Zebra Mussel Risk Analysis for Arizona

Name
Zebra mussel (*Dreissena polymorpha*)

Description
Zebras are small freshwater bivalve mulluscs which can grow up to five centimeters, though individuals rarely exceed 4 centimeters (NBII). The color patterns, which typically have alternating dark and white strips on the shell, can also have no stripes at all. These mussels, which are D-shaped, are typically found attached to objects, surfaces or each other by byssal threads which originate underneath the shells. One way zebras are distinguishable from quagga mussels is that they have a flattened underside allowing them to lay flat on a surface.

Life History
There are five stages in the life cycle of a Zebra. The first three stages are microscopic (egg, veliger, post-veliger) where they remain suspended in the water column for up to four weeks, which allows them to easily pass through filters and strainers. As the shell is developed they drop out of the water column (settling stage) and attach to both hard and soft surfaces. Adults have a tendency to aggregate and form massive colonies. The life span for a Zebra is approximately three to five years.

Reproductive Strategy
Zebras have separate sexes with an equal ratio of male to female and become sexually mature when they reach 8 to 10 mm in length and fertilization takes place externally. Synchronized spawning occurs once they reach sexual maturity and is influenced by water temperatures (NBII). Zebras can produce up to 40,000 eggs per breeding cycle, with multiple breeding cycles every year and could produce up to one million eggs in a year.

Environmental Tolerances and Restrictions
Zebra mussels can survive and reproduce in a wide range of habitats and environmental conditions. The great diversity of Arizona's habitats and water chemistries will result in different rates of invasion or establishment in some waters. However, phenotypic plasticity of the zebra will determine the ultimate extent of the invasion. It is clear that the genus *Dreissena* is highly polymorphic and has a high potential for rapid adaptation to extreme environmental conditions by the evolution of allelic frequencies and combinations, possibly leading to significant long-term impacts on North American waters (Mills et al. 1996). Based on current environmental tolerances of the zebra and using the most restrictive variable (calcium) the invasiveness (high,

moderate, low, very low) of various waters in Arizona to zebra infestation is attached. Zebras can withstand short periods (several days) out of the water if conditions are moist and humid.

Preferred Habitat

Zebras prefer no direct sunlight and are found in shaded areas in lakes, rivers and streams. In infected waters zebras are easily found on undersides of boat hulls, docks, buoys, rock crevasses and have a particular fondness for concrete.

