



NOAA FISHERIES SERVICE



Boats can transport invasive species into new locations. Watercraft operators should follow the Clean, Drain, Dry strategy in between every body of water, every time
(Photo credit: NY Department of Environmental Conservation).



Once introduced, aquatic invasive plants can spread quickly. Once established they reduce light and oxygen to native wildlife
(Photo credit: Maine Bureau of Land and Water Quality).

Preventing Invasive Species: Cleaning Watercraft and Equipment

Background

Aquatic, as well as many non-aquatic, invasive species are readily spread by flowing water. In addition, many aquatic invasive species are capable of survival out of water for extended periods of time. To prevent the accidental introduction of organisms transported through water, all watercraft and equipment that are to be placed in a water body should be cleaned to remove invasive species, including any fragments, seeds, or other materials. This recommendation applies to equipment arriving on the project site as well as equipment that is relocated within the project.

To prevent cross contamination with other lands or water bodies, whenever possible, keep equipment and vehicles at the same project area for use only in that project area. If practical, the least infested (or least likely to be infested) sites should be visited first to reduce the risk of accidentally infecting a new area during restoration activities.

Clean, Drain, and Dry!

When done properly before entering a new body of water, this general set of procedures can effectively prevent the spread of invasive species into new waters.

Drain:

- Drain **every conceivable space** or item that can hold water.
- Follow factory guidelines for eliminating water from engines.
- Always drain the bilges of the boat by removing the drain plug. Bilge pumps are not capable of removing all water from the boat hull.
- Drain live-wells, bilge, ballast tanks, and transom wells.
- Empty water out of kayaks, canoes, rafts, etc.

Clean:

- Remove any visible **plant or plant fragments**, as well as **mud or other debris**. Plant material, mud, and other debris routinely contain other organisms that may be an invasive species.
- Check trailer, including axle and wheel areas, in and around the boat itself: anchor, props and jet engines, ropes, boat bumpers, paddles.
- Clean all parts and equipment that came in contact with water using one or more of the methods listed below.

Dry:

- Allow everything to completely dry before launching into new waters; **five days** in warm, dry weather and up to **30 days** in cool, moist weather. Calculate local dry time at: <http://www.100thmeridian.org/Emersion.asp>
- If sufficient drying time is not available, decontaminate all surfaces using one or more of the cleaning methods described below. Carefully inspect for invasive organisms before entering a new water body.



Cleaning Methods

Set up the best staging area possible for cleaning operations. A paved area with accommodations to elevate vehicles or otherwise allow easy access to the undersides of vehicles and equipment is ideal. Equipment of all types should be cleaned at the location of last use. If this is not possible, arrange for cleaning at a facility that is specially designed for equipment cleaning. Commercial hot-water car washes are effective for disinfecting boats and vehicles.

Water runoff carrying sediment, plant material, algae, animals, and/or petroleum contaminants, must be managed with the use of berms or other containment. Silt fence installed along perimeters of work areas can also aid in preventing spread of contaminated materials outside of the washdown location. Despite very careful efforts to capture and quarantine materials from cleaning operations, site-specific invasions are likely to occur; therefore, part of the cleaning process should involve monitoring the washdown areas for invasive species and using appropriate control methods early to prevent additional spread.

Personnel who use equipment during cleaning operations are responsible for properly using Personal Protective Equipment (PPE) that is appropriate to the cleaning activity. Using cleaning and disinfectant chemicals, power washers, air compressors, and other types of cleaning equipment may present working hazards. PPE items to protect hearing, skin, eyes, and respiration may be required. All personnel should undergo proper training of all equipment prior to performing any cleaning operation.

Brushing (Physical Removal)

Brushing is considered to be moderately effective in removing invasive material from equipment or gear. A follow-up with water washing, high-pressure air blasting, or high-pressure wash is also recommended.

- If there is a nap to fabric (e.g., upholstery, carpeting, or clothing), brush with the nap rather than against it. Brushing against the nap could further embed small seeds or plant fragments into the material.
- A combination of soft and stiff bristles of varying length is recommended for use on carpeting or components made of rubber, nylon, or plastic.
- Bristles of medium length and stiffness are desired for removal of mud and other matter from fabrics and upholstery.
- Stiff bristles are recommended for the tread of wheels that become encrusted with sediment and mud.

