NEBRASKA GAME PARKS
See You Out There

NEBRASKA POND GUIDE

Private Waters Program
Management Assistance for Lakes, Ponds, Pits & Streams

RESOLVING COMMON MAINTENANCE PROBLEMS AQUATIC VEGETATION

Although too much aquatic vegetation may hinder recreational activities, plants are a very important component of the aquatic environment. The process of photosynthesis results in the production of oxygen and new plant tissue (biomass) – either in the form of microscopic plants (algae) or macrophytes (larger algae and flowering plants). Advantages of aquatic vegetation are:

- provides food, nesting sites, shade, and cover for numerous aquatic organisms
- oxygenates the water
- stabilizes shorelines and bottom sediments which help to minimize wind action, shoreline erosion, and water turbidity
- adds aesthetic and natural looking qualities to a pond.

Aquatic plants can become established naturally or by transplanting. See **PG13-2** for details. Waterfowl densities (especially domestic flocks and Canada geese) may have to be controlled before desirable aquatic plants can get established and thrive in ponds and lakes.

Unfortunately, plant growth can become excessive, particularly in many ponds that have become shallow and nutrient enriched due to deposition of dead plants, sediment, and debris over the years. In some situations, extremely aggressive exotic species of plants have been introduced and taken over large amounts of aquatic habitat. Disadvantages of excessive amounts of aquatic vegetation are:

- makes fishing difficult
- upsets the balance between bass and bluegill by providing too many places for young bluegill to hide and avoid predators, producing excessive numbers of small, slow-growing bluegills that will raid bass nests and limit the number of bass produced
- reduces both plant and associated wildlife diversities when an extensive monoculture occurs
- occasional die-offs can occur at the end of growing season or when cloudy weather and/or muddy water cause extended periods of insufficient levels of sunlight to maintain all aquatic plant life present
- decomposition of substantial amounts of dead vegetation can deplete oxygen levels which can stress or kill fish – they can be seen gasping for air at the pond surface during early morning hours (shortly after sunrise)
- dense surface coverage by filamentous algae or free-floating plants can prevent sunlight penetration to desirable, submersed aquatic plants – thereby limiting oxygen production, resulting in reduced dissolved oxygen levels in the water
- certain algae species can impart foul tastes, odors, and/or toxins to the water
- can lower property and aesthetic values.

However, since the many benefits outweigh the disadvantages, aquatic plants should never be totally eliminated from a site.

AQUATIC PLANT IDENTIFICATION

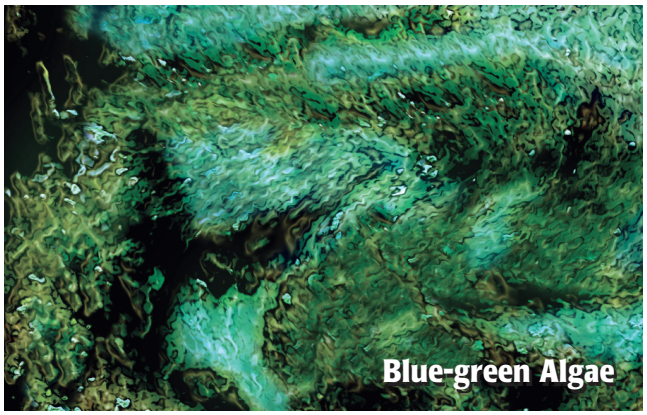
There are five major types of aquatic plants, classified by their growing patterns: algae, free-floating plants, rooted-floating plants, submersed plants, and emergent plants. The latter four types differ from algae by producing flowers and they have an internal conducting (vascular) system. Since the

NEBRASKA GAME PARKS
See You Out There

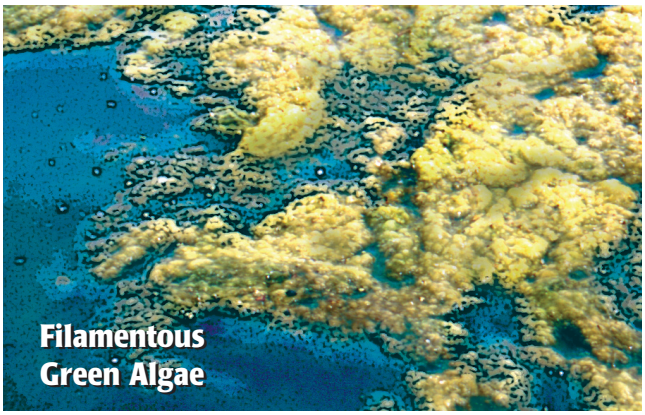
NEBRASKA POND GUIDE

Private Waters Program
Management Assistance for Lakes, Ponds, Pits & Streams

effect each can have on a pond and the best methods of controlling them differ, it is imperative that the plant type is correctly identified if a problem should occur. For some control methods, such as the use of chemicals, it is necessary to identify the plant species in order to purchase the correct herbicide.


Blue-green Algae

Algae are primitive plants without true leaves or flowers. Many species are individual, free-floating, microscopic plants (planktonic) that can turn a pond green, making it look like pea soup or as if paint is floating on the surface. Some species of planktonic algae can be toxic or cause water to have a bad taste or odor. Several blue-green, bloom-forming planktonic algae species produce lethal toxins within the cell walls which are then secreted from living cells or released after death. These toxins can cause sickness, and even death, to pets, livestock, wildlife (especially fish), and humans. Blooms usually occur when nutrients are abundant (nitrogen and especially phosphorus fertilizers). The best solution is to prevent the input of nutrient-laden water. Other species (filamentous) are found together in clumps or strands that are often attached to the bottom or aquatic structure. Filamentous green algae causes the most problems for pond owners. It is a stringy, hair-like plant, often incorrectly called moss, that can form mats which can completely cover the pond surface. The third type of algae, *Chara* spp., grows on the


Filamentous Green Algae

pond bottom and has stem and leaf-like features. They can be identified by their strong musty odor or gritty texture when crushed between fingers. It typically is low-growing in ponds with adequate depth and shouldn't be disturbed; however, it can grow to the surface and be troublesome in shallow-water areas.

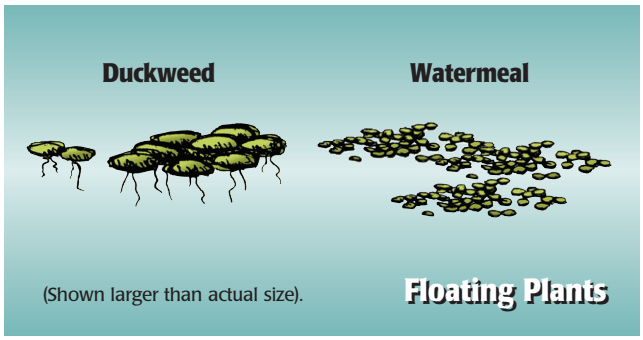
Although many smaller algae species are important food items for zooplankton, high density levels of algae are generally considered undesirable and somewhat difficult to control. If algal blooms keep recurring once control measures have been tried and gizzard shad are present in high numbers, the shad need to be controlled or eliminated. Shad are very efficient filter feeders and can decimate zooplankton populations that naturally feed on various algae species.

Free-floating plants are not attached to the bottom by roots. They float freely on the surface with roots hanging down in the water and move with the prevailing winds. Duckweed and the much smaller watermeal are common floating plants. They can become very abundant and cover the entire surface of smaller ponds protected from the wind. Complete surface coverage shades out desirable underwater plants, thus causing oxygen depletion in deeper water. They are typically found in nutrient enriched ponds; thus, restricting nutrient inputs is one solution.