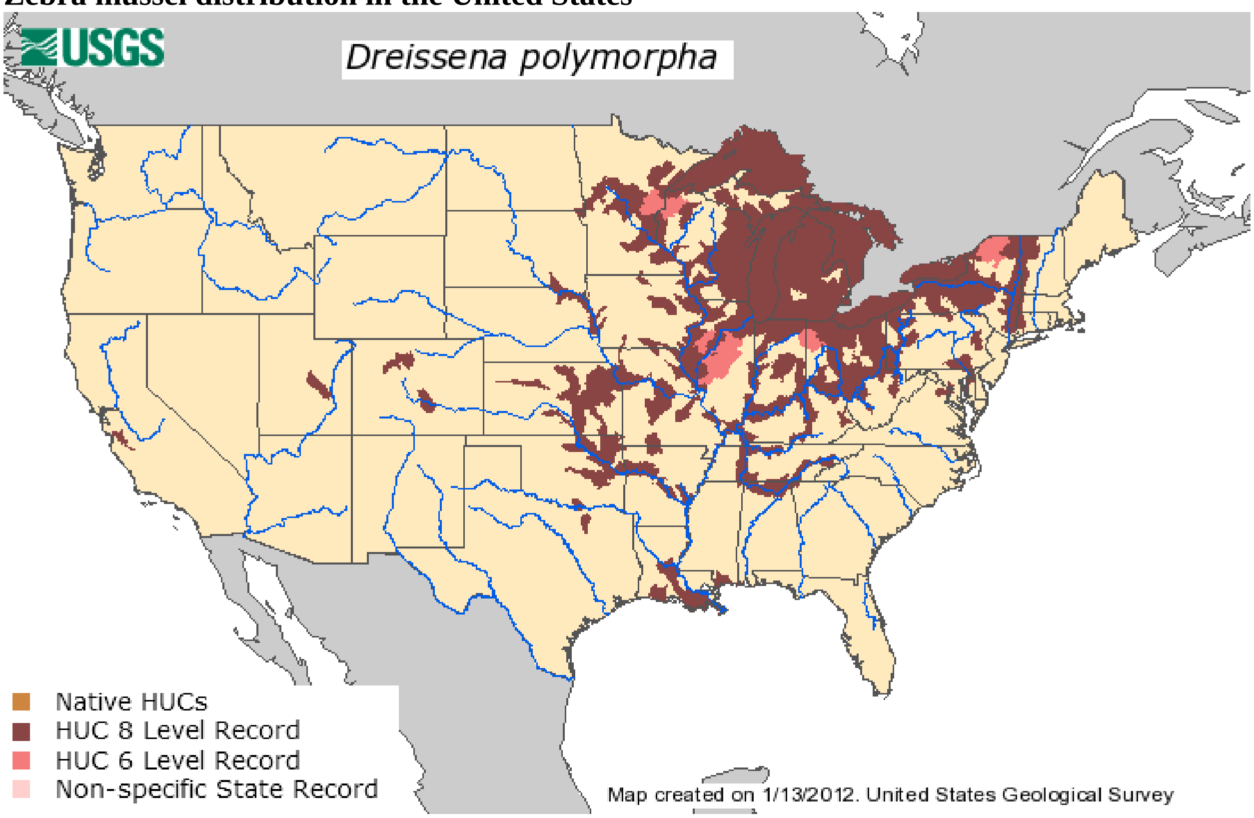
Distribution

Native Range: Black, Caspian, and Azov Seas of Eastern Europe.

Expanded Range in United States

By 1990 zebra mussels were found in all of the Great Lakes. By 1992 the Mississippi, Ohio, Arkansas, Cumberland, Hudson, Illinois, and Tennessee rivers had zebra mussel occurrences. Established populations have been found in the following states; Iowa, Kentucky, Michigan, New York, Ohio, Pennsylvania, Alabama, Indiana, Louisiana, Minnesota, Oklahoma, Massachusetts, Vermont, Connecticut, West Virginia, Wisconsin, Colorado, Utah and California (see map below).

Zebra mussel distribution in the United States



Current Status in Arizona

Currently, there are no zebra mussels found in Arizona.

Pathways

Zebra mussels use passive methods for dispersal primarily during the pelagic state. Eggs, veligers and post-veligers are distributed in lake and stream currents for up to four weeks before settling. Adults attached to logs and floating debris are also carried on currents to new areas. Overland translocation is accomplished through the movement of water and therefore eggs and veligers in live wells and bilges in boats. Adults can be transported great distances attached to boats and other equipment.

Potential Impacts

Wildlife/Habitat

Zebra mussels are prodigious water filterers (up to one liter/individual/day), removing substantial amounts of phytoplankton and suspended particulates, such as bacteria, protozoan, zebra mussel veligers, other microzooplankton and silt from the water. By removing the phytoplankton, zebra mussels in turn decrease the food source for zooplankton, therefore altering the food web and impacting fisheries. Impacts associated with the filtration of water include increases in water transparency, decreases in mean chlorophyll a concentrations, and accumulation of pseudofeces (Claxton et al. 1998). Water clarity increases light penetration causing a proliferation of aquatic plants that can change species dominance and alter the entire ecosystem. The pseudofeces that are produced from filtering the water accumulate and create a foul environment. As the waste particles decompose, oxygen is used up, and the pH becomes very acidic and toxic byproducts are produced. In addition, zebra mussels accumulate organic pollutants within their tissues to levels more than 300,000 times greater than concentrations in the environment and these pollutants are found in their pseudofeces, which can be passed up the food chain, therefore increasing wildlife exposure to organic pollutants (Snyder et al. 1997). Zebras are able to colonize to both hard and soft substrata so there are negative impacts on native freshwater mussels and invertebrates.

