Boat Inspection and Cleaning Procedures For All Water Craft Owners

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Introduction [1]

These procedures have been developed to help prevent the spread of aquatic invasive species, especially quagga and zebra mussels, on trailered watercraft. Benefits to you include protecting your engine from overheating, enhanced boat performance and reduced gasoline consumption. When properly used, these procedures also preserve fishing, protect the aquatic environment, and save millions of dollars in water-supply and electric-power generating equipment maintenance. It protects water bodies from the many destructive invasive species that hitchhike on boats. Finally, it enables you to comply with state and federal laws prohibiting the spread of quagga and zebra mussels. Failure to comply could result in your boat being impounded and you could be subject to criminal prosecution. The few minutes required to inspect and clean your equipment are more than worth the many benefits.

These instructions enable you to inspect every part of your equipment that has been in contact with the water. They allow you to discover, remove, and kill, all mussels – including attached adults, juveniles and larvae. Microscopic, free-floating larvae can be found anywhere there is standing water remaining on your vessel or trailer. Attached juveniles the size of sand grains, older juveniles as large as shotgun shot, or adults up to an inch in length, might be found anywhere on your boat. Therefore, the inspection must be detailed and thorough.

When a water body is known to be infected with mussels:

- Boats entering the water are not required to be inspected and cleaned.
- **Boaters leaving the water are strongly encouraged to have their craft inspected and cleaned according to these procedures.**

When a water body is known to NOT be infected with mussels:

- **Arriving boaters should be strongly encouraged to have their craft inspected according to these procedures before entering the water. If ANY mussel adults, juveniles or larvae are discovered, a complete cleaning of all equipment according to these procedures is required.**
- Boats leaving the water are not required to be inspected and cleaned.

Western water bodies known to contain quagga mussels include Lake Mead, Lake Mohave, Lake Havasu, and the Colorado River Drainage below these lakes. Water bodies located in the following states and Canadian provinces are known to contain quagga and/or zebra mussels. Alabama, Arizona, Arkansas, California, Connecticut, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Nebraska, Nevada New York, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, Vermont, Virginia, West Virginia, Wisconsin, as well as, Ontario, Canada and Quebec, Canada.[2]

General Instructions Common to All Water Craft

Boats leaving a water body known to be infected: Immediately upon securing the craft to the trailer, remove it from the water and drive to the area designated for boat inspection and cleaning. (Figure 1)

Boats arriving at a water body known to NOT be infected: Drive to the area designated for boat inspection.

Dispose of unused bait by emptying the bait bucket into a dumpster. Do not take bait home. Do not empty it on the ground. NEVER put left over, unwanted bait into any water body.

Drain ALL water from the boat, especially the live well. Drain all water from the bilge, motor well, (Figure 2) water-holding compartments, and water-skiing ballast tanks and bladders. See detailed instructions below for ballast tanks.

Completely drain all water from the motor cooling system. Some motors, like outboards, drain freely and easily. Other motors, like some inboards and stern-drives, can only be drained using special equipment and procedures.[3] Follow the motor manufacturers instructions or obtain the services of a qualified service technician. This is exactly the same as draining the motor at the end of boating season to prevent freezing in the engine cooling system. Failure to do this can result in mussels growing inside the engine block and in the lines carrying cooling water to and from the motor. The consequences can be overheating, resulting in serious damage to the motor, in addition to transporting the mussels. (Figures 3, 4, & 5)

Thoroughly inspect the boat, trailer and all equipment for mud, plants and mussels. Completely remove these contaminants. In addition to looking – inspect by gently running your hand along the entire surface of the equipment. Take time and carefully feel for juvenile mussels; when you locate them, it will feel like sandpaper. (Figures 6, 7, & 8) Specifically, check the following areas.

Trailer (Figures 9 & 10)

Trailer frame	Rollers & bunks	License plate	Lights	Wiring
Axles	Springs	Fenders	Hangers	
Pockets & hollow spaces		Trailer tires & wheels		

Water Craft Exterior (Figure 1 and Figures 11, 12 & 13)

Entire hull	Trim tabs: top & bottom of hinges	Thru-hull fittings	Transducers
Pitot tube	Cavitation Plates	Ropes & Lines	Anchors
Depth sounders	Water intakes	Water outlets	Lights

Motors (Figures 3, 4, & 5)

Entire exterior housing	Propeller	Propeller shaft
Propeller shaft support	Propeller guards	Propulsion systems
Lower unit	Gimbal area	Water intakes & outlets

