1973); Trautman (1981); and Vincent (1992).

Appendix 5.—Amphibians found in Michigan lacustrine habitats. Information compiled by Amy Harrington and Liz Hay-Chmielewski (Michigan Department of Natural Resources, Fisheries Division) from sources listed below<sup>1</sup>. Michigan status indicated as follows: \*—non-indigenous, (T)—threatened, (En)—endangered, (Ep)—extirpated, (Ex)—extinct, (Sc)—special concern.

Common name	Name	Lacustrine habitat
Salamanders	<i>Caudata</i>	
Mudpuppies and waterdogs	<i>Proteidae</i>	
Mudpuppy	<i>Necturus maculosus maculosus</i>	Permanent lakes including the Great Lakes
Sirens	<i>Sirenidae</i>	
Western lesser siren	<i>Siren intermedia nettingi</i>	Shallow, weedy ponds and lakes
Mole salamanders	<i>Ambystomatidae</i>	
Blue spotted salamander	<i>Ambystoma laterale</i>	Semi-permanent woodland ponds
Spotted salamander	<i>Ambystoma maculatum</i>	Woodland vernal ponds
Marbled salamander (T)	<i>Ambystoma opacum</i>	Woodland ponds
Small-mouthed salamander (En)	<i>Ambystoma texanum</i>	Woodland vernal ponds
Eastern tiger salamander	<i>Ambystoma tigrinum tigrinum</i>	Woodland and farm ponds, marshes
Newts	<i>Salamandridae</i>	
Red spotted newt	<i>Notophthalmus viridescens viridescens</i>	Shallow lakes, ponds, marshes
Central newt	<i>Notophthalmus viridescens louisianensis</i>	Shallow lakes, ponds, marshes
Lungless salamanders	<i>Plethodontidae</i>	
Four-toed salamander	<i>Hemidactylium scutatum</i>	Woodland ponds, bogs, conifer swamps
Frogs and toads	<i>Anura</i>	
True toads	<i>Bufo</i>	
Eastern American toad	<i>Bufo americanus americanus</i>	Ponds, lakes, ditches
Fowler's toad	<i>Bufo woodhousii fowleri</i>	Ponds in sandy open woods and fields, dunes
True tree frogs	<i>Hylidae</i>	
Blanchards cricket frog (Sp)	<i>Acris crepitans blanchardi</i>	Permanent ponds and lakes, mud flats adjacent water preferred
Western chorus frog	<i>Psuedacris triseriata triseriata</i>	Woodland ponds and swamps, marshes
Boreal chorus frog (Sp)	<i>Psuedacris triseriata maculate</i>	Woodland ponds and swamps, marshes
Northern spring peeper	<i>Psuedacris crucifer crucifer</i>	Ponds, marshes, swamps
Easter gray treefrog	<i>Hyla versicolor</i>	Lakes, ponds, swamps, marshes
Cope's gray treefrog	<i>Hyla chrysoscelis</i>	Lakes, ponds, swamps, marshes
True frogs	<i>Ranidae</i>	
Green frog	<i>Rana clamitans melanota</i>	Lakes and ponds with abundant vegetation & mud bottom, marshes, wooded swamps, adults stay near water.



## Conservation Guidelines for Michigan Lakes

### Appendix 5.–Continued.

Common name	Name	Lacustrine habitat
Bullfrog	<i>Rana catesbeiana</i>	Permanent ponds, lakes, and marshes with mud bottom
Northern leopard frog	<i>Rana pipiens</i>	Marshes, meadows and gassy edges of ponds & lakes with abundant vegetation, young stay near water.
Pickerel frog	<i>Rana plaustris</i>	Grassy and marshy edges of lakes and bogs
Mink frog	<i>Rana septentrionalis</i>	Ponds, bogs and lakes with abundant vegetation
Wood frog	<i>Rana sylvatica</i>	Woodland ponds & bogs

<sup>1</sup> Conant and Collins (1998), Harding and Holman (1992), and Ruthven et al. (1928)

Appendix 6.—Reptiles found in Michigan lacustrine habitats. Information compiled by Amy Harrington and Liz Hay-Chmielewski (Michigan Department of Natural Resources, Fisheries Division) from sources listed below<sup>1</sup>. Michigan status indicated as follows: \*—non-indigenous, (T)—threatened, (En)—Endangered, (Ep)—Extirpated, (Ex)—extinct, (Sc)—special concern.

