Alaska
Aquatic Pest Control
Manual

Category Six

In general, applicators who apply pesticides to property other than their own must obtain certification from the Alaska Department of Environmental Conservation (DEC). Applicators who apply restricted-use pesticides, regardless of location, must also be certified.

ALL individuals who apply pesticides to any type of surface water, including lakes, ponds, streams, rivers, or wetlands must be certified by DEC in the Aquatic Pest Control category (Category Six). This includes any waters of the state, including marine water, surface water, or wetlands.

The information needed to successfully complete the written core examination required for all certified pesticide applicators in Alaska includes:

1. National Pesticide Applicator Certification Core Manual;
2. Alaska Core Manual; and
3. State of Alaska Pesticide Regulations in Title 18, Chapter 90 of the Alaska Administrative Code (18 AAC 90).

The information needed to successfully obtain certification in Category Six in Alaska includes:

1. This Alaska Manual; and
2. The Michigan State University *Aquatic Pest Management Manual.*

Learning Objectives for this manual

- Explain when and what types of permits are required from DEC for applying pesticides to water.
- Describe how rotenone works to kill fish.
- List some non-chemical methods to control Northern pike, and explain the reasons why they are generally not effective.
- Describe the development, life cycle, biology, damage caused by, and appropriate control methods for mosquitoes, purple loosestrife, yellow pond lily, reed canarygrass, and elodea.

CALCULATIONS

Because calculations related to aquatic applications can be extremely challenging, applicators in this category are expected to have very strong math skills. Aquatic applicators must be able to calculate area and volume of irregular pond shapes. Aquatic applicators must also be able to determine stream flow and other complex calculations. The Michigan State University *Aquatic Pest Management Manual* provides additional information on required calculations.

PERMIT REQUIREMENTS

All applications of pesticide to water bodies require a pesticide-use permit. This is true regardless of who owns the surrounding lands. Please refer to the Alaska Core Manual for further information regarding permits.

APDES PERMIT REQUIREMENTS

In addition to the Alaska Pesticide-Use Permits, an Alaska Pollution Discharge Elimination System (APDES) Permit is required before a pesticide may be applied to any surface water.

The APDES permit is available through the DEC wastewater division, and must be obtained prior to applying for Pesticide Use Permit from the DEC Pesticide Control Program. For more information, contact at **james.rypkema@alaska.gov**, or (907) 334-2288.

PESTICIDE LABELING

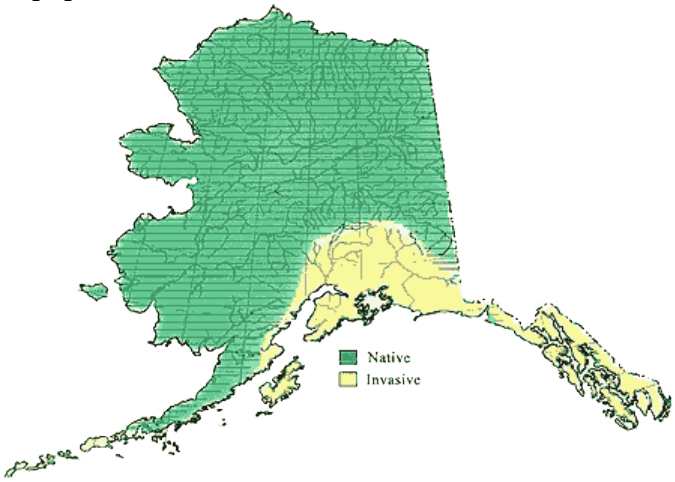
As with all pesticides, state and federal law requires you to comply with all label instructions. It is particularly important to ensure that any pesticides applied to water bodies are **specifically labeled for aquatic use**.

COMMON AQUATIC PESTS IN ALASKA

Invasive **Northern Pike** and **Mosquitoes** are the most common aquatic animals for which pesticides are used in Alaska. Aquatic vegetation control is most commonly considered for **Algae**, **Milfoil, Purple Loosestrife, Yellow Pond-Lily, Reed Canarygrass**, and **Elodea**.

Invasive Northern Pike

The Northern pike is native to most of northern and western Alaska. However, in Southcentral Alaska, the Northern pike is an invasive species that does not occur naturally. Pike are top-level predators in aquatic food chains, and will consume fish, waterfowl, and other native animals. In Southcentral Alaska, Northern pike do not have any natural predators, and are capable of decimating native populations of trout, salmon and other fish.



Areas where northern pike do not naturally occur are shaded in yellow.
(From the Alaska Department of Fish and Game website)

Control of Northern Pike with Rotenone

Rotenone has been used by fish managers in the U.S. since the 1930s to remove unwanted or invasive fish. Rotenone is commercially available as either a wettable-powder or liquid and is registered by the Environmental Protection Agency (EPA) as a restricted-use pesticide for fish management.