Vacuuming (Physical Removal)

Vacuuming equipment or clothing with a brush attachment is suggested to remove most loose particle matter, but care should be taken because small seeds and plant fragments may become further embedded in materials. To prevent contained plant and soil matter from being redeposited following the cleaning process, collected matter should be bagged and incinerated or disposed of in a sanitary landfill. A follow up with water washing, high-pressure air blasting, or high-pressure wash is also recommended.

Use of Adhesive Roller (Physical Removal)

Adhesive is considered to be moderately effective in removing the majority of plant material from equipment or gear. Seed and fragment materials readily attach to the adhesive sheets and are effectively lifted out of seams and the weave of loose particle fabrics; proper attention and care given during removal is a direct reflection of the potential efficiency of this technique. A follow up with water washing, high-pressure air blasting, or high-pressure wash is also recommended. To prevent contained plant and soil matter from being redeposited following the cleaning process, adhesive sheets should be bagged and incinerated or disposed of in a sanitary landfill.



Thermal Treatment

Thermal treatments involve the use of extremely hot temperatures in order to kill all invasive material. Using steam, hot air, or hot water to clean vehicles and field equipment has proven to be especially effective when used to bring the surface temperature of the up to 140 °F for 30 seconds. A hand-held infrared thermometer can be used to verify the surface temperature. Disadvantages to the use of thermal treatments are the apparent risk of burns, its labor-intensive nature, and the initial cost of equipment.



Chemical Treatment

Many chemical agents are available to prevent the potential movement of invasive species. However, the use of chemical treatments sometimes poses disposal and wastewater concerns. If chemical treatments are used, local standards of waste disposal must be followed. Since local regulations for chemical disposal may vary, always contact a local chemical waste management facility, the Environmental Protection Agency, or refer to the Material Safety Data Sheet for recommendations on proper disposal prior to use of any chemical. Some states may also require certification or licensing for personnel who use chemical treatments. Finally, some solutions may cause corrosion on metal surfaces and electrical connections; thus be sure to follow all label restrictions and manufacturer guidelines. Following treatment, rinse all surfaces with clean water and dry thoroughly.

To prevent the spread of invasive species, all equipment should be inspected and cleaned after exiting the water body.

Diluted household bleach solution provides an inexpensive, effective way to control invasive species. Soak or spray equipment for at least one minute with a two percent bleach solution (three ounces of household bleach mixed with one gallon of water). If invasive pathogens or diseases are suspected, a 10 percent solution should be used (13 ounces of household bleach mixed with one gallon of water). Bleach is an extremely effective disinfection agent, but it is a caustic substance that can be corrosive to aluminum and other sensitive fishing and boating equipment.

Of the materials traditionally used to disinfect for human or animal health purposes, quaternary ammonium compounds have been found to be effective in controlling viruses and pathogens. Commercial formulations, such as Parvasol® and Kennelsol®, are available through laboratory or veterinary supply companies. Household cleansers/disinfectants, such as Formula 409® and Fantastic® that contain the quaternary ammonium compound alkyl dimethyl benzyl ammonium chloride can also be used to disinfect equipment. These solutions can be used full strength as a spray, or diluted for soaking with two parts water to one part disinfectant. For all materials, follow label instructions and be sure to soak equipment for a minimum of 10 minutes. *Be sure to dispose of materials away from surface waters in accordance with label restrictions.*

Other common chemical decontamination methods are:

- Undiluted white vinegar for 20 minutes.
- 1% potassium permanganate solution at 24-hour exposure.
- 5% quaternary ammonium solution for 10 minutes.
- 250 mg/L ROCCAL (benzalkonium chloride) for 15 minutes
- 500 mg/L hydrogen peroxide for 60 minutes
- 167 mg/L formalin for 60 minutes



General Water Washing

General water washing can be used in conjunction with a physical removal technique such as brushing or vacuuming and is moderately effective in removing residual foreign material. Some seeds or fragments may remain viable following a wash treatment. In extreme situations, where known invasive materials are present, wastewater can be treated or filtered, and the waste materials bagged and incinerated or disposed of in a sanitary landfill.

High-Pressure Water Washing

High-pressure washing is the most effective means of cleaning heavily soiled and contaminated items to eliminate invasive species materials and prevent their spread. There are many models of high-pressure washers, from simple hand-held nozzles to laser guided systems. In some cases, containment sheds are portable. Not all items are capable of withstanding the pressure of this treatment, and it should only be used where applicable. In certain situations cleaning with compressed air, rather than water, could prevent damage to certain equipment areas such as engine wiring systems and vehicle cabs.



