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Research Article

Applying the Extended Parallel Process Model to aquatic invasive species prevention behaviors in wading anglers

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Abstract

Although wading anglers represent a known risk for the spread of Aquatic Invasive Species (AIS), minimal research has investigated prevention messaging targeted at this demographic. We applied the Extended Parallel Process Model (EPPM) of persuasion to this context and tested whether messaging that emphasized threat, efficacy, or both threat and efficacy was more effective in persuading wading anglers to implement preventive behaviors. We found support for the EPPM, but for a single exposure to the tested AIS messages, we found no effects of type of message. Pre-message attitudes toward AIS were a better predictor of intended behavior than our messages, indicating a ceiling effect. Highlighting the effectiveness of preventive behaviors (response efficacy) was related to more reactance toward the message. Our findings suggest that messaging may be more effective if it acknowledges wading anglers' experience and awareness of AIS threats while providing straightforward self-efficacy information. Messaging should emphasize the actions wading anglers can perform that reduce AIS introduction risk.

Key words: outreach, behavior change, communication, message testing, recreational activities, trout

Introduction

Aquatic invasive species (AIS) are organisms introduced to a location outside their native aquatic environment that are able to survive and spread in this new non-native environment, often leading to negative impacts such as competing with native species for food (Blackburn et al. 2011). Once AIS are introduced, it is very difficult to stop or reverse their spread (Vander Zanden and Olden 2008), so prevention is crucial. Preventative actions have successfully reduced risk and prevented invasions through pathways such as maritime commerce (Ricciardi and MacIsaac 2022) and recreational boaters (Jensen 2010; Connelly et al. 2014; Witzling et al. 2016). Yet one recreation-related invasion pathway that has not seen significant educational investment and research is wading anglers.

Wading anglers are anglers who fish from within the water as opposed to anglers who fish from other locations, such as from the shore or using a watercraft. This group is a known AIS invasion pathway due to their willingness to travel long distances to fish (Anderson 2016; Tank 2020), tendency to fish in small streams and rivers, and use of gear that can transport AIS (Richards et al. 2004; Gates et al. 2008; O'Reilly and Root 2012). Despite these factors, previous research has either been limited to collecting information about how such factors contribute to the risk of AIS being spread by wading anglers (Tank 2020; Geist et al. 2022b) or has focused on the beliefs, values, and behaviors of other groups such as anglers more generally (Connelly et al. 2014; Golebie et al. 2021) or recreational boaters (Witzling et al. 2015) to understand their role in AIS spread (Wallen and Kyle 2018; Shaw et al. 2021). While there are AIS-prevention guidelines for wading anglers (Aquatic Nuisance Species Task Force 2014), the communication of these guidelines to wading anglers has received less effort than to other groups such as recreational boaters. Thus, it is necessary to focus specifically on wading anglers and to examine what type of messaging will be most effective in promoting AIS prevention behaviors in this population.

Two message features that may be useful in this context are an emphasis on either the severity of the AIS threat (Golebie et al. 2021) or on the efficacy of the prevention actions. These features are explored in the Extended Parallel Processing Model (EPPM; Witte 1992). The EPPM is a persuasion model that has primarily been applied to health-related threats such as meningitis (Gore and Bracken 2005) and hearing loss (Smith et al. 2008), but it is relevant to environmental threats due to the role of threat and efficacy themes in AIS messaging campaigns (Golebie et al. 2021) and the role of human behavior in spreading AIS. Such themes are already prevalent in other environmental messaging, such as climate communication (Hart and Feldman 2014), but this is the first study to test the EPPM in the context of preventing AIS.

Aquatic Invasive Species and Wading Anglers in the Great Lakes and Driftless Regions

Wading anglers are a significant demographic in the Great Lakes and Driftless Regions of the US Upper Midwest. They contribute more than $1 billion to the Driftless area economy (Anderson 2016), which consists of southwestern Wisconsin, southeastern Minnesota, northeastern Iowa, and northwestern Illinois. Since the tributaries of the Great Lakes are stocked with salmon and trout to specifically provide a spring and fall season for anglers without boats, and since there are more than 5,700 miles of trout streams in the Driftless Region (Anderson 2016), wading angling is a popular activity. The large number of wading anglers and the numerous locations to fish, however, increases the risk of AIS spread due to their use of wading

gear. Wading angler gear can contain New Zealand mudsnails, didymo, myxospores, and other invasive species (Gates et al. 2008; O'Reilly and Root 2012; Stockton and Moffitt 2013; Geist et al. 2022a) and can retain water that allows AIS to survive longer (O'Reilly and Root 2012). Thus, the most likely method for these specific AIS to spread is via contaminated equipment (Richards et al. 2004). Wading angling gear can also transport sediment (Gates et al. 2009), which may contain viable invasive organisms (Amengol et al. 2016). Additionally, wading anglers are willing to travel substantial distances to fish and may fish multiple streams in the same day or on consecutive days, including small streams not utilized by motorized watercraft (Anderson 2016; Tank 2020). These factors can contribute to the inadvertent spread of AIS (Ready et al. 2018). Particularly in the Great Lakes and Driftless regions, where AIS such as New Zealand mudsnails have a relatively limited distribution (USGS NAS 2023), engaging in AIS prevention now is key because the invasive populations can still be contained and their spread limited.