NEBRASKA GAME PARKS
See You Out There

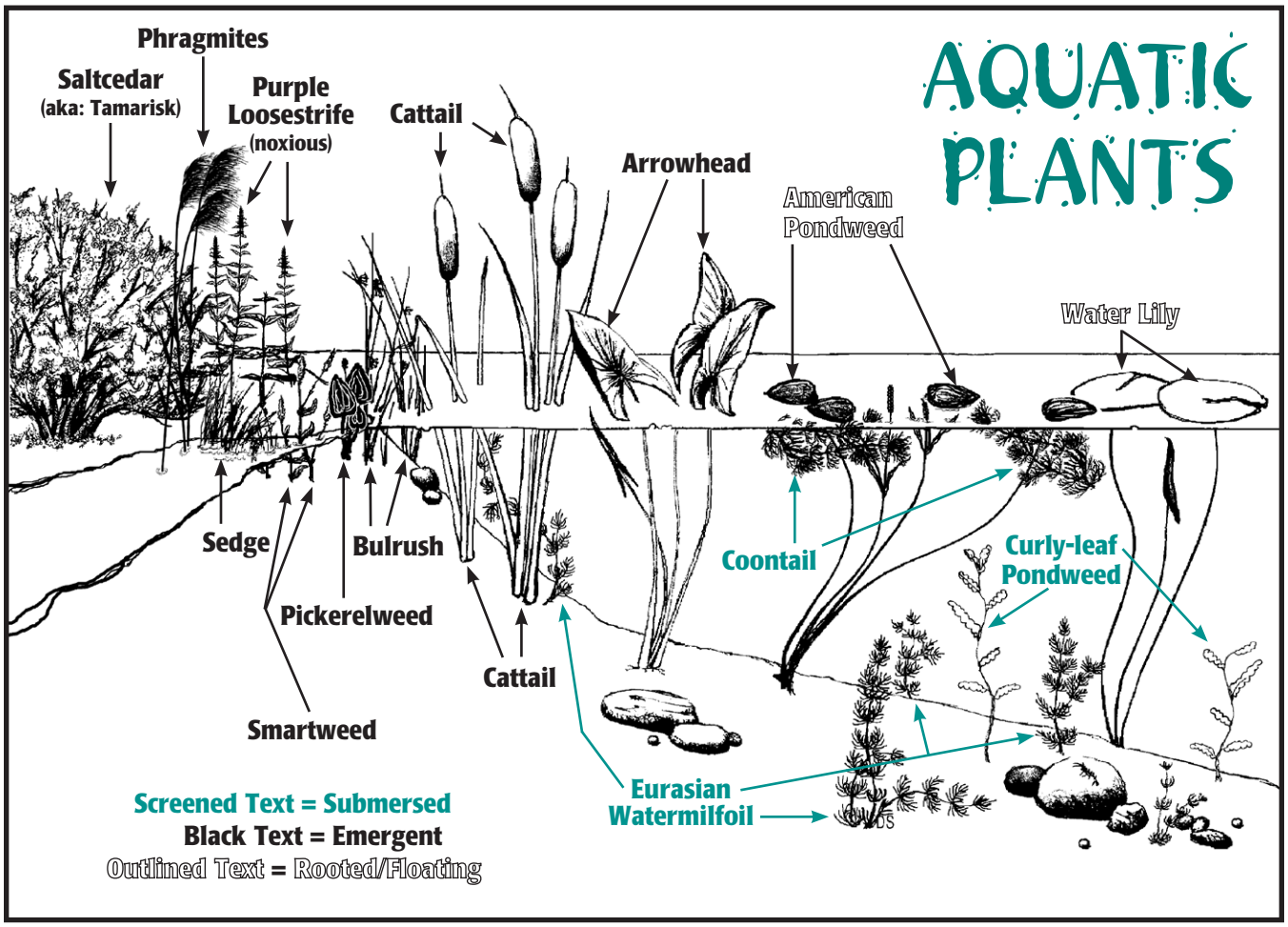
NEBRASKA POND GUIDE

Private Waters Program
Management Assistance for Lakes, Ponds, Pits & Streams



Rooted-floating plants (water lilies) are attached to the bottom; their leaves are typically floating on the surface and blossoms above the water. They are generally found in shallow water less than 4 to 5 feet deep. They provide valuable wildlife habitat and shouldn't be totally eradicated; however, they can interfere with fishing when they become over abundant.

Submersed plants are usually rooted to the bottom and grow upward to the surface of the pond. Their blossoms and seed pods extend above the water surface. The plant usually consists of a long flexible stem, with clumps of narrow leaves along it. Surface leaves of some species look quite different than lower leaves. These plants can form thick beds that interfere with fishing, swimming, and boating. Examples are pondweeds (*Potamogeton* spp.), coontail, and watermilfoil. Depending on water clarity,



some of these plants can grow in water depths exceeding 10 feet. Some (curly-leaf pondweed and Eurasian watermilfoil) are invasive, aggressive weeds that replace more desirable species. Having adequate pond depth is the best solution.

Emergent plants are rigid, rooted to the pond bottom and extend upwards out of the water. They usually occur along the shoreline and grow in water depths less than 3 feet. Many emergents reproduce by seeds and rhizomes. Cattails are probably the most familiar emergent plants. Although they provide excellent shoreline protection and sediment entrapment, they are notorious for rapidly filling-in shallow areas of ponds. This can result in elimination of other desirable aquatic plants and limit shoreline activities such as fishing, wading, and boating. Bulrushes, sedges, smartweeds, arrowheads, and pickerelweeds are other common emergent plants. Trees, such as willow and cottonwood, are also included in this group. Purple loosestrife, phragmites, and salt cedar are exotic, emergent invaders, that have little, if any, wildlife values, and are considered serious weeds that can take over extensive shoreline areas and even entire wetlands.

CONTROLLING AQUATIC PLANTS

Although aquatic vegetation provides a variety of benefits, a particular level of abundance may be too much for one pond owner but just right for another. As long as aquatic vegetation, primarily submersed types, isn't negatively affecting fish populations, especially largemouth bass, it can be allowed to cover 40% or more of the pond surface, depending on fish management goals. Once it gets above 40%, some may have to be removed to create open-water areas. Control for each vegetation type can involve one or more of the following techniques.

Preventive Control Methods

Prevention is the best control. Many aquatic plants, fragments of plants, or their seeds, can be carried into a pond by wind, flowing water, birds (mostly waterfowl - particularly Canada geese), fish introductions, boat trailers, live wells, and anglers. Even small plant fragments (less than one inch long) that do not completely dry out during transfer can survive and produce new plants. Therefore, eliminate or reduce the causes of spread whenever possible.

