Wisconsin's Critical Habitat Designation Manual

A Comprehensive Conservation Strategy For Identification of Sensitive Areas and Public Rights Features in Wisconsin Lakes

Critical Habitat Designation Program includes formal designations of sensitive areas, public rights features, and resource protection areas. All of these elements combine to provide regulatory and management advice to the State of Wisconsin, counties, local units of governments, and others who hold authorities or are interested in protecting and preserving these unique habitats for future generations. It is the State's responsibility to channel society's desire to enjoy these beautiful places into patterns of development that maintains the productivity and quality of our natural resources.

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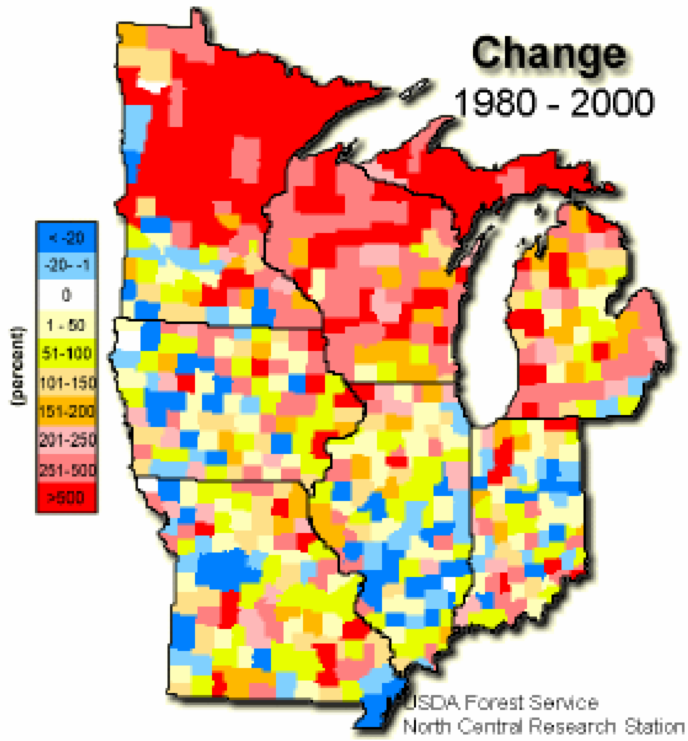
Chapter 1. An Introduction to Lakeshore Critical Habitats

The Wisconsin DNR is concerned about the growing number of threats to sustainable healthy lakes in the state. While many positive measures have been initiated within Wisconsin over the past few decades, habitat and water quality continue to be impacted. Conversion of lakeshore to residential development has greatly accelerated over the past 30 years. Over the past 20-years, the upper Great Lakes states of Michigan, Minnesota, and Wisconsin, each rich in natural inland lakes, have experienced extremely high increases in population (Figures 1-2). Patterns of growth tend to be away from agriculture and urban core areas and toward suburbs and lake rich areas such as central and northern Minnesota, northern Wisconsin, and the upper peninsula and lake regions of lower Michigan.

Figure 1.



Increases in shoreland development are changing lake ecosystems. Development pressure is increasing with more dwellings per lake each year (Kelly and Stinchfield 1998, Schnaiberg et al., 2002). Human habitation along the shore has a cumulative effect on fish and wildlife habitat, water quality, and biota of lake ecosystems (Engel and Pederson 1998, Ramstack et al. 2004). Christensen et al. (1996) found significantly less coarse woody debris along developed shorelines in Wisconsin and Michigan, predicting that recent losses in developed lakes will affect littoral communities for about two centuries. Meyer et al. (1997) concluded that housing development along shores of northern Wisconsin lakes dramatically altered native vegetation, especially shrubs, and reduced frog populations. Elias and Meyer (2003) found that the mean number of plant species and the percent of native species were both greater at undeveloped sites than along developed Wisconsin lakeshores for upland, shoreline, and shallow water areas. Jennings et al. (1996) noted changes in nearshore substrate composition in Wisconsin lakes due to human activity. In an Iowa lake, Byran and Scarnecchia (1992) found significant reductions in aquatic macrophyte abundance in developed compared with undeveloped shorelines. Jennings et al. (1999) also found that the amount of littoral wood remains and emergent and floating-leaf vegetation was lower at developed sites and lakes with greater development density. Radomski and Goeman (2001) estimated a 20-28% loss of emergent and floating-leaf coverage from human development for a class of Minnesota lakes by comparing vegetation abundance along undeveloped and developed shorelines for 44 lakes. Alteration of natural littoral zone habitats has negative consequences to fish and wildlife. Walleye spawn on wave-washed nearshore gravel areas (Becker 1983), and these areas are sensitive to nutrient and sediment runoff. Littoral zone vegetation is important for amphibians, ducks, loons, herons, and other wildlife (Meyer et al. 1997; Lindsay et al. 2002; Woodford and Meyer 2003). Floating-leaf and emergent vegetation provides fish with foraging areas and refuge from predators (Killgore et al. 1993; Valley et al. 2004). Many fish depend on this habitat for some part or most of their life (Becker 1983). Floating-leaf vegetation, such as white water lily *Nymphaea odorata*, provide shade and overhead cover for largemouth bass *Micropterus salmoides* and other centrarchids. Emergent vegetation, such as hardstem bulrush *Scirpus acutus*, provide spawning habitat, cover, and colonization sites for aquatic invertebrates and protection from shore erosion by dampening wave energy. Perhaps as important, the native flora, more than anything else, defines the ecological character of our lakes. Numerous fish species use protected embayments and vegetative cover disproportionately to their availability (Wei et al. 2004). Human activities that change vegetative cover can alter ecological processes and energy flow within lakes, thereby reducing their ability to support diverse and healthy fisheries (Schindler and Scheuerell 2002).

Shorelines along lakes may vary greatly with a variety of ecological characteristics that provide varying habitats for wildlife and fish species, and performing different water quality functions. Yet without Critical Habitat Designations; the Department has been essentially treating all shorelines within a lake the same--from shoreland development, to APM, piers and water regulation permits.

Within lakes, littoral regions (Figure 3) are extremely important to the structure, function, and integrity of lake ecosystems (Hall and Werner 1977, Gelwick and Matthews 1990, Benson and Magnuson 1992). Evidence suggests that transfer of food energy from the littoral zones of lakes may influence overall fish production and biomass (Boisclair and Leggett 1985). Most lake-resident fish in Wisconsin, including those that inhabit cool- or coldwater offshore habitats in summer in northern temperate lakes, seasonally rely on littoral areas for spawning and rearing (Becker 1983). Moreover, many of these species make diel and seasonal use of littoral regions for foraging (Becker 1983). In addition to species that use these areas seasonally, many species use littoral regions throughout the year, and many use littoral regions throughout their entire life cycle

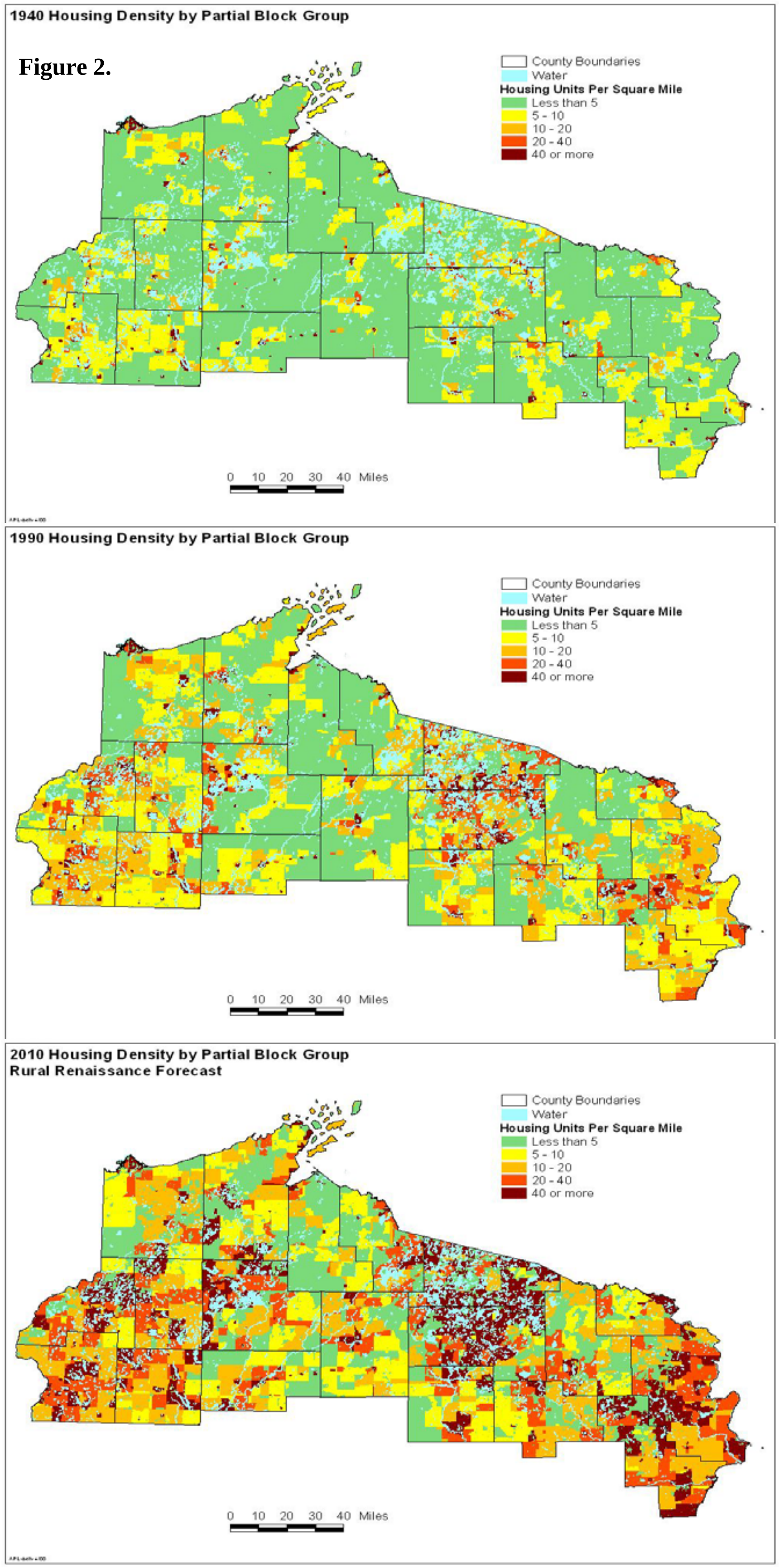
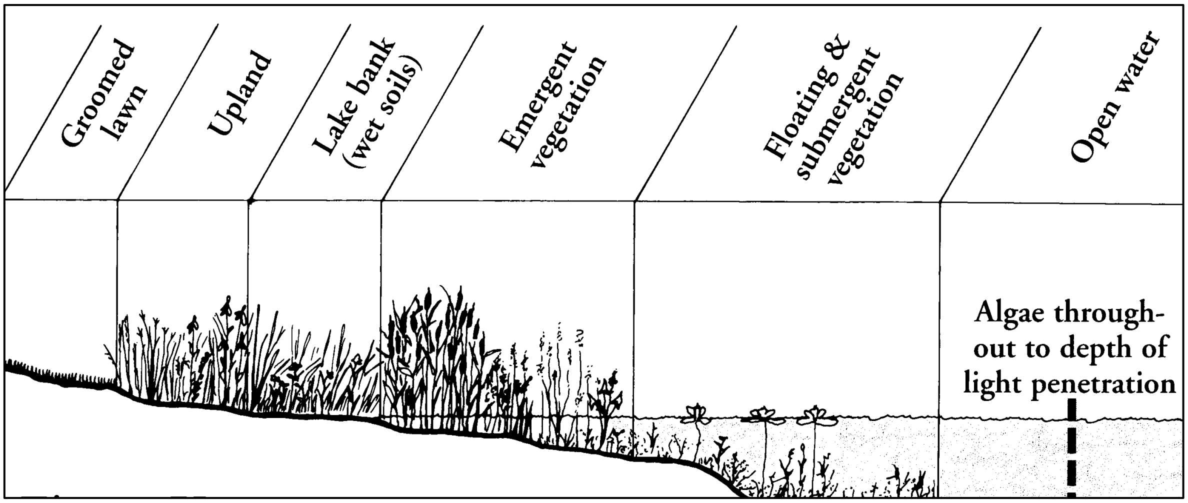


Figure 2.

Figure 3.



(Becker 1983). The relationships between fish and habitat have been the subject of numerous ecological investigations. The fact that fish are habitat specialists (Gorman and Karr 1978) has been well established by studies conducted in a variety of freshwater habitats. For instance, northern pike require dense mats of short aquatic vegetation in shallow water (< 0.5 m) for spawning (Clark 1950, Forney 1968); fry use these mats during early rearing for protection from predators and for feeding (Franklin and Smith 1963, Frost and Kipling 1967). White suckers, an important native forage fish in Wisconsin, utilize shallow (20-25 cm) gravel substrates in inflowing or outflowing streams or in shallow, nearshore littoral regions of lakes (Krieger 1980). Yellow perch broadcast strands of eggs in shallower water (1-3 m) where moderate levels of vegetation help capture the egg strands and increase their potential survival (Clady and Hutchinson 1975).

The most extensive literature on fish-habitat relations and effects of habitat alterations on fish populations is from streams where two general areas relevant to shoreland management have been particularly well studied, including the role of complex in-water habitat and the role of riparian vegetation. Many of the concepts developed in stream systems are equally relevant to lake systems. The importance of structurally complex habitat has been demonstrated to affect a wide range of fishes and other stream biota, including salmonids (reviewed by Marcus et al. 1990), insects (Minshall 1984), and salamanders (Hawkins et al. 1983). Woody debris and complex bottom substrates directly provide cover and habitat for food production and also affect the hydraulics that shape the stream channel (Hawkins et al. 1993). Angermeier and Karr (1984) demonstrated that removal of complex woody habitat on one-half of a warmwater stream led to a reduction in the number of fish, while no change was observed in the other half, where no habitat was removed. Schlosser (1982) observed similar results in a comparative study of two warmwater streams, one of which was subject to modifications including removal of riparian vegetation and channel straightening. Removal of complex substrates from streams not only eliminates spawning habitat and refuge cover but also changes the processes (hydraulics, channel formation) to which natural communities are adapted.

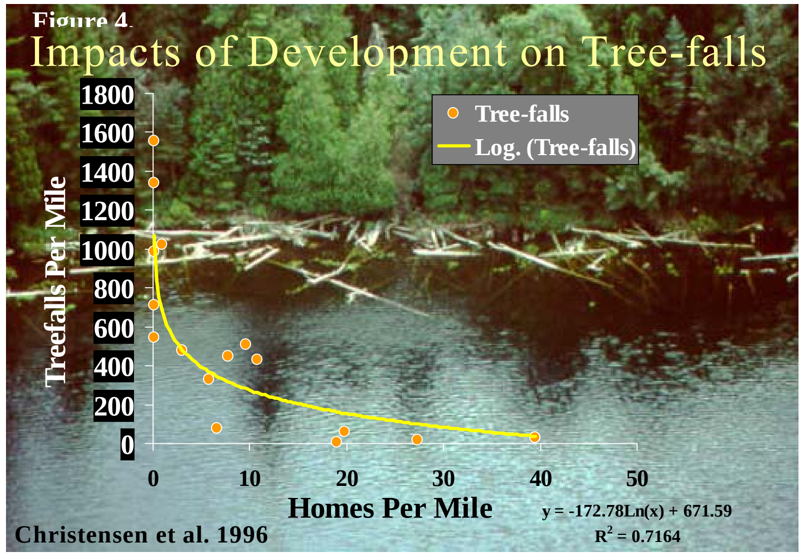
Activities in the riparian zone can also affect the habitat available to fish by directly eliminating overhanging cover, removing shade that moderates temperature regimes (reviewed by Marcus et al. 1990), and limiting the source of woody debris (Christensen et al., 1997). Ecologically, the shoreland, or riparian zone, is a living bridge between interdependent aquatic and terrestrial worlds. Shallow near-shore waters, known as the littoral zone in lakes, are the most biologically productive part of lake ecosystems. Stream, lake, and wetland ecosystems are inextricably linked to adjacent uplands through both structural habitat and food chain connections between the aquatic system and the riparian area. The role of habitat in the maintenance of healthy fish and aquatic life is as important as the role of water quality. Riparian zones have unique physical and biological conditions that allow them to host a great variety of wildlife. The shoreland buffer is intended to protect the habitat of both species that are totally aquatic, such as fish; and those that rely on the unique habitat found in riparian areas, such as waterfowl, fish-eating birds, amphibians and reptiles, and mammals.

There are many different types of habitat found in a shoreland buffer and many different ways in which the shoreland buffer affects aquatic systems. Along larger rivers, wetland complexes such as floodplain forests are found with many associated backwater sloughs and ponds that host a wide variety of habitats for amphibians, reptiles, birds, mammals, and fish. Smaller rivers and streams with narrower floodplains flow through a wide variety of vegetative communities, from large upland forests to large wetland complexes composed of meadow, shrub, and forest communities. In agricultural landscapes, riparian corridors along streams may be fairly narrow or nonexistent. Smaller river-edge wet meadows (sometimes referred to as backswamps) lie in the floodplain. Similarly, lakeshore topography varies from steep cliffs and slopes, to gently sloping uplands, to flat wetlands, and vegetation displays varying combinations of forest, shrub, or herbaceous cover. The enormous variety of habitat types created by the combination of topography, soil, and vegetation along shorelines leads to a wide variety of ways in which habitat functions are performed along different shorelines.

Large Woody Cover

Coarse woody debris in the littoral zone protects lakeshores. The debris blunts waves and ice action that scour the lake bed and keep seeds from sprouting or shoots from rooting. Lorang and Stanford (1993) measured shoreline reconfiguration along a forest and beach zone on Flathead Lake, northwestern Montana. Their study site was perpendicular to the lake's maximum fetch of 33 km. Shoreline morphology and vegetation determined the type of erosion process and the rate of shoreline retreat. Shoreline retreat was offset by localized and dramatic accretion caused by sediment entrapment by drift logs bordering the shoreline. Drift logs naturally protected the shoreline from direct wave attack and stimulated sediment accretion, providing new recruitment area for riparian vegetation. The density of wood drift logs (>5cm) at 0.5 m depths along undeveloped northern Wisconsin lakes averages 555 logs/km of shoreline, whereas wood logs along dense residential -developed shorelines are essentially absent (Christensen et al. 1996; Figure 4). Drift logs may accumulate along northeast and east shorelines in greater density (Guyette and Cole 1999), given prevailing wind conditions. This natural and compensatory shore protection can result from greater recruitment rates of drift logs along these exposed shorelines.

Figure 4.



Tree-falls and woody cover is a dynamic and ancient component of nearshore aquatic habitat of lakes. Tree-falls are not a static structural component of lakes, but are dynamic, with typically slow input and depletion rates. How long woody debris lasts in water depends on the size and type of wood, water temperature, and sedimentation rate (Harmon et al. 1986; Bilby et al. 1999). Logs outlast branches, red cedars (*Juniperus virginiana* L.) outlast birches (*Betula*), and buried or water submerged wood outlasts exposed wood . Conifer species contain higher levels of compounds that retard decomposition of there heartwood (Scheffer and Cowling 1966). Guyette and Cole, 1999) used dendrochonological methods to analyze age characteristics of eastern white pine in the littoral zone of Swan Lake, Ontario. Eastern white pine decays very slowly; the average date of the outer rings of sampled Swan Lake white pine logs was year 1661, and residence time in the littoral zone ranged between 100 to 900 years. Decay rates increase with water temperature, especially in aerobic environments.

Adding new woody debris or uncovering old debris is needed to maintain prey density and fish refuge sites (Harmon et al. 1986).

Woody cover, known as *snag habitat* in streams because it traps a variety of drifting particles, the debris in lakes collects sediment and becomes coated with algae and detritus (animal and plant remains) that macroscopic invertebrates consume (Harmon et al. 1986). Woody debris thus supports high densities of midge (Chironomidae) larvae and pupae, including species that tunnel into bark or the heartwood of submersed pulpwood logs. Although few aquatic insects are known to eat wood (Harmon et al. 1986), their tunneling hastens decomposition by fungi (Basidiomycetes) and bacteria (McLachlan 1970).

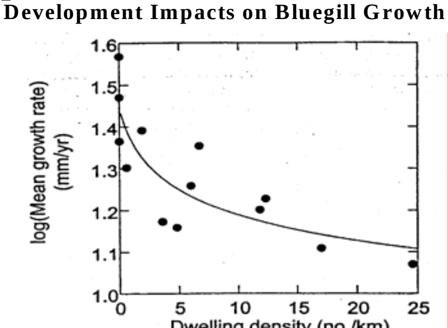
Removing woody debris by dragging submerged trees and stout logs onto shore can trample lakeshore vegetation and the nests of fishes and shorebirds. Shore erosion can increase directly from shore damage and indirectly from wind and wave action on the newly exposed shore. Water turbidity then increases from shore erosion and particles of soil and wood falling off the debris into the water. In extreme cases, stirring bottom sediments during woody debris removal can raise biochemical oxygen demand enough to deplete dissolved oxygen (Sproul and Sharpe 1968), killing sedentary invertebrates.