To help wading anglers take action to prevent the spread of AIS, the Aquatic Nuisance Species Task Force developed AIS prevention guidelines for wading anglers (Aquatic Nuisance Species Task Force 2014). This guidance includes inspecting for and cleaning off plants, animals, and mud from gear and equipment, scrubbing visible material on footwear with a stiff brush, and draining water and drying gear for five or more days. Additionally, treating gear with chemicals, hot water, or cold temperatures can achieve high rates of mortality for AIS found on wading gear (Schisler et al. 2008; O'Reilly and Root 2012; Stockton and Moffitt 2013; De Stasio et al. 2019). Recent work suggests that trout anglers are most willing to use the readily available multi-surface cleaner, Formula 409, on their gear over other methods (Geist et al. 2022b). However, chemical treatment is not recommended by the ANSTF (Aquatic Nuisance Species Task Force 2014), in part due to the varying effectiveness of chemicals across different AIS (Wisconsin Department of Natural Resources 2014), but some of these other methods are not easily feasible in field settings (Winterbourn 1973; Richards et al. 2004; Avila et al. 2016; De Stasio et al. 2019).

Despite the potential for AIS spread by wading anglers, research suggests that anglers are generally aware of AIS threats but may not engage in behaviors necessary to reduce the spread of AIS (Connelly et al. 2014; Golebie et al. 2021). Most research has assessed anglers as a whole and not differentiated among the different subgroups, but a limited body has explored the beliefs, attitudes, and behavior of wading anglers specifically regarding their own ability to prevent the spread of AIS. This existing research shows that less than half of specific populations of wading anglers perform additional steps to decontaminate their angling gear (Anderson et al. 2014; Tank 2020). Further, the basic step of scrubbing gear, which aligns with national guidelines, is not among the common additional steps that wading anglers take (Tank 2020).

Given the discrepancy between wading anglers' role in spreading AIS and their tendency to engage in preventative behaviors, persuasion research offers a promising line of inquiry to advance knowledge about preventing the spread of AIS. Previous research has examined what type of AIS messaging may be most effective in reaching boaters and anglers (Eiswerth et al. 2011; Connelly et al. 2014; Kemp et al. 2017). Such messaging can include written text and images through reports or slogans to increase awareness of the AIS threat (Connelly et al. 2014; Kemp et al. 2017) or face-to-face communication such as conversations at a lake association meeting (Eiswerth et al. 2011). Connelly et al. (2014) found that the majority of anglers they surveyed in the Great Lakes region were aware of educational campaigns such as "Stop Aquatic Hitchhikers", while Kemp et al. (2017) found that participants preferred the clear language and simple imagery of national campaigns such as "Stop Aquatic Hitchhikers" over more ambiguous slogans and imagery. Other research has investigated the effect of message framing on intended behaviors and action. For example, while pro-environmental, economic loss, and comprehensive message frames did not have an effect on intention to implement AIS prevention behaviors (Lee et al. 2015), regulation framed messaging (e.g., "It's the law") did increase behavioral intention (Wallen and Kyle 2018). Finally, research exploring different biological invasion metaphors and emphasis frames suggests that the use of more neutral science-based or hitchhiker frames can lead to similar engagement as frames that might have unintended consequences, such as militaristic frames (Shaw et al. 2021).

Despite these findings, existing research continues to suggest that anglers are often not taking all the necessary steps to reduce AIS spread (Connelly et al. 2016; Cole et al. 2016), even when they are aware of prevention campaigns (Connelly et al. 2014). Thus, additional research is needed to examine what factors may be important in motivating wading anglers to engage in preventive behaviors and whether particular messaging about AIS could help or hinder outreach efforts. We use the persuasive theory of the Extended Parallel Process Model (EPPM) to understand factors that could motivate engaging in preventive behaviors and to help understand what effective messaging could include when targeted at wading anglers.

Extended Parallel Processing Model

The Extended Parallel Process Model (EPPM) examines how fear of a threat can motivate people to change their behavior to reduce that threat (Witte 1998). The EPPM has been applied to health messaging and other contexts in situations that involve a threat, such as hearing loss (Smith et al. 2008), and a specific, individual behavior that could be taken to reduce the threat, such as wearing protection when engaging in work involving loud noises. Given the element of threat involved with AIS messaging and the focus on providing specific, actionable steps that individuals can take,

the EPPM could be an appropriate framework with which to develop persuasive messaging. We focus on EPPM over other persuasive models, like the Elaboration Likelihood Model or Reasoned Action Model, because the EPPM focuses more on behavior change than the development of attitudes.

The EPPM suggests that there are two primary components in a message that can motivate individuals to engage in threat reduction behavior (Witte 1998): perceived threat and perceived efficacy. First, in order to motivate behavior, people need to perceive that there is a threat. This threat must be perceived as severe enough that it could be harmful (threat severity), and the individuals must perceive that they are personally susceptible to the threat (threat susceptibility). For example, wading anglers who primarily fish in inland waterways may perceive that an AIS problem is severe, but if they perceive that it is a problem of the Great Lakes and not of inland waterways, they may not worry about the threat because they do not believe that they are susceptible to it (Golebie et al. 2021). Therefore, the "threat" component of the EPPM includes two sub-components: severity of the threat and susceptibility to the threat. Both sub-components are needed to promote a level of fear toward the threat (Witte 1998). Previous research on AIS messaging has found that perception of a risk does predict AIS prevention engagement (O'Connor et al. 1999; Kothe et al. 2019; Golebie et al. 2021). Golebie et al. (2021) found that susceptibility was especially important in motivating behavior; they noted "for most anglers, regardless of their perceptions of general risks of aquatic invasive species, they are unlikely to take preventative action until they believe that those risks will impact their own lives" (p. 1819).

