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## Using Risk Perceptions to Develop Effective Great Lakes Aquatic Invasive Species Outreach

Erin L. Pavloski  
*Michigan State University*

Heather A. Triezenberg  
*Michigan State University*

Bruno Takahashi  
*Michigan State University*

William W. Taylor  
*Michigan State University*

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## **Using Risk Perceptions to Develop Effective Great Lakes Aquatic Invasive Species Outreach**

### **Abstract**

We examined risk perceptions that aquatic-based recreation stakeholders in the Great Lakes region held about fish diseases, using viral hemorrhagic septicemia (VHS) as our case study. Eighty-five percent of study participants knew nothing or very little about VHS. Regarding risks posed by VHS, participants overall were most concerned about risks to the environment and fishing. Additionally, greater than 75% were concerned about fish diseases, in general, affecting the Great Lakes or inland lakes. Outreach efforts can be enhanced by focusing on areas of greatest risk invasion; targeting boaters, paddlers, kayakers, and anglers; increasing awareness of and concern about fish diseases; and communicating actions boaters should take.

**Keywords:** [risk perceptions](#), [viral hemorrhagic septicemia](#), [aquatic invasive species](#), [fish disease](#), [Great Lakes region](#)

**Erin L. Pavloski**  
Master's Student  
Department of  
Fisheries and Wildlife  
[erin.jarvie@macd.org](mailto:erin.jarvie@macd.org)

**Heather A. Triezenberg**  
Extension Specialist  
and Michigan Sea  
Grant Extension  
Program Coordinator  
Department of  
Fisheries and Wildlife  
[vanden64@msu.edu](mailto:vanden64@msu.edu)  
[@HTriezenberg](#)

**Bruno Takahashi**  
Associate Professor  
and Codirector of  
Journalism Graduate  
Studies  
AgBioResearch  
[btakahas@msu.edu](mailto:btakahas@msu.edu)

**William W. Taylor**  
University  
Distinguished  
Professor  
Department of  
Fisheries and Wildlife  
[taylorw@msu.edu](mailto:taylorw@msu.edu)

Michigan State  
University  
East Lansing, Michigan

## **Introduction**

Aquatic invasive species (AIS) (e.g., plants, fish, pathogens) affect the North American Great Lakes and inland lake ecosystems (Egan, 2017). Land-grant and sea-grant Extension-based programs have focused on protecting ecosystem sustainability (Shaw, Dalrymple, & Brossard, 2012; Vaughn, 1989) by engaging citizens and working with partners to address AIS educational needs and thereby increase awareness of and motivate adoption of decontamination practices.

Fish diseases affect fish health populations worldwide (Riley, Munkittrick, Evans, & Krueger, 2008). Infectious diseases such as whirling disease, largemouth bass virus, furunculosis, and viral hemorrhagic septicemia (VHS) are currently present in the Great Lakes region (Faisal et al., 2013). Because fish diseases are largely invisible to stakeholders until impacts such as fish kills are observed, they present a unique challenge to AIS

educational programs.

In this article, we report on our use of VHS as a case study for understanding stakeholders' perceptions of risk from fish diseases. We selected VHS because it can be found in many fish species in the Northern Hemisphere (Faisal et al., 2012) and its impacts are visible as compared to other diseases, making it likely the most well-known fish disease in the Great Lakes region. VHS has been reported in the Great Lakes region since 2005 (Michigan Sea Grant, 2014; U.S. Department of Agriculture, 2006) and has resulted in numerous fish kills. These kills have occurred in the Great Lakes, Lake St. Clair, and other bodies of water around the region (Michigan Department of Natural Resources, 2018; Michigan Sea Grant, 2014).

