# DECONTAMINATION FOR WHIRLING DISEASE ON THE SEELEY FIRE IN UTAH 2012: Sharing an Important Process with our Fellow Teams

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## Introduction

The Seeley Fire UT.MLF.002129 (P4GZN4) located in central Utah was caused by a lightning strike on the Manti-La Sal National Forest on 26 June 2012. The Eastern Arizona Incident Management Team was mobilized 27 June. The fire was returned to the local organization on 13 July 2012. The fire perimeter contained about 48,000 acres of mixed conifer, sagebrush and grasslands. The area has numerous small lakes and reservoirs important for sport fishery which includes several trout species (Rainbow, Tiger, Bonneville cut-throat, Brook, and Lake) as well as Splake and Tiger muskie. Whirling disease is an issue in the Huntington Creek drainage and Electric Lake.

Decontamination (disinfection) for whirling disease became a task of the Seeley Fire Ground Support Unit along with weed washing. The process, prescriptions and rationale behind the prescriptions were researched during the fire assignment by the Ground Support Unit. The local Forest's recommended prescription raised many questions due to the concentrated doses. Although the assigned Resource Advisor was helpful, answers to questions were not always shelf-ready. Utah Department of Natural Resources assisted in tracking interagency guidance and technical reports which provided the needed rationale.

The treatment process was still in question. The Equipment Manager for the weed wash and disinfection unit was a seasoned veteran in fire logistics, and dedicated to building a treatment facility that could be accomplished with apparatus available from the Cache and Supply Unit.

The report that follows is a condensed summary of the interagency guidance on biology, treatment, rationale for treatment doses, plumbing set up and logistics. The intention of this report is to share our lessons learned and provide shelf-ready information and rationale for treating whirling disease in fire camp. The process is also a model for other aquatic invasive species (AIS) diseases; however the prescription for treatment varies among diseases. This report references the treatment of whirling disease and the associated weed wash unit for the Seeley Fire.

## The Biology and Spread of Whirling Disease

Whirling disease is caused by a microscopic parasite (*Myxobolus cerebralis*) which was introduced to the United States from Europe in the 1950s and has spread to at least twenty-five western states. All species of trout and salmon can be infected but not all develop the whirling disease; native species are more susceptible than non-native brown trout. Once established in a water body the parasite cannot be eradicated without significant damage to the ecosystem. Therefore prevention of spreading the disease is the best deterrent (Interagency Guidance 2009a).

The Whirling disease parasite requires a host for survival; it uses the tubifex worm (*Tubifex tubifex*) which is common around the world. Tubifex worms live in lake and stream sediments rich in organic matter. There are two infective spore forms of Whirling disease, the myxospore and the triactinomyxon (TAM). The myxospore is small and durable and attaches to the tubifex worm. The TAM attaches to the fish's skin and injects parasites into the fish's body (Interagency Guidance 2009a). Therefore the

disinfection of water holding tanks and the cleansing of mud and organic matter from fire equipment is an important process before the fire equipment demobilizes from an assignment.

Spread of the disease is thought to be primarily from infected fish and fish parts, possibly birds, and fishing equipment that has not been disinfected. The transfer of mud and organic sediments on fire equipment is also a potential source of transfer, or the contaminated water held within an Engine, Water Tender, or Helicopter and their hoses (http://whirlingdisease.montana.edu *in* Interagency Guidance 2009a).

Treatment

Treatment procedures are detailed in a number of interagency documents and include guidance for Whirling disease and other aquatic invasive species (AIS); for the Southwest Region this includes Interagency Guidance 2009a&b,for the Intermountain Region this includes USFS 2011 a&b.

For whirling disease treatments may include time and temperature, air drying in sunlight, bleach, and disinfection (Table 1).

| **Table 1. Whirling Disease Methods of Control (Ref: USDA FS 2011a)** | |
|---|---|
| Sources | Hedrick etal. 2008, Wagner 2002. |
| Wash and remove organics (e.g. mud) | Yes |
| Temperature and Time | 90 degree C (195 degree F) for 10 minutes |
| Drying | Air dry for 24 hours; in sunlight is best |
| Bleach (e.g. Clorox) 6% sodium hypochlorite (NaClO) | 1% bleach solution for 10 minutes (500 ppm NaClO)<br>• 1 Liquid oz Clorox per gal water = 1.1 ratio<br>• 1 Tbsp liquid Clorox per gal water = 2.2 ratio<br>• 1 Gallon Clorox per 100 gal water = 0.9 ratio |
| | |
| **Quaternary ammonium compounds (e.g. alkyl dimethyl benzylammonium chloride (ADBAC); diecyl dimethyl ammonium chloride (DDAC))** | **10-15 minutes (1500 ppm Quat compounds)** |
| 4.4% Sanicare Quat 128 solution | • 1 Liquid oz Quat 128 per gal water = 6.1 ratio<br>• 1 Gallon Quat 128 per 100 gal water = 4.8 ratio |
| 3% Sparquat 256 solution (12.5% quat compounds) | • 1 Liquid oz Sparquat 256 per gal water = 4.1 ratio<br>• Gallon Sparquat per 100 gal water = 3.2 ratio |
| 1.7% Green Solutions High Dilution 256 solution | • 1 Liquid oz Green Solutions 256 per gal water = 2.4 oz/gal<br>• 1Gallon Green Solutions per 100 gal water = 1.9 ratio |

Bleach is not a practical disinfectant where fire hose is concerned. The recommended concentrations are high enough to damage rubber and cloth. Air drying is not always practical but was considered sufficient after weed washing for the exterior of vehicles that do not take on water. The quat solutions recommended by the interagency guidance are more concentrated than the Manufacturers'

recommendations in order to reduce the amount of contact time necessary for disinfection. Interagency quat solution formulas are presented in Table 2.

Table 2. Recipe for 5% cleaning solution (based on using Quat 128 or Sparquat 256). Ref: Interagency Guidance 2009 a&b, USFS 2011 a&b)

| Volume of tap water | Volume of Quat 128 | Volume of Sparquat 256 |
|---|---|---|
| 100 mL water | 4.63 mL | 3.00 mL |
| 1 gallon water | 6.35 liquid oz | 4.12 liquid oz |
| 1 gallon water | 12.7 tbsp | 8.2 tbsp |
| 1 gallon water | 0.79 cups | 0.51 cups |
| 100 gallons water | 4.96 gallons | 3.22 gallons |
| 1000 gallons water | 49.6 gallons | 32.2 gallons |

For the Seeley Fire the local Forest recommended Carroll Co. Multi-Q Sanitizer. The Manufacturer's recommendations suggest 625 ppm active quat (www.carrollco.com). This formula is designed to be used without rinsing when used per label directions and has been approved for use in food service areas. The local Forest recommended 50 gallons Quat128 per 1,000 gallons water.

Concentration of disinfectant is monitored with Quat-check papers to ensure a range of at least 600-800 ppm. This is a simple test similar to checking for pH with litmus paper. The Quat-check papers are a separate purchase from the Quat solution and should be ordered at the same time as the Quat order if otherwise not available.

Additional effective treatments for aquatic invasive species found in the Intermountain West and Southwest (in addition to whirling disease) is provided in Appendix A (Interagency Guidance 2009a).

Staging Area

It is important to have enough room to set up the weed wash and the decontamination units near one another, side-by-side if possible.

The Seeley Fire was fortunate to have an area near the rodeo grounds with a hard top parking for weed wash set up. An additional area ¾ acre in size was used for the fold-a-tank set up. This area was a dirt lot that was groomed with a grader. An adjacent 2 acre area topped with recycled pavement was used for releasing rinse water from Engines and Water Tenders. In addition to this area was a 2 acre dirt lot available for vehicles in waiting. The units in total used about 5 acres (Figure 1).

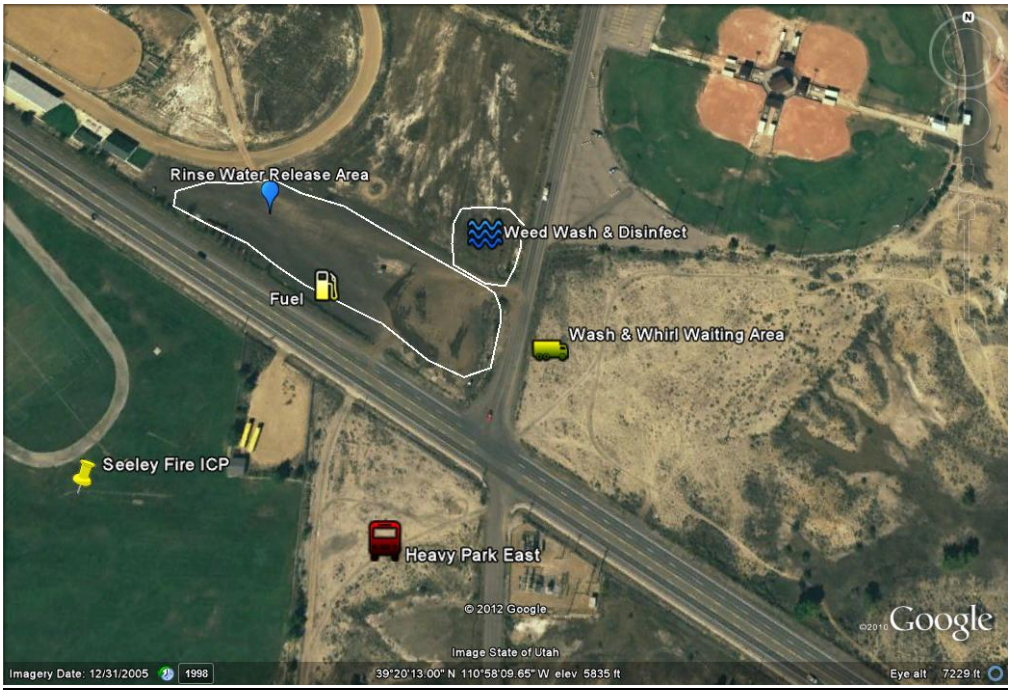



Figure 1. Staging area of the Seeley Fire Whirling disease and weed wash units.

Plumbing Apparatus

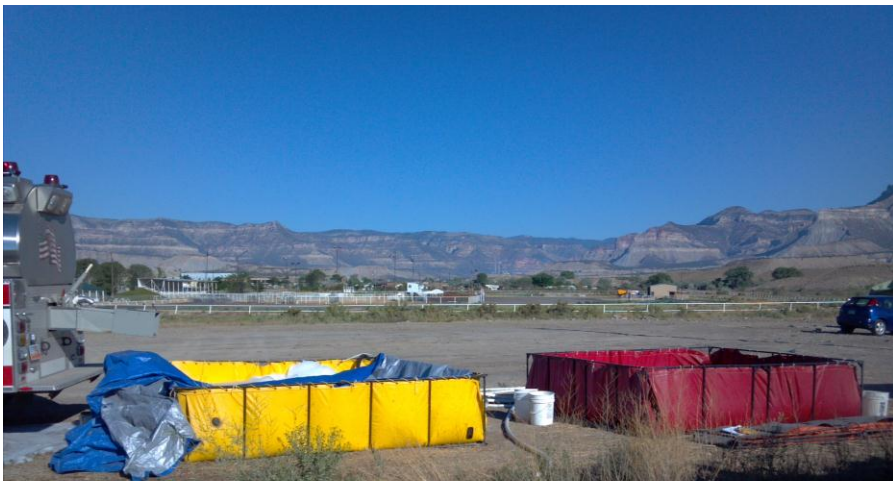
All plumbing appliances and apparatus are available from Cache or Supply and include the following:

1. Three fold-a-tanks (of different color preferred); one holds decontamination solution, one holds fresh water, and the third is held in reserve for replacement if one of the others is damaged
2. One Mark III pump kit including gated wye, gas can, miscellaneous fittings and berms
3. One reducer (1" to ¾") for garden hose
4. ¾" garden hose (attaches to pressure relief "blow-by" valve and feeds solution back into the fold-a-tank for agitation of the solution)
5. Hoses and nozzles to fit the gated wye; hose length should be at least 100' long
6. One 12' x 12' tarp to cover the fold-a-tank holding the decontamination solution
7. Two Hot Cans with handles (plastic 5 gallon buckets from the Supply Unit)
8. Parachute cord (about 50')
9. Shade tarp for workers
10. Plastic zip ties
11. Rubber gloves for each handler
12. Goggles for each handler

It is preferred to have fold-a-tanks of different colors so that Equipment Operators can simply direct traffic e.g., to the "red tank" or to the "yellow tank." Tanks should be placed adjacent to one another (Figure 2) in an area that is sufficiently large to accommodate the turning radius of very large

equipment, maneuvering space, vehicles in waiting, and a large area for release of rinse water from Engines and Water Tenders.

Figure 2. Yellow and red fold –a-tanks hold quat solution and rinse water, respectively.



Hook up the Mark III pump kit the same way it is normally implemented for pumping from a lake or stream. Hook up the garden hose and reducer to the pressure relief valve. Feed the garden hose back into the fold-a-tank that will hold the decontamination solution. Secure it with a plastic tie.

A fold-a-tank is preferable to a pumpkin in this process. The pumpkin has a wide base which prohibits some vehicles from getting close enough to release solution back into the unit holding the whirling disease solution (Figures 3 and 4).

Figure 3. Side view of Engine off loading solution into fold-a-tank for recycle.

