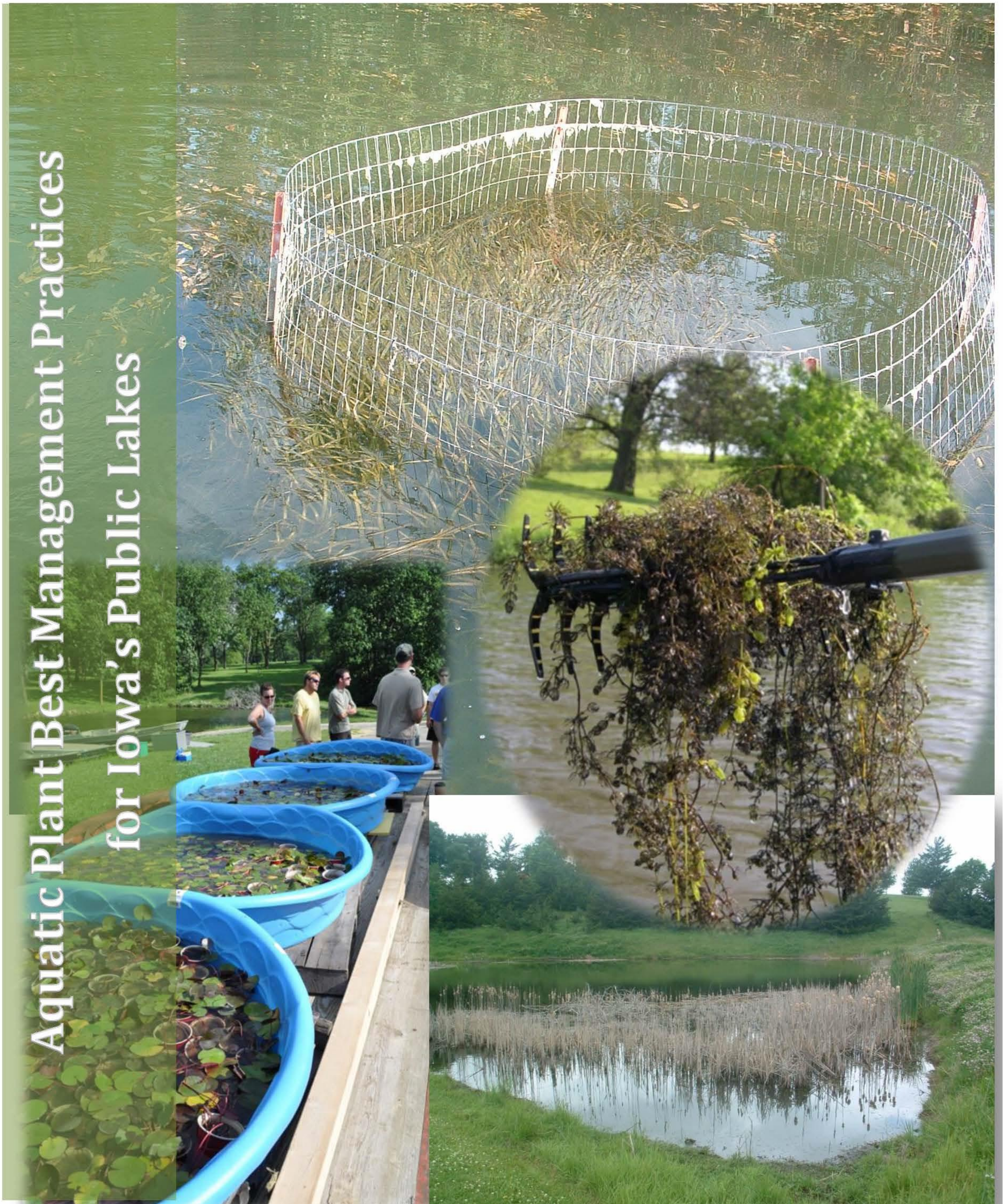
Aquatic Plant Best Management Practices for Iowa's Public Lakes



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Introduction

This best management practices manual was written to serve the information needs of professional fishery management biologists regarding aquatic vegetation as they manage public lakes for both fishery and other recreational uses. Fishery managers with the Iowa Department of Natural Resources (DNR) were asked what information would be most helpful to have on hand as they collect information and encounter challenges to control aquatic plants in Iowa lakes; this manual is the result. As new information needs are encountered, this manual will expand to include that information.

The Iowa DNR has changed how lakes are managed during the last two decades. Previous management efforts focused on the lake and the fish in it. Today's approach is more broadly focused, taking into consideration the watershed, water quality, invasive/undesirable species and habitat constraints that impact the quality of the fishery. A comprehensive lake water quality monitoring program began in 2000 (Downing et al. 2005) and led to prioritizing 127 of Iowa's significant public lakes for restoration. This systems-based restoration approach involving citizen stakeholders has led to lakes being removed from the impaired waters list. The resulting clearer water in these lakes contains lower concentrations of dissolved plant nutrients, but can actually be better suited to grow rooted aquatic plants. The rooted aquatic plants in these and other lakes are desirable fish habitat and they also compete for nutrients and light, reducing problematic algae blooms. In some cases however, especially lakes with a lot of shallow water, rooted aquatic vegetation can become too dense and interfere with recreational activities. Where there is clear water, nutrients, and suitable substrate, plants will grow.

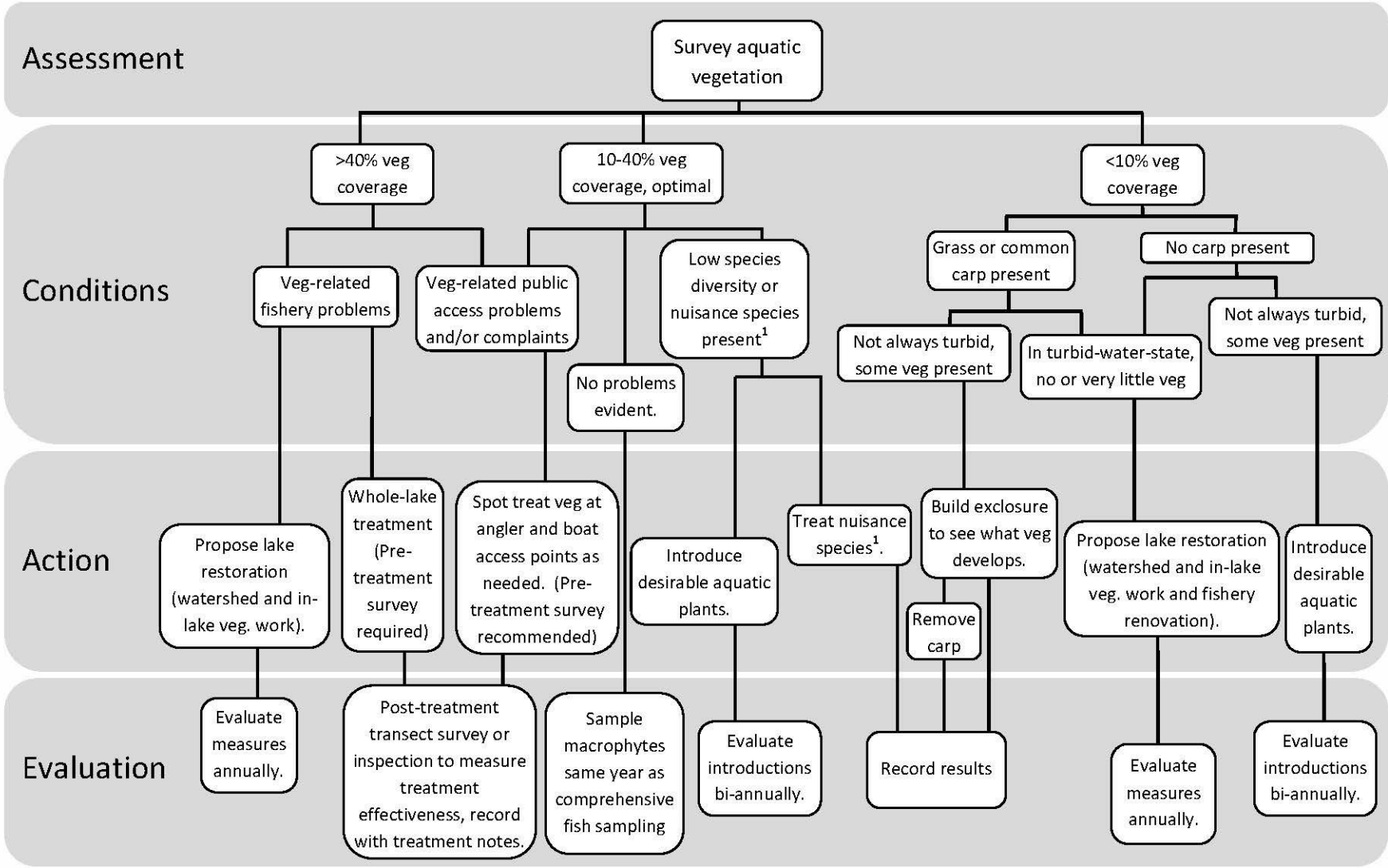
In Iowa aquatic plant abundance can experience extreme annual changes. For example: Cool spring temperatures in the spring can delay submersed plant growth long enough to allow an algae bloom which further reduces submersed plant abundance. Years with little precipitation can enhance plant growth due to clearer water. Extreme precipitation events can also result in poor water quality due to turbidity shading out submersed plants. A drawdown of the lake's water level implemented in the spring or early summer can allow growth of moist-soil plants through the summer and fall. Flooding of this type of vegetation can result in much clearer water the following spring and increased growth of submersed species. A short-term drawdown persisting through the winter months where moist soil vegetation has not developed can result in greatly reduced macrophyte abundance the following spring due to freezing roots of submersed plants; This in turn could lead to a spring algal bloom further hampering macrophyte development. Due to the unpredictable changes in weather and other influences each year, aquatic plant management can be complicated and is also dependent on early diagnosis and flexibility.

Optimal growth and survival of fish occurs when vegetation covers 10-40% of a lakes surface area (Dibble et al. 1996). Though it then seems logical to expect negative impacts to a fishery at levels above or below this range, negative impacts have only been documented at the extremes in Iowa. Under conditions of virtually no vegetation coverage, low biomass and poor size distribution of bluegill and crappie has been documented (Cashatt and Bruce 2008) as well as summer kill when algal blooms were present in a shallow lake (Silver Lake, Delaware Co., D. Kirby pers comm. 2007). Under conditions of abundant plant coverage, over-recruitment and slow growth of bluegill have been observed, most likely due to inability of bass to be effective predators in dense vegetation. Winter-kill in shallow lakes with excessive macrophyte coverage has also occurred in Iowa.

There are no tried-and-true management strategies that will fix aquatic vegetation problems in constructed or natural lakes in Iowa. In fact, the lake environment is controlled by so many different variables (e.g., watershed, depth, residence time, basin slope, weather variables, plant and fish species present) that lake managers need to be flexible in their use of any strategies to accomplish plant management goals.

Management strategies are presented for three scenarios in a flow chart based on submersed vegetation abundance and appropriate options for each case (Figure 1). A manager's choice of the option to pursue would be determined by his/her goals. Though not stated in the flow chart, "no action" is always an option that is based on management goals, priority level, as well as budget or time limitations, and project feasibility. Some of the strategies discussed below are, at best, a brief overview of methods described by other authors (Holdren et al. 2001, Wagner 2004, Netherland 2009). Other options exist, and these may be added or options expanded upon in this manual as need and experiences arise. Although these management strategies can be used in natural lakes, determining the best practices requires more public

involvement due to the number of stakeholders involved and awareness of existing regulations in these systems. (see Plant Management in Natural Lakes in the Special Considerations section page 27). Several sources were major references for these descriptions, and can be referred to if more information is needed.



[1] If invasive species are found, consult with aquatic invasive species (AIS) personnel.

Figure 1. Flow chart to guide lake management decisions based on aquatic vegetation status.

Plant Identification

Aquatic plant identification is the most important part of sampling and management. It is therefore important that managers set aside preparation and training time each year before entering the field. The list of plant species commonly found in Iowa waters (Appendix 1) should be reviewed. Sampling crews should review the slide presentation available on the DNR website, or one of the websites listed in Appendix 2. This will help staff to become familiar with the aquatic plant species and their distinguishing characteristics in the lakes to be surveyed (obtain a copy of the Aquatic Invasive Species (AIS) database and query lakes to be surveyed). Every fisheries office should have the following guides available to bring into the field:

- Through the Looking Glass…A Field Guide to Aquatic Plants. Wisconsin Lakes Partnership publication (Borman et al 2001).
- An Aquatic Plant Identification Manual for Washington's Freshwater Plants (Hamel and Parsons, 2001).

Two other helpful field manuals include Runkel and Roosa. 1999, and Eggers and Reed 1997.

Sampling crews should be prepared to collect plant subsamples from each sampled lake to serve as voucher specimens. Vouchers are required to create a permanent record of species at any water body (Appendix 3). Further assistance with plant identification is available by: 1) Sending photos or samples to Cold Springs research staff; 2) Visiting websites that have excellent identification aids as well as photos (Appendix 2); 3) Purchasing a good key and using it after returning from the field to distinguish between similar-looking species (Crow and Hellquist 2000, Fassett 1956); 4) Arranging for assistance in the field in advance with Cold Springs research staff.

Iowa's most common nuisance plants are normally filamentous algae or one of the thirteen species (or groups of similar-looking species) described below. Measurements of distinguishing characteristics were taken from "Through the Looking Glass, a Field Guide to Aquatic Plants" (Borman et al. 2001). Symbols used in the description are as follows: N = native, NN = non-native, D = dicot, M = monocot

1. **Free-floating plants**
   a. **Duckweeds and watermeal**: One or all three species are found as part of the nearshore plant community in most lakes in Iowa. These usually grow to nuisance levels only in waters with severe nutrient enrichment as from a feedlot, other manure source, or in a lagoon. Difficult to successfully treat due to small leaves present in layers.
      i. **Small duckweed** (*Lemna minor*). N, M. Round or oval-shaped green leaves a little larger than a pin-head (1.5-6 mm), underside of leaf is also green. Found growing singly or in groups, each leaf or frond with a single root (Figure 2A). Often found growing with large duckweed.
      ii. **Big or large duckweed** (*Spirodela polyrhiza*). N, M. Irregular, oval shaped green leaf. Approximately twice the size of small duckweed (3-10mm). Dark, reddish spot on top of leaf, underside of leaf also reddish with many roots per leaf (Figure 2B). Is often found growing with small duckweed.
      iii. **Common watermeal** (*Wolffia columbiana*). N, M. Corn-meal-sized, green plants without roots. The hardest to chemically treat of the three floating species (Figure 2C).

2. **Submersed plants**
   a. **Pondweeds**: Leaves arranged alternately on the stem. Have distinct midvein or needle-like leaves. Flowers or seeds borne on a stalk.
      i. **Curly leaf pondweed** (*Potamogeton crispus*). NN, M. Submersed leaves are oblong and attach directly to the stem (3-8 cm long, 5-12 mm wide). Margins of the leaves are wavy or curly and serrated. Growth begins at ice-out and continues through June. Plants usually senescing by the end of June and early July (Figure 2D).
      ii. **Leafy pondweed** (*Potamogeton foliosus*). N, M. Narrow, alternate leaves with a distinct midvein. The stems and leaves of leafy pondweed can be seen when pulled from the water, seeds have a keel around the edge and are borne on a short (5-15 mm) stalk (Figure 2E, F). Very similar in appearance to small pondweed (*P. pusillus*) though stems and leaves of small pondweed are very delicate and difficult to observe unless floated in the water, seeds are smooth around the edge and are borne on a long slender stalk.

iii. **Sago pondweed** (*Stuckenia pectinatus*). N, M. Needle-like leaves without midvein, borne alternately on slightly zig-zag stem. Leaves can be densely clustered at growing tips giving a bushy appearance. Each leaf is fused to the stipule for its entire length, forming a sheath around the stems. Seeds on a long stalk resemble clumped string-of-pearls (Figure 2G, H).

b. **Naiads**: Narrow leaves arranged oppositely on the stem. Midvein not distinct. Seeds borne where the leaf attaches to the stem.
   i. **Slender naiad** (*Najas flexilis*). N, M. Size and spacing of the leaves is extremely variable. Leaves can be paired or arranged in bunches along the stem (1-4 cm long, 0.2 -1.0 mm wide). Stems sometimes appear reddish. The growing tip can have a paintbrush appearance (Figure 2I, J). Seeds at the leaf nodes look shiny. Similar in appearance is southern naiad (*Najas guadalupensis*). Leaves of this species are up to 2mm wider and seeds are smaller and dull in appearance.
   ii. **Brittle naiad** (*Najas minor*). NN, M. Long, pointy leaves with distinct spines along their margins, become recurved as the plant matures (Figure 2K, L). Banana shaped seeds can be 1/3 length of the leaves.

c. **Whorled-leaved plants**: Leaves arranged in whorls around the stem.
   i. **Coontail** (*Ceratophyllum demersum*). N, D. Leaflets are stiff and forked once or twice, 5-12 are present at each node or attachment point to the stem. Much variation in leaf size and spacing seasonally and between water bodies (Figure 2M, N). Similar in appearance to muskgrass (a macrophytic algae) and watermilfoil (*Myriophyllum spp*.).
   ii. **Muskgrass** (*Chara vulgaris*). N, macrophytic algae. Resembling a higher plant, though without true stems and leaves. Can be branched, whorled "leaves" not forked, single, and usually encrusted with lime which gives this species a gritty feel (Figure 2O). Is grayish-green in color and has a distinct skunk-like odor.
   iii. **Eurasian watermilfoil** (*Myriophyllum spicatum*). NN, D. Stems are reddish and have 3 to 6 leaves per whorl and 12-21 pairs of thread-like leaflets per leaf. Leaves are limp and not forked (Figure 2P).
   iv. **Canada waterweed** (*Elodea canadensis*). N, M. Lance-shaped leaves are arranged in whorls of 2-3 leaves per node that attach directly to the stem. Leaves tend to be more crowded at the growing tips of the branched stems (Figure 2Q).

3. Floating leaved plants

a. **American lotus** (*Nelumbo lutea*). N, D. The round stalks are attached to the center of the round, unnotched leaves. Leaves grow to be quite large and are both floating and emergent Figure 2R). This species easily becomes a nuisance as it shades out other plants, grows to depths of 12' and impedes boat traffic and fishing activity.

