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Annex 1: Asian Carp Expert Elicitation Question Set
Annex 2: A. lacustre Expert Elicitation Question Set
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Introduction
This appendix describes the process by which the probabilities of establishment (P(establisment)) for Asian carp (both Bighead and Silver carp) and A. lacustre were estimated, as well as the results of that process. Each species is addressed separately, with the Bighead and Silver carp process described first, followed by the A. lacustre process. Each species narrative is developed as follows:

- Estimating P(establishment)
- The Experts
- The Elicitation
- The Model
- The Composite Expert
- The Results
  - Probability of Establishment If No New Federal Action Is Taken (No New Federal Action Alternative)
  - P(establishment) Estimates by expert associated with each alternative Using Individual Expert Opinions
  - P(establishment) Estimates by alternative Using Individual Expert Opinions
- Comparison of the Technology and Nonstructural Alternative to the No New Federal Action Alternative

1. Bighead and Silver Carp

1.1. Estimating P(establishment)
The GLMRIS Risk Assessment provided qualitative estimates of the P(establishment) of Bighead and Silver Carp. The overall P(establishment) was defined in that document as consisting of five probability values using conditional notation:

\[ P(\text{establishment}) = P(\text{pathway}) \times P(\text{arrival}|\text{pathway}) \times P(\text{passage}|\text{arrival}) \times P(\text{colonization}|\text{passage}) \times P(\text{spread}|\text{colonization}) \]

Each of the probability element values assumes that the preceding element has occurred (e.g. passage must occur for colonization to be possible). The probability of these independent events is, hereafter, represented more simply as:

\[ P(\text{establishment}) = P(\text{pathway}) \times P(\text{arrival}) \times P(\text{passage}) \times P(\text{colonization}) \times P(\text{spread}) \]

The establishment elements are generally defined as:

- P(pathway) - the probability that a complete aquatic pathway is available for interbasin transfer between the Mississippi River Basin (MRB) and Great Lakes Basin (GLB) through the Chicago Area Waterway (CAWS) aquatic pathway;
- P(arrival) - the probability of Bighead and Silver Carp arriving in the Dresden Island Pool located upstream of Dresden Dam to below BRLD;
- P(Passage) – the movement of Bighead and Silver Carp through the CAWS from below BR to Lake Michigan;
- P(colonization) - the probability of Bighead and Silver Carp colonizing in Lake Michigan, and;
- P(spread) - the probability of Bighead and Silver Carp spreading beyond Lake Michigan and into the other Great Lakes.
The values for $P(\text{arrival})$, $P(\text{passage})$, $P(\text{colonization})$, and $P(\text{spread})$ were obtained via expert elicitation as these values are currently unknown and there was no reasonable expectation of such data becoming available in the near-term.

Initially, it was envisioned that the independent probability values would be multiplied to give an estimation of the overall $P(\text{establishment})$. However, it was not possible to multiply the five probability values due to the biological complexities of Bighead and Silver Carp establishment in the GLB. For example, the number of fish that could pass from BRLD into Lake Michigan is influenced by the number of fish below BRLD. Therefore, passage must be estimated for multiple $P(\text{arrival})$ scenarios, each with different assumptions about the numbers of Bighead and Silver Carp that arrive below BRLD. Similarly, passage could not be defined as the probability that any one fish passes into Lake Michigan, because more than one fish is required for colonization to occur.

To account for these and other complexities, several variations of the basic $P(\text{establishment})$ model were considered. The ideal quantitative model, one that would include a dynamic population model capable of allowing fish to grow, reproduce, die off, find habitat and each other, was not within the time and budget constraints of the GLMRIS-BR. Therefore, a $P(\text{establishment})$ model that utilized quantitative values elicited from ANS experts was developed. It was necessary that the model reliably enabled the team to distinguish among the six GLMRIS-BR Alternatives. The questions the model needed to answer in a credible way were:

- What is the probability of establishment of Bighead and Silver carp by 2021/2031/2071 if the No New Federal Action Alternative is implemented?
- What is the probability of establishment of Bighead and Silver carp by 2021/2031/2071 if the Nonstructural Alternative is implemented?
- What is the probability of establishment of Bighead and Silver carp by 2021/2031/2071 if the Technology Alternative-Electric Barrier is implemented?
- What is the probability of establishment of Bighead and Silver carp by 2021/2031/2071 if the Technology Alternative- Acoustic Fish Deterrent is implemented?
- What is the probability of establishment of Bighead and Silver carp by 2021/2031/2071 if the Technology Alternative- Acoustic Fish Deterrent with Electric Barrier is implemented?
- What is the probability of establishment of Bighead and Silver carp by 2021/2031/2071 if the Lock Closure Alternative is implemented?

With answers to those questions it would be possible to investigate the answers to many other questions, such as the risk reduction attributed to any plan.

### 1.2. The Experts

An expert elicitation was needed because there was and is no credible data for several of the model inputs. An expert elicitation was the most cost-effective and reliable way to characterize the uncertainty about the $P(\text{establishment})$ values for the ANS control alternatives. Aquatic biologists on the GLMRIS-BR team identified experts in the field (e.g., researchers, academia, etc). Experts had to be knowledgeable and have extensive experience with Bighead and Silver Carp life cycles, fisheries management, invasion biology, and aquatic nuisance species management. Six experts were identified to participate in the Bighead and Silver carp elicitation, they are:

- Duane Chapman, US Geologic Survey, Columbia Environmental Research Center
- Greg Conover, U.S. Fish and Wildlife Service, Large Rivers Fisheries Coordination Office, Midwest Region
• Kevin Irons Aquatic Nuisance Species Program Manager, Illinois Department of Natural Resources
• Jack Killgore, US Army Corps of Engineers, U.S. Army Engineer Research and Development Center, Environmental Laboratory
• Nicholas Mandrak, Department of Biological Sciences, University of Toronto Scarborough
• Greg Sass, Escanaba Lake Research Station, Wisconsin Department of Natural Resources.

The alphabetical order in which the experts are listed here does not correspond to the expert numbers that follow. The CV’s of the experts are found in Addendum 1 to this appendix.

1.3. The Elicitation Process
Once the expert panel was assembled they were provided with a read ahead package of reference materials and factsheets describing:

1. The Elicitation Methodology
2. Brandon Road Lock and Dam (BRLD)
3. Existing Electric Barriers at Romeoville, IL
4. General Information on Bighead and Silver Carp
5. Current Activities
6. No New Federal Action Alternative
7. Nonstructural Alternative
8. Technology Alternative - Electric Barrier
9. Technology Alternative - Acoustic Fish Deterrent
10. Technology Alternative - Acoustic Fish Deterrent and Electric Barrier
11. Lock Closure
12. Pertinent Literature References.

The expert elicitation process took place at the Chicago District Offices from November 30 through December 4, 2015. The elicitation process began with a three day meeting of the experts with study team members, the elicitations were then conducted over the next few days. The purposes of the three-day meeting included:

• Site visits to BRLD for the expert panel
• Providing experts an opportunity to learn details of the alternative plans from top domain experts
• Discussion and information sharing about Bighead and Silver Carp and alternative plans among the experts
• Arriving at common assumptions, where assumptions were needed
• Training with the elicitation technique.

Highlights of the three-day pre-elicitation meeting included group discussions of the following topics:

• Operation of BRLD
• Aquatic nuisance species of concern overview
• FluEGG model
• Barge entrainment of fish at the existing electric barrier
• Influential factors for Bighead and Silver Carp arrival at BRLD including the four population arrival scenarios
• Operation and weaknesses of the electric dispersal barrier at Romeoville, IL
- 2-D hydraulic modeling of BR L&D approach channel and conditions under which fish can be carried across the barrier
- No New Federal Action Alternative
- Influential factors for Bighead and Silver Carp passage from BR L&D to Lake Michigan via the CAWS under FWOP conditions
- Nonstructural Alternative overview
- Technology Alternative-Electric Barrier overview, included the flushing lock and fish entrainment
- Technology Alternative -Acoustic Fish Deterrent overview including laboratory and field trials
- Technology Alternative- Acoustic Fish Deterrent and Electric Barrier overview
- Lock Closure Alternative overview
- Influential factors for Bighead and Silver Carp passage from BR L&D to Lake Michigan via the CAWS with alternatives
- Hydraulic and water-quality data collection for the investigation of Great Lakes tributaries for Bighead and Silver Carp spawning and egg-transport suitability
- Could a Bighead and Silver Carp population establish in the Great Lakes from a small introduction?
- Influential factors that impact Bighead and Silver Carp Colonization
- Influential factors that impact Bighead and Silver Carp spread
- Recap of elicitation process/alternatives
- Elicitation process and calibration exercise.

For a description of the alternatives, refer to the main report, chapter 6, Alternative Formulation. Following most of these discussions the experts identified the key factors and assumptions for each discussion. These were recorded and reviewed with the expert before and during the individual elicitations as appropriate.

1.4. The Elicitation

An elicitation provides useful information but it does not provide answers. An elicitation does not create new knowledge. It is not appropriate to treat an elicited value, range of values or distribution of values as “a fact.” Rather, the numerical values elicited from the experts were used as inputs to the \( P(\text{establishment}) \) model described below.

When faced with uncertainty, especially in controversial or emergency situations, decision-makers seek agreement or a clear consensus from experts. However, it is not always reasonable to expect consensus on a difficult question, especially the prediction of chance events—floods, hurricane landings and paths, failure of components and infrastructure, and establishment of aquatic nuisance species (Aspinall, 2010). Consensus is not certainty. Efforts to force experts who disagree to agree or reach consensus may dampen the value of the work of the elicitation, because the goal of an elicitation is to quantify uncertainty, not to disguise it through forced consensus. When multiple estimates exist the multiple estimates can be used individually in the analysis to help define the range of impacts that can be expected. The multiple estimates can also be pooled to define the range of uncertainty. Both individual and composite expert results are presented in this appendix.

The actual elicitation were conducted individually with each expert in the days following the three-day meeting. The elicitation team consisted of one expert panel member, one Bighead and Silver Carp domain expert, one USACE alternative plan domain expert, and one elicitation facilitator. The domain experts were available to answer any questions that arose for the expert panel member.
Before each new quantity or scenario was elicited, the panel expert was reminded of the key factors identified by the plenary panel of the experts and a summary of the features of each plan scenario was provided.

The elicitation consisted of a series of questions related to the P(establishment) elements. Responses to these questions were elicited for each of the six alternatives. Each expert provided numerical estimates for the following:

- Probability that Asian carp populations sizes (negligible, small, medium, large) would arrive at BRLD under the No New Federal Action Alternative and the Nonstructural Alternative scenarios for three time frames 2021, 2031, 2071
- An estimate of the annual number of fish that would pass from below BRLD into Lake Michigan under three carp population sizes for each of six alternative future scenarios
- An estimate of the cumulative threshold number of fish that would have to enter Lake Michigan by 2021, 2031, and 2071 that could result in colonization
- An estimate of the probability that Asian carp spread beyond Lake Michigan given that a colony is established.

The complete set of 26 questions are included in Annex 1 to this Appendix. The expert’s responses were recorded on an input sheet in a spreadsheet file that was visible to the expert at all times. Following each question the expert was queried about the main considerations that shaped their response. Experts were informed they could change their initial answers at any time they desired and were encouraged to do so including after the conclusion of the elicitation. After providing answers to the questions, each expert was shown how the model would use their inputs to calculate the probabilities of colonization and establishment. The experts were told they would be provided with a summary of the results obtained from their expert opinions and at that time they would have the option of revisiting any or all of their answers to the elicitation questions. Once these probabilities were estimated each expert was given the opportunity to review the results of their model runs as reasonably representative of their views. Only one expert chose to modify his inputs as a result of the calculations.

In January 2016, new sampling data became available that indicated three Silver Carp larvae were found in the Dresden Island Pool of the Dresden Island Pool, and Asian carp eggs (either Silver or Bighead Carp) were identified in the Marseilles and Starved Rock pools of the Illinois River. These detections are within areas that Bighead and Silver Carp have historically been captured; however, the larval fish capture was approximately 90 miles upstream from prior detections. See http://www.asiancarp.us/news/CarpEggs.htm. Every member of the expert panel was provided with the new data and afforded an opportunity to modify any or all parts of their elicitation. One of the six experts opted to modify his elicitation values.

The next section describes how the elicited values were used in the model to estimate the probability of establishment.

1.5. The Model

A numerical model was constructed using Microsoft Excel and Palisades @Risk software. The logic of that model is presented in the following paragraphs and figures. Twenty-eight Input quantities were estimated individually by the experts. These input values were used to generate 28 probability distributions for each expert that characterized the expert’s uncertainty about each quantity. The model, described below, estimates a number of fish that could pass through the CAWS using population arrival and fish passage quantities from the experts. That number of fish is compared to a colonization threshold.
value. The model is iterated to obtain an estimate of P(colonization), which when multiplied by the P(spread) yields an estimate of P(establishment). The model was run separately for each expert. Figure 1 introduces the initial calculations of the simulation model. The values in column C of Figure 1 are randomly generated from each expert’s cumulative distribution function (CDF) that was provided in answer to the following question:

“Considering the currently existing system that is in place, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could pass from below the dam to Lake Michigan in a year?”

