Has River use in the Mississippi River Basin changed Following the Invasion of Asian Carp?

HAS RIVER USE IN THE MISSISSIPPI RIVER BASIN CHANGED FOLLOWING THE INVASION OF ASIAN CARP?

Molly R. Spacapan
Illinois Natural History Survey
1816 South Oak Street, MC 652
Champaign, IL 61820
Phone: (217) 333-6880
Fax: (217) 244-0802

Craig A. Miller
Illinois Natural History Survey

Greg G. Sass
Wisconsin Department of Natural Resources

Abstract
Invasive bighead (*Hypophthalmichthys nobilis*) and silver carp (*H. molitrix)* are two federally injurious fishes, commonly referred to as Asian carp, found in the Mississippi River Basin. We hypothesized that silver carp, in particular, may negatively influence river users due to their tendency to leap from the water when startled. We tested whether Asian carp have influenced stakeholder use in a low fish density Mississippi River city and three high fish density cities of the Illinois River between June 2010 and July 2011 using intercept surveys. Our response rate was 39 %. Our results suggest that most respondents use these rivers for recreational purposes. Boating, swimming, and aesthetic uses of the Illinois River changed between 2010 and 2011. Nearly three quarters of Illinois River town users who have observed an Asian carp jump have been hit by one. Our findings may help susceptible river towns prepare for social, cultural, and economic changes due to these invasive fishes.

1.0 Introduction

Invasive bighead *(Hypophthalmichthys nobilis*) and silver carp *(H.* molitrix), collectively Asian carp, were introduced intentionally to the United States in the early 1970s to improve aquaculture pond water quality (Kolar et al., 2007). Shortly thereafter, they escaped aquacultural confinement and colonized the Mississippi River. Flooding of the Mississippi River in the early 1990's facilitated greater range expansions (Irons et al., 2007). As filter feeders, Asian carp primarily consume phyto- and zooplankton, literally eating as they respire (Jennings, 1988; Smith, 1989; Vörös, 1997). Their filtering feeding behavior is potentially problematic because prey may be reduced for native fishes (Irons et al., 2007). In the past decade, these highly fecund, rapidly growing species have established in the Mississippi River and its major tributaries (Junk et al., 1989; Kolar et al., 2007). The first documented bighead and silver carp were recorded in the La Grange Reach of the Illinois River in 1995 and 1998, respectively (Irons et al. 2007). Fifteen years later, a single bighead carp was captured in Lake Calumet, upstream of the aquatic nuisance species dispersal barrier in Romeoville, Illinois. This barrier serves to prevent aquatic invasive species transfers between the Illinois River and Lake Michigan (Hood, 2010; Sass et al. 2010); however, fishes appear to be capable of traversing this barrier.

Research on the basic biology and ecology of Asian carp in their non-native range is ongoing; however, little research has focused on their potential socio-economic influences on river communities. To our knowledge, there has been no research testing whether Asian carp have influenced human river usage. We hypothesized that silver carp, in particular, may negatively influence river users due to their propensity to leap from the water when startled. Our study quantifies river town community's use of the La Grange Reach of the Illinois River (a high Asian carp density reach) and a town on Pool 13 of the Mississippi River (a low Asian carp density pool).

1.2 Study Objectives

Our study objectives were to: (a) describe use of the La Grange Reach of the Illinois River and Pool 13 of the Mississippi River, and (b) test for changes in river use as a result of Asian carp between the two reaches that differ in Asian carp densities.

1.3 Study Sites

We selected three river communities (Beardstown, Havana, and Pekin, Illinois) located along the La Grange Reach of the Illinois River due to high densities of Asian carp (Figure 1). During the 2011 phase of this study, we also selected Bellevue, Iowa (located on Pool 13 of the Mississippi River) to serve as a control for our study (Figure 1). Pool 13 has not yet experienced high densities of Asian carp. We used our control site to test whether river use was independent of Asian carp presence.