Infrastructure

Dreissena species ability to rapidly colonize hard surfaces causes serious economic problems. These major biofouling organisms can clog water intake structures, such as pipes and screens, therefore reducing pumping capabilities for power, agriculture and water treatment plants, affecting industries and communities. Recreation-based industries and activities have also been impacted; docks, breakwalls, buoys, boats, and beaches have all been heavily colonized. One of the differences between the zebra and the quagga mussel is that the zebra has a higher rate of byssal thread synthesis, about two times faster than the quagga, particularly within a short-term attachment period (Peyer et al 2009). Also the rate of byssal thread synthesis in zebra mussels generally increases in response to increasing water velocity over a three week period (Clark and McMahon, 1996a). This rapid byssal thread synthesis and stronger attachment will enable the zebra mussel to colonize areas of higher velocity and become more problematic than the quagga mussel.

Economic

Dreissena species (quagga and zebra mussels) have costs millions of dollars annually to control.

In the United States, Congressional researchers estimated that zebra mussels alone cost the power industry $3.1 billion in the 1993-1999 period, with their impact on industries, businesses, and communities more than $5 billion.

Human Health

Broken shells are very sharp and have caused lacerations to swimmers and anglers.

Benefits

As zebra mussel density increases water clarification will also increase through biodeposition of the suspended material. Zebras could also supply a high protein and high calcium food source for fish (redear sunfish, *Lepomis microlophus* and razorback sucker, *Xyrauchen texanus*) and waterfowl.

Recommendation

Through Arizona Game and Fish Department Directors Order {A.R.S. §17-255.01(B)}, list zebra mussel (*Dreissena polymorpha*) as an aquatic invasive species in Arizona, with subsequent affected waters listing and mandatory conditions for movement.

References

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Arizona Waters 5/29/2009

High Risk Based on Calcium Requirements for Dreissena

High >28 mg/l Ca

Site	Region	pH su	Cond umhos	Ca-total mg/l	Range	Number of samples	Risk
Agua Fria River	VI	8.43	610	65.5	63-68	2	High
Alamo Lake	IV	8.24	701	29.0	23 - 35	**2**	High
Alvord Lake	VI	8.19	1692	58.4	33 -115	4	High
Apache Lake	VI	8.19	1780	51.6	46 - 58	20	High
Arlinton Wildlife Area Pond	VI	8.96	3025	96.0		1	High
Ash Creek	V		320	54.1		1	High
Babacamori River	V	7.48	448	55.6		1	High
Bartlett Lake	VI	8.71	646	41.2	30-46	4	High
Big Casa Blanca Canyon	V			28.9	27-31	2	High
Big Springs	II	8.50	350	39.3		1	High
Black Butte Well	VI	7.60		328.0		1	High
Boulder Creek	III	7.52	1123	105.6	18-212	5	High
BPH Artesian Lab Well	II	7.54	322	49.2		1	High
Brown's Fish Farm	V			44.9		1	High
Bubbling Ponds Hatchery	II	7.83	383	46.0	42-51	4	High
Buckeye Hills Catchment	VI			29.1		1	High
Canyon Lake	VI	8.13	1716	51.0	46-56	9	High
CAP Canal	III,IV,V,VI			73.9	70-78	2	High
Cave Creek	VI	8.48	0	48.0	40-73	5	High
Chaparral Lake	VI	8.57	550	41.8	42	1	High
Chase Creek	V	3.66	1400	96.5	56-138	8	High
Chevelon Creek	I	8.37	226	26.9	17-33	9	High
Cholla Lake	I	8.44	2554	130.8	90-217	16	High
Clear Creek Reservoir	I	7.89	1076	34.9	31-37	3	High
Cocio Wash	V	7.70	105	40.0		1	High
Colorado River	II,III,IV	8.27	1337	64.6	25-110	16	High
Coors Lake	III	7.48	375	31.5		1	High
Copper Creek	III	3.75		520.0		1	High
Desert West	VI	9.12	1151	34.7	25-45	8	High
Dripping Springs	V	8.08	748	87.3	84-99	3	High
East Clear Creek @ Kinder Xing	II	6.30		37.7		1	High
Encanto Park Lake	VI	8.43	961	46.3		1	High
Fain Lake	III	8.02	364	39.3	36-42	2	High
Fossil Creek	II	7.77	631	72.0	48-99	5	High
Gila River	IV,V,IV	7.95	2756	111.8	55-343	12	High
Gila River Pond	IV	7.78	5560	253.0		1	High
Gold Gulch @ Wier	V	8.95	1850	352.0		1	High
Granite Basin Lake	III	7.27	375	41.0		1	High
Green Valley Lake	V	8.70	762	46.4		1	High
Horseshoe Lake	VI	7.96	618	46.2	42-50	3	High
Hunter's Hole	IV			180.4	78-322	6	High