The expert provided a minimum and maximum quantity as well as 33rd and 67th percentile values.

In a similar fashion, the annual fish quantities found in columns D and E, were derived from the expert’s CDF’s derived from similar questions for medium and large populations. Each iteration of the model generated a different and unique pattern of fish that could make their way through the existing pathway from below BRLD into Lake Michigan. Thus, the number of fish that make their way along that pathway depends very directly on the size of the population of Bighead and Silver Carp that arrives downstream of the lock and dam.

```
<table>
<thead>
<tr>
<th>Year</th>
<th>Small Population</th>
<th>Medium Population</th>
<th>Large Population</th>
<th>Population Size Arrived</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>74</td>
<td>655</td>
<td>3299</td>
<td>Population size 1 2 3</td>
</tr>
<tr>
<td>2016</td>
<td>29</td>
<td>220</td>
<td>370</td>
<td>Population Sequence 1 2 3</td>
</tr>
<tr>
<td>2017</td>
<td>126</td>
<td>194</td>
<td>2237</td>
<td>Negligible 0 0 0</td>
</tr>
<tr>
<td>2018</td>
<td>51</td>
<td>453</td>
<td>2248</td>
<td>Small 506 539 1844</td>
</tr>
<tr>
<td>2019</td>
<td>135</td>
<td>799</td>
<td>2764</td>
<td>Medium 2624 1364 15905</td>
</tr>
<tr>
<td>2020</td>
<td>72</td>
<td>170</td>
<td>389</td>
<td>Large 14468 21757 54050</td>
</tr>
<tr>
<td>2021</td>
<td>19</td>
<td>133</td>
<td>3161</td>
<td>Select 506 1364 54050</td>
</tr>
<tr>
<td>2022</td>
<td>88</td>
<td>11</td>
<td>3111</td>
<td>Sum of fish 506 1870 55920</td>
</tr>
<tr>
<td>2023</td>
<td>85</td>
<td>59</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>2024</td>
<td>7</td>
<td>54</td>
<td>2800</td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td>38</td>
<td>424</td>
<td>3131</td>
<td></td>
</tr>
<tr>
<td>2026</td>
<td>58</td>
<td>21</td>
<td>2819</td>
<td></td>
</tr>
<tr>
<td>2027</td>
<td>57</td>
<td>62</td>
<td>1809</td>
<td></td>
</tr>
<tr>
<td>2028</td>
<td>88</td>
<td>255</td>
<td>360</td>
<td></td>
</tr>
</tbody>
</table>
```

Figure 1: A portion of the model used to estimate the probability of establishment of Bighead and Silver Carp
Figure 2 shows an example of a CDF used to generate the values in column C. This distribution was constructed using the four values elicited from the expert. Each cell in column C has a copy of this CDF. A value is randomly selected from this distribution and displayed in the model. In a similar fashion, there is a CDF for each cell in columns D and E through the year 2071. For the GLMRIS-Brandon Road Study, USACE utilized a 50-year period of analysis. However, in order to most realistically represent ANS establishment, the probability of establishment model incorporated all years beginning in 2015 (when the elicitation was conducted) through 2071.

![Example Expert Fish Passage CDF, Small Population](image)

**Figure 2: CDF of fish passage given a small population of Bighead and Silver Carp have arrived below Brandon Road Lock and Dam**

Cells G9 through J12 in Figure 1 indicate how the model estimates the size of the population that has arrived below the lock and dam. In the iteration shown it is assumed that a small size population density (1) exists from 2015-2021, a medium population density (2) exists from 2022-2031 and a large population density (3) is present from 2032-2071. The population densities for small was equal to population density in the Dresden Island Pool; medium was equal to the population density of the Starved Rock Pool; and high was equal to the population density of the Peoria Pool. The densities were based on Asian carp monitoring data collected between 2012-2014 as displayed in Figure 2b (Coulter, 2015). Row 12 assures that this sequence of population sizes never gets smaller over time. Hence, for example, a sequence of negligible (0), large (3), small (1) populations density is not possible, it would be changed to (0), (3), (3).

---

1 Coulter, D., 2015, E-mail communication, Southern Illinois University, Dec. 2.
Figure 3 shows the probability of different fish population densities arriving below BRLD during the period 2032-2071 as a discrete distribution, constructed from weights provided by the expert.

These probabilities of arrival differ for each of the three time periods. They were arrived at by asking the experts:

When thinking about the number of Bighead and Silver Carp that could arrive at Brandon Road by the year 2021, please rate the following population sizes by their relative probability of arriving (larger numbers indicate a higher probability):
Negligible Population__________
Small Population ______________
Medium Population ____________
Large Population _______________
TOTAL 100 Points
Figure 3: Expert estimation of the probability of arrival for negligible (0), small (1), medium (2), or large (3) carp populations for the period 2032-2071 below Brandon Road Lock and Dam

Cells G13 through J16 in Figure 1 simply sum the number of fish for a population of a given size and a given time frame. Thus, cells C11 through C17 sum to 506 fish. Cells H17 through J18 add up the subtotals of fish. In this iteration 506 fish get through the pathway from 2015-2021 because a small population size is present. From 2015 through 2031, 1,364 fish pass through the system. A total of 55,920 fish are estimated to pass through the system from 2015 through 2071. These would reflect fish of every size. After estimating the number of Bighead and Silver Carp that have passed into Lake Michigan, the next step is to determine whether that number is enough to result in the establishment of a sustainable colony of carp in Lake Michigan.

Bighead and Silver Carp colonization threshold values were generated from CDF’s developed by the experts in response to the following question:

“What is smallest total number of fish that must make it to Lake Michigan between now and the end of 2021 to convince you that those fish are, by themselves, numerous enough to colonize in Lake Michigan at some point in the future?”
The experts were asked to answer the same question for 2031 and 2071 as well. Figure 4 shows the threshold number of fish required to establish a sustainable colony by time period. These threshold values were randomly sampled from a CDF constructed of four points (minimum, maximum, 33rd and 67th percentiles) provided by the expert. For this iteration, if 4,781 or more fish enter Lake Michigan from 2015-2021 a colony will be established. If 14,340 fish enter between 2015 and 2032 there will be a colony established, as there will be if 47,389 fish enter the Lake between 2015 and 2071.

![Colonization Threshold Table](image)

<table>
<thead>
<tr>
<th></th>
<th>2021</th>
<th>2031</th>
<th>2071</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colonization Threshold</td>
<td>4781</td>
<td>14340</td>
<td>47389</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2021</th>
<th>2031</th>
<th>2071</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occurs?</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>P(Col)</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

**Figure 4: Colonization threshold values and colonization check where 0 means no colonization and 1 means colonization for the time period shown.**

Only 506 fish arrived by 2021 (Figure 1), that is less than the threshold 4,781 so no (0) colonization occurred by 2021 in this instance (Figure 4). However, 55,920 fish passed into Lake Michigan by 2071 (Figure 1) and that exceeds the 47,389 fish threshold for 2071, so colonization is assumed to have occurred (Figure 4). Model logic assures that if colonization occurs in an earlier period it occurs in the later periods as well.

Fifty simulations of 1,000 iterations each were run for the steps described above. Summing the zeroes and ones and dividing by 1,000 a point estimate of P(Colonization) can be calculated for each simulation. Fifty simulations generated a sequence of 50 point estimates of the probability of colonization. For example, in the first simulation of 1,000 iterations (not shown) colonization resulted in 427 of those iterations yielding a point estimate of P(colonization) of 0.427. The mean of those 50 simulations is 0.440 and the standard deviation is 0.008. These two parameters, along with the Central Limit Theorem enable us to represent the P(colonization) as a normal distribution that is written into the P(col) Distribution row seen in Figure 7 below.
Figure 5 shows an example of a cumulative distribution function used to generate a random threshold value, in this case for time 2071. Figure 6 shows an example of a sampling distribution generated for $P(\text{Colonization})$ through the 50 simulations of 1,000 iterations each.

Figure 5: Expert CDF for colonization threshold for Bighead and Silver Carp entering Lake Michigan from 2015 through 2071.

Figure 6: Sampling distribution derived for $P(\text{Colonization})$ for the 2015-2071 time period.
After $P(\text{colonization})$ was estimated, the final step was to estimate $P(\text{establishment})$. This was done in a second stage of the model by multiplying the $P(\text{colonization})$ (generated in the first stage of the model) by $P(\text{spread}|\text{colonization})$ to get $P(\text{establishment})$. Figure 7 shows a single value for $P(\text{spread}|\text{colonization})$ of 0.81. This spread probability was obtained by asking each expert the following:

“Assume that Asian Carp have a colony in Lake Michigan. What is the probability that Asian Carp will spread beyond Lake Michigan?”

In the model, the $P(\text{colonization})$ values are multiplied by the probability of spread to obtain the $P(\text{establishment})$ values in columns R, S, and T of Figure 7 in a simulation of 10,000 iterations.

<table>
<thead>
<tr>
<th>Q</th>
<th>R</th>
<th>S</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability of Spread</td>
<td>0.808246077</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td>2031</td>
<td>2071</td>
<td></td>
</tr>
<tr>
<td>$P(\text{Est})$</td>
<td>0.032597</td>
<td>0.10863533</td>
<td>0.352522</td>
</tr>
</tbody>
</table>

50 simulations of 1000 iterations were run to obtain the sampling distribution of $P(\text{Col})$ below.

| $P(\text{Col})$ Distribution | 0.04033 | 0.13440873 | 0.436157 |

Figure 7: $P(\text{colonization})$ and $P(\text{establishment})$ calculations in the model spreadsheet.

The calculations described above were performed for each of the six Alternatives: No New Action, Nonstructural, Technology Alternative-Electric Barrier, Technology Alternative-Acoustic Fish Deterrent, Technology Alternative-Acoustic Fish Deterrent with Electric Barrier, and Lock Closure. The results for the No New Federal Action Alternative are shown in Figure 8. The sample output in Figure 8 is derived from numerical values provided by a single expert. Each expert had a uniquely shaped distribution that was uniquely located on the zero to one probability scale. Six different experts were elicited and each expert provided inputs for the six different Alternatives. The ANS control alternatives act on the arrival and passage components of $P(\text{establishment})$. For example, the alternative control measures could alter the probability of the arrived population by size or affect the numbers of fish that could pass through the system. These different values would lead to different values of $P(\text{establishment})$ for each ANS control alternative.
1.6. The Composite Expert

When multiple estimates are available from multiple experts, it is common practice to aggregate the results of the expert elicitations. That can be done using behavioral methods, which rely on having the experts interact together to construct a single estimate. That was not an appropriate choice for GLMRIS-BR because the team was aware of and wanted to demonstrate the range of opinions (i.e. uncertainty) that exist about the likelihood of carp becoming established. Instead a mathematical aggregation of the results was used. Bolger and Rowe (2015) concluded that the costs of weighting the experts outweighs the benefits of doing so. Simple averaging of the model outputs for each expert was used because each expert was considered equal in credibility so equal weights were assigned to each. This method obtained “x” values for the minimum and maximum values and for percentiles 1, 5, 10, …, 95, 99. The x values were averaged across percentiles to obtain a composite expert. While the use of a linear opinion pool like this is widely debated in the literature there are several references supporting the use of a simple average:


The composite expert represents the average of all six experts and as such it is not representative of any one expert. However, the composite expert values are useful because they facilitate the comparison of the

![Figure 8: Sample model output showing P(establishment) in 2071 for a selected expert for the No New Federal Action Alternative condition.](image)
P(establishment) values for the six Alternatives. In this Appendix, the P(establishment) model outputs are presented for both individual experts and the composite expert.

1.7. Results
The probabilities presented in the sections that follow were not directly provided by the experts. They were directly estimated using values provided by the experts as inputs to the model described above. Thus, it is most proper to characterize these values as estimates based on the experts’ opinions.

1.7.1. Probability of Establishment If No New Federal Action Is Taken (Federal Without Project Condition)
Figure 9 shows the P(establishment) of Bighead and Silver Carp in the GLB based on inputs from the six experts and the composite expert as a box and whisker plot. The solid box in the center captures the middle 50% of all values. The whisker to the left depicts the lowest 25% of values, the whisker to the right depicts the highest 25% of values. Dots to the left or right of the whiskers indicate outlier values, the dots should be thought of as extensions to the whiskers. The span of the box and whisker plot is indicative of the uncertainty generated with the expert’s inputs, but the span also depends on the scale of the axis, which changes in some figures that follow. The model output indicated that there was less than a 10% chance that Bighead and Silver Carp will become established by 2021, the earliest date by which the nonstructural plan could be in effect. Using the composite expert to characterize this uncertain value there is less than a 4% chance of establishment.

Figure 9: P(establishment) of Bighead and Silver Carp by 2021 for the No New Federal Action Alternative based on estimates provided by each expert and for the composite expert.
If the period under consideration increases to 2015 through 2031 the P(establishment) of Bighead and Silver Carp increases (Figure 10). All experts agree that P(establishment) was less than 35% at 2031. Five of the six experts have the probability at around 10% or less. The composite expert suggests the probability is about 10% or less (Figure 10).