Common name	Scientific name	Lacustrine habitat
Turtles and tortoises	<i>Testudines</i>	
Snapping turtles	<i>Chelydridae</i>	
Snapping turtle	<i>Chelydra serpentine</i>	Marshes and muddy-bottomed lakes with abundant vegetation
Musk and mud turtles	<i>Kinosternidae</i>	
Common musk turtle	<i>Sternotherus odoratus</i>	Shallow water lakes with some vegetation; muck, marl, sand or gravel bottom
Pond and box turtles	<i>Emydidae</i>	
Spotted turtle (T)	<i>Clemmys guttata</i>	Shallow, clear water with mud bottom & abundant vegetation
Wood turtle (Sp)	<i>Clemmys insculpta</i>	Primarily rivers with sand sediment.
Eastern box turtle (Sp)	<i>Terrapene carolina carolina</i>	Use ponds for cooling in hot weather
Blandings turtle (Sp)	<i>Emydoidea blandingii</i>	Shallow water with mud bottom and some vegetation
Common map turtle	<i>Graptemys geographica</i>	Clean, large lakes
Painted turtle	<i>Chrysemys picta</i>	Shallow water with aquatic vegetation and mud bottom
Red-eared slider	<i>Trachemys scripta elegans</i>	Lakes and ponds with abundant vegetation and mud bottom
Softshell turtles	<i>Trionychidae</i>	
Spiny softshell	<i>Apalone [-Trionyx] spinifera</i>	Large lakes with sand and mud bottom
Lizards and snakes	<i>Squamata</i>	
Snakes	<i>Suerpentes</i>	
	<i>Colubridae</i>	
Kirtland's snake (En)	<i>Clonophis kirtlandi</i>	Wet meadows and forests, tamarack swamps
Northern copperbelly snake (En)	<i>Nerodia erythrogaster neglecta</i>	Lakes, woodland ponds, shrub wetlands
Northern water snake	<i>Nerodia sipedon sipedon</i>	Permanent ponds, lakes, marshes, and wetlands
Queen snake	<i>Regina septemwittata</i>	Edges of ponds, lakes, and marshes
Brown snake	<i>Storeria dekayi</i>	Areas with moist soils
Northern red-bellied snake	<i>Storeria occipitomaculata occipitomaculata</i>	Moist substrates including marshes and sphagnum bogs
Eastern garter snake	<i>Thamnophis sirtalis sirtalis</i>	Moist grassy areas near edges of ponds, lakes, and streams
Butler's garter snake	<i>Thamnophis butleri</i>	Moist grassy places and marshy pond and lake borders
Northern ribbon snake	<i>Thamnophis sauritus septentrionalis</i>	Edges of ponds, lakes, bogs, and marshes with grass, sedges, and shrubs

Conservation Guidelines for Michigan Lakes

Appendix 6.—Continued.

Common name	Scientific name	Lacustrine habitat
Northern ringneck snake	<i>Diadophis punctatus edwardsi</i>	Moist, shady woodlands and grassy, stable dunes & beaches
Blue racer	<i>Coluber constrictor foxi</i>	Edges of lakes and marshes
Black rat snake (Sp)	<i>Elaphe obsoleta obsoleta</i>	Marsh and bog edges
Eastern fox snake (T)	<i>Elaphe vulpina gloydi</i>	Great Lakes shoreline marshes, dunes, and beaches
Eastern milk snake	<i>Lampropeltis triangulum triangulum</i>	Bogs, wetlands, marshes, and lakeshores
Eastern smooth green snake	<i>Opheodrys vernalis vernalis</i>	Moist, grassy places
Vipers	Viperidae	
Eastern massasauga rattlesnake (Sp)	<i>Sistrurus catenatus catenatus</i>	Marshes and swamps

<sup>1</sup> Conant and Collins (1998); Harding (1997); Harding and Holman (1990); Holman et al. (1999); and Ruthven et al. (1928).

Appendix 7.—Birds commonly associated with Michigan lake communities. These species are largely migratory and use Michigan lakes and wetlands for breeding and staging for seasonal migrations. Information compiled from sources listed below<sup>1</sup>. Status indicated as follows: \*—non-indigenous, (T)—threatened, (En)—endangered, (Ep)—extirpated, (Ex)—extinct, (Sc)—special concern, (C)—continental concern (See Soulliere 2005).

