AQUATIC INVASIVE SPECIES OF CONCERN AND METHODS OF CONTROL						
	Whirling Disease	**New Zealand Mudsnails**	**Chytrid Fungus**	**Zebra/Quagga Mussels**	**Didymo**	**Eurasian Watermilfoil**
Sources	C.Wilson; E. Wagner UDWR Hedrick et al. 2008 Wagner 2002	M. Vinson, USU Schisler et al. 2008 Hosea&Findlayson 2005 Richards et al 2004	K. Hatch, BYU (Johnson et al 03)	J. Herod, FWS Sprecher & Getsinger 2000 Cope et al. 2003 D. Britton, FWS, per.com.	Spaulding and Elwell, 2007 Kilroy et al. 2006 Matthews 2007	Smith&Barko 1990 Madsen&Smith 1997
Wash and remove organics (e.g. mud)	Yes	Yes	Yes	Yes, pressure wash flushes veligers	Yes	Yes
Temperature	90 °C (195 ° F);10 min	46°C (120°F); 5 min -3°C (27 °F); 1 hr	60°C (140°F);5 min	≥140°F water	60°C (140°F); 1 min	NA
Drying	Be dry for 24 h, in sunlight best	Be dry for 48 hr, in sunlight best	Be dry for 3 hr, in sunlight best	3-5 days, in sunlight best	Be dry for 48 h, in sunlight best	NA
Bleach (e.g. Clorox®) 6% sodium hypochlorite (NaClO)	For 10 min: 1% bleach solution (500 ppm NaClO) ▪Liquid oz Clorox per gallon water = 1.1 ▪Tbsp liquid Clorox per gallon water =2.2 ▪Gallons Clorox per 100 gallons water = 0.9	Not effective	For 30 sec: 20% bleach solution (>1% NaClO) ▪Liquid oz Clorox per gallon water = 22 ▪Gallons Clorox per 100 gallons water =17 OR For 10 min: 7% bleach solution (0.4% NaClO) ▪Liquid oz Clorox per gallon water = 9 ▪Gallons Clorox per 100 gallons water = 7	Gear rinsed with 0.5% bleach solution (250 ppm NaClO) ▪Liquid oz Clorox per gallon water = 0.6 ▪Tbsp liquid Clorox per gallon water =1.1 ▪Gallons Clorox per 100 gallons water =0.5	For 1 min: 2% bleach solution (800 ppm NaClO) ▪Liquid oz Clorox per gallon water =1.8 ▪Tbsp liquid Clorox per gallon water =3.6 ▪Gallons Clorox per 100 gallons water = 1.4	NA

AQUATIC INVASIVE SPECIES OF CONCERN AND METHODS OF CONTROL							
	Whirling Disease		**New Zealand Mudsnails**	**Chytrid Fungus**	**Zebra/Quagga Mussels**	**Didymo**	**Eurasian Watermilfoil**
Quaternary ammonium compounds (e.g. alkyl dimethyl benzylammonium chloride [ADBAC]; diecyl dimethyl ammonium chloride [DDAC])	For 10-15 minutes: (1500ppm quat compounds) *Quat128*® solution (7.7% quat compounds)		For 10 min: 4.6% *Quat128*® solution ▪Liquid oz Quat128 per gallon water = 6.4 ▪Gallons Quat 128 per 100 gallons water = 5 OR 3.1 % *Sparquat256* ® solution ▪Liquid oz Sparquat256 per gallon water = 4.3 ▪Gallons Sparquat256 per 100 gallons water = 3.4	For 30 sec: .015% *Quat128*® solution ▪Liquid oz Quat128 per gallon water =0.02 ▪ml Quat128 per gallon water= 0.6 ▪tsp Quat128 per gallon water= 1/8 ▪Cups Quat 128 per 100 gallons water = ⅓ ▪Tbsp Quat128 per 100 gallons water = 4	Likely effective Preliminary studies have shown that a 3% solution of Sparquat 256 was effective in killing quagga veligers after 10 min exposure. (D. Britton, USFWS, pers. com). However, more research is necessary.	For 1 min: 2% *Quat128*® solution ▪Liquid oz Quat128 per gallon water= 2.4 ▪Gallons Quat 128 per 100 gallons water = 1.9 OR 1.2% *Sparquat256* solution ▪Liquid oz Sparquat256 per gallon water =1.7oz/gal ▪Gallons Sparquat256 per 100 gallons water = 1.3 (See Matthews 2007 for support documentation)	NA
	Low Risk 4.4% *Quat128* ▪Liquid oz Quat128 per gallon water =	Unknown Level of Risk 2%*Quat128* ▪Liquid oz Quat128 per gallon water					

	6.1 ▪Gallons Quat 128 per 100 gallons water = 4.8	= 2.4 ▪Gallons Quat 128 per 100 gallons water = 1.9					
	OR *Sparquat 256*® solution (12.5% quat compounds)						
	Low Risk 3% *Sparquat* ▪Liquid oz Sparquat256 per gallon water =4.1oz/gal ▪Gallons Sparquat per 100 gallons water = 3.2	Unknown Level of Risk 1.2% S*parquat* ▪Liquid oz Sparquat256 per gallon water =1.7oz/gal ▪Gallons Sparquat per 100 gallons water = 1.3					

RECOMMENDATIONS					
Whirling disease	**NZ Mudsnails**	**Chytrid Fungus**	**Zebra/Quagga Mussels**	**Didymo**	**Eurasian Watermilfoil**
The principle vector for spread of whirling disease is contaminated fish parts and not typically through fire activities. Avoiding and removal of 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 a quaternary ammonium compound, such as *Quat128*. 'Low risk' concentrations of quat compounds are backed by research. 'Unknown level of risk' dilutions are **likely** effective, but not yet proven. While 6.1 oz per gal (low risk) is required for whirling disease, a slightly higher concentration (6.4oz/gal) would also knock out NZ mudsnails.	NZ 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 bottom sediments, they are unlikely to get 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 chytrid fungus.	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 tsp per gal is required for chytrid, a higher concentration (6.4oz/gal) would also knock out whirling disease and /or NZ mudsnails.	Fire activities are unlikely to come into contact with adult mussels. However, it is possible that water used for activities or surfaces of gear may be contaminated with the microscopic veliger stage. Pressure washing and strong flushing of tanks and hoses should be sufficient to injure and remove these organisms. Wet internal tanks and hoses, if originating from an unknown location, should be decontaminated with 5% Quat 128 or 3% Sparquat solutions to eliminate veligers.	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 to acceptable levels. For waders, routine protocols for chytrid or whirling disease may apply for this species. Though little research is available for effectiveness of quat compounds, it is probable that the concentrations provided for *Quat128* and *Sparquat* will work. See Matthews 2007 for supportive documentation.	Watermilfoil propagates from broken stems. Avoiding organics, power washing, and flushing to ensure the removal of all plant parts will prevent transport on external and internal gear.

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