In aquatic applications rotenone is absorbed through the gills, and inhibits the ability of fish to utilize the oxygen in their blood during cellular respiration. Because of the low concentration used for fish management, rotenone use poses little threat to birds, mammals (including humans), and other non-gill breathing organisms. Under warm temperatures, rotenone is quickly degraded. However, it is known to persist longer in cold Alaskan waters. It can be neutralized with potassium permanganate. Rotenone has low mobility in soil, and therefore is unlikely to impact groundwater.

Alternatives to Rotenone

Alternative methods to remove invasive fish are generally not as effective or efficient as rotenone.

Fishing Regulations: Increasing bag limits and easing equipment requirements has not been effective in eradicating Northern pike. Smaller pike are often released by fishermen, allowing for continued populations.

Predator Stocking: Introduction of non-native fish to prey on Northern pike could have serious consequences and disrupt the ecological balance. There are no biological controls of Northern pike recommended for use in Alaska.

Sterilized Pike: Releasing sterilized pike to outcompete fertile spawners would take years to implement and is not likely to be effective.

Netting: Nets can be used only in shallow, non-vegetated water bodies, which is not the habitat that Northern pike prefer. Nets generally don't catch all the fish, and most of the smaller fish generally escape. Repeated netting is necessary to completely eradicate a population, and these programs are labor intensive and costly. Nets also catch non-target species of fish and other types of wildlife. Netting can reduce populations of invasive fish, but will not eliminate them completely.

Electrofishing: Electrofishing equipment delivers an electrical current into the water, which stuns nearby fish. Because pike prefer areas with dense aquatic plants, electrofishing has limited success for pike removal. Electrofishing loses its effectiveness in water deeper than six feet. Electrofishing is unlikely to effectively eradicate all target fish.

Water Level Drawdown: Draining all the water out of a lake can effectively eradicate all target fish. However, draining even a small water body is extremely difficult, and is not possible for rivers or streams. This method also kills all aquatic life, not just the target species.

Percussion: Explosives have been used in the past to eradicate unwanted fish. Explosives are expensive, dangerous, and kill all nearby aquatic life, not just the target species. The explosion must occur very close to the fish to be effective, so it is unlikely to effectively eradicate all target fish.

Mosquitoes

There are approximately 35 different species of mosquito known in Alaska. The most common mosquitoes belong to the genus *Aedes*. Mosquitoes of the genus *Culiseta* are also present, and are often the first to emerge in spring.

Order: Diptera (flies)
Family: Culicidae
Subfamily: Anophelinae
Genus: Aedes
Genus: Culiseta

Most people are familiar with the appearance of mosquitoes and the itchy bumps caused by their bites. Both males and females feed on plant nectars. Only the females are capable of taking a blood meal, which ensures larger egg clutches.

Developmental Stages

A single female mosquito may lay up to 3,000 eggs, with up to 80 percent hatching. Mosquito eggs are white in color when first deposited but darken within 12 to 24 hours. Most species' eggs appear similar when seen by the naked eye. When viewed with magnification, eggs of different species can be seen to vary in shape. Some species lay eggs singly, and others glue them together to form rafts. The incubation period (time between when eggs are laid and when they hatch) varies with species and is also influenced by environmental factors. All eggs require slow moving or stagnant water at some point before hatching will occur.

Based on where they lay their eggs, mosquitoes are divided into two basic categories: floodwater species and permanent water species. Floodwater species deposit their eggs in dry areas that are subject to periodic flooding, such as soil in depressions, areas of marshes that are not always submerged, inside tree holes, or artificial containers including discarded cans, tires, rain barrels, gutters, and other areas where water may accumulate. These eggs need to dry out for a period of time before they will can hatch. Once they have passed through the critical drying time, they may hatch if the area is flooded by snow melt, rain, or seasonal flooding. Eggs may accumulate over time as more eggs are laid and await the right conditions for hatching. When temporarily flooded, all the eggs hatch at once, which can rapidly increase populations. Some species have eggs which require freezing temperatures in order to hatch. They produce one to several generations annually. In most floodwater species the adult mosquitoes die off during winter, but the eggs survive to hatch the next year.

Standing water species deposit their eggs on the surface of permanent pools of standing water, including lakes, ponds, and wet areas of swamps. Eggs are deposited either as single eggs, or in rafts of several hundred eggs. These eggs will not survive being dried out. Eggs may hatch in one to four days, depending on temperature. They usually produce several generations each year, and overwinter as mated, engorged females.