Common name	Scientific name	Common community type
Waterfowl	<i>Anatidae</i>	
Swans	<i>Cygnini</i>	
Tundra Swan (C)	<i>Cygnus columbianus</i>	Lake and marsh
Trumpeter Swan (T, C)	<i>Cygnus buccinator</i>	Lake, marsh, and river
Mute Swan*	<i>Cygnus olor</i>	Lake, marsh, and river
Geese	<i>Anserini</i>	
Canada Goose	<i>Branta canadensis</i>	Lake, marsh, river, and swamp
Ducks	<i>Anatinae</i>	
Wood Duck	<i>Aix sponsa</i>	River, stream, swamp, and marsh
Green-winged Teal	<i>Anas crecca</i>	Marsh and swamp
American Black Duck (C)	<i>Anas rubripes</i>	Marsh, river, and swamp
Mallard	<i>Anas platyrhynchos</i>	Marsh, river, and swamp
Northern Pintail (C)	<i>Anas acuta</i>	Marsh
Blue-winged Teal (C)	<i>Anas discors</i>	Marsh
Northern Shoveler	<i>Anas clypeata</i>	Marsh
Gadwall	<i>Anas strepera</i>	Marsh
American Wigeon	<i>Anas americana</i>	Marsh and lake
Canvasback (C)	<i>Aythya valisineria</i>	Lake and marsh
Redhead (C)	<i>Aythya Americana</i>	Lake and marsh
Ring-necked Duck	<i>Aythya collaris</i>	Marsh and lake
Greater Scaup	<i>Aythya marila</i>	Lake
Lesser Scaup (C)	<i>Aythya affinis</i>	Lake
Long-tailed Duck	<i>Clangula hyemalis</i>	Lake
Common Goldeneye (C)	<i>Bucephala clangula</i>	Lake, river and swamp
Bufflehead	<i>Bucephala albeola</i>	Lake and river
Hooded Merganser	<i>Mergus cucullatus</i>	River, stream, marsh, and lake
Common Merganser	<i>Mergus merganser</i>	Lake and river
Red-breasted Merganser	<i>Mergus serrator</i>	Lake and river
Ruddy Duck	<i>Oxyura jamaicensis</i>	Lake and marsh
Waterbirds		
Grebes	<i>Podicipedidae</i>	
Horned Grebe	<i>Podiceps auritus</i>	Lake and marsh
Pied-billed Grebe	<i>Podilymbus podiceps</i>	Lake and marsh
Rails, moorhens, and coots	<i>Rallidae</i>	
King Rail (E, C)	<i>Rallus elegans</i>	Marsh
Virginia Rail	<i>Rallus limicola</i>	Marsh
Sora	<i>Porzana Carolina</i>	Marsh
Common Moorhen (Sc)	<i>Gallinula chloropus</i>	Marsh
American Coot	<i>Fulica americana</i>	Marsh and lake

Conservation Guidelines for Michigan Lakes

Appendix 7.—Continued.