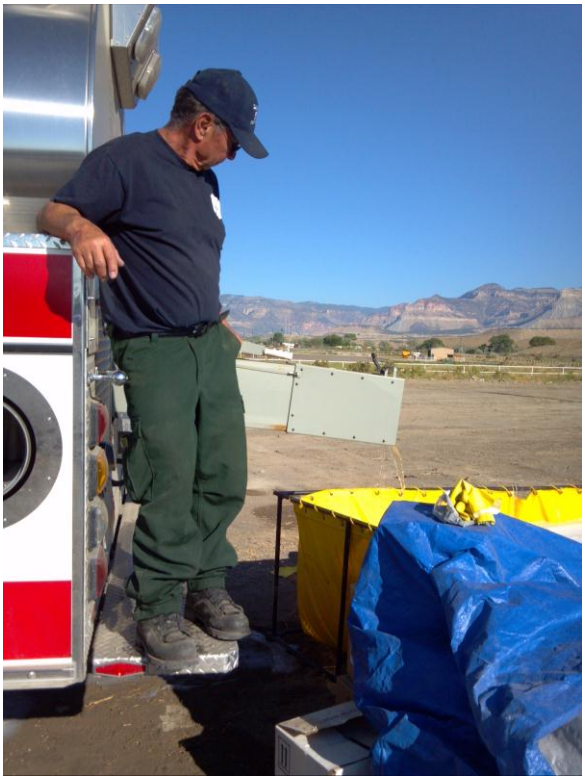
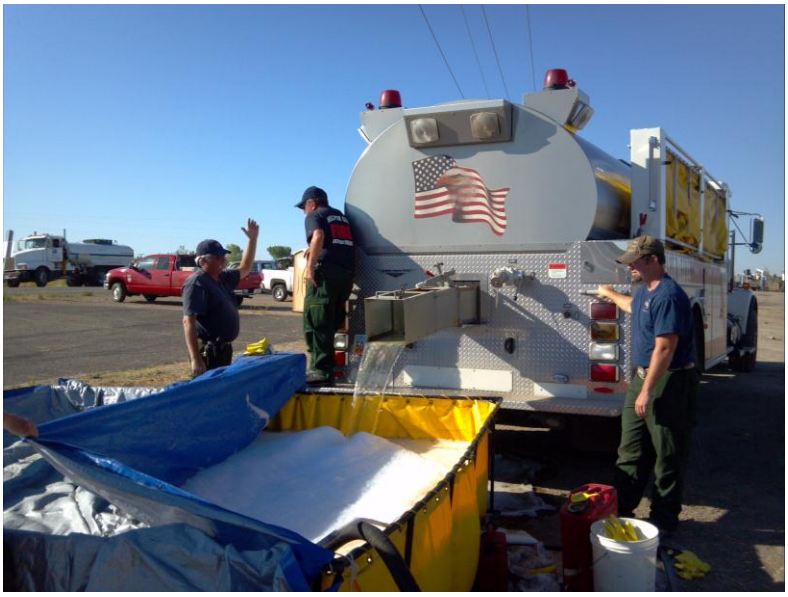


Figure 4. Rear view of Engine off-loading quat solution to recycle back into the treatment process.



Demob Process

Whirling disease is a spore that survives in muddy wet soil. It is important that all vehicles, whether or not they take on water, hose down in the field before returning to ICP on demob day. Vehicles carrying water should self-hose and assist other units such as dozers to remove as much mud and organic matter as possible. Select an area where the run-off will not run back into the drainage ways or water bodies. Return to ICP with an empty tank.

Weed-wash at ICP. Vehicles not taking on water may be released at this point. Vehicles which have crossed streams or driven in flood zones, as well as all units taking on water need to proceed to decontamination.

Additional exterior hosing may be desired by the Resource Advisor (READ). Most aquatic invasive species can be treated with 140 degree F water. However, Whirling disease requires 195 degree F water if hot water is the treatment of choice. Otherwise, a quat solution is recommended for fire line activities. A complete air drying for 24 hours will also provide treatment.

Vehicles that take on water must be decontaminated within the holding tanks and hoses with a Quat solution. The empty vehicle water tank will draft from the Fold-a-tank solution. The Mark III pump is used to help fill the vehicle holding tank with Quat. For Water Tenders this is done from the top hatch. Wet down the surfaces and place the nozzle under water in the solution as soon as possible. To prevent excessive foaming and bubbles do not use a fine-spray setting. The water tank interior and hoses should be wetted for at least ten minutes; the hard line is used to re-circulate the Quat water back to the Fold-a-tank

After the ten minute decontamination process, the vehicle will release the quat solution back into the quat tank. The vehicle then drafts from the fresh water. The Seeley Fire also had the advantage of a municipal hydrant on-site if vehicles were unable to draft from the rinse tank. After rinsing, the Engine/Water Tender proceeds to release the rinse water onto the paved parking lot where it evaporates.

The Seeley Fire had the advantage of two acres of rough paved area. Vehicles drove across this parking lot to release their water. The solution evaporated without making muddy areas. Also, the quat provided was environmentally safe (certified for use in food service areas). The Manufacturer's recommendations for food-grade quat require no rinsing. However, local Forest/Interagency protocol may require this step, and Fire Personnel may want this step to reduce future foaming in the tank.

If the Fire does not have the advantage of a large acreage suitable for release of the rinse water, it is suggested that the State's grey water procedure be followed. In this case the rinse water is clean and no chlorine/bleach is required for treatment. In New Mexico the Fire Community has an Agreement with New Mexico Environment Department to release treated grey water on dirt Forest Roads where the water will evaporate and there is little or no chance of run-off into drainage ways and water bodies

(George 2012, see Appendix B). Similarly in Arizona, Fire Teams may request a waiver to dispose of diluted/used Quat solution over open land where there is no potential for run-off into storm drains, waterways, or sensitive habitat (Interagency Guidance 2009) Fire Teams should check with the respective State's protocol.

A summary of the Quat wash process follows:

1. Hose off excess mud and organics in the field, away from drainages and water bodies.
2. Return to ICP with an empty tank.
3. Weed wash.
4. Decontaminate.
5. Rinse.
6. Retain the decontamination certificate as you proceed to your next assignment (see section below).

* Vehicles that were inspected by the EQPI team afterward were occasionally sent back to the weed wash for additional de-mudding. See discussion below "Integration with DOT Inspectors."

Integration with DOT Inspectors

Early in the Seeley Fire the local Forest weed wash unit was used. This is a high pressure spray wash that does not have the ability to hose the under-carriage of vehicles. It was replaced by a commercial unit that had a spinning spray nozzle on wheels that could reach under the vehicles. Even so, some vehicles were so caked with mud that they were sent back to the washing unit by the DOT Equipment Inspectors (EQPI). One of the EQPIs was also trained as a Resource Advisor on his home unit and was particularly careful to ensure that the weed wash was effective in removing mud and organics in order to improve prevention of whirling disease and weed transfer through mud.

This experience incubated discussion on how to capitalize on better integration of the DOT inspections into the weed wash and decontamination units. Vehicles that have been hosed down, especially on the under-carriage tend to get more thorough inspections because the EQPIs can see the parts better. For example, cracks in springs and shackles are exposed when the mud and dirt are cleaned off. The EQPI can also send a vehicle back to the washing unit if it still has mud and organics hung up in the under-carriage.

Logistics

The combination of weed wash and whirling disease decontamination can be a slow process during the demobilization of crews. Seeley Fire Ground Support timed the process by clocking the last vehicle in line on one demob morning. There were nine vehicles in line and five of these were six-pack crew cabs. Heavy equipment on transports may take up to 1-1.5 hours to remove the excess mud using a high-pressure hose if they do not take care of this chore in the field. Vehicles that do not take on water may be de-mudded, weed-washed and released to air dry. Seeley Fire recommendations are:

- Light rigs allow 15 minutes per vehicle plus wait time for the weed wash line.

- Heavy equipment on transports allow for 1.5-2.0 hr. for the weed washing if the vehicle is heavily soiled.
- Engines and Water Tenders allow 45 minutes to 1 hour plus wait time for the weed wash and whirling disease decontamination.

To minimize waiting time at the weed wash and decontamination unit, Overhead and single resources should try to use the demob weed wash unit mid-day and at times when Engines and Crews are not going through the demob process.

If weed washing is not part of the demob process, it is highly recommended that an alternate high-pressure wash (such as a commercial car wash) be used prior to whirling disease decontamination. The Utah Department of Natural Resources has mobile units that provide a high pressure wash at 140 degree F. Although this temperature is lower than that required for whirling disease hot water decontamination (195 degree F), it would provide an effective high pressure wash and treatment for other aquatic invasive diseases (Appendix A).

The Seeley Fire had the DOT inspection unit separated from the weed wash and decontamination units. In retrospect it would have been beneficial to have all three of these units in the same area for more efficient coordination and collaboration. During heavy demob hours the Logistics Section would also benefit by separating weed- wash- only vehicles from weed wash and decontaminate vehicles.

Certification

The USFS Missoula Technology and Development Center (MTDC) have proposed a decontamination certification which would guarantee the AIS cleaning status of fire equipment and gear (Tait 2009). They suggest the certificate be signed by a responsible fire official and verify that the equipment was decontaminated. The certificate should specify which protocols were used in the cleaning procedure, be recognized by both USFS and BLM as well as appropriate state agencies, and be applicable across state and jurisdictional boundaries.

Potential benefits from certification identified by MTDC were described “By normalizing AIS cleaning procedures after every demobilization, this certification process would decrease the risk of spreading AIS, and would solve our internal FS problem of being certain that equipment at initial attack was clean and ready to go. It would eliminate unnecessary cleaning procedures at the units and thereby increase efficiency, reduce confusion, and reduce costs. Because western states are currently considering mandatory border inspections of all conveyances that could carry infected water, including firefighting equipment, certification would also be a way to assure States that the equipment is not contaminated. Certificates could be presented at ports-of-entry, or shown to State Officials at other locations; this collaborative process would further our AIS partnerships with states and demonstrate our cooperation in the fight against AIS” (Tait 2009). A certificate prepared by the Seeley Fire Ground Support is provided as Figure 5.

**Figure 5**

AIS DECONTAMINATION CERTIFICATE

**THIS CERTIFICATE VERIFIES THAT VEHICLE**

_____

**WAS DECONTAMINATED FOR WHIRLING DISEASE BEFORE LEAVING THE SEELEY FIRE UT-MLF-002129 JULY ___ 2012, HUNTINGTON, UTAH, USING PROTOCOL ESTABLISHED BY USFS REGION 4.**

1. **Mud and organics removed with high pressure hose.**
2. **Weed washing.**
3. **Internal hard lines, pumps, holding tanks:**
    a. **50 gal disinfectant to 1000 gal water (600-800 ppm); 10 minute contact time**
4. **Rinsing.**
5. **Inspection for mud, organics and weed seed by READ or EQPI at EQPI station.* (Step added in retrospect to the Seeley Fire.)**

**Ref:**

**USFS Intermountain Region Guidance – Revised May 2011 "Preventing Spread of Aquatic Invasive Organisms Common to the Intermountain Region: Operational Guidelines for 2011 Fire Activities" and "2011 Technical Guidelines for Fire Operations."**

**Carroll Multi Q Sanitizer – Institutional grade safe for food processing facilities. http://www.carrollco.com/disinfectant/index.htm**

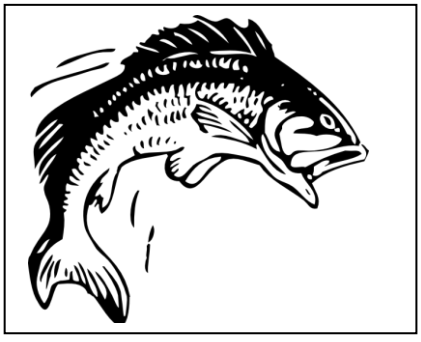
Eastern Arizona Incident Management Team

John Philbin, Incident Commander

Jerry Bradley & Elroy Brown, Logistic Section Chiefs

Guy Gillespie, Ground Support Unit Leader

Al Gibbons, Equipment Manager



_____ _____

Fire Official Signature Date

Lessons Learned

*Tracking Divisions with and without Whirling Disease*

There should be an attempt to coordinate Fire Equipment and Divisions located in watersheds that have or do not have whirling disease. Equipment that does not work in watersheds that have whirling disease could be waived from the decontamination process if a good tracking system were in place. Conversely, Equipment that is reassigned from one Division to another should go through the decontamination process at that time.

*Flash Floods*

The Seeley Fire experienced a lot of flash-flooding. Some Engines experienced mud and debris that was as high as the battery case and over the engine compartment. The weed washing unit does not normally go into the engine compartment. Vehicles that experienced flash-floods should be sent to Equipment Inspection after weed washing to ensure the washing was thorough.

*Back Haul and Cache*

Back haul from watersheds known to have Whirling disease should be flagged in the field. If in doubt, all hose and equipment should be red-flagged and returned to the Cache with a note that the equipment and tools have been exposed to whirling disease (or other AIS). The Supply/Receiving and Distribution Unit will need to isolate the exposed hose, equipment and tools from other Supply items. The Cache should be notified as soon as possible so the warehouse manager can be ready to provide the proper decontamination protocol for the returned equipment and hose. This includes all items returning from the fire line including pumpkins, pumps, Fold-a-tanks, all hose, etc.