Figure 2. Top nuisance macrophyte species in Iowa.
Image credits-A, B - Graves Lovell, Alabama Dept. of Conservation and Natural Resources, C, F, G, H, I, J, K, N, O, P, Q, R - Cold Springs Research, Iowa DNR; D, E, L, M, P - Theresa Shay, Iowa DNR

A - Little duckweed

B - Big duckweed

C - Watermeal

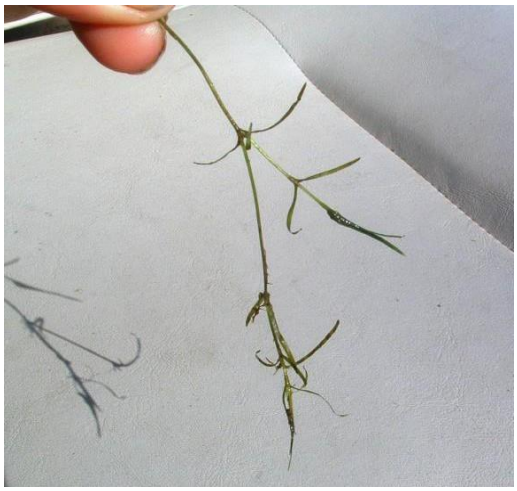
D - Curlyleaf pondweed

E - Leafy pondweed

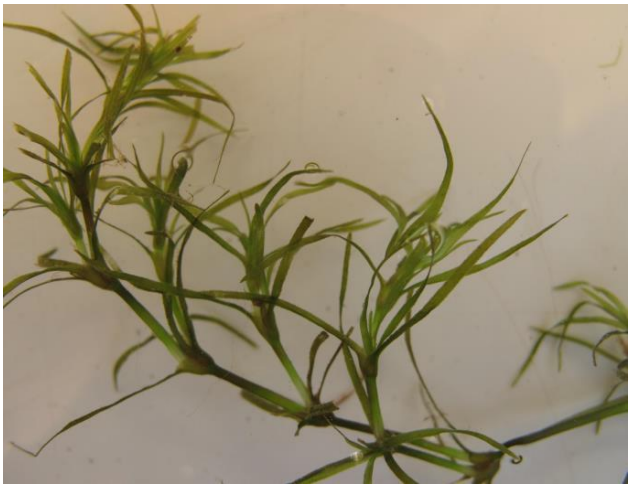
F - Leafy pondweed

G - Sago pondweed

H - Sago pondweed



I - Slender naiad



J - Slender naiad

K - Brittle naiad

L - Brittle naiad

M - Coontail

N - Coontail

O - Muskgrass

P - Eurasian watermilfoil

Q – Canada waterweed

R - Lotus

Plant Sampling

Goals

Plants are sampled in public lakes for a variety of reasons. The most common reason to sample plants in any lake is to provide records that can be used to support management decisions regarding the recreational fishery. Other sampling objectives include documenting pre- and post-project impacts (e.g., lake restoration, herbicide treatment, and plant introduction), monitoring for aquatic invasive species, and assessing changes in vegetation communities. The Iowa DNR's sampling protocols were designed to provide managers sufficient information with minimal effort (e.g., day or less of sampling). Information summarized here is from four years of sampling on Iowa man-made lakes and a thorough literature review.

Sampling

In most Iowa lakes, identification of all species of submersed aquatic macrophytes and the extent of coverage by these species cannot be done reliably by sight because not all species grow to the surface, and waters have both organic and inorganic turbidity that limits visibility. Plant sampling is likely to occur on an infrequent basis, and most fisheries biologists are not current in plant taxonomy, so voucher specimens will be important to establish sampling validity. Digital photos showing distinguishing characteristics may be substituted for actual samples of common species (e.g., coontail, longleaf pondweed, curlyleaf pondweed etc.). For vouchers, site information should also be collected and a record stored with either photos or pressed specimens (Appendix 3).

The two sampling methods described below differ in their efficiency of sampling plant growth forms, as well as ease of data summary and visualization.

Introduction Transect and Point-Intercept Methods

The transect method provides a thorough assessment of emergent and submersed vegetation. It uses fixed transects stratified by depth. This method can be used to gather general baseline information with one day or less of effort for a 2-3 person crew and this information can be compared over time. Sampling frequency depends on the priority level of the lake and the information need of the lake manager. Fixed transects are chosen to both meet goals for random site selection and distribute samples in all areas of the lake. Each transect is randomly placed within equally-sized zones (number of zones corresponds to the number of transects to be sampled, so the entire shoreline is represented).

When compared to transect sampling, the Point-Intercept (PI) method under-sampled, in proportion to its abundance, 0-2' water in constructed lakes (Cashatt and Bruce 2011). Minnesota DNR acknowledges that the PI method may under-sample near-shore and shallow-water areas, and uses an additional sampling protocol to encompass these areas (Minnesota DNR 2008).

In Iowa, the transect versus PI methods did not differ in finding the maximum depth of macrophyte growth, number of macrophyte species sampled or mean total rake density of submersed macrophytes sampled. The only significant differences were estimates of the proportion of littoral zone that was vegetated and the number of species after emergent and floating/floating-leaved species were added. Both the proportion of the littoral zone vegetated and number of species were significantly higher for transect sampling (Cashatt and Bruce 2011).

Natural lakes generally have a larger proportion of shallow littoral area that can be colonized by vegetation. A seed bank of emergent plants exists in these sediments and vegetation can quickly establish when conditions are right. However, constructed lakes in Iowa do not normally support large or extensive beds of emergent plants because they tend to have steeper sloping shoreline areas, lack a historic seed bank in shallow water sediments, and often have near-shore rock armoring. If it is known that plants are likely to be found only at depths 4 feet and less, transect sampling is recommended. PI sampling should be chosen if sampling the entire lake littoral zone or producing a vegetation map is a goal. Research is needed in Iowa to identify a minimum number of required points for this method; at this time it is recommended at least 75-200 points should be sampled on lakes <500 acres. This is similar to the number of points that would be sampled with the transect method but still less than recommended for the PI method in Minnesota. Minnesota DNR recommends at least 250 sampling points on most lakes with a goal of one sample point per littoral acre (65 meter spacing). A two- person crew can usually sample from 100-300 points per day (Minnesota DNR 2008).

If abundant emergent and floating-leaved species make navigation difficult (as may be the case for a shallow, natural lake that has just been filled after a period of drawdown), the transect method may be preferred to avoid the difficulty of locating sampling points within beds of vegetation, and the resulting damage to the plants from boat travel. With either method, the sampler can leave the boat when surveying shallower points.

Survey Procedures

1. Timing: plant surveys can be conducted from April 15th through September 30th. Most plant species obtain maximum biomass and maturity from late June through August, therefore these are ideal times to sample. Preferably, all samples should be taken on a single day. Alternately, sampling can be done on consecutive days.

   Special note about sampling curlyleaf pondweed. To assess curly leaf pondweed, the survey should be conducted between early spring ice-out and early May before this species reaches full growth and begins to die back. Fall sampling could also be done, though fall sampling will show a lower frequency of occurrence than would be obtained in the spring.

2. Water level should be noted before each survey is started.
   a. The location used to observe and record lake level should be a permanent fixture on the lake and be marked with UTM coordinates for future reference. Outlets or other permanent structures are preferred over docks, stakes, or trees.

3. A complete temperature/oxygen profile should be recorded at an open water sampling site (usually the deepest water on constructed lakes). If temperature and oxygen concentration is uniform, readings need not be taken at

every foot. When either temperature or oxygen begins to change, take measurements at smaller depth intervals. Take readings all the way to the bottom if your cable allows. ***Note the depth to the lake bottom on the data sheet.***

4. Each plant species has a four to six letter code that should be used on datasheets (Appendix 1).

Transect Method

Basics

1. The number of transects to be sampled is based on lake size (Table 1).

2. Each transect will start with a sample at the water's edge and continue outward perpendicular to shore. Collect samples at 2' contour depth increments. A transect is complete when two consecutive rake grabs sample no vegetation and water depths have been sampled out to at least 8' depth, or water depth starts to decrease instead of increase (e.g. you start to go up the other shoreline or an island). A minimum of five samples (i.e., last sample at the 8' depth contour) should be collected per transect.

Table 1. Plant sampling transect number.

Lake Size (acres)	No. of Transects
<100	11
100-249	15
250-499	20
≥500	25

Example: Pondweed Lake water level is 3' low. The first sample is located at the current water's edge. There is no floating or emergent vegetation, and rake grabs at contour depths 2', 4', and 6' do not have vegetation but sampling is continued to the 8' station. Plants are present at the 8' contour, so sampling continues at the subsequent contours of 10' and 12'; and because there is no vegetation at these stations sampling this transect is complete after sampling 7 points. If there had been vegetation at these depths and sampling continued to the 16' contour where vegetation was also present, only one additional rake grab would be collected at the 18' contour and vegetation would be recorded as present or absent.

Note: samples should be collected at the beginning of each contour. For example, if you are backing up from sampling at the shoreline to sample the 2' contour and there is a long expanse of water of this depth, the sample will be collected as soon as the water depth reaches 2' not somewhere between the 2' and 2.5' contour. Depth finders/sonar equipment are very useful to find approximate depths along a transect; however the final station location and depth should be determined using a measuring rod or the sample rake.

3. If only submersed vegetation is present, the double sided rake will be the only sampling equipment used for that specific sample point (Figure 3). A floating hoop/quadrate, described below, is used to sample emergent, floating and floating-leaved vegetation (Figure 3).

Sampling transects for emergent and floating leaved species

1. Emergent and floating leaved species should be evaluated at each contour before submersed species are sampled. If present, they should be sampled at all contours (e.g. there is duckweed present at the 4- foot station, its coverage should be estimated before pulling a rake sample).

2. A 1-m (3.3') diameter hoop/quadrate will be used to sample emergent, floating and floating leaved vegetation (EFAV). It can be constructed of 3.14m (10.4') of flexible waterline formed into a circular hoop by a connection with a hose barb. The hoop will be placed over the same area the rake sample is to be collected. If EFAV is found on the 1st sample point, the edge of the hoop will be placed where the water meets the shoreline so the entire area of the hoop is floating on the water (Figure 3).

Figure 3. Floating hoop used to sample emergent, floating and floating leaved aquatic plants (left). Double-sided rake on an extendable pole used to sample submersed aquatic plants (right).

3. After the hoop is placed on the water, coverage of all EFAV plants is estimated (1-100% coverage, if there is no vegetation, this will be recorded as NOVEG, 100% as 0% cannot be recorded). Plants must be on the surface or breaking the surface to be considered for the plant coverage rating (i.e., wind-rowed submersed vegetation and submersed vegetation without floating leaves should not be included in the EFAV coverage). When floating in a mat, filamentous algae will be noted as present, though will not be included in total EFAV coverage.

4. Abundance of individual species will be recorded on the same scale (1-100%) at each depth contour.

   For example, about half the area inside the hoop is covered with three different species. Hoop density would be recorded as 50%. This is then broken down by percentage comprised of each species, with the total being 100%: Longleaf pond weed is covering ¾ of this area so species abundance would be 75%, and arrowhead and cattail each cover about the same proportion of the remaining area and would be recorded as 12%, the extra percentage point would be given to the longleaf pondweed, then recorded as 76% (76 + 12 + 12 = 100%).

Sampling on a transect for submersed species

1. Samples of submersed macrophytes will be collected using a double sided rake (Figure 3). Two garden rakes measuring 14" wide and having 14, 2" long teeth, are welded together and attached to an extendable pole (Yin et al. 2000) marked at 6" increments. The rake teeth are also marked, dividing each tooth into five equal-length segments. If emergent or floating leaved plants have been sampled first, the rake can be placed in the center of the floating hoop. Depth should be read on the pole. A 5-6' extension will be needed for sampling depths over 12'. This can be made using a length of PVC pipe that fits inside the hollow pole.

2. To sample submersed species, the rake will be lowered to the bottom and twisted 180° and brought back to the surface. Substrate composition should be noted and recorded at this time. If the rake has more than a strand or two of vegetation and is muddy, before estimating rake density or pulling the rake into the boat, pull the rake horizontally (swish) through vegetation-free water to rinse and compact vegetation on the rake head (Yin et al. 2000). If there are long strands of vegetation trailing the rake during this maneuver, catch them with the leading tines of the rake while underwater, and then pull the rake into the boat. If there is abundant vegetation at the surface and rinsing in this manner is not possible, a gentle and repeated dipping can be done to remove substrate from the sample.

3. After the rake has been pulled out of the water and into the boat, plant material still hanging off the rake head (i.e. not on the rake pole) can be added to the tines. Plant strands hanging off the rake pole should be ignored. The rake should be read while holding vertically so plant material does not fall off.

4. Density of the entire rake sample will be from 1 to 100%. These estimates should be based on an average of the entire rake (Figure 4 & Figure 5). If there is no vegetation, this will be recorded as NOVEG, 100%, as 0% cannot be recorded in the database, though is a valid entry. Emergent species or dead submersed species should not be included in the rake density figure (Figure 5B). The portion of the sample composed of emergent or dead

vegetation should be removed from the total coverage. If emergent vegetation is too thick to twist the rake 180o, do not sample that station with the rake. Indicate this by putting a dash in the "Rake Density" space on the data sheet. Similarly, if terrestrial brush overhangs the edge making plant sampling with the hoop and rake impossible, put dashes in both the emergent/floating and submersed coverage spaces.

Figure 4. Examples of plant rake density percentage.

A **B**

Figure 5. Two-headed rake used for submersed vegetation sampling. A) Rake with submersed vegetation being held for estimating total rake density. B) Emergent vegetation in the rake along with submersed species.

5. The entire rake sample will then be taken off the rake head and separated by individual species. This can be done either with visual observation, or by manual manipulation of the sample. The latter is recommended until a sampler is proficient. Abundance of individual species will be recorded on a scale from 1 to 100%. Filamentous algae should be noted when present but not included in submersed plant density estimate.

6. A data sheet (Appendix 4) and database should also be requested from the Cold Springs Research Team.

Point Intercept Method

This method samples plants over the entire lake and is easily summarized for visual comparison using GIS software. Its weakness is that emergent and near-shore-floating and floating-leaved species are under sampled. One way to adjust for this would be to sample the shoreline by extending each third line of points to shore and sample at the water's edge (as is done with the transect sampling).

Plants are sampled at points on a grid overlaid on the lake. The grid size or distance between the points is determined so the number of points sampled will fall between 50 and 200 in the littoral zone for lakes under 500 surface acres (varies by lake size, Table 2). For lakes over 500 surface acres, sample size should increase proportionately. The minimum number of points was loosely based on the number of points sampled by the transect method (Table 1). Because the exact depth to which plants are growing is likely unknown, more points than the minimum should be delineated as many will be at depths greater than plant growth.

Table 2. Minimum number of points to sample with the PI method. Actual numbers can exceed this limit.

Lake Size (acres)	Approximate No. of Points
<100	≥50
100-249	≥100
250-499	≥150
≥500	≥200

To begin sampling, use a handheld GPS unit to navigate to each point. The maximum depth that will be sampled with the rake is 16'. If vegetation is found at the 16 foot depth, greater depths can be sampled with a weighted rake on a rope (WRR) (Figure 6). Both rake and individual species densities will be recorded at each point. Depth finders are required to note the approximate depth of each sampling point prior to sampling with the rake. Depth information can be used to decide if a point should be sampled. If sampled, the rake can be extended to a length that will reach the bottom, or the WRR can used. When the sampling point is located, the boat operator will communicate to the plant sampler the approximate depth once the boat is correctly positioned. At this time the plant sampler will first sample with the floating hoop if EFAV species are present, and then with the rake for submersed macrophytes. The rake will be pushed to the bottom, depth read, rake twisted 180o, sediment composition determined and rake brought to the surface. If the WRR is used, because there is not a firm connection between the sampler and the rake, depth will be determined with the depth finder and the substrate will not be determined. The rake will be thrown, allowed to sink, dragged for less than a meter, and pulled to the surface.

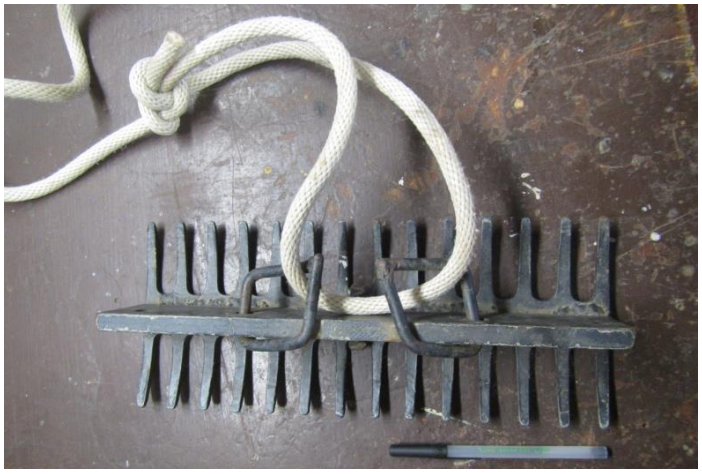


Figure 6. Weighted rake on a rope (WRR) for sampling at depths over 16 feet.

Sampling each point for emergent and submersed species and procedures for estimating rake coverage and plant densities will be executed using the same methods described for transect sampling (see above).

A PI survey takes more time more time because more points are sampled and finding points takes more time than with transect sampling. Grids are set up in ArcView and then downloaded to a handheld GPS unit. Field offices without ArcView should contact the Cold Springs research team for assistance. A data sheet and database should also be requested from the Cold Springs Research Team.

Sonar Estimate of Coverage and Biovolume

Iowa DNR's lake mapping equipment can be used to estimate plant canopy height and abundance while mapping depth and bottom type. This technology allows production of a fairly accurate map of plant coverage and estimate of plant biovolume. One shortcoming is the inability to obtain measurements in water shallower than two feet. Species composition, if important, needs to be determined with onsite sampling close to the same time that sonar data is collected.

This method of plant sampling can only be completed by personnel trained with the lake mapping equipment.

Therefore, vegetation mapping projects need to be prioritized with other lake mapping requests. If a lake is scheduled to be mapped and a detailed vegetation map is needed, managers should work with the lake mapping crew to ensure the lake is mapped during times of peak plant coverage (mid- to late-June through mid- to late- September). A transect or point-intercept survey should be conducted concurrent with lake mapping.

Plant Management and Treatment

In attempting to control aquatic plants, management goals should be set that are not conflicting with the lake's fisheries and recreational uses. Whether a problem comes to light from public complaint or after sampling a lake for macrophytes, reviewing the many control techniques is the first step in formulating an integrated approach to plant management.

There are four general classes under which aquatic plant management is performed: preventive, mechanical/physical, chemical, and biological; all with either spot or whole lake strategies. **Whole lake** techniques are used for widespread control (e.g. invasive species). **Spot treatment** is the management of small areas for the purpose of alleviating boat and angler access problems, or targeting a particular invasive species. Vegetation management is often a complex problem and plans for control will need to be integrated; using several supportive techniques. Professional consultation is useful for many techniques and diagnostic feasibility assessment for complex issues is cost effective.