Figure 10: P(establishment) of Bighead and Silver Carp by 2031 for the No New Federal Action Alternative based on estimates provided by each expert and for the composite expert.

The P(establishment) by 2071 is subject to the greatest uncertainty (Figure 11). One expert (1) shows establishment as virtually assured while three experts suggest there is less than a 5% chance of establishment. The estimates for the other two experts are much less certain about the outcome. Using the composite expert the P(establishment) by 2071 is between 22 and 36%.
Figure 11: $P(\text{establishment})$ of Bighead and Silver Carp by 2071 for the No New Federal Action Alternative based on estimates provided by each expert and for the composite expert.

If we use a 50% chance of establishment as the equally likely point and the most uncertain value of all, then this analysis suggests that most expert-based probability estimates consider the establishment of Bighead and Silver Carp in the Great Lakes to be more unlikely than likely. No estimate exceeded 0.5 for the time periods 2021 and 2031. Estimates based on expert 1’s opinions suggest establishment is highly likely. The upper range of estimates based on expert 2 also exceed a 0.5 chance. Most of expert 2’s values and all of those of the other four experts were less than 0.5.

There are considerable differences among the estimates obtained from the expert opinions, suggesting there is a great deal of uncertainty about whether Bighead and Silver Carp will establish in the GLB. The inputs provided by Experts 3, 4, and 5 resulted in low estimates of $P(\text{establishment})$, with no estimate in excess of 5% and many far less than that. In contrast, the opinions of Expert 1 lead to a $P(\text{establishment})$ estimate between 93 and 99%. The two intermediate calculations for experts 2 and 6 tend toward the lower half of the probability spectrum. The results indicate that any preconceived belief about the likelihood of Bighead and Silver Carp establishing could be supported by the opinion of at least one of our experts.

Despite this uncertainty, a composite expert has been created by taking the average of all six experts (Figure 12)\(^2\). Table 1 provides a numerical summary for the composite expert estimate of $P(\text{establishment})$ under the No New Federal Action scenario for three time periods.

---

\(^2\) The CDF for each expert is displayed and x values are averaged for the minimum, 1\(^{st}\), 5\(^{th}\), 10\(^{th}\), 15\(^{th}\), …, 95\(^{th}\), 99\(^{th}\) percentiles and the maximum value to construct a composite expert CDF.
Table 1: Composite expert estimates of $P(\text{establishment})$ of Asian carp under the No New Federal Action scenario for three time periods.

<table>
<thead>
<tr>
<th>Composite Expert No New Federal Action Scenario</th>
<th>$P(\text{est})$ 2071</th>
<th>$P(\text{est})$ 2031</th>
<th>$P(\text{est})$ 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>0.22</td>
<td>0.06</td>
<td>0.01</td>
</tr>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; Quartile</td>
<td>0.26</td>
<td>0.08</td>
<td>0.02</td>
</tr>
<tr>
<td>Median</td>
<td>0.29</td>
<td>0.08</td>
<td>0.02</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; Quartile</td>
<td>0.32</td>
<td>0.09</td>
<td>0.02</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.36</td>
<td>0.11</td>
<td>0.03</td>
</tr>
</tbody>
</table>

The probability that Asian Carp will become established in the Great Lakes at some point in the future because of what happens between now and 2071 is uncertain. That chance is between 22% and 36%.

Figure 12: Composite expert $P(\text{establishment})$ estimates for the No New Federal Action Alternative at three time periods with median and percent change in median.

The composite expert estimate of the $P(\text{establishment})$ by 2021 was estimated at a maximum of 3% (Figure 12). The median probability of establishment quadruples (436% increase) from 2021 to 2031. The probability of establishment more than triples again (349% increase) from 2031 to 2071 where it ranges from 22 to 36% if No New Federal Action is taken. Note that the uncertainty around the $P(\text{establishment})$ estimate increases as the time period gets farther into the future as indicated by the wider distribution (Figure 12).
1.7.2. P(establishment) Estimates Using Individual Expert Opinions

This section presents the individual results for each of the six Bighead and Silver Carp experts. It is important to pay careful attention to the scale of the horizontal axis of the figures, as it varies dramatically in some instances.

Figure 13 presents the results for Expert One using a box and whisker diagram. The box and whisker plots are distinctively separated, except for Technology Alternative-Acoustic Fish Deterrent and Technology Alternative-Acoustic Fish Deterrent with Electric Barrier. The separation indicates that these alternatives have distinctive effects based on the expert’s inputs.

Figure 13: Bighead and Silver Carp P(establishment) values at 2017 for the No New Federal Action Alternative, Technology Alternatives, and Lock Closure Alternative estimated with input values from Expert One.

Figure 13 shows Expert One’s inputs result in a high probability of establishment under the No New Federal Action Alternative. Subsequent box and whisker plots move to the left of the No New Federal Action Alternative, indicating the reductions in the P(establishment) that can be attributed to each Alternative. The P(establishment) from highest to lowest is No New Federal Action > Nonstructural Alternative > Technology Alternative-Acoustic Fish Deterrent > Technology Alternative-Acoustic Fish Deterrent and Electric Barrier > Technology Alternative-Electric Barrier > Lock Closure Alternative. This order of efficacy of the alternatives holds unvaryingly for all six experts, although the actual P(establishment) values vary significantly at times. Expert 1’s inputs resulted in the highest P(establishment) values for all scenarios from among all the experts.
Figure 14 shows results for Expert Two. Notice the width of the box and whisker plots is greater than those for Expert One. This indicates greater uncertainty derived from Expert Two’s inputs. Also note how the scale of the horizontal axis changes from figure to figure. Expert Two’s inputs led to the second highest estimate of \( P(\text{establishment}) \) for the No New Federal Action Alternative and all other scenarios as well. As noted earlier, the same order of plan effectiveness prevails for all experts.

The box and whisker plots tend to overlap considerably, indicating uncertainty about the distinctive efficacy of the alternatives. If one looks at the boxes alone, it is clear that the Nonstructural and Technology Alternatives are more effective than the No New Federal Action Alternative in reducing the \( P(\text{establishment}) \) of Bighead and Silver Carp.

![Box and Whisker Plot]

**Figure 14:** Bighead and Silver Carp \( P(\text{establishment}) \) values for the No New Federal Action Alternative, Nonstructural Alternative, Technology Alternatives, and Lock Closure Alternative estimated with input values from Expert Two.
Expert Three’s inputs lead to the smallest estimates of $P(\text{establishment})$ for the No New Federal Action Alternative and all other Alternatives. Notice the horizontal scale on this figure, so the ‘apparent’ width of the box and whisker plots does not mislead you. There is less than a 0.4% chance of establishment based on the Expert three’s inputs. This probability is so small that the plans have negligible impact in reducing the probabilities of establishment. The dots that extend beyond the rightmost whisker indicate outliers. These are values that are $\geq 1.5$ times the interquartile range in distance from the median. The interquartile range is the width of the box. In this instance, the box is so narrow that outliers are common. Despite the small numbers, Expert Three’s inputs provided the same order of efficacy of alternatives as every other expert.

**Figure 15:** Bighead and Silver Carp $P(\text{establishment})$ values for the No New Federal Action Alternative and five other Alternatives estimated with input values from Expert Three.
Expert Four also has provided values that lead to a low $P(\text{establishment})$ for the No New Federal Action Alternative and all other scenarios. The $P(\text{establishment})$ for 2071 is less than 2%. The three technology alternatives are estimated to have effectively the same impact on reducing $P(\text{establishment})$, although numerically they maintain the same order of efficacy. The overlap in the boxes indicates the reduction in $P(\text{establishment})$ would be minimal because $P(\text{establishment})$ is so small to begin with.

![Graph showing $P(\text{establishment})$ for different alternatives.](image)

**Figure 16**: Bighead and Silver Carp $P(\text{establishment})$ values for the No New Federal Action Alternative, Technology Alternatives, and Lock Closure Alternative estimated with input values from Expert Four.
Expert Five is the third expert whose inputs provided a low $P(\text{establishment})$ for the No New Federal Action Alternative. It is less than 5%. Once again, because the baseline comparison probability (No New Federal Action Alternative) is so low the effects of the plans is also reduced. The order of efficacy is maintained.

![Figure 17: Bighead and Silver Carp P(establishment) values for the No New Federal Action Alternative, the Technology Alternatives, and the Lock Closure Alternative estimated with input values from Expert Five.](image-url)
Expert Six results are shown in Figure 18. Expert Six’s inputs lead to results that were closest to the Composite Expert results, they also exhibit the second highest extent of uncertainty based on the spread in the box and whisker plots. The Nonstructural plan is minimally effective in this expert’s views, but the other plans offer distinct reductions in the \( P(\text{establishment}) \) compared to the No New Federal Action Alternative.

![Figure 18: Bighead and Silver Carp \( P(\text{establishment}) \) values for the No New Federal Action Alternative, the Technology Alternatives, and the Lock Closure Alternative estimated with input values from Expert Six.](image)

Three of the six expert results indicate the \( P(\text{establishment}) \) for the No New Federal Action Alternative is less than 5%. This means the probability that Bighead and Silver Carp will become established in the Great Lakes at some time in the future as a direct result of what happens between now and 2071 is less than 5%. One of the expert’s results indicate the same probability is in excess of 90% (92.8 to 99.3%). The other two experts’ results were the least certain and they ranged from 17.0 to 35.3% and 14.1 to 60.6%.

These results indicate that the experts are divided in their views about what will happen in the future. The uncertainty that results when considering the six experts together is so great that the resulting \( P(\text{establishment}) \) estimates range from nearly zero to nearly one. That high degree of uncertainty should not be dismissed, overlooked or ignored.

1.7.3. Additional Evaluations

After the describing the alternatives to the experts, the experts asked why they weren’t evaluating an alternative that had the same measures as the Technology Alternative – Acoustic Fish Deterrent with Electric Barrier but with a continuously operated electric barrier. The number of alternatives was limited to ensure the experts were not fatigued by the number of questions they were asked. At the conclusion of
each elicitation, the experts were asked to rank an alternative that included the same features as the Technology Alternative – Acoustic Fish Deterrent with Electric Barrier but with a continuously operated electric barrier rather than an intermittently-operated electric barrier. They were not asked the questions that would provide input into the model to calculate a distinctive P(establishment) value for this alternative. The expert all indicated they would rank this alternative as being similar to Technology Alternative – Electric Barrier.

1.7.4. Two Important Conclusions

The method used to estimate P(establishment) values results in quantitative estimates that are better interpreted as measures of the relative effectiveness of the alternatives when compared to the No New Federal Action Alternative than they are actual estimates of P(establishment). There was a great degree of spread in the P(establishment) estimates obtained from the experts’ characterization of the uncertainty about the numbers of fish that would pass through the pathway under different future conditions and the numbers of fish required for colonization and subsequent spread. The range in obtained P(establishment) values spans from near zero to near one.

There are at least two very important conclusions than can be drawn from the results of the expert elicitation. First, all experts agree in the order of efficacy in the alternatives as measured by the lowest P(establishment) through 2071. From least [highest P(establishment)] to most [lowest P(establishment)] effective the alternatives are:

1. Federal No Action Plan
2. Nonstructural Alternative
3. Technology Alternative-Acoustic Fish Deterrent
4. Technology Alternative- Acoustic Fish Deterrent with Electric Barrier. (The electric barrier would NOT be operated when vessels are approaching the engineered channel, in the engineered channel and in the lock. Acoustic Fish Deterrent would be operated during this time.)
5. Technology Alternative- Electric Barrier (intended to be continuous operation)
6. Lock Closure

The characterizations of all six experts lead to exactly the same order. As result there is a high degree of confidence about which plans do the best job of reducing P(establishment) whatever its true value is.

Second, data from each expert show a significant reduction in the mean P(establishment) as compared to the No Action mean P(establishment) for all alternative plans. The individual reductions estimated for each expert are shown in Table 2. The percentages represent mean values for the expert and scenario pair. Thus, 97% is the mean of Expert One’s estimate of P(establishment) under the No New Federal Action scenario.

This table shows the estimated size of the reduction in P(establishment) that results from each alternative using results obtained for each expert. According to Expert One the nonstructural alternative reduces the No New Federal Action P(establishment) from 97% to 69% a 29% reduction in risk. This value is obtained by calculating (97% - 69%)/97%. This is a common way of estimating risk reduction. The mean reduction is the average of the six expert’s values.
Table 2: Reduction in mean P(establishment) attributable to the alternatives using uncertainty characterizations obtained from each expert in the elicitation.