Fish use of woody debris varies with the type and arrangement of debris and the age and species of fishes (Wege and Anderson 1979, Moring et al. 1986). Bluegills prefer woody debris built of evergreen trees to brush piles, especially when the trees are compacted (Johnson and Lynch 1992). Tree tops sunk with cinder blocks attract bluegills and largemouth bass mostly shorter than 5.9 inches in total length (Graham 1992). Adult largemouth bass also visit woody debris as well as piers but seldom linger (Prince and Maughan 1979, Colle et al. 1989). Male smallmouth bass (*Micropterus dolomieu* Lacepède) in Wisconsin lakes, however, excavated nests near logs and boulders for their own cover and that of newly hatched fry (Baylis et al. 1993). Largemouth bass in an Arkansas reservoir preferred to nest in coves with artificial brush piles, though smallmouth bass showed no such preference (Vogele and Rainwater 1975). However, similar to aquatic plants and shoreland habitat the amount of woody debris and tree falls decreases as development increases, thereby decreasing fish and animal habitat (Figure 4; Christensen et al. 1996).

Removal of fallen trees even can affect bluegill and bass populations. Schindler and Carpenter (2000) examined largemouth bass and bluegill growth across a residential development gradient in 14 lakes near Boulder Junction, Wisconsin. Growth rates of bluegill in lakes surrounded by cottages were slower, by one-third, than growth rates of bluegill in lakes with no cottages around the shore (Figure 5). Bluegill populations of undeveloped lakes were more than twice as productive as those of lakes surround by cottages. Largemouth bass growth showed similar trends, but were not as clear-cut as those for bluegill, however. The main habitat change associated with these lakes are up to ten-fold declines in tree-falls (these nutrient poor lakes contain few aquatic plants) as a consequence of cottage development.

Figure 5

Development Impacts on Bluegill Growth



(Taken from Schindler and Carpenter 2000)

The Submergent Plant Community and its biota (Birds, Mammals, Fish, Amphibians, Reptiles, Invertebrates, Endangered, Threatened, and species of special concern)

Habitat preferences differ among fish species. Inshore fish sampling in Lake St. Clair found 11 species along wetlands, 10 species along undeveloped shores, 6 species along developed shores, and 5 species along beaches (Brazner and Magnuson 1994). Bluegills (*Lepomis macrochirus* Rafinesque) and black bass in this lake preferred altered (dredged and bulkheaded) shores, whereas minnows and darters (*Etheostoma* and *Percina*) preferred unaltered shores (Poe et al. 1986). In lakes with sparse rooted vegetation, more nearshore fishes use rocky and bouldery shores than use sandy and gravelly ones (Emery 1978, Beauchamp et al. 1994). Only occasionally do sandy and rocky shores attract more fishes, if fewer species, than bouldery or well-vegetated shores (Guillory et al. 1979).

Plant habitat attracts fishes in variety and abundance. Plant beds harbored 11 fish species—beach habitat, only seven species—in central Florida's Lake Conway (Guillory et al. 1979). Plant cover was positively correlated ($P < 0.05$) with fish abundance in Florida's Lake Okeechobee (Chick and McIvor 1994), Iowa's Spirit Lake (Bryan and Scarnecchia 1992), and 25 central Ontario lakes (Hinch and Collins 1993). Plant species diversity was positively correlated ($P < 0.05$) with fish species diversity among six Wisconsin lakes, especially when depth was considered (Benson and Magnuson 1992). Plant beds enable bluegills and pumpkinseed sunfish to coexist despite predation pressure from largemouth bass (Mittelbach and Chesson 1987).

Many small fishes seek plant beds as refuge from predators but will use piers, boulder spits, rock outcrops, and woody debris especially when plant beds are scarce. Young fishes, including those of black bass and northern pike (*Esox lucius* L.), hide among thick foliage when piscivores (fish eaters) are present but stay outside thick foliage or seek sparse foliage when such predators are absent (Johnson et al. 1988, Lynch and Johnson 1989). Stocked fingerling muskellunge use emersed, floating-leaf, and submersed foliage as nursery areas for hiding and feeding (Hanson and Margenau 1992). Log perch (*Percina caprodes* [Rafinesque]) and mottled sculpins (*Cottus bairdi* Girard) seek crevices between rocks and boulders in lakes with sparse vegetation. Rock bass (*Ambloplites rupestris* [Rafinesque]) seek underwater brush piles by day but leave them by night (Rodeheffer 1940).

Some large fishes are also attracted to plant beds. Adult muskellunge (*Esox masquinongy* Mitchill) and northern pike with ultrasonic transmitters have been tracked to plant beds, especially pondweeds on sunny days (Crossman 1977, Diana et al. 1977). Largemouth bass switch hunting tactics from cruising to ambushing prey as plant density increases (Savino and Stein 1989). Even walleyes (*Stizostedion vitreum* [Mitchill]) cruise plant beds for such prey fish as yellow perch (Engel 1990).

Fishes also seek boulder spits, rock outcrops, and woody debris for prey, though fish species differ in what prey they capture. Specialized feeders like black crappies (*Pomoxis nigromaculatus* [Lesueur]) select a few small prey, such as midwater zooplankton, whereas more generalized feeders (opportunists) like bluegills select a broad array of larger prey, such as bottom- or plant-dwelling midge and caddisfly larvae (Keast 1970). Plant-dwelling rock bass and pumpkinseed sunfish (both 2.2–3.7 inches in total length) in Lake St. Clair ate insects on or beneath plant shoots, though rock bass took fewer but larger ones than did pumpkinseed sunfish (French 1988).

Although the muskellunge is relatively long-lived (>20 years, Casselman and Crossman 1986), it has been associated with extremely high egg mortality (>99%), both under natural conditions (Farrell 2001) and experimental incubations carried out *in situ* (Zorn et al. 1998). This suggests that high early-life mortality is the norm for this broadcast-spawning species which can produce 22,000 to 225,000 eggs in a single spawning period (Oehmcke et al. 1958). Because of this slim margin of survivorship habitat alterations that reduce spawning success even fractions of a percent could have serious consequences for juvenile survivorship, overall recruitment , and ultimately sustainable naturally reproducing populations.

Unlike other esocids, muskie sac fry, which are the product of hatched eggs, are sessile for ten days after hatching (Zorn et al. 1998). Should environmental conditions become de-oxygenated during this period, they would not be able to relocate, and would die. Thus, muskellunge populations are quite dependent on high-quality spawning habitat. Since spawning adult muskie are philopatric (an innate propensity of adults and their offspring to use a specific location within its range to fulfill a specific life history component; Crossman 1990; Lebeau 1992), consistent annual spawning-site quality is especially important for both individual and population survivorship. Dombeck. 1986. Nevin (1901) reported muskellunge spawning in areas of greatest log, stump, and brush density. Oehmcke et al. (1974) described spawning habitat as shallow (< 3 ft) bays over muck bottoms covered with detritus and dead vegetation. *Chara* was present in spawning areas in several self-sustaining Michigan Lakes (Dombeck et al. 1984a). *Chara* occurs in hard water associated with calcarious deposition areas.

A Wisconsin shore protection study found that fish were significantly effected by shoreline type. Fish and habitat were measured in 354 shoreline sites. Because habitat attributes were measurably different among the shoreline types and because fish respond to habitat, fish distribution also differed among the three types of shorelines. Differences in species richness, as well as abundance of fish with taxonomic or functional groups were related to features of habitat such as aquatic vegetation, overhanging cover, particle size of bottom material, level of embeddedness of interstitial spaces of bottom material, and water depth. As result of these relationships, the number of species found at shoreline sites with rock riprap was greater than the number found at other sites. Groups of fishes that were more abundant at rock riprap included intolerant species (fishes sensitive to degradion of habitat), benthic fishes (darters, sculpins, and other fishes that are usually found on the lake bottom) and some centrarchids.

The differences in fish community structure and abundance occurring among shoreline types were statistically significant. These differences were detected despite considerable variation in sampling season, geographic region, lake type, and the fish community in a particular lake. In other words, the results clearly reflected robust differences that persisted under a wide range of conditions.

Some fishes can shift diet and habitat as food competition and prey availability change (Mittelbach 1984). For example, bluegills shift to eating smaller prey as large ones dwindle during summer (Mittelbach 1981) and shift from plant-dwelling prey to open-water ones when bottom-feeding pumpkinseed sunfish are present (Werner and Hall 1977). They also shift to open-water or bottom-dwelling prey when the plant beds or woody debris they inhabit are decimated (Bettoli et al. 1993), though small bluegills then face increased predation.

The value of plant beds to fishes differs with plant density. Dense plant beds in aquaria(46 stems/ft^2), for example, afford age-0 bluegills(1.7–2.5 inches in total length) maximum protection against fish predators but hinder bluegill feeding on insects (Gotceitas 1990*a*). Plant beds of modest density (10 stems/ft^2) afford plant-dwelling bluegills a better compromise between food and safety (Wiley et al. 1984). However, age-0 bluegills(>2.0 inches in total length) kept for 117 days in lake enclosures differing in artificial plant density (0, 37, 89, and 324 stems/ft^2) showed no significant ($P > 0.05$) difference in growth (Hayse and Wissing 1996), because the bluegills could eat zooplankton outside the plants and dart for cover when threatened.

Floating-Leafed and Emergent Plant Community and its biota (Birds, Mammals, Fish, Amphibians, Reptiles, Invertebrates, Endangered, Threatened, and species of special concern)

Emergent and floating plants are important habitat elements for fishes. These plants provide surfaces on which periphyton and invertebrates colonize, affecting availability of food for fishes, and also provide hiding cover. Tonn and Magnuson (1982) and Benson and Magnuson (1992) found that species richness increased with increasing macrophyte diversity in littoral regions of lakes.

While the role that macrophytes play in the ecology of fishes is generally understood, few studies have addressed how specific attributes of macrophyte morphology influence habitat use by fish. Quantification of macrophyte density using these three categories were based on broad morphological and functional (i.e., relative to fish usage) similarities found in aquatic plants within each of these categories (see Hotchkiss 1972). Floating macrophytes such as pond lilies (e.g., Lemna sp., Nuphar sp., and Nymphaea sp.) provide shading and overhead cover that attract certain species of fish (Helfman 1979), but their narrow and widely spaced (or absent) stems provide little lateral underwater structural cover or complexity. Emergent vegetation, such as sedges and bulrush (e.g., Scirpus and Carex sp.) also have long slender stems but are more closely spaced than floating vegetation because they have no floating leaves that reduce available sunlight. As such, they would provide little overhead cover, but provide some lateral underwater cover. Many species of submersed vegetation such as broad-leafed Potamogeton spp. and narrow-leaved submergents such as Myriophyllum sp. and Ceratophllym sp. provide both lateral underwater and overhead cover.

Several amphibians also use the shallow littoral zone for breeding, foraging, metamorphosing and overwintering. Development of lakeshores often degrades these habitats for these species in a number of ways. The loss of emergent and floating vegetation coupled with the loss of coarse woody debris (CWD), reduces egg deposition structure and may concentrate egg deposition to unaffected areas, potentially increasing predation rates on eggs and larvae at those sites. Flat eggs masses laid on the surface and attached to floating vegetation are more susceptible to being fragmented by wave action when plant densities are reduced and subsequently can wash ashore where they perish. In a study that compared habitats between developed and undeveloped lakeshores, Meyer (1997) found that in the shallow water areas, percent cover of floating vegetation was significantly greater at undeveloped compared to developed sites.

The relative amount of CWD was significantly greater at undeveloped sites, compared to developed sites. The majority of undeveloped sites contained an abundant amount of CWD, while the majority of developed sites contained no CWD. Downed trees and floating logs are used for basking by Blanding's, musk, map and painted turtles. If these structures are removed because of development, turtles are forced to either concentrate in suitable habitat or bask on the shore--which often makes them more susceptible to predation due to exposure and the inability to quickly escape into deep water.

Shoreline Edge and Bank and its biota (Birds, Mammals, Fish, Amphibians, Reptiles, Invertebrates, Endangered, Threatened, and species of special concern)

Amphibians are a crucial link between aquatic and terrestrial ecosystems because of their significant contribution to the vertebrate biomass of these systems. In many aquatic habitats, freshwater turtles represent the majority of the vertebrate biomass (Congdon et al. 1986). Because of their large biomass and their movement between terrestrial and aquatic systems, amphibian populations can influence important ecosystem functions such as primary and secondary productivity, nutrient influx, and competition (Seale 1980, Osborne and McLachlan 1985, Cunningham and Brooks 1995).

Most of Wisconsin's amphibian species and many of the reptile species rely on riparian habitat in some way. Riparian habitat quality is critical for those species that are considered shoreline dependent including two endangered herptiles. Five frogs and two reptiles are considered shoreline-dependent species in Wisconsin because they spend most or all of their life history in a relatively narrow band which includes both near-shore aquatic habitat and the near-shore riparian habitat (Vogt 1981, Oldfield and Moriarty 1994). The frog species include: Blanchard's cricket frog, a state endangered species, the bullfrog and pickerel frog, both special concern species, and the green and mink frogs. The two reptiles include the queen snake, a state endangered species, and the northern water snake.

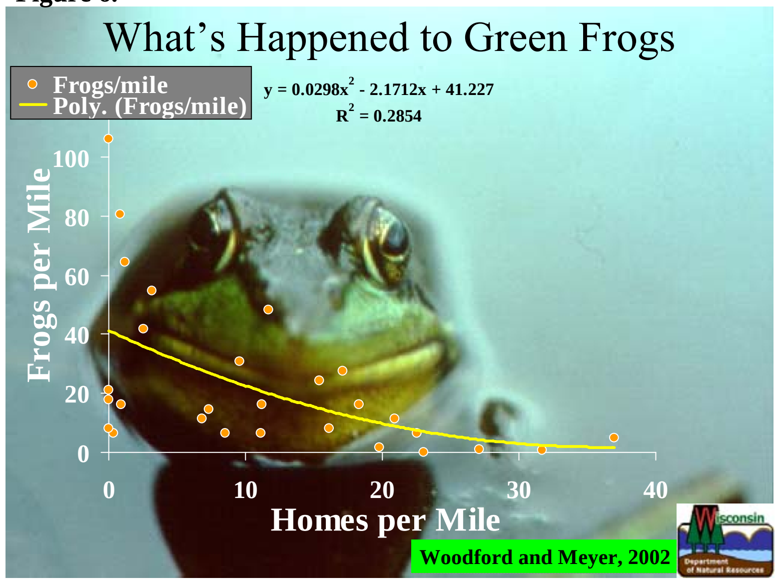
Although habitat requirements for these frog species vary somewhat, most require moist soil and moderate to dense vegetative cover in the immediate shoreline area. These features provide a cooler microclimate and cover for predator avoidance. Bullfrogs and green frogs spend much of their time basking, resting, or foraging in fringe wetlands with tall dense cover, or in tall grassy cover along the shoreline (Flemming 1976). Mink frogs spend most of their time in shallow near-shore water, especially near the inlets and outlets of northern lakes and streams, resting on floating mats of vegetation. All 12 Wisconsin's frog and several salamander species lay their eggs in shallow water among submerged or floating vegetation or attached to coarse woody debris, primarily to submerged tree branches. The larvae or tadpoles of these species prefer to live in shallow water that is structurally diverse because it offers cover for predator avoidance and because this structure supports their food sources (i.e. algae and invertebrates).

Woodford and Meyer (2003; Figure 6) found that adult green frog populations were significantly lower on lakes with varying degrees of shoreline house and cottage development than lakes with little or no development. A negative linear relationship existed between shoreline development densities and the number of adult green frogs.

Thus, suggesting that greater development densities significantly decrease breeding habitat, resulting in lower adult green frog abundance. These and other findings suggest that current shoreline protection measures are not protecting sensitive amphibian species.

Changes to lake fringe habitats associated with lawns also reduce the usage of the nearshore edge (<.2 m depth) by small fish. Collins et al. (1997 Midwest Fish and Wildlife Conference, Milwaukee) monitored fish use (traffic levels and feeding rates) using underwater video cameras along the nearshore edge for small oligotrophic Ontario Lakes. These unproductive shield lakes contain sparse vegetation along the lake fringe. Daytime small fish traffic levels were 2.5 times higher in undeveloped than in developed sites. Feeding rates were eight times higher in undeveloped than in developed sits. Effects of development were less marked during dawn and dusk.

Figure 6.



Eutrophication and Water Quality

Studies of the water quality impacts of lakeshore development point to the importance of reducing the cumulative impact of lakeshore development, both in terms of the impacts to habitat and in terms of phosphorus loading. A study in Maine (Dennis 1986) of paired watersheds of similar size and physical characteristics compared an undeveloped, forested watershed to an adjacent watershed with 40% forest and a subdivision developed with 1-acre lots. The more developed watershed showed an increase of 720% in phosphorus export, the main nutrient of concern in lakes because of its role in the eutrophication process described below.

When shoreland vegetation is disturbed or removed by human activities, aquatic plants and animals will be affected by elevated sediment, nutrient, and toxicant loads. A recent study modeling land use pattern and topography in the Lake Mendota watershed found that increases in phosphorous loading were strongest with conversions of undisturbed riparian (shoreland) areas to either urban or agriculture uses (Soranno, et al 1996). Toxic materials, such as pesticides, herbicides, and heavy metals, can cause acute mortality of aquatic life. Most commonly, however, they cause chronic effects by affecting reproduction and degrading habitat.

Studies of Cumulative Water Quality Impacts

One technique to measure the relative eutrophication of a lake is to measure the rate at which water in the hypolimnion of a lake basin loses oxygen and the volume of anoxic water in the hypolimnion. Water quality problems associated with eutrophication are indicated by a greater relative volume of anoxic water in the hypolimnion. A study on a single forested, hourglass-shaped lake in northern Wisconsin, with two distinct basins of sharply differing levels of development, found that the more developed basin had a larger volume of anoxic water than the lesser developed basin, the opposite of what the physical conditions in these two basins would predict (Ganske 1990). A 20-year study of a Michigan lake with three distinct basins used similar oxygen deficit methodology to track the rate of eutrophication at ten year intervals. The most developed basin was found to be the most eutrophic (greatest oxygen deficit) over time, and a lesser developed basin had a consistently lower oxygen deficit, while one basin showed wide anomalous fluctuations (Lind and Davalos-Lind 1993). Two basins showed an increasing rate in eutrophication during the time period of the study (1971 to 1991). By extrapolating their data backward and comparing with a measure of eutrophication in 1922, the authors approximate that the rate of eutrophication began increasing in about 1950, coincident with an increase in summer home construction during the postwar economic boom.

These two studies are insightful because they were able to control for some of the many variables, besides the level of shoreland development, that also influence water quality in lakes, by looking at separate basins of the same lake. Even in these studies however, some physical factors such as the shape, size, and orientation of the basin interact with level of shoreland development to determine water quality.

Modelling studies of sediment and nutrient delivery to two different lakes in northern Wisconsin also show increases of from 200% to 700% in phosphorus loading as lots are cleared and developed (J. Panuska, Wisconsin Department of Natural Resources, to P. Sorge, internal memorandum Nov. 16, 1994; E&S Environmental Chemistry, Inc. 1992). Dillon, et al. (1995) found that phosphorus delivery from on-site sewage disposal systems associated with shoreline development accounted for a significant portion of the observed total phosphorus level in four Ontario lakes. On two of the lakes with thinner soils all total phosphorus transported into and out of septic systems reached the lakes. About one-third of the total phosphorus from septic systems reached the third lake, which had a thicker layer of till/soil, while the fourth lake was undeveloped. Weber (1994) found significantly greater nitrogen and phosphorus concentrations in the seepage water, sediment, and plant tissues in the near-shore waters of Legend Lake, along shorelands with septic systems where groundwater flowed toward the lake, compared to groundwater outflow sites and sites with no septic system.

The amount of phosphorus loading can be reduced by best management practices directed to minimize soil compaction and control erosion and sediment delivery during construction. However, it is clear from these studies that more densely settled shorelands can contribute greater phosphorus loading.

Paleolimnological studies offer the opportunity to look at a historical record that documents the response of a lake to land-use changes in its watershed. This technique involves taking sediment cores from the lake, dating core layers, and examining the chemical and fossil record preserved in the cores. A sharp increase in the sedimentation rate soon after European settlement and clearing for agriculture, logging, or town establishment in the watershed has been thoroughly documented throughout Wisconsin (E&S Environmental Chemistry, Inc. 1992, Garrison 1993, Garrison and Hurley 1993). Although each lake has a unique history, these studies all show increasing water quality degradation related to increased phosphorus loading, starting in the 1960s and 1970s, and continuing to the present, apparently related to increasing levels of lakeshore development.

The record for Lake Ripley, a highly developed lake in a watershed that is shifting from agricultural to residential land use, showed a slight decrease in phosphorus in the 1960s when land was beginning to be taken out of agriculture for homesite development, but since the mid-1970s, phosphorus loading has increased even though the rate of erosion in the watershed has decreased (Garrison 1993). The author concludes that lakeshore homes are now the largest source of nutrient loading to the lake. The record for Lac La Belle, shows that lake productivity (excessive productivity is an indication of eutrophication) dropped for a time after sewer installation in 1980, but has begun to increase again in recent years, with recent phosphorus concentrations at levels similar to those just prior to sewer installation (P. Garrison, Wisconsin Department of Natural Resources, letter to L. Conley, Sept. 6, 1995). This suggests that providing sewer service to lake subdivisions, while providing major water quality benefits, does not control all the important sources of phosphorus to a lake. The benefits of sewer service may be offset by increases in phosphorus loading and habitat degradation due to increased residential density.

By way of contrast, deep sediment in Little Bearskin Lake, a lightly developed lake in Oneida County with 12% residential development, has not shown an increase in phosphorus concentration in the last century (Garrison and Winkelman 1995). Although phosphorus loading has likely increased, phosphorus appears to be taken up by aquatic plants along the shoreline. This has resulted in a less diverse but more dense aquatic plant community with increased density of coontail, which is becoming a nuisance to lake homeowners at some sites.