Common name	Scientific name	Common community type
Wading birds		
Herons		
<i>Ardeidae</i>		
American Bittern (Sc, C)	<i>Botaurus lentiginosus</i>	Marsh
Least Bittern (T, C)	<i>Ixobrychus exilis</i>	Marsh
Great Blue Heron	<i>Ardea herodias</i>	Marsh, river, stream, and swamp
Great Egret	<i>Casmerodius albus</i>	Marsh
Cattle Egret	<i>Bubulcus ibis</i>	Marsh
Green-backed Heron	<i>Butorides striatus</i>	Marsh and swamp
Black-crowned Night-heron (C)	<i>Nycticorax nycticorax</i>	Marsh and swamp
Gulls and terns		
<i>Laridae and Sterinae</i>		
Bonaparte's Gull	<i>Larus Philadelphia</i>	Lake
Ring-billed Gull	<i>Larus delawarensis</i>	Lake
Glaucous Gull	<i>Larus hyperboreus</i>	Lake
Herring Gull	<i>Larus argentatus</i>	Lake
Little Gull	<i>Larus minutus</i>	Lake
Great Black-backed Gull	<i>Larus marinus</i>	Lake
Iceland Gull	<i>Larus glaucoides</i>	Lake
Caspian Tern (T)	<i>Sterna caspia</i>	Lake
Common Tern (T, C)	<i>Sterna hirundo</i>	Lake
Forster's Tern (Sc, C)	<i>Sterna forsteri</i>	Lake
Black Tern (Sc, C)	<i>Chlidonias niger</i>	Marsh and lake
Shorebirds		
Plovers and sandpipers		
<i>Charadriidae and Scolopacidae</i>		
Piping Plover (E, C)	<i>Charadrius melodus</i>	Lakeshore
Greater Yellowlegs (C)	<i>Tringa melanocleuca</i>	Marsh
Lesser Yellowlegs	<i>Tringa flavipes</i>	Marsh
Spotted Sandpiper	<i>Actitis macularia</i>	Lake and river shoreline
Solitary Sandpiper (C)	<i>Bartramia longicauda</i>	Lake and river shoreline
Dunlin	<i>Calidris alpina</i>	Lakeshore
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	Marsh
Ruddy Turnstone (C)	<i>Arenaria interpres</i>	Lakeshore
American Woodcock (C)	<i>Scolopax minor</i>	Lowland forest and swamp edge
Common Snipe	<i>Gallinago gallinago</i>	Marsh and lakeshore
Raptors		
Osprey (T)	<i>Pandion haliaetus</i>	Lake and river
Bald Eagle (T)	<i>Haliaeetus leucocephalus</i>	Lake and river
Northern Harrier (Sc)	<i>Circus cyaneus</i>	Marsh
Sharp-shinned Hawk	<i>Accipiter striatus</i>	Lowland forest edge
Cooper's Hawk	<i>Accipiter cooperil</i>	Lowland forest edge
Red-tailed Hawk	<i>Buteo jamaicensis</i>	Lowland forest
Rough-legged Hawk	<i>Buteo lagopus</i>	Lowland forest
Broad-winged Hawk	<i>Buteo platypterus</i>	Lowland forest
American Kestrel	<i>Falco sparverius</i>	Lowland forest and swamp edge
Short-eared Owl (E)	<i>Asio flammeus</i>	Marsh

## Appendix 7.–Continued.

Common name	Scientific name	Common community type
Perching and other birds	<i>Passeriformes</i>	
Belted Kingfisher	<i>Ceryle alcyon</i>	River and stream
Marsh Wren (Sc)	<i>Cistothorus palustris</i>	Marsh
Sedge Wren	<i>Cistothorus platensis</i>	Marsh edge
Veery	<i>Catharus fuscescens</i>	Lowland forest
Yellow Warbler	<i>Dendroica petechia</i>	Lowland forest edge
Common Yellowthroat	<i>Geothlypis trichas</i>	Marsh, river and lake edge
Eastern Meadowlark	<i>Sturnella magna</i>	Marsh and river edge
Yellow-headed Blackbird (Sc)	<i>Xanthocephalus xanthocephalus</i>	Marsh
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	Marsh
Common Grackle	<i>Quiscalus guiscula</i>	Marsh and forest edge
Swamp Sparrow	<i>Melospiza Georgiana</i>	Marsh
Savannah Sparrow	<i>Passerculus sandwichensis</i>	Marsh edge

<sup>1</sup> Brewer et al. (1991); Brown et al. (2001); Helmers (1992); Hendorff et al. (1986); Kushlan et al. (2002); Monfils (1996); NAWMP (2004); and Soulliere (2005).

## Conservation Guidelines for Michigan Lakes

Appendix 8.—Mammals commonly associated with Michigan lake communities. Data compiled from sources listed below<sup>1</sup>. Status indicated as follows: \*—non-indigenous, (T)—threatened, (En)—endangered, (Ep)—extirpated, (Ex)—extinct, (Sc)—special concern.