Freshwater ecosystems continue to be at risk for fish disease invasions because of the multiple pathways for introduction from large ship ballast water, disposal of unwanted baitfish, and movement of aquatic equipment from one lake to another (Connelly, Lauber, Stedman, & Knuth, 2016). As an example, more than two thirds of Michigan and Wisconsin boaters do not routinely clean their trailered boats when moving from one body of water to another (Rothlisberger, Chadderton, McNulty, & Lodge, 2010). Anglers from the Great Lakes region are generally aware of AIS and their potential impact on fish populations, so an assumption might be that they would undertake decontamination actions such as inspecting and draining water from equipment (Connelly et al., 2016). However, despite awareness and intention, anglers across the Great Lakes region have not implemented these important decontamination activities or other behaviors, such as disinfecting, rinsing with hot water, or drying equipment, as much or as consistently as might be expected (Connelly et al., 2016).

## Risk Perceptions and Outreach Efforts

Risk perception, as opposed to technical risk assessment, is one's cognitive or affective assessment of the probability of a hazard occurring (also known as intuitive risk judgment) (Renn, 1992; Slovic, 1987). Risks perceived by public audiences are usually different from those perceived by technical experts (Slovic, Fischhoff, & Lichtenstein, 1979). Specifically, public risk perceptions are generally influenced by imaginability and memorability of a hazard as well as worry or fear and the likelihood of the hazard's being fatal or being a catastrophic event (Slovic et al., 1979). In our case study, we used the perceived hazard characteristics frame (Table 1) of the zoonotic disease risk information seeking and processing model to examine stakeholder risk perceptions associated with VHS (Clarke, 2009; Triezenberg, Gore, Riley, & Lapinski, 2014).

**Table 1.**  
Perceived Hazard Characteristics of Fish Diseases

<b>Dimension</b>	<b>Example</b>
Health	Perception that the individual's personal health is at risk from VHS
Natural environment	Perception that fish populations, other aquatic animals, the balance of food webs, and so on are at risk for VHS
Economic livelihood	Perception that the individual's personal way of supporting himself or herself financially is at risk from VHS
Fishing in Michigan	Perception that successful catch rates and angler recruitment are at risk from VHS
Culture of fishing in	Perception that the reputations of fishing communities and the ways in which people currently fish

*Note.* VHS = viral hemorrhagic septicemia.

Having information about individuals' risk perceptions can inform tailored outreach to specific stakeholder groups (Gore & Knuth, 2006), increasing program effectiveness and facilitating the achievement of conservation goals. In the context of AIS, a needs assessment of current awareness levels and risk perceptions can inform the development and implementation of effective outreach efforts. Successful outreach programs would achieve the goal of increasing recreational boaters' knowledge and implementation of decontamination actions for reducing spread of fish diseases and other AIS.

Extension or other outreach program designs based on an understanding of characteristics of target audiences, such as their risk perceptions, attitudes, and sociodemographic factors, are likely to be more effective than traditional information dissemination because they address issues relevant to the audience (Shaw et al., 2012). Designing and implementing educational efforts that are responsive to these issues increases the likelihood of proenvironmental behaviors (Shaw et al., 2012) by the key target audiences and demonstrates relevancy and impact of Extension programming regarding critical issues related to fisheries and AIS management.

Little is known about aquatic-based recreation stakeholders' perceptions of risk from fish diseases in Michigan. With our study, we examined (a) perceptions of VHS and its management held by recreational boaters and other aquatic-based recreationists, (b) variation in these perceptions relative to level of awareness of fish disease, and (c) level of concern of fish disease spread from the Great Lakes to inland lakes.