Differences between cores from two nearby lakes demonstrate the importance of lake and watershed characteristics in determining how a particular lake's water quality is affected by land-use changes. Garrison (in press) compared the cores of Long Lake, a deep 1,050-acre stratified drainage lake, to nearby Round Lake, a 215-acre softwater shallow seepage lake that does not stratify. Long Lake water quality began to decline in the 1880s in response to added sediment and nutrients delivered to the lake by inflowing streams, caused by erosion from logging in the watershed. Round Lake was not as affected by the initial land clearing, because its lack of inflowing streams meant that it did not receive as large a nutrient load. However, water quality has declined in recent years, evidenced by a profound change in the algal community. The increased nutrient loading is most likely the result of cottage development around the shoreline. Today, Round Lake suffers from algal blooms during years of high rainfall while Long Lake does not.

This comparative study has some important implications for lake planning because it lends support to the notion that smaller, shallower seepage lakes are likely to receive a larger portion of their nutrient inputs from the immediate shoreland, while drainage lakes receive a larger portion of their inputs from the larger watershed (Shaw et al. 1994). This implies that shoreland zoning along lakeshores, as a water quality tool, may be more effective in buffering seepage lakes. However, any measure that can reduce phosphorous loading to any lake type will contribute to water quality. Buffers along streams, along with other best management practices, are essential to control nutrient inputs to drainage lakes and impoundments, especially in agricultural watersheds.

Landowner practices, in terms of construction activities and yard-care practices, will greatly affect the ability of the shoreline buffer to trap and retain sediments, nutrients, and toxicants. On average, the typical lakeshore or streamshore home setting can be expected to have a smaller contributing area and considerably less soil disturbance than the agricultural or logging activities which most of the buffer research has evaluated. However, research studies typically assume an unbroken buffer, and the current shoreland standards allow for a clear-cut area along the shoreline. If this area is highly disturbed and runoff flow begins to be channelized through it, sediment trapping and nutrient retention functions will be lost. Other site circumstances that can reduce the effectiveness of the 35-foot shoreline buffer for runoff pollution control are erodible and fine-grained soils, steep slopes, construction disturbance, large impervious surfaces or compacted soils, and heavy use of fertilizers and pesticides.

Preserving wetlands maintains an essential water quality buffering agent for associated lakes and streams. The water quality function of a wetland is closely tied to its position in the landscape and on the wetland type (Brinson 1993, Beilfuss and Siebert 1996). Wetlands that have organic soils, saturated soil or shallow water depths, and longer retention times experience the predominantly anaerobic (oxygen-free) conditions needed for nutrient transformation. In addition, those that have dense vegetation and are located between upland pollutant sources and lakes and rivers, offer the greatest amount of sediment and nutrient retention. These types of wetlands, such as sedge meadows, fresh wet meadows, wooded swamps, and shallow marshes, have both the opportunity and advantageous soil conditions to facilitate the processes of denitrification, sulfate reduction, and transformation of nutrients to more soluble forms for plant uptake. Wetlands can permanently remove metals and organic compounds if they remain adsorbed to sediments and the sediments eventually become buried below the root uptake zone of wetland plants (Elder 1987).

The Need

The growing interest in land use and demand for waterfront property have been a catalyst for review of the effectiveness of NR115. Most studies suggest that under ideal site conditions current standards may only meet minimums for controlling runoff of sediments and nutrients. The 35-foot buffer, if it contains undisturbed vegetation, will provide only minimal habitat for some species. (Berthal 1997, Bernthal and Jones 1997).

“A little here and there may seem to be nothing to become excited about. But one fill, though comparatively inconsequential may lead to another, and another, and before long a great body of water may be eaten away until it may no longer exist. Our navigable waters are a precious natural heritage: once gone, they disappear forever.” This is a famous quote taken from the Wisconsin Supreme Court in Hixon v. PSC, 1966. Well, the same concern about cumulative impact exists for our shorelands. As more and more of us move near the water, we change the shore area’s natural features by building structures and removing the natural vegetation. We slowly but surely change the very nature of the lake ecosystem. Small seasonal cabins are being converted to large year-round homes, increasing their impact to the shores and lake. A little lawn here, a little sand beach here, a pier here, a boathouse there, storage shed here, and soon our natural shorelands habitats disappear. As our growing population seeks places to live near our waters this is trend is understandable. This is a critical time for Wisconsin's lakes and their wetlands. Our challenge and the goals of the Critical Habitat Designation Program is to channel society’s desire to enjoy these beautiful places into patterns of development that maintains the productivity and quality of our natural resources. It’s this quality and productivity that compels each of us to our shores.

Chapter 2. Department Authority and the Designation Process

Wisconsin's Waters Belong to Everyone

Wisconsin lakes and rivers are public resources, owned in common by all Wisconsin citizens under the state's Public Trust Doctrine. Based on the state constitution, this doctrine has been further defined by case law and statute. It declares that all navigable waters are "common highways and forever free", and held in trust by the Department of Natural Resources.

Assures Public Rights in Waters

Wisconsin citizens have pursued legal and legislative action to clarify or change how this body of law is interpreted and implemented. As a result, the public interest, once primarily interpreted to protect public rights to transportation on navigable waters, has been broadened to include protected public rights to water quality and quantity, recreational activities, and scenic beauty (Quick 1994). All Wisconsin citizens have the right to boat, fish, hunt, ice skate, and swim on navigable waters, as well as enjoy the natural scenic beauty of navigable waters, and enjoy the quality and quantity of water that supports those uses (WDNR 1995). Wisconsin law recognizes that owners of lands bordering lakes and rivers - "riparian" owners - hold rights in the water next to their property. These riparian rights include the use of the shoreline, reasonable use of the water, and a right to access the water. However, the Wisconsin State Supreme Court has ruled that when conflicts occur between the rights of riparian owners and public rights, the public's rights are primary and the riparian owner's secondary (Quick 1994).

Wisconsin's Public Trust Doctrine requires the state to intervene to protect public rights in the commercial or recreational use of navigable waters. The DNR, as the state agent charged with this responsibility, can do so through permitting requirements for water projects, through court action to stop nuisances in navigable waters, and through statutes authorizing local zoning ordinances that limit development along navigable waterways.

The court has ruled that DNR staff, when they review projects that could impact Wisconsin lakes and rivers, must consider the cumulative impacts of individual projects in their decisions. "A little fill here and there may seem to be nothing to become excited about. But one fill, though comparatively inconsequential, may lead to another, and another, and before long a great body may be eaten away until it may no longer exist. *Our navigable waters are a precious natural heritage, once gone, they disappear forever,"* wrote the Wisconsin State Supreme Court justices in their opinion resolving Hixon v. PSC.

Through various case laws and decisions, Wisconsin holds *navigable waters* in trust for all its citizens. Initially, waters were judged "navigable in fact" if they could float a saw log (*Olson v. Merrill*, 42 Wis. 203, 1877). Currently however, these waters must float a "boat, skiff or canoe of the shallowest draft" for at least part of each year (*DeGayner and Co. Inc. v. DNR*, 70 Wis. 2d 936, 1975). The state has an "affirmative duty" to keep navigable waters safe from water pollution (*Reuter v. DNR*, 43 Wis. 2d 272, 1969) and open to public fishing (*Willow River Club v. Wade*, 100 Wis. 86, 1898), hunting (*Diana Shooting Club v. Husting*, 156 Wis. 261, 1914), and other recreational uses such as enjoyment of scenic beauty (*Muench v. PSC*, 261 Wis. 492, 1952). Thereby these decisions further require the Department to protect the public interest in or on the bed of navigable waters.

The area above the OHWM is regulated under Wisconsin's Shoreland Zoning Program (Adm. Code NR 115, NR 117). This program is a partnership between state and local government that requires development near navigable lakes and streams to meet statewide minimum standards. These minimum statewide standards were developed in the late 1960s based on a combination of the best available scientific information, best professional judgment, and the feasibility of implementation at that time. With the exception of the wetland protection provisions added in the early 1980s, the rules (Ch. NR 115 and NR 117, Wis. Adm. Code) have essentially remained unchanged. County shoreland zoning ordinances must meet or exceed the minimum state standards with each county administering and enforcing its own shoreland zoning ordinance.

The Supreme Court in the 1952 landmark decision Muench v. Public Service Commission, declared that the state has a duty to protect the public's enjoyment of natural scenic beauty as part of its navigable waters public trust responsibilities under the Wisconsin State Constitution. Almost 30 years ago when it created the Shoreland Management Act, the Legislature specifically included the protection of the shoreline's natural beauty as a goal and as part of the zoning ordinance standards that county governments are required to enact. The Court in 1972 again spoke to the issue of aesthetic impacts in Clafin v. DNR when it ruled that scenic beauty on its own is a proper basis to deny a permit application for a boathouse. Following the direction of the Court and the Legislature, aesthetics is a consideration for the agency every time it reviews permit applications for construction projects in the public trust waters of the state.

In addition, the potential for disruption of fish and wildlife habitat must also be assessed. Many animals spend their whole lives in wetlands; for others, wetlands are critical habitat for feeding, breeding, resting, nesting, escape cover or travel corridors. Wisconsin wetlands are spawning grounds for northern pike, nurseries for fish and ducklings, critical habitat for shorebirds and songbirds and lifelong habitat for some frogs and turtles. Wetlands also provide essential habitat for smaller aquatic organisms in the food web, including crustaceans, mollusks, insects, and plankton. Some of the most valuable wetlands for fish and wildlife provide diverse plant cover and open water within large, undeveloped tracts of land. This function may be considered particularly important if the habitat is regionally scarce, such as the last remaining wetland in an urban setting.

Thirdly, wetland values must me taken into consideration and thereby standardized assessment methods are used to evaluate the extent to which a specific wetland may perform any given function. The presence or absence of specific characteristics are used to determine the importance of each functional value for the site in question. These characteristics may or may not be obvious to the casual observer. The dynamic (changing) nature of wetlands can hide many of these traits. Migratory bird use, for example, is not always obvious except in spring and fall. And the occurrence of various wetland plants gives important, yet subtle clues about habitat, water quality and biodiversity. These types of observations help us evaluate a wetland's intrinsic value and overall importance to society. food web, including crustaceans, mollusks, insects, and planktonic organisms. Some of the most valuable wetlands for fish and wildlife provide diverse plant cover and open water within large, undeveloped tracts of land. This function may be considered particularly important if the habitat is regionally scarce, such as the last remaining wetland in an urban setting.

Fourthly, water quality and associated wetland plants and soils that have the capacity to store and filter pollutants ranging from pesticides to animal wastes must be assessed. Calm wetland waters, with their flat surface and flow characteristics, allow particles of toxins and nutrients to settle out of the water column. Plants take up certain nutrients from the water. Other substances can be stored or transformed to a less toxic state within wetlands. As a result, our lakes, rivers and streams are cleaner and our drinking water is safer. Larger wetlands and those which contain dense vegetation are most effective in protecting water quality. If surrounding land uses contribute to soil runoff or introduce manure or other pollutants into a watershed, the value of this function may be especially high. Wetlands which filter or store sediments or nutrients for extended periods may undergo fundamental changes. Sediments will eventually fill in wetlands and nutrients will eventually modify the vegetation. Such changes may result in the loss of this function over time.

The Role of Critical Habitat Designation

By developing statutory language, administrative code, and from previous case law, Wisconsin has developed broad regulations related to structures and alterations of public waters. At the forefront of each of these regulatory mechanisms is the idea of public interest and rights. For numerous waterway and wetland permits, the department has developed factors identified in Administrative Code that are to be taken into consideration and to aid in following legislative and judicial mandates. The Critical Habitat Designation Program plays a pivotal role in implementing legislative and judicial mandates entrusted to the Department. **Critical Habitat Designation** is a program that includes formal designations of sensitive areas according to Ch. NR 107, public rights features according to Ch. NR 1.06, and resource protection areas (areas within the shoreland zone). All of these elements combine to provide regulatory and management advice to the State of Wisconsin, counties, local units of governments, and others who hold authorities or are interested in protecting and preserving these unique habitats for future generations.

Public rights features are defined in Ch. NR 1.06 include the following: (1) Fish and wildlife habitat, including specific sites necessary for breeding, nesting, nursery and *feeding (Note: Physical features constituting fish and wildlife habitat include stands of aquatic plants; riffles and pools in streams; undercut banks with overhanging vegetation or that are vegetated above; areas of lake or streambed where fish nests are visible; large woody cover);* (2) Physical features of lakes and streams that ensure protection of water quality *((Note: Physical features that protect water quality include stands of aquatic plants (that protect against erosion and so minimize sedimentation), natural streambed features such as riffles or boulders (that cause turbulent stream flow and so provide aeration))*; (3) Reaches of bank, shore or bed that are predominantly natural in appearance (not man−made or artificial) or that screen man−made or artificial features (*Note: Reaches include those with stands of vegetation that include intermixed trees, shrubs and grasses; stands of mature pines or other conifer species; bog fringe; bluffs rising from the water's edge; beds of emergent plants such as wild rice, wild celery, reeds, arrowhead*); and 4) Navigation thoroughfares or areas traditionally used for navigation during recreational boating, angling, hunting or enjoyment of natural scenic *beauty (Note: Physical features indicative of navigation thoroughfares include shallow water areas typically used by wading anglers or areas frequently occupied by regularly repeated public uses such as water shows)*. **Sensitive areas** (defined in Ch. NR 107) are areas of aquatic vegetation identified by the department as offering critical or unique fish and wildlife habitat, including seasonal or lifestage requirements, or offering water quality or erosion control benefits to the body of water.

Public Rights Features Designations by rule always include sensitive areas (sensitive areas are one subset of Public Rights Features), however some laws specifically address only Sensitive Areas. ***Appendix1 (***Appendix_1_Summary of CHD_activity_rules.doc***)*** is a comprehensive summary of all activity-based laws which apply Public Rights Features including Sensitive Areas.

What is the procedure for identifying public rights features?

After survey data shows possible locations of public rights features, the department must give notice in the official state newspaper or other local media the department selects in the area affected which is likely to inform residents. Next, the department must notify the county clerk of any count bordering the lake, legislators whose districts include the affected public waters and the chairpersons of the committees of the legislature with jurisdiction for natural resource issues, and local, regional, or state lake. The notice needs to contain the location and description of the possible public rights features and the basis for its determination that the location is likely to contain public rights features. If a hearing is not requested in writing within 30 days after the mailing of the notice, the department may waive the hearing. Upon receipt of a request for a hearing, the department must, not less than 10 days before the hearing, mail a written notice thereof to each person notified under par. (b), and shall provide notice on its website and through its system of electronic notices to state media. Finally, at each hearing, the department has to take evidence offered by persons in support of or in opposition to the determination. If the department finds any location not properly classified, the location may not be identified as the location containing public rights features.

Chapter 3 – Desktop Review of Existing Resource Information

Selecting Lakes for Critical Habitat Designation

Selection of lakes for Critical Habitat Designation is generally done as part of the Department's biennial work planning process. Each region (for work planning purposes) shall identify one regional Critical Habitat Project Author. Each regional author shall coordinate with regional staff and submit one critical habitat designation project. Project narratives should identify, by year, waters to be designated. Projects shall personally identify the interdisciplinary staff (WT/Water quality biologist; FH/Fisheries Biologist; WM/Wildlife Biologist) responsible for each waterbody designation.

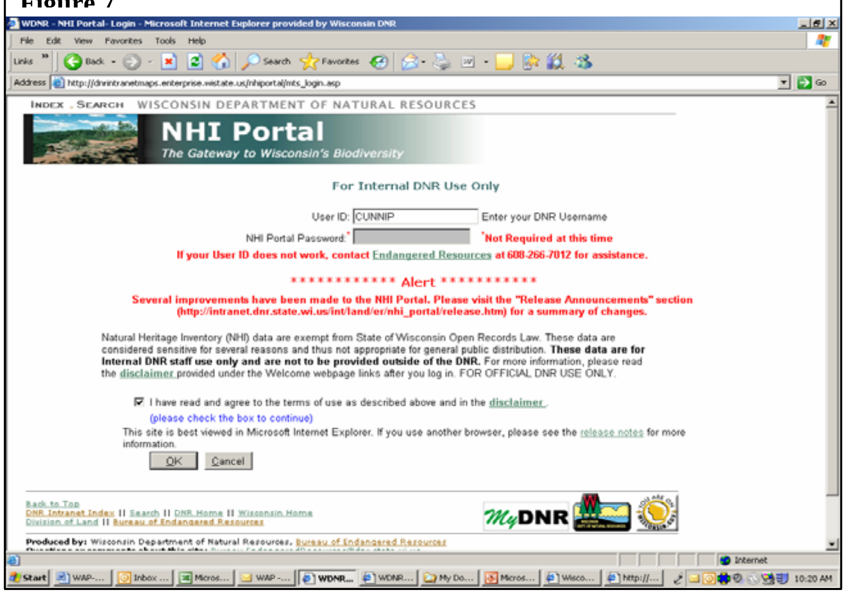
The selection of waters for conducting designations should contemplate three basic factors: 1) quality of the resource; 2) amount of knowledge and information the Department holds regarding the waterbody; and 3) current and future risks of the resource to riparian development and in-lake activities. **Appendix 2; Lakes_Selection_spreadheet.xls** is a statewide summary of 1460 lakes by region that uses statewide available data to classify the quality of the resource and the amount of knowledge for each lake in the database. This spreadsheet also describes the methods used for ranking lakes by knowledge and the quality of the resource (pearl status). There is no statewide data to index current and future risks to riparian development and in-lake activities. Here, managers should examine the percent of shoreline in public ownership, permitting activities, etc. to make best professional judgments regarding risk.

Do Your Homework - Inventory and Collection of Existing Data and Reports

The first work step in identifying critical habitat areas requires the review and compilation of the existing data. Sources of potential existing data on Wisconsin lakes and lakeshore plant and animal communities include but are not limited to: fisheries survey data and Reports, Natural Heritage Inventory, Lakes Planning Grant Reports, Waterbody Designations (ORW, ERW, 303D, ASNRI, etc), Wisconsin Wetland Inventory, SWIMS data, Soil Surveys, SHPO, County Lakes Classification Information, and Riparian areas under public ownership. Assembling map information from these inventories will be used to identify targets of focus related to fish, wildlife, endangered resources, and their habitats. This desktop homework exercise will help identify resource concerns for the waterbody. Chapter 3 provides instructions on how to query existing spatial information which will guide the Critical Habitat Designation Team in field delineation work.

Rare Species and Natural Communities; Natural Heritage Inventory (NHI) NHI Data provides site-specific information for rare species and natural communities. The NHI Portal (Figure 7) is currently available to DNR staff only and is the Endangered Resource Program's official method of delivering NHI data for NHI Screening. **Confidentiality:** DNR staff agree to comply with the data confidentiality guidance. Natural Heritage Inventory Data is exempt from State of Wisconsin Open Records Law. These data are considered sensitive for several reasons and thus not appropriate for general public distribution.

Figure 7



These data are for Internal DNR staff use only and specific location information is not to be provided outside of the DNR.

NHI data is information collected on three types of ***elements*** in the state which include:

- rare or declining species of plants and animals, for example the pale-purple coneflower or the peregrin falcon.
- high-quality or rare natural communities, like hemlock relicts or pine barrens, and
- unique and significant natural features which includes animal concentration areas like hibernacula, mussel beds, and migratory bird concentration points, and special geologic features for example caves.

In Wisconsin, these three types of *elements* comprise the NHI Working List and locational information on where these elements occur on the landscape is recorded in the NHI database as an *element occurrence* record.

The Wisconsin Natural Heritage Working List **(Appendix 3; Appendix_3_NHI_Working_List_2006.pdf)** contains species known or suspected to be rare in the state and natural communities native to Wisconsin. It includes species legally designated as "Endangered" or "Threatened" as well as species in the advisory "Special Concern" category.

NHI Training NHI Methodology and Screening Training

The NHI Methodology and Screening Training is the core training for DNR staff using NHI data. The training has been divided into 9 sessions and typically takes 4.5 hours to complete. The purpose of the 1-day training is to:

- **Increase the understanding** of NHI Screening process and NHI data/resources;
- **Increase the staff's capacity** to make decisions when an ER resource will likely be impacted.
- **Introduce the NHI Portal application** that provides access to NHI data and rare species information.

The training provides answers to the basic questions of "what is legally protected", "how to screen" and "what to do with a hit." ER Review staff conduct the training sessions and can answer questions and provide valuable insight and advice. The Agenda for NHI Methodology and Screening Training covers:

- Overview: NHI Program, Endangered Species Law
- Accessing NHI data through the NHI Portal Web Application
- How to Screen: Endangered Resources Screening Guidance
- What to do with a Hit? How to Avoid potential impacts
- Hands-on examples

Short of a full day training session, the Bureau of Endangered Resources sponsors the following training videos at their website (***http://dnr.wi.gov/org/land/er/presentations/NHITraining.htm***) which will prepare you to use the NHI inventory and screening process. The **bolded** training videos listed below should be viewed before accessing the NHI portal. These three videos will give you the core skills needed when prepping NHI Screening prior to Critical Habitat Delineation work.