Potential advantages and disadvantages of the treatment are listed under each specific technique. Because each lake is different, these potential impacts need to be evaluated on a lake-by-lake basis. A more comprehensive description of each technique is available in Holdren et al. 2001.

Preventive control methods are practices usually put into place in a new lake or while a lake is undergoing a renovation process that naturally inhibits plant growth by limiting nutrients, light or substrate. Another form of prevention is *Cultural control;* these methods (e.g. education, watercraft inspection) are used by the DNR's Aquatic Invasive Species (AIS) Program to prevent or reduce the entry or spread of invasive aquatic plant species. Contact IA DNR Fisheries AIS personnel for more information.

Mechanical and **physical** controls vary in scope from hand raking and shading to using a mechanical harvester. These can accompany other control methods as part of an integrated management plan.

Chemical treatment is done with a chemical (usually herbicide) added to the water to impact plant or algal growth. Application timing, concentration, location to urban areas, lake water use (e.g. livestock watering, irrigation, domestic water supply), label directions and state law come into play with chemical treatment (see also Netherland 2009). If a particular lake is in a high use or residential area, an education and outreach campaign designed to inform and gather feedback from stakeholders may be beneficial. As a public agency, the Iowa DNR Fisheries Bureau's Category 5 Licensed Applicators can apply herbicides to public waters under general guidance of the following rules:

<u>Iowa DNR Permitting Procedure and Rules for Herbicide Application:</u>

1. Water supply lakes (class C water): Submit an "Aquatic Pesticide Application to Prohibited Waters" permit application to Michael Anderson (Iowa DNR Water Use Division, phone 515-725-0336) about one month in advance of your planned treatment (Appendix 5A).
2. Outstanding Iowa Water (OIW) (Big Spirit or West Okoboji lakes): Apply for an individual national pollution discharge elimination system (NPDES) permit through the NPDES section. Applications of herbicides to OIW waters were not included in the general permit. There is not an application form so send a letter indicating intent to apply to an OIW water and include the information on the Notice of Intent (NOI) form in Appendix 5B.
3. If the lake is not a class C water or an OIW, herbicides can be applied without a specific permit under General Permit No. 7 by a Category 5 certified applicator.
4. For **<u>all lakes regardless of classification</u>**, General Permit No. 7 requires that records are kept (Appendix 5C), and best management practices followed (e.g., consider an integrated approach, conduct regular equipment maintenance, follow label instructions, and visually monitor application sites). **The application records need be**

compiled into an annual report for the DNR Fisheries bureau. A spreadsheet is available from the Cold Springs Research team for recording treatment information and summarizing information for the annual report (darcy.cashatt@dnr.iowa.gov).

Biological control or biomanipulation uses human-introduced living organisms to compete with or to suppress aquatic plants; either a wide range of species or targeting one particular plant species. Complete eradication of all aquatic plants should not be a goal of biological control, though the whole waterbody is impacted. In general a parasite, predator or pathogen is employed; including the herbivorous grass carp (*Ctenopharyngodon idella*), non-native and native insects like the water milfoil weevil (*Euhrychiopsis lecontei*), and fungal pathogens like *Mycoleptodiscus terrestris* (Mt) being researched for use controling Eurasian watermilfoil and hyrilla (Getsinger et al. 2005. Cuda, 2009)

Restoring, maintaining, or encouraging a healthy native plant population can also be used as part of an integrated approach to limit invasive species or reduce nuisance growths of native species through competition.

Preventative

Whole-Lake Treatment

- ***Watershed Best Management Practices*.** All measures done in a lake's watershed to positively impact the lake. For example, reduce the flow of water, soil, plant nutrients and/or other pollutants into the lake (e.g. land management strategies, soil testing, sediment/retention basins, terracing, wetlands, stream buffers, rain gardens, permeable concrete, etc.). Installed practices will help to decrease nutrient loading, increase the longevity of the lake and other plant management practices. Many of these practices are implemented during the lake restoration process and are generally preceded by a diagnostic feasibility study to enable targeting of areas that would produce the most benefit for the time and money invested.

Spot Treatment

- ***Shoreline deepening*.** Limit shoreline plant growth by deepening select areas to decrease light penetration to bottom sediments. This can be done by either pushing or excavating with heavy equipment. Shoreline fishing jetties can be constructed using near shore material pushed up and armored for protection from wave erosion. Use of this technique is most effective when external sources of sediment have been controlled, shorelines are stabilized, and the sediments are removed from the nearby watershed.

  Advantages: Relatively long-lived solution.
  Disadvantages: Temporary disturbance to established uses, expense, requires some maintenance.

- ***Bottom blanketing*.** Produce an area with bottom substrate unsuitable to submersed aquatic plants by using gravel, riprap, sand, barrier fabric or a combination in the littoral zone.

  Advantages: Several years of control. Provides fish spawning habitat or a beach area.
  Disadvantages: Expense. Sedimentation from allochthonous or autochthonous sources will eventually allow plant growth.

- ***Shoreline armoring*.** Limit shoreline erosion and retreat by installation of rip-rap, concrete or other hard substrates at the water's edge. Generally not installed exclusively as a vegetation control technique.

  Advantages: Very infrequent maintenance needed. Stabilizes shoreline from wave erosion. Supplies angler access. Provides crevice and boulder habitat for fish.
  Disadvantages: Expense. Requires a 401/404 Joint permit. Makes substrate unsuitable for turtles, mussels or other burrowing animals. Can appear unnatural.

Mechanical/Physical

Whole-Lake Treatment

- ***Lake drawdown.*** A short-term drawdown to disrupt the growth of submersed plants by drying and/or freezing roots and reproductive structures during the most suitable time of year. Do not confuse with long-term

drawdown (i.e., at least one or two growing seasons) used to encourage development of emergent species on natural lakes and wetland areas. Overall the response of macrophytes is variable. Short-term drawdowns work better on species with overwintering structures (coontail, milfoils., water shield, lilies, many pondweeds) and not as well on some seed producers (slender naiad)(Cooke 1980). Mixed results have been experienced with some species (e.g., Elodea)(Cooke 1980). Can expect short- term (1-2 years) control of some/most species **if** there is good dewatering of the substrate, minimal insulating snow cover, and a month or more of freezing or extreme heat (Cooke 1980).

Advantages: Low cost, widespread control, opportunity to repair or install in-lake structures, consolidation and oxidation of exposed substrates.
Disadvantages: Access/recreation and shoreline erosion issues. Potential for; increased algal blooms, rapid spread of resistant macrophytes, fish winterkill. Mortality of mollusks, hibernating reptiles and amphibians.

- ***Selective withdrawal.*** This technique discharges more nutrient-rich waters from near the bottom either during times of overflow using the overflow structure or a siphon when the lake is thermally stratified. This practice reduces water column phosphorus concentration to lessen the frequency of algal blooms and improve environment for emergent and submersed aquatic macrophytes. This method can also be used long term to decrease build-up of plant nutrients (mainly phosphorus) in lake water and sediments. Alternatively selective withdrawal can be done for a period of years until water column phosphorus has decreased to desired levels. A water level control structure with this capability can be planned during the lake restoration process, or modifications made to existing structures if restoration is not planned (pond and standpipe retrofits shown in Appendix 6). Care must be taken not to break down thermal stratification during the summer months or to severely impair discharge waters. However, the risk of impairment to discharge waters is lowest during times of high water inflow (i.e. those times that selective withdrawals will be easiest to implement).

  Advantages: No annual utility bill. Longer retention of beneficial plankton blooms
  Disadvantages: Requires onsite start-up, inspection and monitoring (frequency depends on project size and goals of the operation). Risk of algal bloom if discharge breaks down thermocline.

- ***Aeration or oxygenation.*** This method controls algal growth by oxygenating the hypolimnetic area to reduce the in-lake release of phosphorus to the water column. Use of this technique can also slow the buildup of minimally decomposed organic matter near the bottom of the lake, thereby reducing oxygen demand year-round. Thermal stratification may be broken down, though in many applications is purposely not disrupted. Hypolimetic oxygenation is most often implemented during the spring and summer months, though can be used year-round if oxygen demand dictates. External sources of phosphorus should be controlled prior to use of this technique. A diagnostic study of internal phosphorus sources, oxygen demand of hypolimnetic waters and/or sediment is needed prior to implementation. Enough oxygen must be added to satisfy the hypolimnetic oxygen demand, and there must be enough compounds present that will bind phosphorus once oxidized. Results are mixed and there are many methods for aeration. For more information see Holdren et al. 2001, pages 231-241. Professional consultation is recommended to design a system appropriate for individual lakes.

  Advantages: Ideally minimal day-to-day labor. Potential for positive impacts to invertebrates and fish.
  Disadvantages: High initial investment. Utility bill if system is not solar-powered. Will not control filamentous algae or aquatic macrophytes.

- ***Circulation and destratification.*** Reduces the frequency or severity of algal blooms by mixing shallow lakes to prevent stagnation or destratifying deep lakes. Implement by using mechanically circulated water or injected air. Algae may just be redistributed through the water column, or prevented by reducing the release of phosphorus due to oxygenated conditions. Professional consultation is recommended to design a system appropriate for individual lakes.

  Advantages: Ideally minimal day-to-day labor. May offer benefits to the fishery when half or more of the lake benthic area and volume are below the thermocline and this stratification is broken or significantly deepened

(Hill 1987, 1992). Can eliminate local problems without whole-lake impacts.
Disadvantages: High initial investment. Utility bill if system is not solar-powered. May spread localized effects. May increase oxygen demand at greater depths by suspending organic sediments.

Spot Treatment

- ***Removal.*** The control of submersed, emergent or floating aquatic vegetation by removing vegetation in high-use areas (e.g. hand pulling, raking, cutting, or seining). Raking, cutting and seining are not recommended when colonization of other areas is undesired because many species can spread by the rooting of small fragments. Hand pulling can be implemented by divers in clear lakes for control of pioneer populations of invasive species. This method can be coupled with placement of small bottom barriers to inhibit regrowth of the invasive plant).

  Advantages: No chemicals or applicators license needed. Flexible control. Can balance habitat and recreational needs. Rakes and cutters are commercially available.
  Disadvantages: Labor intensive. Regrowth in one season is likely.

- ***Disturbance.*** Rooted aquatic plant growth is discouraged by regular disturbance of the sediments; ideal for providing access to small, intensely-used areas. Prior to and throughout the season of use, disturb the area by dragging some sort of substrate rake or harrowing device. Automatic (electric) rollers are available commercially, though installation does not guarantee success. High use areas like a beach or fishing dock are appropriate areas to use this technique. To have the best chance for success, efforts should be implemented early in the growing season. Consider using this technique as part of an integrated approach. For example, disturbance can be used with or to follow-up physical removal, bottom barrier techniques and chemical control.

  Advantages: No chemicals or applicators license needed. Very flexible control. Commercial products are available.
  Disadvantages: Labor intensive. Requires periodic treatment throughout the growing season.

- ***Bottom barriers.*** Prevent vegetation growth or kill existing vegetation by the use of some type of light and growth inhibiting cover. This technique is best used as a preventive measure, though can be installed over existing vegetation. There are two types of barriers (permanent and temporary) and they can be used in combination:

  Permanent: Cover areas with rock, gravel or sand (beach) to limit substrate for plant growth. Permanent barriers are commonly used with jetty or fish mound creation. Plant sampling in Iowa shows that very little vegetation becomes established on these areas.

  Advantages: Several years of control without annual effort. Can also provide fish spawning habitat or a beach area.
  Disadvantages: Expense. Sedimentation from allochthonous or autochthonous sources will eventually allow plant growth.

  Temporary: For seasonal control, cover the area with weed barrier material (e.g. commercially produced barrier fabric, sheets of fiber glass, fine-mesh screening, tarps, thick black plastic). Floating barriers are another option. Best results are obtained if the barrier is installed early in the growing season. For example, weed barrier can be weighted on the bottom early in the spring (it can also be installed in a frame for ease of deployment and retrieval) to establish fishing lanes in existing waters. Barriers can also be moved throughout the season to expand the treatment zone. It is recommended that barriers be removed and cleaned or flipped over after being deployed for 1 to 2 months because silt buildup can support plant growth. If the barrier material is not porous, puncturing to allow gases to escape is necessary. Use of this technique has not been documented in Iowa. Practical advice, vendors of commercial products and a case history is available at:

  Examples: For very small intensively used areas (e.g., beach, boat lane to open water) - deploy barrier early in the spring so at least three weeks of shading is possible, more is desirable. Remove right before season of heavy use. Follow up with periodic disturbance for extended control.

http://www.ecy.wa.gov/programs/wq/plants/management/.

Advantages: No chemicals used, no herbicide applicators license needed. Commercially produced products are available.
Disadvantages: Upfront cost depending on material. May require some type of fabrication. Requires regular maintenance. Can be difficult to anchor if the fabric is not negatively buoyant. Can become a safety hazard if improperly anchored. Can be damaged or dislodged by propellers, fishing gear, boat anchors or wind turbulence.

- ***Harvester.*** This method uses mechanical equipment to cut the top 5-6 feet of vegetation and remove it from the lake. It can also require re-cutting during the growing season and can be a full-time job. This technique is not recommended when colonization of other areas is undesired because many species can spread by fragmentation. The cutter requires a high initial investment; therefore, there should be a lake plan in place before investing in this option. Approximately 15-23 acres can be cleared with 30 hours of harvest time per week, depending on the size of the harvester and logistics of materials handling. Cost to operate a harvester will be approximately $10 to $25/hour (2012 estimate, includes fuel, oil, repairs, higher estimate includes insurance, does not include payroll). A dump/materials handling site(s) must be established in advance unless using a non-harvest variation, such as a cutter (just cut, no disposal) or cutter-grinder (plants are ground and disposed of in the lake). Public relations are another important component of the operation. If interested in harvesters, obtain a copy of the LakeLine publication from the North American Lake Management Society (Volume 18, Number 1, March 1998).

  Advantages: No risk of treating unintended areas. Water can be used immediately following treatment (no restrictions on water use as with some herbicides). No risk of oxygen loss to water if weeds are removed. Some habitat remains. Removal of some phosphorus within the plant material if disposed of in a containment site.
  Disadvantages: Equipment is expensive. Fish by-catch may be an issue in small lakes with repeated cuttings. Recovery and regrowth of vegetation may occur shortly after cutting/harvest.

Chemical Treatment
Whole-Lake Treatment

Whole-lake herbicide treatments are generally less selective and should be used when goals include lake-wide control. With some methods, there is risk of changing a lake with clear water to one that is in an algae dominated, turbid-water state; heavy algal blooms are a possibility in many Iowa lakes due to generally high levels of plant nutrients and the influx of more nutrients from decaying plants.

- ***Dyes***. Reduce nuisance growth by limiting required wavelengths of sunlight to both single-celled algae and rooted plants by the use of a non-toxic dye. This technique is best for low inflow lakes where public access and/or aesthetic concerns are extremely important and severely impaired. Dye must be applied early in the spring before significant plant growth and the concentration should be increased after significant inflow events. There is a potential for increased anoxia near the sediment water boundary that may impact lake nutrient cycling. Before pursuing this option know the lake's flushing rate, water depth, volume to be treated, and the lakes thermal regime.

  Advantages: Can effectively reduce coverage by both algae and macrophytes. Relatively low cost and easy application for a whole-lake treatment in small water bodies. Appealing color and illusion of depth. No restrictions on water use.
  Disadvantages: Will reduce lake productivity by reducing production at the base of the food chain. Unlikely to impact plant coverage in water less than 2-foot depth. May not control surface blooming algal species. Limiting light penetration may reduce depth to the oxy- and thermocline and shallower areas may stratify. Surface water temperatures will increase due to light absorption.

- ***Herbicide***. Use of either fast- or slow-acting herbicides (Table 3) to kill plants throughout the lake. In Iowa, slow-acting fluridone is used mainly for the control of the invasive species Eurasian milfoil and brittle naiad. Another

example would be to use a low concentration of a fast-acting herbicide (e.g. diquat, granular or liquid endothall) in April to selectively control early emerging curlyleaf pondweed. Dispersal must be thorough whenever using a fast-acting herbicide.

Advantages: Control is lake-wide. Longer term control with fluridone treatments (up to a year or more). **Disadvantages**: Application time and expense. Complete eradication of all rooted plants can result in algal blooms, and potentially change the lake to an algae-dominated turbid-water state.

Case Study 1: In 2009 Carter Lake, received an alum treatment to both bind water column phosphorus and create a seal over the bottom sediments, thereby reducing in-lake phosphorus about 70%. The treatment was very effective, resulting in Secchi depths of over 7 feet during the summer of 2009. In addition the fishery was renovated in the fall of 2010. Currently the lake is dominated by submersed plants instead of blue-green algae due to and resulting in much improved water clarity. Total cost of alum treatment: $1,570,000 (~$5000/acre) and $200,000 for the fish renovation. In recent years an aquatic plant harvester and herbicide treatments have been used to control excess rooted aquatic plants that have hindered boat access to the lake.

- ***Phosphorus inactivation***. This method controls planktonic algae by limiting phosphorus (P) availability. Chemicals are used to either remove P from the water column by precipitation, or prevent the release of P from the sediments by adding a P binder to the lake. In lakes that are in the turbid-water-state (i.e. dominated by blue-green algal blooms), this method can be employed to bring about the clear-water- state. It is most effective when the primary source of phosphorus is internal and nutrient loading from the watershed has been sufficiently reduced (P loading from each source should be measured). Salts of aluminum (i.e., alum), iron or calcium are added to the lake during the open water season. High doses (applied as a liquid or a powder) are needed to effectively bind phosphorus in the upper inches of sediment. Use of a professional consultant and commercial applicator are recommended. If common carp are present, they should be removed before or shortly after this treatment to give the treatment the best chance for long-term success. A thorough understanding of the lake's chemistry is needed before using this technique.

  Advantages: Success will be evident within hours or a few days. May remove other nutrients and contaminants as well as P. No known negative side effects. Improved recreational appeal. Long term control of phosphorus (can tie up P for up to 10 years).
  Disadvantages: Growth of submersed macrophytes in the resulting clear water can happen rapidly after treatment. Changes in pH can be severe enough to cause fish kills and decalcification in sensitive organisms. Phosphorus may be released under anoxia or extreme pH. Recreational use may need to be limited in some areas to increase longevity of the treatment. May need re-treatment in 10 years.