The larvae of all mosquitoes live in water, usually near the surface. They are often called 'wigglers' in this stage because of how they move in the water. In most species there is a siphon

or air tube near the last abdominal segment. This allows the larvae to breath while remaining below the surface of the water. Mosquito larvae hang with their heads down. The brushes near their mouths filter the water for algae, plankton, fungi, bacteria and other microorganisms.

Depending on the species and environmental conditions, mosquitoes may take anywhere from a few days to several weeks to complete larval development. During the larval stage, the mosquito will shed its skin, or molt, four times. Each of the periods in between the molts is called an instar. Towards the end of the fourth instar the mosquito larva stops feeding as it prepares to become a pupae.

The pupal stage of the mosquito is also aquatic. The mosquito pupa is shaped like a comma. They generally float near the surface, but can be very active when disturbed. They are often called “tumblers” because of their rapid, tumbling movements. Mosquito pupae breathe through two respiratory “horns” when at the water’s surface. They do not feed at this stage. They typically transform into adults in two or more days. Once it is developed, the adult mosquito splits the pupal case and emerges to the surface of the water, where it rests until its body dries.

The adults of some species remain within a few hundred feet of where they spent the larval stage, but others may migrate up to 50 miles or more. A few days after females take a blood meal they begin to develop eggs. Mosquitoes live for varying amounts of time depending on the species. Most floodwater species die off during winter months, while some standing water species hibernate during winter and emerge in spring. Some species are limited to a single generation per year, while others have multiple generations.

Life Cycle and Habitat

There are many differences in appearance between different species of mosquitoes, which allows for accurate identification. Behavioral differences permit various species to occupy numerous ecological niches with relatively little overlap. Knowledge of the source or breeding habitat of mosquitoes can allow for accurate identification.

Identifying the species of mosquito can be extremely helpful in determining life cycles, feeding preferences, larval habitats, adult resting places, and flight ranges. This information is used to develop effective control strategies.

Aedes

Mosquitoes in the genus *Aedes* lay their eggs singly, usually on damp soil. Eggs can withstand long periods of dry and cold. Adults die off during winter, while eggs remain dormant over winter until spring snow melt or wet weather dampens them and allows them to hatch. Eggs can hatch even when water temperatures are near freezing.

The larvae live in puddles, pools, marshes and other areas of temporary standing water. Larvae can develop and emerge as adults in less than a month, even if water temperatures are very low. Warmer water results in more rapid maturation. *Aedes* are strong fliers and are known to fly many miles from their larval developments sites.

Culiseta

Mosquitoes in the genus *Culiseta* lay their eggs on the surface of permanent water in rafts of up to 200 eggs. Culisetta overwinter as adults, going dormant under the snow and then emerge to feed shortly after snow melt begins. Snow mosquitoes, big, slow moving mosquitoes that appear when snow is still on the ground belong to this genus. Adults are active in cooler temperatures. Activity declines in warmer temperatures over the mid-70s F.

Some mosquitoes in hibernation have been shown to survive temperatures down to -25 F, as long as they are protected by snowpack. Winters with limited snowpack may cause a reduction in mosquito populations, as the hibernating insects freeze and die and die off. However, mosquito eggs are not impacted by amount of snowpack.

Control of Mosquitoes

The use of pesticides for mosquito control is only a temporary, short term solution. It is not possible to completely eliminate the next generation of insects, so relying on chemical control means that the process will have to be repeated frequently to achieve any significant reduction in populations.

Preventative measures are more effective and long term solutions for controlling the number of biting insects in an area. Eliminating breeding grounds is a very effective way to reduce the number of adult mosquitoes that become a nuisance. Alaska is covered with ponds, lakes, and swamps, so it is not possible to remove all sources of water. However, in specific areas, reducing potential breeding grounds can have a significant impact on mosquito populations. This can include simple source reduction measures such as removing discarded buckets, tires, and other items where water may water collect or raking up leaves. It can also include more complex habitat modification measures such as grading or drainage efforts to reduce potential for water to accumulate in an area.

The application of larvacides to kill immature mosquitoes is the most effective means of controlling mosquitoes. Larvae are usually concentrated in smaller areas and are relatively immobile compared with adults, which may rapidly disperse over large areas. Larvacides include some types of bio-controls such as diptera-specific bacteria, insect growth regulators, chitin synthesis inhibitors, some conventional types of insecticides, as well as several nonpetroleum oils which smother the lavae.

Most biting flies are capable of migrating significant distances from their breeding grounds to obtain a blood meal. For this reason, it can be difficult to identify the breeding ground where larvae develop. For most of these insects, larval habitat can be large, diverse and ecologically sensitive, which makes treatment even more problematic. Visual observations of adult flies can help determine which species are present, and helps narrow the search for larval habitat.