NHI Training Day Overview [VIDEO length 00:29:08]
Andy Galvin, Jamie Schlangen

NHI Training Part 1: Introduction - What is NHI? [VIDEO length 00:14:00]
Andy Galvin

NHI Training Part 2: What is NHI Data - NHI Methodology [VIDEO length 00:30:15]
Jamie Schlangen

NHI Training Part 3: Why NHI Data - Endangered Species Laws [VIDEO length 00:44:39]
Andy Galvin

NHI Training Part 4: Screening Guidance [VIDEO length 00:10:51]
Andy Galvin

NHI Training Part 5: Decision Making Process (a.m.) [VIDEO length 00:09:48]
Jamie Schlangen

NHI Training Part 5: Decision Making Process (p.m.) [VIDEO length 00:15:21]
Jamie Schlangen

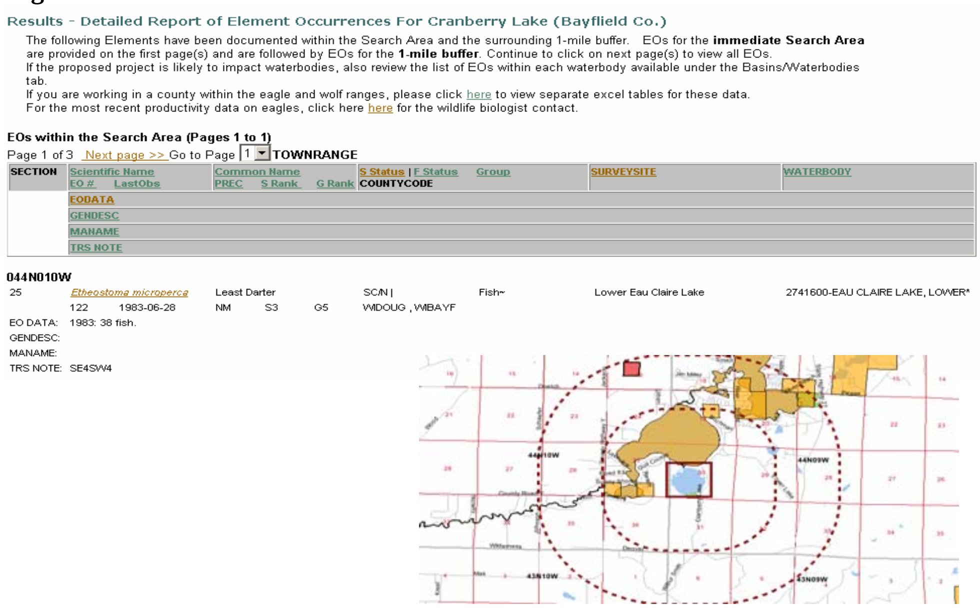
NHI Training Part 6: Accessing NHI Data - The NHI Portal [VIDEO length 00:42:57]
Andy Galvin

NHI Training Part 7: Case Studies [VIDEO length 00:54:52]
Andy Galvin, Jamie Schlangen

DNR NHI Regional Ecologists
These Regional Ecologists have agreed to help and act as coaches on how to approach the NHI data. They can answer general questions on how to do an NHI screen and how to think about the "hits" you are finding in and around your project area. Always keep in mind, that there may be other staff in your office and region with expertise that may be able to help as well. Central Office Training: Rori Paloski, (608) 264-6040 .
South Central Region:
Cathy Bleser, SCR/Fitchburg, (608) 275-3308
Southeast Region:
Owen Boyle, Regional Ecologist, SER/Milwaukee, (414) 263-8681
Northeast Region:
Joe Henry, Regional Ecologist, NER/Green Bay, (920) 662-5194
Northern Region:
Ryan Magana, Regional Ecologist, NOR/Spooner, (715) 635-4153
West Central Region:
Armund Bartz, Regional Ecologist, WCR/Eau Claire, (608)-785-9019

Staff shall print a "Detailed Report of Element Occurrences" within the search area for the waterbody of interest and within a 1-mile radius, along with a map (see example in Figure 8).

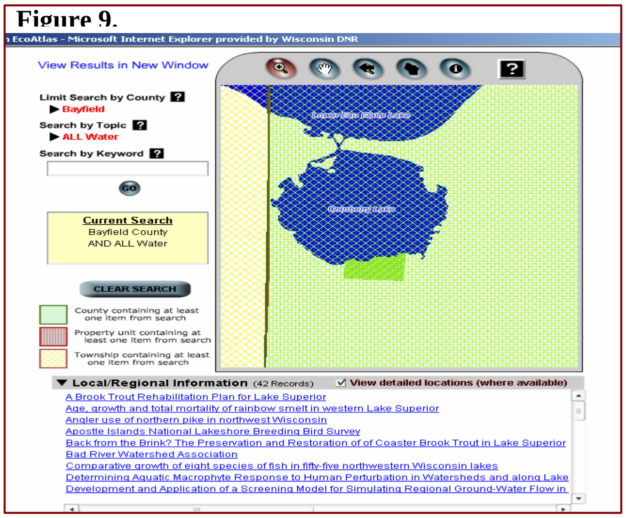
Figure 8.



Published literature and agency reports; Wisconsin EcoAtlas (http://ecoatlas.wiatri.net/)

The EcoAtlas (Figure 9) is one source collection of information about past and current research and monitoring activities relevant to Wisconsin's natural resources. EcoAtlas catalog allows you to search by county, topic or keyword.

Figure 9.



Intranet Surface Water Data Viewer

The Department's Surface Water Data Viewer is a gateway to numerous spatial data layers. Several of these should be reviewed prior to conducting field work. The following sections below, highlight several of most relevant portions of the Surface Water Viewer like boating ordinances, waterway alteration permits, , Wisconsin Wetland Inventory, and planning grants. The spatial data layers available in the surface water viewer are shown in the **May Layers** in figure 10.

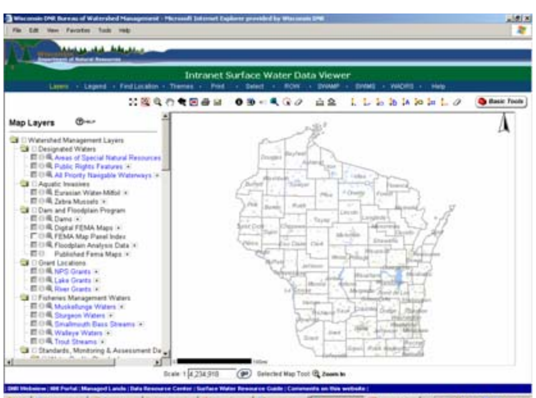


Figure 10.

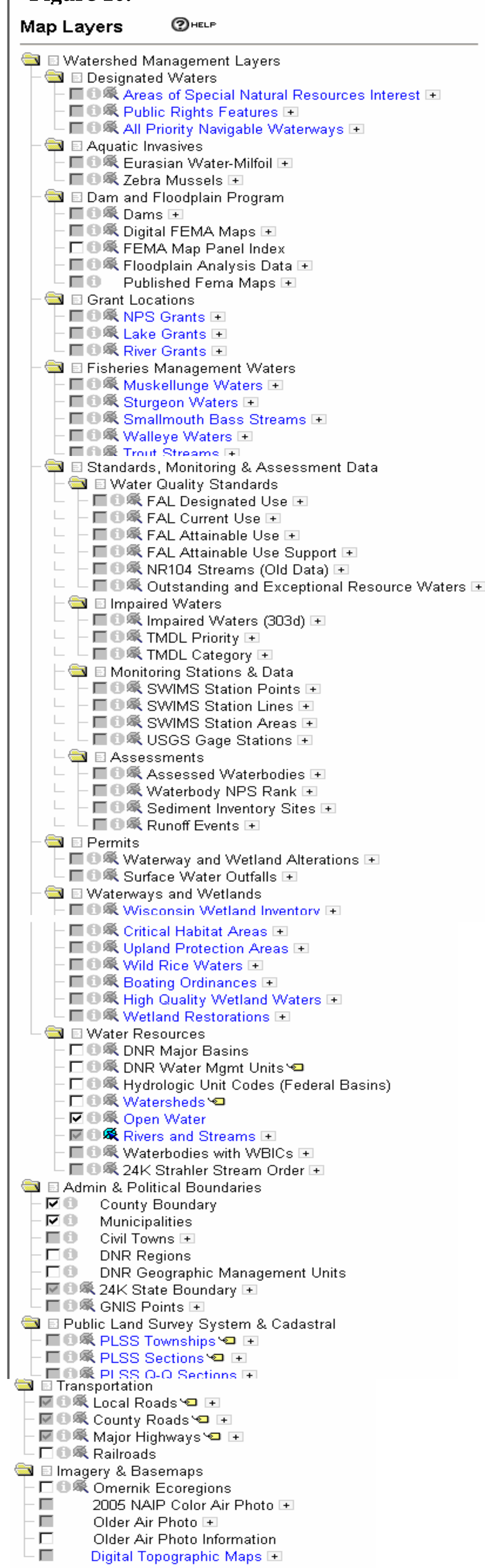
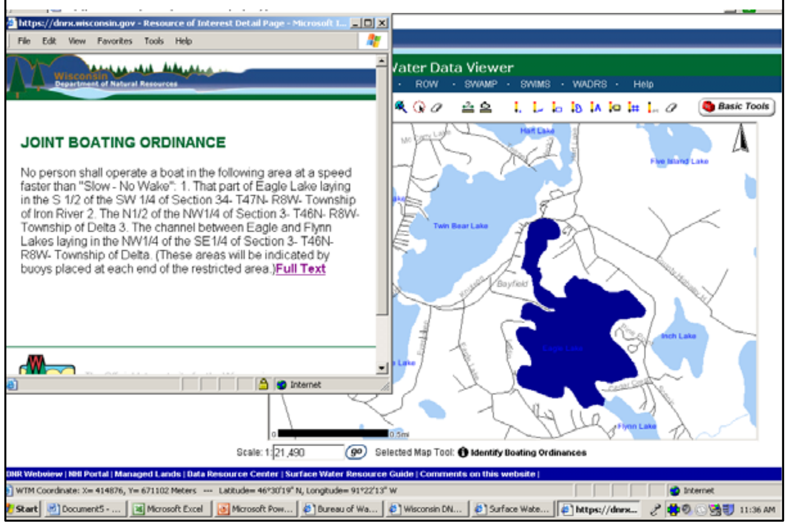


Figure 11

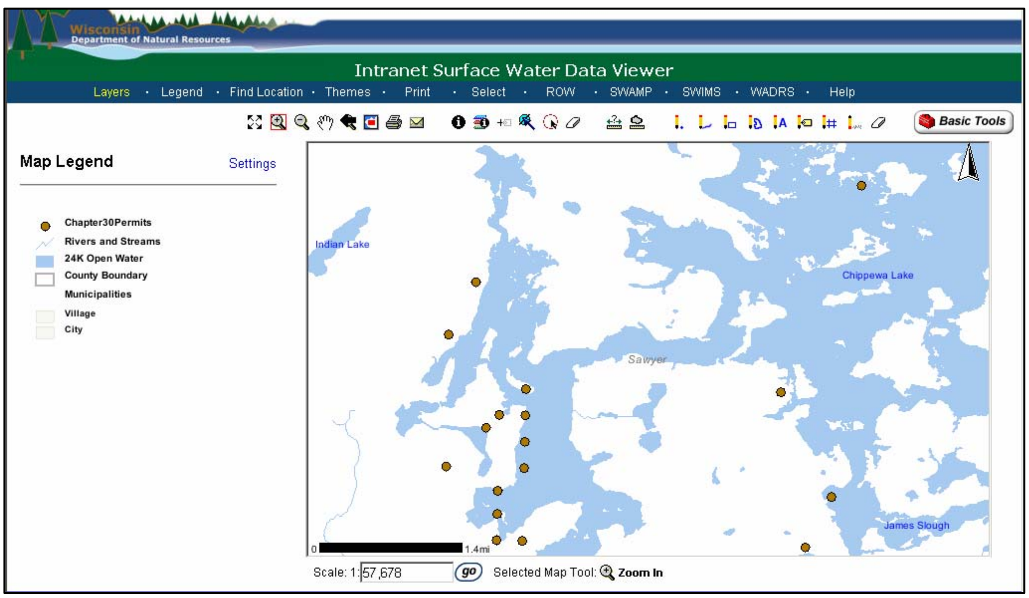
Boating Ordinance Review



Boating Ordinance Lookup--The Wisconsin Boating Ordinance data set available on the Surface Water Viewer shows waterbodies where local boating ordinances are in effect and where the Wisconsin Department of Natural Resources has a copy on file (Figure 11). The data layer only shows water bodies, municipalities or counties, as a whole, where ordinances are in effect. It does not show the location of actual waterway markers.

By law, the Wisconsin Department of Natural Resources must receive a copy of each local boating ordinance. The Boating Ordinance data set is the result of a two-year effort to scan and map the ordinances on file. As new ordinances come in, they are added to the database. However, there may be some delay between the time a local boating ordinance is passed and the time it gets into the database.

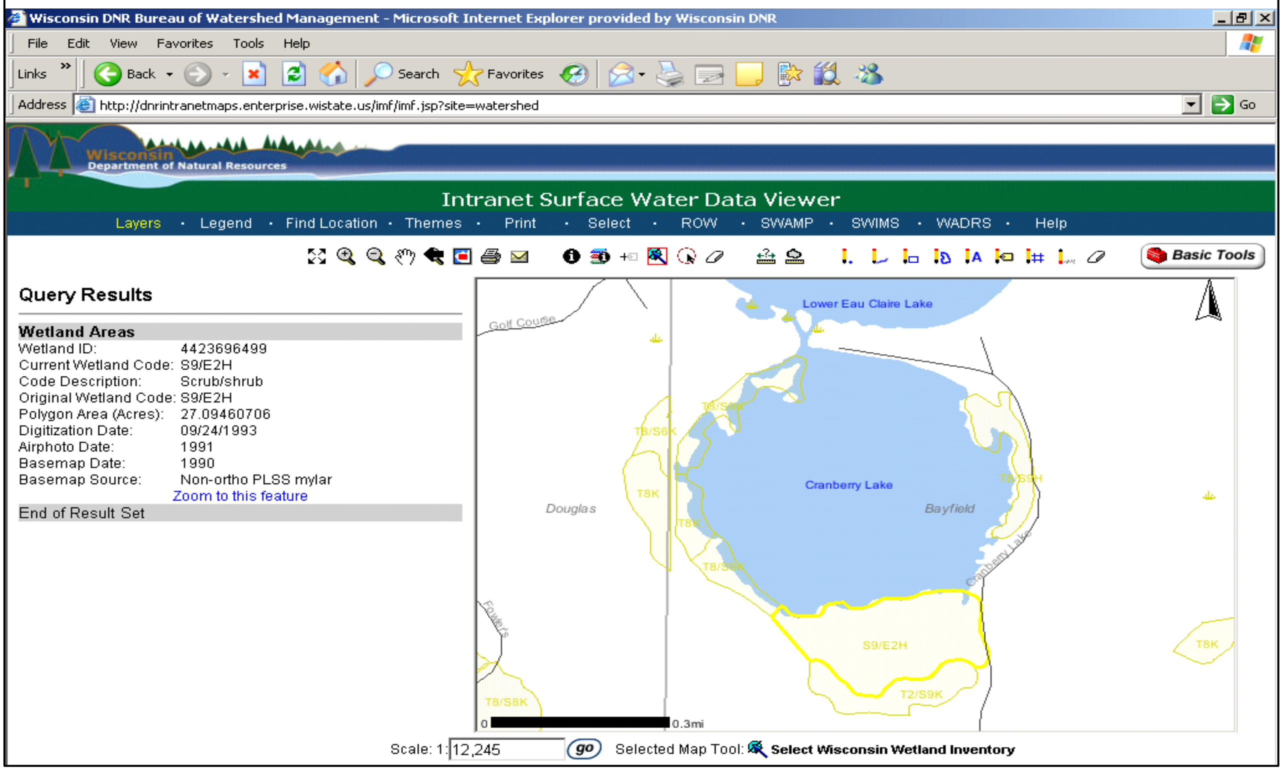
Figure 12.



Waterway Alteration Permits--Placement of structures, dredging and similar activities in or adjacent to navigable waters are regulated under chapter 30 of Wisconsin Statutes, and often require permits from the Department of Natural Resources. All permits issued by the Waterway and Wetland Protection Program are entered into a statewide database which exists on the Surface Water Viewer (Figure 12). Permit locations can be used as a relative index of historical disturbances to shorelines, in that human habitation along the shore has negative cumulative effects on fish and wildlife habitat. Users can apply the identify tool to any given permit location and quickly pull-up basic permit data that summarizes the waterway alteration at the site of interest. Permit data can be spatially displayed to identify shorelines that may have had little disturbance and are more likely to have more diverse, intact nearshore habitats.

Wisconsin Wetland Inventory—(WWI) maps (Figure 13) show graphic representations of the type, size and location of wetlands in Wisconsin. These maps have been prepared from the analysis of high altitude imagery in conjunction with soil surveys, topographic maps, previous wetland inventories and field work. State statutes define a wetland as "an area where water is at, near or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation and which has soils indicative of wet conditions." The principal focus of the WWI is to produce wetland maps that are graphic representations of the type, size and location of wetlands in Wisconsin.

Figure 13.



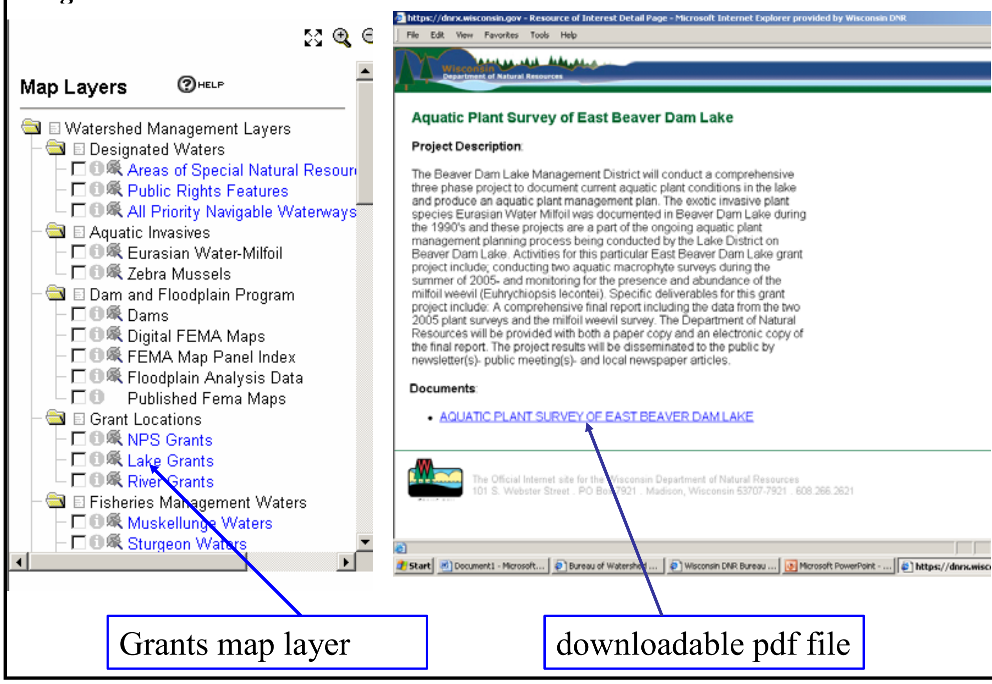
Within this context, the objective of the WWI is to produce reconnaissance level information on the location, type, size of these habitats such that they are accurate at the nominal scale of the 1:24,000 (1 inch = 2000 feet) base map. The DNR recognizes the limitations of using remotely sensed information as the primary data source. They are to be used as a guide for planning purposes. Detailed descriptions and abbreviations of the covertype classes for the WWI and components of the classification can be found in The Wisconsin Wetland Inventory Classification Guide **(Appendix 4; Appendix_4_WWI_Classification.pdf)**

There is no attempt, in either the design or products of this inventory, to define the limits of jurisdiction of any Federal, State, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, State, or local agencies concerning specified agency regulatory programs and jurisdictions that may affect such activities. The most accurate method of determining the legal extent of a wetland for federal or state regulations is a field delineation of the wetland boundary by a professional trained in wetland delineation techniques.

Not all of the WWI is available on the Surface Water Viewer yet (Vilas, Oneida, Chippewa Florence, Forest, Dunn, Eau Claire, Pepin, Jackson, LaCrosse, Waupaca, Waushara, Marquette, Green Lake, and Calumet Counties are NOT yet digitally available). The status of the Digital Wisconsin Wetland Inventory maps development can be found in **Appendix_5**; **Appendix_5_Digital_Wetland_Status_Map.pdf.** This map will tell you which counties were mapped using orthophotography and which counties were not.

Aquatic Plant Surveys

Figure 14.



Aquatic plant surveys conducted by consultants under grants awarded by the Lake Planning and Protection Program are often available on our **Intranet Surface Water Data Viewer** (Figure 14). To locate specific reports, activate the highlight and identify buttons on the Lake Grants map layer. Using the identify tool on the waterbody of interest will list grants that have been awarded to date. The list of grants also contains a link to downloadable pdf files (where appropriate) of the reports themselves. Department conducted plant survey work is not yet available on SWIMS. Jennifer Hauxwell (608-221-6373; jennifer.hauxwell@wisconsin.gov) maintains a statewide database of recent point intercept plant surveys and can provide the data upon request.

Soil Survey Inventory and Mapping

Figure 15.