Spot Treatment

- ***Herbicides***. There are a variety of herbicides available, each with different efficacy for different species (Table 3 & Table 4). In most cases, treating vegetation early in the season is the best strategy. At this time, biomass has not reached a maximum, so the amount of decomposition of submersed species will be minimized, oxygen sags can be avoided, and less chemical may be needed. Seed and reproductive structure production will also be minimized with early-season treatment. Some emergent species, like cattails and lotus, respond well to a late summer or early fall application of the systemic herbicide glyphosate, when the plant is preparing for dormancy by moving energy stores to the roots. Read the label carefully and follow all instructions. Application of liquid herbicide to submersed species should be done by subsurface injection. Plans for bow-mounted, weighted trailing hoses are available at (http://edis.ifas.ufl.edu/ag360). Very small spot treatment areas can also be implemented for invasive species (Figure 7).

Case Study 2: : Lake: Cold Springs, 90% coverage with Naiad by late April, topped out by mid-May 2010.
Goal: Clear a few fishing lanes for anglers. Used boom application a few inches below the surface (i.e., prop and wind dispersion, and diffusion relied on to achieve contact with vegetation in deeper water).
Strategy: Treated mid-May with Reward and Cutrine Plus at label rates.
Results: No change noted.
Conclusion: Construct subsurface injection boom with weighted hoses. Treat early for best results.


Lake Macbride Fish Management, DNR

Figure 7. Wand applicator used in clear water to treat small clumps of brittle naiad with liquid herbicide.

When using a fast-acting herbicide (e.g. copper, diquat, endothall), treatment will be much more effective if you follow 4 general rules, allowing more anglers to **CAST**:

i. **C**orrect identification of target species
ii. **A**M (morning) treatment: to maximize photosynthetic activity necessary for herbicide effectiveness.
iii. **S**unny forecast: to maximize photosynthetic activity necessary for herbicide effectiveness and avoid precipitation that can rinse herbicides from plant surfaces.
iv. **T**ranquil conditions: if it's windy surface spray will drift, and subsurface application will be more quickly displaced by wave current.

Common Herbicides

Table 3. Characteristics of some herbicides. Tx=treatment, NS=non-selective, E=emergent, F=floating, FL=floating-leaved, S=submersed. Highlighted trade names were used to calculate cost figures.

Herbicide	Copper Complex	Diquat	Endothall	Glyposate	2,4-D		Fluridone	Triclopyr
Trade Name examples	Cutrine Plus, Harpoon[1], Komeen[1] & others	Reward, Weedtrine-D, Tribune	Aquathol K, Aquathol Super K	Rodeo & many others	Sculpin-G, Navigate Aquacide	AquaKleen, DMA 4 IVM	Sonar Q, Whitecap	Renovate3, Renovate OTF
Mode of Action	Contact	Contact	Contact	Systemic	Systemic		Systemic	Systemic
Formulation	Liquid, granular	Liquid	Liquid, granular	Liquid	Granular	Liquid	Liquid, granular	Liquid, granular
Selectivity	Algae, S	NS, F, FL, S	NS, FL, S	E & FL	Dicots, FL, S		NS, F, FL, S	Dicots, E, FL, F, S
Best Uses	Spot Tx	Spot Tx	Spot Tx	Spot Tx	Spot Tx		Whole lake	Spot Tx
Restrictions[4]	None	Irrigation, potable intake	Irrigation, potable intake	Potable intake	Irrigation (varies), potable intake, swimming[3]		Irrigation, potable intake	Irrigation 120d, Grazing/Haying, potable intake
Additives		Surfactant[2]		Surfactant				Surfactant2
Cost (acre-ft)[5]	$10 - $52	$10 – $40	$81 - $118 $60 - $2306	$8 - $12/A	$102 - $277	$35 - $70	$50 - $102	$70 - $230

[1]Copper complex that is effective on some submersed macrophytes
[2]For application to emergent and floating-leaved species
[3]This restriction not on all labels
[4]Specific lengths of time and concentrations or setbacks can be different for differing products with the same active ingredient. Always read the label for restriction specifics.
[5]Costs reflect the range of concentrations specified in the label, cost from State Contract (2013, MA# 005 4393-13) for all but 2,4-D-based herbicides. Per acre-ft unless specified otherwise.
[6]Granular form.

- ***Copper and copper complexes*** are fast-acting contact herbicides used for control of algae and macro- algae. However, several formulations of chelated copper are able to control certain submersed macrophytes. Tank mixes with diquat can also improve effectiveness of control for some plant species, though is generally used to be effective on a mixed growth of macrophytes and algae. Chelates are more effective in high alkalinity waters that rapidly precipitate copper ion. Copper should not be used in waters with alkalinities below 40 ppm due to increased toxicity to fish, or in lakes used to water sheep. Remember, thorough dispersal is necessary for good control with all contact herbicides.

  Advantages: No restrictions for water use.
  Disadvantages: Regular use of copper sulfate can result in sediments with toxicity to fish eggs (not as likely with chelates due to lower concentration of copper). Regrowth of algae can occur within the season.

- ***Diquat*** is a fast-acting contact herbicide used to control many submersed, floating, floating leaved as well as some algal and emergent species (Table 4). It is available only as a liquid. It is quickly adsorbed by negatively-charged clay, so is not effective in muddy water or on plants that are encrusted with fine silts, clay or marl. Only the leaves of the plants are killed (there is no impact on the roots) so regrowth is possible. Remember, thorough or zone-specific dispersal is necessary for good control with all contact herbicides.

  Advantages: Control is evident within 2 weeks. Minimal restrictions. Moderate cost.
  Disadvantages: Plant regrowth within the season is possible. Control in deep water is difficult.

Case Study 3: Carter Lake was largely covered with a mixture of small-leaved pondweed, curlyleaf pondweed, longleaf pondweed and coontail in 2012.
Goal: Clear 100 acres of the 300 acre lake to allow both dredging and boating.
Strategy: Use Reward/diquat to treat 100 acres. This area was broken into 3 treatment zones with 10-14 days between treatments to avoid an oxygen sag. This also allowed observation of the water quality to avoid changing the lake to an algae dominated state. After successfully treating a 27-acre area on June 8 with 54 gallons of diquat, and a 30-acre area on June 21st with 60 gallons of diquat, the final treatment to the remaining 43-acre area was cancelled due to the developing algal bloom.
Results: The algae bloom was sufficient to manage the density of rooted plants through the remainder of the summer, but did not completely eliminate them. Water quality throughout the open water season was in line with the lake restoration plan goals.

- ***Endothall*** is a fast-acting, contact herbicide used to control many submersed species and some algal infestations (Table 4). There are two forms of the active ingredient: the inorganic potassium salt that is found in the products Aquathol® K and Aquathol®Super K (granular); and the alkylamine salt formulations of Hydrothol®, 191 Hydrothol® and 191 Granular. Neither form is affected by muddy water. Only the leaves of the plant are killed (there is no impact on the roots) so regrowth is possible. Fish are extremely sensitive to Hydrotholl®, and its use can cause fish kills. Hydrothol® is effective against algae, but Aquathol is not. Both forms are quickly degraded by microbial action and persist in water up to 16 days. Remember, thorough dispersal is necessary for good control with all contact herbicides

  Advantages: Control is fast. Effective against a wide variety of species. Granular formulations make control in deep water possible.
  Disadvantages: High cost. Non-selective. Regrowth from roots is common.

Case Study 4: Lake: Cold Springs, 90% coverage with Naiad in 2010. In 2011 treated early June, growth still short, coverage similar.
Goal: eliminate weed coverage on 5.7 acres so total coverage by submersed veg. approaches 50%.
Strategy: Spot-treated 4 areas at 3ppm concentration using Aquathol Super K (low end of 3-5ppm recommended on label).
Results: Three weeks after treatment naiad dead and bloom of blue-green algae present. Naiad coverage in August 0%. Whole-lake treatment label rate 2-4ppm. Actual concentration of chemical in lake 0.9ppm.
Conclusion: There is a delicate balance in some lakes between the clear and turbid water state.

Table 4. Efficacy of some herbicides. E=excellent, G=Good, F=Fair, P=Poor, Y=will kill, though efficacy unknown, "blank"=not recommended. If there is more than one rating per species, efficacy differed between authors.
Sources consulted: http://aquaplant.tamu.edu/, Wagner 2004, Holdren et al. (2001), http://plants.ifas.ufl.edu/manage/.

Common	Code(s)	Copper Complex	Diquat	Endothall (Aquathol)	Glyphosate	2,4-D		Fluridone	Triclopyr
						Granular	Liquid		
Algae									
Filamentous	ALGAE	E	G	G[3]					
Planktonic	ALGAE	E	P	G[3]					
Stonewort	CHARA	E	P	G[3]					
Floating									
Bladderworts	UTMA		G			G, F		G	
Mexican Water Fern	AZME		G		F		F	E	
Duckweed	LEMI3, SPPO		G, F				F	E	
Salvinia			G		G		G	E, F	
Water hyacinth		G[1]	E		G		E	E	E
Water lettuce		G[1]	E		G		F, G	G	G, *
Watermeal	WOCO		F			F		G	
Floating-leaved									
Lily	NYODT, NYODO		P	Pi	E, G	E, F		E, F	G
Lotus	NELU				G	G	F	F	
Spatterdock	NULU				G	E	F	F	
Watershield	BRSC		P		G	E, F		G, F	
Submersed									
Coontail	CEDE4	G[1]	E	E		G		E	
Elodea	ELCA7	G[1]	E	F, P				E	
Fanwort	CABOM		G	F		F		E	
Hydrilla	HYVE3	G[1]	E, G	E, G				E	
Milfoil, Eurasian	MYSP2		G	G		G		G	E
Milfoil, other		G[1]	G			E		G	E
Niade, brittle	NAMI	P	E	E		F		E, G	
Niade, southern, slender	NAGU, NAFL	G[1], P	E, G	E, G		F		E, G	
Parrot feather	MYAQ2	P	E, G	E		E, G, F		E, F	G, F
Pondweed spp.			G	E		P		E	
Pondweed, longleaf	PONO2		G	E	Pi			E	
Pondweed, curly	POCR3		E, G	E		P		E	
Pondweed, horned	ZAPA					P			
Pondweed, Illinois	POIL		G, F	E, G		P, F		E, F	
Pondweed, largeleaf	POAM5		F	G		F		F	
Pondweed, claspingleaf	PORI2		F	G		P, F		F	
Pondweed, sago	STPE15		G[2]	E		P		E	
Pondweed, small-leaved	POFO3, POPU7		Gi			P			
Water chestnut						G		F	
Water marigold			G				Y	F	
White water	RAAQ		G				Y	F	

Common	Code(s)	Copper Complex	Diquat	Endothall (Aquathol)	Glyphosate	2,4-D		Fluridone	Triclopyr
						Granular	Liquid		
crowfoot									
Wild celery	VAAM3		F	F					F
Emergent									
Arrowhead	SAGIT				G			Y	
Button bush			F	P	G	F		P	
Canary grass	PHAR3		P		P[i]				
Cattails	TYLA, TYAN		G, F	P	E	F		F	
Giant reed	PHAU7		F		E	F		F	
Purple loosestrife	LYSA2				G				
Rush, flowering					F				
Spikerush	ELEOC, ELPA3		F					F	
Water primrose	LUPE5		F	P	E	E		F	E
Willows			F	P	E	E		P	E

*not recommended,
[1]Specific copper complexes only (see labels),
[2]Alone or with complexed copper,
[3]Hydrothol formulation,
[i]Iowa result

Case study 5: In 2008 the upper end and much of the western shoreline of Lake of 3 Fires, Taylor County, IA (95 acres) were covered with lotus.
Goal: Significantly reduce the area covered by lotus.
Strategy: Treatment with glyphosate began in late summer 2008 with both a boom and hand- held sprayer. Annual late summer treatments were made through 2010.
Results: 75% reduction of lotus over a three year treatment period. These treatments were discontinued and by summer of 2012 the level of infestation was back to original levels.
Conclusion: A lotus infestation will need to be controlled with herbicide at regular intervals.

- ***Glyphosate*** is a fast-acting systemic herbicide (i.e., being translocated from the leaves through the stems to the roots) that can be used to control most emergent and floating-leaved species. A surfactant must be added so the chemical will stick to leaves. Rinsing by prop-wash, waves or rainfall should be avoided for a number of hours after treatment (refer to the specific product label, typically a 6 hour contact time is needed).

  Advantages: Minimal cost. Low toxicity in water. The entire plant is killed (i.e. leaves, stems and roots).
  Disadvantages: Spray application drift is non-selective.

- ***2, 4-D*** is a fast-acting, systemic herbicide effective only on dicots (e.g., broadleaves - milfoils, lilies, stargrass, bladderwort, coontail, water chestnut). It is available in liquid or granular forms (sodium and potassium salts, ammonia or amine salts and as an ester, though the liquid ester formulation is harmful to fish). In sensitive environments where there can be several broadleaf species, invasive species have been enclosed behind plastic curtains for treatment with 2,4 D (Holdren et al. 2001). Treat early in the season before winter-bud or seed formation.

  Advantages: Selectively treats Eurasian milfoil and other broadleaved plants with no impact on many native species. The entire plant is killed (i.e. leaves, stems and roots).
  Disadvantages: High in restrictions, negative public perception.

- ***Fluridone*** is a slow-acting, systemic herbicide used to control some floating and most submersed and floating-leaved species (poor control of emergents, no control of algae). Annual control is possible with one application. Testing must be done on lake water to insure that treatment concentration is maintained for 45 days or longer (To determine testing frequency and order testing supplies, contact the manufacturer, each test will cost approximately $90 + S&H). Be prepared to increase the concentration after testing by having extra chemical on

hand.

Advantages: Year-long control is possible. Can use low concentrations to selectively control Eurasian watermilfoil or curlyleaf pondweed.
Disadvantages: High cost, long contact period required, slow action.

- ***Triclopyr*** is a slow-acting, systemic herbicide that is effective in controlling some dicots (e.g., milfoil spp., lilies, purple loosestrife, waterhyacinth). Use a surfactant when treating emergent or floating-leaved species.

  Advantages: Selectively treats broadleaved species with no impact on many native species.
  Disadvantages: Slow action.

Failed or poor chemical control

- ***Herbicide Resistance*****.** Over a period of years using the same herbicide to treat the same location, plants can develop resistance and no longer be effectively controlled. Strategies to reduce the chances of resistance include: rotating herbicide active ingredient or mode of action, using different modes of action within the same season, and/or using non-chemical control (Madsen et al. 2012). For lotus control where treatment may be required annually, keeping notes on the effectiveness of annual control will help in making an unlikely diagnosis of herbicide resistance.

  Other factors more likely to cause poor or failed chemical control are:
  1. Incorrect plant ID
  2. Rate miscalculation
  3. Improper application (e.g., surface applied when subsurface necessary for contact).
  4. Wrong timing (too late, too early)
  5. Water properties (temperature, chemistry or turbidity)
  6. Weather complications (rainstorms, high winds, extended cloud cover)
  7. Failure to follow label instructions (e.g. use of a surfactant or adjuvant).

Biological

Grass Carp

In Iowa, the use of grass carp (or white amur) for the suppression of rooted aquatic plants has most often led to eradication of aquatic plants. Complete eradication often results because grass carp reduce the plant population to a level that it no longer uses enough plant nutrients, shades, or has alelopathic influences on the algae population during the growing season. This critically low plant density in the face of high levels of plant nutrients can result in dense algae blooms that shade out the remaining vegetation and is difficult to reverse. Grass carp can live over 30 years and experience very low mortality. So for many years the lake may be held in a turbid state which negatively impacts the recreational fishery and lake aesthetics. For this reason grass carp are no longer being used as a vegetation control strategy by the Fisheries Bureau of the Iowa DNR in public waters.

Herbivorous insects

When an invasive species is transported from its native habitat, it does not come with any of the predators that controlled its abundance in its native environment. For this reason insects, both naturalized and native, have been researched for use for the control of invasive plant species across the United States (Cuda 2009, Getsinger et al. 2005). Many of the most noxious invasive plants have either yet to appear in Iowa (e.g. *Egeria*, flowering rush (*Butomus umbellatus*), *Hydrilla*, waterchestnut (*Trapa natans*), or are not a problem here due to the temperate climate (e.g. water lettuce (*Pistia stratiotes*), waterhyacinth (*Eichhornia crassipes*). Aquatic plant species present in Iowa where biological control has been attempted using insects include:

- Eurasian watermilfoil (*Myriophyllum spicatum*): No introduced insect species has been successful at reliable control. Several native species have been associated with declines in northern states, though assessment of these species as biocontrol agents is difficult (Cuda 2009) and control is not predictable (Madsen 2009).
- Purple loosestrife (*Lythrum salicaria*): Introduction of leaf-feeding beetles (*Calerucella calmariensis* and *G. pusilla*) has resulted in up to 90-95% reduction in biomass in some areas (Cuda 2009, Johnson 2009). Two

weevils (*Hylobius transversovittatus* and *Nanophyes marmoratus*) have also been found to contribute to successful control of purple loosestrife (Cuda 2009).

Pulling a small seine to detect large populations of crayfish is recommended in small, plant- free waters that are being considered for planting to provide a nursery population of plants for future introductions.

Plant Introduction

One experimental, method of controlling aquatic plant growth that can be integrated with other control methods is to foster competition by introducing desirable native species. Desirable species are those whose growth forms and habits do not normally result in a nuisance to recreational users or lake managers. Pioneer species will become established after new construction or after any form of disturbance (e.g., drawdown or lake dewatering for lake restoration activities, herbicide control). These same disturbances can also favor establishment or spread of invasive species. In constructed waters, pioneer species include sago pondweed (*Stuckenia pectinatus*), southern and slender naiad (*Najas guadalupensis, N. flexilis*), horned pondweed (*Zannichellia palustris*), leafy and small pondweed (*Potamogeton foliosus, P. pusillus*). These fine- leaved species, though valuable for fishery habitat and improved water clarity, can grow in dense beds that inhibit shoreline angling and even boat traffic where water is clear and depths are less than eight feet. The same is true of invasive species such as curly-leaf pondweed, Eurasian watermilfoil, and brittle naiad. Proactively encouraging a diverse mix of native species by introducing desirable aquatic plants is one strategy that may help prevent the spread and dominance of nuisance exotic plants (Smart et al. 1998). A diverse plant community will also provide valuable fish and wildlife habitat, improve water clarity, and provide anglers with a diversity of fishing habitat.