Algae & Milfoil

Algae and milfoil control is covered in the Michigan manual. Review this material carefully to ensure you are familiar with the development, life cycles, biology, symptoms, typical damage caused, and appropriate control methods for these pests.

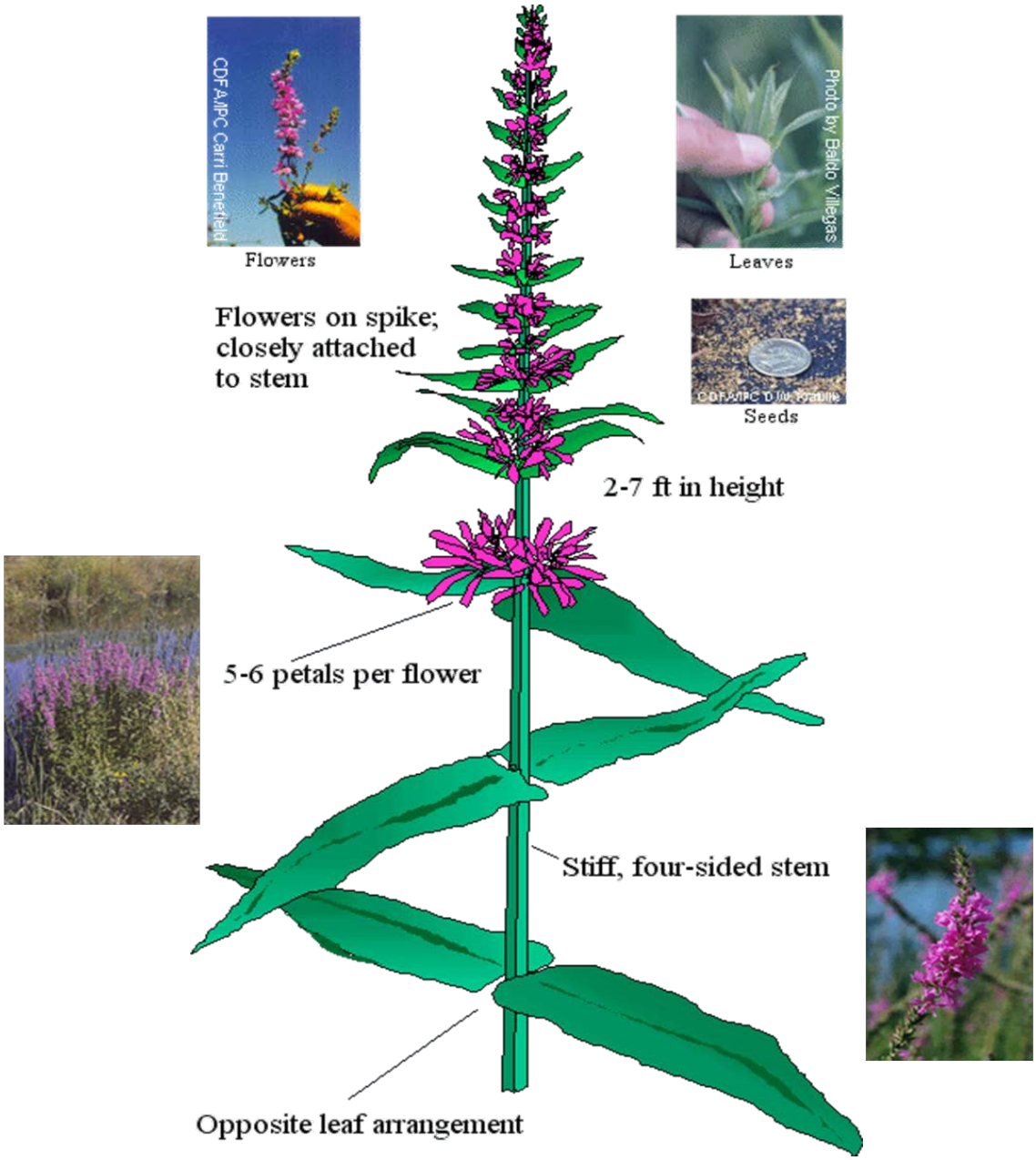
Purple Loosestrife

Purple Loosestrife (*Lythrum salicaria)* is an invasive species that is now found in waterways and wetlands across North America. Loosestrife is capable of invading most types of wetlands, including wet freshwater meadows, tidal and non-tidal marshes, river and stream banks, pond edges, reservoirs, and ditches.