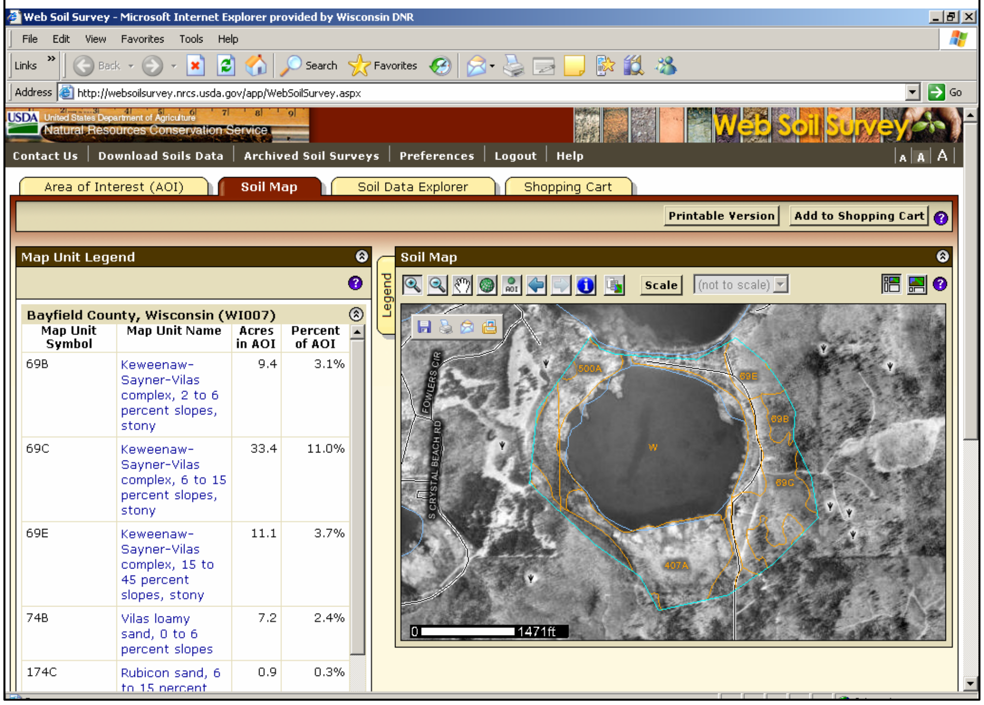
http://websoilsurvey.nrcs.usda.gov/app/

Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey (Figure 15). It is operated by the USDA Natural Resources Conservation Service (NRCS) and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties and anticipates having 100 percent in the near future. The site is updated and maintained online as the single authoritative source of soil survey information.

The Basic Steps involved with Mapping Soils for your CHD Project are as follows (Figure 16):

- Define area of interest – you must specifically set the AOI before you can view any maps or reports
- View Soil Map – if available for AOI
- Browse/Explore soil data and related information
- Generate thematic maps, Access official soil survey data tables, Build custom soil resource report in Shopping Cart
- Print/download the selected map or report

Figure 16.



Aerial Photo Delineation

Existing aerial photographs can be used to desktop map emergent and floating-leaf vegetation.   Aerial photos are available from the Surface Water Viewer or available for ArcMap users. Cattail *(Typha spp.)*, wild rice *(Zizania spp).*, white waterlily (*Nymphaea odorata)*, yellow waterlily (*Nuphar variegate),* and watershield (*Brasenia schreber)* can all be detected with various degrees of effectiveness. Some issues associated with this method include difficulties in identifying vegetation beds from photos. This may result in missing small or floating-leaf vegetation beds altogether. Extensive bulrush (*Scirpus spp.*) beds are difficult to see on aerial photos and mapping in the field is required.   If possible use several sources of photos because different types of vegetation may appear differently on separate photos. The locations on the photo are only as accurate as the photo rectification. Changes in vegetation observed between different photo dates can also be confirmed.

Other Agency and Organization Involvement.

Once you've collected readily available data and reports related to the waterbody, now is the time to notify others of the Department's intent to conduct a Critical Habitat Designation. This notification should be offered as an invitation or solicitation of other pertinent resource information that other agencies and organizations may possess. Here a formal letter of notification and information solicitation should be sent to: 1) local governments (County Land and Water Conservation Department, County Forestry, City, Town, Village, or Lake/Sanitary Districts); 2) Local organizations (Lake Associations, Duck Unlimited, WI Trappers Assocation, Muskies, Inc. Walleyes for Tomorrow, Nature Conservancy Audobon Society, Sierra Club, and County Lakes Organization); 3) potential federal agencies (U.S. Forest Service and US. Fish and Wildlife Service); and 4) potential local business who may have local resource knowledges and information (environmental consultants, fish guides, resort owners, etc.).

Interpreting Homework and Applying our Knowledge to Identification of Priorities Areas

The interdisciplinary staff will **integrate site information gained from the research stage. We need to provide direction to the reader on how to apply the “spatial homework” in honing in on site selection. We need to expend some intellectual energy on this section. (existing development) (embayments)**

In some instances a staff member may be able to communicate on a map or through a written description where on the lake their particular disciplines area of interests are located. A paper lake map with bathymetry that has the proposed critical habitat areas drawn on it and notes indicating the justification can be taken to the field and will help in navigating to and keeping track of the sites.

Preparation of Trimble Units For Field Work

The Statewide Critical Habitat Coordinator in the central office is responsible for populating Trimble Units with digital orthophotographs, the hydrolayer, Wisconsin Wetland Inventory, and the Critical Habitat Layer prior to the field season. Bureau staff can accommodate other specific requests and populate other GIS data on the Trimble units. Regional field staff are responsible for providing a list of their work-planned lakes (and WBIC’s) to the Bureau of Fisheries one month prior to their field work. The Bureau of Fisheries provides this technical service to the field teams based on the list of waters in their schedule and workplan. **Appendix 6 (Appendix_6_creating_new_geodatabase.doc)** and **Appendix 7 (Appendix_7_Data_Prep_Trimble.doc)** provides detailed guidance to Bureau Staff or others on how to download GIS data to Arc Pad and set-up the Trimble Units.

Chapter 4. Critical Habitat Delineation

The purpose of this chapter is to familiarize staff with the process of critical habitat delineation. This chapter provides a brief overview of the composition of the teams involved, the process of critical habitat delineation, and the operation of the Trimble Geo-XM unit.

Critical Habitat Delineation Teams

<u>Composition</u>

Critical Habitat Designation teams consist of a WT/Water quality biologist, a FH/Fisheries Biologist, and a WM/Wildlife Biologist, with at least one of the team members trained to record the delineation areas and the associated attribute data with the Trimble GPS unit.

<u>Roles, Responsibilities & Objectives</u>

One member of the team will assume the responsibility of being the **team leader**. Each team leader shall coordinate the regional staff involved in the selection, delineation, public review and final submittal of the critical habitat designation project. The interdisciplinary staff will **integrate site information gained from the research stage** (may want to expand on this thought here) along with their own local and professional experience to guide the site selection process. A lake map with the proposed sites will guide the team in their field delineation work.

Safety and Disinfection Protocols

By Department manual code **(Appendix_8_MC918250.pdf)** all personnel assigned to crews working on water must be trained and certified in a National Association of State Boating Law Administrators (NASBLA) approved boating safety course and the operational techniques of equipment to be used, or be a Wisconsin DNR certified boating safety instructor. Approved Personal Flotation Devices (PFD) must be standard equipment on all DNR boats. They shall be worn at all times by all personnel working on water and all non-DNR personnel in DNR boats.

Since Department staff regularly move boats and equipment between waters, it is important that DNR staff follow proper protocols to set a good example for the boating public, to insure that we are not contributing to the spread of aquatic invasive species through our work activities, and because it's the law. By Department manual code **(Appendix_9_Boat and Gear Disinfection mc.doc**), disinfection measures must be taken prior to moving boats, equipment and other gear from one waterbody to another. They are not needed daily when sampling the same waterbody or for law enforcement equipment in emergency situations. In cases where boats and gear return to state hatcheries, disinfection should be done in a location away from ponds and water supplies to prevent disinfectant or untreated water from entering those areas. Every effort should be made to keep the disinfection solution and rinse water out of surface waters. The most current disinfection protocols, safety precautions and mixing concentrations can be found at the following website: http://dnr.wi.gov/fish/documents/disinfection_protocols.pdf.

An Introduction to Delineation using Trimble GPS Units and ArcPad

This section lays out the instructional resources at their fingertips (along with the quick reference quide and the manufactures manual) provides the reader with the necessary information to complete field delineations using the Trimble Geo-XM The following PDF files are additional reference resources that will help staff to become familiar with the unit and related procedures.

<u>ArcPad Quick Reference Guide</u> **<u>(Appendix_10_ArcPad_QuickReference.pdf)</u>**

- This two-page pamphlet explains GPS Position windows and button functions in ArcPad

<u>Trimble GPScorrect Quick Reference Guide</u>
<u>(Appendix_11_GPScorrect_Quick_Reference_Guide.pdf)</u>

- This manual explains the GPScorrect extension to ArcPad and how to configure settings for it. This extension provides the link between the GPS receiver and the ArcPad application. GPScorrect also facilitates Satellite Based Augmentation System (SBAS) real-time differential correction.

Trimble GeoExplorer 2005 Getting Started Guide
(Appendix_12_GeoExplorer_2005_Getting_Started_Guide.pdf)

- The Getting Started Guide is the manufacturers owner's manual for the Trimble Geo-XM unit explaining usage and maintenance. The guide also explains the functioning of the operating system (Microsoft® Windows Mobile™ Version 5.0 software for Pocket PC) and addresses the GPS Connector, GPS Controller, GPScorrect™ extension for ESRI, ArcPad software and Microsoft ActiveSync® technology. The guide includes specifications and accessories for GeoExplorer 2005 series handhelds.

ArcPad User Guide **(Appendix_13_ArcPad_UserGuide.pdf)**

- Chapter 1 Welcome to ArcPad
- Chapter 2 Introduction to Windows Mobile
- Chapter 3 Quick-start tutorial
- Chapter 4 ArcPad basics
- Chapter 5 Creating maps
- Chapter 6 Managing layers
- Chapter 7 Symbolizing your data
- Chapter 8 Querying your data
- Chapter 9 Connecting your GPS receiver
- Chapter 10 Using the GPS Position Window
- Chapter 11 Navigating with your GPS
- Chapter 12 Using your rangefinder
- Chapter 13 Using your digital camera
- Chapter 14 Editing basics
- Chapter 15 Creating new features
- Chapter 16 Creating new features with a GPS and rangefinder
- Chapter 17 Editing existing features

ArcPad Reference Guide **(Appendix_14_ArcPad_Reference_Guide.pdf)**

- Chapter 1 Welcome to the ArcPad Reference Guide
- Chapter 2 ArcPad toolbars
- Chapter 3 ArcPad Options
- Chapter 4 GPS and Rangefinder Preferences
- Chapter 5 Map Properties
- Chapter 6 Table of Contents
- Chapter 7 Layer Properties
- Chapter 8 Label Properties
- Chapter 9 Symbol Properties
- Chapter 10 Feature Properties
- Chapter 11 Locales and codepages
- Chapter 12 Fonts
- Chapter 13 Projections and datums
- Chapter 14 Supported data formats

Conducting the Field Delineation *(Under Development)*

This section elaborates on 7 sequential steps staff need to know when using the Trimble to record Critical Habitat Designation Boundaries.

1. Should have a plan with target sites located on maps of the target lakes and basic equipment to bring. Sometimes previous habitat delineation data layers may exist that will be useful to look at and review in the field or previous track log files.

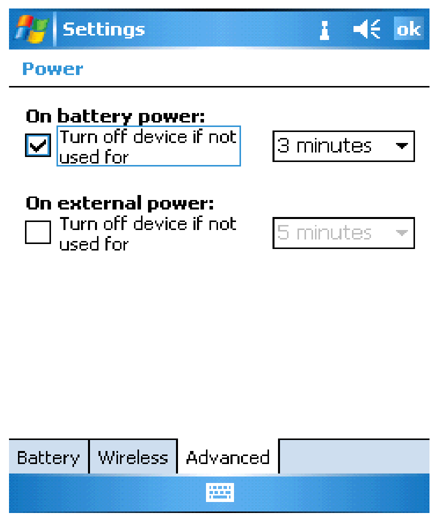
Sorry, there is no back-up battery. The day before going out in the field, be sure to check the amount of charge remaining on the battery. Tap *Start / Settings / System tab / Power*, then look at the *Main Battery* charge indicator bar to view the level of power remaining in the battery (100% = fully charged). A fully charged battery should get you through a full day (8 hour) day. To charge the unit a cradle (support module) and the AC power adapter are needed.

The Unit should be protected by its padded nylon pouch until ready for use. To prevent scratching the screen, it is recommended that a clear plastic screen protector be used along with a stylus or soft plastic pen cap. If the existing screen protector is dirty or hard to see through there are replacements available.

2. Warm up the Trimble
Always start out each day and the beginning of each new session with a complete power down and restart. The power down and restart is also advisable as a remedy (but only after you have demonstrated your exceptional patience) for most problems that occur with the Trimble such as extremely slow behavior or if the screen locks up or is unresponsive. Once the unit has rebooted and you see the Windows Mobile desktop then start up ArcPad. The "soft key" icon in the lower right of the screen.

Suspend mode-- When you quickly press the **Power** button to turn off the handheld, the handheld goes into Suspend mode. This is a low-power mode that maintains the main memory contents but does not allow you to operate any of the handheld's functions. The handheld appears to be turned off. The integrated GPS receiver is turned off and any application using GPS is disconnected. To turn on the handheld when it is in Suspend mode, press the **Power** button. The handheld is ready for operation. There may be a delay of up to 30 seconds while the integrated GPS receiver automatically reactivates.You can configure the handheld to automatically enter Suspend mode when it has been idle for a specified time. By default, the handheld is set to enter Suspend mode if the handheld is not used for three minutes. To change the time to enter Suspend mode:

1. Tap */Settings* / *System* / *Power*.
2. Tap the *Advanced* tab.
3. From the *On battery power* group, select the *Turn off device if not used for* check box and select the idle time from the drop-down list.
4. Tap **OK**.



Flight mode and disabling other functions (eg. Screen sleep mode, Lock and unlocked, [check GPS preferences])on the Trimble that might distract or mess with your mapping.

It may takes a long time to get lock on satellites and the PDOP threshold is not permitting recording of GPS positions, or when the unit needs to be rebooted. Locking and unlocking, screen hibernation and wakeup. The "Can't see SD" as folder card bug.

3.   Start up ArcPad
Usually for Critical Habitat Delineation there should be a folder for each lake with an ArcPad Map document inside. Once ArcPad loads you see the toolbars and a blank view then go to "File"→"Open" → then select "existing map". Make sure "all folders" is selected as ArcPad searches for map document files. Wait for the list of found map documents to appear select the appropriate lake. vs. creating new map vs. using template chd point or poly layer. Or create new [check if first layer also sets projection default in ArcPad]

Collecting data in the field: Using the Trimble GeoXM
Start ArcPad, find yourself on the map, confirm you are on the correct lake, activate GPS, get feed back through the form of the GPS position window, clicking on the coordinates in that window yields several different formats, check the number and availability of satellites describe what the colors and shapes mean. Once GPS PDOP threshold is meet and exceeded the can begin to create polygons. Make the appropriate point or polygon layer editable. I need to

explore the ability to go back and forth between editing point and poly layers and back and forth between manual data entry and streaming entry. Explain flip-flopping between automatically panning the map view based on your GPS position. Explain snapping. How to edit the attribute table if you make mistakes. Explain complete polygon button and undo button

Table of contents change the position in the stack of the different layers, turn visibility off and on, allow the info tool to query a layer, allow it to be edited or delete the layer from the map.

Navigating through the file structure and useful screens of the Trimble.

4. Acquire Satellites, Is everything OK?
Real time differential correction check on PDOP and DGPS via Trimble GPScorrect, explain the numeric reports, icons and symbols in the sky plot window and how to interpret the horizon circle Global Positioning System (GPS) basics GPS use after a week or several days of rest takes longer to reload new ephemeris and acquire satellites.
Checking the GPS status Trimble GPScorrect Extension Quick Reference Guide **17**
Table 3.1 Status bar: Icons Trimble GPScorrect Extension Quick Reference Guide **31**
Skyplot Trimble GPScorrect Extension Quick Reference Guide **34**

Holding the Unit so you don't block satellites.

To enable averaging or not. Accuracy is a function of time. Want happy medium. PDOP is index of position and geometry, like golf score want a low one. 6 or less. A low PDOP value indicates that the visible satellites are widely separated in the sky, which gives better position information. When the PDOP value rises above the maximum value, the GPS receiver stops logging GPS positions. Specify a lower maximum PDOP to collect fewer, more precise positions. Specify a higher maximum PDOP to collect more, less precise positions. Trimble GPScorrect Extension Quick Reference Guide **69**

ArcPad_Prefs.apx in My documents stores the preferences and is saved when ok on dialog box is clicked.

Tracklog strategies how to turn it on, turn it off, frequency of point capture, where the file is located, how to display, what format it is in, how to display and deal with it later. (Also mentioned in intro to the Trimble) If taking pictures synchronize the camera clock to be the same as the time the of the GPS unit. This allows linking the time a picture was taken to the location at that time according to the track log. May want to note compass direction shot was taken at or any other note

5. Start delineation
Editing a layer adds a third toolbar. Look for red box, to tell if you are editing layer or not Navigating around the Trimble screen and in and out of the data layers. Add layer, Zoom in, zoom out, zoom to full extent, zoom to default book mark, pan. Don't rotate. Adding and using base layers.
Photo logging strategies.

[How to use Goto] both through selection on screen and through attribute table

Edit point feature
Edit poly vertex, delete last vertex, move vertex

Saving map vs. saving edits.

Use stylus not the inky point of a pen or sharp object that will scratch the screen of the unit. If auto-pan checked on, the GPS cursor or marker will always be in the center of the map indicating your position and trend of direction relative to the base layer features, this is an aid while moving, but can be a nuisance when editing a polygon that is no longer close to your current position. Change it in preferences. Can Snap to hydro layer or snap to adjacent polygon. Capturing vertices of polys vs. streaming, streaming no averaging in the interests of time over accuracy Click add GPS vertices continuously button to start streaming unclick to add manually.

Offset tool. Depth finder should be on the equipment list for field work, use it for the water ward delineation.
Using bathymetry if it is current and reliable
Editing vertices of polys, moving appending and using GPS to move
Function of the red circle with white X icon vs. green circle with white check mark icon

Concept of polygon or area delineation:
Polygons are digital spatial records of field observations of the presence of one of the above CHD criteria. While in streaming mode the GPS device records the path that is traveled by the unit as it is held in the hand of the operator. Usually the boat that is transporting the GPS operator will be piloted to follow the edge of the bull rush or submerged aquatic vegetation that represents the polygon feature to be recorded. If the bulrush bed extends to the shoreline the GPS operator can finish the polygon in several ways.
Land-ward vs. offshore side of CHD polygon. If the boat has a reliable depth finder, having the boat stay at a constant depth contour will aid in defining the water ward edge SAV.
CHD poly feature are mixture of can incorporate OHWM, wetland border, no clean up, snap-to hydro, snap-to wetlands, in field manual, back in office editing—on the water vs. shoreline vs. OHWM or upland wetland border
Delineation techniques-- streaming= no clean up, snap-to hydro, snap-to wetlands, in field manual, back in office editing—on the water vs. shoreline vs. OHWM or upland wetland border . What % of the shoreline or surface area do we delineate? (Here we use Paul’s analysis). What kinds of habitat are deserving designation and at risk? Discussion here as to the Justification fields are intended to direct the follow-up sampling protocols.

GPS Mapping Rules: Do boundaries overlap? Can polys be within a parent poly? Can a poly have more than one sub-type (SAD, Other PRF, or RPA)? Can a Designation be a point? (No) Can a designation be a line? (No). Can a poly have more than one justification feature? Can boundaries follow transition zone in near-shore vegetation communities.

6. Close Polygons and identify Attributes

Editable point and polygon feature classes and domains and how the drop down lists are populated with the appropriate choices for attributes in the field

Steps in entering data once poly closed or point entered.

Recording field observations via GPS mapping
Recording the boundaries of a CHD area that has one or more of the following attributes:

1. Bio-diverse Submerged Aquatic Vegetation (SAV)
2. SAV Important to Fish and Wildlife Habitat
3. Emergent and Floating Leaf Vegetation
4. Bulrush Bed
5. Wild Rice Bed
6. Extensive Riparian Wetland
7. Woody Habitat
8. Spawning Substrate
9. Water Quality (springs, etc)
10. Natural Scenic Beauty
11. Extensive Public Use

Deciding the subtype:

SAD
Other Public Rights Feature
Resource Protection Area

What stage of polygon clean-up happens when?
Person who created delineation should be one to edit them, so next person using data will be able to interpret what polygon’s attributes are.

The Attributes page is used to display and edit the attributes and associated values of the selected feature. When accessed via the Identify tool, all values are read only. When accessed via the Feature Properties tool—or by doubletapping a feature with the elect tool—all values are read/write. An attribute that is used to efine the symbology of the layer is displayed in red.

7. Saving and Reviewing Field Data
Closing ArcPad X in upper right corner vs. using exit from pull down menu
Map/data/polygon Clean-up
Data file management/backups
Feature class vs. shapefiles, extra vba magic that happens when checking out layers from ArcMap to ArcPad.

If you choose the check out and check in option it has to be to the same map.

Ecological habitat issues for team judgments and decisions

Number of critical habitats. There is no required minimum or maximum number of Critical Habitats to be defined for a waterbody. Past decisions are informative: An examination of 127 historic sensitive areas shows considerable variation in the numbers of sensitive areas staff have designated (Meannumber SADs=6, Min=1, Max=34). As expected, there is positive relationship between the number of sensitive areas and the waterbody size (Figure 17). Likewise there is no required minimum or maximum percent of the waterbody to be designated. Historic designations have captured an average of 27% of the waterbody. However the percentage of surface area designated is similarly, quite variable. For lakes less than 2,000 acres a negative relationship exists between % of lake area designated and lake size (Figure 18 small lakes tend to have a larger percent of their surface area designated as sensitive area.