Boat Contents (Figure 14)

ALL nets	Float belts	Personal floatation devices	Float cushions
Rope lockers	Equipment lockers	Waterfowl decoys and camouflage blinds	
Water skis & ropes	Ski gloves	Clothing & footwear	Floats

Water weenies, torpedoes, towable tubes, inner tubes, inflatable pontoons, & similar items
Downriggers & other fishing equipment that entered the water Bait & live wells

When adult quagga or zebra mussel shells are found attached to any surface – remove and KILL THEM. (Figures 15 through 20 and Figures 35, 36, & 39) There must be no reservation nor hesitation. These are the invasive creatures that cause so much environmental damage and cost so much money. They must be completely removed from wherever they are found – and

destroyed. Adults are indicated by shells of any visible size. They are the highest risk since they are the toughest to kill and they reproduce very rapidly. There has been much research on how to kill them using chemicals, radiation, heat and other methods that are complex and difficult to implement. Therefore, simply crush them to death by stepping on them or hitting them with a rock, hammer or whatever is available. Wear eye protection, gloves and protective clothing. Dispose of the remains in a dumpster. Depending on the degree of contamination, killing all adult mussels could be a substantial amount of work. (Figures 18, 19, 20, 35, 36 & 39)

Specific Instructions Common to All Water Craft

All boats that have been in water known to be infested for over 24 hours and
Boats and equipment where mussel juveniles have been discovered – that sandpaper feel:

(Figure 21) Completely wash with a pressurized power sprayer using water of **140° F** or hotter. Contact with water at this temperature will kill quagga and zebra mussel juveniles and larvae in a few seconds. Qualified mussel researchers have established 104° F will work. However, hotter water works better and temperatures of 140°F and higher are common for the many power sprayers available.

- Completely spray the entire exterior of the craft and the trailer. Perform the wash slowly and carefully. The idea is to "cook 'em" with heat and "remove 'em" with the pressurized water. Spray all small nooks and crannies where mussel larvae may be lodged.
- No soap, detergent or chemicals are necessary.
- Be careful not to remove decals, paint or labels from the boat while spraying.

Using a power sprayer carwash, even one with hot water, is NOT adequate. One of the largest expenses in that business is energy to heat the water, regardless of the fuel used. Thus, there is considerable incentive to maximize profits by minimizing water heating. Some carwashes do not have any water heaters and only provide cold water washes.[4] There is no assurance that carwashes use water of at least 104° F. Live mussel juveniles and larvae could be washed into storm drains that empty into the nearest stream. In addition to not cleaning the boat, this would spread mussels into waterways and reservoirs. This situation indicates using carwashes to control mussels is not advised.

Equipment Cleaning

Fishing waders are a proven means of spreading invasive species. Everything from whirling disease to mud snails to quagga and zebra mussels are transported around Utah by waders. Fishermen tromp in ideal habitat and readily pick up these creatures. First, separate all individual components such as insoles, socks, booties, ankle guards, and laces. Then wash everything inside and out to remove dirt, plants and other visible substances. Be sure the treads are completely clean. Finally, soak them in a bucket or bathtub full of hot water from your house. Allow sufficient soaking time for all components to reach the water temperature; thick felt soles take time. Repeat the soak with fresh hot water. Another option would be to soak them in a potassium chloride solution made as described below. Completely dry all components and reassemble the waders. (Remember, it's worth it.)

Ropes, lines and cords – and – fish nets and all nets. Thoroughly wash them to remove dirt, plants and other visible substances. Then soak them in a bucket full of hot water from your house. Allow sufficient soaking time for all components to reach the water temperature. Repeat the soak with fresh hot water. Another option would be to soak them in a potassium chloride solution made as described below. Completely dry them, ideally in the sun on a hot day.

Drying Kills Mussels

Mussels are tough, and it's often difficult to know what exact conditions kill them. Thus, it's beneficial to know basic concepts. High temperatures, low humidity, and prolonged time are all injurious to mussels and increase the likelihood of death. Boaters are advised to do everything possible to expose their equipment to hot and dry conditions for as long as possible. Multiple researchers have shown that any dry exposure longer than 21 days will kill all mussels.[5] Notice that these procedures contain specific actions which foster these conditions. They also prevent mildew with attendant cost and health issues, and your equipment lasts longer. It's recommended to leave your boat outside in the sun, after opening and exposing compartments and wet locations.