Cleaning boats and equipment before leaving the landing is an important step that citizens can take to prevent the spread of invasive species
(Photo credit: Aquatic Nuisance Species Project).

Minimum water pressure for vehicle cleaning should be at least 90 pounds per square inch. Water can be supplied as high volume/low pressure or low volume/high pressure. Each option has advantages and disadvantages based on specific cleaning needs and water availability:

- Heavy accumulations of soil and debris on large equipment can best be cleaned using high water volumes.
- Cleaning watercraft and in-water equipment usually requires lower volume, high-pressure washing systems.

Water Availability and Disposal

Water availability must be considered in cleaning operations. Freshwater in a quantity suitable for all cleaning operations is necessary. When this is not possible, consideration should be given to other water options such as water recycling systems or use of compressed air to remove soil. Raw water, or even gray water, is sometimes used, but potential health issues may require precautions such as immunizations or specialized safety equipment for personnel. If pumping water from field sources, unintentional movement of exotic plants, algae, and other invasive aquatic species must be addressed. Proper placement of pumps away from aquatic or shoreline vegetation that is known to be invasive is a practical first step.

Water storage tanks, filters, and recapture systems can offer adequate onsite water supplies with less water use than would otherwise be necessary without recycling. By using sand or cartridge filters, many contaminated substances can be captured during cleaning operations to be safely handled later. In addition to soil and invasive species, wash water and used wash water filters may also contain oily residues from cleaning certain types of equipment. Such items may require handling, treatment, and disposal according to state and local standards.

Activities that require use of water also need to consider invasive species control. The equipment used in transporting and spraying water should be cleaned before arrival on site.



Decontamination of Specific Watercraft Parts

Watercraft Compartments

- Bilge compartments, water holding tanks, wet wells, live wells, and any other compartments that could hold water from an infested water body should be drained of water at the boat ramp before leaving the area.
- If a compartment has carried water from another location, remove all water into a container and heat it to at least 140 °F, or treat it with one of the chemical treatment solutions listed above. If adult mussels are found in these compartments, use the recommended hot water treatment.
- If the compartment is too large to make filling practical, high pressure wash the compartment thoroughly with hot water.

Watercraft Hull Surfaces, Anchors, and Trailers

- Wash down with hot, high-pressure water. Then, visually inspect and feel by hand to remove any remaining foreign material.
- Watercraft hulls, anchors, or trailers will be assumed to be free of invasive species if they have been thoroughly scrubbed, inspected, and any visible foreign materials have been removed or if they have remained dry and out of the water for five days.

When inspecting and cleaning, special attention should be given to the cracks and crevices in which material may become trapped as well as aquatic plants or fragments that may be present on trailers or propellers. Particular attention must be paid to trailer pads made of carpet and foam rubber, which could trap invasive species. If possible, such material should be removed from trailers before doing work in infested waters.



Invasive species can become trapped in watercraft engines and transported to new locations. Proper engine flushing is recommended to prevent future invasions (Photo credit: Bureau of Reclamation).

Watercraft Engines

If the watercraft engine is not a closed cooling system configuration (if the engine intakes its cooling water from the environment), the following applies:

- A hot water treatment is recommended for engine decontamination; barrel filled with 140 °F to 160 °F water and operating the engine for 5 to 10 minutes.
- An appropriate flushing attachment, such as an “earmuff” attachment, may be used in place of the hot water treatment. Refer to the manufacturer’s directions for flushing attachment hookup and operation.
- Running a chemical solution through an engine to decontaminate it may violate the terms of the engine’s warranty, or otherwise damage the engine. Chemical treatments on engines are **not** recommended, unless specified by the manufacturer.

All surfaces of the propeller, rudder, driveshaft, and driveshaft bearing and supports must be cleaned to remove any clinging foreign material by washing with hot, high-pressure water. Then, visually inspect, feel by hand, and remove any remaining foreign material. Finally, decontaminate the engine cooling system by using the appropriate flushing attachment.