Individuals who agreed to participate in our survey had the option to return the questionnaire on-site or via United States Postal Service (USPS) First-Class mail. The questionnaire consisted of one sheet tri-folded into a brochure, preaddressed, stamped, and a included a fastening mechanism (e.g., sticker). The front flap of the questionnaire included a picture of an Asian carp, the title of the survey, the research organization, and instructions for return. The first eight questions focused on experiences related to river use and the back of the brochure featured about five demographic questions.

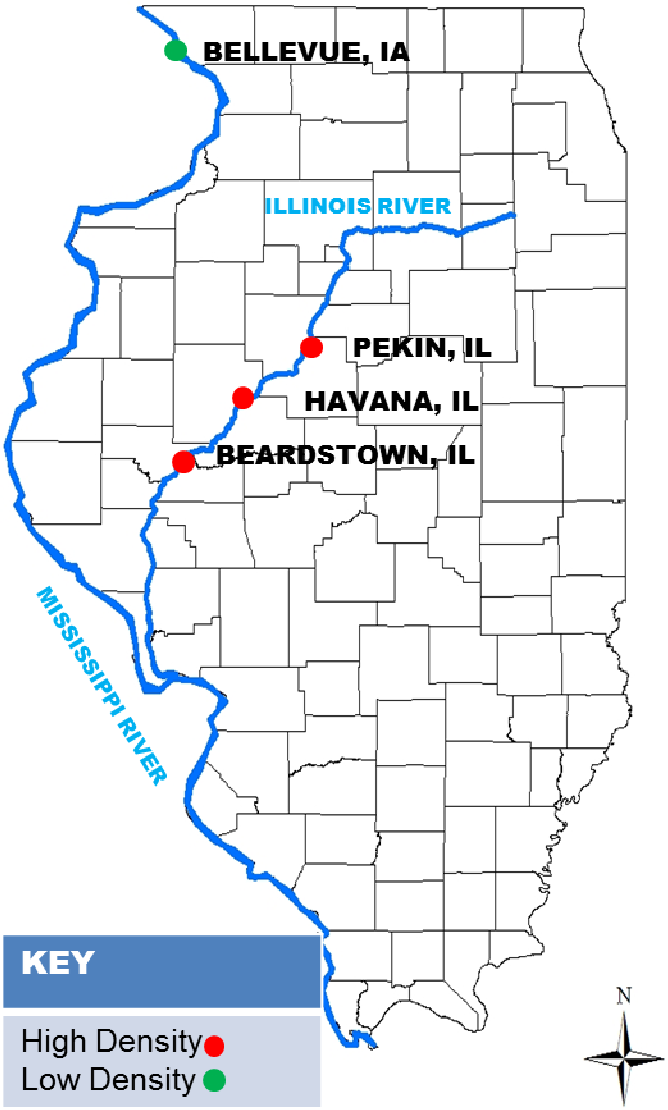

Figure 1. Map of sampling sites in Illinois and Iowa. Red dots denote high density Asian carp river communities and a green dot denotes a low density Asian carp river community.

2.0 Methods

We conducted intercept surveys using a modified Dillman (2009) approach.

We administered 400 surveys in Beardstown and Havana, Illinois and 560 in Pekin, Illinois between June 2010 and July 2011 to people over 18 years old. Two-hundred-and-fifty-three surveys were distributed to people 18 or older in Bellevue, Iowa in July, 2011. We collected data by distributing mail-back intercept surveys at one gas station and one river front area in each community for a total of eight sampling sites. We distributed a total of 1,213 questionnaires between June 2010 and July 2011; 469 usable questionnaires were returned for a response rate of 39%.

2.1 Data Analysis

We tested for changes between 2010 and 2011 in usage of the La Grange Reach of the Illinois River using Pearson's chi-squared test. Cramer's *V* was used to determine effect size. Frequencies were used to determine the number of times survey respondents identified as a user, what activities were participated in per year, Asian carp experiences encountered and demographic information.