<table>
<thead>
<tr>
<th>Expert</th>
<th>NNA</th>
<th>NS</th>
<th>EB</th>
<th>CN</th>
<th>BN</th>
<th>LC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>97.00%</td>
<td>69.00%</td>
<td>42.00%</td>
<td>54.00%</td>
<td>50.00%</td>
<td>7.20%</td>
</tr>
<tr>
<td>2</td>
<td>37.00%</td>
<td>19.00%</td>
<td>8.00%</td>
<td>14.00%</td>
<td>10.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>3</td>
<td>0.060%</td>
<td>0.052%</td>
<td>0.037%</td>
<td>0.051%</td>
<td>0.039%</td>
<td>0.010%</td>
</tr>
<tr>
<td>4</td>
<td>2.00%</td>
<td>1.60%</td>
<td>1.40%</td>
<td>1.50%</td>
<td>1.50%</td>
<td>0.48%</td>
</tr>
<tr>
<td>5</td>
<td>5.40%</td>
<td>4.20%</td>
<td>1.90%</td>
<td>2.30%</td>
<td>2.30%</td>
<td>1.10%</td>
</tr>
<tr>
<td>6</td>
<td>32.00%</td>
<td>27.00%</td>
<td>13.00%</td>
<td>19.00%</td>
<td>15.00%</td>
<td>2.70%</td>
</tr>
</tbody>
</table>


There was considerable uncertainty in the estimates of P(establishment) derived from each expert’s characterization of the uncertainty. Thus, it is impossible to know what the actual P(establishment) value is. Regardless of the P(establishment) estimated for the No New Federal Action future scenario, each expert’s characterization of the uncertainty about the alternative plans’ performances lead to significant reductions in that initial probability. Thus, all expert data show the alternatives are effective in reducing the P(establishment), whether their estimate was low, high or in between (Table 2).

For the Recommended Plan the minimum reduction in the existing probability was 25%, the maximum reduction was 73%. The average of these six reductions (49%) suggests the TSP is likely to cut the P(establishment) in half, no matter what its true value might be. This is a strong argument in favor of the TSP’s ability to reduce the risk of establishment significantly. Thus, there is a high degree of confidence that the TSP does indeed make effective reductions in P(establishment).
The actual P(establishment) is uncertain and unknown and is likely to remain so indefinitely. This analysis has produced a set of six estimates of this value based on the expert opinions of six leading Asian carp experts. No one of them can be considered right or wrong. Together they characterize the cumulative uncertainty about Asian carp becoming established in the Great Lakes via the CAWS pathway.

In an effort to aid decision makers and to facilitate an incremental cost and cost effectiveness analysis the estimates obtained from the opinions of the six experts were combined in a synthetic composite expert. This simplifies the summary of the expert elicitation by producing a set of composite values that are representative of the six experts. The values produced for this composite expert represent the average opinions of the six experts. As such they should not be interpreted as best estimates of the P(establishment). Instead they are indicators of the relative order of effectiveness of the plans and they provide a rough estimate of the relative reductions in P(establishment) provided by the alternative plans.

1.7.5. P(establishment) Estimates by Scenario Using Individual Expert Opinions

This section provides the reader the opportunity to compare P(establishment) 2071 estimates for each of the formulated plans by expert. The estimates of P(establishment) in order from highest to lowest is: Expert 1 > Expert 2 > Expert 6 > Expert 5 > Expert 4 > Expert 3. This pattern holds for all alternative scenarios elicited. The results for each alternative scenario are presented in Figures 19 through 23. Pay particular attention to the scale of the horizontal axis, which changes from figure to figure.

**Figure 19:** Bighead and Silver Carp P(establishment) 2071 values for the Nonstructural Alternative based on estimates provided by each expert and for the composite expert.
Figure 20: Bighead and Silver Carp $P(\text{establishment})$ 2071 values for Technology Alternative-Electric Barrier based on estimates provided by each expert and for the composite expert.

Figure 21: Bighead and Silver Carp $P(\text{establishment})$ 2071 values for Technology Alternative-Acoustic Fish Deterrent based on estimates provided by each expert and for the composite expert.
Figure 22: Bighead and Silver Carp $P(\text{establishment})$ 2071 values for Technology Alternative-Acoustic Fish Deterrent with Electric Barrier based on estimates provided by each expert and for the composite expert.
1.7.6. Composite Expert Residual \( P(\text{establishment}) \) for With Condition Scenarios

Table 3 presents numerical estimates of the \( P(\text{establishment}) \) for Bighead and Silver Carp by 2071. Note that these probabilities do not include any estimation of the residual risk of establishment due to non-aquatic pathways.

No future alternative implementation scenario results in a zero risk of establishment of Bighead and Silver Carp or \textit{A. lacustris}. No matter which plan is implemented there is still some probability of establishment. That probability is the residual \( P(\text{establishment}) \). As with all \( P(\text{establishment}) \) estimates these residual estimates are uncertain.

### Table 3: Five number summary estimates of Bighead and Silver Carp \( P(\text{establishment}) \) 2071 for composite expert No New Federal Action Alternative, Technology Alternatives, and Lock Closure.

<table>
<thead>
<tr>
<th></th>
<th>No New Federal Action</th>
<th>Nonstructural</th>
<th>Technology Alternative-Electric Barrier</th>
<th>Technology Alternative-Acoustic Fish Deterrent</th>
<th>Technology Alternative-Acoustic Fish Deterrent with Electric Barrier</th>
<th>Lock Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>0.22</td>
<td>0.15</td>
<td>0.08</td>
<td>0.11</td>
<td>0.10</td>
<td>0.01</td>
</tr>
<tr>
<td>1st Quartile</td>
<td>0.26</td>
<td>0.18</td>
<td>0.10</td>
<td>0.14</td>
<td>0.12</td>
<td>0.02</td>
</tr>
<tr>
<td>Median</td>
<td>0.29</td>
<td>0.20</td>
<td>0.11</td>
<td>0.15</td>
<td>0.13</td>
<td>0.02</td>
</tr>
<tr>
<td>3rd Quartile</td>
<td>0.32</td>
<td>0.22</td>
<td>0.12</td>
<td>0.17</td>
<td>0.14</td>
<td>0.02</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.36</td>
<td>0.26</td>
<td>0.14</td>
<td>0.19</td>
<td>0.17</td>
<td>0.03</td>
</tr>
</tbody>
</table>
These data are presented graphically in Figures 24 and 25. Figure 24 shows the distributions of the uncertain estimates of the P(establishment) 2071 values for the No New Federal Action Alternative, Nonstructural Alternative, Technology Alternatives, and Lock Closure. The highest Bighead and Silver Carp P(establishment) value is associated with the No New Federal Action Alternative, located to the far right in Figure 24. The spread in this distribution suggests the uncertainty of this estimate. By contrast, closing the lock shifts the distribution from a range of 22 to 36% to a range of 1 to 3%. This is the largest reduction in P(establishment) obtained by the formulated plans.

The second best reduction is 8 to 14%, which is obtained by the Technology Alternative-Electric Barrier. The barrier and noise are expected to lower the probability to 10 to 17%, while noise alone reduces the probability to 11 to 19%. The nonstructural plan reduces P(establishment) to the range of 15 to 26%.

Figure 25 adds a few features to Figure 24 to help illustrate the reduction in P(establishment) using the composite expert this time, instead of individual experts, as above. Added to the figure are markers showing the location and value of the median probabilities as well as arrows showing the reduction in median probabilities. All of these reductions are relative to the median P(establishment) of the No New Federal Action Alternative. Thus, a decrease from 0.29 to 0.02 is \( \frac{0.27}{0.29} \approx 0.93 \). Note this reduction is not a probability value. It simply means that the median P(establishment) with lock closure is 93% lower than the median P(establishment) of the No New Federal Action Alternative.
Figure 24: Estimated Bighead and Silver Carp \( P(\text{establishment}) \) 2071 distributions for composite expert No New Federal Action Alternative (Without Condition), Nonstructural Alternative (Nonstructural), Technology Alternative-Acoustic Fish Deterrent (Acoustic Fish Deterrent), Technology Alternative-Acoustic Fish Deterrent with Electric Barrier (Barrier & Acoustics), Technology Alternative – Electric Barrier (Electric Barrier) and Lock Closure Alternative (Close Lock).
Figure 25: Estimated Reductions in composite expert Bighead and Silver Carp P(establishment) 2071 distribution No New Federal Action Alternative, Nonstructural Alternative, the three Technology Alternatives, and Lock Closure Alternative.
Figure 26 shows the same data in a different format. With the cumulative distribution functions the vertical axis of the figure has meaning. Curves further to the left, indicating lower P(establishment), are more desirable. Uncertainty is reflected in the footprint of the upward sloping curve.

![Figure 26: CDF’s for composite expert Bighead and Silver Carp P(establishment) 2071 for the No New Federal Action Alternative (Without Condition), Nonstructural Alternative (Nonstructural), Technology Alternative-Acoustic Fish Deterrent (Acoustic Fish Deterrent), Technology Alternative-Acoustic Fish Deterrent with Electric Barrier (Barrier & Noise), Technology Alternative – Electric Barrier (Electric Barrier) and Lock Closure Alternative (Close Lock).](image)

**P(establishment) Points of Agreement and Divergence Among Experts**

The P(establishment) of Bighead and Silver Carp in the GLB is unknown and uncertain. However, one can characterize the uncertainty and this was achieved for the GLMRIS-BR study by having national experts provide expert opinions in a controlled expert elicitation process. The experts’ inputs did produce agreement on three major outputs from the model:

- P(establishment) cannot be reduced to zero
- The order of effectiveness of the plans was consistently rated. The Lock Closure Alternative resulted in the lowest P(establishment). The Technology Alternative-Electric Barrier, which was more effective than the Technology Alternative Acoustic Fish Deterrent and Electric Barrier, which was more effective than Technology Alternative-Acoustic Fish Deterrent, which was more effective than the Nonstructural Alternative, which was more effective than No New Federal Action.
- Estimates of P(establishment) derived from all six experts show significant relative reductions in P(establishment), thus, suggesting that although the precise P(establishment) is not known, P(establishment) is significantly reduced no matter what level it may be.
Experts differed on their opinions about the inputs. Figure 27 shows how the experts differed on the size of the population that would arrive at BRLD by 2021. Four of six experts thought there was some chance of a negligible sized population arriving. A small population size was designated most likely by everyone but Expert 2.

![Population Arrival 2021 by Population Size](image)

**Figure 27: Population size arrival by 2021 probabilities for Bighead and Silver Carp and all experts**

Figure 28 suggests considerable disagreement about the maximum number of fish that could pass from below BRLD into Lake Michigan on an annual basis. The differences become greater as the size of the population assumed to have arrived increases. Expert 6, who had the highest P(establishment) value estimated a significantly larger number of fish would pass through the system each year. It is worth noting that the experts disagreed on the size of the fish that would pass through the system and size differences accounts for some of the differences in numbers. Experts who believed small fish were more likely to pass through the system tended to estimate larger numbers of fish.

![Maximum Fish Passage by Population Arrived for Without Condition](image)

**Figure 28: Maximum number of Bighead and Silver Carp passing through the existing system in a year given the size population arriving at Brandon Road Lock and Dam**
Colonization thresholds were another point of significant divergence. Figure 29 shows the minimum colonization threshold by year. Contrast the difference between Expert 2 with a 1000 minimum and Expert 3 with a minimum of 2. Expert 2’s high threshold values account for the corresponding low levels of P(establishment).

![Minimum Colonization Threshold by Expert](image_url)

**Figure 29:** Minimum number of Bighead and Silver Carp required to possibly result in colonization.

Figure 30 suggests more agreement on the maximum probability of spread with relatively less agreement on the minimum probability. Expert 1 was much more certain of the spread probability than any of the other experts, for example.

![Minimum & Maximum Spread Probability by Expert](image_url)

**Figure 30:** Minimum and maximum estimates of the probability of the spread of Bighead and Silver Carp once a colony has been established.
Figure 31 shows the amount of risk reduction, i.e. percent decline in P(establishment), attributed to each alternative by each expert. The numerical values are means of all expert reductions. What is significant here is that no matter how the P(establishment) values estimated from expert opinions differ numerically, the alternative plans on average have significant effects on the reduction of P(establishment). While there is less confidence in what the actual P(establishment) is based on the results, there is considerable confidence that that P(establishment) is significantly reduced by the alternatives.

![Risk Reduction of Alternative by Expert](image)

Figure 31: P(establishment) 2071 reductions attributed to each alternative by expert. The No New Federal Action value for that expert is noted at the top of each set of bars.

2. Lacustre

2.1. Estimating P(establishment)

The GLMRIS Risk Assessment provided qualitative estimates of the P(establishment) of *A. lacustre*. The P(establishment) was defined in that document as consisting of five probability values, with the overall P(establishment) defined using conditional notation as:

\[
P(\text{establishment}) = P(\text{pathway}) \times P(\text{arrival} | \text{pathway}) \times P(\text{passage} | \text{arrival}) \times P(\text{colonization} | \text{passage}) \times P(\text{spread} | \text{colonization})
\]

The probability of these independent events is, hereafter, represented more simply as:

\[
P(\text{establishment}) = P(\text{pathway}) \times P(\text{arrival}) \times P(\text{passage}) \times P(\text{colonization}) \times P(\text{spread}).
\]

The establishment elements are generally defined as:

- \(P(\text{pathway})\) - the probability that a complete aquatic pathway is available for interbasin transfer between the Mississippi River Basin (MRB) and Great Lakes Basin (GLB) through the Chicago Area Waterway (CAWS) aquatic pathway;
- \(P(\text{arrival})\) - the probability of *A. lacustre* arriving in the Dresden Island Pool located upstream of Dresden Dam to below BRLD;
- \(P(\text{passage})\) – the movement of *A. lacustre* through the CAWS from below BR to Lake Michigan;
- \(P(\text{colonization})\) - the probability of *A. lacustre* colonizing in Lake Michigan, and;
- $P(\text{spread})$ - the probability of $A. lacustre$ spreading beyond Lake Michigan and into the other Great Lakes.