Jacques Marsh	I	8.69	606	33.0		1	High
Kearny Lake	V	8.06	4449	156.2	82-258	12	High
Lake Pleasant	VI	8.03	796	62.4	33-96	56	High
Lakeside Lake	V	7.70	445	27.8	24-31	2	High
Little Colorado River	I,II	8.08	1082	95.7	31-330	6	High
Lyman Lake	V	8.61	343	36.1	31-40	3	High
Lynx Creek	III	7.33	336	60.5	31-95	3	High
Lynx Lake	III	7.94	362	46.3	32-62	15	High
Martinez Lake	IV	7.48	1200	89.0		1	High
Mineral Creek	VI	8.20	965	90.9	66-120	7	High
Montezuma Tinaja	II	8.10	1350	124.0		1	High
Mormon Lake	II	8.00	257	28.6		1	High
Nelson Lake	I	8.51	326	31.2	25-34	6	High
Nutrioso Creek @ Correjo Xing	I	8.17	293	31.7	15-46	6	High
Oak Creek	II	8.29	277	38.7	37-44	5	High
Page Springs Hatchery	II	7.53	330	39.0	35-41	5	High
Painted Rock Borrow Pit	IV	8.06	5200	253.0		1	High
Paria River @ Utah Hwy 89	II			127.2		1	High
Paria River @ Lee's Ferry	II			47.1	36-58	2	High
Parker Canyon Lake	V	8.36	193	28.1	28	2	High
Patagonia Lake	V	8.32	700	89.0	89	1	High
Peck's Lake	II	8.82	550	37.3	27-46	5	High
Pena Blanca Wash	V		484	62.9	63	2	High
Phoenix 91 Avenue WWTP	VI	7.09	1337	71.2		1	High
Phoenix Zoo	VI			48.9	49	2	High
Pinal County Fairgrounds	V	7.99	2313	268.5	246-291	2	High
Pinery Canyon	V	8.07	1023	145.9	80-179	3	High
Pintail Lake	I	9.98	950	38.0		1	High
Pinto Creek	VI			219.2	99-339	2	High
Road Tank	II	7.96	775	30.4		1	High
Rock Creek	VI			60.7		1	High
Rocky Gulch	V	2.34	9760	117.6	22-213	2	High
Roosevelt Lake	VI	8.23	1497	55.7	31-218	52	High
Roper Lake	V	8.29	3324	33.7	11-75	16	High
Rudd Creek	I	8.08	347	37.4	17-79	6	High
Safford Park Lake	V	8.50	666	52.2		1	High
Saguaro Lake	VI	8.09	1419	48.0	44-54	16	High
Salt River	VI	8.02	1973	141.7	52-438	6	High
San Francisco River	V	8.52	465	55.1	35-86	5	High
San Pedro River	V	7.59	685	83.3	53-123	15	High
Silverbell Lake	V	8.73	1326	49.1	34-63	4	High
SRP Canal	VI	8.10	1216	49.8	46-53	3	High
Trout Creek Canyon wall	III			35.8		1	High
Trout Creek Pool	III	8.50		34.5		1	High
Verde River	III, VI	8.07	498	45.0	37-52	6	High
Water Ranch	VI	8.39	2762	107.6	91	2	High
Watson Lake	III	8.91	300	25.9	19-39	3	High
West Clear Creek	II	7.79	380	38.6	30-43	3	High