Good growing conditions for aquatic plants entails a pond being shallow, or has shallow areas with good sunlight penetration, and an ample supply of nutrients in the water or stored in the sediment. Follow pond depth and slope guidelines presented in **PG13-1** to reduce the amount of shallow-water areas where plants can grow. Eliminate obvious sources of nutrients (nitrogen and phosphorus) by:

- utilizing wise land use practices that prevent soil erosion and keep nutrients on the land and out of the water
- preventing animal wastes from entering, either by constructing a sewage lagoon to catch feedlot and barnyard runoff or diverting it around the pond through a grass-lined ditch when permissible
- not fertilizing the pond, since it is likely rich enough in food organisms, or not applying fertilizers within 30 feet of the shoreline
- ideally maintaining a 100-foot wide fenced vegetative buffer around the entire pond and areas that drain into the pond that will absorb incoming nutrients and reduce erosion
- reducing fertility, as well as turbidity and bank erosion, by not allowing livestock direct access to the pond; either fence the pond and water the animals from a stock tank below the dam/outside the fence, or allow them limited access if the pond is the only source of water

- establishing a small settling/retention pond above the main pond to entrap nutrients and sediment.

Habitat Alteration Methods

The following methods of altering (manipulating) the aquatic environment can be effective in managing aquatic plants.

Rock Rip-Rap and Pond Liners

Rooted plant growth can be prevented by rock rip-rapping 2 to 3 feet above and below the water-line or by anchoring either perforated black plastic sheeting or fine mesh black landscaping fabric on bottom sediments. The sheeting and fabric also limit nutrient exchange between the pond bottom and the water. Heavier plastic sheeting (4 mm or thicker) should be used, then weighted to keep it in place, and perforated to allow gases to escape from the pond bottom. Large sections of window screen can also be placed on top of submerged plants and weighted down. This will compress and shade the plants, which should cause them to die in a couple of weeks. The process can then be repeated in another area.

Water Level Manipulation

Lowering the water level of a pond can be an easy way to control many unwanted aquatic plants. Pond drawdown, especially during the winter, can dry out plants or kill underground structures (roots, bulbs, tubers, etc.) by exposing them to harsh conditions, including alternating freezing and thawing temperatures, wind, and sediment compaction. This method can be effective for controlling Eurasian watermilfoil and waterlilies - the degree of success depends on the severity of the winter. For winter control to be effective, the bottom mud should freeze to a depth of four inches for at least a month. Dead plant material should be removed from the pond basin as soon as possible, definitely before refilling, so their nutrients are not released back into the water. Make sure the pond still has sufficient depths of 10 to 12 feet during the winter months to prevent a fish kill.

Cattails can be effectively controlled by lowering the water level, cutting or shredding the plants, and then flooding them during the winter. They will drown, provided the roots are kept completely submerged for an extended period of time, especially during the following growing season, and there is no attached top growth remaining to funnel air down to the roots.

Dredging and Deepening

Many aquatic vegetation problems can be eliminated by deepening shoreline areas. Creating a 3:1 slope to a depth of 4 to 5 feet, then tapering off rapidly into greater depths, will limit where plants can grow. At least 25% of the pond's surface area should contain a depth of at least 10 feet, 12 feet in northern and western parts of the state. Dredging, or partially draining the pond and excavating, reduces vegetation problems directly by removing the plants, bottom sediments, and their associated nutrients.

Shading

Limiting the amount of sunlight available to aquatic plants with dyes that stain the water is another control method. Too much chemical shading, however, can reduce the pond's overall productivity, including fish production. To be effective, the dye must persist in the water for several weeks. Ponds with constant flow may not be good candidates for this technique. For best results, dye should be used early in the spring before plants start growing. If rooted, underwater plants have already grown to the surface or they are growing in water depths less than 2 to 3 feet, dyes will not work. Supplemental treatments of copper sulfate are often needed for algae control.

Floating objects such as piers or swimming platforms may shade a small area of the pond

and prevent vegetation growth. Or, black plastic sheeting with styrofoam floats can be anchored around swimming areas or boat launches to shade specific areas.

Aeration

Aeration systems have been found to lessen the severity of algal blooms, provided the system isn't bringing an excessive amount of nutrients to the surface. When ponds contain water depths in excess of 12 to 15 feet that are void of oxygen, or when ponds are protected from the wind which then prevents circulation of oxygen to lower water depths, phosphorus is no longer retained in bottom sediments. It then rises toward the surface and typically triggers extensive algal blooms. Thus, aeration systems provide the oxygen necessary for microbial utilization of bottom organic materials and related nutrients, which prevents the release of phosphorus. Do not allow the aerator diffuser (air stone) to rest on the pond bottom as this will stir up organic materials, accelerating their decay and increasing oxygen consumption. Algal blooms can result if large amounts of bottom nutrients are carried to the surface as the bubbles rise. Either place the diffuser on a pedestal or in a weighted 5-gallon bucket, or suspend it at least 2 to 3 feet off the bottom.

If an aeration system is really churning the water and the rising air bubbles have caused an excessive up-welling of bottom sediment and/or nutrients, the pond can become turbid or have an extensive algal bloom. If either should occur, the diffuser can be raised some more, or the output decreased, or another diffuser added.

Water circulation systems can also be used to lessen the severity of algal blooms, especially if fish are artificially fed. Install the system near the deeper part and orientate it so that it can circulate the majority of the pond.

Physical or Mechanical Control Methods

The physical removal of aquatic vegetation from a pond is a valuable control technique. This is done by cutting or uprooting rooted plants and removing them from the pond. Free-floating plants can be collected with seines and removed, especially on windy days when the plants are concentrated along one shoreline. Plants can be removed by hand with simple tools or with special cutting machines. In shallow shoreline areas, plants can be pulled by hand, cut with a sickle, dug out with a shovel, or removed with a rake or a chain pulled through the pond behind a tractor or ATV. Undesirable plants should be controlled when they first show up before they get a chance to spread extensively. Remove as much of the plant's roots as possible, when applicable, otherwise it may resprout.

For larger ponds or deep water, commercial motor-driven underwater weed harvesters can be utilized. Weed harvesting may have to be done several times during the season to prevent plants from growing to the surface and becoming a nuisance. The harvested material can be used as a fertilizer, garden mulch, or taken to a land fill.

The most important part of mechanical control is to remove the cut plants from the pond. Since many aquatic plants can grow from plant fragments, cutting one stem in half doubles your problem. Fragments that don't grow will decompose and release nutrients that stimulate other plants to grow. The decomposition process also uses up oxygen and can cause fish kills. Removing the cut vegetation from the pond removes all the nutrients stored in them, thus reducing the likelihood of causing future problems.

Removing plants physically or mechanically provides only temporary relief and may be practical for only a small portion of the pond. Both processes will likely need to be repeated several times throughout the growing season and in subsequent years.