Common name	Scientific name
Virginia opossum	<i>Didelphis virginiana</i>
Eastern cottontail	<i>Sylvilagus floridanus</i>
European hare	<i>Lepus capensis</i>
Woodchuck	<i>Marmota monax</i>
Gray squirrel	<i>Sciurus carolinensis</i>
Fox squirrel	<i>Sciurus niger</i>
Red squirrel	<i>Tamiasciurus hudsonicus</i>
Muskrat	<i>Ondatra zibethicus</i>
Red fox	<i>Vulpes fulva</i>
Raccoon	<i>Procyon lotor</i>
Long-tailed weasel	<i>Mustela frenata</i>
Mink	<i>Mustela vison</i>
Striped skunk	<i>Mephitis mephitis</i>
Badger	<i>Taxidea tus</i>
White-tailed deer	<i>Odocoileus virginianus</i>
Otter	<i>Lutra Canadensis</i>
Water shrew	<i>Sorex palustris</i>
Star-nosed mole	<i>Condylura cristata</i>
Beaver	<i>Castor canadensis</i>

<sup>1</sup> Baker 1983.

Appendix 9.–Lake watershed assessments and management plans.

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## **LAKE WATERSHED ASSESSMENTS AND MANAGEMENT PLANS**

The natural resources of Michigan lakes are used by a multitude of recreational and commercial stakeholders. Swimming, boating, sunbathing, relaxation, scuba diving, sightseeing, fishing, hunting, trapping, and wildlife viewing are some of the reasons people are attracted to lakes. In 2001, the value of fishing, migratory bird hunting, and wildlife viewing on Michigan lakes was estimated at over \$1 billion. Many lakes are heavily developed for varying human interests by riparian property owners. Recreational use, commercial use, and residential development continue to increase on and along the shores of our lakes.

Roughly 40% of Michigan is covered by the Great Lakes and 1,000 square miles is covered by inland lakes. There are over 35,000 mapped inland lakes with a surface area 0.1 acres or larger. Over 2,000 are larger than 50 acres and 11,000 are larger than 5 acres. Houghton Lake is the largest inland lake in Michigan encompassing 20,044 acres.

Lakes are some of the most productive and biologically diverse ecosystems in Michigan. Under the public trust doctrine, Michigan holds natural resources in trust for the benefit of the people of Michigan. The views of diverse stakeholders on management of natural resources in lakes can be very different. A thorough knowledge and proper planning of lake resources and human alterations will help assure ecosystem integrity and sustainable natural resources for current and future generations of Michigan citizens.

Lake assessments and management plans provide an organized approach to identifying opportunities and solving problems. They provide a mechanism for public involvement in management decisions; allowing citizens to learn, participate, and help determine decisions. These documents provide an organized reference for Department of Natural Resources personnel, other agencies, and citizens who need information about a particular aspect of a lake system.

Inland lakes can have relatively small to very large watersheds, depending on the number and size of their tributary streams. Lakes with no tributary streams will have relatively small watersheds. Some lakes have very large tributary streams encompassing some of the largest watersheds in Michigan. Depending on the size of the watershed and available resources, river assessments and plans may be developed separately from lake assessments and plans.

The process of developing an assessment and management plan is provided below. The procedures are intended for Department of Natural Resources use, but can serve as a guide for other organizations involved in lake planning. The assessment incorporates a review of the physical, biological, and social features of the lake's watershed. A list of management options are developed based on assessment of the watershed's features. A draft of the assessment is then distributed to the public and interested groups and agencies. Appropriate revisions are made to the assessment following public comment, and options are selected and incorporated into a management plan.

Required and recommended information and procedures for assessments will change as new research and techniques become available. Detailed directions for developing assessments will not be provided here. A current description of features and information that should be incorporated into lake assessments is provided below. Lake assessments will have standard formats including the following preliminary sections: Cover Page, Title Page, Table of Contents, List of Tables, List of Figures, List of Appendices, Acknowledgements, and Executive Summary.



## **INTRODUCTION**

The introduction should describe the purpose and goals of the lake assessment and management plan. A summary of the process used to complete these documents should be incorporated. All stakeholders and partners involved in development of the documents should be listed.

## **ASSESSMENT**

The assessment provides a description of the historical and present day natural resources in the lake. It summarizes the physical, biological, and social factors that have influenced resources historically, and will influence future management. The assessment provides the framework and boundaries that guide management direction. A description of the various features that should be incorporated into the assessment follows.

### **Geography**

Information in this section should provide a description of the location of the waterbody and watershed in Michigan, tributary streams, watershed size, river basin, and Great Lakes basin. Political boundaries such as counties, cities, villages, and other landmarks should be described. The Michigan Department of Natural Resources (DNR), Digital Water Atlas of Michigan and the Michigan Geographic Data Library can provide much of the information.