Figure 17.

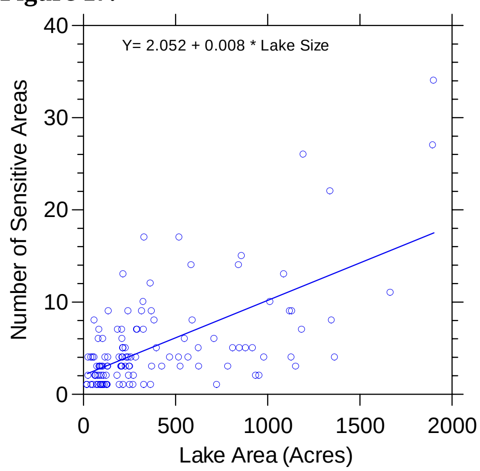
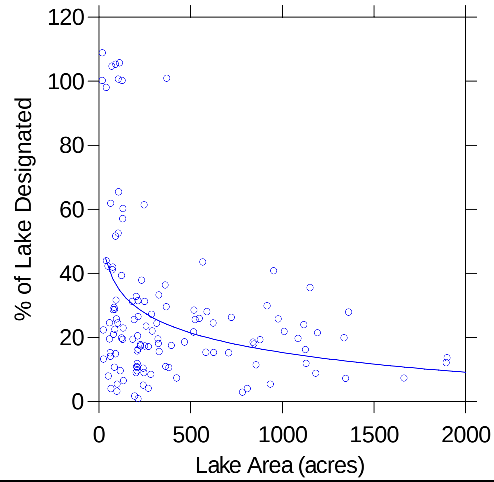
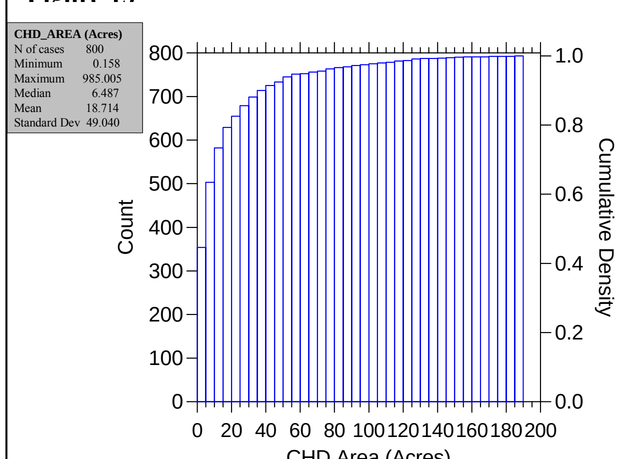


Figure 18



Critical habitat size. There is no required minimum or maximum size of individual Critical Habitat to be defined within a waterbody. An examination of 807 historic sensitive areas shows considerable variation in the size of sensitive areas staff have designated (Figure 19; min=0.158 acres, mean=18.7 acres, median=6.5 acres). An examination of the data reveals no significant relationship (P=0.638) between the average size of the sensitive areas and waterbody size. Approximately 80% of the total sensitive areas designated are less than 20 acres in size (Figure 19).

Figure 19

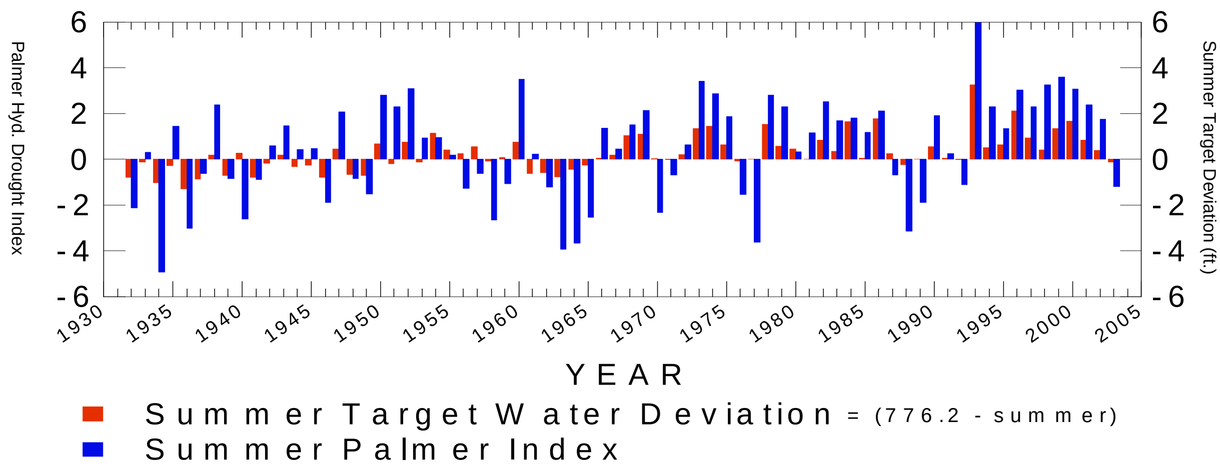


Of the 800 cases, 7 were excluded by setting the x-axis maximum @ 200 acres

Emergent and Floating-leaf plant beds.   Several recent scientific investigations elucidate the negative impacts of riparian residential development activities on aquatic macrophytes, emergent and floating types are particularly more vulnerable (Alexander et al. 2008, Radomski and Goeman 2001, Meyer et al. 1997, and Ostendorp et al. 1995). The frequency of occurrence of the common emergent and floating-leaf species are negatively correlated to the number of homes per kilometer. Among the emergents and floaters, hardstem bulrush has the highest correlation between percent of transects in which a given plant species occurred and homes per kilometer (Radomski and Goeman 2001). Therefore, emergent and floating leaf plant beds remaining are most often of associated with lightly or undeveloped shorelines.   The slope of the littoral zone and wind exposure of the site also influences their distribution, where they are more likely to occur along shallow sloped littoral regions which are more wind protected. These broad shallow-sloped lake beds also tend to dampen wave action, further favoring emergent and floating leaf plants. On many lakes, tributary areas and wind protected embayments are the most likely areas for this habitat type.

Staff should contemplate water-level variations and understand a temporal reference to the wet/dry hydrologic cycle (example of wet/dry cycle in **Figure 20)** during their delineation, particularly for shallow bays and shallow lakes. This wet/dry cycle exerts considerable influence on the aerial extent of wetland vegetation, particularly emergent

Figure 20.   Time Series Trend – Relationship between Lake Koshkonong Water Levels and Hydrologic Conditions



plants.   Van der Valk (2004), outlines the four vegetation stages that occur during the wet-dry cycle in **Figure 21** (taken from Van der Valk 2004). The depth and duration of inundation of water during the growing season is the principal factor governing distribution and composition of wetland vegetation**.** During drought or lower water levels, the marsh bottom is exposed. During the drawdown seeds of emergent species present in the seed bank germinate as well as the seeds of large number of mudflat annuals also present in the seed bank. Seeds of emergent plants will not germinate underwater; therefore many emergent species cannot become re-established until the next drought when the wetland goes dry enough to provide moist soil conditions. When the drought ends, the marsh re-floods. This eliminates all the annuals that cannot tolerate flooding, but leaves the emergents. Submersed species

Figure 21. Hydrologic Cycle and Wetland

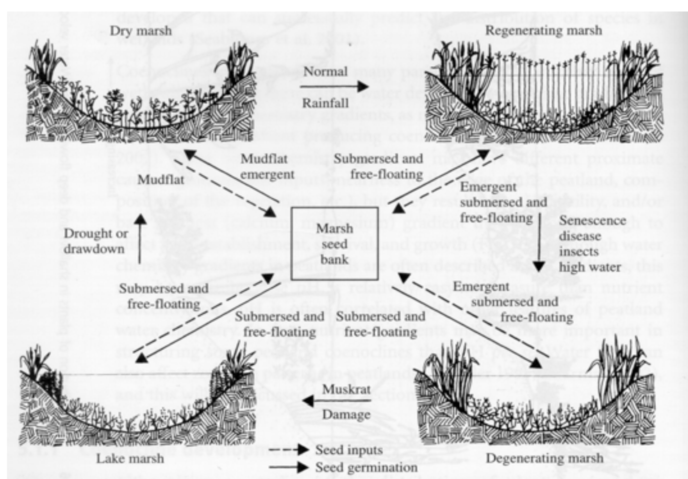


Fig. 5.7   Changes in coenoclines during the four stages of an idealized wet-dry cycle in a semipermanent prairie pothole. (Redrawn from van der Valk and Davis 1978.)

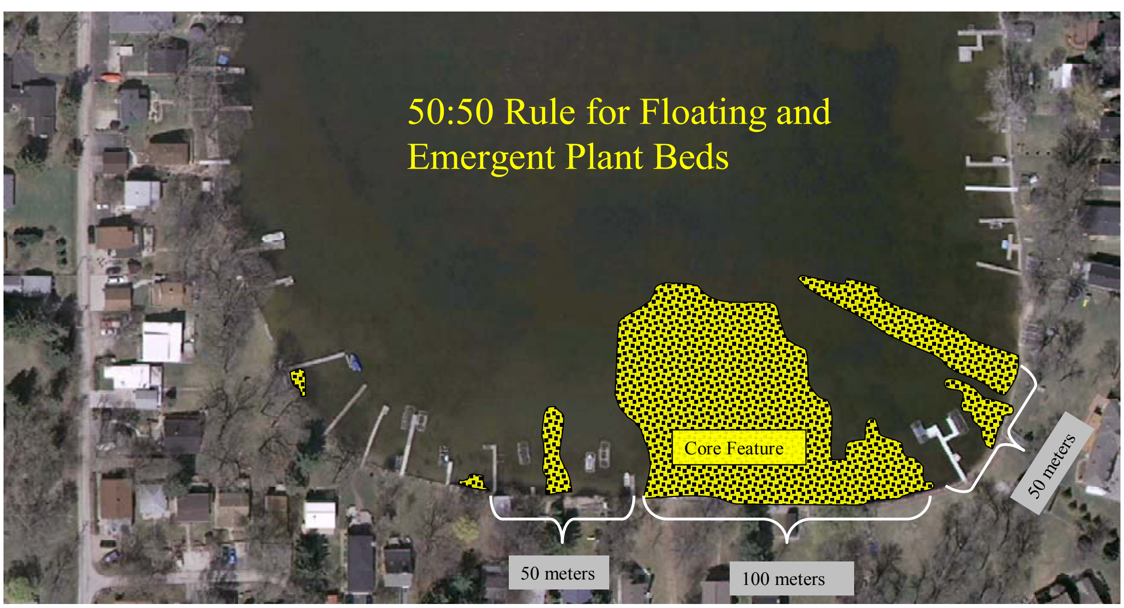
also become reestablished from seed as soon as the marsh re-floods. The next few years after re-flooding are referred to as the regenerating marsh state, the emergent plants spread by vegetative propagation and the zonation patterns of the wetlands redevelop. It takes several years for emergent wetland zones to fully redevelop after the dry marsh refloods.   The return of high water for a numbers of years gives way to the degenerating marsh as some of the emergent species begin to be drowned out. The first few years of the degenerating marsh state are often referred to as hemi-marsh conditions. The lake marsh stage terminates the cycle when emergents have receded to their maximum extent during extended high water level periods. If the delineation team is capturing emergents during an extended wet period they may underestimate the footprint of emergent expansion during future dry periods. Research has demonstrated that the recession of wetland emergent zones is the result of water level changes across many years, rather water level changes within a year.

Boundaries--Staff should delineate emergent plant beds which occupy more than 30 meters of shoreline or contain a footprint equal to or greater than 300 m^2. When delineating emergent and floating-leaf beds be sure to establish at least a 30-meter buffer waterward of the beds. Critical habitats comprised of extremely narrow bands are often difficult to detect on the surface water viewer (it's advantageous to establish a broader buffer so the critical habitat area is visible at the "lakewide" mapping view on the surface water viewer). Moreover it's insufficient to delineate only "footprint" boundaries for boating ordinances and APM decisions.   For floating and emergent vegetation, often the bed being delineated abuts developed properties, where various degrees of the bed have been removed (example in Figure 22 photos). In these situations defining the boundary of the critical habitat can be problematic.

Figure 22

Here staff may apply the **50:50 majority rule** as follows*:* Define the shoreline length of the core feature, then examine adjacent shorelines on each side to a distance of 50% of the original length of the core feature. If, in the adjacent areas, a majority (50%) of the habitat features are still present, then expand the boundary to a distance at which additional habitat features comprises less than 50% of the shoreline length. The example in **Figure 23** shows fragmentation of the plant bed on the left side of the core feature, which is not of significant size for inclusion. However, inclusion of the plant beds on the right side of the core feature is warranted.

Figure 23.



Ordinary High Water Mark
Under Wisconsin's Constitution, lakes and rivers belong to everybody and DNR manages them for the benefit of all citizens. The state Supreme Court has ruled that the state owns title to lakebeds (not streambeds or flowed lands), and that the ordinary high water mark, (OHWM) establishes the boundary between public lakebed and private land. In 1914, the Wisconsin Supreme Court defined the OHWM as "the point on the bank or shore up to which the presence and action of the water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial vegetation or other easily recognized characteristic." Water marks are often at various elevations, but the most permanent and prevalent marks constitute the ordinary high water mark. The OHWM doesn't change with temporary fluctuations in water levels, nor is it always at or near open water, as is the case with cattail marshes and bogs. The Supreme Court has ruled that the area between the water's edge and the OHWM need not be navigable to be held in the public trust. The DNR does not systematically delineate lakebeds; OHWM determinations occur because waterfront property owners take actions that trigger the need for an ordinary high water mark. DNR also sets OHWMs when reviewing applications for permits to grade or make other changes to the shoreline. At their request, DNR also helps counties set OHWMs for shoreland zoning. DNR uses several techniques for complex sites. When the OHWM can't be identified at a particular site because the shoreline's been disturbed, the DNR staffer may need to identify the mark at another location on the waterbody and transfer the elevation level to the site in question. To determine the OHWM elevation at a shoreline with a wetland fringe or bog can be complicated. The DNR evaluates lake mechanics and forces, wetland evolution and function, soil types and water level history. Complex OHWM determinations may need to be conducted by a trained expert and sometimes require surveying skills.

Sensitive Area Boundaries-- The jurisdiction of NR 103, 107, and 109 is more broadly related to areas of aquatic vegetation, which can be found in numerous wetland types and is not bound by the OHWM. Nonetheless, Sensitive Area Designation boundaries can often extend a considerable distance landward from the edge of the open water and still be below the OHWM. OHWM elevations are not specifically established and their subsequent boundaries are unknown to staff when conducting field delineations. Many Sensitive Area delineations often include emergent and sedge meadows, shrub/scrub, and forested wetlands. The boundaries of the Wisconsin Wetland Inventory are not always extremely precise, so staff should use WWI (WETCODE and Class) and examination of DOPs as a guide when making delineations. Landward boundaries (particularly when the CHD captures wetlands) can be further examined and adjusted at the desktop after the field visit. Staff should never delineate and capture upland habitats within a SAD.

Other PRF's--Jurisdiction of Ch. 30 Wisconsin Stats., and its related administrative rules reference the OHWM. For the other-PRF subtype, the OHWM is the landward boundary. When drafting boundaries for **other PRF's** apply the hydrolayer and the DOP's and ignore any Wetland Layers as the delineation is unrelated to aquatic plants. Here the open-water edge during normal-high water levels is a reasonable approximation of the OHWM (because these shorelines typically contain steeper slopes) and should be used. Staff should never delineate and capture upland habitats within a other PRF.

Resource Protection Areas—Resource Protection Areas are upland areas above the ordinary high water mark within the shoreland zone offering unique values to wildlife habitat, natural scenic beauty, and water quality. Resource Protection Areas are not directly used by Department staff when making regulatory decisions, but serve as management guidance for local units of government and non-profit conservation organizations when developing local ordinances or considering acquisition of easements or fee title.

Chapter 5 - Sampling Protocols

Common Sampling Protocols for all CHD's

Table 1 is a summary of the Justification codes field staff record during the delineation process and their related sampling protocols. Justification features for Extensive riparian wetland, water quality, natural scenic beauty and extensive public use require no sampling beyond the common protocols. Staff shall use Appendix 15 **(Appendix_15_Critical_Habitat_Data_Sheet.xls)** to record data for common sampling protocols. Additional wood habitat, substrate, and aquatic plant sampling protocols are described in subsequent sections of Chapter 5.

Table 1.

Entry Code	***Justification Feature***	***Additional Sampling Protocols***
1	Bio-diverse SAV	Aquatic Plant
2	SAV Important to Fish and Wildlife Habitat	Aquatic Plant
3	Emergent and Floating Leaf Vegetation	Aquatic Plant
4	Rush *(Scirpus spp.)* beds	Aquatic Plant + Bed Footprint Polygon
5	Wild Rice Bed	Aquatic Plant
6	Extensive Riparian Wetland	
7	Woody Habitat	Woody Habitat
8	Spawning Substrate	Substrate
9	Water Quality (springs, etc)	
10	Natural Scenic Beauty	
11	Extensive Public Use	

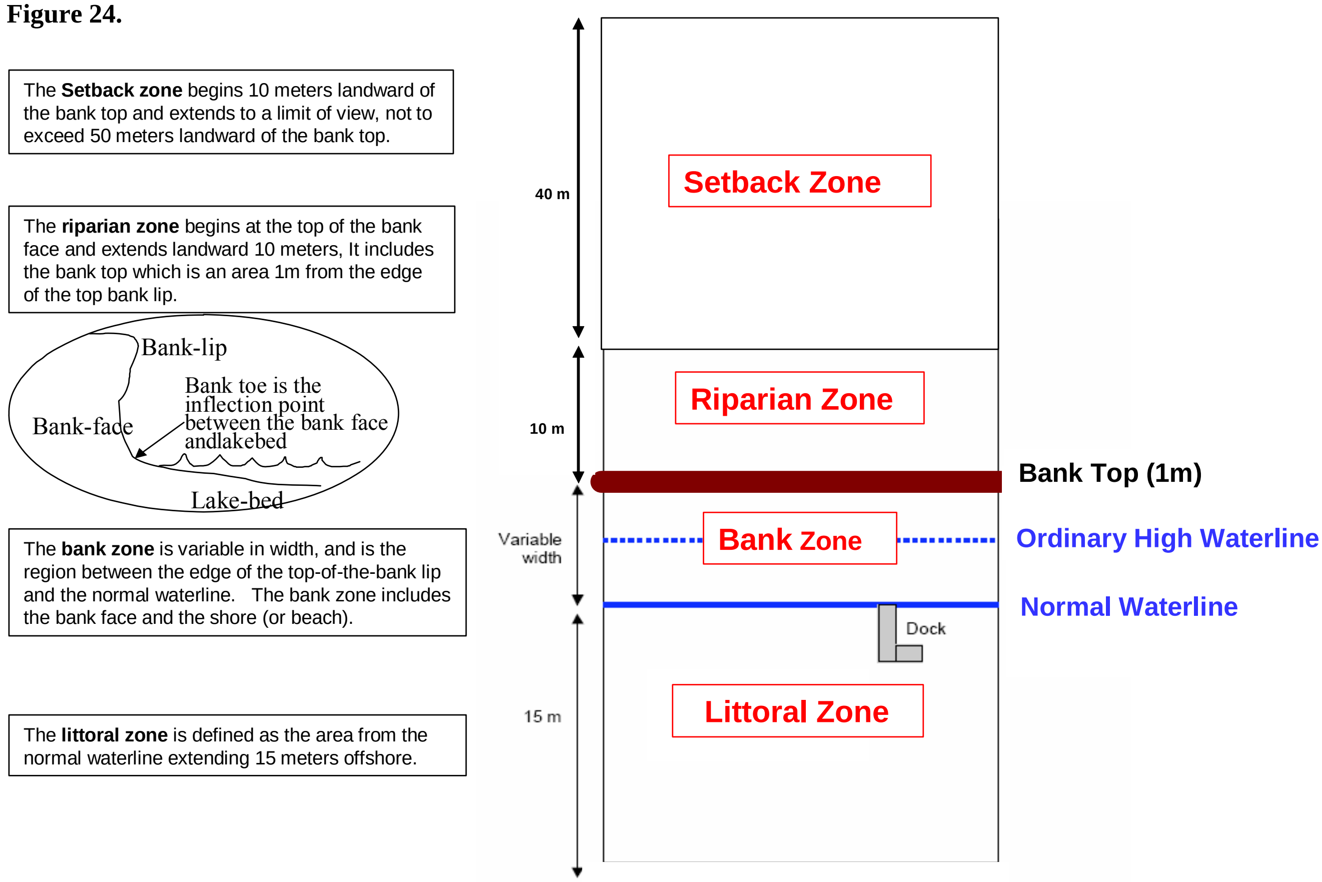
Setback Zone Inventory

Using the multiple tally counter, **count** the following occurrences within the setback zone (Figure 24). Standard counter buttons should be set-up for items 1 and 2.

1) **Homes** (note: if any portion of the home is within the riparian zone, tally it within the riparian buffer zone and do not tally the same home in the setback zone (no double counts)).
2) **Accessory Structures** (enumerate any of the following as accessory structures; stairways, gazebos, unattached decks, unattached garages, storage sheds, dry boathouse)
3) **Commercial Buildings**

Multiple Tally Counter

Figure 24.



Riparian Zone Inventory

Using the multiple tally counter, **count** the following occurrences within the riparian zone. Standard counter buttons should be set-up for items 1 and 2.