Second, being fearful of a threat may not of itself motivate behavior change. In fact, using fear to persuade could elicit a backlash and reactance if people feel they do not have a viable means to reduce the threat (Maloney et al. 2011). Therefore, the second component of the EPPM is efficacy. Efficacy also includes two sub-components: response efficacy and self-efficacy. Response efficacy refers to how effective a response is toward reducing the threat, while self-efficacy refers to how able one is to actually engage in the behavior. Both types of efficacy are important. If people perceive that effective behaviors to reduce the spread of AIS exist (high response efficacy) but are unwilling to engage in these behaviors (low self-efficacy), then they are unlikely to be motivated to engage in behavior change (Witte 1998). The role of self-efficacy in AIS messaging may be especially important given that anglers may be aware of the steps necessary to prevent the spread of AIS (Eiswerth et al. 2011; Kemp et al. 2017) but still not take them (Connelly et al. 2016; Cole et al. 2016).

The goal of the EPPM is to outweigh fear of the threat with a sense of efficacy, such that individuals feel capable of reducing and controlling the threat. This sense of greater efficacy should motivate message acceptance and a desire to control the threat itself (Witte 1998). For example, a wading

angler who perceives a strong threat of AIS but believes they can effectively prevent it through their behavior would be persuaded to engage in this behavior to reduce the danger of the threat. In this study, we apply the EPPM to an AIS context with wading anglers. Following previous research, we begin by examining the two primary components and their relation to self-reported AIS prevention behavioral intentions among wading anglers. Thus, we hypothesize:

Hypothesis 1: Increases in perceived threat severity and perceived efficacy will be associated with greater intention to implement behaviors that reduce the spread of AIS.

However, the EPPM (Witte 1998) predicts that if the sense of threat is greater than the efficacy to deal with the threat, a person will instead engage in fear control by avoiding thinking about the issue or by downplaying or denying the threat. Generally, if someone engages in fear control, then the persuasive message of behavior change is rejected. For example, if an angler perceives a strong threat of AIS but perceives their ability to respond as weak, they may be unlikely to take preventive actions to control the threat.

In addition to fear control, another negative outcome of using fear without offering an effective response is that the person receiving the message may feel manipulated by the use of fear or believe that the fear is overblown. This can lead to message rejection and reactance, which is the perception that the message is manipulative and restrictive of one's behavior (Shen and Coles 2015). A wading angler may view a message about AIS prevention as a threat to their perceived freedom to fish where and how they choose, for example, and may therefore reject the message. This can lead to the individual choosing to not engage in the preventative action, such as a wading angler deliberately not engaging in preventative action in order to avoid external control. Further, strong reactance can lead to the individual choosing attitudes or behaviors that are contrary to the persuasive message (Brehm 1966). According to the EPPM, one approach to prevent reactance and message rejection is to emphasize efficacy in the persuasive message. For example, if the message emphasizes a solution to AIS spread, wading anglers will be less likely to reject it as manipulative or controlling. Thus, we hypothesize:

Hypothesis 2: Increases in perceived efficacy will be associated with lower reactance toward engaging in AIS prevention behaviors.

Along with examining the primary components of threat and efficacy, we also explore the separate effects of each sub-component: response efficacy, self-efficacy, threat severity, and threat susceptibility. Research results are mixed about whether severity or susceptibility is more strongly connected to behavioral intentions; for example, Golebie at al. (2021) found that susceptibility may be a more important factor than severity, but others research has suggested the opposite (van der Linden 2015; van Riper

et al. 2020). Due to limited research on this topic, we do not hypothesize that one type of efficacy or threat will be more effective than the other, but simply pose research questions.

Research Question 1: Will self-efficacy or response efficacy be more strongly associated with greater intention to implement behaviors to reduce the spread of AIS?

Research Question 2: Will one type of threat, severity or susceptibility, be more strongly associated with greater intention to implement behaviors to reduce the spread of AIS?

In addition to exploring the relationship between threat and efficacy and AIS prevention behavior, we use the EPPM to test the role of threat and efficacy in AIS messaging with wading anglers. Specifically, we expose wading anglers to messaging with only threat information, only efficacy information, or both efficacy and threat information to examine if messaging providing both efficacy and threat information is the most effective.

Hypothesis 3: Messaging that conveys both the severity of the AIS threat and the efficacy of prevention actions will lead to greater willingness to implement the recommended prevention steps than messaging that conveys either threat or efficacy alone.

Methods

Participants

A priori power analysis indicated that 264 participants would be needed to reach 90% power with an effect size of 0.27 and $\alpha = 0.05$. Through Qualtrics, we recruited 320 anglers who have fished for trout or salmon from shore or by wading in the Great Lakes and Driftless regions in the Midwestern United States in the past year. Because we were interested in current wading anglers, we excluded those who only use other methods to fish (e.g., from a boat). Seventeen participants were excluded due to incomplete or unreasonably quick responses (less than 5.4 minutes, compared to an average completion time of 18.12 minutes), or due to invalid responses to the open-ended questions, such as "Gvvhbbbjbbccghvhbbv." The resulting sample included 303 participants, including 59.6% male, 39.6% female, 0.7% no answer. The average age was 45.08 (SD = 15.3). The largest group of participants (48.2%) indicated they had eleven or more years of fishing experience, followed by 15.4% with 6–10 years, 31.4% with 1–5 years, and 5% with less than one year. While our sample was not designed to be a nationally representative sample, many of our key demographics align with national reports, such as a 2020 report showing that adult anglers are more likely to be male (64%) with an average age of approximately 44.6 (Recreational Boating and Fishing Foundation 2020). However, our sample had a higher percentage of avid anglers, with 34% reporting that they fish weekly compared to 7% nationally. Additional descriptive statistics of the sample are presented in Table 1.