Contractor and municipal crews' hose will need to be replaced with clean hose and their exposed hose returned with the back haul to Cache or they will need to submit a claim with the ICP Compensation/Claims unit. This step in the process led to discussion over the winter after the Seeley Fire. Our best suggestion after a winter of moldering follows:

> First off consider "settling a claim for damages." The Supply Unit has no authority to settle claims for privately owned property damages nor do they have authority to give away Federal property. The Forest Service (FS) Fire hose may be of lower quality than that of some municipal or contract unit hose. In contrast, the contractors may have inferior and/or old worn out hose that they trade in for new cache hose. We believe the FS position would be for contractors and municipal fire departments to submit written claims (SF 95 forms) for hose replacement to the Compensation/Claims Unit Leader. We think the best and most practical thing is to have the contractor and municipal fire department hose decontaminated at the ICP so that they go home with what they brought and there are no claims to settle later. A contractor or municipal fire department while at the decontamination station would simply connect their hose together and pump decontamination solution through their hose and back into the fold-a-tank for the required number of minutes just as we did with their hard rubber live reel hose that is mounted

on the truck. We believe that method would be the path of least resistance for contractor and municipal fire department hose. The vast amount of hose used would be Federal hose which could go to the Cache for treatment.

*Integration of EQPI and Weed Wash Units*

The employment of an EQPI who also has READ qualifications will promote the integration of Equipment inspection with the weed wash and decontamination unit. Co-location of these units will also promote integration.

Appendix A. Effective treatments for aquatic invasive species found in the Intermountain West and Southwest (Interagency Guidance 2009a).

| **Aquatic Invasive Species** | **Wash and remove organics (e.g. mud)** | **Temperature** | **Drying** | **Bleach (e.g. Clorox®) 6% sodium hypochlorite** (NaClO) | **Quaternary ammonium compounds** [e.g. n-alkyl dimethyl benzyl ammonium chloride (ADBAC); didecyl dimethyl ammonium chloride (DDAC)] |
|---|---|---|---|---|---|
| **Whirling Disease** | Yes | 90°C (195° F);10 min | Be dry for 24 h, in sunlight best | For 10 min: 1% bleach solution (1 oz/1gal water) | For 10-15 minutes: Quat 128 (6oz/1gal), Sparquat 256 (4.3oz/1gal) |
| **Viral Hemorrhagic Septicemia (VHS), other viruses** | Thoroughly wash | 46°C (120°F); 5 min<br>Inactive after 24 hours at 20°C (68° F) | Be dry for 24 h, in sunlight best | For 10 min soak or circulate: 1% bleach solution<br>(1 oz/1gal water) | Unknown, but likely effective. For 10-15 minutes soak or circulate: Quat 128 (6oz/1gal), Sparquat 256 (4.3oz/1gal) |
| **Amphibian Chytrid Fungus** | Yes | 60°C (140°F); 5 min | Be dry for 3 hr, in sunlight best | For 30 sec: 20% solution (22oz/1 gal) -or- for 10 min: 7% solution 9oz/1gal | For 30 sec: Quat 128 (1/8 tsp/1gal) |
| **New Zealand Mudsnails** | Yes | 46°C (120°F); 5 min | Be dry for 48 hr, in sunlight best | Not effective | For 10-15 minutes: Quat 128 (6oz/1gal), Sparquat 256 (4.3oz/1gal) |
| **Zebra/Quagga Mussels** | Yes, pressure wash flushes veligers | ≥140°F water | 3-30 days, in sunlight best | For 1 min: 0.5% bleach solution (1/2 oz/1gal water) | No data, but likely effective |
| **Didymo** | Yes | 60°C (140°F); 1 min | Be dry for 48 h, in sunlight best | For 1 min: 2% bleach solution (2 oz/1gal water) | No data, but likely effective |
| **Golden Alga** | Thoroughly wash | >104°F | Be dry for 2-3 days in direct | For 24 h at 62.5-500 mg/l (0.01-0.07 oz/gal); 1 h at 3,125 mg/l | No data, but likely effective |

Appendix A. Effective treatments for aquatic invasive species found in the Intermountain West and Southwest (Interagency Guidance 2009a).

| **Aquatic Invasive Species** | **Wash and remove organics (e.g. mud)** | **Temperature** | **Drying** | **Bleach (e.g. Clorox®) 6% sodium hypochlorite** (NaClO) | **Quaternary ammonium compounds** [e.g. n-alkyl dimethyl benzyl ammonium chloride (ADBAC); didecyl dimethyl ammonium chloride (DDAC)] |
|---|---|---|---|---|---|
| | | | sunlight | (0.42 oz/gal); or 15 min at 12,500 mg/l (1.67 oz/gal). | |
| **Giant Salvinia** | Yes | >43°C (109°F) or < -3°C (26 °F) for > 2 hours | Uncertain, but dry at least 48 h, in sunlight best | No data, but likely effective. | No data, but likely effective |
| **Eurasian Watermilfoil and Parrot Feather** | No data but likely killed with>60°C (140°F) | Uncertain, but completely dry at least 48 h, in sunlight best | No data, but likely effective. | No data, but likely effective | No data but likely effective |
| **Hydrilla** | Yes | No data but likely killed with>60°C (140°F) | Uncertain, but dry at least 48 h, in sunlight best | No data, but likely effective. | No data, but likely effective |
| **Fish & Amphibians** | Yes | ≥140°F water | Be dry for 3 hr, in sunlight best | For 30 sec: 20% solution (22oz/1 gal) | Acute toxicity (EPA) |
| **Crayfish** | Yes | ≥140°F water | Be dry for 3 hr, in sunlight best | For 30 sec: 20% solution (22oz/1 gal) | No data, but likely effective as ADBAC is toxic to most aquatic organisms |
| **Other** | (Similar species of snails, plants, pathogens, and vertebrate and invertebrate invasive species). No data but treatments for whirling disease and/or New Zealand mudsnails are likely effective. | | | | |

Appendix B

**From:** George, Robert, NMENV [mailto:robert.george@state.nm.us]
**Sent:** Tuesday, February 21, 2012 12:11 PM
**To:** Catron, Mark -FS
**Cc:** Marshall, Clint, NMENV; Schoeppner, Jerry, NMENV; Baca, Jessica A -FS
**Subject:** RE: NOI to Discharge Grey Water at Fire Camps Waiver Request CY 2012

Mark,

I have reviewed your updated protocol and discussed it with management here. Please note that what is under discussion is not a "waiver" from any regulation, but rather; NMED's determination that a permit is not required for this activity. As long as the Forest Service follows the approved protocol, the discharge is not required to be managed under a Discharge Permit. Also note that I had one slight correction to the protocol, which is shown in red below:

1. Prohibit disposal of grey water within 500 feet of standing water or running water surfaces. This also includes around fire camp locations and other areas of firefighter concentrations (we call them command posts, staging areas, helibases, and spike camps).
2. Prohibit disposal of treated grey water within 100 feet of any dry washes or arroyos.
3. The fire camp can discharge any amount of volume treated grey water if associated with fire camp activity.
4. That "black water" and kitchen grease are SPECIFICALLY NOT INCLUDED in this request and excluded from this NOI waiver request.
5. Treatment rate for qualifying grey water shall be 1/2 gallon of chlorine bleach per 1,000 gallons of grey water. The bleach will be added to the non-potable water tank (disposal vehicle), not the storage tanks/bladders. The bleach will be added approximately ½ hour prior to the disposal, but not longer than two hours so that the bleach remains effective. The transport process will help mix the bleach.
6. The spreading process for treated grey water will minimize pooling and runoff.

The purpose of this change is to allow sufficient time for the disinfection to take place, after the bleach has been added. With this slight change, NMED **approves** this protocol and these types of grey water discharges can continue at Fire Camps (and other areas where firefighters are concentrated) throughout the state as long as they conform to the protocol.

Let me also take this opportunity to point out that NMED realizes that spills of grey water, black water or other liquids that do not conform to this protocol may inadvertently occur at fire camps. If spills do occur, the party responsible for the spill is obligated to orally contact NMED within 24 hour pursuant to 20.6.2.1203 NMAC of the Water Quality Control Commission (WQCC) Regulations. A written spill report and corrective action report will then be required to be filed with NMED and approved. Spills are most easily reported to NMED's hotline at: 505-827-9329 (24 hours a day - emergencies) or 866-428-6535 (voice mail, 24 hours a day – non emergency)

*page last updated 07/14*

If you have any questions, please feel free to contact me. Thanks, and good luck this year with the fires!

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DECONTAMINATION FOR WHIRLING DISEASE ON THE SEELEY FIRE IN UTAH 2012: Sharing an Important Process with our Fellow Teams

The authors worked in the Ground Support Unit of the Seeley Fire.

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Suggested Reference Citation: Cockman, Joneen S. , Al Gibbons and Sean Kelly, 2012. DECONTAMINATION FOR WHIRLING DISEASE ON THE SEELEY FIRE IN UTAH 2012: Sharing an Important Process with our Fellow Teams. Wildland Fire Lessons Learned Center (http://www.wildfirelessons.net/Home.aspx).

# PREVENTING SPREAD OF AQUATIC INVASIVE ORGANISMS COMMON TO THE SOUTHWESTERN REGION

## TECHNICAL GUIDELINES FOR FIRE OPERATIONS

The following technical guidelines were developed to assist fire personnel in reducing the potential for the spread of aquatic invasive species during fire management and suppression activities. These technical guidelines are intended for use by Resource Advisors (READs), biologists, and other resource specialists and supplement the two page "Operational Guidelines for Aquatic Invasive Species Prevention and Equipment Cleaning" prepared for fire managers in the southwestern U.S. These recommendations were patterned after guidance developed by the Forest Service's Intermountain Region, but have been modified to address aquatic invasive species of the Southwest. The aquatic invasive species considered here were selected based on their current significance in the Southwest. Because of the large expanses over which fire crews and their equipment travel, the potential for firefighters to serve as vectors for invasive species is significant. These guidelines are based on what we know about prevention methods for common species at this time and will be refined and revised over time as needed.

### Aquatic Invasive Species

Invasive species are organisms that are introduced into a non-native ecosystem and that cause, or are likely to cause, harm to the economy, environment, or human health. Many of these invasive species come from outside the U.S.; the nonnative quagga mussel from eastern Europe is pervasive throughout the lower Colorado River system, and zebra mussels and New Zealand mudsnails are significant threats in the southwestern U.S. Giant salvinia is a serious threat along the lower Colorado River, and golden alga is an invasive microscopic invasive algal cell that now occurs throughout much of the world. There are also many species native to other areas within the U.S. that are invasive in the Southwest; examples include green sunfish, bullfrogs, and crayfish. Aquatic invasive species are organisms that occur in aquatic, riverine, or wetland environments and can be spread by fire equipment including boats, barges, vehicles, water buckets, water tanks, hoses, and other equipment. The Nonindigenous Aquatic Nuisance Species Control and Prevention Act of 1990 (P.L. 101-646) highlights the concern for adverse impacts to native aquatic species from nonindigenous species. Executive Order 13112 (February 3, 1999) directs all Federal agencies to ensure that their actions do not promote the introduction or spread of invasive species.

Invasive plants and animals have many impacts on fish and wildlife resources and native environments. Invasive species degrade, change, or displace habitats and compete with our native fish, wildlife, and plant resources. In addition, many of these aquatic invasive organisms can damage or destroy fire supression equipment by clogging valves, pumps, motors, etc. The prevention and sanitation guidelines presented here can help prevent the spread of these organisms to other environments and help to ensure that fire suppression equipment remains operational.

### Administration

READs are commonly assigned to fire incidents from the local land management agency in order to advise the Incident Commander of resource concerns and issues. As such, READs are a vital

link in implementing these guidelines during fire incidents. READ training occurs periodically and may be offered on a unit-specific, agency-specific, or interagency basis. In addition, some units or agencies offer annual READ refresher classes, and all fire personnel must attend an annual fireline refresher. These Fire Incident Resource Advisor classes and refreshers are the primary venue for training READs (and other fire personnel) on the use of these guidelines. With or without formal training, personnel expected to serve as READs during fire season should be familiar with the Technical Guidelines and the companion Operational Guidelines, as well as the distribution of aquatic invasive species on their local units.

READs should routinely be assigned to fire incidents on their local units according to the criteria established by the unit's Fire Management Plan or agency policy. When a fire incident exceeds the local unit's capacity for management and is transitioned to a Type I, II, or III incident management organization, READ(s) should also be assigned to the incident management team and continue to advise on issues related to aquatic invasive species. Additionally, the Operational Guidelines, the companion document to these Technical Guidelines, should be incorporated by reference into the Delegation of Authority from the Agency Administrator to the Incident Commander.

**Preventing Spread**

Preventing introductions of potentially harmful species is the most efficient way to reduce the threat of aquatic invasive species. These species can be spread by vehicles and equipment that come into contact with any wetted area. Firefighter and public safety are always the first priority, but wherever possible, applying the following guidelines will help to prevent the spread of these organisms.