NEBRASKA GAME PARKS
See You Out There

NEBRASKA POND GUIDE

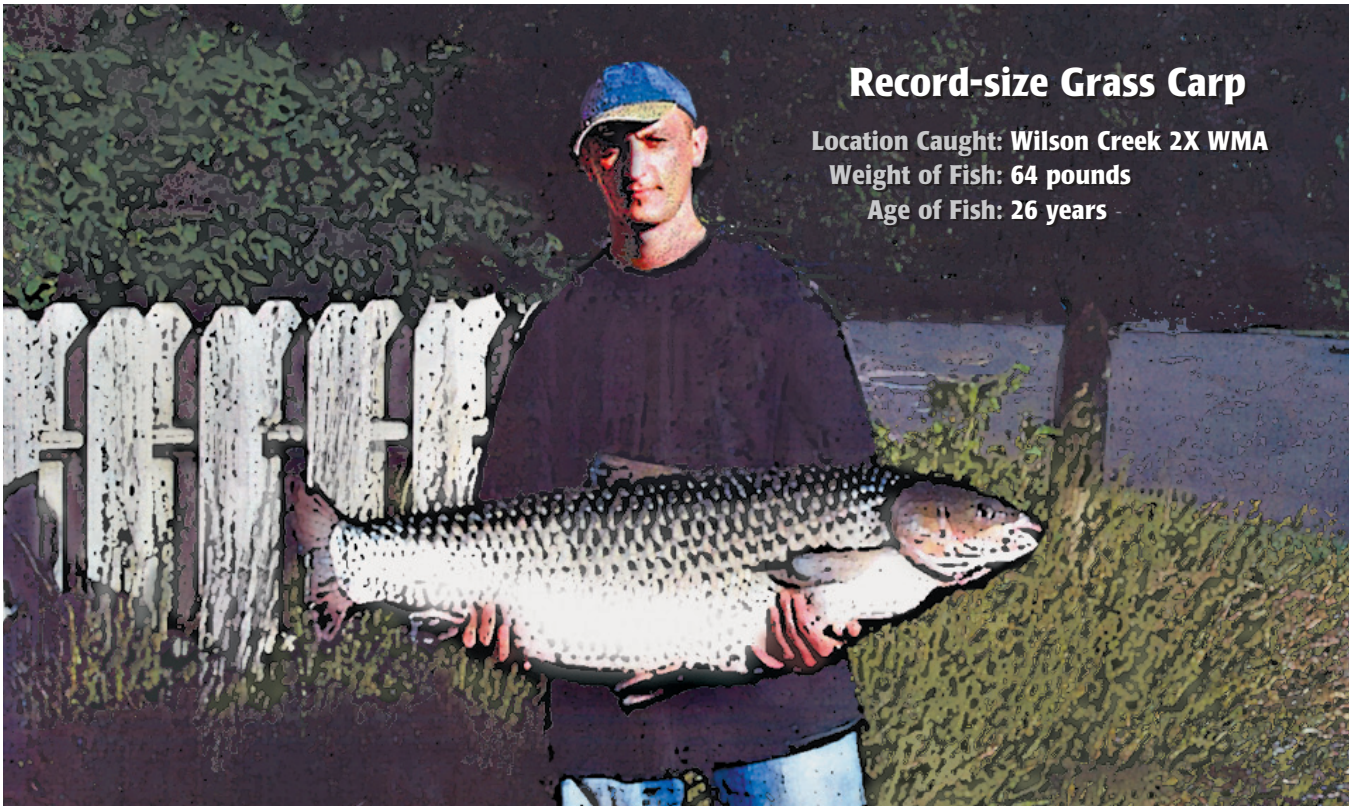
Private Waters Program
Management Assistance for Lakes, Ponds, Pits & Streams

Biological Control Methods

Biological controls (organisms used to control pest organisms) are being investigated for control of nuisance aquatic plants. Fungi, bacteria, and insects have already been studied with certain insects appearing to have the potential to control Eurasian watermilfoil and purple loosestrife. The grass carp, also known as white amur, is a plant-eating (herbivorous) fish native to Asia that has been introduced in the U.S. for aquatic vegetation control in ponds and lakes. They subsequently "escaped" and are now present in many large river systems across the country where they are able to successfully spawn naturally.

Grass carp feed almost exclusively on aquatic vegetation, eating 2 to 3 times their weight each day during the summer months. Grass carp are grazers and prefer certain types of plants (especially native pondweeds), eliminating them before they consume less-palatable or smaller species. They are not successful in controlling Eurasian watermilfoil, coontail, watermeal, duckweed, pond lilies, or most algae species, especially *Chara* spp. Grass carp are very inefficient at converting food into body tissue. Their excrement is high in nutrients, which promotes the production of more vegetation. Too many grass carp can result in total elimination of the desirable submerged plants that were utilizing or tying up available nutrients. This can result in planktonic and filamentous algal blooms.

Since the pond owner has no control over which plants grass carp eat or how much they eat, the Commission rarely recommends them for vegetation control. Spot treatment with chemicals is a better option. If a pond owner insists, grass carp should only be stocked in ponds that have severe submergent



vegetation problems that are negatively affecting fish populations. However, grass carp should not be stocked in a new pond, nor should they be stocked if there is only a narrow band of vegetation around the pond edge because they will eliminate critical habitat for bluegill and largemouth bass. Grass carp will have no appreciable effect on filamentous algae species commonly referred to as moss or pond scum. They should only be stocked at a density of no more than 5 fish per vegetated acre to control plants so that some vegetation remains, or 15 per acre to eliminate them (golf course ponds). Always start at a low stocking density and add fish as needed. It may take two to three years before plant growth is reduced. Stocked fish should be at least 10 inches long to prevent immediate predation by largemouth bass and birds. Keep in mind grass carp can live for decades and can grow quite large (current state record – 64 pounds). Once they are stocked in a pond, it is virtually impossible to remove them without killing everything in the pond or draining it. Successful grass carp reproduction has not been documented in a pond or lake. They may need to be restocked at less than 5 per surface acre every 5 years to compensate for natural mortality and the likelihood some may have been flushed-out during high water flows. Restock only when vegetation is causing a problem again.

Barley straw can be used as a biological control for algae. It is normally applied at a rate of 225 pounds per surface acre of water. As the straw decomposes in the pond, it produces a growth-inhibiting chemical that will prevent new algae growth but may not kill off what is already present. For this reason, it should be applied in March or April, before the algae starts to grow. Barley straw doesn't work on all kinds of algae. The first step is to properly identify which species you have. Contact the University of Nebraska – Lake Water Quality Extension Service (402-643-2981, ext. 115) for algae identification/control measures. If that isn't possible, experiment with an algae sample taken from your pond. Place it, along with an adequate amount of pond water, in a large tub or tank. Apply barley straw and determine if control occurs. It may take 2 weeks to see any results, longer if the water temperature is below 68 degrees. Depending on the availability and cost of barley straw and the size of your pond, it may be easier to just do the treatment if you had major algae problems in the past, and then monitor results. Keep in mind the decomposition process uses oxygen, which will reduce oxygen levels in the pond and stress or kill fish if the straw is over-applied.

Chemical Control Methods

If you are unable to determine a source of nutrients, or if you still have vegetation problems following nutrient reduction and removal efforts, chemical treatments can then be considered. Many herbicides that control aquatic vegetation in ponds are available from commercial distributors. Some are listed as restricted use and must be purchased and applied by a licensed aquatic pesticide applicator.

Some advantages of herbicides are:

- They (contact herbicides) generally produce fast results.
- They are usually easy to apply.
- They are often available locally.
- They are normally selective for a particular plant species and leave others unaffected.
- They typically give the pond owner control over how much vegetation is eliminated.

Some disadvantages and precautions for herbicides are:

- They are expensive.
- They usually require multiple applications during a season to maintain control. Retreatment is usually necessary in succeeding years. Also, one type/species of plant may be controlled, but is often replaced by another type/species because nutrients and other

NEBRASKA GAME PARKS
See You Out There

NEBRASKA POND GUIDE

Private Waters Program
Management Assistance for Lakes, Ponds, Pits & Streams

favorable environmental conditions are still present.