Arizona Waters

5/29/2009

Moderate Risk Based on Calcium Requirements for Dreissena

Moderate 20-28 mg/l

Site	Region	pH su	Cond umhos	Ca-total mg/l	Range	Number of samples	Risk
Auger Creek	I	7.87	255	25.1	21-27	3	Moderate
Benton Creek	I	7.67	193	20.1	15-24	3	Moderate
Biscuit Tank	VI	8.05	425	23.5		1	Moderate
Black Canyon Lake	I	8.26	164	23.3	9 - 36	15	Moderate
Cluff Pond	VI	8.75	224	26.3	25-28	2	Moderate
Concho Lake	I	9.11	228	20.1	17-26	7	Moderate
Granite Creek	III	8.50	404	26.4		1	Moderate
Kennedy Lake	VI	9.02	554	16.6	11-27	3	Moderate
Kiwanis Lake	VI	8.63		22.5	20-25	2	Moderate
Long Lake	II	8.58	211	19.8	18-26	4	Moderate
Lower Lake Mary	II	8.46	105	11.7	11-28	2	Moderate
Luna Lake	I	8.56	235	23.9	16-28	9	Moderate
McKay Reservoir	I	9.40	117	17.9	11-25	2	Moderate
Rainbow Lake	I	8.89	255	22.4	14-34	9	Moderate
Show Low Creek	I	8.13	195	19.1	12-29	9	Moderate
South Fork Little Colorado River	I	8.15	90	20.2		1	Moderate
Stoneman Lake	II	9.78	283	20.6	15-26	3	Moderate
Woodland Lake	I	8.71	217	22.8	18-29	7	Moderate

Arizona Waters 5/29/2009

Low Risk Based on Calcium Requirements for Dreissena

Low 12-20 mg/l

Site	Region	pH su	Cond umhos	Ca-total mg/l	Range	Number of samples	Risk
BASF	VI		525	16.9		1	Low
Billy Creek	I	8.06	169	15.7	15-16	3	Low
Boneyard Bog	I	8.16	166	13.6	12-16	12	Low
Cambell Blue	I	8.56	208	14.7	11-19	2	Low
Canyon Creek Hatchery	VI	7.23	116	14.3	14	2	Low
Carnero Lake	I	9.27	147	12.5	10-16	4	Low
Colter Creek	I	7.73	134	13.4	13-16	3	Low
Concho Creek above Concho Lake	I	8.43	190	15.2		1	Low
Coyote Creek	I	8.26	108	13.5	8-19	2	Low
Cresent Lake	I	9.14	123	11.6	10-13	17	Low
Dankworth Pond	V	7.80	2087	19.1	19	2	Low
Marshall Lake	II	9.50	115	12.7	12-13	2	Low
Milk Creek	I	8.00	132	14.1		1	Low
Mud Springs	II	7.68	1748	16.6	7-22	4	Low
North Canyon Creek	II	8.50	320	0.1		1	Low
Paddy Creek @ Nutrioso confluence	I	8.00	157	17.7	15-23	3	Low
Pena Blanca Lake	V	7.31	163	19.0	17-21	5	Low
Pinetop Hatchery	I	7.30	167	16.4		1	Low
Porter Creek	I	8.31	138	12.3	9-15	3	Low
Russel Tank	II	9.15	144	13.8	12-16	2	Low
Scotts Reservoir	I	8.30	110	11.1	8-14	2	Low
Show Low Lake	I	7.51	115	12.9	12-14	3	Low
Smith Spring Pond	V	7.35	4968	18.9		1	Low
Walnut Creek	I	8.21	209	19.3	18-20	3	Low
Wolf Creek	III	8.25	110	14.7		1	Low

Arizona Waters 5/29/2009

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BASF	VI		525	16.9		1	Low
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Coyote Creek	I	8.26	108	13.5	8-19	2	Low
Cresent Lake	I	9.14	123	11.6	10-13	17	Low
Dankworth Pond	V	7.80	2087	19.1	19	2	Low
Marshall Lake	II	9.50	115	12.7	12-13	2	Low
Milk Creek	I	8.00	132	14.1		1	Low
Mud Springs	II	7.68	1748	16.6	7-22	4	Low
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