1) For all operations, assume that aquatic invasive species could be present in any water body. If available, obtain maps with local presence of these organisms' distributions within watersheds where fire management operations will take place. Local land management agencies may have GIS shape files of individual species that are accessible to resource advisors, biologists, and fire personnel. Species-specific information, some distribution maps, and links to web sites are included in Appendix A and on the internet at the following sites:

   - USGS Nonindigenous Aquatic Species website: http://nas.er.usgs.gov (includes real time maps of distribution of several species)
   - Forest Service Intermountain Region Aquatic Invasive Species website: http://www.fs.fed.us/r4/resources/aquatic/index.shtml
   - Additional information regarding selection of water bodies may be found in Forest Service guidance at the following website: http://www.fs.fed.us/eng/pubs/pdf/WaterToolkit/o1_06251806.pdf

   Although distribution information at these web sites is kept as current as possible, a lack of mapped locations within the fire management area does not necessarily mean the species does not occur there. Apply the following steps, regardless of whether or not the species has been documented from the area.

2) Avoid driving through water bodies or contacting mud and aquatic plants with any vehicles or equipment. Vehicles and equipment can carry these organisms from one place to another if they come in contact with water or any substrate containing these organisms. Organisms such as quagga mussels can survive for up to 30 days out of water in some areas of the Southwest, depending on temperature and humidity.

3) Avoid transferring water between drainages by dumping water from one drainage into another or moving water between unconnected water bodies within the same drainage. Some organisms such as quagga mussels have microscopic life stages that are not readily apparent when water is drafted and are small enough to pass through screens.

4) Avoid obtaining water from multiple sources during a single operational period unless drafting/dipping equipment is sanitized between sources. Any wetted surface can carry some of these organisms and spread them from one water body to another.

5) Use screens when drafting and avoid sucking organic and bottom material when drafting from streams, ponds, or stock tanks. Screens are important to avoid transporting fish, amphibians, and crayfish between water bodies. Water drafting operations have the potential to spread aquatic invasive species through pumps and equipment. As stated above, pre-field review of potential aquatic invasive species within the watershed can identify the risk level. Water source specifications may include screen location and orientation, approach velocity, sweeping velocity, minimum screen size, screen mesh size, shape and material type, and bypass facilities. Other direction may provide information on pumping rates and draw-down of upstream or downstream pools or lakes and ponds where potential impacts to aquatic species may exist. See http://swr.nmfs.noaa.gov/habitat.htm http://www.fs.fed.us/eng/pubs/pdf/WaterToolkit/01_06251806.pdf

**Cleaning and Sanitizing Vehicles and Equipment**

1) Any equipment that comes into contact with raw water (water other than from a treated community or domestic water source) should be sanitized (Table 1). Microscopic larvae of zebra and quagga mussels (veligers) can be transported in tanks, buckets, hoses, bilges, and any other equipment that holds water. Minute parts of the invasive plant giant salvinia transported to uninfected areas can grow and spread.

2) Drying alone may be effective in some situations, depending upon the target species, types of equipment, temperature, and relative humidity. A quarantine time calculator for zebra/quagga mussels is available at the 100th Meridian website: http://100thmeridian.org/Emersion.asp. See Table 1 for specific-species considerations if using this option.

3) Clean and/or sanitize all vehicles and equipment before moving from one incident to another or when moving between watersheds. Cleaning and sanitizing equipment as described here will be necessary before use as well as after use if equipment has been obtained from a source where sanitizing history is unknown. While operational quality control is beyond the scope of this guidance, using an equipment check-in system where sanitizing could be documented and guaranteed with certification or tagging would be extremely valuable.

4) In coordination with the READ, establish sanitation areas where there is no potential for runoff into storm drains, waterways, or sensitive habitats. Be sure that wash water will not contaminate another water source.

5) Remove all visible plant parts, soil, and other materials from external surfaces of vehicles, gear, and equipment. Powerwash all accessible surfaces with clean, hot water ($\geq 140^{o}$F, if possible); weed washers can be used. Powerwashing will greatly reduce the likelihood that aquatic invasive species are present, and chemical sanitation of external surfaces is not necessary (see Table 1 for water temperature/wash time recommendations for specific species). New Zealand mudsnails can insert themselves into small crevices and resist flushing; avoid driving through streams and scraping up bottom sediments when dipping to reduce the likelihood of picking up this species.

6) Intake hoses, pumps, and tanks can become contaminated with infected water or by sucking the organisms up from the bottom of a stream or pond. Disinfect tanks after each incident, and disinfect tanks before use if previous sanitation of the equipment has not occurred or is unknown. Set up a portable disinfection tank (e.g. "pumpkin," fold-a-tank, 55 gallon barrel, 5 gallon bucket, etc. depending on the cleaning capacity needed) using a 5% cleaning solution of quaternary ammonium compound. This is a common cleaning agent used in homes, swimming pools, and hospitals, and is safe when used at the recommended concentration. Using liquid bleach (such as Clorox) is not recommended because it evaporates quickly and damages gaskets and canvas gear. Do not mix bleach with quaternary ammonium compound. Quaternary ammonium compounds [brand names *Quat 128* (by Waxie) and *Sparquat*] need to be ordered or purchased from a local supplier or GSA, but solutions are safe for gear and remain effective for about one week if not overly diluted or muddied (see Testing the Solution, below).

   Recipe for 5% cleaning solution using either *Quat128*® ***or*** *Sparquat 256*®
   Disinfection with quaternary ammonium compounds is the recommended treatment for most aquatic invasive species found in the Southwest. These products are labeled for use as fungicides/virucides. Be sure to follow individual agency integrated pest management requirements, including pesticide use proposals. Species-specific concentrations and alternatives for hot water power washing, drying, and bleach solutions are in Table 1.

| **Volume of tap water** | **Volume of *Quat128*®** | **Volume of *Sparquat 256*®** |
|---|---|---|
| 100 ml water | 4.63 ml | 3.00 ml |
| 1 gallon water | 6.35 liquid oz. | 4.12 liquid oz. |
| 1 gallon water | 12.7 tbsp | 8.2 tbsp |
| 1 gallon water | 0.79 cups | 0.51 cups |
| 100 gallons water | 4.96 gallons | 3.22 gallons |
| 1000 gallons water | 49.6 gallons | 32.2 gallons |

   Empty the tank and flush tanks and hoses with clean water, then circulate the 5% cleaning solution for at least10 minutes. Float portable pumps in the disinfection tank and pump cleaning solution through for 10 minutes. Pump the solution through the hose, then rinse with water. Discharge used cleaning solution back into the disinfection tank for re-use.

**Testing the Solution**

To determine if the solution has been diluted below the 5% concentration, use "Quat Chek 1000" test papers. These can be purchased from the cleaning compound supplier. The used solution must be diluted to about 600 parts per million (ppm) of ammonium compound for proper testing.

1) Take **one** cup of used *Sparquat 256*® cleaning solution, pour into a bucket. Add **5** cups of water. Mix. OR
2) Take **one** cup of used *Quat128*® cleaning solution, pour into a bucket. Add **4** cups of water. Mix.

Test the diluted solution with "Quat Chek" Test Paper. Match up the color of the paper with the ppm on the color chart. For optimal disinfection, the diluted solution should have a concentration between 600 and 800 ppm. If it is too dilute, dispose of properly (see below) and mix a new cleaning solution.

**Disposal**

Use caution when disposing the used cleaning solution and follow all federal, state, and local regulations. Do not dump cleaning solution into any stream or lake, or on areas where it can migrate into any stormdrain, waterbody, or sensitive habitat. Small quantities may be disposed of down sanitary drains into a municipal sewer system. Larger quantities may need to be transported to a municipal wastewater treatment facility. Consult the facility operator/manager prior to disposal.

Used cleaning solution may or may not be suitable for disposal in on-site septic systems. Consult the local agency's utilities supervisor or facilities manager prior to disposal.

It may be possible to dispose of used cleaning solution over open land or on roadways where there is no potential for runoff into stormdrains, waterways, or sensitive habitats. Consult the READ for appropriate locations before using this method and check with the appropriate state or county authority as state or local permits may be required.

Within Arizona, if necessary, disposal of used cleaning solution can be done over open land and away from any waterbodies with a temporary emergency waiver from the Arizona Department of Environmental Quality (ADEQ). Please use other disposal methods first, if possible. Notify ADEQ, using the template letter that is attached in Appendix C, as soon as possible following any discharge of solution.

**Safety**

At the recommended dilution, ammonium quaternary compounds are safe for use. However, personal protective equipment (PPE) should always be used when working with these compounds and when handling the concentrated product. Use protective, unlined rubber gloves and splash goggles or a face shield when handling the cleaning solution, and take extra precautions when handling undiluted chemicals. Have eye wash and clean water available on-site to treat accidental exposure. Respiratory protection is not normally required if there is good ventilation.

Always use these products in accordance with label instructions. Never mix quaternary ammonium compounds with bleach; toxic fumes may result. Consult the product label and Material Safety Data Sheets (http://www.fs.fed.us/r4/resources/aquatic/guidelines/index.shtml) for additional information.

Hot water at 140ºF can pose a significant scalding risk. When using hot water or steam in power washers as a disinfection option, be sure to use appropriate PPE such as protective gloves and clothing to avoid scalding or burning skin.

**Storage**

*Sparquat 256*® and *Quat128*® can be stored for up to two years in an unopened container without losing their effectiveness. Both should be stored in a cool dry place, out of direct sunlight. The manufacturer recommends storage temperatures between 32º to 110º F.

**Purchase**

Both products are available from GSA (https://www.gsaadvantage.gov) and are commonly available through local janitorial and swimming pool chemical suppliers.

- *Quat 128*® by Waxie's Enterprises Inc.; GSA (NSN No. 170304) =$36/case (4 gal); EPA registration number 1839-166-14994.
  Additional information can be found at http://www.waxie.com
- *Sparquat 256*® by Spartan Chemical Company; GSA (NSN No. 1025-04) = $54/case (4 gal); EPA registration number 5741-9. Additional information can be found at http://www.spartanchemical.com

Remember to buy "Quat Chek 1000" test papers when you purchase the chemicals.

Table 1. Effective treatments for aquatic invasive species found in the Intermountain West and Southwest. For more information about specific organisms, see Appendix A.

| **Aquatic Invasive Species** | **Wash and remove organics (e.g. mud)** | **Temperature** | **Drying** | **Bleach (e.g. Clorox®) 6% sodium hypochlorite** (NaClO) | **Quaternary ammonium compounds** [e.g. n-alkyl dimethyl benzyl ammonium chloride (ADBAC); didecyl dimethyl ammonium chloride (DDAC)] |
|---|---|---|---|---|---|
| **Whirling Disease** | Yes | 90 °C (195 ° F);10 min | Be dry for 24 h, in sunlight best | For 10 min: 1% bleach solution (1 oz/1gal water) | For 10-15 minutes: Quat 128 (6oz/1gal), Sparquat 256 (4.3oz/1gal) |
| **Viral Hemorrhagic Septicemia (VHS), other viruses** | Thoroughly wash | 46°C (120°F); 5 min Inactive after 24 hours at 20°C (68° F) | Be dry for 24 h, in sunlight best | For 10 min soak or circulate: 1% bleach solution (1 oz/1gal water) | Unknown, but likely effective. For 10-15 minutes soak or circulate: Quat 128 (6oz/1gal), Sparquat 256 (4.3oz/1gal) |
| **Amphibian Chytrid Fungus** | Yes | 60°C (140°F); 5 min | Be dry for 3 hr, in sunlight best | For 30 sec: 20% solution (22oz/1 gal) -or- for 10 min: 7% solution 9oz/1gal | For 30 sec: Quat 128 (1/8 tsp/1gal) |
| **New Zealand Mudsnails** | Yes | 46°C (120°F); 5 min | Be dry for 48 hr, in sunlight best | Not effective | For 10-15 minutes: Quat 128 (6oz/1gal), Sparquat 256 (4.3oz/1gal) |
| **Zebra/Quagga Mussels** | Yes, pressure wash flushes veligers | ≥140°F water | 3-30 days, in sunlight best | For 1 min: 0.5% bleach solution (1/2 oz/1gal water) | No data, but likely effective |
| **Didymo** | Yes | 60°C (140°F); 1 min | Be dry for 48 h, in sunlight best | For 1 min: 2% bleach solution (2 oz/1gal water) | No data, but likely effective |
| **Golden Alga** | Thoroughly wash | >104°F | Be dry for 2-3 days in direct sunlight | For 24 h at 62.5-500 mg/l (0.01-0.07 oz/gal); 1 h at 3,125 mg/l (0.42 oz/gal); or 15 min at 12,500 mg/l (1.67 oz/gal). | No data, but likely effective |
| **Giant Salvinia** | Yes | >43°C (109°F) or < -3°C (26 °F) for > 2 hours | Uncertain, but dry at least 48 h, in sunlight best | No data, but likely effective. | No data, but likely effective |
| **Eurasian Watermilfoil and Parrot Feather** | No data but likely killed with>60°C (140°F) | Uncertain, but completely dry at least 48 h, in sunlight best | No data, but likely effective. | No data, but likely effective | No data but likely effective |

| **Aquatic Invasive Species** | **Wash and remove organics (e.g. mud)** | **Temperature** | **Drying** | **Bleach (e.g. Clorox®) 6% sodium hypochlorite** (NaClO) | **Quaternary ammonium compounds** [e.g. n-alkyl dimethyl benzyl ammonium chloride (ADBAC); didecyl dimethyl ammonium chloride (DDAC)] |
|---|---|---|---|---|---|
| **Hydrilla** | Yes | No data but likely killed with>60°C (140°F) | Uncertain, but dry at least 48 h, in sunlight best | No data, but likely effective. | No data, but likely effective |
| **Fish & Amphibians** | Yes | ≥140°F water | Be dry for 3 hr, in sunlight best | For 30 sec: 20% solution (22oz/1 gal) | Acute toxicity (EPA) |
| **Crayfish** | Yes | ≥140°F water | Be dry for 3 hr, in sunlight best | For 30 sec: 20% solution (22oz/1 gal) | No data, but likely effective as ADBAC is toxic to most aquatic organisms |
| **Other** | (Similar species of snails, plants, pathogens, and vertebrate and invertebrate invasive species)<br><br>No data but treatments for whirling disease and/or New Zealand mudsnails are likely effective | | | | |

**FEEDBACK**

These guidelines were developed by an interagency group including representatives from Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service, U.S. Forest Service, Arizona Game and Fish Department, and New Mexico Department of Game and Fish. These guidelines will be revised as needed, based on new information and suggestions from fire managers, READs, biologists, and others involved in their implementation. Please report use of these guidelines and suggestions for improvements to your agency contact.