Lakes to target for plant introduction include those with very low abundance of aquatic plants and favorable conditions (i.e., lack of common and grass carp), new lakes, newly restored lakes, lakes with a low species' diversity or lakes with 25- and 30-year-old grass carp populations that are showing some aquatic plant re- establishment. Prior to engaging in plant introduction in waters that do not support many submersed plants, it can be beneficial to install a small fenced exclosure into shallow water early in the growing season in order to see if plants become established without any planting effort. A heavy-gauge (12ga) 2" x 4" welded wire will exclude all but crayfish (e.g., grass or common carp, muskrats, geese, deer and most turtles), and can be used or re-used for several years (Figure 8). Establishment of submersed plants inside an exclosure within 2-3 weeks is evidence of lake-wide herbivory that will inhibit introduction efforts if exclosures are not used.

Figure 8. **Welded wire exclosure.**

Locally adapted species will likely be most suited and preferred by managers for lakes in each district. Transporting nursery-grown aquatic plants long distances can negatively impact propagated plants and should be avoided if at all possible. Lake managers should start slowly with propagation of a few species and introduction to small water bodies near their base of operation. Cold Springs research staff are available to provide support.

Recommended Species

Recommended species provide fisheries habitat benefits while being less of a barrier to anglers and recreational users, are sometimes easier to control and often aesthetically pleasing. Some are later successional species, though not all. It is important to keep in mind that any species can become a nuisance under the right conditions, and it will be impossible to meet everyone's expectations.

Species that have successfully been established in Iowa include emergent species with shorter height and floating-leaved species that can shade out pioneer species, and submersed species that have larger interstitial spaces, a leaf form that is less prone to entangle fishing lures, or other qualities that make it suitable for introduction (Appendix 7). With the exception of pink water lilies, all species are either native to Iowa and documented in Iowa, or are native to neighboring states. Introductions in Iowa have focused on constructed lakes with relatively stable water levels. More research is needed on introductions in more hostile conditions (e.g., flood-control reservoir).

Hazard Analysis and Critical Control Point (HACCP)

Managers of larger public waters will likely use other public waters as a source of plants for introduction. Therefore, prior to transplanting or propagating any aquatic species, it is necessary to have a plan in place to ensure that invasive aquatic species are not introduced. Because there is risk of AIS in any water with public access, avoid inadvertently introducing AIS into other waters using a two-fold approach. First, work to establish sources for future introduction in smaller waters with limited public access. Examples of these areas include small wildlife or county conservation area ponds, silt ponds or wetlands above larger lakes. Though it will take several years for these plants to become established, plants harvested from these waters will have a much reduced chance of harboring AIS. Second, because we may not have a choice except to obtain some of our plant stock from larger public waters, employ a HACCP procedure that will eliminate AIS:

1. Do not harvest any plants from waters with known populations of Eurasian water milfoil, brittle naiad, or zebra mussels.
2. When harvesting plants that will establish from stem cuttings, do not harvest the roots; roots are harder to clean than stems. For water willow, harvest just the portion of the stem that is above water, do not immerse stems in the lake (and skip step 3).
3. For all plants harvested with roots or from below the water's surface from any water body employ a "triple-wash" cleaning process prior to transplanting or propagating any plant roots or stem cuttings.

    - Transport plants in a cooler or similar container to the propagation facility (Situation A) or to the lake into which plants will be transplanted (Situation B). Empty water from the transport container (away from the water's edge) and move the plants into another container with either (Situation A) tap/well water or (Situation B) lake water. Set up several large containers and fill each with clean tap/well or lake water (Figure 9). Pick up one plant or root at a time and wash in the first container, being careful to observe and remove any foreign matter. At this time, cut stems into pieces for planting or trim leaves from plants with roots as needed. Repeat this process two more times into clean water. Plants are now ready for planting or propagation.

4. This 3-step procedure should also be used when using cuttings or dormant rootstock purchased from commercial sources.

Figure 9. Plant going through HACCP triple wash.

Collection, transportation, propagation and planting

Specifics for techniques used to introduce aquatic plants can be found in the plant introduction companion to this manual.

Funding Available for Plant Introduction Projects

As of this writing the only known funding for aquatic plant introduction projects is through DNR County Fish Habitat Grants. Eligible costs include purchased plants, erosion control materials necessary for plant establishment, as well as materials for exclosures.

Special Considerations

Plant Management in Natural Lakes

Many of the above strategies can be successfully implemented in Iowa's natural lakes. One important consideration when managing plants on natural lakes is that the state of Iowa holds sovereign title in trust for the benefit of the public to the beds of natural or meandered lakes and rivers. Permitting authority for construction and other projects is governed to the Iowa Department of Natural Resources through 571 Iowa Administrative Code Chapter 13 (Appendix 8), and for removal or introduction of vegetation through Chapter 54 (Appendix 9).

Furthermore, unlike constructed lakes in public ownership, many of these lakes have a majority of the shoreline in private ownership. Therefore differing goals and expectations may exist. Managers should work with existing lake associations to prepare a lake-specific vegetation management plan with agreed upon goals and strategies. The vegetation management plan could also be a part of a more encompassing lake plan that included guidance and rules for other lake uses. In developing any lake plan an indispensible reference for both the biologist and public stake holders would be the "Managing Lakes and Reservoirs" manual (Holdren et al. 2001). Chapters cover ecological concepts, planning, problem identification, predicting lake water quality, watershed management, in-lake management techniques, management plan development and implementation, and lake protection and maintenance. The manual was published as a cooperative project between the North American Lake Management Society, Terrene Institute and US Environmental Protection Agency.

Plant Management Strategies to Include in Lake Restoration Planning

An impaired lake (and watershed) that could provide recreational angling, whether urban or rural, ultimately needs to be considered for restoration. Implementation is a lengthy process, evolving over the course of 3-5 years depending on the lake's problems, statewide priority, and ease of restoration. Practices to implement during the restoration process that can limit nuisance plant growth include:

- **Watershed land use practices.** Keeping soil and associated nutrients on the land for as long as possible by using appropriate BMPs is by far the best strategy to limit in-lake plant growth.
- **Littoral deepening and shaping**. Increase depth of near shore areas with dry dredging or jetty creation. Serves to remove seedbed of existing plants as well as create areas where light will not reach the bottom to encourage plant growth. Can also selectively make some shoreline areas shallow to encourage plant growth.
- **Limnetic deepening**. This practice is implemented with mechanical or hydraulic with dredging.
- **Bottom blanketing**. See Preventive Control section (page 15).
- **Emergent / submersed plant restoration**. Emergent plant restoration is done in shallow, natural lakes by implementing an extended drawdown period to encourage emergent plant growth as well as sediment consolidation. Submersed plants can be introduced, ideally, during the first year a restored lake fills to take advantage of the clear water. See Biological Control (page 25).
- **Selective withdrawal**. Instead of allowing the water with the least amount of plant nutrients and the most zooplankton (i.e. secondary production) to be lost from the lake at times of high flow, modify the overflow structure to allow the withdrawal of water from the bottom where plant nutrients are in higher concentration. See Mechanical/Physical Control section (page 16).
- **Plant introduction**. Shortly after completing lake restoration, work to introduce desirable aquatic plants as part of an integrated control strategy. See Biological Control section (page 25).

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Appendix 1. Aquatic plants commonly found in Iowa lakes.

Common Name	Scientific Name	Plant Code
Submersed		
Bladderwort	*Utricularia macrorhiza*	UTMA
Canada Waterweed	*Elodea canadensis*	ELCA7
Coontail	*Ceratophyllum demersum*	CEDE4
Pondweed	*Potamogeton sp.*	POTAM
Pondweed, Claspingleaf	*Potamogeton richardsonii*	PORI2
Pondweed, Curlyleaf	*Potamogeton crispus*	POCR3
Pondweed, Flatstem	*Potamogeton zosteriformis*	POZO
Pondweed, Floatingleaf	*Potamogeton natans*	PONA4
Pondweed, Fries	*Potamogeton friesii*	POFR3
Pondweed, Horned	*Zannichellia palustris*	ZAPA
Pondweed, Illinois	*Potamogeton illinoensis*	POIL
Pondweed, Largeleaf	*Potamogeton amplifolius*	POAM5
Pondweed, Leafy	*Potamogeton foliosus*	POFO3
Pondweed, Longleaf	*Potamogeton nodosus*	PONO2
Pondweed, Sago	*Stuckenia pectinatus*	STPE15
Pondweed, Small	*Potamogeton pusillus*	POPU7
Muskgrass	*Chara vulgaris*	CHARA
Naiad, Brittle	*Najas minor*	NAMI
Naiad, Slender/ Bushy Pondweed	*Najas flexilis*	NAFL
Naiad, Southern	*Najas guadalupensis*	NAGU
Watermilfoil, Eurasian	*Myriophyllum spicatum*	MYSP2
Watermilfoil, Northern	*Myriophyllum sibiricum*	MYSI
Water Stargrass	*Heteranthera dubia*	HEDU2
White Water Crowfoot	*Ranunculus aquatilis*	RAAQ
White Water Crowfoot II	*Ranunculus longirostris*	RALO2
Widgeon Grass	*Ruppia maritima*	RUMA5
Wild Celery	*Vallisneria americana*	VAAM3
Emergent		
Arrowhead	*Sagittaria sp.*	SAGIT
Arrowhead, Broadleaf	*Sagittaria latifolia*	SALA2
Arrowhead, Narrowleaf	*Sagittaria cuneata*	SACU
Blue Flag Iris	*Iris versicolor*	IRVE2

Common Name	Scientific Name	Plant Code
Bulrush	*Schoenoplectus sp.*	SCHOE 6
Bulrush, Green	*Scirpus atrovirens*	SCAT2
Bulrush, Hardstem	*Schoenoplectus acutus*	SCAC3
Bulrush, River	*Schoenoplectus fluviatilis*	SCFL11
Bulrush, Softstem	*Schoenoplectus tabernaemontani*	SCTA2
Burhead, Upright	*Echinodorus berteroi*	ECBE2
Burreed	*Sparganium sp.*	SPARG
Quillwort	*Isoetes sp.*	ISOET
Burreed, Giant	*Sparganium eurycarpum*	SPEU
Cattail	*Typha sp.*	TYPHA
Cattail, Common	*Typha latifolia*	TYLA
Cattail, Hybrid	*Typha × glauca*	TYGL
Cattail, Narrowleaf	*Typha angustifolia*	TYAN
Giant Reed	*Phragmites australis*	PHAU7
Marsh Milkweed	*Asclepias incarnata*	ASIN
Pickerelweed	*Pontederia cordata*	POCO14
Prairie Cordgrass	*Spartina pectinata*	SPPE
Purple Loosestrife	*Lythrum salicaria*	LYSA2
Reed Canarygrass	*Phalaris arundinacea*	PHAR3
Rice Cutgrass	*Leersia oryzoides*	LEOR
Rush, Common	*Juncus effusus*	JUEF
Sedge	*Carex sp.*	CAREX
Smartweed	*Polygonum sp.*	POLYG
Smartweed, Water	*Polygonum amphibium*	POAM8
Spikerush	*Eleocharis sp.*	ELEOC
Sweet Flag	*Acorus calamus*	ACAM
Water Horsetail	*Equisetum fluviatile*	EQFL
Water Plantain	*Alisma sp.*	ALISM
Water Willow	*Justicia americana*	JUAM
Floating leafed		
American Lotus	*Nelumbo lutea*	NELU
Duckweed, Big	*Spirodela polyrrhiza*	SPPO
Duckweed, Little	*Lemna minor*	LEMI3
Duckweed, Star	*Lemna trisulca*	LETR
Mexican Water-fern	*Azolla mexicana*	AZME
Pondweed, Floating leaf	*Potamogeton natans*	PONA4
Pondweed, Illinois	*Potamogeton illinoensis*	POIL
Pondweed, Longleaf	*Potamogeton nodosus*	PONO2

Common Name	Scientific Name	Plant Code
Waterlily, Fragrant	*Nymphaea odorata odorata*	NYODO
Waterlily, White	*Nymphaea odorata tuberosa*	NYODT
Waterlily, Yellow	*Nuphar lutea variegata*	NULU
Watermeal	*Wolffia columbiana*	WOCO
Water Clover	*Marsilea spp.*	MARSI

Common Name	Scientific Name	Plant Code
Water Shield	*Brasenia schreberi*	BRSC
Other Codes		
Algae	*All species of green algae*	ALGAE
No Aquatic Vegetation		NOVEG
Unknown species		UNK

Source: http://plants.nrcs.usda.gov/cgi_bin/topics.cgi?earl=dl_state.html

Appendix 2. Web Resources for Aquatic Plant ID

1. http://www.outdooralabama.com/fishing/freshwater/where/ponds/p/ap/guide/ Part of the Alabama Department of Conservation and Natural Resources website. By far the best and easiest to use picture key for aquatic plants. Has most common Iowa species.
2. http://aquaplant.tamu.edu/ Texas A&M University, Extension, Pond Manager Diagnostics Tool. Another excellent resource. Can use either alphabetical or visual index for identification. Once species is known lists methods available for control and cultivation. Note: Pond fertilization is a common recommendation for suppression in southern waters that would not be suitable for Iowa ponds. Grass carp stocking rates are also a bit on the high side. Tilapia are sometimes recommended as a biological control.
3. http://el.erdc.usace.army.mil/aqua/apis/Intro.aspx USACE Aquatic Plant Information System (APIS). Lists control methods for each species. Handy ID Systems appropriate for technical as well as non-technical users. Site is a bit slow.
4. www.ecy.wa.gov/programs/wq/plants/plantid2/index.html On-line version of an "Aquatic Plant Identification Manual for Washington's Freshwater Plants"
5. http://plants.usda.gov/ USDA Plants Database. Can have photos, shows nation-wide distribution. We use these codes for our plant surveys, can type in a code and get to the plant (1st 2 letters of Genus and 1st two letters of species name)
6. http://www.uwgb.edu/biodiversity/herbarium/wetland_plants/wetland_plants01.htm The Cofrin Center for Biodiversity herbarium site. Features about 200 species of wetland species. Excellent photos. Botanical terms are explained in photos and text.
7. www.npwrc.usgs.gov/resource/plants/floramw/species.htm USGS, Northern Prairie Wildlife Research Center. Wetland Flora ID Key
8. http://plants.ifas.ufl.edu/node/488 University of Florida, Center for Aquatic and Invasive Plants, plant photo gallery. Also has other links to handy plant information.
9. http://www.aquatics.org/index.htm Aquatic Ecosystem Restoration Foundation (AERF) To answer questions about aquatic invasive species management and herbicides for control.
10. http://www.missouriplants.com/index.html Missouri flora. Neat online key with great photos of many aquatic plants, especially emergent. Just need to start with leaf arrangement and flower color.
11. http://mdc.mo.gov/landwater-care/lake-and-pond-management/aquaguides MO Dept of Conservation site for Lake and Pond Management articles and Aquaguide factsheets.
12. http://www.efloras.org/ World-wide flora. True online dichotomous key. Includes Missouri and North America categories. Start with the family name of your plant of interest; this is a good dichotomous key. May need a botanical terms guide (see below).
13. http://en.wikipedia.org/wiki/Glossary_of_botanical_terms This is a good list of botanical terms and definitions. Sometimes a web search is also instructive.
14. http://www.iowadnr.gov/Environment/ThreatenedEndangered.aspx To see a list of plants that are listed in Iowa as endangered, threatened and species of special concern.

Appendix 3. Aquatic Plant Vouchering

Voucher Specimen Collection

1. As plant species in a lake are encountered for the first time, they should be saved as a voucher specimen. ***Digital photos will suffice for common species, though should be taken of all species to include with the pressed plant***. If possible, photograph or collect plants that have seeds or fruiting structures, in many cases these are the only thing that will allow the plant to be keyed to species. Other notes to take for each species include: substrate type, water depth, plant height, root type, growth form and abundance. A field data sheet is available for field use from Cold Springs research staff (Table Appendix 3-1 below).

Table Appendix 3-1. Data sheet to use when colleting aquatic plants that will be voucher specimens

Lake:	Plant Height:
Transect #:	Picture: ☐ Yes ☐ N
Specimen #:	Abundance:
Collector:	GPS Coord.:
Office:	**Reproductive Structure:** ☐ seeds ☐ flowers ☐ other ☐ none
Date:	**Root Structure:** ☐ taproot ☐ fine roots ☐ tuberous ☐ rhizome
Depth:	**Soil Substrate:** ☐ boulder ☐ riprap ☐ gravel ☐ sand ☐ clay ☐ silt
Notes:	

2. Plants collected in the field should be stored in water until you identify and press them, coolers or zip- lock bags filled with water work well for storing plants in the field.

3. Staff at the Cold Springs, Decorah and Bellview offices are available to help with plant i.d. Send your digital photos for assistance with identification.

4. After identification, put plants in a plant press. These are designed to dry the plant as quickly as possible. To press a delicate, submersed or floating leaved plant, the specimen can be floated in a pan of water with a submerged piece of newspaper underneath the plant and carefully lifted out. Place this wet paper on top of other newspapers to dry excess moisture. Flowers or fruiting structures should be clearly visible, move leaves and stems if necessary. Place a label and a copy of the field data sheet with the specimen.

5. With all plants, but especially with emergent species, pull, clean, and press a portion of the plant's roots. Stems can be cut or folded, and plant height noted in the field notes. Always press the seed head with the plant. Thick structures may need to be cut in half before pressing.

6. Plant presses are arranged for plant pressing in the following sequence of steps:
    i. Bottom of plant press
    ii. Cardboard
    iii. Blotter paper(thick paper towel)
    iv. Newspaper
    v. Plant
    vi. Newspaper
    vii. Blotter paper(thick paper towel)
    viii. Cardboard
    ix. Insert ii-vii for each plant
    x. Top of plant press
    xi. Wrap straps around frame and tighten.

7. The press should be put in a warm place to speed the drying process (e.g. inside a vehicle on a warm day).

8. Multiple plants can be preserved in one plant press at the same time.

9. Once pressed and dried, sheets can be stored in a large envelope. Cold Springs research staff can mount your plants onto herbarium sheets and return them to you. This will insure that the plants don't deteriorate, and provide a long-term record.

Appendix 4. Aquatic Plant Sampling Data Sheets.

Aquatic Plant Survey Cover Sheet

Date: _____ Lake Code: _____ Lake Level (in): + -

Time: _____ Secchi Disk (in): _____ Algae Bloom? ☐ Yes ☐ No

Wave Intensity: ☐ Calm ☐ Slight ☐ Moderate ☐ Severe ☐ Extreme Air Temp (°F): _____

Wind Direction: _____ Cond. (µmhos/cm): _____ Depth to Bottom: _____

Comments: _____

Survey Crew: _____

Depth	°F	ppm O_2	Depth	°F	ppm O_2	Depth	°F	ppm O_2
Surface			16'			32'		
1'			17'			33'		
2'			18'			34'		
3'			19'			35'		
4'			20'			36'		
5'			21'			37'		
6'			22'			38'		
7'			23'			39'		
8'			24'			40'		
9'			25'			41'		
10'			26'			42'		
11'			27'			43'		
12'			28'			44'		
13'			29'			45'		
14'			30'			46'		
15'			31'			47'		

Lowest DO Reading Limited by cable length? ☐ Yes ☐ No

Was the DO meter calibrated today? ☐ Yes ☐ No

Rake % Density Examples

20 **40** **60** **80** **100**

Single Species Plant Abundance: Individual species collected at each station of a transect will be broken down into 1% increments and recorded as a percent. These densities should add to 100%.