This was the model used to estimate $P(\text{establishment})$ for $A. lacustre$. Members of the expert panel provided direct estimates of each of the last four probabilities on the right hand side of the equation. $P(\text{Pathway})$ is known to equal 1 and was not elicited. The four probabilities were multiplied together to obtain estimates of $P(\text{establishment})$. Once these probabilities were estimated each expert was given the opportunity to review the calculations obtained with their inputs for their reasonableness. All the experts accepted the results derived from their opinions.

Each expert provided opinions for the following values:

- An estimate of the four probabilities above at 2021, 2031, and 2071 for each of the scenarios below:
  - No New Federal Action
  - Nonstructural Alternative
  - Technology Alternative - Electric Barrier
  - Technology Alternative - Acoustic Fish Deterrent
  - Technology Alternative – Acoustic Fish Deterrent with Electric Barrier
  - Lock Closure Alternative

These values were characterized as cumulative distribution functions defined by a minimum, 33rd and 67th percentiles, and a maximum value to characterize the uncertainty about these unknown and unknowable values. A simulation model generated random probability values from each distribution and multiplied them to obtain an estimate of $P(\text{establishment})$. This calculation was repeated 10,000 times to generate a distribution of $P(\text{establishment})$ values. This calculation was completed for three different time periods and six different scenarios, the No New Federal Action Alternative, Nonstructural Alternative, Technology Alternatives, and Lock Closure.

### 2.2. The Experts

An expert elicitation was needed because there was and is no credible data for several of the model inputs. An expert elicitation was the most cost-effective and reliable way to characterize the uncertainty about the $P(\text{establishment})$ values for the ANS control alternatives. Aquatic biologists on the GLMRIS- BR Team identified experts in the field (e.g. researchers, academia, etc.) The team sought experts that were knowledgeable and have extensive experience with crustacean life cycles, aquatic nuisance species management and control, and invasion biology. Five experts were identified to participate in the $A. lacustre$ elicitation, they are:

1. Safra Altman, U.S. Army Corps of Engineers, U.S. Army Engineer Research and Development Center;
2. Theodore (Ted) R. Angradi, US Environmental Protection Agency;
3. Andrew M. Kramer, Odum School of Ecology, University of Georgia Athens;
4. Reuben P. Keller - Loyola University Chicago, Institute of Environmental Sustainability;
5. Linda S. Nelson, U.S. Army Corps of Engineers, U.S. Army Engineer Research & Development Center Environmental Laboratory

For the qualifications of the experts, please refer to their CV's which are an addendum (Addendum 1) to Attachment 1 in Appendix C.
2.3. The Elicitation Process

Once the expert panel was assembled they were provided with a read ahead package of reference materials and factsheets describing:

1. The CAWS
2. The pools of the Illinois Waterway System
3. The distribution of *A. lacustre*
4. General biology of *A. lacustre*
5. BRLD diagram and operational information
6. Electric dispersal barrier at Romeoville, IL
7. Current activities related to *A. lacustre*
9. Pertinent Literature References.

The elicitations were preceded by a two-day meeting of the experts with study team members, the elicitations were then conducted over the next two days. The meeting took place at the Chicago District Offices on December 14 and 15, 2015. The purposes of the two-day was to provide experts an opportunity to learn details of the alternative plans from top domain experts, discuss *A. lacustre* and alternative control plans, arrive at common assumptions where assumptions were needed, and provide training with the elicitation technique.

Highlights of the two-day pre-elicitation meeting included group discussions of the following topics:

- Influential Factors for *A. lacustre* Passage from BRLD to Lake Michigan via the CAWS – With Alternatives
- Influential Factors that Impact *A. lacustre* Colonization and spread
- Historic vessel movement patterns in the CAWS and Great Lakes

Following most of these discussions the experts identified the key factors and assumptions for each discussion. These were recorded and reviewed with the expert during the individual elicitations as appropriate.

2.4. The Elicitation

The elicitation team consisted of one expert panel member, one *A. lacustre* domain expert, one USACE alternative plan domain expert, and one elicitation facilitator. The domain experts were available to answer any questions that arose for the expert panel member. The elicitations were conducted via webinar.

Before each new quantity or scenario was elicited, the panel expert was reminded of the key factors identified by the plenary panel of the experts and a summary of the features of each plan scenario was provided. The elicitation consisted of the 30 questions included in Annex 2 to this Appendix. Following each question the expert was queried about the main considerations that shaped their response. Notes were taken.

The expert’s responses were recorded on an input sheet in a spreadsheet file that was visible to the expert at all times. Experts were informed they could change their initial answers at any time they desired and were encouraged to do so including after the conclusion of the elicitation. The experts were told they would be provided with a summary of the results obtained from their expert opinions and at that time they
would have the option of revisiting any or all of their answers to the elicitation questions. These summaries were provided about a week later and all experts accepted the results of their model runs as reasonably representative of their views.

In the next section you will learn how the model used to estimate the probability of establishment works.

### 2.5. The Model

The structure of the model is illustrated in Figure 32, using inputs from one expert on the $P(\text{establishment})$ of *A. lacustre* in 2071. Notice $P(\text{establishment})$ is calculated for three different time periods and for six separate alternative scenarios.

The data for this calculation was obtained directly from each expert in answer to the following questions:

1. What is the probability that a population of *A. lacustre* will arrive at Brandon Road Lock and Dam by 2021/2031/2071?
2. Considering the currently existing system that is in place, assume that a population of *A. lacustre* have arrived at Brandon Road Lock and Dam. What is the probability that some non-trivial number of *A. lacustre* will pass from below the dam to Lake Michigan by 2021/2031/2071?
3. Considering the amount of *A. lacustre* you believe will pass through the system by 2021, what is the probability those *A. lacustre* will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional *A. lacustre* enter the lake after 2021/2031/2071?
4. Assume that *A. lacustre* has a colony in Lake Michigan. What is the probability that *A. lacustre* will spread beyond Lake Michigan?

The answers to these questions were elicited from the experts as minimum, maximum, 33rd and 67th percentiles. These four values were used to construct the expert’s CDF’s, samples of which are shown in Figure -32. A value was randomly selected from the CDF of each of the four establishment probability elements using a Monte Carlo process with Latin Hypercube sampling. These values were multiplied together to obtain a single estimate of the $P(\text{establishment})$ for the given time period and scenario for each expert. A sample output distribution is shown for one expert (Figure 32).
Figure 32: Illustrated example of the simulation model used to estimate $P(\text{establishment})$ for $A. \text{lacustre}$.
2.6. The Results

The probabilities presented in the sections that follow were not directly provided by the experts. They were directly estimated using values provided by the experts. Thus, it is most proper to characterize these values as estimates based on the experts’ opinions.

2.6.1. Probability of Establishment If No New Federal Action Is Taken (Federal Without Project Condition)

If the Federal government takes no new action, the expert consensus is that the establishment of *A. lacustre* in the GLB is more likely than not. Figures 33, 34, and 35 show estimates of the P(establishment) of *A. lacustre* under the No New Federal Action Alternative for three time periods 2071, 2031, and 2021 for all five experts and the composite expert3. These estimates characterize the risk of establishment of *A. lacustre* if no further action is taken as a direct result of the subject study. Beginning with 2071, we see substantial overlap among the estimates of all experts. The box and whisker plots show the spread in the P(establishment) obtained from each expert’s characterization of the uncertainty in the component elements of that calculation. The spread in a box plot indicates the uncertainty in that value. The relative differences in each expert’s box illustrates differences in opinion among the experts. Table 4 shows the numerical values used to create the box plots for Figure 33 to 36.

![Box and Whisker Plot](image)

*Figure 33: P(establishment) of A. lacustre for all experts under the No New Federal Action Alternative in 2071.*

3 The composite expert was generated using the same methodology used for the Asian carp elicitation. The CDF’s for the five experts were averaged across percentile values from 1% to 99% with 5% increments between.
Table 4: Five number summary for P(establishment)

<table>
<thead>
<tr>
<th>Expert</th>
<th>Minimum</th>
<th>1st Quartile</th>
<th>Median</th>
<th>3rd Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert 1</td>
<td>0.75</td>
<td>0.83</td>
<td>0.92</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Expert 2</td>
<td>0.08</td>
<td>0.21</td>
<td>0.28</td>
<td>0.36</td>
<td>0.58</td>
</tr>
<tr>
<td>Expert 3</td>
<td>0.51</td>
<td>0.71</td>
<td>0.78</td>
<td>0.84</td>
<td>0.98</td>
</tr>
<tr>
<td>Expert 4</td>
<td>0.25</td>
<td>0.49</td>
<td>0.57</td>
<td>0.66</td>
<td>0.95</td>
</tr>
<tr>
<td>Expert 5</td>
<td>0.20</td>
<td>0.40</td>
<td>0.49</td>
<td>0.58</td>
<td>0.88</td>
</tr>
<tr>
<td>Composite</td>
<td>0.36</td>
<td>0.53</td>
<td>0.61</td>
<td>0.69</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Expert 1’s results indicate the highest likelihood of establishment with a range from 75 to 100%. Expert 2, by contrast, has the lowest estimate of establishment ranging from 8 to 58%. It is important to consider the range of uncertainty expressed by the expert panel. To facilitate discussion of the relative effectiveness of the individual alternatives a composite expert was prepared as described in the Bighead and Silver Carp discussion, by averaging the CDF’s for the five experts. The P(establishment) 2071 is between 36 and 88%. There is a 50% chance it is above 61% and a 50% chance it is below 61%.

The P(establishment) of A. lacustre increases over time (Figure 33 to 36). Figure 34 shows P(establishment) for 2031 ranges from 22 to 79% with a median of 45% and P(establishment) for 2021 ranges from 12 to 64% with a median of 32% as seen in Figure 35. The composite expert results were obtained by averaging the CDF’s of all the experts.

![Figure 34: P(establishment) of A. lacustre for all experts for the No New Federal Action Alternative in 2031.](image)
Figure 35: P(establishment) of *A. lacustre* for all experts for the No New Federal Action Alternative in 2021.

Figure 36 juxtaposes the composite expert P(establishment) distributions for the three time periods. Notice there is significant overlap among the distributions. Establishment of *A. lacustre* by 2071 is more likely than not.
Figure 36: $P(\text{establishment})$ for *A. lacustre* under the No Action Alternative for three time periods.
2.6.2. P(establishment) Estimates Using Individual Expert Opinions

It is instructive to consider the results of each expert elicitation in considering how well the plans work to reduce the P(establishment) of *A. lacustre*. The next five figures show the estimated P(establishment) values for all experts and all Alternatives. Pay attention to changes in the horizontal axis. These differences indicate differences in opinion about how likely establishment is. Expert 1 (Figure 37), as noted, has the highest estimate of establishment and Expert 2 has the lowest estimate (Figure 38). Experts 1, 3, 4, and 5 tend to find all the plans but lock closure to be rather ineffective in reducing the P(establishment) for *A. lacustre* (Figure 37 to 41).

**Figure 37: Expert 1 P(establishment) of *A. lacustre* in 2071 by Alternative.**

Only Expert 2 found a plan other than lock closure to have some effect on P(establishment). The Electric Barrier, Acoustic Fish Deterrent, and Acoustic Fish Deterrent with Electric Barrier Technology Alternatives, all have an equally effective impact on reducing P(establishment) (Figure 38).
Figure 38: Expert 2 $P(\text{establishment})$ of $A. \ lacustre$ in 2071 by Alternative.

Figure 39: Expert 3 $P(\text{establishment})$ of $A. \ lacustre$ in 2071 by Alternative.
Figure 40: Expert 4 P(establishment) of *A. lacustre* in 2071 by Alternative.

Figure 41: Expert 5 P(establishment) of *A. lacustre* in 2071 by Alternative.
There is strong agreement that the technology alternatives will be ineffective in reducing \( P(\text{establishment}) \) for \( A. \ lacustre \). Even closing the lock has limited effectiveness.

Figure 42 shows the composite expert estimates of \( P(\text{establishment}) \) for all Alternatives. The nonstructural plan has no effect and the technology plans show a minimal reduction on \( P(\text{establishment}) \) reflecting Expert 2’s judgments about the relative effectiveness of the plans. Closing the lock reduces the \( P(\text{establishment}) \) to the No New Federal Action Alternative levels for 2021. The \( P(\text{establishment}) \) shown for lock closure is the \( P(\text{establishment}) \) of \( A. \ lacustre \) between now and 2021, after which time the lock would be closed and the probability would then be reduced to zero.