**Agency Contacts**

| | |
|---|---|
| Bureau of Indian Affairs | Leon Ben, Jr.<br>Western Regional Office, Phoenix, AZ<br>(602) 379-6798<br>Leon.Ben@bia.gov<br><br>Jason Greenlee<br>Navajo Area Office, Gallup, NM<br>Jason.Greenlee@bia.gov<br><br>Cal Pino<br>Southwest Regional Office, Albuquerque, NM<br>505-563-3385<br>Cal.Pino@bia.gov |
| Bureau of Land Management | Kelly Castillo<br>602-417-9550<br>Kelly_Castillo@blm.gov<br><br>Darren Mathis<br>602-417-9308<br>Darren_Mathis@blm.gov<br>Arizona State Office, Phoenix, AZ<br><br>Hector Madrid<br>New Mexico State Office, Santa Fe, NM<br>505-438-7430<br>Hector_Madrid@blm.gov<br><br>Dave Bott<br>New Mexico State Office, Santa Fe, NM<br>505-438-7580<br>Dave_Bott@blm.gov |

| | |
|---|---|
| National Park Service | Myron Chase<br>Intermountain Region, Denver, CO<br>303-969-2863<br>Myron_Chase@nps.gov<br><br>Erv Gasser<br>Pacific West Region, Seattle, WA<br>206-220-4263<br>Erv_Gasser@nps.gov |
| U.S. Fish and Wildlife Service | Mark Kaib<br>Southwestern Regional Office, Albuquerque, NM<br>505-248-6819<br>Mark_Kaib@fws.gov<br><br>Brenda Smith<br>Arizona Ecological Services Office, Flagstaff, AZ<br>928-226-0614 x101<br>Brenda_Smith@fws.gov |
| U.S. Forest Service | Marsha Kearney<br>Southwestern Region, Albuquerque, NM<br>505-842-3350<br>mkearney@fs.fed.us |
| State of Arizona | Tom McMahon<br>Arizona Game and Fish Department, Phoenix, AZ<br>623-236-7271<br>TMcMahon@azgfd.gov |
| State of New Mexico | Brian Lang<br>New Mexico Department of Game and Fish, Santa Fe, NM<br>505-476-8108<br>Brian.Lang@state.nm.us |

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# APPENDIX A

## SPECIES SPECIFIC INFORMATION ON IMPACTS, DISTRIBUTION, SPREAD AND TREATMENTS

**WHIRLING DISEASE**

Whirling disease is caused by a microscopic parasite called *Myxobolus cerebralis*. The parasite was introduced to the United States from Europe in the 1950s and has spread to many streams across the U.S. All species of trout and salmon can be infected with the parasite, but not all species will develop whirling disease. Native species of trout and salmon are more susceptible than nonnative brown trout. Once established in a stream, the parasite cannot be eradicated, nor can its worm host, without significantly damaging the ecosystem. Whirling disease has no known human health effects.

Tubifex worms (*Tubifex tubifex)* are the required invertebrate hosts for the parasite. They are very small (about ½-inch in length) and are common and widespread around the world. They live in sediments of lakes and streams and thrive in areas with abundant fine sediment and rich organic material. There are two infective spore forms, the myxospore and the triactinomyxon (TAM). The myxospore is a very small, round, durable spore that infects the Tubifex worm while in the sediment of a stream. The more vulnerable TAM attaches to the fish's skin and injects the parasite into the fish's body.

**How is whirling disease spread?** Whirling disease is transmitted mainly by infected fish and fish parts. It may also be transmitted by birds, and it is possible anglers can carry the parasite on fishing equipment. Transfer of organic sediments in or on fire equipment is a potential vector. For more information, see the following link: http://whirlingdisease.montana.edu/

**Where is whirling disease found in the West?** The whirling disease parasite has been found in wild fish and fish hatcheries in 25 states. Whirling Disease has been detected in many drainages in the Intermountain West and in parts of the Southwest. It is best to treat all water sources as potentially contaminated. For interactive maps at the HUC-8 level, see the following link: http://bsi1.msu.montana.edu/whirlingdisease/default.aspx

**Treatments effective on both stages of the parasite: the mature spore and the TAM**

| **Wash and remove organics (e.g. mud)** | **Temperature** | **Drying** | **Bleach (e.g. Clorox®) 6% sodium hypochlorite** (NaClO) | **Quaternary ammonium compounds** [e.g. n-alkyl dimethyl benzyl ammonium chloride (ADBAC); didecyl dimethyl ammonium chloride (DDAC)] |
|---|---|---|---|---|
| Thoroughly wash and scrub with stiff brush: Spores and TAMS | 90 °C (195 ° F);10 min; Spores and TAMS | Be dry for 24 h, in sunlight best; TAMS only | Soak or circulate for 10 min: 1% bleach solution (1 oz/1gal water); Spores and TAMS | Soak or circulate for 10-15 min: Quat 128 (6oz/1gal), Sparquat 256 (4.3oz/1gal); Spores and TAMS |

**General considerations:** The principle vector for spread of whirling disease is contaminated fish parts; it is not typically spread through fire activities. Avoiding and removing organics (the spores reside in mud), power washing, and flushing will greatly reduce or eliminate spores on external gear surfaces. However, wet internal tanks and hoses should be decontaminated with very hot water or a quaternary ammonium compound, such as *Quat128,* used to decontaminate equipment for amphibian chytrid fungus and viral hemorrhagic septicemia. Whirling disease and New Zealand mudsnails are the most difficult organisms to kill. Treatment for these species will be effective for all other species as well.

**VIRAL HEMORRHAGIC SEPTICEMIA (VHS) and other viruses**

Viral hemorrhagic septicemia (VHS) (*Novirhabdovirus sp.)* is indigenous to eastern and western Europe, Japan, and the Pacific (California to Alaska) and Atlantic coasts of North America. The clinical signs of VHS differ depending on the course of infection. In the latent manifestation of the disease, some mortality may occur and fish become hyperactive, sometimes displaying nervous symptoms such as twisting of the body and behavior that involves swimming erratically in circles or in a corkscrew pattern. In the acute form of the disease, fish become lethargic, dark, and anemic, with bulging eyes, congested kidneys, mottled liver, and with hemorrhaging in the eyes, skin, gills, fin bases, skeletal muscle and viscera. Mortality is very high, and the disease is short-lived. However, some fish are carriers and show no symptoms. Survivors of infection can be carriers of the virus throughout the rest of their lives. Nearly 50 species of fish are known to be susceptible to VHS. The virus was first isolated from most of these species only within the past two decades. Susceptible fishes include several species of commercial importance [e.g. lake trout (*Salvelinus namaycush)*, rainbow trout (*Oncorhynchus mykiss)*, brook trout (*Salvelinus fontinalis*), and coregonids (*Coregonus* spp)]. Fish mortality from VHS is greatest at 3–12º C and is very rare above 15º C. For more information, visit this link:
http://www.glerl.noaa.gov/res/Programs/ncrais/docs/factsheets/novirhabdovirus.html

**How is VHS spread?** It is not known how VHS was initially introduced to the Great Lakes-St. Lawrence River system; however, genetic evidence suggests that the virus originated from the Atlantic coast of North America, possibly via transport in ballast water or infected migratory fishes. Aquaculture activities are implicated in the spread of the virus. The virus can be spread by live or dead bait fish, demonstrated by the virus' recovery in cell culture from frozen Pacific herring (*Clupea pallasi*) after two freeze/thaw cycles in a conventional freezer. Waterfowl may also play a role in transmitting the virus.

**Where is VHS found in the West?** VHS is not yet found in the interior western U.S. VHS virus has been present in the Great Lakes since at least 2003. The North American strain of VHS virus is present in Lake Huron, Lake St. Clair, Lake Erie, Lake Ontario, the St. Lawrence River, and the Ohio River.

**Treatments Effective on VHS and other viruses**

| **Wash and remove organics (e.g. mud)** | **Temperature** | **Drying** | **Bleach (e.g. Clorox®) 6% sodium hypochlorite** (NaClO) | **Quaternary ammonium compounds** [e.g. n-alkyl dimethyl benzyl ammonium chloride (ADBAC); didecyl dimethyl ammonium chloride (DDAC)] |
|---|---|---|---|---|
| Thoroughly wash | 46°C (120°F); 5 min Inactive after 24 hours at 20°C (68° F) | Be dry for 24 h, in sunlight best | Soak or circulate for 10 min: 1% bleach solution (1 oz/1gal water) | Unknown, but likely effective. Soak or circulate for 10-15 min: Quat 128 (6oz/1gal), Sparquat 256 (4.3oz/1gal) |

**General considerations:** Although VHS has not yet been found in the West, the high mortality it causes in susceptible species is of great concern for declining native and endangered species of the desert Southwest. Although quaternary compounds have not been tested on VHS, these products are used for anti-viral cleaning in hospitals. Treatment for VHS is should also be effective for whirling disease and New Zealand mudsnails.

**AMPHIBIAN CHYTRID FUNGUS**

The amphibian chytrid fungus (*Batrachochytrium dendrobatidis)* (commonly referred to as "Bd") attacks amphibians and can kill entire populations of frogs, toads and salamanders in a short time, although some individuals are resistant and serve as harbors for the fungus. Bd has been found to affect at least 93 amphibian species from the orders Anura (frogs and toads) and Caudata (salamanders) in all continents except Asia. It is believed to be one of the main causes of the global decline in frog populations since the 1960s and the dramatic population crashes from the 1970s onwards. Bd kills frogs within 10 to 18 days, although it is not known how. It may be physical, affecting respiration by altering the frog's skin, or the fungus may give off a toxin. For a summary on the impacts of *B. dendrobatidis,* please follow this link: http://www.issg.org/database/species/reference_files/batden/batdenimp.pdf

**Where is amphibian chytrid fungus found in the West?** Occurrences of Bd have been identified in many locations around the West including Arizona, New Mexico, Colorado, and California. All water sources should be treated as potential sources of contamination. There is no detailed map, but distribution information can be found at: http://www.issg.org/database/species/distribution.asp?si=123&fr=1&sts=&lang=EN

**How is amphibian chytrid fungus spread?** The infective stage of *Batrachochytrium dendrobatidis* is the zoospore, and transmission of the disease requires water as the zoospore is not tolerant to dehydration. *B. dendrobatidis* remains viable in tap water for up to 3 weeks, in deionized water for up to 4 weeks, and in lake water for even longer. Infection with extremely small inocula (100 zoospores) can prove fatal. The fungus can exist in water or mud and can be spread by humans with wet or muddy boots, vehicles, cattle, and other animals moving among aquatic sites; during scientific sampling of fish, amphibians, or other aquatic organisms; or fire suppression activities. Bd could be carried on mud clinging to wheel wells or tires, or on shovels or other equipment.

**Treatments effective on all stages of chytrid fungus**

| **Wash and remove organics (e.g. mud)** | **Temperature** | **Drying** | **Bleach (e.g. Clorox®) 6% sodium hypochlorite** (NaClO) | **Quaternary ammonium compounds** [e.g. n-alkyl dimethyl benzyl ammonium chloride (ADBAC); didecyl dimethyl ammonium chloride (DDAC)] |
|---|---|---|---|---|
| Yes – completely remove all debris | 60°C (140°F); 5 min | Be dry for 3 hr, in sunlight best | For 30 sec: 20% solution (22oz/1 gal); or for 10 min: 7% solution (9oz/1gal) | For 30 sec: Quat 128 (1/8 tsp/1gal) |

**General considerations:** Fortunately, Bd is vulnerable to many treatments. Drying, high temperatures, and low concentrations of chlorine or quaternary ammonium compounds are effective treatments. Avoiding organics, power washing, flushing, and letting equipment dry in the sun for 3 hours (if possible) will reduce risk of transfer on external surfaces. However, wet internal tanks and hoses should be decontaminated with a quaternary ammonium compound, such as *Quat128*. While only 1/8 teaspoon per gallon of water is required for Bd, a higher concentration (6.4oz/gal) would also effectively remove whirling disease and /or New Zealand mudsnails.