Data were coded and entered into SPSS 19.0 (SPSS 2010). We employed Pearson's chi-square to determine significance and Cramer's to denote effect size for all comparative analyses.

3.0 Results

The average respondent was 40-69 years old (39%) and was of Caucasian decent (74%). Two-thirds of respondents were male and reported using the river for recreational or work purposes (83%). About one-third (32%) of respondents used the river at least one time per week and 61% of respondents used the river for 20 or more years. More than half (54%) of respondents reported using the river for recreational fishing; the popularity of this activity was followed closely by boating (52%). Hunting (22%), swimming (21%), and aesthetic uses (16%)(e.g., walking along the shore) were other commonly cited interactions with the river.

A majority (65%) of respondents from Illinois River sites saw an Asian carp jump, and a jumping Asian carp hit 72% of these respondents, or 47% of all high density respondents; however, few (9%) sustained injuries. Furthermore, few (15%) respondents sustained watercraft damage from Asian carp. Few (4%) Bellevue, Iowa respondents reported seeing a jumping Asian carp or being hit by an Asian carp.

Between 2010 and 2011, the proportion of people who participated in swimming decreased from 60% to 47%, and those participating in boating decreased 28% to 16%. Decreases in swimming and boating use were significant at $p<.001$ and .005, respectively. Reported use of the La Grange Reach for aesthetic reasons increased significantly from 10% in 2010 to 20% in 2011 ($p < .001$). Seventy-six percent of people reporting a change in boating use between 2010 and 2011 suggested this change was due to Asian carp ($X^2 = 11.2$, $p<.001$), but Cramer's V was minimal at 0.186. Fifty percent of people who reported a change in using the river for aesthetic reasons explained this increase was a result of Asian carp ($X^2 = 5.6$, $p=.018$), but Cramer's V was minimal at 0.132. Fifty-nine percent of total respondents reported changing their use as a direct result of Asian carp, whereas 41% of respondents reported their use had not changed due to Asian carp (Table 1).

Table 1. Summary of findings

River user	***%***
User	83
Non-User	17
Years using river	
<10	18
10-19	20
>20	61
Frequency of use	
Yearly	38
≥1x a week	32
Monthly	29
Weekly	20
Daily	12
High-density Asian carp experiences	
Seen jump	65
Hit	47
Watercraft damage	15
injured	9
Total respondent Asian carp experiences	
Seen jump	55
Hit	40
Watercraft damage	12
injured	8

Usage Changes	**2010%**	**2011%**	**%Change**	X^2	***p***	**Cramer's V**
Boating	60	46	14	7.875	0.005	0.152
Swimming	28	16	12	10.789	0.001	0.132
Aesthetic	10	20	10	10.768	0.001	0.152

Usage Change due to Asian carp	X^2	***p***	**Cramer's V**
Boating	11.189	0.001	0.186
Aesthetic	5.630	0.018	0.132

Age	
20-39 years	24
49-69 years	38
70+ years	36
Gender	
Female	32
Male	64
Ethnicity	
Caucasian	74
Latino/Latina	0.4
African American	0.2
Missing responses	25

4.0 Discussion

The average respondent to our survey was male and used the river one or more times a week for 20 or more years. Because our sample size was small, results collected in our study are most generalizable to river towns within the La Grange Reach of the Illinois River. The majority of the respondents used the river for recreational purposes; therefore, our findings may not be applicable for those who use the river for commercial purposes. Surprisingly, nearly three-quarters of respondents in high Asian carp density towns who witnessed an Asian carp jump have also been hit by an Asian carp. Only 4% of Bellevue Iowa residents have observed Asian carp jump and 100% of these respondents have been hit by a

jumping Asian carp. Our finding suggests that when Asian carp populations are robust, a person that observes a carp is likely to experience an impact. Our findings provide information for the public, so Illinois River users are properly educated of potential risks related to Asian carp. Additionally, our results provide support for labeling towns as having high- or low-density Asian carp populations.