**Figure 42: Composite expert \( P(\text{establishment}) \) of \( A. \ lacustre \) in 2071 by Alternative.**

2.6.3. \( P(\text{establishment}) \) Estimates by Scenario Using Individual Expert Opinions

This section provides the opportunity to compare \( P(\text{establishment}) \) 2071 estimates for each of the formulated plans by expert. The estimates of \( P(\text{establishment}) \) in order from highest to lowest is: Expert 1 > Expert 3 > Expert 4 > Expert 5 > Expert 2. The experts were very consistent in their relative rankings, as this pattern holds for all plans elicited.

The results for each plan scenario are presented in Figures 43 through 47. Pay particular attention to the scale of the horizontal axis, which changes from figure to figure.
Figure 43: *A. lacustre* $P(\text{establishment})$ 2071 values for the Nonstructural Alternative estimated for all five experts and the composite expert.

Figure 44: *A. lacustre* $P(\text{establishment})$ 2071 values for the Technology Alternative-Electric Barrier estimated for all five experts and the composite expert.
Figure 45: *A. lacustre* $P(\text{establishment})$ 2071 values for Technology Alternative-Acoustic Fish Deterrent estimated for all five experts and the composite expert.

Figure 46: *A. lacustre* $P(\text{establishment})$ 2071 values for Technology Alternative –Acoustic Fish Deterrent and Electric Barrier estimated for all five experts and the composite expert.
2.6.4. Composite Expert Residual P(establishment) for the No New Federal Action Alternative

There is no future scenario that has zero risk of establishment of *A. lacustre*. No matter which plan is implemented there is still some probability of establishment. Closing the lock would reduce \( P(\text{establishment}) \) to 0 but there is some probability of establishment by 2021, so even that option is not guaranteed to prevent the establishment of *A. lacustre* in the GLB.

The probability of establishment that remains with a plan in place is the residual \( P(\text{establishment}) \). As with all \( P(\text{establishment}) \) estimates these residual estimates are uncertain. Table 5 presents numerical estimates of the 2071 \( P(\text{establishment}) \) for *A. lacustre*. Note that these probabilities do not include any estimation of the residual risk of establishment due to non-aquatic pathways.

**Table 5. Five number summary estimates of *A. lacustre* \( P(\text{establishment}) \) 2071 for composite expert No New Federal Action Alternative, Technology Alternatives, and Lock Closure**

<table>
<thead>
<tr>
<th></th>
<th>No New Federal Action</th>
<th>Nonstructural</th>
<th>Technology Alternative- Electric Barrier</th>
<th>Technology Alternative- Acoustic Fish Deterrent</th>
<th>Technology Alternative- Acoustic Fish Deterrent with Electric Barrier</th>
<th>Lock Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>0.36</td>
<td>0.36</td>
<td>0.34</td>
<td>0.34</td>
<td>0.34</td>
<td>0.17</td>
</tr>
<tr>
<td>1st Quartile</td>
<td>0.53</td>
<td>0.53</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.33</td>
</tr>
<tr>
<td>Median</td>
<td>0.61</td>
<td>0.61</td>
<td>0.58</td>
<td>0.58</td>
<td>0.58</td>
<td>0.42</td>
</tr>
<tr>
<td>3rd Quartile</td>
<td>0.69</td>
<td>0.69</td>
<td>0.65</td>
<td>0.66</td>
<td>0.66</td>
<td>0.52</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.88</td>
<td>0.88</td>
<td>0.86</td>
<td>0.86</td>
<td>0.86</td>
<td>0.78</td>
</tr>
</tbody>
</table>
P(establishment) is identical for the No New Federal Action and Nonstructural Alternatives. All technology alternatives have essentially the same negligible effect on the P(establishment) values. None of these measures are effective in reducing P(establishment) for *A. lacustre*. The composite distributions are presented graphically in Figure 48, which shows little difference among P(establishment) estimates for five of the six Alternatives.

*Closing the lock is the only alternative that reduces the probability estimates noticeably. Even so, considerable uncertainty remains with a range from 17-78% and a median probability of 42%.*
Figure 48: Estimated *A. lacustre* $P(\text{establishment})$ 2071 distributions for composite expert No New Federal Action Alternative, Nonstructural Alternative, Technology Alternatives, and Lock Closure Alternative.
Annex 1: Asian Carp Expert Elicitation Question Set

Without Project Condition Questions

1. When thinking about the number of Asian Carp that could arrive at Brandon Road by the year 2021, please rate the following population sizes by their relative probability of arriving (larger numbers indicate a higher probability):
   Negligible Population
   Small Population
   Medium Population
   Large Population
   TOTAL 100 Points

2. When thinking about the number of Asian Carp that could arrive at Brandon Road by the year 2031, please rate the following population sizes by their relative probability of arriving (larger numbers indicate a higher probability):
   Negligible Population
   Small Population
   Medium Population
   Large Population
   TOTAL 100 Points

3. When thinking about the number of Asian Carp that could arrive at Brandon Road by the year 2071, please rate the following population sizes by their relative probability of arriving (larger numbers indicate a higher probability):
   Negligible Population
   Small Population
   Medium Population
   Large Population
   TOTAL 100 Points

   What were the main considerations in shaping your answer?

4. Considering the currently existing system that is in place, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could pass from below the dam to Lake Michigan in a year?

5. Considering the currently existing system that is in place, assume that a medium population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from
downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could pass from below the dam to Lake Michigan in a year?

6. Considering the currently existing system that is in place, assume that a large population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could pass from below the dam to Lake Michigan in a year?

What were the main considerations in shaping your answer?

7. What is smallest total number of fish that must make it to Lake Michigan between now and the end of 2021 to convince you that those fish are, by themselves, numerous enough to colonize in Lake Michigan at some point in the future?

8. What is smallest total number of fish that must make it to Lake Michigan between now and the end of 2031 to convince you that those fish are, by themselves, numerous enough to colonize in Lake Michigan at some point in the future?

9. What is smallest total number of fish that must make it to Lake Michigan between now and the end of 2071 to convince you that those fish are, by themselves, numerous enough to colonize in Lake Michigan at some point in the future?

What were the main considerations in shaping your answer?

10. Assume that Asian Carp have a colony in Lake Michigan. What is the probability that Asian Carp will spread beyond Lake Michigan?

What were the main considerations in shaping your answer?
Nonstructural Plan

11. Considering the elements of the nonstructural plan to be in place and functioning as well as you think they are capable of functioning, when thinking about the number of Asian Carp that could arrive at Brandon Road by the year 2021, please rate the following population sizes by their relative probability of arriving (larger numbers indicate a higher probability):
   Negligible Population__________
   Small Population _____________
   Medium Population ___________
   Large Population ______________
   TOTAL 100 Points

12. Considering the elements of the nonstructural plan to be in place and functioning as well as you think they are capable of functioning, when thinking about the number of Asian Carp that could arrive at Brandon Road by the year 2031, please rate the following population sizes by their relative probability of arriving (larger numbers indicate a higher probability):
   Negligible Population__________
   Small Population _____________
   Medium Population ___________
   Large Population ______________
   TOTAL 100 Points

13. Considering the elements of the nonstructural plan to be in place and functioning as you think well as they are capable of functioning, when thinking about the number of Asian Carp that could arrive at Brandon Road by the year 2071, please rate the following population sizes by their relative probability of arriving (larger numbers indicate a higher probability):
   Negligible Population__________
   Small Population _____________
   Medium Population ___________
   Large Population _____________
   TOTAL 100 Points

What were the main considerations in shaping your answer?

14. Considering the elements of the nonstructural plan to be in place and functioning as well as you think they are capable of functioning, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

15. Considering the elements of the nonstructural plan to be in place and functioning as well as you think they are capable of functioning, assume that a medium population of Asian Carp have arrived at Brandon road.
Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

15. Considering the elements of the nonstructural plan to be in place and functioning as well as you think they are capable of functioning, assume that a large population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

What were the main considerations in shaping your answer?

Technology Alternative – Electric Barrier

15. Considering the elements of the electric barrier and barge entrainment plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

16. Considering the elements of the electric barrier and barge entrainment plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a medium population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

17. Considering the elements of the electric barrier and barge entrainment plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a large population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

What were the main considerations in shaping your answer?
Lock Closure

18. Considering the elements of the lock closure plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

19. Considering the elements of the lock closure plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

20. Considering the elements of the lock closure plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

What were the main considerations in shaping your answer?

Technology Alternative – Acoustic Fish Deterrent

15. Considering the elements of the acoustic fish deterrent plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

16. Considering the elements of the acoustic fish deterrent plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a medium population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

17. Considering the elements of the acoustic fish deterrent plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning,
assume that a large population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

What were the main considerations in shaping your answer?

**Technology Alternative – Acoustic Fish Deterrent with Electric Barrier**

21. Considering the elements of the electric barrier and acoustic fish deterrent plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

22. Considering the elements of the electric barrier and acoustic fish deterrent plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a medium population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

23. Considering the elements of the electric barrier and acoustic fish deterrent plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a large population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

What were the main considerations in shaping your answer?
Annex 2: A. lacustre Expert Elicitation Question Set

No New Federal Action (Without Condition)

1. What is the probability that a population of scud will arrive at Brandon Road Lock and Dam by 2021?
2. What is the probability that a population of scud will arrive at Brandon Road Lock and Dam by 2031?
3. What is the probability that a population of scud will arrive at Brandon Road Lock and Dam by 2071?
4. Considering the currently existing system that is in place, assume that a population of scud have arrived at Brandon Road Lock and Dam. What is the probability that some non-trivial number of scud will pass from below the dam to Lake Michigan by 2021?
5. Considering the currently existing system that is in place, assume that a population of scud have arrived at Brandon Road Lock and Dam. What is the probability that some non-trivial number of scud will pass from below the dam to Lake Michigan by 2031?
6. Considering the currently existing system that is in place, assume that a population of scud have arrived at Brandon Road Lock and Dam. What is the probability that some non-trivial number of scud will pass from below the dam to Lake Michigan by 2071?
7. Considering the amount of scud you believe will pass through the system by 2021, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2021?
8. Considering the amount of scud you believe will pass through the system by 2031, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2031?
9. Considering the amount of scud you believe will pass through the system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2071?
10. Assume that scud have a colony in Lake Michigan. What is the probability that scud will spread beyond Lake Michigan?

Nonstructural

11. Considering the elements of the nonstructural plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2031?
12. Considering the amount of scud you believe could pass through the nonstructural system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2031?
13. Considering the elements of the nonstructural plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and
Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2071?

14. Considering the amount of scud you believe could pass through the nonstructural system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2071?

**Close Lock**

15. Considering the elements of the lock closure plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2031?

16. Considering the amount of scud you believe could pass through the system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2031?

17. Considering the elements of the lock closure plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2071?

18. Considering the amount of scud you believe could pass through the system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2071?

**Technology Alternative - Electric Barrier**

19. Considering the elements of the electric barrier plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2031?

20. Considering the amount of scud you believe could pass through the electric barrier system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2031?

21. Considering the elements of the electric barrier plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2071?

22. Considering the amount of scud you believe could pass through the electric barrier system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2071?
Technology Alternative - Acoustic Fish Deterrent

23. Considering the elements of the acoustic fish deterrent plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2031?

24. Considering the amount of scud you believe could pass through the acoustic fish deterrent system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2031?

25. Considering the elements of the acoustic fish deterrent plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2071?

26. Considering the amount of scud you believe could pass through the acoustic fish deterrent system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2071?

Technology Alternative - Acoustic Fish Deterrent with Electric Barrier

27. Considering the elements of the electric barrier and acoustic fish deterrent plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2031?

28. Considering the amount of scud you believe could pass through the electric barrier and acoustic fish deterrent system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2031?

29. Considering the elements of the electric barrier and acoustic fish deterrent plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2071?

30. Considering the amount of scud you believe could pass through the electric barrier and acoustic fish deterrent system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2071?
Addendum 1

Experts’ Curriculum Vitaes
Safra Altman, Ph.D. 104 Dana Place Vicksburg, MS 39180 ph. 860-961-3976 email: safraaltman@gmail.com

EDUCATION


B.A. Biology (1997). Brown University, Providence, RI. Advisor: Jon Witman

RESEARCH EXPERIENCE

2014-present Research Ecologist, U.S. Army Engineer Research and Development Center, Environmental Laboratory  Principal investigator in the Wetlands and Coastal Ecology Branch. Collaborator on various projects including landscape modeling of vegetation change on Assateague Island, MD, cost/benefit and network analysis of oyster reef connectivity, habitat suitability of invasive species, and review of the current state of microplastic as an emerging contaminant of benthic habitats. Collaboration within the U.S. Army, Army Corps of Engineers district offices, academic research groups, the International Maritime Organization (IMO), and U.S. Agency for International Development (USAID).

2013-2014 Senior Biologist, One Stop Environmental, LLC Worked on developing landscape ecology model for Assateague Island, MD, in collaboration and use for the U.S. Army Engineer Research and Development Center – Environmental Laboratory. Projects included developing a landscape model that links landscape pattern, landscape metrics and ecological processes to identify ecological benefits including evaluation of ecosystem services and developing a relational database to serve as a U.S. Army Corps of Engineer project planning tool. Other projects focus on threatened and endangered species protection and understanding connectivity between ecosystems.