Table 1. Characteristics of wading anglers in the Great Lakes and Driftless regions. *Note:* Percentages may not sum to 100% due to some participants refusing to answer certain questions or selecting multiple answers (travel for trout fishing).

Variable		Frequency	Percent
Age	18–24	25	8.93
	25–34	59	21.07
	35–44	62	22.14
	45–54	48	17.14
	55–64	47	16.79
	65–74	36	12.86
	75+	3	1.07
Gender	Male	169	60.36
	Female	110	39.39
Race/ethnicity	Non-White	25	8.93
	White, non-Hispanic	252	90.0
Primary trout fishing state	Illinois	17	6.07
	Indiana	15	5.36
	Iowa	9	3.21
	Michigan	50	17.86
	Minnesota	8	2.86
	New York	37	13.21
	Ohio	42	15.00
	Pennsylvania	82	29.29
	Wisconsin	20	7.14
Fishing experience	Less than one year	14	5.0
	1–5 years	88	31.43
	6–10 years	43	15.36
	11+ years	135	48.21
Fishing frequency	Once per year	21	7.50
	A few times per year	108	38.57
	Monthly	56	20.0
	Weekly	95	33.93
Travel for trout fishing	Only fish in home state	174	62.14
	Traveled to neighboring state to fish	68	24.29
	Fished in multiple Great Lakes	54	19.29
	Traveled to Western U.S. to fish	20	7.14
	Traveled internationally to fish	10	3.57
Primary trout fishing method	Live bait	157	56.07
	Artificial bait	46	16.43
	Spinning gear	42	15.00
	Fly fishing	34	12.14

Procedure

We obtained IRB approval (UW Madison IRB #2021-0688), and participants provided informed consent. We utilized a survey experiment. After screening questions and initial questions about perceptions of AIS and current AIS prevention actions (detailed below), participants were randomly assigned to one of three conditions, with each condition (only threat [n = 97]; only efficacy [n = 105]; both threat and efficacy [n = 101]) viewing a different poster designed to provide a message about AIS based on elements of the EPPM model. The first message emphasized the threat and its severity, including both text and images that demonstrated the impact of AIS on stream fishing. The second message, in contrast, emphasized efficacy by providing information about AIS prevention, including teaching anglers about

Figure 1. The stimulus materials shown to anglers to test the impacts of threat, efficacy, and combined message frames on the intention to implement invasive species prevention behviors. The message frame did not have a significant effect on angler intention to implement prevention behaviors.

preventative actions, emphasizing the ease of these actions, and highlighting the efficacy of the actions in preventing the spread of AIS. The third message combined the first two approaches to emphasize the severity of the problem as well as the efficacy of the preventative actions (Figure 1)

We conducted a priori, qualitative testing of experimental messaging materials for manipulations. The three posters were reviewed by six experienced professionals with knowledge of AIS and messaging, including three invasive species outreach specialists who are also anglers, two individuals from trout angling groups, and a fishing guide with connections to the Wisconsin Aquatic Invasive Species Partnership. We asked each professional to review the three posters. After they viewed each poster, we asked them to elaborate on the theme of the poster, the emotion conveyed, and highlight how it made them feel. Reviewers were able to identify the theme of each poster (threat, efficacy, or both). They expressed feelings that corresponded to the message of each poster. They also provided feedback on the posters and offered suggestions on how to improve each theme, which we incorporated into the final messages viewed by participants. Five of the reviewers also provided constructive feedback on the questionnaire in order to improve the wording of our questions.

After viewing one of the three messages, participants completed an attention check question and then several scales to measure perceived threat, perceived efficacy, intention to the implement the advice, and reactance to the message. These measures are detailed below. Participants also answered two open-ended questions about actions they might take in response to the message and their feelings based on the message. Finally, participants provided demographic information.

Table 2. Means, standard deviations, and correlations. *Note:* M and SD are used to represent mean and standard deviation, respectively. All measures are on a 1–5 scale.

Variable	M	SD	1	2	3	4	5	6
1. Severity	3.94	.686						
2. Susceptibility	3.65	.755	.617*					
3. Self-efficacy	3.90	.697	.359*	.247*				
4. Response efficacy	4.02	.664	.426*	.295*	.590*			
5. Intention to implement	1.47	.578	.540*	.390*	.482*	.440*		
6. Reactance	2.25	.826	-.512*	-.346*	-.355*	-.250*	-.598*	
7. Initial attitudes	2.99	.661	.370*	.423*	.267*	.234*	.387*	-.303*

* indicates $p < .001$

Measures

The below scales utilized 5-point Likert-type response formats. The full questionnaire is available in the supplementary materials. A correlation matrix with all measures is displayed in Table 2.

Initial Attitudes and Experience

Prior to viewing one of the three messages, participants answered six questions about their attitudes toward AIS. The questions were drawn from several sources related to AIS (Witzling et al. 2015, 2016; Hammond et al. 2019). We modified the first five questions slightly to emphasize wading anglers; for example, participants rated their perception of the threat of AIS on the quality of trout fishing (*no threat* [1] to *extreme threat* [5]). The final question asked participants how often they take action to prevent the spread of AIS, but we modified it to include six specific behaviors such as scrubbing fishing gear with a brush or draining all water from fishing gear. Reliability for this index was acceptable (α = .77).