The number of people who reported using the river for swimming and boating decreased between 2010 and 2011. Future research should test whether these changes are specific to these years (e.g., the economic climate between 2010 and 2011), or more suggestive of a current trend in changes in river use. The reduction in boating may be a result of perceived risk imposed by Asian carp. Changes in respondents' use of the river for aesthetic reasons between 2010 and 2011 may be a result of questionnaire development. Our 2010 questionnaire did not specifically ask respondents about their aesthetic uses of the river. Due to the frequency of people reporting this use, we included aesthetic uses as a river activity in the 2011 questionnaire. The change in aesthetic use of the La Grange Reach of the Illinois River between 2010 and 2011 should be investigated further to increase confidence in the results. Our study did not investigate reasons for changes in other activities.

Though a majority of survey respondents did report their use changing as a result of Asian carp density, nearly half of survey respondents reported no change in their river use. We propose three possibilities for this phenomenon. The first may be due to culture that exists in river towns. Resident's past and present lives, as well as the history of the town, are intertwined with the river. Therefore, the river is part of the community. It may take more than an invasive fish to radically change river use. The second possibility is that as of 2011, no deaths had been confirmed as a result of an Asian carp and few collisions have resulted in watercraft damage. Thus, Asian carp may not be perceived as life threatening. Lastly, most respondents used the river for recreational purposes. Equipment for these activities has already been purchased and money is already invested. Financial investment in recreational equipment, such as boats, may motivate people to continue using the river contrary to perceived risks.

Although we acknowledge the small sample sizes used in this study, our results provide an initial review of people's individual river use in relation to Asian carp densities in the Mississippi River Basin. As Asian carp populations along the La Grange Reach of the Illinois River continue to increase, researchers should continue to monitor how people interact and are affected by Asian carp. The potential changes Asian carp may impart on the relationship between the river and people of river towns could have important social, cultural, and economic implications in coming years. Further studies should be conducted to test for the extent of influence these fish have on river communities.

5.0 Acknowledgements

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6.0 Citations

Dillman, D. A. (2009).*Mail and internet surveys: The tailored design method* (second ed.). New York: Wiley.

Irons, K.S., Sass G.G., McClelland, M.A., & Stafford, J.D. (2007). Reduced condition factor of two native fish species coincident with invasion of non-native Asian carps in the Illinois River, USA. Is this evidence for competition and reduced fitness? Journal of Fish Biology 71, 258–273

Jennings, D. P. (1988). Bighead carp (Hypophthalmichthysnobilis): A biological synopsis. U.S. Fish Wildlife Service, Biology Report 88, 1–35.

Junk, W. J., Bailey,P. B.&Sparks, R. E.. (1989). The flood pulse concept in river–floodplain systems. Canadian Special Publication of Fisheries and Aquatic Sciences 106, 110–127.

Kolar, C.S., Chapman D.C., Courtenay W.R. Jr, Housel C.M., Williams J.D., & Jennings, D.P. (2007). Bigheaded carps: A biological synopsis and environmental risk assessment. American Fisheries Society Special Publication 33, Maryland, USA.

Sass, G.G., Cook, T.R., Irons, K.S., McClelland, M.A., Michalels, N.N., O'Hara, T.A., &Stroub, M.R. (2010). A mark-recapture population estimate for invasive silver carp (Hypophthalmichthysmolitrix) in the La Grange Reach, Illinois River. Biological Invasions 12, 433-436.

SPSS, Inc. (2010). SPSS base 19.0 for windows user's guide. SPSS Inc., Chicago, IL, USA.

Smith, D. W. (1989). The feeding selectivity of silver carp, Hypophthalmichthysmolitrix Val. Journal of Fish Biology 34, 819–828

Vörös, L. (1997). Size-selective filtration and taxon-specific digestion of plankton algae by silver carp (Hypophthalmichthysmolitrix Val.). Hydrobiologia 342, 223–228.