The opposite of hot, dry conditions is found with boats that are used, and moored, in mussel-infested waters. Below the waterline it is cool and totally wet, and the boat sits for weeks, months, and sometimes years. This is ideal mussel habitat! Phytoplankton (microscopic plant food) float everywhere in the water to nourish them. Microscopic larvae attach to the hull when the boat is anchored on cruises, and when moored. Then they vigorously grow and reproduce. In a short time, they can cover the entire underside of a boat with a layer of hard-shelled creatures. This creates drag that increases gasoline consumption, can plug motor cooling systems, can damage the specialty systems described below, and generates a huge cleanup problem. Large boats that remain in mussel-infested waters for extended times are almost certain to have them. When moved to uninfested waters, they constitute the highest risk to transporting mussels. Exercise all possible diligence to inspect and clean such boats.

Boats leaving a water body known to be infected:
After inspection and cleaning according to these procedures, allow the boat and trailer to air-dry for at least 7 days.[6] Longer is better.

Boats arriving at a water body known to NOT be infected:
Preferably, the boat and equipment have already been inspected, cleaned and dried. Personnel at the location will confirm the boat's history. If justified by inspection, the boat will be required to undergo cleaning.

Additional Instructions for Specialty Systems on Selected Water Craft

Internal ballast tank systems in water ski boats are one of the greatest risks for transporting mussel larvae and juveniles. It was ballast systems in ocean-going ships that first brought quagga and zebra mussels to the Great Lakes in 1988. Clearly, ballast systems transport invasive species.

Drain ballast water from every tank as much as possible. Then add mussel-killing solution to each tank and allow it to remain there for about 12 hours. Install the solution immediately upon leaving mussel-infested waters and allow the solution to act while traveling to the next destination. Upon arriving, simply resume your normal ballast system operation; the tanks do not have to be drained. This is exactly the same as putting anti-freeze in the system at the end of the boating season. Follow the boat manufacturers instructions or obtain the services of a qualified service technician. Be sure to install antifreeze in the system at the end of the boating season. (Figures 22 through 27)

Failure to do this will definitely result in mussels growing inside the entire system. The consequences will be restriction of water lines, overheating, and damage to the pumps. Complete replacement of system components, possibly even the tanks, will become necessary and this is costly.

There are also portable, collapsible ballast tank systems retrofitted on boats which do not have internal systems built in at the factory. These systems should also have the water drained and then have mussel-killing solution added and operated as described above. Otherwise, they too will grow mussels inside with the same consequences.

An effective mussel-killing solution – for each ballast tank – is two gallons of a 200 parts per million (ppm) solution of potassium chloride (KCL). Despite the fact that it will kill mussels, this solution is harmless to humans and to the environment.[7] It also has extremely low corrosion characteristics and has been used in the oil well drilling industry for decades due to these characteristics.[8] A chloride concentration of 250 ppm is allowable for drinking water[9] and the solution is below that level. Potassium chloride salt crystals are used in water softener systems; people drink and bath in such water.[10] Conservative estimates of potassium and chloride concentration in Lake Powell with usage as indicated above, indicate concentrations of 1 part per trillion. That is far below possible environmental harm.[11] In fact, KCL solution was used in Virginia to completely kill all zebra mussels in a quarry. "In dramatic contrast, other aquatic wildlife including turtles, fishes, aquatic insects, and snails continue to thrive in the quarry."[12]

Potassium chloride (KCL) solutions in concentrations of 200 ppm can be made by thoroughly mixing one teaspoon of dry KCL salt crystals in two gallons of water. KCL salt crystals are available at stores such as Home Depot and water softener suppliers. Morton Salt Company offers KCL in 40-pound bags.[13] Do NOT use any other kind of salt or solution. Potassium chloride premixed solutions are available from suppliers to the oil well drilling industry; a Salt Lake City dealer has indicated willingness to do so.[14] KCL is mined in Moab and is also available in the Uintah Basin. The solution can be provided in larger quantities, such as drums, that may be suitable for marinas and others providing boat maintenance services.

Large boats, houseboats for example, may have special systems that use lake water. These systems require additional effort to protect them from plugging. Located deep inside the hull, these systems are especially difficult to access to clean should they become mussel infested. Complete replacement of system components may become necessary and this is costly. This is a prime example of, "an ounce of prevention is worth a pound of cure." The entire system should be completely drained and dried immediately upon leaving the water. The longer boats are left in infested waters, the more likely these systems will become plugged. The entire system includes water supply and discharge lines, filter screens, pumps, valves, and associated components. Special systems that use lake water include:

- **Air conditioning systems.** Liquid coolant in the air conditioner system removes heat from living quarters. That liquid coolant then transfers the heat (through a radiator) to lake water that is circulated past the radiator. Small passages in the radiator core are highly susceptible to plugging by mussels.
- **Personal sanitation systems** that take lake water and use if for bath showers and other "gray water" uses.
- **Washdown systems** that pump water into hoses for boat cleaning, water slides and general use.