**NEW ZEALAND MUDSNAIL**

The New Zealand mudsnail [*Potamopyrgus antipodarum* (Gray)] is a medium-sized hydrobiid snail native to New Zealand, but has also been established throughout waters in Europe, Asia, and Australia since the mid 1800s. In about the last 15 years, it has invaded North American waters and is now well established in several of the major river drainages throughout the western U.S., including the headwaters of the Missouri and Columbia Rivers and Yellowstone National Park. Until recently, the impacts of the New Zealand mudsnail on aquatic ecosystems in the U.S. have been unknown but were anticipated to be great due to its ability to attain extremely high densities.

**Where are New Zealand mudsnails found in the West?** The New Zealand mudsnail is now reported from all western states except New Mexico. It is concentrated in tailwater rivers below dams. The Snake River in Idaho is heavily infested, as is the Colorado River below Glen Canyon Dam in Arizona, and the Green River below Flaming Gorge Dam in Utah. Up-to-date maps can be found at this link: http://www.esg.montana.edu/aim/mollusca/nzms/status.html

**How are New Zealand mudsnails spread?** Their large populations at many sites, small body size, and broad environmental tolerance make the New Zealand mudsnail well adapted to accidental transport by humans on muddy equipment or in containers such as bait buckets or water tenders. As an asexual live-bearer, a single individual can start a new population. Birds can also be transporters because the snails are not digested in the gut and often pass through alive.

**Treatments effective for New Zealand mudsnail**

| **Wash and remove organics (e.g. mud)** | **Temperature** | **Drying** | **Bleach (e.g. Clorox®) 6% sodium hypochlorite** (NaClO) | **Quaternary ammonium compounds** [e.g. n-alkyl dimethyl benzyl ammonium chloride (ADBAC); didecyl dimethyl ammonium chloride (DDAC)] |
|---|---|---|---|---|
| Yes, power wash is best | 46°C (120°F); 5 min | Be dry for 48 hr, in sunlight best | Not effective | For 10-15 minutes: Quat 128 (6oz/1gal), Sparquat 256 (4.3oz/1gal) |

**General considerations:** New Zealand mudsnails are resistant to treatment and may insert themselves in small crevices and resist flushing. However, unless vehicles are driving through streams or buckets scrape up bottom sediments, they are unlikely to pick up snails on external surfaces. Avoiding organics, power washing, flushing, and drying gear in the sun for 48 hours (if possible) will reduce risk. Wet internal tanks and hoses should be decontaminated with a quaternary ammonium compound, such as *Quat128,* at a concentration of 6.4oz/gal. This concentration will also kill whirling disease spores and amphibian chytrid fungus.

## ZEBRA/QUAGGA MUSSELS

Zebra *(Dreissena polymorpha)* and quagga mussels (*Dreissena rostriformis bugensis)* are small bivalves native to Eastern Europe. They were introduced to the Great Lakes in North America via ballast water dumped from ocean-going ships. Zebra mussels, discovered in 1988, followed by quagga mussels, rapidly spread throughout many major river systems and the Great Lakes, causing substantial ecological and environmental impacts. Zebra mussels prefer warm, eutrophic, shallow water; quaggas prefer shallow, warm water to deep, oligotrophic, cold-water habitats. Both the quagga mussel and zebra mussel are prolific breeders, possibly contributing to their spread and abundance. A fully mature female mussel is capable of producing up to one million eggs per season. Pelagic microscopic larvae, or veligers, develop within a few days and can drift with the currents for three to four weeks before finding suitable substrata to settle upon. Their recent introduction and rapid spread in the West is cause for concern for environmental and infrastructure impacts. Controlling the spread is imperative, since they cannot be eradicated once established. For more information: http://nas.er.usgs.gov/taxgroup/mollusks/zebramussel/

**Where are Zebra/Quagga mussels found in the West?** Quagga mussels were discovered in Lake Mead in 2006. They have since spread throughout the lower Colorado River aqueduct system in Arizona, California, and Nevada, and to the upper Colorado River above Lake Powell in Lake Granby, Colorado. Zebra mussels are established in Pueblo Reservoir in eastern Colorado, and both species now occur in western Colorado in Grand Lake. Efforts to control the spread of these invasive mussels were quickly implemented in all states including boat washing and inspection stations at many major reservoirs, and an education blitz of billboards, public announcements, websites, and free literature. For frequently updated maps of distribution see: http://nas.er.usgs.gov/taxgroup/mollusks/zebramussel/maps/current_zm_quag_map.jpg

**How are they spread?** Dreissenid mussels are usually spread by boats trailored between waters, as well as downstream transport from infested water. A boat that has spent more than a few hours in infested water could carry attached mussels too small to see as well as veligers in live wells, bilges, and other areas that hold water. Mussels can survive several days out of water in cool temperatures. During fire suppression activities, veligers could be transported by water tenders or other water carrying equipment.

**Treatments for zebra and quagga mussels**

| **Wash and remove organics (e.g. mud)** | **Temperature** | **Drying** | **Bleach (e.g. Clorox®) 6% sodium hypochlorite** (NaClO) | **Quaternary ammonium compounds** [e.g. n-alkyl dimethyl benzyl ammonium chloride (ADBAC); didecyl dimethyl ammonium chloride (DDAC)] |
|---|---|---|---|---|
| Yes, pressure wash flushes veligers | ≥140°F water | 3-30 days, in sunlight best | For 1 min: 0.5% bleach solution (1/2 oz/1gal water) | No data, but likely effective |

**General considerations:** Except for boats used for fire suppression, fire management activities are unlikely to spread adult mussels. However, it is possible that water used for these activities or surfaces of gear may become contaminated with the microscopic veliger stage. Pressure washing and strong flushing of tanks and hoses should be sufficient to remove these organisms. The chemical treatments for whirling disease and New Zealand mudsnails should be effective against the juvenile and adult stages of the mussels. Air-drying the equipment for at least fifteen days before use in any other waterway is effective only for exterior surfaces. Drying time for summer and winter season is recommended at 5 and 15 days, respectively.

## DIDYMO

*Didymosphenia geminata*, commonly referred to as "didymo", is a freshwater microscopic diatom. It is found in streams and rivers in much of North America. Didymo increasingly poses a threat to aquatic ecosystems because it forms extensive mats on stream beds. Didymo attaches to the streambed by a stalk. These stalks have a rough texture similar to wet wool and mimic strands of toilet paper, as opposed to other algal species, which feel "slimy". Didymo is an invasive freshwater alga that can form massive blooms. Didymo can smother streambeds and adversely affect freshwater fish, plant, and invertebrate species by depriving them of habitat and can also impact recreational opportunities. It is not considered a significant human health risk, but in recent years has been spreading to previously unaffected areas in North America, Europe, and Asia, and has been detected in New Zealand. This species historically formed blooms in fast-flowing, cold, clean waters, but now didymo is increasing its ecological range. Recent research shows that many countries across the globe provide suitable habitat for didymo to thrive. For more information visit http://www.epa.gov/region8/water/didymosphenia/

**Where is didymo found in the West?** Didymo has been reported from the states of Alaska, Washington, Idaho, Montana, Wyoming, Utah, Colorado, and California. However, Colorado has the most reported occurrences of didymo. It is most commonly found in its invasive form in tailwaters below dams. For a distribution map, follow this link: http://www.epa.gov/region8/water/didymosphenia/na_dis.map.pdf

**How is didymo spread?** Didymo can be spread by recreational and fire suppression equipment, including wet or muddy boots, vehicles, or during scientific sampling of fish, amphibians, or other aquatic organisms, or fire suppression activities. Didymo can remain viable for several days if kept moist, and can be transferred in microscopic form on equipment to new waterways. Infection may only need a single cell. It is not possible to eliminate didymo from a waterway once it has become affected. Decontaminating equipment between uses in different freshwater systems is the key to preventing further spread.

### Treatments for didymo

| **Wash and remove organics (e.g. mud)** | **Temperature** | **Drying** | **Bleach (e.g. Clorox®) 6% sodium hypochlorite** (NaClO) | **Quaternary ammonium compounds** [e.g. n-alkyl dimethyl benzyl ammonium chloride (ADBAC); didecyl dimethyl ammonium chloride (DDAC)] |
|---|---|---|---|---|
| Yes | 60°C (140°F); 1 min | Be dry for 48 h, in sunlight best | For 1 min: 2% bleach solution (2 oz/1gal water) | No data, but likely effective |

### General Considerations

Didymo is a native diatom that erupts into high densities in special habitats, such as tailwaters below dams. Avoiding contaminated water sources and organics, power washing, and flushing would likely reduce risk of transfer on fire equipment. For waders, routine protocols for amphibian chytrid fungus or whirling disease may apply for this species.

## GOLDEN ALGA

The golden alga or algae (*Prymnesium parvum*) is a freshwater microscopic algal cell. It is found principally in lakes and impoundments and has a preference for waters of higher salinities and higher alkalinities, which describes many of the lakes in the Southwest. First described in 1937 from England, it is widely distributed on every continent except Antarctica and is known from at least 14 countries. It was first reported in New Mexico and Texas waters in the 1980s, but may have been present in the Pecos River since the 1960s. Golden alga produces a toxin that is lethal to gill-breathing organisms (larval insects, mollusks, crustaceans, fish, amphibians), resulting in suffocation. Blooms usually occur in winter and early spring. On large water bodies, it is virtually impossible to eradicate. It has no reported human health risks.

### Where is golden alga found in the West?

This species is most often associated with estuarine or marine waters, but can exist in inland waters such as ponds, reservoirs, streams, and rivers. In the West, golden alga has been reported from Texas, California, Arizona, New Mexico, Colorado, Wyoming, and Oklahoma. However, New Mexico and Texas have the most frequently reported occurrences.

**How is golden alga spread?** Transfer of water containing viable algal cells can introduce golden alga to new water bodies. It can be spread by recreational and fire suppression equipment, including wet or muddy boots; vehicles; during scientific sampling of fish, amphibians, or other aquatic organisms; or fire suppression activities. It may spread through water along river or canal pathways; by water birds; by humans transporting water in live wells, bilge tanks, or minnow buckets; or businesses trucking products in water. Golden alga has a "resting stage" that may allow for dried cells or cysts to persist for long periods in dried lake or bank sediments, affording the opportunity for dispersal with equipment and perhaps even aerial distribution. Infestation may only need a single cyst. It is virtually impossible to eliminate golden alga from a waterway once it has become affected. Decontaminating equipment between uses in different freshwater systems is the key to preventing further spread.

### Treatments for Golden alga

| **Wash and remove organics (e.g. mud)** | **Temperature** | **Drying** | **Bleach (e.g. Clorox®) 6% sodium hypochlorite** (NaClO) | **Quaternary ammonium compounds** [e.g. n-alkyl dimethyl benzyl ammonium chloride (ADBAC); didecyl dimethyl ammonium chloride (DDAC)] |
|---|---|---|---|---|
| Thoroughly wash | >104°F | Be dry for 2-3 days in direct sunlight | Soak or circulate for 24 h at 62.5-500 mg/l (0.01-0.07 oz/gal); 1 h at 3,125 mg/l (0.42 oz/gal); or 15 min at 12,500 mg/l (1.67 oz/gal). Higher concentrations can be used to disinfect equipment but are likely to be harmful to fishes. | No data, but likely effective |

**General considerations:** Golden alga is a native diatom that erupts into high densities in special habitats, such as impounded waters above dams. Avoiding contaminated water sources, power washing, and flushing would likely reduce risk of transfer on fire equipment to acceptable levels. It is also susceptible to algicides containing chelated copper compounds. For boots or waders, routine protocols for amphibian chytrid fungus or whirling disease may apply for this species.

## GIANT SALVINIA

Giant salvinia (*Salvinia molesta* ), also known as Kariba weed, African pyle, aquarium watermoss, koi kandy, or simply salvinia, is an aquatic plant native to freshwaters of South America. It was likely introduced into the United States for use as an ornamental plant in fish aquariums and ponds. Salvinia is a floating, rootless aquatic fern that reproduces through vegetative means with a high potential for rapid growth. It occupies lakes, ponds, oxbows, ditches, swamps, marshes, rice fields, and slow-flowing streams and rivers. It reproduces asexually; fragments of the plant can regenerate into viable plants. It is a prodigious reproducer, and growth can double within days. The plant forms dense mats up to several feet thick and strong enough to support a concrete block. Its rapid growth, vegetative reproduction, and tolerance to environmental stress make it an aggressive, competitive species capable of covering the entire surface of water bodies, causing large economic losses and a wide range of ecological problems to native species and communities. It also provides habitat for vectors of human disease. Giant salvinia is susceptible to freezing; a strong freeze can cause the plant to die back; however it is rarely eliminated. Fragments of giant salvinia can remain viable out of water for some time, especially if kept moist or insulated from thorough drying.

**Where is giant salvinia found in the West?** Salvinia has been reported in Arizona, California, Texas, Oklahoma, and Hawaii. The most severe infestation of salvinia in the U.S. was recently discovered in east Texas and Oklahoma where an estimated 1,000 acres of waterfowl habitat has been heavily impacted and degraded. It was detected in Arizona and California along the lower Colorado River in 2000. In the Colorado River, it does not thrive in the main channel of the river but establishes patches in slack water areas and is common in "drift" in the river currents. Giant salvinia has spread down the Colorado River into Mexico where it has been diverted into canals and aqueducts. Occurrence in New Mexico has not been documented. Distribution maps may be found at: http://www.fws.gov/texascoastalprogram/giant_salvinia.htm

**How is giant salvinia spread?** Salvinia is spread within and between aquatic systems mainly by people. It is spread accidentally when equipment or boats are moved. It can also be carried by animals as they move between infested and non-infested waters. Salvinia plant fragments can be carried by fire suppression equipment, including wet or muddy boots and vehicles. Removing mud and debris from personal and fire suppression equipment, or decontamination between uses in different freshwater systems, can assist in preventing the further spread of salvinia.