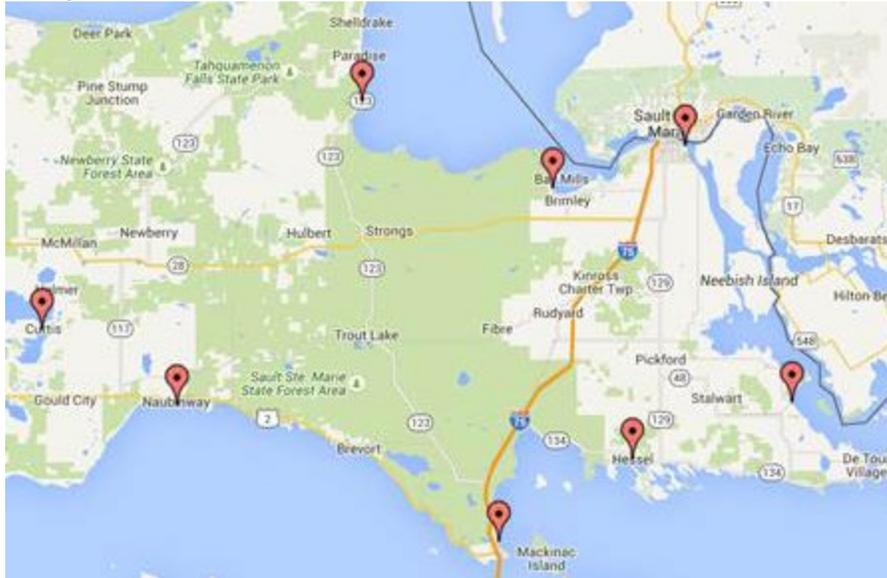
## Methods

### Data Collection

In July and August 2015, we conducted semistructured interviews with 82 aquatic-based recreation users at eight recreation access sites (i.e., boat ramps) across Michigan's Eastern Upper Peninsula in Chippewa, Luce, and Mackinac Counties (Figure 1). At the time of our study, these counties were proximate to all three VHS management area designations: positive, surveillance, and free. The Michigan State University Institutional Review Board approved our research (x15-651e).

#### Figure 1.

Data Collection Sites in Eastern Upper Peninsula of Michigan, 2015



After being invited to take part in the study and providing confirmation via the oral consent process of being 18 years or older, study subjects participated in individual interviews. The interviewer, a member of our research team, recorded responses and took notes. At an interview's conclusion, the participant was given a VHS fact sheet, which had been reviewed by staff from the Michigan Department of Natural Resources Fisheries Division for accuracy. The decline rate was not recorded because we were interested in purposeful maximum variation sampling rather than representative sampling to generalize to a population (Patton, 2002).

## Survey Instrument

A guide was used for the interviews and included questions about involvement in aquatic-based recreational activities, such as fishing from land or shore; fishing from any type of boat, canoe, or kayak; boating recreationally; using a personal watercraft; and paddling recreationally. We also asked each respondent whether he or she was a member of an association, an organization, or a club related to aquatic-based recreation (e.g., fishing club, boating organization). Additionally, we asked whether respondents had heard of "viral hemorrhagic septicemia or VHS" and whether they knew something about it.

We used the following questions to elicit stakeholder risk perceptions regarding VHS: "When you think of VHS, what do you believe it poses a threat to?" "What about the risks to your health?" "What about the risks to the natural environment?" "What about risks to your economic livelihood?" "What about risks to fishing in Michigan?" "What about risks to the culture of fishing in Michigan?" Also, using closed-ended questions, we asked participants to identify their top concern about risks from VHS and their top concern about risks from its management—that is, whether their top concern was their health, the natural environment, their economic livelihood, fishing, or the culture of fishing. Additionally, we asked participants to rate their levels of concern about fish diseases in the Great Lakes and fish diseases in Michigan's inland lakes using a scale of *very concerned*, *moderately concerned*, *slightly concerned*, or *not at all concerned*, with an additional option of *never thought about it before this interview*. Sociodemographic questions regarding characteristics such as gender, birth year, level of education, household income, and city and state of residence also were included in the interview guide.

## Analyses

We used SPSS Version 22 to calculate descriptive statistics, summaries, cross tabs, and chi-square and Fisher's exact tests.

## Results

Eighty-two aquatic-based recreation users participated in our study. Eighty interviews were completed in total; two were incomplete due to participant time and inclement weather and were not included in the final data analysis. Those who declined interviews reported that they were not interested or did not have time to participate in our study. Respondent sociodemographic information is summarized in Table 2.