Risk Behavior Diagnosis Scale

The Risk Behavior Diagnosis scale (Witte et al. 1996) is a twelve-item scale that measures each of the four key elements of the EPPM. It is often used in studies of the EPPM because it has been validated (Witte et al. 1996) and tested extensively (e.g., Liu et al. 2021). It includes three questions each for severity, susceptibility, self-efficacy, and response efficacy. Participants indicated their agreement with statements such as "I believe the impacts of aquatic invasive species are severe" (severity), "It is likely the streams and rivers where I fish will be affected by aquatic invasive species" (susceptibility), "I am able to clean my fishing gear to prevent the spread of aquatic invasive species" (self-efficacy), and "Cleaning fishing gear is effective in preventing the spread of aquatic invasive species" (response efficacy). Each of these measures had acceptable or strong reliability (severity, α = .86; susceptibility, α = .83; self-efficacy, α = 0.72; response efficacy, α = .78), so we retained all twelve measures. Following previous EPPM studies (e.g., Smith et al. 2008), we also collapsed the categories to create a single threat measure made up of severity and susceptibility questions (α = .88) and to create a single efficacy measure made up of response efficacy and self-efficacy questions (α = .83).

Intention to Implement

We measured participants' behavioral intentions regarding AIS prevention steps. We developed one question to ask how often participants planned to implement the AIS prevention steps on future fishing trips (*never* [1] to *always* [5]). Another four questions regarding participants' behavioral intentions were modified from Yun and Berry (2017) and MacGeorge et al. (2004). For example, "I will put an effort toward preventing the spread of aquatic invasive species to areas where I fish." These questions were anchored by *strongly disagree* (1) and *strongly agree* (5). The five-item index had good reliability (α = .84).

Reactance

Reactance to the message was measured using seven questions from Yun and Berry (2017). The questions asked whether participants thought the message was exaggerated, overstated, overblown, misleading, distorted, or manipulative and was "trying to deliberately change my thoughts." The reliability of this index was very good (α = .92).

Open-Ended Questions

Two open-ended questions assessed participants' thoughts and feelings regarding the message they viewed. The first question asked, "What are your thoughts about actions you might take in response to the message you viewed?" The second question asked, "What are your feelings about the message?" On average, participants' responses to the first question were 13.48 words, and responses to the second question were 9.83 words. We used these questions to screen respondents, as detailed above. Some participants responded to these questions with responses such as "I don't know" or "I have no thoughts," and while these responses did not warrant removing such participants from the dataset altogether, we wondered if these participants would have been likely to spend less time processing the message and thinking about their responses. Thus, we created a variable to control for these participants, which was significant for many of our models. Additionally, we used the open-ended responses to contextualize and add detail to the discussion. These quotations were selected from across the sample based on the degree to which they exemplified the concept in question.

Results

The Extended Parallel Processing Model

The EPPM predicts that the combination of high perceived threat and high perceived solution efficacy increases message acceptance and behavior change. We tested this model in the context of AIS using linear regression in Stata Version 17.0. Assumptions for linear regression such as independence and linearity were met. We conducted the analysis using a stepwise regression

Table 3. Standardized EPPM primary components predicting wading anglers' intention to implement the behaviors. *Note*: CI refers to confidence interval. LL denotes lower limit, and UL denotes upper limit.

	Estimate	*SE*	95% CI	
			LL	UL
Intention to implement AIS prevention steps				
Threat***	.343	.064	.215	.470
Efficacy***	.400	.061	.281	.519
Gender**	.141	.065	.014	.268
Age**	.006	.002	.002	.010
Initial attitudes**	.191	.070	.053	.328
Low attention***	−.352	.136	−.619	−.085

** .01 significance, *** < .001 significance

method, where non-significant control variables were dropped. This included education level, ethnicity, fishing frequency, and fishing experience. Gender, age, and low attention were significant for some models, as were participants' initial attitudes.

We began by regressing the combined measure of threat (severity and susceptibility) and the combined measure of efficacy (self and response) on intention to implement, controlling for gender and initial attitudes. The model was significant, $F(6, 295) = 63.42$, $p < 0.001$. Both threat ($\beta = 0.343$, $p < 0.001$) and efficacy ($\beta = 0.40$, $p < 0.001$) were statistically significant and had a clear positive association with the intention to implement AIS prevention steps. See Table 3 for full regression results. These results provide support for Hypothesis 1 and for the EPPM, indicating that greater perceived threat and greater perceived efficacy to enact the behaviors both contribute to anglers' intention to implement AIS prevention steps.

Turning to reactance, we again found general support for the EPPM. We again used linear regression to examine the association between the EPPM components and reactance, or the perception that the message is manipulative. Since Hypothesis 2 predicted that increases in perceived efficacy would be associated with lower reactance, we utilized the four sub-components in this model in order to separately examine self-efficacy and response efficacy. We regressed severity, susceptibility, self-efficacy, and response efficacy on reactance and found that the model was significant, $F(5, 296) = 31.51$, $p < 0.001$ (see Table 4). Severity ($\beta = -.404$, $p < 0.001$) and self-efficacy ($\beta = -.279$, $p < 0.001$) were both significant in this model. Susceptibility was not significant ($\beta = -.062$, $p = 0.304$). Response efficacy was significant ($\beta = .136$, $p = 0.035$) but with an effect in the opposite direction than the other variables. This suggests that higher perceptions of severity and self-efficacy are associated with less reactance to AIS messaging, but higher perceived response efficacy predicts more reactance. Thus, hypothesis 2 is partially supported.