1) **Homes** (note: if any portion of the home is within the riparian buffer zone, tally it within the riparian buffer zone and do not tally the same home in the setback zone (no double counts).
2) **Accessory Structures** (enumerate any of the following as accessory structures; stairways, gazebos, unattached decks, unattached garages, storage sheds, dry boathouse)
3) **Commercial Buildings**

Using the multiple tally counter, **measure (estimate**) the total length of shoreline comprised of the following landcover disturbances in the riparian zone. Increments are tallied in 10-meter intervals. While in the field, occasionally calibrate your estimates using the GPS distance measure tool. Standard counter buttons should be set-up for items 1, 2, and 3. Items 4-9 will be used infrequently (no standard counter button).

1) **Shrub Layer** (0.5m-5m; Woody Shrubs, saplings, tall herbs and grasses) mostly absent.
2) **Both Shrub Layer and Ground Cover** (<.5m; woody shrubs, seedlings, herbs, grasses, bryophytes) **mostly absent**
3) **Established Lawn** (Shrub Layer and Ground Cover Absent)
4) **Beaches**
5) **Roads, railways, & parking lots**
6) **Row Crop**
7) **Pastureland**
8) **Other**

9) **Not Visible**
10) **Natural understory vegetation**: here do not estimate this value, measure the total shoreline length using freehand measure on your Geo-XM and then calculate the undisturbed portion as the remainder. **Undisturbed natural landcover = total freehand length measured on the Trimble - (sum of items 1-9)**

For each CHD estimate the % of the shoreline length for each of the following vegetation cover categories within the riparian zone.

1) **Boreal Forest** (White Spruce, Balsam Fir, Tamarack, White Cedar, White Birch, Aspen)
2) **Coniferous Forest** (White Pine, Red Pine)
3) **Mixed Coniferous-Deciduous Forest** (Hemlock, White Pine, Red Pine, White Birch, Yellow Birch, Sugar Maple, Beech, Aspen)
4) **Deciduous Forest** (Beech, Sugar Maple, Basswood, Red Oak, White Oak, Black Oak)
5) B**arrens** (Jack Pine, Scrub (Hill's) Oak Forest and Barrens)
6) **Oak Savanna** (White Oak, Black Oak, Bur Oak with approx. 20% closed canopy)
7) **Prairie**
8) **Forested Wetland-Swamp Conifers** (White Cedar, Black Spruce, Tamarack, Hemlock)
9) **Lowland Hardwoods** (Willow, Silver Maple, Box Elder, Ash, Elm Cottonwood, River Birch)
10) **Emergent/Wet Meadow**
11) **Wetland Scrub/Shrub**
12) **Bog**

Bank Zone Inventory

Using the multiple tally counter, **measure (estimate**) the total length of bank comprised of the following disturbances in the bank zone (Figure 24). Increments are tallied in 10-meter intervals. While in the field, occasionally calibrate your estimates using the GPS distance measure tool. Standard counter buttons should be set-up for items 1 and 2. Items 3-5 will be used infrequently (no standard counter button).

1) Seawall "Seawall" means an upright structure that is steeper than 1.5 feet vertical to one foot horizontal and that is installed parallel to the shore to prevent the sliding or slumping of the land and to protect the adjacent upland from wave action. **Note:** Seawalls are commonly constructed of timber, rock (including gabions), concrete, steel or aluminum sheet piling, and may incorporate biological components
2) Riprap "Riprap" means a layer or layers of rock, including filter material, placed on the bed and bank of a navigable waterway to prevent erosion, scour or sloughing of the existing bank. Revegetation is typically not associated with riprap.
3) Hard bioengineering means a structure that combines 2 separate treatments: structural treatment with inert materials such as rock for toe protection at the base of the bank and biological materials on the upper portion of the bank.
4) Soft bioengineering- Soft bioengineering " means a erosion control structure that relies solely on biological materials. Biological materials are living or organic materials that are biodegradable such as native grasses, sedges, forbs, shrubs and trees; live stakes and posts; non−treated wood; jute netting; biologs, fiber rolls and mats; logs; and branches.
5) Artificial Beach
6) Pea Gravel Blanket
7) Natural Bank : here do not estimate this value, measure the total bank length using freehand measure on your Geo-XM **(note:** this measure is the same as the riparian zone total length measure) and then calculate as the remainder.
Natural Bank = total freehand length measured on the Trimble - (sum of items 1-6)

Using the multiple tally counter, **count** the following occurrences within the bank zone. Standard counter buttons should be set-up for item 1.

1) **Boat Ramps**
2) **Stormwater outflow discharges (pipe or swale)**

Littoral Zone Inventory

Using the multiple tally counter, **count** the following occurrences within the littoral zone (Figure 24). Standard counter buttons should be set-up for items 1-4.

1) **Piers**
2) **Boat Lifts**
3) **Swims Rafts/Water Trampolines**

4) **Boathouses (over the water)**
5) **Mooring Buoys (each buoy counts as one)**
6) **Dredge channels**
7) **Commercial Marinas**
8) **Bridges**
9) **Weed rollers or other mechanical plant removal device observed.**
10) **Marked Recreational/Public Beaches**

Woody Habitat –Designations where Coarse Wood Habitat is identified as an important feature. Sampling measurement protocols follow methods developed as part of the North Temperate Lake Long Term Ecological Research (NTL-LTER) web page http://www.limnology.wisc.edu. Our sampling design is random, non-overlapping, without replacement, approximately sampling 20% of the total shoreline length. Each designation for wood will have at least 4 transects. Transect lengths vary between 10-50 meters, depending on total shoreline length. Apply Table 2 to determine the length of the transects. On tributary streams and rivers if you've captured the whole channel and both shorelines in the poly you should then randomly select @ the 20% level based one one-side on the river, and then randomly select @ the 20% level from the opposite bank.

Table 2. Wood Habitat Sampling Transect Design

Shoreline Length	Wood Transect Length	Number of Transects
<200 meters	10 meters	4
201-400 meters	20 meters	4
401-600 meters	30 meters	4
601-800 meters	40 meters	4
801-1000 meters	50 meters	4
>1000 meters	50 meters	4 + 1 additional for every additional 250 meters.

First measure the total length of the Critical Habitat polygon that adjoins the shoreline in ArcView. Then randomly select starting points using 1-meter increments. For example: A measured shore of 1,250 meters, subsampled @ 20% would then have 250 meters sampled, which totals to (5) 50-meter wood transects Randomly select five starting points from a set of possible starting points from 0-1200 meters (=1,250-50; need to leave room for the last transect). Remember that transects should not overlap so you may need to discard some values that may overlap. In this example I generated a list of 6 random numbers from 0-1200, and discarded the bolded value it violated sampling without replacement: 22, **47**, 195, 665, 770, and 832. So now my start points along the shoreline begin with transect-1 @ the 22-meter point, transect-2 @ the 195-meter point, transect-3 @ the 665-meter point, transect-4 @ the 770-meter point, and transect-5 @ at the 832 meter-point. Transects always move clockwise when facing the shore from the water. Then, use the measure tool in ArcView to respectively measure out 22m, 195m, 665m, 770m, and the 832m points in a clockwise fashion from the beginning of the polygon and record each of their coordinates. Transect starting coordinates are then downloaded to the Trimble Unit.

Figure 24.

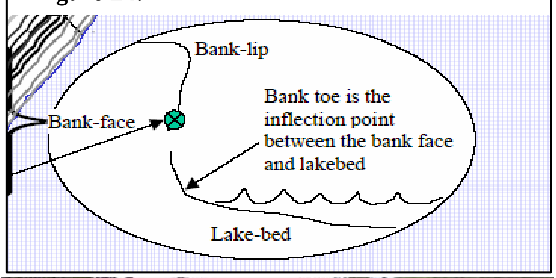


Figure 25

The 0.5 meter-depth transect running parallel to the shoreline is based on normal pool elevation (depicted in the diagram below). Normal pool is found at the bank toe, and is typified by the inflection point between the bank face and the lake bed (Figure 24). You need to examine current conditions (vertical deviation of the current level above or below normal pool level) and adjust accordingly. When water level conditions are very low, you may hardly get your have your feet wet when walking the ½ meter @ normal pool depth (Figure 25).

Woody habitat is measured by two people along a 10-50 meter transect parallel to shore along the ½ meter depth contour from the normal pool elevation at each site. The two littoral woody habitat variables are calculated: the number of logs km > 5 cm diameter; and the number of logs km > 10 cm. Appendix 16 **(Appendix_16_Wood Data Sheet.xls**) is an XLS field data sheet.

1) **Tally all logs greater than or equal to 5 cm but less than 10 cm diameter** and greater than 150 cm (~5 ft.) in length by 10-m segment (record no further measurements on these logs). Do not tally logs that are completely submerged under the substrate.

2) **For logs greater than 10 cm diameter** (at the point where they cross the transect) and longer than 150 cm, determine total length, decay class, elevation, orientation, amount of branching,10 m segment (A,B, C, D, E) where first encountered and the number of other 10cm logs that cross the subject log between 0 and 1 m depth (see illustrations below). If a log has a branch that is greater than 10 cm in diameter and longer than 150 cm AND it crosses the transect, count it as a log, measuring the length from the point of attachment to the main log to the tip of the branch.

Measure diameter of CWH encountered along the inside edge of the half-meter depth contour at the point where the log crosses the contour line (but orthogonal to the log itself). Do not measure logs that are completely submerged under the substrate.

Elevation (taken at the point of intersection with the .5m contour)
0: logs which are partially submerged or resting on the bottom
1: logs slightly elevated from the bottom (up to about a palm-width off the bottom)
2: more elevated than 1, but not floating
3: floating on the surface of the lake or elevated above the surface of the water at the .5 m transect but submerged at the waterline.

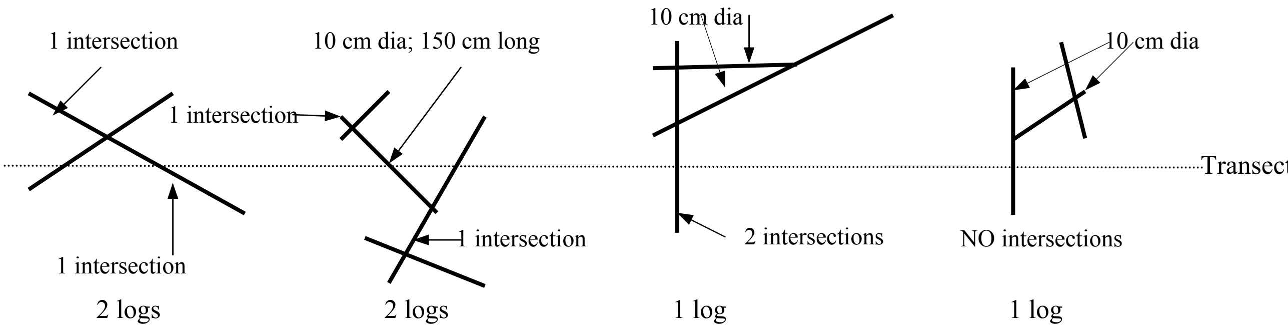
Orientation:
- oblique = oblique to shore (30- 60° and 120– 150°)
- parallel= parallel to shore (0- 30° and 150- 180°)
- perpendicular= perpendicular to shore(60-120°)

Branchiness:
0: no branches,
1: few branches
2: moderate number of branches
3: many branches (full crown)

Decay:
1: recently downed,
2: algal growth but bark still sound,

3: bark sloughing off but wood still sound,
4: wood soft,
5: wood very soft no longer structurally sound
NOTE: paper birch retains its bark long after the wood has rotted, score logs of this species by the softness of the wood, not the bark

Number of Intersections: number of other 10cm logs that cross this log between 0 and 1m depth (number).



- DIAMETER_ESTIMATED
  - 0 = No
  - 1 = Yes

- LENGTH_ESTIMATED
  - 0 = No
  - 1 = Yes

- LENGTH_RANGE_CODE
  - 1 = < 300 cm
  - 2 = 300 to 600 cm
  - 3 = > 600 cm

- SOURCE
  - B = beaver
  - N = natural
  - U = unnatural
  - UNK = unknown

Substrate- Critical Habitat Designations where substrate is identified as an important feature. Substrate refers to the material that makes up the lake or stream bed. Substrate is important because it provides cover and spawning habitat for many fishes and benthic invertebrates. Substrate composition can be determined by pebble counts, sieve method, or visually estimated as the percent of the surface area of the bed. Here we will visually estimate the percent composition of substrate on the bed.

Transects: 10 equally spaced transects, perpendicular to shore, should be sampled within the site when substrate is identified as the feature of interest. For tributary streams and rivers, transect spacing should be 3 times mean stream width. Transects run from the right bank across the channel to the left bank.

Length of Transect: This is the length of the transect from the shore to a depth of 3 ft. If water depth does not exceed 3 feet within 50 feet (15m) of shore, stop and record >50 feet. The shore is identified as the toe of the bank, regardless of water level conditions. The length should be measured with a tape measure to the nearest 1 ft. perpendicular to shore. This measure will be used to calculate bottom slope and the widths of substrate bands in the nearshore.   Stake the transect tape to the nearshore using rebar at the toe of the bank. Using the “taped” transect identify and record the starting and ending points of the **band groups** identified in **Table 3.** Do not overlook the substrate band group associated with the toe of the bank as it may be quite narrow, and possible above the wetted perimeter of the shoreline. As your proceed lakeward or channel-ward, identifying starting-ending distances for each band group, select the mid-point of each band group and estimate substrate composition and the degree of embeddedness.

Table 3. Substrate Categories and Band Group

Substrate Category	Band Group	Description	Size Range
Marl	Marl	Deposits of calcium carbonate; often whitish in color. Individual particles very fine; sticky and muddy. Does not support a person’s weight when underfoot; difficult to move through. Often found near springs and marshy areas.	
Detritus	Detritus	Partially decayed organic matter such as leave, sticks, dead macrophytes, etc. When very fine, may appear similar to silt.	
Clay	Clay	Very fine inorganic dark brown or gray particles; individual particles barely or not visible to the unaided eyes. Feels gummy and sticky in hands; slippery when underfoot. Retains shape when compacted, and partially or completely supports a person’s weight when it makes up the bottom.	<0.0004 mm
Silt	Silt	Fine inorganic particles, typically dark brown in color. Feels greasy and muddy in hands. Loose: does not retain shape when compacted into a ball. Will not support a person’s weight when it makes up the bottom.	0.004-0.062mm
Sand	Sand	Inorganic particles smaller than fine gravel but coarser than silt. The material typically found on the beach.	0.062- 2mm
Fine Gravel	Gravel	Marble sized rocks that range larger than sand and smaller than ping-pong balls.	2-16 mm
Coarse Gravel		Ping-pong ball sized rocks that are larger than ¾” and smaller than a tennis ball.	16-64mm
Rubble/Cobble	Rubble/Cobble	Rocks that a larger than a tennis ball, yet smaller than a basketball	64-256mm
Small Boulder	Boulder	Rocks that are larger than a basketball, yet smaller than a beach ball	256-512mm
Large Boulder		Rocks larger than a beach ball.	>512mm
Bedrock	Bedrock	Solid uniform rock bottom	

Figure 26 is an hypothetical example of 4 substrate bands and three transects showing substrate band mid-points. We recommend that each category of substrate be visually estimated to the nearest 5% at the mid-point using 0.3m x 0.3m quadrats. Use the following categories of substrate in **Table 3** (modified from Platts et al. 1993, and Rankin 1989). For every quadrat, percent coverage of the substrate categories should sum to 100%. If the bottom cannot be seen such as during above normal water levels or in turbid or stained water, hand and feet may be used to feel the bed.

For every appropriate quadrat record the degree of embeddedness following the coded values and parameters outlined in **Table 4.** Embeddeness is the the degree to which gravel, rubble/cobble, and boulder particles are surround by or covered with sand, silt, or clay (Bain 1999). Embeddeness is an index of sediment deposition in the interstitial spaces of rocks, and high values negatively affect spawning habitat of several fish species. Eggs deposited on rocky substrate will settle into cracks and crevices where they are protected from predation. If crevices become filled with sediment, protection is no longer afforded, and sedimentation may interfere with gas exchange (Daykin 1965). High embeddedness is generally considered detrimental to the quality of spawning shoals and the quality of stream habitat. Embeddedness values are only estimated for fine and coarse gravel or rubble/ cobble substrates: if these two substrates are absent then embeddedness cannot be estimated. Staff should use Appendix 17 **(Appendix_17_Substrate Data Sheet.xls)** to record substrate data.

Table 4. Embeddedness rate for bed materials (from Platts et al. 1983). Fine sediment includes material less than 2 mm in diameter: sand, silt, and clay.

Level of Embeddedness	**Coded Value**	**Description**
Negligible	5	Gravels, rubble/cobble, and boulder particles have <5% of the surface covered by fine sediment (sand, silt, or clay)
Low	4	Gravels, rubble/cobble, and boulder particles have 5-25% of the surface covered by fine sediment (sand, silt, or clay)
Moderate	3	Gravels, rubble/cobble, and boulder particles have 25-50% of the surface covered by fine sediment (sand, silt, or clay)
High	2	Gravels, rubble/cobble, and boulder particles have 50-75% of the surface covered by fine sediment (sand, silt, or clay)
Very High	1	Gravels, rubble/cobble, and boulder particles have >75 % of the surface covered by fine sediment (sand, silt, or clay)

Stream/River Stations

The length of a station is 35 X mean stream width (MSW). Each station should contain 12 transects. Transects are spaced 3 MSW apart. The stream station start point is the downstream location, transects are conducted working upstream. Planned Station Start points are populated in the Trimble units. Transect locations are captured in the field when possible. Station selection involves calculating MSW from the DOP's, multiplying MSW by 35 to calculate station length, calculating total stream length within the within the Critical Habitat poly, subtracting station length from the total stream length, then doing a rand selection from 0 to (total poly/stream length - station length). This rand value is the downstream startpoint of the station. Avoid bridges and dams with the station by 10 MSW upstream and downstream when possible. For small polys where 35XMSW exceeds the total poly-length begin the station at the downstream edge of the poly and proceed with transect spacing (3 MSW) until you reach the upstream poly boundary.

Aquatic Plants

Protocols for sampling emergent and submergent vegetation shall follow methods describe by Hauxwell et al. (2004) and found in Appendix 18 **; (Appendix_18_Plant_Sampling_Protocol.pdf)** with modifications described below. Aquatic Plant sampling field sheets are found in Appendix 19 **(Appendix_19_Aquatic_Plant_field_sheets.xls).** Appendix 20 (**Appendix_20_Calculate FQI.xls)** is an excel tool for calculating the Floristic Quality Index (FQI). The point intercept vegetation survey method estimates plant frequency by determining the proportion of survey points that "hit" or intercept vegetation. Frequencies of individual species can also be estimated by recording the plant species when intercepted by a point. The Grid Point Intercept vegetation survey methodology follows that of Madsen (1999), and the technique has been extensively used in Minnesota (Donna Perleberg, personal communication), the Minnesota DNR Wildlife Shallow Lakes Program, and it has been adopted by the Wisconsin DNR as their standard lake vegetation survey method (Hauxwell et al. 2004). In comparisons of several boat-based aquatic vegetation survey methods, the Grid Point Intercept Method was found to provide the most rapid, repeatable, GIS-based method to assess lake wide plant species abundance and associated depth data (Perleberg 2001a,Perleberg 2001b). Other boat-based methods (Jesson and Lound 1962, Yin et al. 2000) provide more site-specific detail, but require the boat to be anchored at each sample site, thus reducing the total number of sites that can be sampled per hour. The Grid Point Intercept Method used here records frequency of occurrence presence/absence) as the measure to estimate plant abundance and individual species abundance. While other options for estimating abundance are used elsewhere with this method, such as cover, density or biomass, the advantages of just collecting frequency data include ease and rapidity of data collection, consistency in data collection between different surveyors, ability to monitor a variety of plant growth forms, opportunity to monitor at flexible times throughout the growing season, and uncomplicated data analysis (Elzinga et al. 2001, Nichols 1984). In addition, frequency data are recommended as an appropriate abundance estimate when studying long-term changes in communities (Nichols 1997).

One concern with the Grid Survey methodology is that it may under sample near-shore, shallow sites where the habitat is often quite different. To compensate for this shortcoming, the sampling protocols have been modified in the following ways: 1) Point intercept locations are not clipped from the hydrolayer, but are clipped from the open water surface (defined from a recent digital orthophoto). This method will capture more points along the nearshore edge. Spacing of points shall follow the guidelines identified in Table 5; and 2) Staff will establish and locate additional inshore points while a field. These additional "field-established" points may add approximately 15-20% more points than those initially populated into the Trimble GPS units. Here staff will systematically follow the row/grid landward to a nearshore point defined by the limits of navigation (poling with a duckbill push-pole). Here staff will establish a new additional plant way-point, and proceed with sampling. This approach differs from methods outlined by Hauxwell et al. (2004,) and eliminates the need to conduct a general boat survey review of the nearshore vegetation, and ensures all plant survey samples be geo-located. Plant communities for each sensitive area will include metrics from Hauxwell et al. (2004) and the Floristic Quality Index (FQI) as described by Nichols (1998).

Table 5.

Critical Habitat Area (open water acres)	Points per Acre	Distance between sample points (m)
<5	10	20
>=5 - <10	8	22.5
>=10 - <15	6	26
>=15 - <30	5	28.5
>=30 - <50	4.5	30
>=50 - <100	3.5	34
>=100 - <200	2.5	40
>=200 - <300	2	45
>=300	1	63.6

GPS Delineation of *Scirpus spp*. Beds

Field mapping will focus on extensive bulrush (*Scirpus spp.*) beds, which are difficult to see on aerial photos. Extensive bulrush habitat will be mapped and digitized using GPS. There are a variety of issues, however, that complicate this method, including: defining mixed vegetation beds, assigning species and stand densities when they are variable, delineating back bays filled with dense vegetation that makes motoring and mapping difficult, the need for GIS editing of the field data, and the amount of time and resources it takes to complete this type of survey, especially on a large lake.