2010-2013 Postdoctoral Research Associate, The University of Georgia Odum School of Ecology & UGA Marine Institute. Advisor: James E. Byers. Lived and worked on Sapelo Island. Main project focused on the ecology of the marsh/upland ecotone by 1) testing the accuracy of current Georgia laws to define the upland salt marsh border and 2) understanding how marine invertebrates use and depend on the marsh/upland buffer or ecotone. There was a large field component to this study requiring extensive use of differential GPS and RTK GPS equipment to measure changes in coastal topography, geomorphology, shoreline position and salt marsh elevation. Extensive knowledge of experimental design, statistical analysis and taxonomic expertise (plant and invertebrate) was critical. This work was funded by GA Sea Grant. An additional study funded by NSF focused on biogeography and phylogeography of marine and estuarine species along the eastern coast of North America.

2006–2009 Smithsonian Institution Predoctoral Fellow, Smithsonian Environmental Research Center.

2000-2002 Graduate Research Assistant and Technician, University of Connecticut  Provided research support for laboratory activities including monitoring weekly recruitment of subtidal fouling communities, assisting in a number of field projects, research diving, and data collection. Collected hard and soft substrate marine invertebrates. Processed benthic samples and identified benthic organisms. Trained and mentored 1 undergraduate intern. Additional organizational duties consisted of data entry.
1998-2000 Biological Technician, Smithsonian Environmental Research Center Participated in a number of collaborative projects involving ballast water research. Project leader for the host/parasite interaction study of Macoma balthica and Perkinsus marinus. Project leader for the North Atlantic Arrivals ballast water project and laboratory safety officer. Main responsibilities included zoo- and phytoplankton identification and enumeration, sample collection, processing, curation, data entry, and data analysis. Other responsibilities included collection and identification of fouling community invertebrates, culturing zoo- and phytoplankton, fieldwork and laboratory maintenance. 1997 Research Assistant, Brown University Assisted Dr. Jon Whitman in data collection and analysis for multiple projects involving recruitment dynamics of the blue mussel Mytilus edulis. Studied demography of Asterias vulgaris seastar populations in the Southern Gulf of Maine.

MARINE POLICY EXPERIENCE

2010 Senior Advisor for Research and Development, U.S. Committee for the Marine Transportation System, Office of the Executive Secretariat Coordinated 27 government agencies and offices in the development of a national research and development strategy for the U.S. Marine Transportation System. Planned and organized a national conference for government, industry and private stakeholders to participate in strategic planning process and identify stakeholder needs. Co-Author research and development strategic plan.

2009-2010 Sea Grant Knauss Marine Policy Fellow, National Oceanic & Atmospheric Administration, Oceanic and Atmospheric Research Headquarters, Office of Policy, Planning, and Evaluation

Served as executive secretariat to the Committee for the Marine Transportation System’s Integrated Action Team on Research & Development. Participated in the NOAA strategic planning process through internal proposals, serving as a liaison between labs and headquarters, and informing division Administrators. Served on the Joint Subcommittee for Ocean Science and Technology Ocean Partnership Interagency Working Group on Biodiversity, and on internal NOAA Biodiversity working group efforts.

TEACHING, MENTORING & OUTREACH EXPERIENCE


U-MD: Kenan Matterson (now pursuing PhD at University of Alabama)  
SERC: Micheal Um (now pursuing MD at Washington University), Mary-Jane Ides (Peninsula College), Autumn Turner (University of Washington).  
UConn: Kimberly Barber Bradley.


Science Fair Judge South River High School, Rye Middle School, Elsie Whitlow Stokes Elementary

SELECTED PRESENTATIONS  


Altman, S. Sitting on the dock of the bay: Patterns of native and invasive diversity in San Francisco fouling communities. 6th International Marine Bioinvasions Conference, Portland, OR, August 2009.


PUBLICATIONS

Altman, S., M.K. Reif, and T.M. Swannack. 2014. Linking critical ecological processes to landscape pattern: Implications for USACE planning and operations. ERDC/CHL CHETN
V-23. Vicksburg, MS: U.S. Army Engineer Research and Development Center. 
http://chl.erdc.usace.army.mil/chetn


Altman, S, and JE Byers. Temporally and spatially variable use of an ecotone. In Review.


AWARDS AND FELLOWSHIPS

International Marine Bioinvasions Conference
Summer 2009 Student Travel Award

Invited International Student Collaborator, Spring 2009 Global Invasions Research Coordination Network, National Science Foundation

Smithsonian Institution Predoctoral Fellow Summer 2006 – Spring 2009

Millhauser Graduate Fellow, The Park School of Baltimore 2007, 2002

Explorer’s Club Grant Summer 2006

Link Foundation Graduate Fellowship Summer 2005

Smithsonian Institution Graduate Student Fellowship Summer 2004

S.Y. Feng Graduate Student Travel Award, Spring 2003, 2002 University of Connecticut

INVITED LECTURES


WORKSHOPS AND SHORT COURSES


Participant, Ecology and Taxonomy of Tunicates, Smithsonian Tropical Research Institute, Bocas del Toro, Panama, August 2006.


SERVICE 
Member, Georgia Cooperative Invasive Species Management Area, 2012-2014.
Proposal Reviewer: Maryland Sea Grant, National Sea Grant, Hawaii Coral Reef Initiative Research Program, Graduate Women in Science Peer Reviewer, Manuscripts from: Journal of Experimental Marine Biology and Ecology, Biological Invasions, Environmental Research Steering Committee, 2008 Benthic Ecology Meeting, Providence, RI Steering Committee, Maryland Sea Grant Aquatic Invasive Species Vectors Workshop, 2010

PROFESSIONAL MEMBERSHIPS 
American Geophysical Union Ecological Society of America Western Society of Naturalists Sigma Delta Epsilon, Graduate Women in Science Sigma Xi, The Scientific Research Society Diver’s Alert Network

ADDITIONAL QUALIFICATIONS

REFERENCES
Patricia Tuminello (Direct Supervisor) Chief, Wetlands and Coastal Ecology Branch USACE Engineer Research & Development Center – Environmental Laboratory 3909 Halls Ferry Road Vicksburg, MS 39180 Email: Patricia.T.Tuminello@usace.army.mil Phone: 601-634-4826
James Byers (Postdoctoral Advisor) Associate Professor Odum School of Ecology University of Georgia 140 E. Green St. Athens, GA 30602 Email: jebyers@uga.edu Office Phone: (706) 583-0012 Fax: (706) 542-4819
Anson H. Hines (Dissertation Co-Advisor) Director and Senior Scientist Fish & Invertebrate Ecology Smithsonian Environmental Research Center 647 Contees Wharf Rd Edgewater, MD 21037 Email: hinesa@si.edu Office Phone: (443) 482-2208 Fax: (443) 482-238
Gregory M. Ruiz (Dissertation Committee, Employer) Senior Scientist Marine Invasions Research Lab Smithsonian Environmental Research Center 647 Contees Wharf Rd Edgewater, MD 21037 Email: ruizg@si.edu Office Phone: (443) 482-2227 Fax: (443) 482-2380
Theodore (Ted) R. Angradi

**Education:**

B.S., Wildlife Management, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 1984

M.S., Wildlife and Fisheries Science, Pennsylvania State University, University Park, Pennsylvania, 1986

Ph.D., Biology, Idaho State University, Pocatello, Idaho, 1990

**Employment:**

Research Biologist (GS-14), US Environmental Protection Agency, Office of Research and Development, Duluth, MN, October 2010 to present.


Aquatic Ecologist (GS-13), US Forest Service, Northern Research Station, Timber and Watershed Laboratory, Parsons, WV, October 1994 to July 1999. Aquatic Ecologist (GS-12), US Forest Service, Northern Research Station, Timber and Watershed Laboratory, Parsons, WV, May to September 1994

Postdoctoral research associate (GS-11), US Forest Service, Northern Research Station, Timber and Watershed Laboratory, Parsons, WV, 1992-1994

Limnologist, Colorado River Program, Arizona Game and Fish Department, Page, AZ. March 1991 November 1992.

Postdoctoral Research Assistant, Department of Biological Sciences, Idaho State University. 1990 1991.

Research Assistant, Department of Biological Sciences, Idaho State University. 1989-1990.

Teaching Assistant, Department of Biological Sciences, Idaho State University. 1986-1989.

Research Assistant, School of Forest Resources, Pennsylvania State University. 1984-1986.

**Professional societies:**

American Fisheries Society North American Benthological Society

**Honors:**
EPA Bronze Metal for Commendable Service, EPA Region 8 Surface Water Team, 2003 “For outstanding accomplishments in the field of environmental monitoring and assessment in a collaborative project involving ORD, Regions, States, and Tribal nations”

EPA Superior Accomplishment Award, September 2004 “In recognition for technical leadership for GRE Field Manual and field training”


EPA Superior Accomplishment Award, June 2005 “In recognition for reporting UMR results and development of the Great Rivers EMAP Program”

NHEERL Quality Assurance Award, October 2006 “In recognition of their extraordinary accomplishments as the Great River EMAP team and implementation of the NHEERL Quality System”

EPA Bronze Metal for Commendable Service, EMAP Great Rivers Team, 2008 “For successful planning and implementation of the Environmental Monitoring and Assessment Program for Great River Ecosystems”

Scientific and Technological Achievement Award. Level III. 2009. For advancing the Science of Large River monitoring.

Scientific and Technological Achievement Award. Level III. 2010. For advancing the Science of Large River monitoring. EPA Award for exceptional/Outstanding ORD Technical Assistance to Regions or Program Offices. 2012. In support of the development of nutrient criteria for the Nation’s Rivers and Streams.

Research Interests:

Fish ecology and behavior, aquatic ecology, large rivers, bioassessment, estuaries, ecological indicators, macroinvertebrates, invasive species, ecosystem services

Adjunct Faculty Appointments:

Department of Biology, Marshall University, Huntington, West Virginia (Former) Division of Forestry, West Virginia University, Morgantown, West Virginia (Former)

Editorships:

Editorial board, Ecological Indicators Associate Editor, Freshwater Science

Journal articles:


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Proceedings (peer-reviewed):


Other peer-reviewed reports:
Addendum 1

Brandon Road Lock & Dam Feasibility Study
Probability of Establishment


Google scholar statistics:

All citations: 1588 Since 2010:714 h-index: 20 Publications with >10 citations: 35
U.S. GEOLOGICAL SURVEY  
RESEARCH SCIENTIST RECORD  
1. NAME Duane Chapman  
2. DATE PREPARED June 30, 2015  
3. DUTY STATION Columbia Environmental Research Center  
4. REGION Midwest  
5. CLASSIFICATION TITLE, SERIES, AND GRADE GS–482-13  
6. DATE OF ENTRANCE ON DUTY March 10, 1986  
7. DATE OF LAST PROMOTION 10/23/2011  
8. DATE OF LAST RESEARCH GRADE PANEL REVIEW 2011  
9. EDUCATION  
Iowa State University, Major: Fish and Wildlife Biology (Fisheries emphasis), Minor: English, Fall 1978 through Spring 1980. Bachelor of Science, 1980.  
Graceland College, Biology major track, Fall 1975 - Spring 1978.  
10. TECHNICAL TRAINING RECEIVED  
• Veteran Employment Training for Hiring Managers. 1 hour instruction. Columbia, MO 2014  
• Supervisory Challenge Training. 40 hours instruction, Denver, CO, September, 2012  
• Leading Across Generations, 4 hours instruction, Columbia, MO, May, 2012  
• USGS Radiation Safety 1 hour instruction, Columbia, MO, December 2011  
• American Fisheries Society Leadership Principles Workshop, 4 hours instruction, Madison, WI, August, 2004  
• Radio Telemetry for Freshwater Fish Studies, 8 hours instruction, Madison, WI, August, 2004  
• Building Leadership to Further Scientific Excellence, 16 hours instruction, Columbia MO, March, 2004
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Brandon Road Lock & Dam Feasibility Study
Probability of Establishment

11. PROFESSIONAL EXPERIENCE
A. PRESENT ASSIGNMENT
I am a Research Fisheries Biologist in the River Studies Branch at the Columbia Environmental Research Center (CERC). As such, I operate with little guidance in my fields of endeavor. I am Project Chief for CERC’s Asian carp effort, and have spent most of my time on Asian carp projects since 2002. I am arguably the best-known international expert on Asian carps. I am responsible for identifying research needs, developing proposals for extramural funding, planning and conducting research, and interpretation of data and writing reports to client agencies and publishing the research. I hire and employ private contractors or federal term and seasonal employees to perform field data collections and analyses, and I must ensure the quality of work by these employees. I typically oversee the work of 6 – 10 technicians and scientists, including direct supervision of federal employees ranging from GS3 to GS7. In fiscal 2014, I added a GS-9 and a GS-11 to my supervisees. In 2015, my combined budget for these studies was over $600,000, including eight projects funded with appropriated money and two with reimbursable agreements. Over the past four years, most funding has come from the Great Lakes Restoration Initiative (GLRI), USGS Asian carp appropriated funding, and USGS invasive species cyclical funds.
DATES From: May 2010 To: Present

Assessing the risk of Asian Carp Establishment in the Great Lakes (20% of my time)
Potential food resources for bigheaded carps in the Great Lakes. I first proposed this study to (GLRI and received funding in the spring of 2010. We used bioenergetics, remote sensing, and feeding studies to assess food resources, including alternative, non-planktonic foods such as dreissenid pseudofeces and veligers. This project has ended, but manuscripts are in review.