**Treatments for giant salvinia**

| **Wash and remove organics (e.g. mud)** | **Temperature** | **Drying** | **Bleach (e.g. Clorox®) 6% sodium hypochlorite** (NaClO) | **Quaternary ammonium compounds** [e.g. n-alkyl dimethyl benzyl ammonium chloride (ADBAC); didecyl dimethyl ammonium chloride (DDAC)] |
|---|---|---|---|---|
| Yes | >43°C (109°F) or < -3°C (26 °F) for > 2 hours | Uncertain, but dry at least 48 h, in sunlight best | No data, but likely effective. | No data, but likely effective |

**General considerations:** Salvinia is considered by some to be the world's worst invasive plant. It possesses the capability of doubling its surface in 5-7 days and can overwhelm aquatic ecosystems. The spread of salvinia may be limited by the plant's lack of tolerance to freezing water. Preventing spread of this invasive can be accomplished easily by removing all aquatic plants from equipment and thoroughly power washing, flushing, and drying equipment.

## EURASIAN WATERMILFOIL AND PARROT'S FEATHER

Eurasian watermilfoil (*Myriophyllum spicatum*) and the closely related parrot's feather (*M. aquaticum*) are submerged aquatic plants that can quickly take over lakes, rivers, irrigation canals, farm ponds, and other slow-moving waters. They crowd out desirable native vegetation, clog irrigation systems, and make waterways unsuitable for boating, fishing, and swimming. Although very similar species, the Eurasian watermilfoil is native to Europe, Asia, and northern Africa, while the parrot's feather is native to South America. Eurasian watermilfoil was first documented in 1942 from a pond in Washington D.C. and was probably intentionally introduced to the United States. Spread occurred as the species was planted into lakes and streams across the country. It is now one of the most widely distributed of all nonindigenous aquatic plants. It has been confirmed in 45 U.S. states and in the Canadian provinces of British Columbia, Ontario, and Quebec. Parrot's feather is not nearly as widespread and occurs in warmer climates in the southern U.S. and further north along the coasts in milder climates. For more information and distribution of both species, visit: http://nas.er.usgs.gov/taxgroup/plants/docs/my_spica.html or http://ucce.ucdavis.edu/datastore/detailreport.cfm?usernumber=64&surveynumber=182

**Where is the Eurasian watermilfoil and parrot's feather found in the West?** Eurasian watermilfoil is present in most of the western states except Montana and Wyoming. It tends to colonize slow-moving or still water. It occurs in shallow water where it is rooted to the substrate and is able to survive over winter in colder climates. It is particularly troublesome in waterbodies that have experienced disturbances such as nutrient loading, intense plant management, or abundant motorboat use. Parrot's feather also occurs in slow-moving or still water throughout much of the West except the interior states. However, while it seems to grow best in shallow water, it also occurs as a floating plant in deeper water of nutrient-enriched lakes. The emergent stems can survive on wet bands of rivers and lake shores, so it is well adapted to moderate water level fluctuations. Parrot's feather is unable to survive in northern climates where winters are more severe.

**How does Eurasian watermilfoil and parrot's feather spread?** Both species spread by the transport of plant fragments or propagules. If plant parts are maintained in equipment, containers, clothing, boat trailers, etc., they can be introduced to new sites. Animals are also capable of transporting plant parts that may establish new populations. Once introduced to a new drainage, these species can spread throughout the drainage by water currents.

**Treatments effective for Eurasian watermilfoil and parrot's feather**

| **Wash and remove organics (e.g. mud)** | **Temperature** | **Drying** | **Bleach (e.g. Clorox®) 6% sodium hypochlorite** (NaClO) | **Quaternary ammonium compounds** [e.g. n-alkyl dimethyl benzyl ammonium chloride (ADBAC); didecyl dimethyl ammonium chloride (DDAC)] |
|---|---|---|---|---|
| Yes | No data but likely killed with>60°C (140°F) | Uncertain, but completely dry at least 48 h, in sunlight best | No data, but likely effective. | No data, but likely effective |

**General considerations:** Little information is available for controlling the spread of Eurasian watermilfoil or parrot's feather except that it is important to remove debris and plant parts from all pieces of equipment. They are susceptible to drying and likely can be killed when exposed to treatment water used for control of other species. Power washing and flushing to ensure the removal of all plant parts will prevent transport on external and internal gear.

**HYDRILLA**

Hydrilla (*Hydrilla verticillata*) or water thyme is a submersed aquatic invasive plant native to the warmer regions of Asia. It grows at water depths from a few inches to 20 feet, and its long stems and small leaves form dense mats of vegetation, crowding out native aquatic plants. Hydrilla reproduces rapidly, mainly by regrowth of stem fragments; it also reproduces by growth of axillary buds (turions) and subterranean tubers. Tubers can remain viable for 4 to 7 years, and a single tuber can grow to produce more than 6,000 new tubers per square meter. Hydrilla can grow in almost any freshwater area or water with low salinity (up to 7%), and in areas with very low (1% of full) sunlight. It can tolerate oligotrophic (low nutrient) to eutrophic (high nutrient) conditions. It can grow in temperate areas and is somewhat winter-hardy; U.S. southern populations overwinter as perennials; northern populations overwinter and regrow from tubers. It was first discovered in the U.S. in 1960, likely introduced through the aquarium trade. It is now found in all of the Gulf Coast states, Atlantic Coast states north to Connecticut, and in the West in Arizona, California, and Washington. When hydrilla invades, native submersed plants are shaded out by hydrilla's thick mats or are simply outcompeted. It reduces water storage and water movement, clogs water control structures and hydroelectric generators, interferes with boating and fishing, damages fish and wildlife habitat, and produces mosquito breeding habitat.

**Where is hydrilla found in the West?** Hydrilla was introduced to California as a contaminant of water lily rhizomes and was likely similarly introduced into a small lake system in Washington. It was eradicated from two ponds near Phoenix, Arizona, in the 1980s and no longer occurs in Arizona, but is a "state-listed" noxious weed. It has been successfully controlled with aquatic herbicides and is highly preferred by grass carp. Distribution is at: http://pest.ceris.purdue.edu/searchmap.php?selectName=PCHAFBA

**How is hydrilla spread?** Hydrilla is spread within and between aquatic systems mainly by people. It is spread accidentally when equipment or boats are moved. It can also be carried by animals as they move between infested and non-infested waters. Hydrilla plant fragments can be carried by fire suppression equipment, including wet or muddy boots and vehicles. Removing mud and debris from personal and fire suppression equipment, or decontamination between uses in different freshwater systems, can assist in preventing the further spread of hydrilla.

**Treatments for Hydrilla**

| **Wash and remove organics (e.g. mud)** | **Temperature** | **Drying** | **Bleach (e.g. Clorox®) 6% sodium hypochlorite** (NaClO) | **Quaternary ammonium compounds**[e.g. n-alkyl dimethyl benzyl ammonium chloride (ADBAC); didecyl dimethyl ammonium chloride (DDAC)] |
|---|---|---|---|---|
| Yes | No data but likely killed with>60°C (140°F) | Uncertain, but dry at least 48 h, in sunlight best | No data, but likely effective. | No data, but likely effective |

**General considerations:** Hydrilla is considered the world's worst submersed weed. It grows up to an inch per day. Hydrilla infestations are not apparent until it fills the lake or river that it infests, "topping out" at the surface. Human transport on boats and wetted equipment is the main vector for spread of this species. Preventing spread of this invasive can be accomplished by

removing all aquatic plants from equipment and thoroughly power washing, flushing, and drying equipment.

**FISH, AMPHIBIANS, AND CRAYFISH**

Nonnative fish, amphibians, and crayfish have been documented to impact native species and ecosystems throughout the west. Potential impacts include competition with native species for food and habitat, reduction of natives by predation, transmission of diseases or parasites, and habitat alteration. Nonnative fish species present in the West are too numerous to list but include species such as small-mouth bass, green sunfish, and red shiner. While many water bodies have already suffered invasion, the remaining waters are proportionately more deserving of protection. All water bodies are potentially affected, including reservoirs, rivers, streams, springs, and ponds. Nonnative amphibians include bullfrogs (*Rana catesbeiana*). Nonnative crayfish have also been implicated in the decline of native fish and amphibians in the Southwest. The most common species include the virile crayfish (*Orconectes virilis)* and the rusty crayfish (*Orconectes rusticus)*. There are few native crayfish species in the Intermountain West, and their distribution is limited. There are no crayfish native to Arizona.

**Where are nonnative fishes, amphibians, and crayfish found in the west?** Nonnative fishes are found in many locations throughout the west. Larger bodies of water and rivers tend to hold greater abundance and diversity of nonnatives, while smaller high elevation or isolated bodies of water, if not already invaded, are more vulnerable to accidental transfer. Nonnative amphibians and crayfish are less well distributed; however, they are more likely to survive accidental transfer, and pristine areas are highly vulnerable to impacts due to invasion. Bullfrog and crayfish distribution maps can be found at:
http://nas.er.usgs.gov/ARCIMS/interactive/interactive.asp?SpeciesID=71 , and
http://nas.er.usgs.gov/taxgroup/Crustaceans/crayfish.html

**How are nonnative fishes, amphibians and crayfish spread?** Common methods of introduction include intentional and accidental stocking, release of bait fish, release of unwanted aquarium fish, escape from aquaculture facilities, and discharge of ballast water. Accidental live transfer by fire suppression activities is most likely via bucket dipping from shallow lakes, ponds and streams. Many of these organisms live near the bottom of water bodies, so avoiding shallow areas where equipment scrapes the bottom will help prevent accidental transfer. Screening of intake pumps is also effective.

**Treatments for fish, amphibians, and crayfish**

| **Wash and remove organics (e.g. mud)** | **Temperature** | **Drying** | **Bleach (e.g. Clorox®) 6% sodium hypochlorite** (NaClO) | **Quaternary ammonium compounds** [e.g. n-alkyl dimethyl benzyl ammonium chloride (ADBAC); didecyl dimethyl ammonium chloride (DDAC)] |
|---|---|---|---|---|
| Yes | ≥140°F water | Be dry for 3 hr, in sunlight best | For 30 sec: 20% solution (22oz/1 gal) | Acute toxicity to fish and amphibians (EPA). No data on crayfish, but likely effective as ADBAC is toxic to most aquatic organisms. |

**General considerations:** Both impacts to native fishes and amphibians and potential transfer of nonnative fishes and amphibians should be considered. Live transfer is possible via bucket dipping from shallow lakes, ponds and streams. To avoid live transfer, avoid dumping water from one water body into another. Dip from deeper portions of lakes and ponds where possible.

Decontamination procedures for amphibian chytrid fungus should be adequate for all developmental stages of fish, amphibians and crayfish.

## APPENDIX B

*This appendix is taken from the U.S. Forest Service, Intermountain Region document "Preventing Spread of Aquatic Invasive Organisms Common to the Intermountain Region, Guidance for 2008 Fire Operations, Appendix".*

## USING CHLORINE BLEACH

*Important note: Mixing any chlorine-containing compounds (including any form of household bleach or dry form of chlorine) with any ammonia-containing compounds (including fire retardant mixes or residues) can lead to extreme health and safety hazards, including the release of chlorine gas.*

Liquid bleaches, such as household bleach, are a 5-8% solution of sodium hypochlorite, a stabilized form of chlorine. Bleaches can be very corrosive to fabrics, plastics, rubber, and metal, and disinfectant properties will dissipate quickly when exposed to air.

### Dry bleach products

Many dry forms of chlorine are available that would offer advantages for transport and storage. Products such as DryTec or CCH are granular 68% calcium hypochlorite (Arch Chemicals, Inc., manufacturer of both products, 800-478-5727). Granular calcium hypochlorite (68%) can also be ordered from GSA (NSN No. KE0472). The sanitizing active agent in liquid chlorine bleach is the chlorine ($Cl^-$) produced when dry bleach is added to water. The accompanying Technical Chemical Information spreadsheet shows how much dry calcium hypochlorite to mix per gallon of water to obtain the desired concentration. The spreadsheet will automatically calculate dilutions if the dry form of chlorine you purchase has a different percentage of hypochlorite (other than 68%). Just type in the percentage hypochlorite in the yellow cell.

*[Note: The Technical Chemical Information spreadsheet can be downloaded from:* http://www.fs.fed.us/r4/resources/aquatic/guidelines/index.shtml*]*

Lithium hypochlorite is also available in dry form but provides less than half the available chlorine per volume compared to calcium hypochlorite, and is much more expensive.

Do NOT use any pool chemicals that contain something called "trichlor", which is very commonly used as a swimming pool chlorinator. It is trichloro-s-triazinetrione, which includes cyanuric acid to extend its photostability. Following the recent retardant-sodium ferrocyanide decisions, a great deal of caution would be advised before recommending any compounds containing any form of cyanide-containing compound, regardless of its expected safety.