Table 6.

INDIVIDUAL SPECIES STATS:

Frequency of occurrence within vegetated areas (%)
Frequency of occurrence at sites shallower than maximum depth of plants
Relative Frequency (%)
Relative Frequency (squared)
Number of sites where species found
Average Rake Fullness

SUMMARY STATS:

Total number of points sampled
Total number of site with vegetation
Total number of sites shallower than maximum depth of plants
Frequency of occurrence at sites shallower than maximum depth of plants
Simpson Diversity Index
Floristic Quality Index (FQI)
Maximum depth of plants (ft)
Number of sites sampled using rake on Rope (R)
Number of sites sampled using rake on Pole (P)
Average number of all species per site (shallower than max depth)
Average number of all species per site (veg. sites only)
Average number of native species per site (shallower than max depth)
Average number of native species per site (veg. sites only)
Species Richness

The following plant sampling narrative is supplemental information taken from Minnesota's Sensitive Lakeshore Area Identification Manual (Perleburg et al. 2007):
Once sampling has begun, surveyors may determine that little or no vegetation occurs beyond a certain depth, and skip survey points that occur beyond that depth.

All else being equal, estimates of frequency are dependant on sample plot size and total number of samples. The larger the plot is, the more likely that a species will occur within the plot. For lake-wide vegetation surveys conducted from a boat, plot size is, however, limited to the area a surveyor can sample from the boat surface. At depths where sampling can only be conducted by rake tosses, the effective plot size is approximately one meter square. Because plot size is restricted, frequency estimates obtained from boat-based Grid Point Intercept surveys are solely dependant on sample number. Newman (1998) and Middleton (1998) discuss how to calculate the required number of sample points based on the desired sampling error and confidence intervals and the estimated actual frequency of the species. The most common species should be used for calculating the adequacy of the sample because rare species are seldom sampled adequately because of their sparse distribution (Nichols 1984, Elzinga et al. 2001). Nichols (1984) also states that establishing an acceptable error requires good judgment and by slightly lowering the acceptable error or confidence limit, the required number of samples may be greatly reduced. Newman (1998) notes that minimum required sample sizes are independent of lake size because they are based on the relative lake-wide frequency of the common species. For example, if a plant occurs in 80 percent of a 1000 acres lake and in 80 percent of a 100 acre lake, the same number of samples would be required to estimate the frequency with a given confidence limit and error. However, a surveyor may desire more sample points in the larger lake to better estimate distribution of various plant species. The size of the littoral zone and the shape of the lake will determine the number of points and the grid resolution. Within the littoral zone, a minimum of 150 to 250 points will be sampled, to ensure that commonly occurring species are adequately sampled. For mapping purposes, on most lakes, sample points will be placed a maximum distance of 328 feet (100 meters) apart. Where feasible, sample points will be placed 213 feet (65 meters) apart, which will result inapproximately one sample point per littoral acre. The minimum distance between survey points is determined by the accuracy of the GPS; with current GPS technology, a minimum distance of 30 meters is recommended to avoid overlap of sampling locations. A two person crew can generally survey between 100 and 300 points per day (less points with increases in plant densityor species richness).
Sampling is conducted primarily from a boat and GPS units are used to navigate to each sample point. The survey points are not intended to be permanent sampling locations and are not marked with permanent markers. Rather, the goal is to objectively navigate to the approximate location of each sample point. Given the inherent inaccuracy of field-model GPS units, and the shifting movement of the boat due to wave action, surveyors are not always able to stop precisely on the survey point location. Surveyors are directed to navigate to within five meters of survey point coordinates shown on the GPS unit. The boat operator maintains the position of the boat without anchoring and sampling is conducted from a pre-designated side of the boat.

Chapter 6. Data Entry (*SWIMS Under Development***)**

Chapter 7. Public Notice, Meetings, and Hearings

Wisconsin Adm. Code NR 1.06 sets public notice and hearing standards for Critical Habitat Designation Projects.

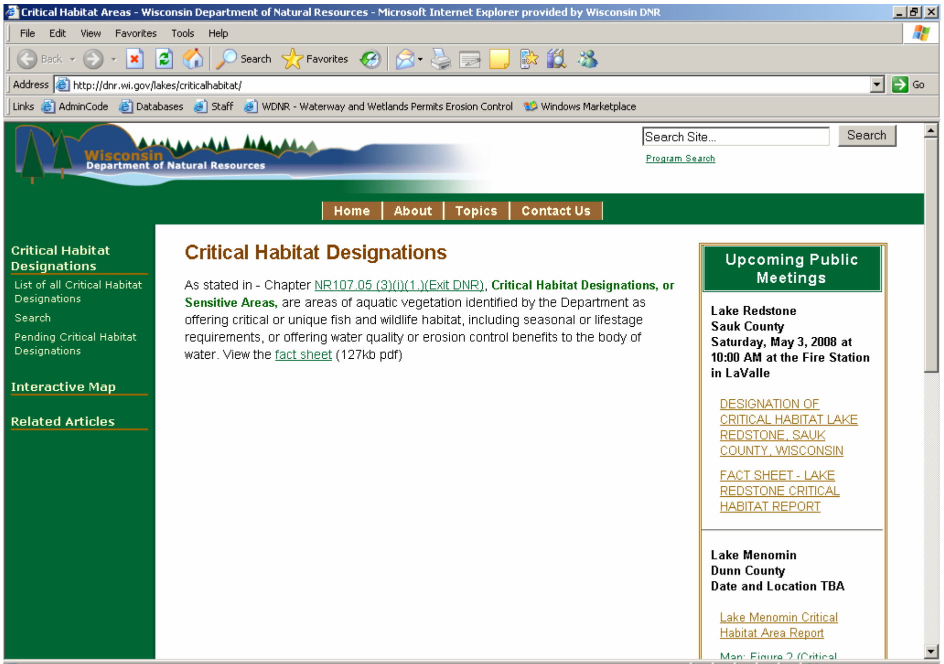
NR 1.06
(6) BASIS OF DEPARTMENT DETERMINATION. The department shall base its identification of public rights features on factual information obtained from reputable sources, including:
(a) Field surveys and inspections, including historical surveys for fish, wildlife, rare species, aquatic plants, geologic features or water quality.
(b) Surveys or plans from federal, state or local agencies.
(c) Factual documentation of features or use patterns from property owners, user groups or knowledgeable users on the waterbody.

7) PROCEDURE FOR IDENTIFYING PUBLIC RIGHTS FEATURES.
(a) After survey data shows possible locations of public rights features, the department shall give notice in the official state newspaper or other local media the department selects in the area affected which is likely to inform the local residents. The department shall provide notice on its website and through its system of electronic notices to state media. (b) The department shall notify the county clerk of any county bordering the lake or reach of a stream, legislators whose districts include the affected public waters and the chairpersons of the committees of the legislature with jurisdiction for natural resources issues, and local, regional or state lake, river or watershed organizations affected by the activity. (c) The notice shall contain the location and description of the possible public rights features and the basis for its determination that the location is likely to contain public rights features. If a hearing is not requested in writing within 30 days after the mailing of the notice, the department may waive the hearing. Upon receipt of a request for a hearing, the department shall, not less than 10 days before the hearing, mail written notice thereof to each person notified under par. (b), and shall provide

Public Notice of Informational Meetings or Public Hearings

Draft designation reports, maps, or summaries should be placed on the Department's website for public access. Send draft reports, maps, etc. to Jennifer Filbert who will upload them to the Critical Habitat Designation Webpage.

For submission of notice for informational meetings or public hearings follow the content format within the DNR Meetings/Hearings Webpage (Where When, etc) and send your draft notice in the body of an email to the following email address: **DNR CAL Hearing Meeting Calendar**. Publications Editor, Paul Holtan (Paul.Holtan@wisconsin.gov ; 608-267-7517) receives these emails and is responsible for uploading your notice and managing this website.



The department shall notify the county clerk of any county bordering the lake or reach of a stream, legislators whose districts include the affected public waters and the chairpersons of the committees of the legislature with jurisdiction for natural resources issues, and local, regional or state lake, river or watershed organizations affected by the activity. A cover letter template is in Appendix 21 (Appendix_21_Cover Letter_Critical_Habitat.doc) , Critical Habitat Designation notice in Appendix 22 (Appendix_22_Notice_Critical_Habitat.doc) and a Public Hearing notice in Appendix 23 (Appendix_23_Notice_Public_Hearing.doc).

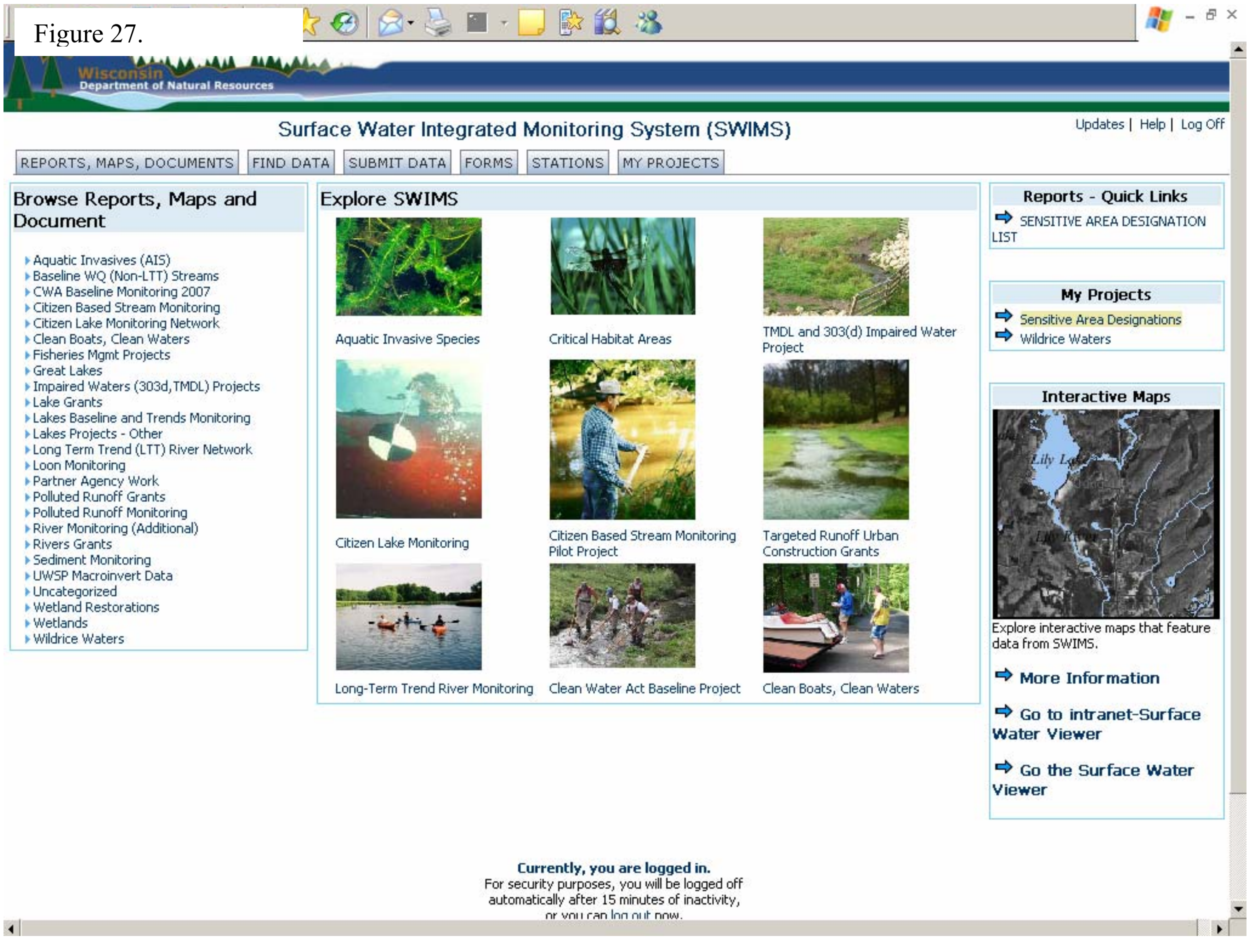
An informational meeting should be scheduled more than 30 days after the date of the public notice. Then, if a formal hearing request is received, the hearing can be held the same day at the conclusion of the informational meeting. **If staff receive a hearing request that qualifies, staff should then update the notice to DNR Calendar email for the hearing as well as an informational meeting.**

An informational meeting can be held like an open house, with displays and maps set up at various tables. Resource staff (e.g. lakes, fisheries, WMS, wildlife, endangered rescources) would be available to answer questions. Staff are encouraged to "batch" several lakes into an informational meeting when appropriate (multiple designations in one county). If a formal hearing was received, staff would simply close the informational meeting, and then a hearing examiner would provide hearing appearance slips, set the ground rules, provide introductory remarks, and open the record for testimony/comments. Because the critical habitat designation is in waters held in trust by the state for all citizens and may be adjacent to private lands, state law provides an opportunity for public input to the Department's decision. The hearing will be a public informational hearing where individuals can learn more about the proposed designation and provide factual information about the waterway, the areas proposed for designations, or other designations in light of the standards below. The Department is currently evaluating the proposal and must consider factual information about the following legal standards in deciding whether to designate the proposed locations. Appendix 24 **(Appendix_24_Public Hearing Script.doc**) is a template script for hearing examiners

Chapter 8. Reports

Final reports are maintained on the Department's Surface Water Integrated Monitoring System (SWIMS) (Figure 27).

Figure 27.



Appendix 25 (**Appendix_25_How to Upload a Critical Habitat Report.doc**) provides detailed instructions on how to upload a **final** Critical Habitat Report to the SWIMS database.

Glossary

Critical Habitat Designation is a program that includes formal designations of sensitive areas according to Ch. NR 107, public rights features according to Ch. NR 1.06, and resource protection areas (areas within the shoreland zone). All of these elements combine to provide regulatory and management advise to the State of Wisconsin, counties, local units of governments, and others who hold authorities or are interested in protecting and preserving these unique habitats for future generations.

"**Flood plain**" means the land which has been or may be hereafter covered by flood water during the regional flood. The flood plain includes the floodway and the flood fringe as those terms are defined in ch. NR 116.

"**Lakeshore**" means the area comprised of the shoreland, shoreline and the near-shore.

"Littoral Zone"

"Management Recommendations" are

"Navigable waterway" means any body of water with a defined bed and bank, which is navigable under the laws of the state. In Wisconsin, a navigable body of water is capable of floating the lightest boat or skiff used for recreation or any other purpose on a regularly recurring basis.

"Nearshore" means the shallow aquatic areas of the lake within 200 meters of the shoreline**.**

"Ordinary high water mark" means the point on the bank or shore up to which the presence and action of water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial vegetation or other easily recognizable characteristic.

"Public Rights Features" as defined in Wisconsin Adm. Code NR 1.06 are:

(a) Fish and wildlife habitat, including specific sites necessary for breeding, nesting, nursery and feeding.

Note: Physical features constituting fish and wildlife habitat include stands of aquatic plants; riffles and pools in streams; undercut banks with overhanging vegetationor that are vegetated above; areas of lake or streambed where fish nests are visible; large woody cover.

(b) Physical features of lakes and streams that ensure protection of water quality.

Note: Physical features that protect water quality include stands of aquatic plants (that protect against erosion and so minimize sedimentation), natural streambed features such as riffles or boulders (that cause turbulent stream flow and so provide aeration).

(c) Reaches of bank, shore or bed that are predominantly natural in appearance (not man−made or artificial) or that screen man−made or artificial features.

Note: Reaches include those with stands of vegetation that include intermixed trees, shrubs and grasses; stands of mature pines or other conifer species; bog fringe; bluffs rising from the water's edge; beds of emergent plants such as wild rice, wild celery, reeds, arrowhead.

(d) Navigation thoroughfares or areas traditionally used for navigation during recreational boating, angling, hunting or enjoyment of natural scenic beauty.

Note: Physical features indicative of navigation thoroughfares include shallow water areas typically used by wading anglers or areas frequently occupied by regularly repeated public uses such as water shows.

“Regulations” means provisions of state statute and administrative code that are relevant to public rights features and sensitive areas.

“Resource Protection Areas” are areas above the ordinary high water mark within the shoreland zone offering unique values to wildlife habitat, natural scenic beauty, and water quality.

“Sensitive areas” are areas of aquatic vegetation identified by the department as offering critical or unique fish and wildlife habitat, including seasonal or lifestage requirements, or offering water quality or erosion control benefits to the body of water.

“Shoreland” means lands within the following distances from the ordinary high-water mark of navigable waters: 1,000 feet from a lake, pond or flowage; and 300 feet from a river or stream or to the landward side of the flood plain, whichever distance is greater.

“Shoreline” means the edge of a body of water and, alternatively, used here with regard to fish and wildlife habitat to refer to a narrow band around the lake centered on the land-water interface.

“Wetland” means an area where water is at, near or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation and which has soils indicative of wet conditions.

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List of Appendices

Name	Description	File Name
Appendix 1	Appendix 1 is a 5-page synopsis of all Department activity based Administrative Rules that provide increased protections within or adjacent to a sensitive area or public rights feature .	Appendix_1_Summaryof CHD_activity_rules.doc
Appendix 2	Appendix 2 is a statewide summary of 1460 lakes by region that uses statewide available data to classify the quality of the resource and the amount of knowledge for each lake in the database. This spreadsheet also describes the methods used for ranking lakes by knowledge and the quality of the resource (pearl status).	Appendix_2_Lakes_Selection_spreadsheet.xls
Appendix 3	Appendix 3 is Wisconsin's Natural Heritage Working List, which contains species known or suspected to be rare in the state and natural communities native to Wisconsin. It includes species legally designated as "Endangered" or "Threatened" as well as species in the advisory "Special Concern" category.	Appendix_3_NHI_Working_List_2006.pdf
Appendix 4	Appendix 4 is The Wisconsin Wetland Inventory Classification Guide (PUBL-WZ-WZ023). This 3-page guide contains detailed descriptions and abbreviations of the covertype classes for Wisconsin Wetland Classifications.	Appendix_4_WWI_Classification.pdf
Appendix 5	Appendix 5 is a one page map showing Wisconsin's 72 counties and provides the current status for Orthorectified Digital and digital wetland data currently available.	Appendix_5_Digital_Wetland_Status_Map.pdf
Appendix 6	Appendix 6 is a six-page document describing the creation of a personal geodatabase and associated domains in ArcCatalog	Appendix_6_Creating_New_Geodatabase.doc
Appendix 7	Appendix 7 is a eight-page document addressing how to load data on to the Trimble unit	Appendix_7_Data_Prep_Trimble.doc
Appendix 8	Appendix 8 is a one-page WIDNR document addressing boat safety, equipment training and operation.	Appendix_8_MC918250.pdf
Appendix 9	Appendix 9 is a one-page WIDNR document addressing Boat, Equipment and Gear Disinfection Protocol.	Appendix_9_Boat and Gear Disinfection mc.doc
Appendix 10	Appendix 10 is a three-page ESRI document explaining the buttons, menus, functions and commands used in the soft ware ArcPad on the Trimble unit	Appendix_10_ArcPad_QuickReference.pdf
Appendix 11	Appendix 11 is a Trimble manual that explains the GPScorrect extension to ArcPad and how to configure settings for it.	Appendix_11_GPScorrect_Quick_Reference_Guide.pdf
Appendix 12	Appendix 12 is the Trimble owner's manual for the Geo-XM unit explaining usage and maintenance.	Appendix_12_GeoExplorer_2005_Getting_Started_Guide.pdf
Appendix 13	Appendix 13 is the ESRI users guide for ArcPad.	Appendix_13_ArcPad_UserGuide.pdf
Appendix 14	Appendix 14 is the ESRI expanded users guide for ArcPad.	Appendix_14_ArcPad_Referenc e_Guide
Appendix 15	Appendix 15 is an Excel field sheet for Common Sampling Protocols.	Appendix_15_Critical_Habitat_Data_Sheet.xls
Appendix 16	Appendix 16 is the Excel field sheet for Woody Habitat Sampling work.	Appendix_16_Wood Data Sheet.xls
Appendix 17	Appendix 17 is the Excel field sheet for Substrate Sampling work.	Appendix_17_Substrate Data Sheet.xls
Appendix 18	Appendix 18 provides protocols for sampling emergent and submergent vegetation.	Appendix_18_Plant_Sampling_Protocol.pdf
Appendix 19	Appendix 19 is the Excel field sheet for Aquatic Plant Survey work.	Appendix_19_Aquatic_Plant_field_sheets.xls
Appendix 20	Appendix 20 is an Excel tool for calculating the Floristic Quality Index (FQI)	Appendix_20_Calculate FQI.xls
Appendix 21	Appendix 21 is a cover letter of CHD notification to organizations, local units of government, and legislators.	Appendix_21_Cover Letter_Critical_Habitat.doc
Appendix 22	Appendix 22 is template for a CHD notification	Appendix_22_Notice_Critical_Habitat.doc
Appendix 23	Appendix 23 is a template for Notice of Public Hearing for Proposed Critical Habitat Designation	Appendix_23_Notice_Public_Hearing.doc
Appendix 24	Appendix 24 is a narrative script template for CHD Hearing Examiners.	Appendix_24_Public Hearing Script.doc
Appendix 25	Appendix 25 is an instructional guide for uploading CHD reports to SWIMS.	Appendix_25_ How to Upload a Critical Habitat Report.doc