Aquatic Plant Survey Data Sheet

Date: _____ Lake Code: _____ Page _____ of _____

Emergent and Floating Leaf									
Transect:	Edge	2’	4’	6’	8’	10’	12’	14’	16’
Total % Cover									
Species Code	Single Species % Plant Abundance								
Submersed									
Rake Density									
Species Code	Single Species % Plant Abundance								
Additional Species**									
Substrate Type*									

Vegetation Greater than 16’ ☐ Yes ☐ No

Additional Comments: _____

Emergent and Floating Leaf									
Transect:	Edge	2’	4’	6’	8’	10’	12’	14’	16’
Total % Cover									
Species Code	Single Species % Plant Abundance								
Submersed									
Rake Density									
Species Code	Single Species % Plant Abundance								
Additional Species**									
Substrate Type*									

Vegetation Greater than 16’ ☐ Yes ☐ No

Additional Comments: _____

*Substrate codes: be-bedrock; bo-boulder; ri-riprap; co-cobble; gr-gravel; ca-sand; si-silt; cl-clay, mu-muck; de-detritus

**Additional species will not be given a percent cover or percent density. If location is between stations “T” for true will be recorded on both contours on the line for that additional species.

Appendix 5. Aquatic Herbicide Information and Forms

Appendix 5A

Class C Iowa Lakes

Key: "A" = contact recreation uses. "A1" = primary contact recreation uses, "A2" = secondary contact recreation uses, and "A3" = children's contact recreation uses. "B" = wildlife and aquatic life uses. "WW-1" = warm water – type 1, "WW-2" = warm water – type 2, and "WW-3" = warm water type 3. "LW" = lakes and wetlands warm water, "C" = raw water source of potable water supply. "HH" = human health. "R" = range. "T" = township. "S" = section, "¼" = quarter.

County	Waterbody Name	¼	S	T	R	A1	A2	B (LW)	HH	C
Adair	Greenfield Lake		13	75	32			X	X	X
Adair	Nodaway Lake County Park		14	75	32	X		X	X	X
Adair	Orient Lake RA		20	74	31	X		X	X	X
Adams	Binder Lake		25	72	34	X		X	X	X
Adams	Lake Icaria County RA		10	72	34	X		X	X	X
Adams	West Lake Corning (aka Corning Reservoir)	SE	26	72	34			X	X	X
Appanoose	Lower Centerville Reservoir		12	68	18	X		X	X	X
Appanoose	Mystic Reservoir		8	69	18	X		X	X	X
Appanoose	Upper Centerville Reservoir (Lelah Bradly Park)		11	68	18	X		X	X	X
Cerro Gordo	Clear Lake State Park		13	96	22	X		X	X	X
Clarke	West Lake (Osceola)		13	72	26			X	X	X
Davis	Lake Fisher Park		23	69	14			X	X	X
Davis	Lake Wapello State Park		34	70	15	X		X	X	X
Decatur	Home Pond		3	67	27			X	X	X
Decatur	Lake LeShane		4	67	27	X		X	X	X
Decatur	Little River Watershed RA Lake		19	69	25	X		X	X	X
Decatur	Nine Eagles State Park Lake		18	67	25	X		X	X	X
Dickinson	Big Spirit Lake SGMA		33	100	36	X	X	X	X	X
Dickinson	Silver Lake SGMA		28	100	38	X		X	X	X
Dickinson	West Okoboji Lake SGMA		20	99	36	X	X	X	X	X
Emmet	Iowa Lake SGMA		12	100	31			X	X	X
Henry	Geode Lake State Park		36	70	5	X		X	X	X
Jasper	Rock Creek Lake State Park		17	80	17	X		X	X	X
Jefferson	Fairfield Municipal Reservoir #1		24	72	10			X	X	X
Jefferson	Fairfield Municipal Reservoir #2		24	72	10			X	X	X
Jefferson	Walton Reservoir		30	72	9			X	X	X
Lucas	Ellis Lake		27	72	21			X	X	X
Lucas	Morris Lake		26	72	21			X	X	X
Lucas	Red Haw Lake State Park		33	72	21		X	X	X	X
Madison	Cedar Lake (aka Winterset City Reservoir)		19	76	27			X	X	X
Mahaska	Lake Keomah State Park		13	75	15		X	X	X	X
Monroe	Albia City Reservoir		9	72	17		X	X	X	X
Montgomery	Viking Lake State Park		6	71	36		X	X	X	X
Polk	Dale Moffitt Reservoir		31	78	25		X	X	X	X
Polk	Des Moines Water Works Recharge		12	78	24		X	X	X	X

	Basins							
Poweshiek	Diamond Lake County Park	2	78	15		X	X	X
Ringgold	Loch Ayr Reservoir	30	69	29	X	X	X	X
Shelby	Prairie Rose Lake State Park	36	79	38	X	X	X	X
Taylor	Bedford Impoundment	26	68	34		X	X	X
Taylor	East Lake (Lenox)	5	70	32	X	X	X	X
Taylor	Lake of Three Fires State Park	12	68	34	X	X	X	X
Taylor	West Lake (Lenox)	5	70	32		X	X	X
Union	Afton City Reservoir	17	72	29		X	X	X
Union	Green Valley Lake State Park	26	73	31	X	X	X	X
Union	Summit Lake	3	72	31		X	X	X
Union	Three Mile Lake	32	73	29		X	X	X
Union	Twelve Mile Creek Lake	12	72	30	X	X	X	X
Van Buren	Lacey Keosauqua State Park Lake	2	68	10	X	X	X	X
Warren	Lake Ahquabi State Park	14	75	24	X	X	X	X
Washington	Lake Darling State Park	21	74	9	X	X	X	X
Wayne	Bob White Lake State Park	4	68	22	X	X	X	X
Wayne	Corydon Reservoir Park	24	69	22	X	X	X	X
Wayne	Humeston Reservoir Park	9	70	23	X	X	X	X
Wayne	Lineville Reservoir	16	67	23		X	X	X
Wayne	Seymour Reservoir	23	68	20	X	X	X	X

Appendix 5B

IOWA DEPARTMENT OF NATURAL RESOURCES

Aquatic Pesticide Application to Prohibited Water
PERMIT APPLICATION FORM

Applicant Name: _____

Address: _____

Email: _____ Phone: _____

Name of Receiving Water (lake, river, stream): _____

Department of Agriculture and Land Stewardship - Category - 5 (Aquatic Pest Control) Certification Number (or enclosed copy of the Certificate): _____

Purpose of Applying the Aquatic Pesticide. (Ex. To control submerged weed growth around dock)

Brief Description of Location of Aquatic Pesticide Application (include address of frontage property):

Sec: _____ Twp: _____ Range: _____ County: _____

Address: _____

Brief Description of Location of Aquatic Pesticide Application (include sketch on side 2). (Example: 50' along both sides of 200' boat dock and walkway located on the west side of Green Beach 80 feet south of Highway 1)

1. Describe the time period (Ex. Beginning June 15 through September 15): _____

2. Frequency of Aquatic Pesticide Application (Ex. Once every 30 days as needed.): _____

3. Rate of Pesticide Application: _____

Brand Name of Aquatic Pesticide: _____

Manufacturer: _____

EPA Pesticide Registration No: _____

Listing & % by weight of Active Ingredient: _____

Name and Location of Known Public and Private Water Supply Intakes within 2000 feet of Application Area and Wells within 50 feet (must be included in the sketch)

Internal Use Only

Permit No: _____ Date Issued: _____

For Sketch of Application Area

(Include important physical features within 2000 feet of application area)

I CERTIFY THAT THE INFORMATION CONTAINED IN THIS APPLICATION IS TRUE, ACCURTAE, AND COMPLETE TO THE BEST OF MY KNOWLEDGE.

Signature _____ **Date** _____

Appendix 5C

Data sheet for recording herbicide treatment information in the field.

Iowa Department of Natural Resources Fisheries Bureau

Herbicide Application Notes

Date: _____ Waterbody: _____ Lake Level (in): + _____ -

Air Temp (°F): _____ Secchi Disk (in): _____ Algae Bloom? ☐ Yes ☐ No

Chemical Applied: _____ Brand: _____ % Active Ingredient: _____

Applicator's: _____ Water Temp (°F): _____

Method of Application: ☐ Surface Wand ☐ Surface Boom ☐ Broadcast (granular)
☐ Subsurface Want ☐ Subsurface Boom ☐ Other: _____

Target Plants:

Species: _____ Species Code(s): _____

% Coverage: _____ Canopy: ☐ Short, subsurface ☐ top-to-bottom ☐ floating leaves
☐ floating and emergent ☐ emergent ☐ free-floating

Weather Conditions:

Wind Direction: _____ Wind Speed (mph estimate): _____

Wave Intensity: ☐ Calm ☐ Slight ☐ Moderate ☐ Severe ☐ Extreme

Precipitation (last 24 hours): _____ Precipitation forecast (next 48 hours): _____

Humidity (estimate): _____ % Cloud cover start: _____ % end: _____

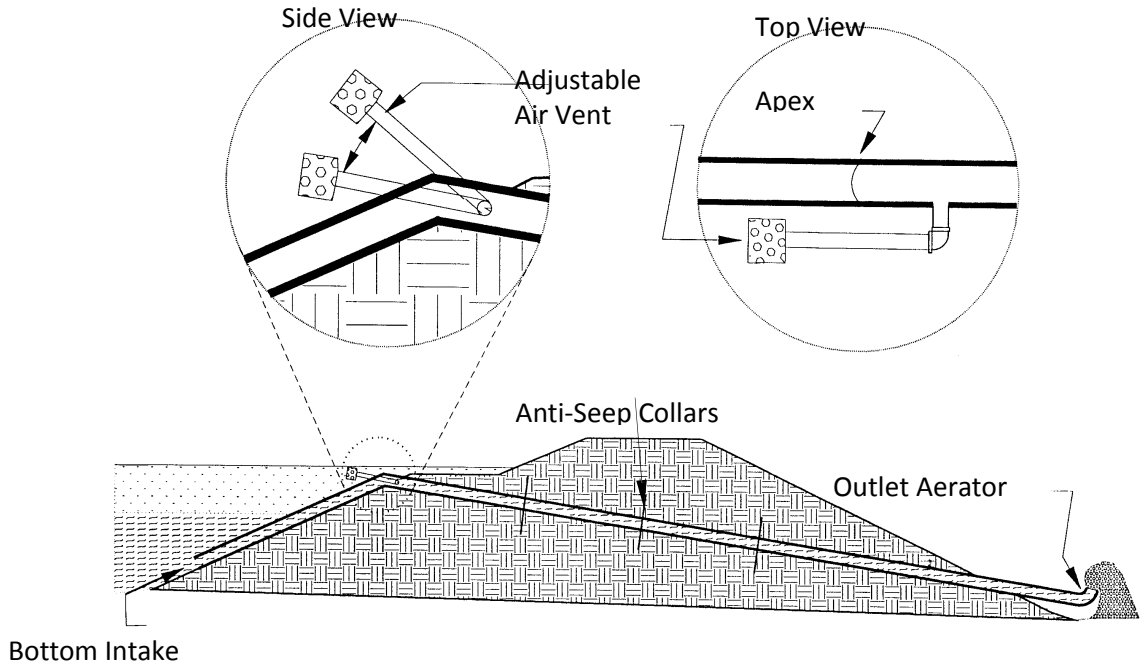
Start Time: _____ End Time: _____

Treatment Area (show on map)	**Surface Area**	**Mean Depth**	**Amount of Chemical** (gal/lbs)	**Dilution**	**Results** (% coverage, date)

Attach a map showing treatment areas. (Use DNR Fisheries lake contour maps http://www.iowadnr.gov/Fishing/Where-to-Fish/Lakes-Ponds-Reservoirs.)

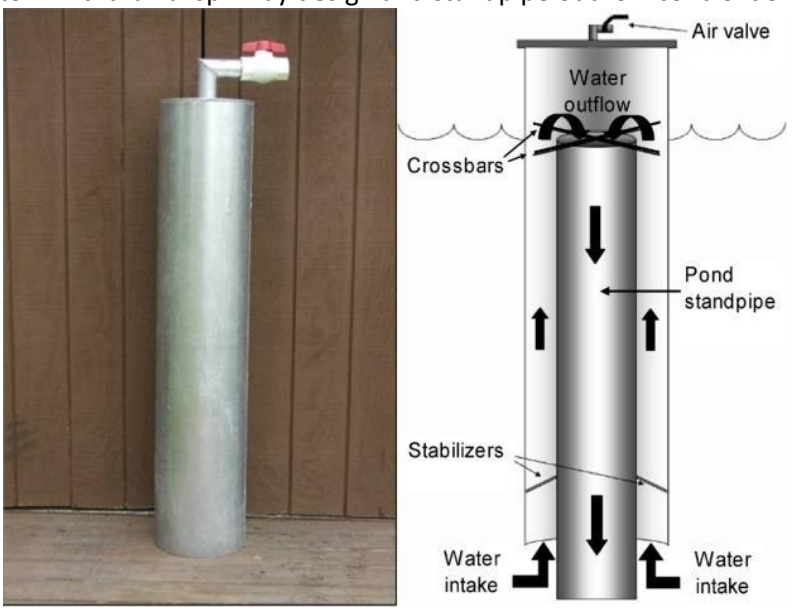
Appendix 6. Bottom Withdrawal Spillway Design

Bottom withdrawal spillway design and standpipe outflow control device.



Used with permission. Clayton, R. 2009. Managing Iowa Fisheries; Building Quality Ponds. Iowa State University Extension. Publication PM 1352k. Additional information concerning the bottom withdrawal spillway may be found in University of Missouri publications: UMC Guide 1530, Operation of a Bottom-withdrawal (Lake-cleaning) Spillway, and UMC Guide 1531, Design Criteria for a Bottom withdrawal (Lake-cleaning) Spillway.

Bottom withdrawal spillway design and standpipe outflow control device.



Pond standpipe Pond Management System™ outflow control device (reproduced from Cope et al. 2008). The 2013 price for a 15" diameter, 6' tall device with a 2" ball valve was ~$900 For information on the Pond Management System™ contact: Cliff Edwards, Premier Ponds Inc, PO Box 36, Louisburg NC 27549, Tel: 919-496-9279

Appendix 7. Aquatic Plant Species Recommended for Introduction

Common Name	Form[1]	Genus	Species	Advantages, Suitability	Introduction Method
Spike rush	E	Eleocharis	quadrangulata[2] & others	Spike rush species spread quickly by rhizome. Good shore protection in small lakes.	Transplant plugs, plants. Propagate root cuttings. Seed[3].
Sweet flag	E	Acorus	calamus	Shorter than cattails, spreads by rhizome.	Transplant root cuttings
Arrowhead	E	Sagittaria	latifolia & others	Short growth form, distinctive leaves. Spreads easily.	Seed. Transplant.
Pickerelweed	E	Pontederia	cordata	Growth form similar to arrowhead. Purple flowers bloom through summer months	Seed. Transplant. Propagate seed[3]
Blue Flag Iris	E	Iris	versicolor	Flowering, shorter than cattails. Not an aggressive spreader	Root division Seed[3]
Water Willow	E	Justicia	americana	(State endangered) Shoreline and shallow water growth. Knee-high.	Stem cuttings.
Upright Burrhead	E, S	Echinodorus	berteroi	Needs clear water for submersed form to grow, never a barrier. <18" tall	Transplant Seedlings[3]. Seeds[3].
Spatterdock	F, E	Nuphar	lutea variegata	Shades submersed species, flowering.	Root cuttings
Water Lily[4]	F	Nymphaea	odorata tuberosa	Shades submersed species, flowering, easy to kill with glyphosate.	Propagated root cuttings.
Largeleaf Pondweed	S, F	Potamogeton	amplifolius	(IA species of concern) Large spaces between leaves, possible to fish through. Holds leaves overwinter, so may successfully establish with curly leaf pondweed.	Propagated stem cuttings. Stem cuttings.
Longleaf Pondweed	S, F	Potamogeton	americana	Does not grow to depths much greater than 3', fairly aggressive spreader.	Propagated stem cuttings. Stem cuttings[3].
Flatstem Pondweed	S	Potamogeton	zosteriformis	Needs clear water, not an aggressive spreader	Propagated stem cuttings.
Water Stargrass	S	Heteranthera	dubia	Late emergence, grows to surface. Can withstand some water level drawdown.	Propagated stem cuttings.
Wild Celery	S	Vallisneria	americana	Relatively easy to fish through.	Transplant dormant roots or growing plants. Propagated plants.

[1]Form; emergent (E), floating- leaved (F), submersed (S).
[2]Species native to neighboring state(s), not noted as being found in Iowa by USDA (http://www.plants.usda.gov/java/)
[3]Should be possible, though more work is needed.
[4]Lilies with both white and pink flowers have been introduced. These are most likely both *N. odorata tuberosa*

Aquatic Plant Species Recommended for Introduction

Image credits: White water lily – Darla Sobatka, all others Cold Springs Research, Iowa DNR

Square-stem spike rush

Sweet Flag

Arrowhead

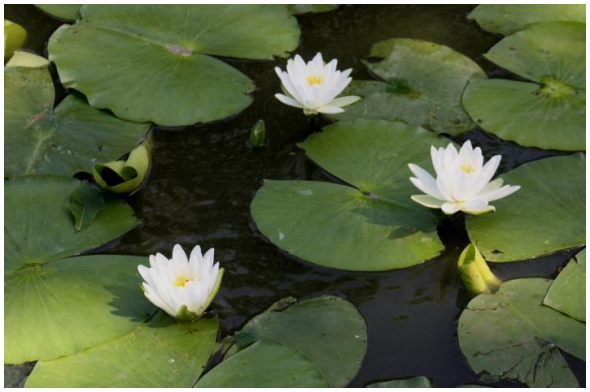
Pickerelweed

Blue flag iris

Water willow

Upright burrhead
Emergent & Underwater Leaves

Spatterdock
Emergent & Floating Leaves



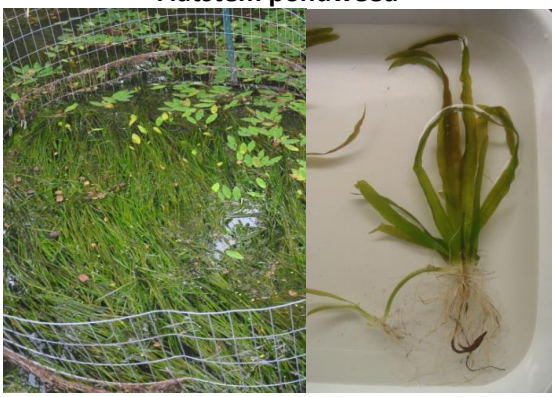
White water lily

Largeleaf pondweed

Long leaf pondweed

Flatstem pondweed

Water star grass



Wild Celery

Appendix 8. State of Iowa Code 571 Chapter 13

PERMITS AND EASEMENTS FOR CONSTRUCTION AND RELATED ACTIVITIES ON PUBLIC LANDS AND WATERS

571—13.1(455A,461A,462A) Purpose. The commission holds lands and waters under its jurisdiction in public trust and protects the interests of all citizens in these lands and waters.