Loosestrife is able to rapidly spread and become established across large areas, and can out-compete and replace native grasses, sedges, and other flowering plants. It forms a dense stand that reduces local biodiversity, provides little value to wildlife, and decreases water flow and quality.

Identification

- **Growth**: Upright, semi-woody perennial with four-sided stalk. Mature plants have dense bushy growth with one to fifty stems. Stems grow from two to eight feet tall, and die back each year.
- **Blooming period**: Mid-June into September
- **Habitat**: Moist soil to shallow water sites, such as lakeshores, stream banks, marshes, canals, and ditches. Established plants can tolerate dry conditions for portions of the year.
- **Flowers**: Pink to reddish-purple flowers with 5-6 petals and yellow centers. Numerous flowers on showy, long spikes.
- **Leaves**: Usually arranged opposite each other in pairs that alternate down the stalk, but may appear in groups of three. Leaves are linear shaped, smooth edged, and attached directly (without stalks) to four-sided stems. Tiny hairs are usually present on leaves and stems. Leaves turn red for brief period in the fall before fading and gradually falling off.
- **Seeds**: Each mature plant can produce almost three million seeds annually. Seeds are small, about the size of ground pepper. Seeds are easily spread by water, wind, wildlife, and people. Each seed can lay dormant for years in the soil before germinating.
- **Perennial rootstock**: Roots of mature plants are extensive, creating a dense web above and below ground that chokes out other plant life.
- **Do not confuse with Fireweed**: Fireweed has a conical flower spike 10-13 cm (4-5 inches) wide at the base. The fireweed stem is round, and leaves alternate up the stalk.



Control Methods

Purple loosestrife can easily spread if improper control methods are used. The best time to control purple loosestrife is in July and early August, when it is in flower. At this time plants are easily recognized, and have not yet gone to seed. When flower petals start to drop from the bottom of the spike, the plant begins to produce seed. Once seeds are produced, control activities are much more likely to disperse seeds.

Proper disposal of plant material is important to prevent re-rooting. Put all plant pieces in plastic bags to promote rotting of the vegetation, and dispose of the bags at a landfill. Composting is not advised, as purple loosestrife seeds will probably not be destroyed, and the thick, woody stem and roots take a long time to decompose. Incineration or burning is also an effective way to dispose of plant material.

Be aware that your clothes and equipment may transport the small seeds to new areas. Thoroughly brush off your clothes and equipment before leaving the site.

Hand Pulling or Digging

Small patches of young plants can be removed by hand with little effort. The entire root mass must be removed, making sure that ALL pieces have been collected. Purple loosestrife can re-root from very small fragments. Dormant seeds may germinate because of soil disturbance during removal activity. For these reasons, it is important to monitor the site for several years.

Mechanical and Cultural Controls

Many mechanical and cultural methods have been tried, including cutting, mowing, fire, flower removal, and water table management. These methods have proven ineffective in controlling established stands of purple loosestrife. In many cases mechanical methods and controlled burns have resulted in further spread of the plant, either by disturbing the soil, which helps promote growth of loosestrife, by distributing plant pieces which are able to re-root, or by dispersing seeds.

Biological Control

The use of specially selected insects that feed on purple loosestrife is being studied to determine effectiveness. There are no biological controls currently recommended for Alaska.

Chemical Control

Herbicides are effective at controlling loosestrife. Glyphosate is often used to control purple loosestrife. Many formulations of glyphosate are sold, **but only those labeled for aquatic use may be applied in or near water**. Best results have been obtained when glyphosate is applied at bloom or shortly thereafter. Since glyphosate does not provide residual control, treated areas will need to be monitored for regrowth from the roots or seedlings for several years.

Spot application to each plant is preferable. Eliminating the entire vegetative cover will promote purple loosestrife seed germination, which can result in an increase in plant density rather than control. Work through the colony starting at one side and backing away from the area you have sprayed to avoid walking through the wet herbicide.

A variety of sprayers, including backpack sprayers and boat-mounted sprayers, can be used to control purple loosestrife in aquatic sites. Wick application is also effective but is labor intensive. Spray dye added to the tank may be useful to ensure uniform application to purple loosestrife with minimal herbicide applied to desirable plants.

Yellow Pond-Lily

Yellow pond-lily (*Nuphar lutea)*, also known as spatterdock, occurs in shallow lakes and ponds across Alaska. This naturally occurring plant provides excellent habitat for fish and other aquatic life, and is therefore generally beneficial. However, extensive growths of this plant can seriously impede recreational use of a waterway, and can obstruct floatplane use.