- They can be dangerous to the applicator. Most are toxic if taken internally and applicator(s) should wear protective clothing, gloves, and a face mask or respirator during mixing and application.
- The plants must be correctly identified, sometimes to species; certain chemicals will work on only some plants and not others.
- The treatment area must be accurately measured. Most chemical applications involve calculating a dosage per acre-foot of water that has a vegetation problem. Examples of surface and volume calculations are provided at the end of this guide.
- If you are uncertain about plant identification or herbicide usage, contact an area Commission fisheries biologist, the extension educator in your county, or an aquatic herbicide manufacturer/dealer.
- Read and follow the directions and precautions on the herbicide label. The label will list what plants can be controlled and dosage recommendations; it will also indicate when the application should or should not occur. Also listed on the label will be any restrictions on usage of treated water, including human contact (swimming, wading, or drinking the treated water), fish consumption, irrigation, and livestock watering.
- Check the pond water temperature. Aquatic plants are typically unaffected by herbicides when the water is too cold. Water temperature should be in the 60s.
- Most aquatic herbicides will not harm fish if properly applied. Try to avoid applying chemicals during spawning periods. Some chemicals can directly or indirectly kill spawning adult fish that refuse to leave treated areas, and they may kill fish eggs or fry.
- Some herbicides, such as copper sulfate used for algae control, should not be used extensively in fishing ponds. Because it is cheaper and perhaps easier to apply than chelated copper-based chemicals, there is a tendency to over-apply copper sulfate. This can negatively affect fish and their food organisms as it disperses through the water column and accumulates in bottom sediment.

Rarely does the entire pond need to be treated. Typically, all that is needed is to open up some fishing and boating lanes or a few shoreline areas for bank fishing, swimming, and wading. If a large portion of the pond surface will eventually be treated, or the growth is extensive, treat only 1/4 to 1/3 of the problem area at a time, and wait about two weeks between subsequent applications. If too much vegetation is killed (including algae types), subsequent decomposition will deplete available oxygen which can stress or even kill fish. When applicable, start treatment in the pond area where the wind is blowing toward and make sure there isn't any chemical drift that could affect non-target plants. Read the label regarding wind restrictions.

Most problem vegetation species should be treated early in the season, when they first start growing and favorable water temperatures are present, not during summer months when the dissolved oxygen levels in the pond may already be low or widely fluctuating. Some plants, such as cattails and water lilies, should be more mature when certain chemicals are used; otherwise, only the top will be killed and the rest of the plant and its roots will be unaffected and regrow. Keep in mind most aquatic plant species die naturally at the end of their growing season and new plants start from plant fragments, root stock, and seeds the following season. Dormant seeds and underground "root" structures are not affected by most aquatic herbicides.

Some herbicides (contacts – such as copper

algacides, endothall, and diquat) work very quickly by killing the plant tissue they contact. This makes them very useful for "spot" treatment of selected patches of vegetation. Other herbicides (systemic) work more slowly and move into the plant – affecting other parts of the plant (underground rhizomes, tubers, etc.) rather than leaf tissue. Some of these herbicides (2,4-D, triclopyr, and glyphosate) can be used for spot treatments but keep in mind they work slowly. One particular herbicide group (systemic-fluridone) cannot be used for spot treatments because it may move away from the treated area before it can have an affect.

Specific Plant Problems

ALGAE

Microscopic algae and *Chara* spp. are typically not eaten by grass carp; although young grass carp can eat filamentous types, adults have a preference for submersed plants. If chemical treatment is needed, algae should be treated with chemicals before they cause a noticeable color in the water. Blue dye products are not particularly effective on algae, especially in shallow or flowing water. It may be useful to add dye after a copper treatment to prevent new growth from rising to the surface.

Control of all three types of algae is mostly accomplished with a copper-based product – primarily copper sulfate. Sometimes copper sulfate is not very effective on some algae types, and it becomes inactivated in very hard (alkaline) water. As mentioned earlier, copper sulfate shouldn't be used extensively or continuously, especially in the same pond. If it is ineffective, a chelated copper product should be used instead.

Chara spp. can be very difficult to control once they have become established and have secreted a heavy, surface coating of calcium carbonate (limestone). Treatment should be done early in the season when plants are young and not heavily calcified. Granular Cutrine can be an effective control when it is dropped into the vegetation.

Although there are typically no water use restrictions for water treated with copper products, they should never be used in trout waters. Still, it is wise to restrict swimming, fishing, utilizing the water for irrigation, drinking or livestock watering, and other activities for 24 hours following an application.

Algacides that can be used:

Copper sulfate (contact chemical). It has various trade names and is available as granular crystals or powder. It is only used on algae; it is not effective on other types of aquatic plants. The powder form should be applied by mixing with water and spraying. The mix should be sprayed directly on and around mat-forming types. Good coverage of mats is critical for control and several treatments may be necessary during a particular season. The granular form is best applied by putting it in a burlap sack and towing it behind a boat through the treatment area until it dissolves. Just tossing the granules into the water isn't very effective; granules that land on bottom sediment are typically absorbed by it and not available for uptake by algae. Copper sulfate is highly corrosive to metals. Plastic, enameled, or copper lined equipment should be used for its mixing/application and sprayers should be thoroughly cleaned after each use.

Copper chelates (contact chemical). Trade names include: Cutrine Plus, Algae Pro, Captain, K-Tea, and others. Available as liquids; Cutrine Plus is also available as a granule. Chelated copper-based chemicals are used primarily for algae control. They are less harmful to fish and their food organisms, less corrosive, and are more effective in hard water. They also persist longer in the water. This longer uptake period provides better control of algae and means less chemical is needed, as compared to copper sulfate. Liquid formulations should be mixed with water and then either sprayed or injected into

the treatment area. Granular formulations can be broadcast by using a seeder/spreader. Both liquid and granular formulations can be used for spot treatments.

Endothall (contact chemical). Trade name: Hydrothol 191. Available as liquid or granule. Should only be used by certified applicators who are specially trained in handling aquatic pesticides. It can cause severe skin burns to applicator. Caution should be used when Hydrothol 191 is used for algae control. It should only be used as a spot treatment, thus assuring there is ample untreated water fish can move into. Small fish have a tendency not to move away from the treated area fast enough, which can result in mortality.

SUBMERSED PLANTS

Many submersed plants can be controlled by a variety of methods (mentioned earlier) other than chemical. Keep in mind if grass carp are going to be used, they are not very effective for controlling Eurasian watermilfoil or coontail, especially when other, more preferred plants are available.

Endothall and diquat products are the most commonly utilized chemicals for submersed plant control. Since they are effective for spot treatments, they can be used to control vegetation in a specific area and not affect plants in other areas. They act quickly (burn-down visible within a week). They are extremely short-lived in water and have short waiting periods for various water uses. If they are tank mixed with copper products, they can also be used to control algae.

Although certain endothall or diquat products will burn-down Eurasian milfoil, it will be more effectively controlled by other chemical product groups, such as 2,4-D, triclopyr, and fluridone. The fluridone products are more expensive; however, they can be used at very low dosages (parts per billion) for control and will not harm existing desirable native plants.

Herbicides that can be used:

Endothall (contact chemical). Trade names include: Aquathol and Hydrothol 191. Both are available as liquids and granules. Aquathol (along with Diquat) is a standard treatment for submersed plants. The liquid formulations should be mixed with water and either sprayed or injected into the treatment area. A seeder can be used to broadcast granular formulations. Both formulation types can be used for spot treatments. See Hydrothol 191 cautions presented in algae section.

Diquat (contact chemical). Trade name is Reward. Only available as liquid. It and Aquathol are standard treatments for submergents and can be used for spot treatments. The chemical/water mixture can be either sprayed or injected. Do not use when water is muddy; suspended soil particles will absorb it.