**Table 2.**

Respondent Sociodemographics, Eastern Upper Peninsula of Michigan, 2015 ( $n = 80$ )

Variable	Responses
Gender	
Male	75.0%, $f = 60$
Female	25.0%, $f = 20$
Age	53 years ( $SD = 15.35$ ); median = 55 years
Education	
Less than high school	0.0%, $f = 0$
High school diploma or GED	15.0%, $f = 11$
Some college or technical school	26.3%, $f = 21$
Associate's degree	7.5%, $f = 6$
College undergraduate degree	26.3%, $f = 21$
Graduate or professional degree	25.0%, $f = 20$
Income	
\$40,000 or less	23.8%, $f = 19$
\$40,000–\$60,000	13.8%, $f = 11$
\$60,000–\$80,000	17.5%, $f = 14$
\$80,000–\$100,000	12.5%, $f = 10$
\$100,000–\$120,000	6.3%, $f = 5$
\$120,000 or more	16.3%, $f = 13$
Prefer not to answer	10.0%, $f = 8$
Management designation where interview was conducted	
Positive	28.8%, $f = 23$

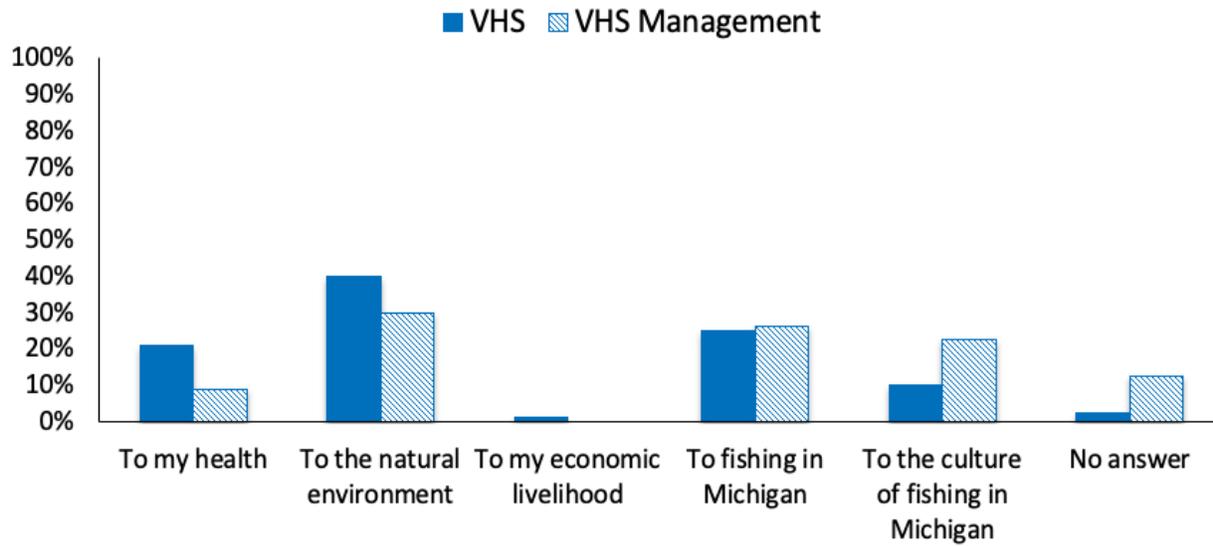
Surveillance	31.3%, $f = 25$
Free	40.0%, $f = 32$
Residence	
Michigan	82.5%, $f = 66$
Other	17.5%, $f = 14$
Recreational activity participation	
Fishing from land/shore	68.8%, $f = 55$
Fishing from boats	72.5%, $f = 58$
General recreation with boats	77.5%, $f = 62$
Personal watercraft	13.8%, $f = 11$
Recreational paddling activities	68.8%, $f = 55$
Aquatic-based recreational club membership	
Yes	23.8%, $f = 19$

Participants were asked whether they had ever heard of the fish disease "viral hemorrhagic septicemia or VHS"; 57.5% ( $f = 46$ ) had never heard of the disease, and 27.5% ( $f = 22$ ) recognized the name but did not know much about the disease. Only 15% ( $f = 12$ ) reported that they recognized the name and knew something about the disease. Across the VHS management areas, 17% of respondents interviewed in the positive management zone recognized the name as compared to 48% in the surveillance zone and 56% in the free zone ( $\chi^2 = 8.719, p = .013$ ). Overall, 85.0% of participants ( $f = 68$ ) either had not heard of VHS at all or did not know much about it.