### **History**

Provide a brief overview of human modifications and present day uses of the lake and its watershed. Typical topics that should be included are human population abundance, historical vegetation and logging activities; agricultural, commercial, industrial, and residential development; chemical and nutrient pollution; major alterations to the lake bottom, shoreline, and biological communities; and changes of important resources. Natural resources agency reports and local libraries are sources of information.

### **Basin Geology, Soils, and Hydrology**

The geology and soils of the basin determine much of the hydrology. This description should focus on surface geology because it primarily affects the hydrology and water quality of lakes. Discuss surface geology types and determine the amount of each type in the watershed, along with soil types (e.g., outwash, moraines, till, bedrock, sands, clays loams, etc.). Information is available from the Quaternary Geology of Michigan, surface geology map of Michigan, Natural Rivers Reports if available, Michigan Department of Environmental Quality (DEQ) MIRIS database, and U. S. Department of Agriculture (USDA) Natural Resources Conservation Districts.

Summarize groundwater and surface water inflows and outflows. Determine a water budget and residence time for the lake if possible. Inflows for the water budget include groundwater, tributaries, other surface runoff and discharges, and direct rainfall. Outflows include groundwater, streams, evaporation, and withdrawals. The sources described below can help determine the water budget. The

## Appendix 9.–Continued.

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evaluation of discharge from tributary streams can be useful in determining if development and drainage in the watershed is affecting water quality.

*i) Climate*

Climate includes rainfall and temperatures in the basin. Data can be obtained from US weather service site locations and either Eichenlaub's (1990) or Sommer's (1977) climatic atlas. Determine average amount of rainfall and seasonal patterns. Calculate water yield (cfs) per square mile of the watershed. Discuss evaporation, winter severity, and growing season.

*ii) Annual Stream Flows*

Describe average annual flows and annual patterns of discharge from streams entering and leaving the lake. Generally this information is available only from USGS gauge sites (data available on the web at <http://www.usgs.gov>). If gauge information is not available, models may provide relevant information. For each location calculate average yield (average annual discharge/drainage area). This gives a broad sense of the water budget for the watershed. Used with precipitation data, you can calculate how much water is lost to evapotranspiration before it gets to the stream. This is particularly important in forested watersheds. Consider flow regulations if dams are present, and water withdrawals for irrigation and industrial use.

*iii) Seasonal Stream Flows*

Seasonal flows help determine flow stability in streams. Flow duration curves, with the data in 5% intervals (USGS web site) will be needed. Develop graphs with percent exceedence on the x axis and standardized discharge on the y axis. For low flow data, the higher the standardized discharge number, the more stable the system is. This is due to groundwater influxes that continually provide water to the stream even during dry periods. For high flow data, the lower the standardized discharge number, the more stable the system is. Stability of stream discharge during rainfall and snowmelt periods results because water infiltrates into the soils and is released slowly, rather than quickly flowing over the surface of the ground to the stream. These values can be compared to other Michigan streams to determine groundwater/surfacewater relationships. Using discharge information and information from the Michigan Valley Segment Ecological Classification System (VSEC), inferences can be made on potential changes in surface runoff in the watershed.

*iv) Daily Stream Flows*

In natural systems daily flow changes are generally gradual. However, impoundments from dams or lake-level control structures can cause dramatic changes in short periods of time. Look at mean daily discharge data for all gauge locations; determine if any unusually wide day to day variation occurred.

Appendix 9.–Continued.

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*v.) Dams and Barriers*

Dams and barriers in tributary streams should be considered in any flow evaluation. They also have effects on animal movements. Lake-level control dams also affect lake water levels and habitat features of the lake.

*vi.) Great Lakes Influences*

Great Lakes water levels and influxes need to be considered where they influence the lake.

Sources of information include the Michigan Geographic Data Library (VSEC), Michigan USGS Water Resources Division ([mi.water.usgs.gov/](http://mi.water.usgs.gov/)), DEQ Geological Survey Division, Michigan State University Institute of Water Research, and university libraries.

**Land Use**

Land use within the watershed and along the shoreline of a lake affects the hydrology of the system and the level of nutrients, chemicals, dissolved substances, and bedload sediment discharged into the lake. Land use along the shoreline of the lake affects water quality, biological communities, and various habitat components like aquatic and land vegetation, deadwood, and shoreline slope.