Fluridone (systemic chemical). Trade names include: Sonar and Avast!. Sonar is available as AS (aqueous solution), SRP (slow release pellet), PR (precision release), and Q (quick release). Mix Sonar AS and Avast! with water and spray or inject the mixture. A seeder can be used to spread pelleted forms. Since Fluridone products are not effective as a spot treatment, they have to be applied to the entire pond surface area. The chemical must stay in contact with target plants; therefore, it shouldn't be used when there is a potential for a lot of water exchange due to runoff or in-flowing water. Since it is a slow uptake/reacting product, it may take 30-90 days for noticeable results. However, targeted plants may be controlled for 2 or more years. Fluridone products can be applied at very low dosages (parts per billion). They are very effective for controlling/eliminating the invasive, exotic Eurasian watermilfoil without affecting native species present.

2,4-D (systemic chemical). Trade names include: Navigate and Aquakleen. Both are granular formulations and should be distributed evenly over the infested area. 2,4-D granules are used for specific

plant species (such as Eurasian watermilfoil and coontail). It can be used to selectively remove target species and not harm grasses or grass-like species (particularly the many native species). There are no liquid formulations currently registered for in-water usage. Although liquid amine formulations can be used for vegetation control around water, the label has to be checked to see if a particular product is registered for that usage. Liquid ester formulations are highly toxic to fish and should not be used around water.

Triclopyr (systemic chemical). Trade name is Renovate 3. Only available as liquid. Similar to 2,4-D in that it can be used to control target species while not affecting grasses or grass-like plants (such as cattails). Since it is approved for in-water usage, it can be used to control Eurasian watermilfoil.

ROOTED-FLOATING and EMERGENT PLANTS

Control can be accomplished by cutting or digging these plants; however, it can be very laborious because the underground rhizomes must also be removed. Grass carp may eat tender, young shoots but not likely the mature plants.

Although Diquat is labeled for emergents, it will just burn the foliage and not kill the plant because it does not move into the underground parts. However, Glyphosate products plus a non-ionic surfactant are effective as foliar spray or wipe-on treatments. They will move downward and effectively kill underground structures, thus providing long-term control. Keep in mind glyphosate products act slowly, effects may not be seen for several weeks. Although they can be applied in the spring as new growth appears, better control can be achieved with a late summer or early fall application before the first freeze. The chemical is then drawn down into the underground structures as the plant goes into winter dormancy. Success can be confirmed by the absence of vegetation the following spring.

Triclopyr (Renovate 3) and some 2,4-D products can be used to selectively remove purple loosestrife and other broadleaved plants from grasses or grass-like plants (such as cattails and bulrushes).

Herbicides that can be used:

Glyphosate (systemic chemical). Trade names are Rodeo, Aqua Neat, and Eagre. Only available as liquids. Since these products are not selective, they will kill any emergent plant they come in contact with, especially cattails. They can also be used to control waterlilies and phragmites. They do not work on plants beneath the water surface. A non-ionic surfactant is required in the chemical/water mixture and then sprayed directly on the foliage. As mentioned earlier, the best time for treatment is late summer or early fall – before the first hard freeze. The chemical mixture can be used as a spot treatment or as a wipe-on application. Protective gloves should be worn when a sponge is used to apply the mixture directly onto foliage of specific plants.

2,4-D (systemic chemical). Some products (check the label) can be used to selectively remove water lilies or purple loosestrife and other broadleaved plants and not harm grasses or grass-like species (particularly the many native species). See 2,4-D cautions presented in the submersed plants section.

Triclopyr (systemic chemical). Trade name is Renovate 3. Only available as liquid. Similar to 2,4-D in that it can be used to selectively control broadleaved emergents (such as purple loosestrife) while not affecting grasses or grass-like plants (such as cattails and bulrushes). It can also be used to control water lilies. Keep in mind that a non-ionic surfactant is required in with the chemical/water spray mixture.

Imazapyr (systemic chemical). Trade name is Habitat. Since it is not selective, it will kill many plants types (on and above water) it comes in contact with – including emergent plants (such as cattails,

purple loosestrife, phragmites, and salt cedar) and rooted-floating plants (such as water lilies). It can only be used by certified applicators. There has to be ample untreated water left for aquatic organisms to escape to.

FREE-FLOATING PLANTS

Duckweed and watermeal are difficult to control. They typically are not consumed by grass carp, and physical/mechanical removal can be very difficult; therefore, chemical control is likely the best option.

Herbicides that can be used:

Diquat (contact chemical). Trade name is Reward. Only available as a liquid. Reward can be used for burndown control; however, the plants typically grow back within a couple of weeks. Thus, continual treatments are necessary throughout the growing season and should start when plants first appear.

Fluridone (systemic chemical). Trade names are Sonar AS and Avast!. Fluridone products are more effective and sometimes give more than one year of control - provided they are used correctly. In order for fluridone to work, there must not be any pond inflow/outflow for at least 30 days to ensure plants remain exposed to the chemical. The dosage (1 quart per surface acre) for duckweed should be applied in two applications about 10 to 14 days apart. Watermeal is typically harder to kill than duckweed; therefore, a higher dosage (1.5 quarts per surface acre) in a split application is recommended.

Imazapyr (systemic chemical). See the prior Rooted-Floating and Emergent Plants section for product information and precautions. Can be used for duckweed control.

Contacts: Jeff Blaser, Private Waters Specialist
Nebraska Game and Parks Commission
2200 North 33rd Street
Lincoln, NE 68503
402-471-5435
or area Commission fisheries biologist.

NOTE: "The Aquatic Plant Management" publication by Carole A. Lembi from Purdue University was an important guideline for a lot of the information used in the chemical treatment portion of this Pond Guide. The various restrictions presented in the following table were primarily in accordance to Indiana regulations. **Check with local and state regulatory agencies for Nebraska restrictions and product labels for current chemical manufacturers' restrictions, dosages, adjuvants (chemicals that can be added to increase effectiveness or safety of herbicide/water mixture), and listed plants.** Consult various websites regarding chemical product listing/labels, such as *www.cdms.net/manuf/manuf.asp.*

NEBRASKA GAME PARKS
See You Out There

NEBRASKA POND GUIDE

Private Waters Program
Management Assistance for Lakes, Ponds, Pits & Streams

AQUATIC HERBICIDE GUIDELINES AND WATER USE RESTRICTIONS

AQUATIC WEED	HERBICIDE	TYPICAL PRODUCT DOSE[1]	RESTRICTIONS[2]
Algae (microscopic, filamentous, *Chara)*	Copper Sulfate (25% Cu)	2.7 lb/A-ft	Do not use in trout-bearing waters
	Copper chelates (Cutrine Plus, Algae Pro, Captain, K-Tea)	Rate varies (consult label)	Do not use in trout-bearing waters
	Endothall (Hydrothol 191) Liquid Granular	 0.6 to 8.8 pt/A-ft 2.2 to 13.2 lbs/A-ft	F = 3 days I, L, D = 7-25 days **Recommended for use by only certified applicators**
Submerged Plants (pondweeds, naiads, others – consult label)	Endothall (Aquathol K liquid) Aquathol Super K (granular)	0.6 to 1.3 gal/A-ft 27 to 54 lbs/A-ft	F = 3 days I[3], L, D = 7-25 days
	Diquat (Reward)	1 to 2 gal/SA	I = 1-5 days; D = 1-3 days; L = 1 day
	Furidone (Sonar, Avast!)	Dose varies with formulation	I = 7-30 days; do not apply within 1/4 mile of potable water intakes
Submerged Plants (Eurasian watermilfoil, coontail)	2,4-D (Navigate, Aquakleen)	100 to 200 lbs/SA	Do not apply to waters for I, D
	Furidone (Sonar, Avast!)	As above	As above
Submerged Plants (Eurasian watermilfoil)	Triclopyr (Renovate 3)	0.7 to 2.3 gal/A for each ft. of depth (consult label)	Consult label for required setback distances from potable water intakes
Free-Floating Plants (duckweed, watermeal)	Diquat (Reward) **plus surfactant**	1 gal/SA	As above
	Fluridone (Sonar AS, Avast!)	1 to 1.5 qt/SA	As above