(Figures 29 through 34 and Figures 37, 38, & 39)

Sailboat Additional Instructions (Figure 36)

Inspect and clean all of the above that apply, in addition to the following.

Centerboard box **(a major concern)** Rudder and transom Keel Fittings

Personal Watercraft Additional Instructions[15] (Figures 40, 41, & 42)

- Do not run your craft through aquatic plants. This could damage the craft, plug water intakes, and increase mussel contamination.
- After finishing activities, push or winch your craft onto the trailer without running the engine.
- Secure the craft to the trailer and remove it from the water.
- Start and run the motor for five to ten seconds to blow out water and contaminants from the underbody jet drive system.
- Stop the engine and remove all plants, mud, and other contaminants from the steering nozzle.
- Look under the craft and remove all contaminants. Especially check the water intake area, including the edges of the intake grate.
- Dry pockets that may be wet or holding water.
- Inspect and clean the craft and trailer as described previously.

Diving Gear Additional Instructions

Diving gear is a well-proven means of spreading invasive species, including quagga and zebra mussels. Divers swim in ideal mussel habitat and easily pick up larvae and juveniles. Thoroughly wash everything inside and out to remove dirt, plants and other visible substances. This includes masks, wetsuits, booties and gloves. Also wash air tanks, air lines, regulators, and flippers. Finally, soak all equipment in a bucket or bathtub full of hot water from your house. Allow sufficient soaking time for all components to reach the water temperature. Repeat the soak with fresh hot water. Completely dry all equipment, ideally in sunlight. (Remember, it's worth it.)

Dive shops might consider providing dip tanks filled with safe mussel-killing solutions. See the description above, "**Internal ballast tank systems in water ski boats**." Individual divers might also use such solutions instead of hot water.

Kayaks, Canoes, and Inflatable Rafts Additional Instructions

Inspect and clean as described previously. Allow to dry thoroughly before using them in any other water body. Be especially careful to dry inflatables before rolling them up.

Additional Information

Chlorine may be used to kill mussels, but only under carefully controlled circumstances.

- Chlorine is toxic, corrosive, and a strong oxidizer; it is extremely reactive.[16] Only properly trained personnel, wearing protective equipment, should use chlorine. Work must be done in specifically designated areas and every one else should be kept out.

- Chlorine can be detrimental to the environment and harmful to water bodies in sufficient concentrations. Control chlorine runoff through evaporation or proper disposal.
- Chlorine has been used for years to kill mussels. Still, treatment should be conducted only as long as necessary to prevent damage. Use only the minimum concentration necessary. These apply to whatever boat system is being treated.

People and Pets: Although the risk is low, people and pets can possibly transport larvae. It's a good idea to clean personal belongings and clothes that have been in contact with the water. It's also a good idea to wash dogs and other pets that have been in the water. Brush their coats and dry them.

<u>Thank you</u> for doing your part to keep our waters clean, healthy and enjoyable!!

It takes some effort to prevent the spread of quagga and zebra mussels, and everyone benefits – including you. Please visit the Internet websites cited below for more information.

A separate pdf document containing only the referenced figures accompanies this document.
The title is, "Pictures to Accompany Boat Inspection & Cleaning Procedures."

[1] Several sources contributed to the content of these instructions. Prominent among them are:

- **Mr. Chuck O'Neill**, Director of the Sea Grant National Aquatic Nuisance Species Clearinghouse, www.aquaticinvaders.org/ (585) 395-5190, email: cro4@cornell.edu
- www.100thmeridian.org/video/clean.asp *Stop Exotics, Clean Your Boat Video*, March 13, 2007.
- www.protectyourwaters.org/ March 13, 2007.

In addition, numerous reviewers have provided valuable insight and additional data. Thank you.

[2] *It Only Takes One, The Battle to Prevent the Spread of Zebra Mussels on Trailered Watercraft*, Pacific States Marine Fisheries Commission, DVD video and Watercraft Inspection Training Guide, 2006, page 13. Arizona, California, and Nevada were added after discovery of quagga mussels in those states in January 2007.

[3] Based on phone conversations with technical personnel at Mercury Marine Co. (920) 929-5884, and Yamaha Motor, Marine Division, (770) 420-5868, March 16, 2007.