Similarly, do not use chemicals containing "dichlor", or dichloro-s-triazinetrione, another member of the chlorinated iso-cyanurate family that is very commonly used in swimming pools. Caution is advised for the same reason as trichlor.

## USING QUATERNARY AMMONIUM COMPOUNDS

Quaternary ammonium compounds, or 'quats', are common disinfectants with an array of uses, from killing algae in swimming pools to sanitizing workout equipment at the gym. They are relatively nontoxic and do not damage fabric, metals, or gaskets. Solutions of quat compounds

retain their effectiveness over days and can be reused if not excessively diluted. These compounds exist as a family with various ratios of carbon to nitrogen and chlorine. There are hundreds, but much of research for their effectiveness against aquatic invasive species has focused so far on one of the alkyl dimethyl benzyl ammonium chlorides, abbreviated as ADBAC, the active ingredient in Formula 409®. Formula 409® was selected to test against whirling disease and New Zealand mudsnails because it was thought to be easy to obtain for anglers, but this household product is not practical for land management use. However, ADBAC, along with other quaternary ammonium compounds, also occurs in Quat 128®, Sparquat 256®, Bioguard Algicide®, and other commercial disinfectants.

Another quaternary ammonium compound, didecyl dimethyl ammonium chloride, or DDAC, was tested against chytrid fungus and found to be effective (see below). DDAC also occurs in Quat 128®, Sparquat 256®, and Bioguard Algicide®.

**Whirling disease and quaternary ammonium compounds**

The effectiveness of quaternary ammonium compounds against whirling disease spores is based on research (in review) by Ronald Hedrick of University of California-Davis. He tested the active ingredient in Formula 409® (ADBAC), and found it to efficiently kill spores in 10 minutes at a concentration of 1500 ppm. The commercial quaternary ammonium products recommended in this guidance contain ADBAC as well as other quaternary compounds which may be quite good at killing spores but that have not been tested. Hedrick (pers. comm.) assumes that the other compounds would function similarly with respect to damaging the spores and thus provide an additive effect in a mixed formulation such as Quat 128®, but because his testing was limited specifically to ADBAC, there is currently no proof that the other compounds would have the same effects as ADBAC. *Consequently, two concentrations of quaternary ammonium products are given in this guidance for whirling disease.* One ("low risk") is conservative and based only on the amount of ADBAC in the product. The other concentration ("unknown level of risk"), which is less than half the concentration of the first, assumes that all the quaternary ammonium compounds in Quat 128® or Sparquat 256® are equally effective; however, this assumption has not yet been tested.

**Chytrid fungus and quaternary ammonium compounds**

The quaternary ammonium compound used as the active ingredient against chytrid fungus was a different one than was tested for whirling disease. For chytrid, Johnson et al. (2003) used DDAC. Both DDAC and the compound tested for whirling disease and New Zealand mudsnails, ADBAC, occur together in Quat 128® and Sparquat 256® (Sparquat has some other quat compounds as well). Consequently, the technical information and calculations for chytrid fungus are derived from DDAC and are shown separately on the spreadsheet.

**Using swimming pool algicides in place of Quat 128® or Sparquat 256®**

Swimming pool chemicals used to kill algae and that have the proper quaternary ammonium compounds as their active ingredients may be substituted for Quat or Sparquat at almost HALF the cost. One example of a pool chemical is BioGuard Algicide28-40® , which is 40% ADBAC, the same active ingredient found in Quat and Sparquat but at a much higher concentration. Dilution formulas for BioGuard Algicide28-40® are calculated for you on the accompanying Excel spreadsheet. If you are looking at other brands of quaternary ammonium products and want to calculate concentrations, type in the % of the active ingredient in the yellow cell under Bioguard, and the spreadsheet will automatically recalculate the dilutions and costs. Bioguard

products (BioLab Inc) are available from local pool vendors and are listed at http://www.bioguard.com/msds.cfm

As the concentration of ADBAC increases, so do the occupational health and safety hazards (irreversible eye damage, skin burns, respiratory irritation) and importance of adhering to personal protective equipment requirements when handling the concentrated product. Check the MSDS's:

*Quat 128*®: http://online.waxie.com/Attachments/attachments/files/pdfs/msds/170304.pdf
*Sparquat 256*®: http://www.spartanchemical.com/web/webhome.nsf

**APPENDIX C**

*Use this format to request a temporary emergency waiver from Arizona Department of Environmental Quality in the event that used decontamination solution is discharged over open land. Please attach the appropriate MSDS from the link on page 26.*

*Agency/Fire #*

Date, Year

Ms. Carrolette Winstead
Arizona Department of Environmental Quality
1110 West Washington Street, Mailcode 5415B-3
Phoenix, Arizona 85007

Dear Ms. Winstead:

We are requesting that Arizona Department of Environmental Quality's Water Quality Division grant a Temporary Emergency Waiver for the purpose of discharging water used in decontaminating fire-fighting equipment to prevent cross-contamination of water bodies within the State of Arizona. Decontamination is accomplished using a 5% solution of quaternary ammonium compound (Quat128® or Sparquat 256®) and water in engines, pumps, or other equipment that has been wetted by any raw (non-domestic or treated) water during fire operations. The solution is re-used until testing indicates it is muddied or diluted. Used cleaning solution is disposed of over open land where there is no potential for runoff into stormdrains, waterways, or sensitive habitats.

*(Fill in information in italics, below)*

- The discharge occurred during management of the *(Name)* Fire during the period *(date or dates of discharge)*, located in an area *(describe general area using roadways, communities, or landmarks)*. The approximate location of the discharge is *(UTM coordinates or legal description)*.

- The discharge consisted of approximately *(volume)* gallons of water from *(water body or other source)* containing approximately 5% *(identify either Quat128® or Sparquat 256®)*.

- The discharge did not occur in or near a water of the U.S., or in an area where runoff could occur into stormdrains or waterways. *(This is essential. If runoff into a water body is unavoidable, do not dispose of solution in the area and truck to a municipal treatment plant.)*

- The Material Safety Data Sheet for the compound discharged is enclosed.

If you have any questions, please contact *(Name)* at *(Phone).* Thank you for your assistance.

Sincerely,

*(Agency Administrator)*
*(Title)*

Enclosure (MSDS)

cc: Assistant Field Supervisor, Fish and Wildlife Service, Flagstaff, AZ (email: brenda_smith@fws.gov)
(Your agency FMO)
(Others?)

**Operational Guidelines for**
**Aquatic Invasive Species Prevention and Equipment Cleaning**

**Why?** Firefighter and public safety is still the first priority, but aquatic invasive plants and animals pose a risk to both the environment and to firefighting equipment (some species can clog valves, pumps, etc. if equipment is not completely drained or treated). Prevention and sanitation can prevent the spread of these organisms to other environments and help to assure that firefighting equipment remains operational.

**Prevention, where possible**

- Avoid dumping water directly from one stream or lake into another.
- Avoid obtaining water from multiple sources during a single operational period unless drafting/dipping equipment is sanitized between sources.
- Use screens and avoid sucking organic and bottom material when drafting from streams or ponds.
- Minimize driving equipment through waterbodies.

**Sanitation**

- Any equipment that comes into contact with raw water should be sanitized. Drying alone may be effective in some situations depending upon equipment, temperature, and relative humidity. Consult the Resource Advisor (READ).
- In coordination with the READ, establish sanitation areas where there is no potential for runoff into stormdrains, waterways, or sensitive habitats.
- Remove all visible plant parts, soil and other materials from external surfaces of gear and equipment. If possible, powerwash all accessible surfaces with clean, hot water (≥140ºF ideally).
- Set up a portable disinfection tank using a 5% cleaning solution of quaternary ammonium compound, a common cleaning agents used in homes, swimming pools, and hospitals, and safe for gear and equipment when used at the recommended concentration. Two brands are readily available from GSA or local suppliers: *Quat128*® (by Waxie) or *Sparquat 256*® (by Spartan). Costs and effectiveness are comparable; both are labeled for use as fungicides/virucides. Follow individual agency integrated pest management requirements, including pesticide use proposals.

Recipe for 5% cleaning solution using either *Quat128*® ***or*** *Sparquat 256*®

| **Volume of tap water** | **Volume of *Quat128*®** | **Volume of *Sparquat 256*®** |
|---|---|---|
| 100 mL water | 4.63 mL | 3.00 mL |
| 1 gallon water | 6.35 liquid oz. | 4.12 liquid oz. |
| 1 gallon water | 12.7 tbsp | 8.2 tbsp |
| 1 gallon water | 0.79 cups | 0.51 cups |
| 100 gallons water | 4.96 gallons | 3.22 gallons |
| 1000 gallons water | 49.6 gallons | 32.2 gallons |

- For engines and tenders, empty the tank then circulate the 5% cleaning solution for 10 minutes. Float portable pumps in the disinfection tank and pump cleaning solution through for 10 minutes. Pump cleaning solution through hose then rinse with water. Discharge cleaning solution back into the disinfection tank for re-use.
- Where feasible dip gear or equipment (e.g. helicopter buckets) into the cleaning solution. Alternatively, put the 5% cleaning solution in backpack spray pumps to clean portable tanks, helicopter buckets, and other equipment. The solution must be in contact with the surface being sanitized for at least 10 minutes and then rinsed with water.
- Under the direction of the READ, test cleaning solution daily according to the directions below. The cleaning solution can be used repeatedly for up to a week unless heavily muddied or diluted. If the concentration is too weak, dispose of the used solution properly and make a new solution.

**Safety**

- Use protective, unlined rubber gloves and splash goggles or face shield when handling the cleaning solution and take extra precautions when handling undiluted chemicals. Have eye wash and clean water available on-site to treat accidental exposure.
- Consult the product label and Material Safety Data Sheet for additional information.

**Testing Solution**

- To determine if the solution is below the 5% strength use "Quat Chek 1000" Test Papers (purchase these from the supplier of the cleaning compound). The used cleaning solution needs to be diluted to about 600 ppm of ammonium compounds before it can be tested with these papers.
  - Take **one** cup of used *Sparquat 256*® cleaning solution, pour into a bucket. Add **5** cups of water. Mix. OR
  - Take **one** cup of used *Quat128*® cleaning solution, pour into a bucket. Add **4** cups of water. Mix.
- Test the diluted solution with "Quat Chek" Test Paper. Match up the color of the paper with the ppm's on the color chart. For optimal disinfection, the diluted solution should have a concentration between 600 and 800 ppm. If it is too dilute, dispose of properly and make a new cleaning solution.

**Disposal**

- Use caution when disposing the used cleaning solution and follow all federal, state, and local regulations.
- Do not dump cleaning solution into any stream or lake, or on areas where it can migrate into any stormdrain, waterbody, or sensitive habitat. Small quantities may be disposed of down sanitary drains into a municipal sewer system. Larger quantities may need to be transported to a municipal wastewater treatment facility. Consult the facility operator/manager prior to disposal.
- Used cleaning solution may or may not be suitable for disposal in on-site septic systems. Consult the local agency's utilities supervisor or facilities manager prior to disposal.
- It may be possible to dispose of used cleaning solution over open land or on roadways where there is no potential for runoff into stormdrains, waterways, or sensitive habitats. Consult the READ for appropriate locations before using this method and check with the appropriate state or county authority as state or local permits may be required[1].

**Storage**

*Sparquat 256*® and *Quat128*® can be stored up to two years in an unopened container without losing its effectiveness. Both should be stored in a cool, dry place, out of direct sunlight. Temperatures can range from 32º to 110º F.

**Purchase**

Both products are available from GSA (https://www.gsaadvantage.gov) and are commonly available through local janitorial and swimming pool chemical suppliers.

- *Quat 128*® by Waxie's Enterprises Inc.; GSA (NSN No. 170304) =$36/case (4 gal); EPA registration #1839-166-14994. Additional info can be found at http://www.waxie.com
- *Sparquat 256*® by Spartan Chemical Company; GSA (NSN No. 1025-04) = $54/case (4 gal); EPA registration #5741-9. Additional info can be found at http://www.spartanchemical.com
- Remember to buy "Quat Chek 1000" test papers when you purchase the chemicals.

[1] For discharges in Arizona, notify Arizona Department of Environmental Quality as soon as possible following the disposal, using the template letter, attached.

*Agency/Fire #*

Date, Year

Ms. Carrolette Winstead
Arizona Department of Environmental Quality
1110 West Washington Street, Mailcode 5415B-3
Phoenix, Arizona 85007

Dear Ms. Winstead:

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- The discharge consisted of approximately *(volume)* gallons of water from *(water body or other source)* containing approximately 5% *(identify either Quat128® or Sparquat 256®).*

- The discharge did not occur in or near a water of the U.S., or in an area where runoff could occur into stormdrains or waterways. *(This is essential. If runoff into a water body is unavoidable, do not dispose of solution in the area and truck to a municipal treatment plant.)*

- The Material Safety Data Sheet for the compound discharged is enclosed.

If you have any questions, please contact *(Name)* at *(Phone).* Thank you for your assistance.

Sincerely,

*(Agency Administrator)*
*(Title)*

Enclosure (MSDS)

cc: Assistant Field Supervisor, Fish and Wildlife Service, Flagstaff, AZ (email: brenda_smith@fws.gov)
(Your agency FMO)
(Others?)