We then turned to Research Questions 1 and 2, which asked whether a specific type of threat (severity or susceptibility) or a specific type of efficacy (self-efficacy or response efficacy) would be more strongly associated with

Table 4. Standardized EPPM sub-components predicting wading anglers' intention to implement the behaviors and reactance toward the message. *Note*: CI refers to confidence interval. LL denotes lower limit, and UL denotes upper limit.

	Estimate	SE	95% CI	
			LL	UL
Intention to implement AIS prevention steps				
Severity***	.197	.060	.078	.316
Susceptibility**	.153	.053	.049	.258
Self-efficacy***	.282	.055	.175	.390
Response efficacy*	.114	.056	.003	.224
Gender*	.136	.064	.010	.261
Age**	.006	.002	.002	.010
Initial attitudes*	.184	.070	.045	.323
Low attention***	−.374	.141	−.651	−.10
Reactance				
Severity***	−.404	.063	−.527	−.280
Susceptibility	−.062	.060	−.180	.056
Self-efficacy***	−.279	.064	−.404	−.154
Response efficacy*	.136	.064	.010	.263
Low attention***	.669	.152	.370	.968

* .05 significance ** .01 significance, *** < .001 significance

wading anglers' intention to perform AIS prevention steps. We again used linear regression to regress the individual measures for severity, susceptibility, self-efficacy, and response efficacy on intention to implement AIS prevention measures (Table 4). This model was again significant, $F(8, 293) = 49.24$, $p < .001$. In this model, severity ($\beta = 0.197$, $p = 0.001$), susceptibility ($\beta = 0.153$, $p = 0.004$), self-efficacy ($\beta = 0.282$, $p < 0.001$), and response efficacy ($\beta = 0.114$, $p = 0.044$) all had significant, positive relationships with intention to implement. The effect sizes were similar for severity and susceptibility, suggesting that wading anglers are attending to both the general severity of the threat and to personal susceptibility of the threat of AIS to the areas where they fish when deciding whether to implement AIS prevention steps. However, the efficacy results indicate that the anglers' perception of their own ability to take prevention steps plays an important role, as the effect size of self-efficacy was more than twice as large as that of response efficacy. Thus, our results show that in the context of AIS, self-efficacy is more strongly associated with the intention to implement behaviors to reduce the spread of AIS than response efficacy but that both threat sub-components have similar associations. This provides answers to RQ1 and RQ2.

We examined responses to the two open-ended questions and found that the themes from the quantitative data were repeated in the qualitative data. Participants frequently provided answers that referenced self-efficacy, such as "I don't see it as a big deal to wait between fishing trips to let my gear dry out" and "Do the steps." Fewer participants mentioned response efficacy, but those who did tended to discuss it in combination with self-efficacy, such as "I think I will remember to take all of these steps to help prevent it." Severity was also mentioned frequently, such as one participant writing that "I think it's a huge problem when there are invasive species."

Many of the responses that touched on either self-efficacy or response efficacy seemed to be predicated on the unsaid assumption that AIS are a serious threat. For example, one participant wrote, "I didn't know I could do those things to prevent AIS, now I know." Responses such as this one indicate that some participants who are willing to take AIS prevention steps are doing so because they understand the severity of the threat and want to take steps to prevent or reduce it. A few participants highlighted susceptibility but many of the severity threats were intertwined with themes of susceptibility, such as the participant who wrote that "we need to get *our* lakes and streams clean for all mankind" (emphasis added). These examples demonstrate that while all four components of EPPM were reflected in the open-ended responses, self-efficacy seemed to be at the forefront. This reflects our quantitative findings about the importance of self-efficacy.

AIS Messaging

We conducted a one-way ANOVA of the three conditions (only threat, only efficacy, and both threat and efficacy) on intention to implement AIS-prevention behaviors, controlling for initial attitudes. We found no significant differences among the three conditions, $F(6, 301) = 0.27$, $p = .762$. Similarly, there were no significant differences in reactance among the conditions, $F(4, 301) = 0.75$, $p = .474$. In combination, these results suggest that the differences in our messaging across the three conditions did not affect participants' attitudes toward AIS or willingness to engage in AIS prevention actions. Hypothesis 3 is, therefore, not supported.

Initial Attitudes

Throughout our analysis, we controlled for participants' initial attitudes toward AIS, which led us to explore the impact of initial attitudes on intention to implement prevention steps as compared to the impact of other factors. As a post-hoc analysis, we returned to our original linear regression model reported above and compared the association between initial attitudes and intention to implement the prevention steps to the associations between the EPPM sub-components and intention to implement. Participants' initial attitudes had an effect that was similar in strength to that of perceived severity and was stronger than susceptibility or response efficacy ($\beta = 1.86$, $p = .010$; see Table 4 for full results). This suggests that one of the best predictors of action is previous attitudes, showing a much stronger effect than a one-time exposure to a message.