[4] www.carwash.com/article.asp?IndexID=6636655 March 17, 2007.

[5] **Mr. Chuck O'Neill**, Director of the Sea Grant National Aquatic Nuisance Species Clearinghouse, www.aquaticinvaders.org/ (585) 395-5190, email: cro4@cornell.edu March 21, 2007.

[6] www.protectyourwaters.org/prevention/prevention_generic.php#1 March 21, 2007

[7] www.dgif.state.va.us/zebramussels/ March 26, 2007.

[8] http://www.bjservices.com/website/Completions.nsf/0/6DE175AADF573F5186256F2A0065674C/$file/Potassium+Chloride-99+Percent.pdf March 26, 2007.

[9] www.rules.utah.gov/publicat/code/r309/r309-200.htm#T6 "The Secondary Maximum Contaminant Levels for public water systems deals with substances which affect the aesthetic quality of drinking water. They are presented here as recommended limits or ranges and are not grounds for rejection. The taste of water may be unpleasant and the usefulness of the water may be impaired if these standards are significantly exceeded."

[10] www.mortonsalt.com/faq/faq_wate.asp?id=19 March 26, 2007.

[11] Investigation conducted by the Utah Division of Water Resources, March 26, 2007. The investigation was verified by the Utah Division of Water Quality as being environmentally safe and by the Utah Division of Drinking Water as being safe for humans.

[12] www.dgif.state.va.us/zebramussels/ March 26, 2007.

[13] www.mortonsalt.com/consumer/products/watersoftening/pc_pellets.htm March 26, 2007.

[14] Intermountain Drilling Supply, 3412 West 2400 South, West Valley City, UT, (801) 972-6455.

[15] www.100thmeridian.org/video/clean.asp *Stop Exotics, Clean Your Boat Video*, March 13, 2007.

[16] www.westlakechemical.com/datasheets/MSDS_Chlorine.pdf March 19, 2007.

Boat Inspection and Cleaning Procedures Photographs

Figure 1 Boat On A Trailer

Figure 2 Motor Well

Figure 3 Two Outboard Motors On A Transom

Figure 4 Stern Drive Motor With Propeller

Figure 5 Inboard Motor Boat With Propeller & Rudder

Figure 6 Carefully Feeling For Juvenile Mussels (not dirt or mineral deposits)

Figure 7 Checking Trim Tab Hinge For Juvenile Mussels

Figure 8 Carefully Feeling Hull & Trim Tab

Figure 9 Trailer Frame, Wheel, Fender & Light

Figure 10 Trailer Frame & Roller. (note boat drains)

Figure 11 Trim Tab On Transom

Figure 12 Water Intake On Hull Under Boat

Figure 13 Boat Bow Light

Figure 14 Towed Inflatable Water Toy

Pictures of Mussel Contamination

Figure 15 Mussels Around Stern Drive

Figure 16 Mussels On Trim Tab

Figure 17 Mussels On Trim Tab Hinge

Figure 18 Mussels Clog Propeller Assembly

Figure 19 Mussels Block Water Intake On Hull

Figure 20 Thick Mussel Encrustation On Motor & Boat

More Boat Inspection and Cleaning Procedures Photographs

Figure 21 Power Washing To Remove Mussels (note clean right side compared to left side)

Figure 22 Water Skiing Boat With Wakeboards

Figure 23 Water Ski Boat Rear End Engine and Ballast System Equipment Below Covers

Figure 24 Water Ski Boat Rear End With Covers Open

Figure 25 Water Ski Boat -- Ballast Water Lines Running Alongside Engine (small white caps)

Figure 26 Ballast System Water Lines - Small White Access Caps (used to introduce mussel-killing solution)