With regard to risks from VHS, participants were most concerned about risk to the natural environment, with 40.0% ( $f = 32$ ) reporting this as their top concern. This perception was followed by concern about risk to fishing in Michigan (25.0%,  $f = 20$ ), which, in turn, was closely followed by concern about risk to personal health (21.3%,  $f = 17$ ). With regard to risks from VHS management, the topic concern was about potential risk to the natural environment (30.0%,  $f = 24$ ). This perception was closely followed by concern about risks to fishing in Michigan (26.3%,  $f = 21$ ) and to the culture of fishing in Michigan (22.5%,  $f = 18$ ). Figure 2 illustrates respondents' top concerns.

### Figure 2.

Respondents' Top Concerns Regarding Risks from Viral Hemorrhagic Septicemia (VHS) and Its Management, Eastern Upper Peninsula of Michigan, 2015 ( $n = 80$ )



We conducted a chi-square test to examine whether having previously heard of VHS was significantly related to participants' top concerns about risks from VHS and its management. Regarding risks from VHS, having heard of VHS was significant only relative to the top concern of risk to fishing (Table 3). Regarding risks from VHS management, having heard of VHS was significant only relative to the top concern of risk to the environment (Table 3).

**Table 3.**

Relationship of Respondents' Having Previously Heard of VHS (No or Yes) to Top Concerns About Risks from VHS and Its Management, Eastern Upper Peninsula of Michigan, 2015 (n=80)

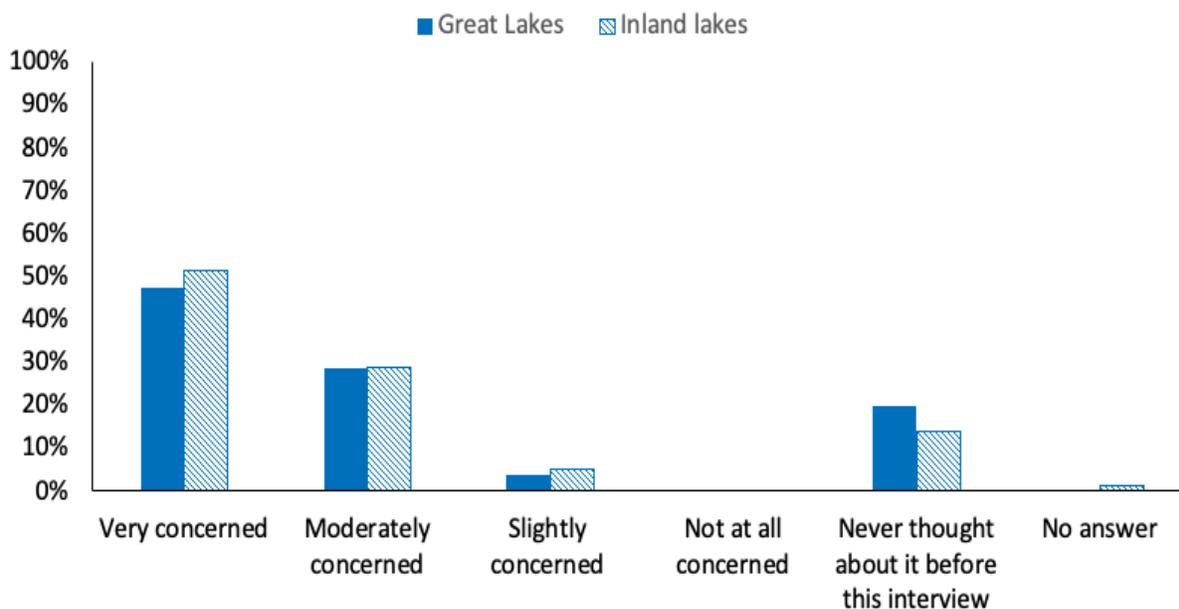
Dimension	% No	% Yes	X <sup>2</sup>		Fisher's exact test 2-sided
			df = 1	p	p
Top VHS risk concern					
Health	70.6	29.4	1.513	.219	.275
Environment	59.4	40.6	.077	.782	.821
Economic livelihood	0.0	100.0	1.370	.242	.425
Fishing in Michigan	35.0	65.0	5.524	.019	.035
Culture of fishing in MI	75.0	25.0	1.114	.291	.456
Top VHS management risk concern					
Health	57.1	42.9	.000	.984	1.00
Environment	75.0	25.0	4.297	.038	.049
Economic livelihood	0.0	0.0	n/a	n/a	n/a
Fishing in Michigan	47.6	52.4	1.138	.286	.314