Describe the historical and present landscape of the watershed. Note any unique areas and why. Discuss and quantify major land-use categories such as agriculture, forest, and urban uses including impervious surface area. Include artificial drainage including designated drains and road drains. Review other relevant alterations like bridge crossings, culverts, roads, oil and gas pipelines, and utility crossings.

Shoreline areas of the lake can be treated separately in the discussion. Include evaluation of these components:

- Tree densities (> 2" in diameter) within 30 feet of the shoreline.
- Shoreline length and lengths of shoreline in the following categories: natural shoreline, semi-natural shoreline (e.g., lawn with emergent vegetation), vertical or hard seawall, rock rip-rap seawall, developed or artificial (lawns, beaches), total number of residences
- Locations of all shallow and deep water wells along the shoreline.
- Density (number/mi) of homes and cottages along the shoreline.

Information sources include the Michigan Geographic Data Library, USDA Natural Resources Conservation Districts, DEQ MIRIS Database, local Health Departments and lake associations, and universities.

**Lake Morphology**

The three dimensional shape of a lake influences water temperature, dissolved oxygen levels, aquatic plant growth, overall biological production and trophic status, biological communities and development. Parameters that should be evaluated include:

## Appendix 9.—Continued.

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- Surface area, volume, maximum length, mean width, maximum width, mean depth, maximum depth, shoreline length, natural shoreline development, and slope of the bottom.
  - Total surface area of littoral zone and plant coverage of total lake surface area.
  - Bottom depth contours (5 ft.)—include volume of water within each depth contour.
  - Wetlands, dunes, or other special features that may be located adjacent the shoreline
  - Quantify and discuss all historical dredging and filling (including beach sanding) within the lake and adjacent wetlands.

Information sources include the DNR Digital Water Atlas of Michigan and the Michigan Geographic Data Library, and DEQ P.A 203 (Wetland Protection) and 346 (Inland Lakes and Streams) permits.

### Water Quality

Water quality is a habitat component that influences the types and levels of biological communities. Water temperatures, oxygen, and pH levels influence animal communities; alkalinity influences production; chlorophyll-*a*, transparency, and nutrient concentrations help determine trophic state; sediment cores help determine historical changes in trophic state; and chemical analyses of water and sediment is needed to determine if pollution is present. Water quality parameters that are important to evaluate include:

Water temperatures—includes temperature profiles of the entire water column to determine epilimnion, metalimnion, and hypolimnion layers.

Dissolved oxygen—collected in the epilimnion; upper, middle, and lower metalimnion; and upper and lower hypolimnion.

- Alkalinity and pH.
- Nitrogen and phosphorus in the water column, preferably during spring and fall turnover periods.
- Chlorophyll-*a* concentrations.
- Transparency, using a secchi disc.
- Sediment coring and nutrient history.

Generally, organic and metal contaminants are not a significant problem in inland waters unless there have been historic discharges to a lake. Airborne contaminants can sometimes be a problem for inland waters, especially for mercury. The Great Lakes and some of the larger connected inland waters and bays have significant historical contamination and some level of ongoing contaminant inputs from industrial discharges, upland runoff carried from tributary streams and stormwater discharges, and airborne sources. Other sources of contamination may include historical land contamination sites that have polluted groundwater. Fish contaminants are a human health issue but advisories often indicate pollution problems and should be summarized.

Sources of information include DEQ Surface Water Quality Division, DNR lake survey records, and the Michigan Department of Public Health for fish contaminant advisories.

Note- for non-point source grants through DEQ, management plans must be developed using specific processes. Refer to Brown et al. (2000) or [www.michigan.gov/deq](http://www.michigan.gov/deq).

Appendix 9.–Continued.

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### **Biological Communities**

The biological communities represent a significant portion of the natural resources of our lakes and are widely used for recreation, food, and commercial enterprises. Species composition and abundance is often a good measure of ecosystem health, especially when compared to original conditions or Michigan lakes with similar characteristics. Discussion should incorporate physical and social factors to explain biological communities and changes that have occurred from original conditions.