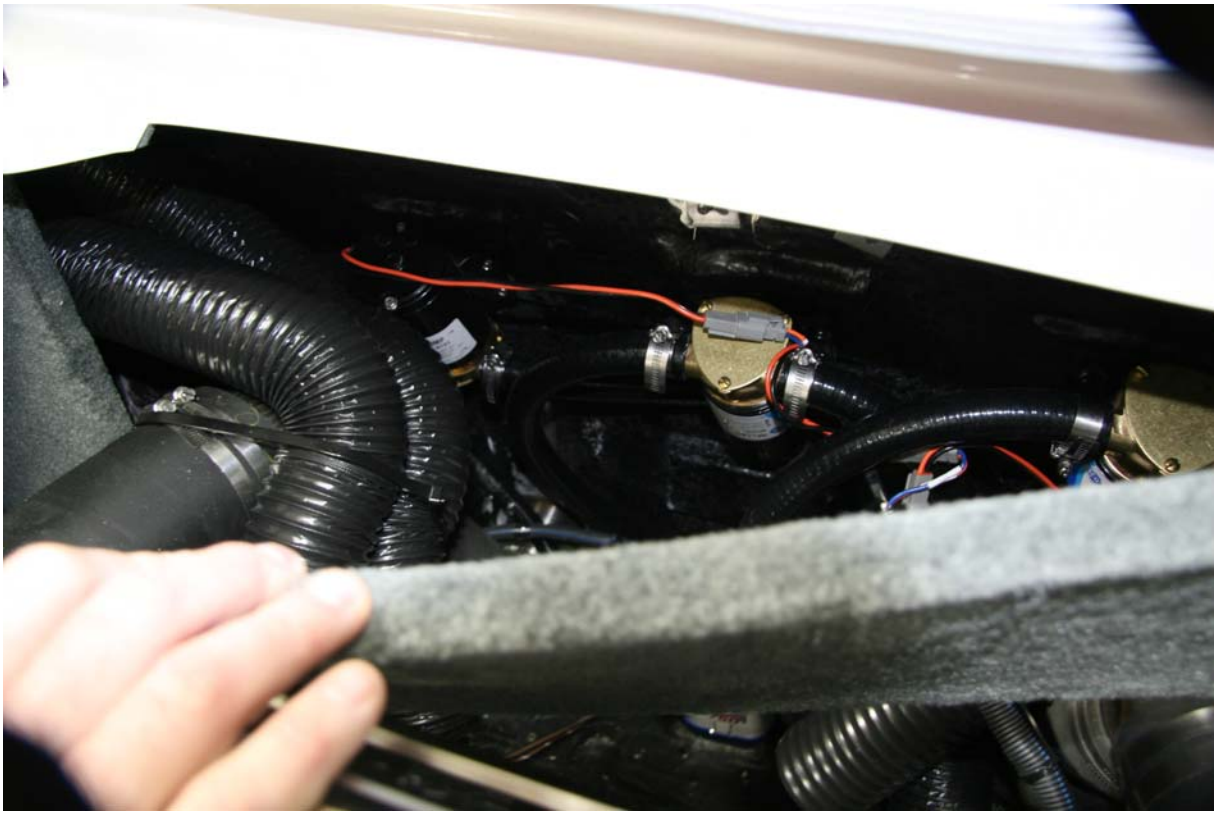

Figure 27 Ballast System Water Pump (mounted on transom, center of picture, one of three)

Figure 28 Everything Possible Must Be Done To Keep Western Reservoirs & Lakes From This

Figure 29 Houseboat On Shore - Side View (No endorsement, just an available photo)

Figure 30 Houseboat Front End (notice how clean it is)

Figure 31 Houseboat Back End With Motors (lots of places for mussels to attach & infest, hard to clean)

Figure 32 Houseboat Hull (clean and new)

Figure 33 Underside of Houseboat With Water Intake (one of several on a typical houseboat)

Figure 34 Houseboat Water Slide (uses special water system)

More Pictures of Mussel Contamination

Figure 35 Flat- Bottom Boat With Mussels (think houseboat with water intakes)

Figure 36 Seriously Mussel-Encrusted Sailboat Bottom (note where centerboard would fit)

Figure 37 Pontoon Boat Rear View

Figure 38 Pontoon Boat Underside Details

Figure 39 Pontoon Boat With Mussel Infestation

More Boat Inspection and Cleaning Procedures Photographs

Figure 40 Personal Watercraft Steering Nozzle

Figure 41 Personal Watercraft Steering Nozzle (note hull drain)

Figure 42 Personal Watercraft With Water In Foot Recesses

Acknowledgements

The following Salt Lake City area businesses graciously allowed their boats to be photographed.

- Utah Water Sports, Inc., 11017 South Jordan Gateway South, www.utahwatersports.com
- Marine Products Pro Shop, 949 West 1700 South, www.marine-products.com
- Robertson's Marine, Inc., 1045 South Main, www.robertson-marine.com

Other photographs were obtained from the following.

- www.100thmeridian.org/ 100th Meridian Initiative
- http://images.google.com/imghp?ie=UTF-8&oe=UTF-8&hl=en&tab=wi&q= Google Images
- Utah Department of Natural Resources, Division of Water Resources & Parks and Recreation