Note. VHS = viral hemorrhagic septicemia.

All 80 participants expressed at least slight concern about the presence of fish diseases in the Great Lakes, and all but one expressed at least slight concern about the presence of fish diseases in inland lakes. Majorities of the interview participants were moderately or very concerned about fish diseases in the Great Lakes (76%,  $f = 61$ ) and in Michigan's inland lakes (79.9%,  $f = 64$ ) (Figure 3). Of the 80 participants, 20% ( $f = 16$ ) had never thought about fish diseases in the Great Lakes before, and 13.8% ( $f = 11$ ) had never thought about fish diseases in Michigan's inland lakes (Figure 3).

**Figure 3.**

Concern About Presence of Fish Diseases in Great Lakes and in Michigan's Inland Lakes, Eastern Upper Peninsula of Michigan, 2015 ( $n = 80$ )



## Discussion

For respondents who were aware of VHS, their top concern was its risk to fishing, presumably because of the impact on fish populations, a finding that is consistent with previous research demonstrating that anglers are generally aware of AIS and their potential impact on native fish populations (Connelly et al., 2016). However, other concerns about risks from VHS or its management were unrelated to level of awareness of the disease.

Most respondents were concerned about fish diseases in the Great Lakes and inland lakes, with there being a slightly higher level of concern about inland lakes, even though respondents' awareness and understanding of VHS specifically was not high. Because they are moved between bodies of water, recreational boats and trailers are important vectors of AIS, but boaters have yet to adopt effective, consistent decontamination behaviors to reduce AIS spread (Rothlisberger et al., 2010). Engaging with recreational boaters, especially anglers with boats, will be an important part of AIS management practices as freshwater recreational fishing activities drive AIS distributions throughout the continental United States (Davis & Darling, 2017).

Outreach efforts, such as Extension educational programs, should target areas where transmission to new

waters is likely. However, we firmly believe that a more general outreach program needs to be designed that will effectively reach the broader community of aquatic-based recreation users if we are to slow the spread of AIS in Michigan. Extension program developers should consider audience characteristics to enhance the efficacy of Extension program curricula or communication campaigns (Shaw et al., 2012).

In the context of our study regarding AIS and disease transmission, any associated curriculum should focus on (a) targeting aquatic-based recreation users, especially recreational boaters, paddlers, kayakers, and anglers with boats; (b) increasing awareness of AIS and fish diseases and the risks they pose to the natural environment and fishing; (c) communicating decontamination actions people can take to reduce spread of disease; and (d) expressing the relatively high level of concern people have about fish diseases in the Great Lakes and inland lakes. Additionally, it is important to evaluate the effectiveness of outreach initiatives at increasing awareness of VHS and other fish diseases as well as motivation and adoption of decontamination actions (Gore, Knuth, Scherer, & Curtis, 2008).

### **Author Note**

Erin L. Pavloski (née Jarvie) is currently the regional coordinator for the Mid-Michigan Cooperative Invasive Species Management Area with the Ingham Conservation District. She can be contacted at [erin.jarvie@macd.org](mailto:erin.jarvie@macd.org) or 517-676-2290, ext. 2.

### **Disclaimers**

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