Discussion

This study examined the relevance of the Extended Parallel Process Model (EPPM) to Aquatic Invasive Species (AIS) messaging for wading anglers and tested whether messages including both threat and efficacy information

were more effective in persuading wading anglers to implement preventive behaviors. We found support for the EPPM, as both efficacy and threat were related to the intention to implement AIS prevention behaviors. However, for a single exposure to the tested AIS messages, we found no effects of including only efficacy, only threat, or both efficacy and threat in the message. Rather, participants' initial attitudes were much stronger predictors of the intention to implement AIS prevention behaviors. We discuss these results and their implications in more depth below.

The Extended Parallel Processing Model

The Extended Parallel Process Model (Witte 1992) states that both threat and efficacy information are important elements of encouraging people to act in response to a threat. Both threat and efficacy were related to wading anglers' intention to engage in AIS preventative behaviors, in support of Hypothesis 1. This also supports the second proposition of the EPPM that when both perceived threat and efficacy are high, people will engage in the threat prevention behavior (Popova 2012). However, we found no differences among our three messages, in contrast to our expectations. While it is possible that this lack of effect is due to flaws in the EPPM itself or in our messaging, a closer examination of Table 2 suggests that a ceiling effect is a more likely cause. Participants' perceptions of the threat of AIS as well as their pre-exposure engagement in AIS prevention were both high, indicating that the wading anglers in our sample are already aware that AIS is a threat and report taking steps to prevent it. Smith et al. (2008) found similar results in their study of hearing loss in farmers, and their threat and efficacy scores in the control condition are comparable to our participants' initial attitudes (Table 2). The EPPM assumes that the audience has a low level of awareness of the threat before exposure to the message (Popova 2012), but other research with the EPPM has found that when audiences are already aware of the threat, exposure to one message may not in itself affect intentions to engage in the behavior (Muthusamy et al. 2009; Roskos-Ewoldsen et al. 2004). Thus, wading anglers who already know that AIS are a threat or have already been exposed to AIS messaging (Eiswerth et al. 2011; Kemp et al. 2017) may still fail to engage in all the necessary prevention steps (Connelly et al. 2016; Cole et al. 2016).

These findings align with existing research on the need for multiple exposures before persuasive messaging has an effect on behavior (Prochaska et al. 1992; Hampton et al. 2009), which provides insight into why our single exposure messages had little impact. Thus, our findings highlight the challenges of one-shot messaging, especially when targeting a hard-to-reach population such as wading anglers. It is particularly difficult to expose wading anglers to a message because there are countless access points and streams where they might fish. As our results demonstrate that wading anglers already

possess knowledge about the threat of AIS and their own efficacy in taking action, this suggests that researchers and practitioners should work to provide anglers with multiple exposures of messaging through outreach, bait shops (Dalrymple et al. 2013; Howell et al. 2014), water access points (Witzling et al. 2015), social media (Shaw et al. 2021), and others. In their open-ended responses, participants highlighted the role the message played in reminding them of the information they already knew. As one participant wrote, "While I do most of that anyway [sic] it's a good reminder to make more of a conscious effort to do it every single time." Still, other participants admitted that previous exposure to similar messaging has not changed their actions, such as the participant who wrote, "I've seen the sign many times amd [sic] admittedly not paid much attention. This has raised my awareness and I will start doing my part." This further highlights the importance of repeated messaging in forming anglers' initial attitudes, allowing posters to serve as reminders rather than the primary source of information. It may also emphasize the importance of relationship building and engaging anglers in ways that may be more likely to change opinions or beliefs, such as presentations to hobbyist groups (e.g., Trout Unlimited) or personal conversations in places anglers gather, like bait shops (Howell et al. 2014).

In addition to testing the model with composite measures for threat and efficacy, we tested the four components of the EPPM separately in order to answer our research questions. Severity of the threat, personal susceptibility to the threat, response efficacy (the effectiveness of preventative behaviors), and self-efficacy of engaging in the preventative behaviors were all significantly related to engaging in AIS prevention behaviors. Self-efficacy had the strongest association, followed by severity. Severity and susceptibility had similar associations with engaging in AIS prevention behaviors, a finding that differs from previous research; Golebie et al. (2021), for example, found that susceptibility (which they referred to as personal risk perceptions) was more strongly related to AIS preventative behaviors in boating anglers than severity (which they referred to as social risk perceptions or perceived threat directed at others). Given the conflicting results, future research should continue to explore both the severity and susceptibility dimensions of threat, and we recommend highlighting both severity and susceptibility in messaging given our results and the results of previous research. For example, AIS messaging could be tailored to the specific waterway (e.g., inland stream vs. Great Lake) and highlight the implications and threat of loss if AIS spread. These results reflect other persuasion research on the importance of connecting specific attitudes to specific behaviors (Fishbein and Ajzen 1975), such as using local campaigns to emphasize how AIS prevention behaviors at a specific location can preserve fishing at that location.

Self-efficacy was especially important in its relationship with AIS prevention behaviors, while response efficacy was significant but less strong. Thus, additional response efficacy information may not be as important in

promoting AIS prevention behaviors and may actually be counterproductive, as our study found that perception of more response efficacy information was actually associated with more reactance and backlash against the message. Anglers may have reached saturation with response efficacy and think "enough already" or believe that such messaging is condescending. Yet, even given their awareness, they may fail to engage in the prevention behaviors, so highlighting how to do these behaviors easily (self-efficacy) may be particularly important for AIS messaging. Since existing research suggests that wading anglers are fairly informed of the importance of AIS prevention (Eiswerth et al. 2011; Connelly et al. 2014; Kemp et al. 2017) but fail to engage in all the necessary steps (Cole et al. 2016; Connelly et al. 2016), our suggestion is to assume that wading anglers are generally informed of the actions they need to take and instead use messaging to highlight self-efficacy. For example, messages might provide helpful how-to hints to anglers or even just offer reminders to help them remember what they already know. Using behavioral prompts as a reminder is a common approach in community-based social marketing (McKenzie-Mohr 2011). These could take the form of branded boot brushes or keychains, and could include online advertising as a cost-effective option (Campbell et al. 2019). As one participant wrote, "I most likely will only take [preventative actions] if I suddenly remember too [*sic*]," suggesting that providing simple reminders to help wading anglers remember AIS prevention actions may be an effective form of messaging.