Decontamination of Field Equipment Used in Water

Thermal Treatment

Field equipment can be effectively decontaminated by soaking in water kept above 140°F for one minute or for 20 minutes in water that is at least 110°F. Note that hot water can delaminate Gore-Tex® fabric and damage other sensitive clothing items. Household steamers may also be used for disinfection by exposing equipment to steam for one minute.

Chemical Treatment

Field equipment can also be cleaned by soaking, dipping in, or scrubbing with one of the chemical decontamination solutions listed above under decontamination of watercraft. If adult mussels are found during inspection, the equipment should be steam cleaned, washed with hot, high-pressure water, or dipped treated in hot water, and allowed to dry completely before the next use. (See *Decontaminating of Mussels*).

NOTE: Felt-soled waders and wading shoes, which have been identified as a vector for whirling disease spores and *Didymo*, are difficult to disinfect. Rubber or studded soles are now readily available that provide similar traction, and are much less likely to transport invasive species.



Personal gear, including waders, can introduce aquatic invasive species into new locations if not properly cleaned following use (Photo credit: NOAA).



Drying equipment for a minimal period of 5 days can be an effective method of preventing the spread of invasive species (Photo credit: NY Department of Environmental Conservation).



Suggested Resources:

Aquatic Invasive Species Hazard Analysis and Critical Control Point Training Curriculum

Sea Grant Great Lakes Network. Aquatic Invasive Species – Hazard Analysis and Critical Control Point Training Curriculum. 2nd Ed. Editors Jeffrey L. Gunderson JL., Ronald E. Kinnunen RE. Minnesota Sea Grant Publications Number: MN SG-F11. 91 pp. Available online at <http://www.seagrant.umn.edu/ais/haccp>
This manual identifies critical pathways through which aquatic invasive species and/or non-target aquatic species could be moved to new waterbodies. It explains an approach (called AIS-HACCP) to prevent the inadvertent transfer of these species.

Inspection and Cleaning Manual for Equipment and Vehicles to Prevent the Spread of Invasive Species

U.S. Department of the Interior Bureau of Reclamation. 2009. Technical Memorandum No. 86-68220-07-05. 203 pp.
Available online at: http://www.usbr.gov/pps/EquipmentInspectionandCleaningManual_Sept09.pdf
This manual provides recommendations for inspection and cleaning of vehicles and equipment as a prevention tool to limit the spread of invasive species.

Maine's Safety Net - A Practical Guide to Building Wash Stations

Friends of the Cobossee Watershed and Lakes Environmental Association. March 2006.28 pp.
Available online at: <http://www.watershedfriends.com/L.%20L.%20Bean%20handbook.pdf>
This handbook has been designed to assist those organizations and citizens in building Boat Wash Stations.

Preventing Accidental Introductions of Freshwater Invasive Species

U.S. Department of Agriculture, Forest Service. Available online at:
http://www.fs.fed.us/invasivespecies/documents/Aquatic_is_prevention.pdf
This document provides standard sterilization techniques that are effective against New Zealand mudsnail, Whirling disease, and Chytrid Fungus.

Protect Your Boat, Fight Quagga and Zebra Mussels A Guide to Cleaning Boats

California Department of Fish and Game. October 2009. Available online at:
<http://www.nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=4957>
This guide was compiled specifically for boat owners and watercraft users. The information contains general guidelines for all boaters and a basic checklist for inspecting and cleaning boats and recreational equipment for Quagga/Zebra mussels

Protect Your Boat and Engine from Zebra Mussels

Wisconsin Department of Natural Resources.
Available online at: <http://dnr.wi.gov/invasives/publications/pdfs/protectyourboat.pdf>
This document describes simple and proactive steps boat owners may implement to protect their investment and prevent the spread of invasive species into more of Wisconsin's waters.

Protect Your Waters

Aquatic Nuisance Species Task Force. Available online at: <http://protectyourwaters.org>
This site provides recommendations for recreational users who want to help prevent the spread aquatic nuisance species.

Transfer of Invasive Species Associated with the Movement of Military Equipment and Personnel. Cofrancesco, Jr. AF., Reaves DR. Averett DE. July 2007. Army Corp of Engineers, Engineer Research and Development Center. ERDC/EL TR-07-8. Washington D.C., 126 pp.
Available online at: <http://el.erdc.usace.army.mil/elpubs/pdf/trel07-8.pdf>

This document provides an overview of the current process that exists to clean, inspect, and regulate the movement of invasive species through ports of embarkation and debarkation.