(continues on page 15)

NEBRASKA GAME PARKS
See You Out There

NEBRASKA POND GUIDE

Private Waters Program
Management Assistance for Lakes, Ponds, Pits & Streams

AQUATIC HERBICIDE GUIDELINES AND WATER USE RESTRICTIONS

(continued from page 14)

AQUATIC WEED	HERBICIDE	TYPICAL PRODUCT DOSE[1]	RESTRICTIONS[2]
Rooted-Floating Plants (waterlilies)	Glyphosate (Rodeo, Aqua Neat, Eagre) **plus surfactant**	Consult label	Do not apply within 1/2 mile upstream of potable water intake
	Triclopyr (Renovate 3) **plus surfactant**	2 to 8 qt/SA	As on previous page
Emergent Plants (most plants including cattails, grasses, purple loosestrife, willows, phragmites)	Glyphosate (Rodeo, Aqua Neat, Eagre) **plus surfactant**	Consult label	As on previous page
Emergent Plants (purple loosestrife)	Triclopyr (Renovate 3) **plus surfactant**	Consult label	Minimize over-spray to open water
Emergent Plants (purple loosestrife, willows, phragmites, salt cedar, cattail) and **Rooted-Floating Plants** (waterlilies) and **Free-Floating Plants** (duckweed)	Imazapyr (Habitat) **plus surfactant**	Consult label	Do not apply within 1/2 mile upstream of potable water intake: nor within 1 mile upstream or 1/2 mile downstream of stream irrigation intake (irrigation delay until treated water passes or 120 days until levels are < 1ppb) **Can only be used by certified applicators.**

FOOTNOTES:

[1]SA = surface acre; A/-ft = acre-feet. These dosages are given only as an indication of amount to use and will vary according to target species and state restrictions. **Read the label to determine actual dosages for a particular target plant.**

[2]F = fishing; I = irrigation; L = drinking water for livestock; D = drinking water for humans. Where range of days is given, the waiting time depends on dose used. Again. Indiana restrictions given – **check with local and state regulatory agencies.**

[3]Liquid formulation only; treated water can be used for sprinkling bent grass immediately.

NEBRASKA GAME PARKS
See You Out There

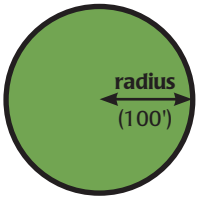
NEBRASKA POND GUIDE

Private Waters Program
Management Assistance for Lakes, Ponds, Pits & Streams

CALCULATING THE SURFACE AREA AND VOLUME OF A POND

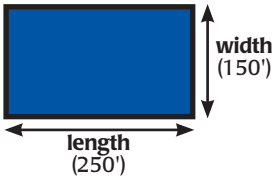
Presented below are formulas for calculating the **surface area** of a pond. Pick a shape that most closely resembles the pond and measure the necessary distances in feet. Put these measurements into the appropriate equation and multiply to find the surface area in square feet. Surface area in acres is simply obtained by dividing the surface area by the number of square feet in an acre (43,560). If a pond is irregular in shape, the best thing to do is divide it into workable shapes and then add the areas of the smaller units together to get the area of the whole.

CIRCLE = 3.14 x radius^2



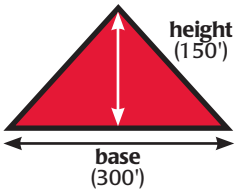
EXAMPLE: pond radius 100 feet x 100 feet x 3.14 = 31,400 square feet total surface area ÷ 43,560 = .72 surface acre

RECTANGLE = length x width



EXAMPLE: pond length 250 feet x width 150 feet = 37,500 square feet total surface area ÷ 43,560 = .86 surface acre

TRIANGLE = $\frac{\text{base x height}}{2}$



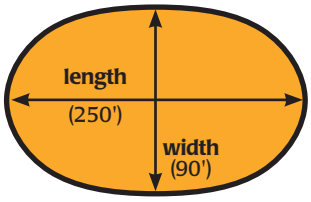
EXAMPLE: pond base 300 feet x height 150 feet = 45,000 square feet ÷ 2 = 22,500 total surface area ÷ 43,560 = .52 surface acre

NEBRASKA GAME PARKS
See You Out There

NEBRASKA POND GUIDE

Private Waters Program
Management Assistance for Lakes, Ponds, Pits & Streams

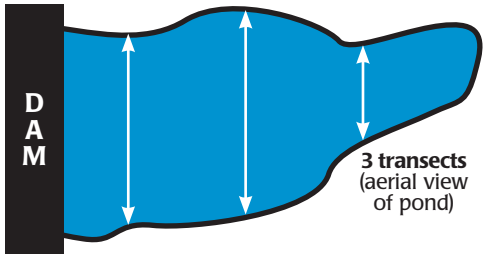
ELLIPSE = length x width x 0.8



EXAMPLE: pond length 250 feet x pond width 90 x 0.8 = 18,000 square feet total surface area ÷ 43,560 = .41 surface acre

The formula for calculating a pond's **volume** is surface area (acres) x average depth (feet). Average pond depth can be estimated by measuring the depth of the water in a number of places throughout the pond, adding these measures together to get a total, and then dividing the total by the number of measurements. Several transects should be established across the pond (from one side straight across to the other side). Depth measurements should be taken/recorded every 40 feet with an electronic depth finder or a weight attached to a string marked in feet.

VOLUME (acre-feet) = surface area (acres) x average depth (feet)



EXAMPLE: forty measurements were taken while conducting three transects across the surface of a .75 acre pond; average depth calculated to be 4 feet; therefore, .75 x 4 = 3 acre-feet

