Assessment of lake suitability to zebra mussel invasion based on calcium concentrations

We reviewed the scientific literature addressing physiological constraints of zebra mussel and found seven studies that measured the effects of water calcium concentrations (mg/l, hereafter Ca) on zebra mussel development and growth (Jones and Ricciardi 2005, Allen and Ramcharan 2001, Hincks and Mackie 1997, Mellina and Rasmussen 1994, Ramcharan et al 1992, Strayer 1991, Sprung 1987). A 95% confidence interval (CI) was applied to the distribution of the calcium concentration thresholds identified in these studies to establish a lower limit for zebra mussel survival. The value obtained for this lower threshold was 10 mg/l (mean mg/l Ca – 95% CI). Similarly, we calculated an upper threshold of 21 mg/l (mean mg/l Ca + 95% CI). These thresholds delimited three classes of lakes: not suitable to zebra mussel invasion (mg/l Ca < 10), borderline suitable ($10 \leq$ mg/l Ca $\leq$ 21) and suitable (mg/l Ca > 21).

Since we were able to gather Ca values from only about 1000 lakes in Wisconsin, we developed a linear regression function between Ca and conductivity based on two sources of data (EPA-Eastern Lake Survey, and CFL Landscape Position Project) that had both Ca and conductivity values. The linear regression function obtained

$$lnCa = -3.11018 + 1.2034 \times lnConductivity$$

was then used to predict mg/l Ca for about 11,000 lakes in Wisconsin and the Upper Peninsula of Michigan for which we had conductivity data. These data were gathered from a variety of past limnological studies, but mostly from the Surface Water Resources Inventory carried out in Wisconsin between 1960 and 1980 by the DNR and other state agencies. The classification was done using ln-transformed thresholds (not suitable: lnCa< 2.302; borderline suitable: $2.302 \leq$ lnCa$\leq$ 3.044; suitable: lnCa>3.044).

Our final dataset thus included over 11,500 lakes with Ca values (measured or predicted) from Wisconsin and the Upper Peninsula of Michigan. We used it in Geographic Information Systems (GIS) to assign the lakes to three different suitability classes to zebra mussel invasion, as described above. About 5500 lakes with surface area < 10 ha and 1300 lakes > 10 ha were omitted from this study due to lack of conductivity or Ca measurements.

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