Describe the biological community including phytoplankton, submergent plants, emergent plants, and near-shore upland plants; invertebrates including microcrustaceans, insects, crayfish, and mussels; fish; amphibians; reptiles; birds; and mammals. Birds and mammals discussed should be those that require the lake for survival. Include summaries of non-indigenous species, extinct species, and the status of species low in abundance or extirpated. Provide a general overview of habitat features as related to the biological community. Include special communities, such as, bogs, swamps, marshes, and wetlands. Summarize resource changes and factors that have affected the biological community since European settlement, like deforestation, development, pollution, changes in water quality and trophic status, lake-level dams, land use, aquatic vegetation removal programs, dredging and filling, seawalls, shoreline development, fish stocking, and harvest of resources. Discuss where important information is lacking or limited.

Aquatic plant summaries should include total coverage of lake surface area, species composition, and relative coverage and densities of dominant plants. Note- for Aquatic Nuisance Control permits, DEQ approved plant sampling procedures must be used for plant community descriptions. Evaluate wetland plant communities using the Floristic Quality Assessment (Herman et al. 2001). Evaluate habitat quality using fish community indices from Schneider (2002) and Schneider (1990).

Information sources include DNR and DEQ records and reports, universities, and libraries.

### **Resource Management**

The Department of Natural Resources is responsible for managing the natural resources of the state, and for the protection of the public trusts in these resources. Discuss historical and present resource management practices for forestry, animals, and water quality. These can include activities within the watershed when relevant. Discuss regulations, user preferences, harvest, and pressure. Identify high-use resources. Summarize research and studies. Identify potential goals for the future.

Other agencies and groups may have plans related to, or affecting natural resources. A summary of relevant features of these plans should be included in the discussion.

### **Recreation Use**

Michigan lakes are used for a multitude of recreational uses. Recreation sometimes directly uses the animal communities. Other uses often have indirect effects on the resources that may be in conflict with good resource management.

Summarize recreation activities like fishing, hunting, trapping, boating, wind surfing, swimming, wildlife observation, hiking, nature study, and picnicking. Include public lands and access sites. Discuss any relevant conflicts.

Appendix 9.–Continued.

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Sources of information include DNR records and reports, and the U. S. Fish and Wildlife Service, National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

### **Special Jurisdictions**

Generally there are several to many entities that have legal jurisdiction over a lake. These jurisdictions may affect resources or resource management.

Summarize federal, state, and local laws that affect the watershed. Determine if the water has been adjudicated navigable under federal or state law. Jurisdictions may include county drain commissioners, natural rivers designations, state game areas, state parks, refuges, and county or city parks. Determine the existence of an established legal lake-level, a lake board, or a special assessment district under P. A. 451. Local zoning laws should be described, especially relative to water frontage properties. Local wastewater and storm water management systems should be included.

Information sources include the DEQ website (<http://www.michigan.gov/deq>) for state laws, DNR Guide to Public Rights on Michigan Waters (Law Enforcement Division Report Number 9, 1993), and federal and local government offices.

### **Citizen Involvement**

Natural resources are managed to provide optimum benefits for the citizens of the state by the Department of Natural Resources. Active citizen involvement in management activities can vary greatly.

Summarize interested groups and partners involved in lake activities including watershed councils, government entities, hunting and fishing groups, and environmental organizations. Discuss relevant activities of these groups to resource management.

## **MANAGEMENT OPTIONS**

A list of management options is prepared based on the assessment of resources in the lake and its watershed. Generally, these options are designed to protect, restore, rehabilitate, mitigate, or enhance natural resources in the system. It is advantageous to describe options in this manner because it helps selection of management options for the management plan. For example, protection activities are usually superior to enhancement activities.

Options must be consistent with the mission statement of the Department of Natural Resources. This mission is to protect and enhance the public trust in natural resources, and promote optimum use of these resources. Options must follow the eight guiding principals of ecosystem management described earlier in this document.

Appendix 9.–Continued.

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## **PUBLIC COMMENT AND REVIEW**

A draft of the assessment will be distributed for public comment. All provided comments will be listed and discussed, with any changes to the assessment noted.

## **GLOSSARY**

Describe any technical or biological terms used in the document.

## **REFERENCES**

List references cited in the format specified for the North American Journal of Fisheries Management.

## **MANAGEMENT PLAN**

A lake management plan is developed following completion of the assessment. The management plan consists of a series of management actions based on selected management options from the assessment. Each management action includes a summary of the management options upon which it is based, the reason for selection, whether it is a long-term or short-term objective, and for short-term objectives a schedule for implementation that includes a time frame, personnel needed, special needs, and finances required.