1. These rules establish procedures and regulate the evaluation and issuance of permits for construction or other related activities that alter the physical characteristics of public lands and waters under the jurisdiction of the commission, including those activities that occur over or under such lands and waters. However, these rules shall not apply to activities accomplished by the department and its agents that would only temporarily alter the characteristics of public lands and waters and that would be considered management practices.
2. These rules also establish procedures for issuance of easements to public utilities and political subdivisions for activities that are determined to have a permanent effect on use and enjoyment of public lands and waters under the jurisdiction of the commission.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.2(455A,461A,462A) Affected public lands and waters. These rules are applicable to all fee title lands and waters under the jurisdiction of the commission; dedicated lands and waters under the jurisdiction of the commission and managed by the commission for public access to a meandered sovereign lake or meandered sovereign river; meandered sovereign lakes; meandered sovereign rivers; and sovereign islands, except those portions of the Iowa River and the Mississippi River where title has been conveyed to charter cities.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.3(455A,461A) Definitions. For the purposes of this chapter, the following definitions shall apply:

"Applicant" means a person who applies for a permit or easement pursuant to these rules.

"Authorized agent" means a person, designated by the applicant, who shall be responsible to perform part or all of the proposed activity and who certifies the application according to subrule 13.9(2).

"Canal" means a narrow strip of water, artificially made, between two water bodies described in rule 571— 13.2(455A,461A,462A).

"Cantilever access structure" means a structure constructed for improving the proximity of access to a lake or river, that has a support footing located entirely on littoral or riparian land above the ordinary high water line, and that extends from the footing and is completely suspended above the water at normal water elevation with no occupation of the lakebed or riverbed.

"Channel" means a narrow body of water that may be natural or artificially made.

"Charter cities" means the city of Wapello operating under special charter enacted in 1856; the city of Camanche operating under special charter enacted in 1857; the city of Davenport by chapter 84, Acts of the 47th General Assembly; the cities of Burlington, Clinton, Dubuque, Fort Madison, Keokuk, and Muscatine by chapter 249, Acts of the 51st General Assembly; and the city of Le Claire by chapter 383, Acts of the 58th General Assembly.

"Commercial boat ramp" means a boat ramp installed or maintained as part of a business to provide access to a public water body where use of the ramp is available to the general public.

"Commission" means the natural resource commission.

"Department" means the department of natural resources.

"Director" means the director of the department of natural resources or the director's designee.

"Easement" means an easement authorized under Iowa Code section 461A.25.

"Fee title lands and waters" means lands and waters for which title is acquired by deed or testamentary devise.

"Lease" means a lease authorized under Iowa Code section 461A.25.

"Littoral land" means land abutting a lake.

"Meandered sovereign lakes" means those lakes which, at the time of the original federal government surveys, were surveyed as navigable and important water bodies and were transferred to the states upon their admission to the union to be transferred or retained by the public in accordance with the laws of the respective states. The state of Iowa holds sovereign title in trust for the benefit of the public to the beds of the following lakes:

County	Lake
Allamakee	Kains
	Lansing Big Lake
	Mud Hen
	New Albin Big Lake
Buena Vista	Pickeral
	Storm
Calhoun	North Twin

	South Twin
	Tow Head
Cerro Gordo	Clear
Clay	Dan Green Slough
	Elk
	Mud
	Pickeral
	Round
	Trumbull
Delaware	Center
	Diamond
	East Okoboji
	Hottes
	Jemmerson Slough
	Little Spirit
	Lower Gar
	Marble
	Minnewashta
	Pleasant
	Prairie
	Silver
	Spirit
	Swan
	Upper Gar
	Welch
	West Okoboji
Emmet	Birge
	Cheerers
	East Swan
	Four Mile
	Grass
	High
	Ingham
	Iowa
	Ryan
	Tuttle
	Twelve Mile
	West Swan
Green	Goose
Hamilton	Little Wall
Hancock	Crystal
	Eagle
	East Twin
	West Twin
Harrison	Nobles
Johnson	Swan
Kossuth	Burt
	Goose
Monona	Blue
Osceola	Iowa
	Rush
Palo Alto	Five Island
	Lost Island
	Rush
	Silver
	Virgin
Pocahontas	Clear
	Lizard

Pottawattamie	Carter
	Manawa
Sac	Black Hawk
Winnebago	Harmon
	Rice
Woodbury	Browns
Worth	Silver
Wright	Big Wall
	Cornelia
	Elm
	Morse

"Meandered sovereign rivers" means those rivers which, at the time of the original federal government surveys, were surveyed as navigable and important water bodies and were transferred to the states upon their admission to the union to be transferred or retained by the public in accordance with the laws of the respective states upon their admission to the union. The state of Iowa holds sovereign title in trust for the benefit of the public to the beds of the following rivers:

River and description

The Mississippi River from the south boundary of the state of Minnesota to the north boundary of the state of Missouri.

The Missouri River from the south boundary of the state of South Dakota to the north boundary of the state of Missouri.

The Big Sioux River from the south boundary of the state of Minnesota to the south boundary of the state of South Dakota.

The Des Moines River from the Mississippi River to the west line of Section 7, Township 89 North, Range 32 West, Palo Alto County (west branch) and to the north line of Section 2, Township 95 North, Range 29 North, Kossuth County (east branch).

The Cedar River from the Iowa River to the west line of Section 7, Township 89 North, Range 13 West, Black Hawk County.

The Iowa River from the Mississippi River to the west line of Section 7, Township 81 North, Range 11 West, Iowa County.

The Little Maquoketa River from the Mississippi River to the west line of Section 35, Township 90 North, Range 2 East, Dubuque County.

The Maquoketa River from the Mississippi River to the west line of Section 18, Township 84 North, Range 3 East, Jackson County.

The Nishnabotna River from the north boundary of the state of Missouri to the north line of Section 1, Township 67 North, Range 42 West, Fremont County.

The Raccoon River from the Des Moines River to the west line of Section 30, Township 78 North, Range 25 West, Polk County.

The Skunk River from the Mississippi River to the north line of Section 1, Township 73 North, Range 8 West, Jefferson County.

The Turkey River from the Mississippi River to the west line of Section 30, Township 95 North, Range 7 West, Fayette County.

The Upper Iowa River from the Mississippi River to the west line of Section 28, Township 100 North, Range 4 West, Allamakee County.

The Wapsipinicon River from the Mississippi River to the west line of Section 19, Township 86 North, Range 6 West, Linn County.

"Native stone riprap" means broken stone, dolomite, quartzite or fieldstone meeting Iowa department of transportation specification 4130, Class D.

"Ordinary high water line" means the boundary between meandered sovereign lakes and rivers, except the Mississippi River, and littoral or riparian property. "Ordinary high water line" is the limit where high water occupies the land so long and continuously as to wrest terrestrial vegetation from the soil or saturate the root zone and destroy its value for agricultural purposes. "Ordinary high water line" is the boundary between upland and wetland as defined by the U.S. Army Corps of Engineers Wetlands Delineation Manual dated January 1987. For Storm Lake in Buena Vista County and Clear Lake in Cerro Gordo County, the elevation has been established by adjudication. A list of elevations for the ordinary high water lines of meandered sovereign lakes, as determined by this definition and applicable court cases, is available on the department's Web site.

"Ordinary high water line of the Mississippi River" means the elevation, as defined by criteria in the Code of Federal Regulations, 33 CFR Part 328.3 (November 13, 1986), promulgated by the U.S. Army Corps of Engineers, where the water exists at or below such elevation 75 percent of the time as shown by water stage records since construction of the locks and dams in the river.

"Permit" means a sovereign lands construction permit issued pursuant to this chapter.

"Permittee" means a person who receives a permit pursuant to these rules, which may also include the authorized agent if designated pursuant to these rules.

"Person" means the same as defined in Iowa Code section 4.1.

"Public boat ramp" means a boat ramp constructed to provide public access from public land to a water body.

"Public lands" means land under the jurisdiction of the commission that is owned by the state or that has been dedicated for public access to a meandered sovereign lake or meandered sovereign river.

"Public waters" means a water body under the jurisdiction of the commission that is owned by the state or that has been dedicated for public access to a meandered sovereign lake or meandered sovereign river.

"Riparian land" means land abutting a river.

"Sovereign island" means an island located within a sovereign meandered lake or a sovereign meandered river that was transferred to the state upon its admission to the union and whose title continues to be retained by the state.

"Standard riprap" means broken stone, dolomite, quartzite, fieldstone, or broken concrete meeting Iowa department of transportation specification 4130, Class D. Broken concrete shall not have reinforcing materials protruding from the surface of the riprap. Standard riprap shall not include petroleum-based materials.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

DIVISION I
PERMITS

571—13.4(455A,461A) Permits required.

13.4(1) *General.* No person shall temporarily or permanently place or build any structure or alter the characteristics of public lands or waters under the jurisdiction of or managed by the commission without a permit issued by the department prior to commencement of such activities as provided in the rules of this chapter.

13.4(2) *Hazardous conditions.* Trees, rock, brush or other natural materials located on sovereign or dedicated lands may be removed by persons without a permit issued pursuant to these rules only after the department, in its sole discretion, determines and evidences in writing that a hazard or other detrimental condition exists and that the proposed mitigative activity is appropriate. Such activity shall be limited only to the work required to address the immediate hazard or other detrimental condition. Any removal allowed by this rule shall conform to the requirements enumerated by the department regarding such removal, or the removal shall be deemed unauthorized action resulting in damage to public lands and waters. Persons proposing to remove hazards must contact a local department official and request an exception to a permit. The department official shall inspect the hazard and provide written authorization to proceed or shall require the person to apply for a permit.

13.4(3) *Impoundments.* These rules do not apply to river impoundments regulated by Iowa Code chapter 462A.

13.4(4) *Docks.* These rules do not apply to docks regulated by 571—Chapter 16, except as specifically described herein.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.5(455A,461A) Interest in real estate. A permit shall be construed to do no more than give the permit holder a license to alter an area as specifically set forth in the permit. The permit creates no interest, personal or real, in the real estate covered by the permit.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.6(455A,461A,462A) Evaluation.

13.6(1) In considering complete applications, the department shall evaluate the impact of the proposed activities on public use and enjoyment of public lands or waters, on the natural resources in the areas within and surrounding the proposed activities, and the department's present and future intended management for the area against the applicant's identified and reasonable need to undertake the proposed activities and the viable alternatives that may exist with respect to the proposed activities.

13.6(2) In no event shall the department issue a permit for activities that:

a. May result in the taking, possession, transport, import, export, processing, selling, buying, transporting, or receiving any species of fish, plants or wildlife appearing on lists referenced in Iowa Code section 481B.5, unless the permittee meets one of the exemptions enumerated in rule 571—77.4(481B).

b. Have not received flood plain permits pursuant to Iowa Code chapter 455B and 567—Chapters 70 through 76, if applicable.

c. May impact a littoral or riparian property owner without the express written permission of the littoral or riparian property owner.

d. Do not comply with the review standards defined in 571—13.7(455A,461A,462A).

e. Interfere with department obligations or limitations related to federal funds or agreements or other restrictive covenants that may be applicable to the affected area.

f. Allow fill to be placed beyond the ordinary high water line of waters described in rule 571— 13.2(455A,461A,462A) for purposes of regaining land lost due to erosion.

13.6(3) The department may withhold a permit when the applicant has not obtained all other required permits or licenses necessary to construct and operate the proposed activity.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.7(455A,461A,462A) Review standards. Department staff shall conduct an environmental review of the application. In completing the environmental review, different bureaus and staff members of the department will provide input based on law, professional judgment, data and accepted scientific theory. The following standards shall apply to permits issued under the rules of

this chapter:

13.7(1) *Uses of public lands and waters.* Development of public lands and public waters permitted by these rules shall be limited to projects that meet all of the following criteria. The projects:

a. Are built to minimally impact the natural resources of public recreational use and navigation on such lands and waters. Specifically, applicants must demonstrate that the project accomplishes all of the following:

(1) Does not negatively impact water quality in or around the proposed permitted area.

(2) Minimizes erosion and sedimentation in or around the proposed area.

(3) Minimizes detrimental impacts to biological and botanical resources in or around the proposed area, including upland, wetland and sensitive areas and unique community structures.

(4) Complies with laws and regulations related to threatened and endangered species, through both federal and state programs.

b. Utilize the smallest amount of public lands and public waters.

c. Do not convert the public lands and public waters to an exclusive or private use.

d. Are the only viable method for conducting the activities, and no viable alternatives to constructing on public lands exist.

13.7(2) *Shoreline erosion protection and retaining walls.* Shoreline erosion protection activities may be permitted if the activities are in compliance with 571—13.6(455A,461A,462A) and the following additional standards:

a. Shoreline erosion protection activities on meandered sovereign lakes shall be limited to placement of native stone riprap, extending to a maximum of 4 feet horizontally within or below the elevation contour line of the ordinary high water line. Placement of earth fill within the ordinary high water line shall not be allowed. Retaining walls, sheet piling, gabions or other retaining structures shall be placed at or above the ordinary high water line. When such retaining structures are placed at the ordinary high water line, they must be faced with native stone riprap.

b. Shoreline erosion protection activities on meandered sovereign rivers, except the Mississippi River, shall be limited to placement of approved in-stream erosion control structures or native stone or standard riprap. Riprap shall extend riverward from the ordinary high water line at a slope of 2 feet horizontal to 1 foot vertical (2:1). Placement of earth fill within the ordinary high water line shall not be allowed. Retaining walls, sheet piling, gabions or other retaining structures shall not be placed within the ordinary high water line. When such retaining structures are placed at the ordinary high water line, they must be faced with riprap.

c. Shoreline erosion protection activities on the Mississippi River shall be limited to placement of approved in- stream erosion control structures or native stone riprap. Riprap shall extend riverward from the ordinary high water line at a slope of 2 feet horizontal to 1 foot vertical (2:1). Placement of earth fill within the ordinary high water line shall not be allowed. Retaining walls, sheet piling, gabions or other retaining structures shall not be placed within the ordinary high water line. When such retaining structures are placed at the ordinary high water line, they must be faced with native stone riprap.

d. Retaining walls on all meandered sovereign lakes and meandered sovereign rivers. The landowner shall maintain the wall system at all times and take corrective measures to eliminate any nuisance condition, repair deterioration of the structure, eliminate erosion around the structure, and repair damage to the structure caused by the action of the water or ice. When a retaining wall or other structure placed on the shoreline prevents the public from traversing the shoreline, the landowner shall grant the public a license to walk from the landowner's property within 15 feet of the top of the wall or structure for the purpose of traversing the shoreline.

e. Notwithstanding the prohibitions in this subrule, nothing in this subrule shall prohibit activities that would be part of habitat development or natural resources mitigation projects constructed or approved by a political subdivision of the state and subject to review under these rules.

13.7(3) *Quality of the applicant.* Applicants or authorized agents who have a current violation for another project are not eligible for consideration for a permit under these rules unless and until all other noncompliant projects have been remediated and any enforcement actions related to the same have been resolved or satisfied.

13.7(4) *Cantilever access structures.* Permanent cantilever access structures that lawfully exist and are lawfully permitted under prior sovereign lands construction permit rules as of April 15, 2009, shall be deemed lawfully permitted under these rules. All cantilever access structures that are not lawfully installed prior to April 15, 2009, or are installed after April 15, 2009, shall be regulated as docks by 571—Chapter 16.

13.7(5) *Beaches, canals, and channels.* Permits may be granted to maintain existing beaches, canals, and channels lawfully installed as of April 15, 2009, to ensure the navigation and safety of those existing lawful beaches, canals, and channels. The department shall not permit new beaches, canals, or artificial channels or expansion of existing beaches, canals, or artificial channels, except that the department may permit new beaches, canals, and artificial channels and expansions of existing beaches, canals, and artificial channels when such establishment or expansion would be under the jurisdiction of a political subdivision of the state, would be accomplished to provide public access to the water, and would meet the review standards established by these rules.

13.7(6) *Stationary blinds.* All stationary blinds installed on lands and waters described in rule 571— 13.2(455A,461A,462A) are subject to regulation by rule 571—51.6(481A) and are not subject to the requirements of these rules.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.8(455A,461A) Leases or easements as a condition of permits. If a permitted structure or its use will have a continuing impact on the availability or desirability of public lands or public waters, the permit shall be conditioned on the requirement that the permittee obtain a lease or easement under Division II of this chapter. However, a lease or easement shall not be required for proposed activities that are wholly within the scope of the permittee's littoral or riparian rights.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.9(455A,461A,462A) Permit application. Applicants shall apply for permits using an application form provided by the department. Applicants shall state the need for the proposed construction or use, the availability of alternatives, and the measures proposed to prevent, minimize or mitigate adverse impacts to natural resources or public use of the affected area. The department reserves the right to refuse to review incomplete applications. Each application, including all amendments, shall be signed by the applicant and authorized agent if one shall be so appointed by the applicant. The applicant's signature shall acknowledge that the application is accurate and made in good faith.

13.9(1) For purposes of this rule, the department will deem an application complete if the application meets all of the following criteria. The application:

a. Is provided on the department's form, and all fields are completed and legible;

b. Includes the name(s), mailing address and telephone number of the applicant(s) and authorized agent(s), if applicable;

c. Describes the proposed activity, including:

(1) Physical address and legal description of the location where the proposed activity is to occur; a written description of existing natural and man-made structures and features; an aerial photograph, if possible or available; and a ground-level photograph(s) showing the area where the activity is proposed to occur;

(2) Schematic or design plans, including cross sections and plan views, that accurately and clearly depict the proposed activities;

(3) Description of the construction methods used to complete the project, the methods used to transport material to the site, and the type and amount of material to be used;

(4) Description of measures proposed to prevent or minimize adverse impacts on the property in the proposed area;

(5) Description of any borrows or disposal sites, including the location of any borrows or disposal sites and the type and amount of material to be borrowed or disposed of in them;

d. Includes identification of the ordinary high water line, if the proposed activities are in or near a meandered sovereign lake or meandered sovereign river;

e. Describes alternative plans to undertake the activity that may be available to the applicant;

f. Identifies the need for the proposed activity in the proposed project area;

g. Provides a statement of consent for the department to enter the property during the term of the proposed permit.