Identification

Yellow pond-lily is a rooted aquatic plant with large, heart shaped leaves 8 to 10 inches long and 5 to 8 inches wide. Leaves are supported by a long, fleshy stem. The leaves may be floating or may grow above the surface. Throughout the summer months, yellow pond-lily produces single yellow flowers on stalks, one to two inches in diameter. The petals are clustered and do not open widely, giving the flower a ball-like appearance. Flowers and leaf stems die back to the rhizome in autumn.

Control Methods

Yellow pond-lily is very difficult to eradicate because any section of rhizome left behind can re-root.

Hand Pulling or Digging

Hand-pulling is labor intensive and generally not effective over larger areas. The entire root mass must be removed, making sure that **all** pieces have been collected. Yellow pond-lily can re-sprout from very small fragments of rhizome.

Mechanical and Cultural Controls

Regular cutting or removal of emerging leaves every other day will eventually kill the plants, but may take several growing seasons. Benthic barriers (described in the Michigan manual) can be effective in small areas.

Biological Control

The use of infertile fish species that feed on yellow pond-lily has been used elsewhere in the United States. However, these species do not survive in Alaska. In addition, introduction of non-native fish to prey could have serious consequences and disrupt the ecological balance. There are no biological controls recommended for aquatic control in Alaska.

Chemical Control

Herbicides are effective at killing yellow pond-lily. Glyphosate applied to emergent leaves is often used to control yellow pond-lily. Granular forms of 2,4-D or other herbicides may also used to apply herbicide at the root or rhizome zone to control this plant. Many formulations of these pesticides are sold, **but only those labeled for aquatic use may be applied in or near water**.

Reed Canarygrass

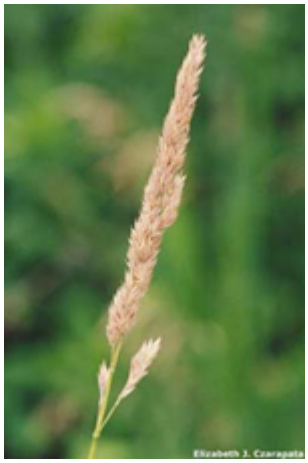
Reed canarygrass is an invasive plant in Alaska. It can out-compete most native plants, and replaces native grasses, sedges, and other flowering plants. It forms a dense stand that reduces local biodiversity, provides little value to wildlife, and decreases water flow and quality.

Identification

Reed canarygrass is a large, coarse grass that can reach two to nine feet in height. It looks similar to other grasses, with an erect stem and gradually tapering leaf blades. Reed canarygrass forms a thick rhizome mat just under the soil surface. It may grow along roadsides, stream banks, or in open fields. Flower heads turn from green or purplish to pale beige.

Reed canarygrass can be differentiated from local grasses in the following ways:

- leaves are usually broader
- leaves are more erect and droop or arch less
- plants are taller
- leaves remain green in fall
- the ligule (membrane where blade and sheath meet) is transparent



Control Methods:

Reed canarygrass is difficult to eradicate; multiple control methods may be necessary to effectively control this grass. Any control activities should be followed by planting native species adapted to the site to prevent re-colonization.

Hand Pulling or Digging

Hand-pulling is labor intensive and generally not effective over larger areas. The entire root mass must be removed, making sure that all pieces have been collected. Reed canarygrass can re-sprout from very small fragments of rhizome.

Mechanical and Cultural Controls

The following methods may help to control reed canarygrass:

- Prescribed burns in late spring or late fall. The burns must be repeated annually for several years, and are generally not effective against dense stands.
- Mowing in mid-June and October can reduce seed production and encourage competition from native species.
- Frequent cultivation followed by fall seeding with native grasses.
- Cover with black plastic for a growing season (effective only on small areas).

Chemical Control

Herbicides are effective at controlling reed canarygrass. Glyphosate is often used to control this pest, but care must be taken to avoid impacting desired vegetation. Many formulations of glyphosate are sold, **but only those labeled for aquatic use may be applied in or near water**. Spot application can be made to cut stems of small outbreaks. Early spring application, when most native plant species are dormant, can be an effective way to control reed canarygrass. Another method is to use a wick application, which affects taller stands of reed canarygrass without impacting the shorter vegetation.

Elodea

Although the Michigan Manual states that Elodea is rarely a problem in Michigan, the same is not true in Alaska. Elodea grows extremely rapidly, resulting in displacement of native plants and degradation of fish habitat. Extensive growths of this plant can also impede boat travel and safe float plane operation.

Elodea is a common aquarium plant. It is thought to have become established in Alaska surface waters by disposal of aquarium contents into waterways. Elodea easily overwinters in Alaska, and can survive being frozen in ice for long periods. This invasive aquatic plant is now found in lakes and waterways throughout Alaska, both on and off the road system, including Chena Slough in Fairbanks, lakes in Anchorage, and even near Cordova.