These results offer suggestions for AIS messaging that focuses less on the severity of the threat and more on the wading anglers' self-efficacy to reduce the spread of AIS. AIS threats are not life or death for wading anglers, and it is possible that while anglers believe that AIS are a threat and that prevention actions are effective, they find the messaging to be patronizing or overdone. This provides a tentative lens for understanding the unexpected relationship between response efficacy and reactance, in which higher perceived response efficacy predicts more reactance. Messages that acknowledge wading anglers' experience and knowledge of the threat while providing straightforward efficacy information may prove to be more effective, but further research is needed to confirm this. Future research could also explore alternative frames that may be perceived as less heavy-handed and manipulative and therefore may create less reactance than fear messaging. For example, one participant wrote that "maybe [the message] could be more sentimental than stark. Like passing down fishing to your kids as opposed to the red and black 'death is coming.'" Loss prevention messaging that highlights preserving good fishing for future generations, cherishing the waterbodies where they fish, or caring for the environment could be effective.

Limitations

There were multiple limitations in this study. First, this survey was cross-sectional and does not test causal relationships. Thus, we cannot unequivocally

state that efficacy or threat predict greater intention to engage in AIS prevention behaviors, though we did find a relationship between these variables. A second limitation relates to the measurement of participants' initial attitudes toward AIS prevention actions. Prior to viewing the messages, participants in all conditions responded to six questions about specific AIS prevention actions they might take. These actions were then highlighted in the only efficacy condition as well as in the efficacy and threat condition, but not in the only threat condition. Since we did not find significant differences among the three conditions (only efficacy; only threat; threat and efficacy) in participants' intention to implement AIS prevention actions, it is possible that merely viewing the actions in advance provided efficacy information to the only threat condition participants as well. However, our results also suggest that initial attitudes are more important than a single exposure, which indicates that the AIS prevention questions are unlikely to have affected participants' views to the same degree that their existing opinions do. A third limitation of this study is the lack of a quantitative pilot test of the experimental manipulation with a larger sample. Although we conducted a priori, qualitative testing of the experimental material with experts and incorporated feedback from those tests, it is possible that a larger sample would have allowed for additional revisions of our messaging. However, we note that other research (e.g. Dillard et al. 1996) has similarly found that messages intended to be fear-arousing do not always cause an increase in participant self-reported fear. Finally, we acknowledge that study participants were recruited using convenience sampling, and the sample characteristics demonstrate that our participants fish more frequently than the average angler. It is possible that individuals who choose to participate in a survey such as this are more likely to have been exposed to AIS-prevention messaging than the average wading angler, a factor that may have biased our results.

Conclusions and recommendations

In support of the EPPM, both efficacy and threat were related to the intention to implement AIS prevention behavior, but one-shot messaging based on EPPM was not related to intentions to engage in AIS prevention. This is likely because we found evidence of a ceiling effect, with wading anglers already well aware of the threat of AIS (Connelly et al. 2014; Kemp et al. 2017). Our work suggests that initial attitudes toward AIS are a better predictor of intended behavior than a single exposure to a sign or message. Outreach efforts that provide a single exposure to a message are likely best used as a reminder as opposed to something that will change attitudes and, ultimately, behavior. Consistent and repetitive messaging across media types and personal communications is likely needed to shift behavior. Relative to recreational boaters, reaching wading anglers can be difficult because they tend to be spread out more across water access points, making inspectors

or signage less practical. Wading anglers' willingness to travel greater distances to fish in remote streams and rivers makes them more difficult to reach and suggests that traditional AIS prevention messaging is less likely to reach this population at the critical moment. More frequent messages and reminders, perhaps through geofence advertising or reminders from a fishing mobile phone application, could be useful. It might also make engaging with wading anglers when they aren't fishing—at sport shows, club meetings, or stores—more important. Both in-person (Sharp et al. 2017) and online (Shannon et al. 2020) approaches have been shown to achieve positive results and could be used to work with wading anglers. Future messaging to wading anglers should emphasize the actions they can perform that reduce AIS introduction risk. Messages that acknowledge wading anglers' experience and knowledge of the threat while providing straightforward efficacy information may prove to be more effective.

This work builds on our understanding on how messaging can influence the aquatic invasive species attitudes and prevention actions of wading anglers. By combining our work with existing research on messaging and motivations (Wallen and Kyle 2018; Golebie et al. 2021; Shaw et al. 2021), we can continue to craft messages and approaches that help wading anglers achieve AIS-prevention goals.

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Author contributions

All authors contributed to every portion of the project.

Ethics and permits

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Supplementary material

The following supplementary material is available for this article:

Appendix 1. Survey instrument.

This material is available as part of online article from:
http://www.reabic.net/journals/mbi/2023/Supplements/MBI_2023_Hutchins_etal_SupplementaryMaterial.pdf