13.9(2) For applications that provide for an authorized agent to perform part or all of the proposed activities, the following additional information shall be required to constitute a complete application:

a. Statement signed by the authorized agent and applicant;

b. Statement signed by the authorized agent acknowledging that the authorized agent is aware of such designation and is responsible to complete the identified work; and

c. Description of the work to be completed by the authorized agent.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.10(455A,461A) Additional information or analysis required for permit review.

13.10(1) The director may require an applicant to provide additional information, at the applicant's sole cost, necessary to complete review of the application, including but not limited to study of alternatives to construction on public lands and waters, social and environmental impacts of the proposed activities, professional surveys to establish the social and environmental impacts of the proposed activities, professional land surveys to delineate or show real property boundaries and other characteristics, and a professional real estate appraisal of the value that a permit may convey.

13.10(2) If the applicant does not respond to a request for additional information within 90 days of such request being made by the department, the department may withdraw the application from consideration and the applicant must reapply for the permit.

13.10(3) When the director determines that the proposed activity will significantly affect the public interest, the director may hold a public meeting in the vicinity of the proposed activity. When a public meeting is held, the director shall consider public input in conjunction with other information collected or provided as part of the application review when acting on a permit application.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.11(455A,461A) Permit issued or denied. The department shall promptly review all permit applications, and the director

shall issue a permit or deny all or part of an application upon completion of review. A permit may include specified conditions denying the application in part and the reasons for the conditions. The denial of a permit may include a proposed removal order. A permit denial shall be final agency action, unless the unsuccessful applicant otherwise has a constitutional right to a contested case, in which case an administrative appeal pursuant to procedures in 571—Chapter 7 shall be available. The unsuccessful applicant's request for a contested case may include a request for a variance or waiver under the provisions of Iowa Code section 17A.9A and 571—Chapter 11. The decision of the presiding officer in a contested case shall constitute final agency action.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.12(455A,461A) Authorized agent. When an authorized agent is designated on the application for a permit and acknowledges the same, that authorized agent shall be responsible in the same manner as the permittee to comply with the terms of the permit issued.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.13(455A,461A) Inspection. The department may inspect the location during the term of the permit to ensure that the permitted activities comply with the terms of the permit. The permittee shall grant the department the right to access the permitted activities for purposes of inspecting the permitted activities during the term of the permit. If the permittee denies permission for entry, the department may obtain an order from the Iowa district court for the county in which the permitted activities or the majority of the permitted activities occur, as needed, to enable the department to carry out its inspection duty. The intent of the inspection is to evaluate compliance with permit conditions and the impact to the natural resources and the public's recreational use of the area.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.14(455A,461A) Additional information or analysis required during term of the permit. The director may require a permittee to provide additional information, at the permittee's sole cost, necessary to ensure that the permittee is complying with the terms of the permit, including but not limited to social and environmental impacts of the activities, professional surveys to establish the social and environmental impacts of the activities, professional land surveys to delineate or show real property boundaries and other characteristics, and a professional real estate appraisal of the value that a permit may convey or has conveyed.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.15(455A,461A) Violations; types of enforcement actions; citation and notice of violation.

13.15(1) Violations.

a. A person shall be in violation of these rules and Iowa Code section 461A.4 in the event the person does any of the following:

(1) Performs construction on or undertakes other activities that alter the physical characteristics of public lands or waters under the jurisdiction of or managed by the commission without a permit required by these rules;

(2) Performs such work out of conformance with specific requirements enumerated in a permit issued in accordance with these rules; or

(3) Fails to comply with an order of the commission under these rules.

b. Each day of a violation shall be considered a separate offense.

13.15(2) *Types of enforcement actions.* A person who violates these rules shall be subject to either of the following:

a. Criminal enforcement. A peace officer of the state may issue a citation for each offense. A person who is found guilty of violating these rules shall be charged with a simple misdemeanor for each violation.

b. Civil enforcement. A civil penalty may be assessed in conformance with Iowa Code section 461A.5B and rule 571—13.17(455A,461A). Written notice of the violation(s) shall be given to the person against whom disciplinary action is being considered. The notice shall state the informal and formal procedures available for determining the matter. If agreement as to appropriate disciplinary sanction, if any, can be reached between the director and the person against whom disciplinary action is being considered, a written stipulation and settlement between the department and the person shall be entered. Such a settlement shall take into account how the corrective actions described in subrule 13.15(3) shall be accomplished. In addition, the stipulation and settlement shall recite the basic facts and violations alleged, any facts brought forth by the person, and the reasons for the particular sanctions imposed. If an agreement as to appropriate disciplinary action, if any, cannot be reached, the director may issue an administrative order as described in rule 571—13.17(455A,461A).

13.15(3) *Actions to be taken upon receipt of citation or notice of violation.* A person who has violated these rules shall cease the specified unauthorized activity upon receipt of a citation or as may be stipulated in the notice of violation. The notice of violation or a written notice accompanying the citation from the department shall require the person to take one or more of the following actions within a specified time:

a. Apply for a permit to authorize completion of construction or maintenance and use, as applicable;

b. Remove materials and restore the affected area to the condition that existed before commencement of the unauthorized activity;

c. Remediate the affected area in a manner and according to a plan approved by the department. The department may enforce such a remediation at the expense of the permittee, adjacent landowner or culpable party.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.16(455A,461A) Removal orders. If the violation includes the unauthorized placement of materials or personal property on the public lands or public waters under the jurisdiction of the commission, and the person, who may include a permittee or authorized agent but may not, fails to comply with the action required by the notice, the director may cause a proposed removal order to be issued to the person responsible for such placement. The proposed removal order shall specify the removal action required and include notice of the right to an administrative appeal including a contested case hearing under procedures in 571—Chapter 7. The proposed decision in a contested case may be appealed to the commission under 571—Chapter 7. If there is no appeal from a proposed decision that includes a removal requirement, the proposed decision shall be presented to the director for review and adoption. A removal order approved by the director shall constitute final agency action under Iowa Code sections 461A.4 and 461A.5A and may be enforced through an original action in equity filed in a district court of the state by the attorney general on behalf of the department and the commission.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.17(455A,461A) Civil penalties. The department may assess a civil penalty of up to $5,000 per offense for each violation of these rules, provided the department does not utilize a criminal citation for a violation. Each day the violation continues shall be a separate offense or violation. Penalties shall be assessed through issuance of an administrative order of the director which recites the facts and the legal requirements that have been violated and a general rationale for the prescribed fines. The order also may be combined with any other order authorized by statute for mandatory or prohibitory injunctive conditions and is subject to normal contested case and appellate review under procedures in 571—Chapter 7. The proposed decision in a contested case may be appealed to the commission under 571—Chapter 7. The commission may refer orders that include singular or cumulative penalties over $10,000 to the attorney general's office.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.18(455A,461A) Report of completion. Once an approved activity is completed, the permittee shall notify the department contact person identified in the permit of such completion through regular mail or E-mail. The permittee shall include with such notice a ground-level photograph(s) of the completed project. The activity shall be subject to final approval before the department determines that the conditions of the permit have been met.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.19(455A,461A) Final inspection. Once the permittee notifies the department pursuant to rule 571— 13.18(455A,461A), the department shall inspect the permitted area to ensure that the permittee has complied with the terms of the permit. Such inspection shall occur within 60 days of the department's receipt of the notice provided pursuant to rule 571—13.18(455A,461A). In the event the department does not provide final inspection within 60 days of the department's receipt of the notice provided pursuant to rule 571—13.18(455A,461A), the permittee shall be deemed compliant and the permit shall expire. The intent of this inspection is to evaluate compliance with permit conditions and the impacts to the natural resources and the public's recreational use of the area.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.20(455A,461A) Permit extensions. Prior to the expiration of a permit, a permittee or an authorized agent may submit an application to the department for an extension of the permit on a form provided by the department. In evaluating whether to grant the extension, the department will consider the work completed, the work to be performed, the extent to which the permit extension is needed and the extent to which the permittee has made efforts to meet the obligations of the original permit. The department reserves the right to modify the conditions of a permit as part of any extension. An extension granted by this rule is not a project modification.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.21(455A,461A) Project modifications. If projects are modified to the extent that the additional or modified work would not be allowed within the original permit, the permittee must apply for a new permit for the additional or modified work.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.22(455A,461A) Transferability. Permits are transferable only upon written approval of the department and only after the department is satisfied that the permitted activities will not change and the new permittee would be eligible to receive a permit under subrule 13.7(3).

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.23 to 13.50 Reserved.

DIVISION II
LEASES AND EASEMENTS

571—13.51(455A,461A) Leases. Where a permitted structure or related activity will have a continuing impact on the availability or desirability of public lands or public waters or exceeds the scope of littoral or riparian rights, the permittee must enter into a lease covering the area affected by the construction. Fees for leases shall be determined by 571—Chapter 18 or other methods approved by the commission and executed pursuant to Iowa Code section 461A.25. Requests for leases shall be made on the form and shall include the information required by rule 571— 13.9(455A,461A,462A) under Division I of this chapter. The department may grant a lease if, in the department's sole discretion, the lease will not impair the state's intended use of the area during the term of the lease; the lease will not negatively impact a federal interest, including related deed restrictions, related to the area during the term of the lease; and the lease will not result in an exclusive use.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.52(455A,461A) Easements. The director may grant an easement to political subdivisions and utility companies pursuant to Iowa Code section 461A.25, provided the following terms are met:

13.52(1) Requests for easements shall be made on the form and shall include the information required by rule 571—13.9(455A,461A,462A) under Division I of this chapter. The department may grant an easement if, in the department's sole discretion, the easement will not impair the state's intended use of the area during the term of the easement or the easement will not negatively impact a federal interest, including related deed restrictions, related to the area during the term of the agreement.

13.52(2) The value of an easement shall be determined by the director based upon a real estate appraisal or other method approved by the commission, as evidenced in the meeting minutes thereof. In addition to fees for easements, the director may assess the applicant for the reasonable transaction costs associated with the issuing of an easement including the cost of appraisals, other methods of establishing values, and land surveys. In determining the fee for an easement, the department may consider the value the proposed activity may contribute to the department's management of the affected property.

13.52(3) Recipients of any easements granted pursuant to this rule shall assume liability for structures installed pursuant to such easement and shall comply with the standards enumerated in rule 571—13.7(455A,461A,462A), as applicable, in the sole discretion of the department.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

571—13.53(455A,461A) Appeals. The department and the commission are under no legal obligation to provide any person a legal interest in property under the jurisdiction of the commission. An applicant may appeal to the director a decision of the department regarding leases and easements and request that the director reconsider a condition of an easement or a lease or a denial of an easement or a lease. The determination of the director shall be final agency action.

[**ARC 7616B**, IAB 3/11/09, effective 4/15/09]

These rules are intended to implement Iowa Code sections 455A.5, 461A.4, 461A.5A, 461A.5B, 461A.6, 461A.18, 461A.25 and 462A.3.

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Appendix 9. State of Iowa Code 571 Chapter 54.5

571—54.5 (461A) Aquatic plants. This rule applies to the introduction and removal of plants in public waters as those waters are defined by rule 571—13.2(455A,461A,462A). For purposes of this rule, aquatic plants are those listed in subrule 54.5(6) and include vegetation that exists at or below the ordinary high water line of a waterway.

54.5(1) *Permits.* The department may issue permits for the introduction and removal of aquatic plants in public waters. To be considered for a permit under this rule, applicants shall use the department's application form for sovereign lands construction permits, as described in rule 571—13.9(455A,461A,462A), and shall complete all relevant information on that application form. Applicants shall also provide any additional information as may be necessary, as described in rule 571—13.10(455A,461A). The term of the permit shall be stated in the permit. Permits are nontransferable and shall be subject to reevaluation upon expiration. Permits may be issued for between one and five years.

54.5(2) *Evaluation.* The department shall evaluate all permits sought under this rule in accordance with the evaluation criteria enumerated in rule 571—13.6(455A,461A,462A). In addition, the department shall consider the following criteria:

a. For aquatic plant introduction:

(1) Unless otherwise approved by the department, all introduced plants shall be included in the list provided in subrule 54.5(6);

(2) Introduced plants shall not include cultivars;

(3) Plants shall be introduced for the purposes of preventing shoreline erosion, stabilizing bottom sediment, providing fish or wildlife habitat, or removing nutrients from the water;

(4) Plants shall be thoroughly rinsed away from the water into which they are being introduced prior to being transported to the site if the plants have not been cultivated on site in a manner to prevent any foreign nonplant or seed material from entering the water prior to introduction; and

(5) Plants shall be obtained from a seed source that is within 50 miles of the introduction area and from stocks of only cultivated material (i.e., material that has not been taken from natural areas) or from a source that is approved by the department. Approval for a seed source may be sought from the department by contacting the area fisheries management biologist.

b. For aquatic plant removal:

(1) The plants shall be removed by hand-cutting, hand-pulling, hand-raking or mechanical cutting only;

(2) The plants shall be removed to establish a designated travel lane from a boat dock that has been permitted in accordance with 571—Chapter 16. Such travel lane shall not exceed a 15-foot width, and the placement of such lane shall be subject to the review and approval of the department. A travel lane allowed under this rule may be in the same location during the term of the permit, may be sited by the department to accommodate vegetation, and may not necessarily be the most direct path from the dock to the open water area; and

(3) All plant material removed under the permit must be left in place or collected and composted on the land owned, leased or otherwise subject to use by the applicant that is adjacent to the removal area.

Unless otherwise provided by this rule, in no event may a person be allowed to apply chemicals including, without limitation, pesticides or herbicides to remove aquatic plants from public waters. For nonpublic waters that meet certain designations in 567—Chapter 66, a person may be required to seek a permit under the rules established herein to use pesticides.

54.5(3) *Inspection requirements.* For the purpose of inspecting for compliance with permit conditions, the department shall have the right to enter the property attached to the public water at or near the place of introduction or removal. This inspection shall include, without limitation, identification of introduced species; a determination as to whether the travel lane is being maintained in accordance with the permit conditions; and whether plant material, if removed, is left on site.

54.5(4) *Violations.* Persons in violation of this rule are guilty of a simple misdemeanor as described by Iowa Code section 461A.57.

54.5(5) Exceptions.

a. Activities accomplished by the department or its agents to introduce or remove aquatic vegetation in public waters shall be deemed appropriate and shall not be subject to the permit requirements of this rule provided the activity is in the public interest and the activity does not constitute one of the prohibited activities described in 571—subrule 13.6(2).

b. Cities and counties in Iowa may use chemicals, including pesticides and herbicides, to remove aquatic vegetation from water intake structures. However, such cities and counties shall be required to obtain a permit under this rule and rules in 567—Chapter 66, as may be required, for such activities.

c. Aquatic vegetation located in public waters may be removed by persons without a permit under this rule only after the department, in its sole discretion, determines and evidences in writing that a hazard or other detrimental condition exists and the proposed mitigative activity is appropriate. Such activity shall be limited only to the work required to address the immediate hazard or other detrimental activity. Any removal allowed by this rule shall conform to the requirements enumerated by the department regarding such removal, or the removal shall be deemed an unauthorized action resulting in damage to public waters. Persons proposing to remove hazards must contact a local department official and request

an exception to a permit. The department official shall inspect the hazard or detrimental condition and provide written authorization to proceed or shall require the person to apply for a permit under this rule.

54.5(6) *Appropriate plants.* The department is committed to maintaining the natural integrity of public waters in the state and strengthening native populations of vegetation and wildlife in those waters. To that end, the following table comprises the plants that may be permitted to be introduced into public waters:

Scientific Name	Common Name
Acorus americanus	Sweet Flag
Alisma plantago-aquatica	Water Plantain
Asclepias incarnata	Marsh Milkweed
Bidens cernua	Nodding Beggars Ticks
Bidens coronata	Tickseed Sunflower
Brasenia schreberi	Water Shield
Calamagrostis canadensis	Blue Joint Grass
Caltha palustris	Marsh Marigold
Carex atherodes	Wheat Sedge
Carex comosa	Longhair Sedge
Carex cristatella	Crested Sedge
Carex hystericina	Bottlebrush Sedge
Carex lacustris	Hairy Sedge
Carex normalis	Greater Straw Sedge
Carex pellita	Wooly Sedge
Carex prairea	Prairie Sedge
Carex scoparia	Broom Sedge
Carex stipata	Awlfruit Sedge
Carex stricta	Upright Sedge
Carex tribuloides	Blunt Broom Sedge
Carex vulpinoidea	Fox Sedge
Ceratophyllum demersum	Coontail
Eleocharis acicularis	Needle Spikerush
Eleocharis obtuse	Blunt Spikerush
Elodea canadensis	Canada Waterweed
Eupatorium perfoliatum	Boneset
Glyceria striata	Fowl Manna Grass
Iris versicolor	Blue Flag Iris
Juncus dudleyi	Dudley’s Rush
Juncus torreyi	Torrey’s Rush
Leersia oryzoides	Rice Cutgrass
Lobelia siphilitica	Great Lobelia
Lysimachia ciliate	Fringed Loosestrife
Lythrum alatum	Winged Loosestrife
Muhlenbergia mexicana	Leafy Satin Grass
Muhlenbergia racemosa	Marsh Muhly
Nymphea tuberosa	White Water Lily
Poa palustris	Fowl Bluegrass

Polygonum amphibium	Water Smartweed
Pontederia cordata	Pickerelweed
Potamogeton nodosus	Longleaf Pondweed
Ranunculus secleratus	Cursed Crowfoot
Sagittaria latifolia	Broadleaf Arrowhead
Schoenoplectus acutus	Hardstem Bulrush
Schoenoplectus fluviatilis	River Bulrush
Schoenoplectus tabernaemontani	Soft-Stem Bulrush
Scirpus atrovirens	Green Bulrush
Sparganium eurycarpum	Giant Burreed
Spartina pectinata	Prairie Cord Grass
Stuckenia pectinatus	Sago Pondweed
Typha latifolia	Broadleaf Cattail

In addition, an applicant may propose, as part of the application, species that do not appear on this list, which the department will consider. The department's consideration of species not on this list will be based on the commitment described above as well as the potential impact of the proposed species to the public water and ecosystem.

[**ARC 8594B**, IAB 3/10/10, effective 4/14/10]