Identification

Elodea is a submersed aquatic plant that may either be rooted or may be free floating. Long trailing stems may be up to nine feet long, with three leaves in clusters around the stems. Individual leaves are oblong, approximately 1 to 1 ¼ inches long, and less than ¼ inch wide.

Elodea flourishes in clear, cold, slow moving water with soft sediment bottoms. Elodea reproduces primarily by vegetative growth. The plant has distinct segments, and easily breaks apart to forming viable segments.

Control Methods
Elodea is very difficult to eradicate because any fragments of plant left behind can re-sprout.

Hand Collection
Hand raking or collecting is labor intensive and generally not effective over larger areas. The entire plant mass must be removed, making sure that **all** pieces have been collected. Elodea can re-sprout from very small fragments.

Mechanical and Cultural Controls
Mechanical cutting, raking, and removal are not recommended for control of elodea. These methods tend to break up the plant and allow it to spread to new areas.

Benthic barriers (described in the Michigan manual) may be effective in small areas.

Dyes and colorants can be used to limit the amount of sunlight penetration in a water body. However, this method can disrupt the pond ecosystem and is not recommended in Alaska.

Drawdown of water prior to winter freeze up may help control elodea. This method is impractical in most water bodies.

Suction dredging is a possible control method. As with other physical methods, care must be taken to collect all fragments and pieces to prevent re-infestation.

Biological Control

The use of infertile grass carp that feed on elodea has been tried elsewhere in the United States. However, this species does not survive in Alaska. In addition, introduction of non-native fish to prey could have serious consequences and disrupt the ecological balance. There are no biological controls recommended for aquatic control in Alaska.

Chemical Control

Elodea is difficult to control with herbicides. Many herbicides are less effective against this plant, and may require longer contact times. In addition, it can be difficult to distribute herbicide adequately through dense weed beds.

Diquat, a contact herbicide, is somewhat effective against elodea in static water bodies. Fluridone is available in both a liquid and granular formulation, and is a systemic herbicide. Because it requires lengthy contact times, it is generally most effective in static water bodies. Flumioxazin has also been successful in controlling elodea. **Only products labeled for aquatic use may be applied in or near water.**

As with any aquatic herbicide, there is a risk of oxygen depletion due to decomposing plant matter. Treating smaller sections or use of aeration can help alleviate this problem.

MICHIGAN *AQUATIC PEST MANAGEMENT MANUAL*

Portions to Disregard

Michigan states rules, requirements, and regulations cited in the Michigan manual do not apply in Alaska, and should be disregarded. Use of pesticides in Alaska is regulated under 18 AAC 90.

You may also disregard the following sections or pages of the Michigan manual, as they do not apply in Alaska:

- **Pages 6-26** (Chapters One and Two), covering information on Michigan laws and regulations, which applies only to Michigan; and principles of pest management, which is covered in the core exam.
- **Pages 52-53,** covering information on biological controls. These techniques are not appropriate for pests found in Alaska.
- **Pages 87-89,** covering information on stunted fish. This problem is not an issue in Alaska.
- **Pages 96-97,** covering information on lampreys. This pest does not occur in Alaska.
- **Pages 106 - 107,** covering information on insect pests associated with aquatic areas. In Alaska mosquito and black fly control requires certification under Category Ten.
- **Page 109-112** (Chapter 12)**,** covering information on vertebrate pests. These pests are generally not controlled through use of aquatic pesticides in Alaska.

- **Pages 113 – 118** (Chapter 13), covering information on public relations. While this information may be useful to applicators, it is not required for certification.
- **Pages 135- 140**, Appendix B Aquatic Nuisance Control Permit Forms. Michigan forms do not apply in Alaska.
- **Pages 141- 147**, Appendix C Mosquito Control Forms; Michigan forms do not apply in Alaska.

Learning Objectives

Integrated Pest Management

- Describe the five components of IPM listed in the Michigan manual.
- List some factors that should be considered or monitored during site evaluation.
- Explain reasons why accurate identification is critical to effective pest management.
- Describe how water temperature may affect pest management.
- List some factors that should be considered when determining action thresholds.
- Explain reasons why pest control records are necessary.

Conditions for Aquatic Growth

- List growth factors that influence growth of aquatic plants.
- Define the terms photic zone, water hardness, and water softness.
- Explain how water hardness can affect the clarity of water.
- Explain how both nutrients suspended in water and sediment nutrients affect plant growth in water bodies.
- Describe what happens to dissolved oxygen levels, and the potential consequences, when large amounts of algae or plant material dies off and decomposes in a water body.
- List some aquatic plants that overwinter under the ice as leafy plants.
- Describe how various types of substrate impact rooting plants.