NOTE: Average depth can be estimated by multiplying the maximum depth by 0.4

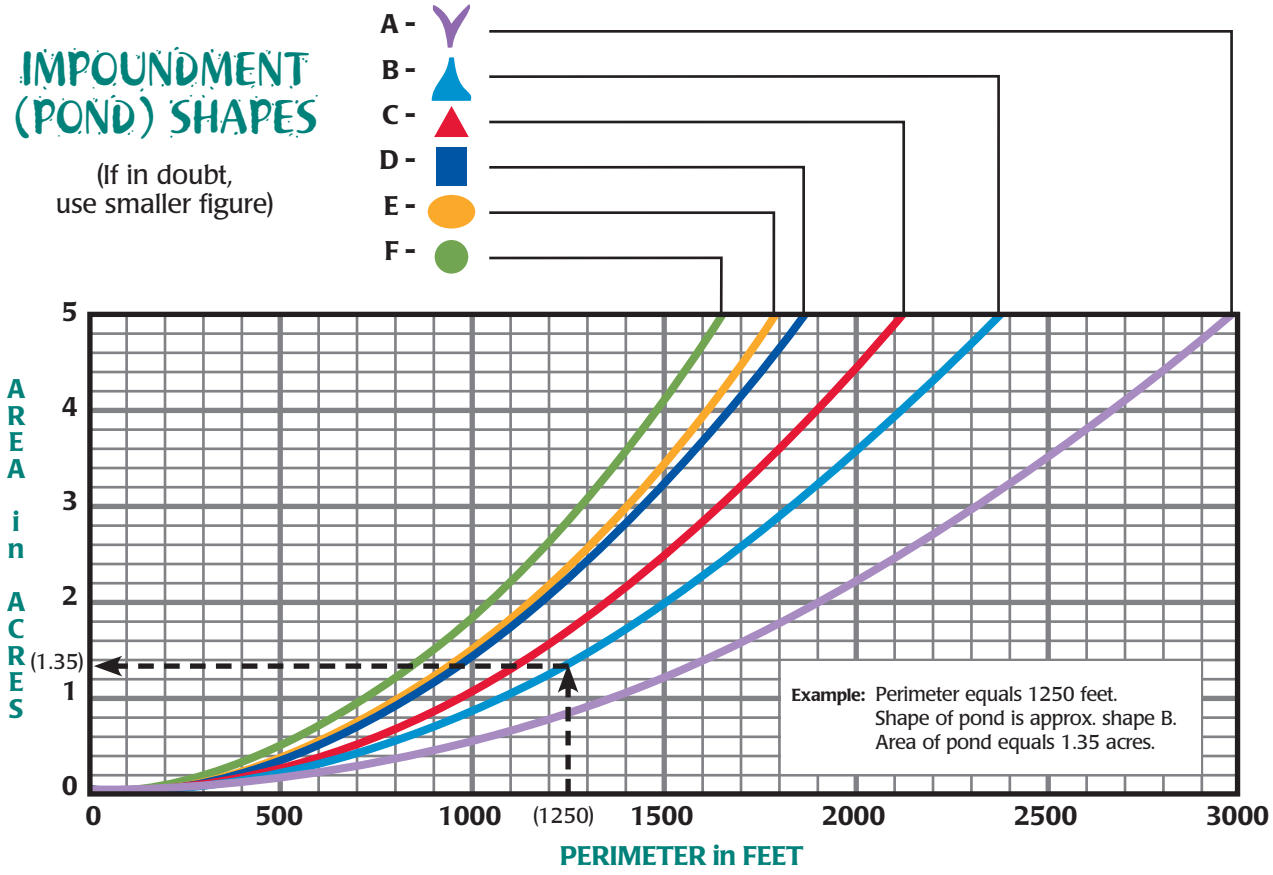
NEBRASKA GAME PARKS
See You Out There

NEBRASKA POND GUIDE

Private Waters Program
Management Assistance for Lakes, Ponds, Pits & Streams

POND AREA ESTIMATOR

If the distance around the entire pond can be measured, this pond estimator can be used.



LIST OF AQUATIC CONSULTANTS AND SERVICES PROVIDED

The Nebraska Game and Parks Commission does not promote or endorse personnel, agencies or companies that are not part of Nebraska state government, but provides a listing as a service. If you would like to request a copy of the listing or would like to be considered for any of the services listed, contact the Private Waters Specialist at the Commission's headquarters (402-471-5435).

The listing contains individuals and/or companies that provide the following services:

Complete Ecological Consulting Services (includes design and construction guidelines)

Construction Contractors

Fisheries/Lake Management
(lake, fisheries and water quality assessment and/or management along with vegetation control)

Aeration Systems

Water Testing

Vegetation Sources

Lake Dredging/Deepening (lakes should be drained and excavated when feasible)

Shoreline Stabilization/Fish Habitat Structures

Pond/Lake Sealing

Flowing Water Filter System

Aquatic Vegetation Control (chemical dealers and chemical applicators)

Clarity Improvement for Turbid Water

Lake Mapping

NEBRASKA GAME PARKS
See You Out There

NEBRASKA POND GUIDE

Private Waters Program
Management Assistance for Lakes, Ponds, Pits & Streams

TECHNICAL ASSISTANCE CONTACTS

Nebraska Game and Parks Commission (Commission)

2200 N 33rd Street PO Box 30370
Lincoln, NE 68503
Private Waters Specialist 402-471-5435
Natural Heritage Program 402-471-5419

Northwest (NW) District - Alliance

Game and Parks Commission
299 Husker Road PO Box 725
Alliance, NE 69301
308-763-2940
Fisheries Division or
Wildlife Habitat Partners Section

Northwest (NW) Field Office - Valentine

Valentine State Fish Hatchery
90164 Hatchery Road
Valentine, NE 69201
402-376-8080 or 402-376-2244

Southeast (SE) District - Lincoln

Game and Parks Commission
2200 N 33rd Street PO Box 30370
Lincoln, NE 68503
402-471-7651 or 402-471-5561
Fisheries Division or
Wildlife Habitat Partners Section

Northeast (NE) District - Norfolk

Game and Parks Commission
2201 N 13th Street
Norfolk, NE 68701
402-370-3374
Fisheries Division or
Wildlife Habitat Partners Section

Northeast (NE) Field Office - Bassett

Game and Parks Commission
524 Panzer Street PO Box 508
Bassett, NE 68714
402-684-2921
Fisheries Division or
Wildlife Habitat Partners Section

Southwest (SW) District - Kearney

Game and Parks Commission
1617 First Avenue
Kearney, NE 68847
308-865-5310
Fisheries Division or
Wildlife Habitat Partners Section

Southwest (SW) Field Office - North Platte

Game and Parks Commission
301 East State Farm Road
North Platte, NE 69101
308-535-8025
Fisheries Division or
Wildlife Habitat Partners Section

NEBRASKA GAME PARKS
See You Out There

NEBRASKA POND GUIDE

Private Waters Program
Management Assistance for Lakes, Ponds, Pits & Streams

United States Department of Agriculture - Natural Resources Conservation Service (NRCS)

Federal Building, Room 152
100 Centennial Mall North
Lincoln, NE 68508
Statewide Wildlife Biologist
402-437-4100
or contact Local County Office

University of Nebraska - Lincoln, Cooperative Extension

211 Agricultural Hall - UNL East Campus
Lincoln, NE 68583
Main Office 402-472-2966
or contact Local County Office;
Water Quality Questions 402-643-2981, ext. 115

Nebraska Department of Natural Resources (DNR)

301 Centennial Mall South, PO Box 94676
Lincoln, NE 68509
Water Storage Permits 402-471-2363 or
Dam Safety Guidelines 402-471-1222

U.S. Army Corps of Engineers (ACOE)

8901 S. 154th Street, Suite 1
Omaha, NE 68138 402-896-0723
or contact the Kearney office at:
1430 Central Avenue
Kearney, NE 68847
308-234-1403

Nebraska Department of Environmental Quality (NDEQ)

1200 N Street, PO Box 98922
The Atrium, Suite 400
Lincoln, NE 68509
402-471-0096

Nebraska Association of Resources Districts (NARD)

601 S. 12th Street, Suite 201
Lincoln, NE 68508
402-471-7670
or contact your local Natural Resources District (NRD)
listed in White Pages of the phone book