Aquatic Plant Identification and Management

- List the ways that algae can reproduce.
- Describe the characteristics and nuisance caused by planktonic, filamentous, and erect algae.
- Describe methods used to control algae.
- Explain the differences between submersed, emergent, free floating, and rooted floating plants.
- Describe the characteristics and typical reproduction methods of watermilfoil.
- Explain why the use of contact herbicides will actually lead to increases in watermilfoil.
- Explain why mechanical control methods will actually lead to increases in watermilfoil.
- Explain some benefits of aquatic vegetation.
- Describe the characteristics and typical reproduction methods of elodea.
- Describe methods used to control duckweed.
- Describe methods used to control cattails.

Nonchemical Aquatic Vegetation

- List the three main objectives of preventative control of aquatic weeds.
- Define the terms eutrophication, point source, and non-point source.
- Describe some methods of mechanical control and list some advantages and disadvantages of each.
- Explain two reasons why it is important that cut or pulled plant material be collected and removed from the water.
- Describe some methods of cultural control and list some advantages and disadvantages of each.
- Define the term benthic barrier.

Herbicide

- Describe the characteristics necessary in an aquatic herbicide.
- List factors that must be considered prior to choosing an aquatic herbicide.
- Explain why contact herbicides are generally less effective on perennial plants.
- Describe how each of the following herbicidal activities function; cell division, tissue development, photosynthesis, respiration, nitrogen metabolism/enzyme activity.
- Describe some factors that affect herbicide selectivity.
- Describe how various weather factors can affect herbicide efficacy.
- Describe some techniques used to effectively apply herbicides in flowing water.
- Explain how the pH, turbidity, and hardness of water can impact herbicide efficacy.
- Describe direct and indirect ways that use of herbicide can kill or harm fish.
- Explain the different types of treatment required during early algal blooms as opposed to after scum develops.
- Describe the various ways in which pesticides degrade in the environment.
- Explain why water temperature must be above 60 degrees Fahrenheit for optimal efficacy.

Herbicide Application

- Describe the method and most appropriate locations for injecting herbicide into bottom waters.
- Explain how granular formulations should be applied to water bodies.
- Describe the most appropriate target for spray applications of herbicide at a water body.
- Describe the method for treating flowing waters with herbicide.
- Calculate stream flow based on stream width, depth, and velocity.
- Explain how a slug treatment works in flowing water.
- Describe the advantages of direct metering of herbicide into the pump.

Calculations and Calibration

- List some methods for measuring distances on water.
- Describe the steps for calculating area of irregular shapes, and be able to calculate the area of irregular shapes.
- Explain why surface areas should be broken into smaller areas of 25 acres or less for pesticide applications.
- Calculate the length of a 25 acre swath, when given swath width.

- Describe the steps for calculating average depth of a water body, and be able to calculate average depth of a water body.
- Calculate the concentration of pesticide in water.
- Describe the steps for calibrating aquatic sprayers and granular spreaders.
- Explain how to measure boat speed.
- Calculate required quantities, percent deviation, unit conversions, and other example problems.

Fish Management

- Describe non-chemical methods of controlling fish populations.
- List the factors that must be considered when determining rate of neutralization that may be needed for a piscicide.
- Describe factors that impact the efficacy of potassium permanganate as a neutralizer.
- Describe methods for treating both small and large ponds with rotenone.
- Describe the factors that must be considered when determining treatment of flowing waters with piscicide.
- Describe how water temperature and sunny weather can impact duration of toxicity of rotenone.
- Explain why it is important to block all outlets of a water body, and make sure to distribute piscicide throughout the entire water body when treating with piscicide.
- Calculate volume of a pond, amount of piscicide needed, pumping rate of a sprayer, output of a spray tank, amount of water needed to mix the pesticide, amount of potassium permanganate needed to detoxify the pond, and other example problems.
- Calculate the discharge of a flowing stream, amount of piscicide to be applied per minute, total amount of piscicide needed, pumping rate of a sprayer, output of a spray tank, amount of water needed to mix the pesticide, amount of potassium permanganate needed to detoxify the pond, and other example problems.
- Calculate stream volume, turnover time, total amount of piscicide needed, number and spacing of drip station, drip duration, and other example problems.

Invertebrates

- Describe the characteristics and give examples of mollusks.
- Describe the development, life cycle, biology, symptoms, typical damage caused, and appropriate control methods for zebra mussels.

Before Using Any Pesticide

STOP

All pesticides can be harmful to health and environment if misused.

Read the label carefully. Use only as directed.