Risk Assessment of Asian Carps in the Great Lakes. I was the US science lead of the 5-person writing team for a bi-national risk assessment of bigheaded carps in the Great Lakes. In 2014, we began similar risk assessments for grass carp and black carp. Funded in part by Canada Department of Fisheries and Oceans and the Great Lakes Fishery Commission.
DATES From: January 2006 To: Present

Early life history of Asian carps (15% of my time) I am PI for these studies. We modeled the time required to reach 60 developmental stages at a range of temperatures, and the sinking rates of eggs, and used these data combined with field collections to determine spawning locations and of Asian carps and to predict the risk that rivers would support Asian carp recruitment. Currently we are working to expand those efforts to understand larval movements and to assess mortality in
eggs that settle, for use in control.

DATES From: Spring 2014 To: Present (10% of my time)
Habitat selection by young of year Asian carp, and factors affecting survival. I am PI on this project, which combines experimental-pond and field work to assess habitat selection by Asian carps and the effect of native predators and the effect of cover availability.

DATES From: January 2013 To: Present (10% of my time)
Current status and range of grass carp and black carp in North America. I am CERC’s lead on this collaboration with USGS-Great Lakes Science Center, US Fish and Wildlife Service (USFWS), universities, and state agencies. Black carp captured anywhere in the USA and grass carp captured from the Great Lakes and the margins of their range are sent to CERC. We perform gonad histology, aging, and diet work on these fish, and parts are sent to others for ploidy analysis, otolith microchemistry, and genetics.

DATES From: Spring 2013 To: Present (10% of my time)
Assessment of Judas fish for the control of Asian carps. I am PI on this project. We are assessing the use of telemetered carp to locate other Asian carps in areas where they are present at low densities. Also, we are assessing methods of sterilization of Asian carps, for use as Judas fish where it is undesirable to release potentially fertile fish.

DATES From: Spring 2013 To: Present (10% of my time)
Assessment of Asian carp gear avoidance behavior. I am PI on this project. We are using DIDSON acoustic video to assess the behavior of Asian carps with the goal of modifying gears or deployments in ways that enhance capture and detection.

DATES From: 2010 To: Present (10% of my time)
eDNA technology. In 2011, I enlisted C. Richter as co-PI on this project, and hired a post-doc. We have focused on eDNA “loading” rates by bigheaded carps under different conditions, and degradation rates of eDNA, and on PCR inhibitors as confounding factors. We are currently using outdoor pond studies and acoustic measurements of fish density in rivers coupled with eDNA measurements, to assess the possibility of modelling population size or biomass of carp from eDNA concentration, and to develop a method of spawning event detection.

DATES From: September 2006 To: present (10% of my time)
Assistance to regional and national invasive species management efforts
I am the USGS representative, and Research and Risk Assessment Committee Chair for the Mississippi River Basin Panel on aquatic nuisance species (MRBP). The panel is funded by the Aquatic Nuisance Species (ANS) Task Force. I report to the panel and Task Force on issues as diverse as fee-fishing operations, navigation as a vector for invasion, and creation of rapid-response protocols. I work with the panel to establish priorities, release RFPs, and to evaluate resulting reports. I have recently been recruited by the USFWS to assist in the prioritization of the goals of the national Asian carp management plan, especially the control section and the research needs section.
DATES From: January 2015 To: present (5% of my time)
Integrated Pest Management (IPM) book I was recently tapped to produce a chapter on early detection and monitoring methods for an American Fisheries Society (AFS) book on IPM of invasive species.
NAME AND TITLE OF SUPERVISOR, TEAM LEADER(S), OR PROJECT CHIEF(S)

Supervisor: Dr. Robert Jacobson, Branch Chief, River Studies Branch

b. PREVIOUS PROFESSIONAL POSITIONS

DATES From: January 1995 To: May 2002
Fisheries biologist in the Ecology Branch at USGS Columbia Environmental Research Center. Designed and conducted contaminant and limnology investigations on streams, wetlands, and reservoirs.

DATES From: March, 1988 To: January 1995
Assistant Leader, Corpus Christi Field Station of CERC. Conducted investigations of contaminant effects on coastal and marine ecosystems. Conducted large-scale sediment quality assessments and developed new porewater toxicity testing techniques. Also directed and conducted coral larval research.

DATES From: September 1987 To: April, 1988
Fishery Biologist. Acting Leader at Denver Field Station of NFCRC (former name of CERC). Duties included completion and publication of striped bass research, Denver field station closure, and opening Corpus Christi field station.

DATES From: March 1986 To: September 1987
Fishery Biologist, temporary, Denver Field Station. Performed striped bass - selenium toxicity tests. Applied and validated larval fish culture techniques which were developed during graduate research.

DATES From: September, 1983 To: August 1985
Research Assistantship. University of Wyoming, US Fish and Wildlife Research Coop Unit, Laramie, WY. Performed fish culture and physiological research on larval striped bass as part of Masters degree program. Also performed work on nutrient assimilation by grass carp.

DATES From: February, 1982 To: May, 1983

DATES From: November, 1980 To: February, 1982
Fish Culture Extensionist. CACTU, Turrialba, Costa Rica. Designed pond construction, taught tilapia and grass carp culture, coordinated harvests, and trained a Costa Rican counterpart.
12. SIGNIFICANT RESEARCH ACCOMPLISHMENTS
a. RECENT ACCOMPLISHMENTS

I have continued to design and coordinate a multi-faceted research program involving Asian carps. This research has greatly expanded our understanding of the biology of these fishes in the United States. Throughout this work, I have strived to identify key needs and incorporate the best available technology to accomplish the mission, regardless of whether the tools and expertise exist at CERC. Thus, the research is diverse in collaborators and in methodology, including bioenergetics, aging, otolith microchemistry, ploidy measurement, aquaculture techniques, surgical sterilization of fish, remote sensing, GIS, diet studies, molecular biology, genetics, telemetry, traditional fish capture techniques, fisheries acoustics, early life history, particle-transport modelling, hydrodynamics, and other tools. The following accomplishments have been realized since my last promotion in late 2011.

Potential food resources for bigheaded carps in the Great Lakes. A published bioenergetic model evaluated availability of food for bigheaded carps in the Great Lakes. We corrected errors in that model, and improved it with parameters derived from bigheaded carps rather than unsimilar species (MS in review IP-055125, technical presentation [TP] 140,151,156). We combined that model with remotely-sensed planktonic food concentrations to assess the potential survival and growth of bigheaded carps in Lakes Erie (pub 60, TP 127,136,142) and Michigan (TP 178). We also tested the ability of bigheaded carps to survive and grow on non-planktonic foods that are abundant in the Great Lakes, such as dreissenid pseudofeces (MS in review IP-057327, TP 131,160) and modelled the ability of bigheaded carps to survive on existing dreissenid veligers (TP 159,165,172).

Risk Assessment of Asian Carps in the Great Lakes. In late 2010 I was invited to be the US science lead of the 5-person writing team for a bi-national risk assessment (BNRA) of bigheaded carps (Pub 48). In 2014, we began similar risk assessments for grass carp and black carp. The grass carp BNRA was submitted for peer review in June 2015 (IP-066352). I also provided an assessment of the risk of bigheaded carps in the Great Lakes in declarations to the US Supreme Court and District court (Pub 39, 41), and worked with USGS-GLSC to assess US tributaries of Lake Erie for their potential to be recruitment locations for Asian carps (Pub 47).

Early life history of Asian carps. I realized that an understanding of the complex early life history would provide tools for both risk assessment and control of these invasive fishes. We modeled the time required to reach 60 early life history stages of Asian carps at different temperatures (pubs 31, 45, 53, 59). We then used field collections of eggs and larvae together with those models and particle transport models to determine Asian carp spawning locations and timing, and number of eggs in the drift (pub 52). That work is now being used as a model for similar work by USGS-UMESC in the impounded reach of the Mississippi River. We used our data together with Chinese and Russian literature data in a model to assess the risk that Asian carps could use Great Lakes tributaries (pub 47) for recruitment. We also measured sinking rates of Asian carp eggs, which is important in physical models. The USGS-ILWSC used our data to model the potential for recruitment at a finer scale, predicting, for example, that Asian carps could use the Sandusky River, OH, for recruitment (TP 175,179,185,196). We shortly thereafter showed that grass carp had recruited there (pub 54, TP 170). We recently developed a development-temperature model specific to grass carp (in review, IP-060743) and it has already been incorporated in to drift models for grass carp risk assessments.

Habitat selection by young of year Asian carp, and factors affecting survival. We have completed a bit over one year of field work on this two-year project, which evaluates habitat selection in sections of the Mississippi, Illinois, and Missouri Rivers. We have completed less than a year of the
experimental pond study, which includes pit tag telemetry, a variety of predator types, and artificial habitat structures (TP 192,193,196,199). In addition, we assessed the ability of young Asian carps to withstand low dissolved oxygen conditions as a refuge from predation (MS in review IP-056596). Current status and range of grass carp and black carp in North America. This collaboration between USGS, USFWS, universities, and state agencies began in 2013. Black carp captured in the USA and grass carp from the Great Lakes and range margins are sent to CERC. We perform gonad histology, aging, and diet work on these fish, and parts are sent to others for ploidy analysis, otolith microchemistry, and genetic work. From these data we have shown that grass carp have recruited in the Lake Erie basin (pub 54, TP 170,176) and are likely established there (TP 182,189,195), and more recently that black carp are established in the Mississippi River Basin (TP 190,197,198).

Assessment of Judas fish for the control of Asian carps. Beginning in mid-2013, telemetry data were collected that shows grouping of Judas fish captured outside the study area are grouping with other fish, including other Asian carp captured and tagged in the study area, but some fish left the study area and returned upstream through two dams to the original capture site. In June 2015 we completed a study of the effectiveness of surgical sterilization of bighead and grass carps. We also have created triploid bighead carp for evaluation as Judas fish; those fish are now one year old.

Calibration of eDNA technology. This new technique for early detection of bigheaded carps was pivotal in making management decisions, especially in the Chicago Area Waterway System (CAWS), but the implications of eDNA “hits” are not well-understood. We assessed the eDNA shedding rates of bigheaded carps under different feed, temperature, and crowding conditions, and eDNA degradation rates. We also detected and proposed solutions for PCR inhibition in field samples (pub 55,57,58; TP 155,161,162,166,183). More recently, we have used those data to produce a potential model to predict carp biomass from eDNA concentrations, and we are evaluating that model in the field by coupling eDNA collections with acoustic enumeration of fish and traditional capture techniques, and hydrology. In addition, we have begun to assess eDNA as a method to detect spawning events, with great success (TP 194).

Population genetics. Collaborations with Chinese colleagues continue to bear fruit since my last promotion. Recent publications have explored the rapid genetic differentiation of introduced populations of Asian carps worldwide (pubs 46, 49). This collaboration was also the recent source of Chinese black carp tissues for a marker development effort led by the US Army Corps of Engineers.

Assistance to regional and national invasive species research efforts.

As Research and Risk Assessment Committee Chair for the Mississippi River Basin Panel on aquatic nuisance species (MRBP), I worked with the EXCOM and in one case with Sea Grant and Coast Guard to issue RFPs, evaluate proposals, and evaluate and disseminate contracted reports.
I was the USGS science lead on the technical review of the Great Lakes-Mississippi River Interconnectivity Study (GLMRIS), which evaluated connections between the Great Lakes and the Mississippi River Basin as pathways for movement of aquatic nuisance species.
Gut microflora of Asian carp. I was a team member on this study to assess the gut microflora of Asian carps for potential use as enhanced eDNA markers (pub 56, TP 177,187).
b. OTHER CAREER ACCOMPLISHMENTS

Early life history of Asian carps. I recognized that an understanding of carp early life history could be the basis for risk assessments and control mechanisms for Asian carps. This work began with the Chapman 2006 (Pub 31) which set the groundwork for early life history work performed at this lab and others, including the recent hydrologic models developed by the ILWSC. A review of that document (Garvey 2007, Stages 28(1):2-3) stated "This translation will aid us in (1) identifying these fishes and (2) comparing physical characteristics of transplanted populations to those in their native waters. As such, we now have a great baseline to which future research can be compared.

Guidance to Asian carp working group. I led the team writing the Control and Mitigation sections of the “Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States”

Population genetics of Asian carps. We produced microsatellite markers for research that can be used to assess kinship, population structure, phylogeography, hybridization, and effective populations in Asian carps (pub 42). An offshoot of this work has been collaboration with Chinese scientists which has resulted in publications on the phylogeny of bighead and silver carp (Pub 35) and on genetic divergence of the carps after their introduction to novel environments and relation to source populations in Asia and Europe (Pub 40,46,49).

Development of a biological synopsis and risk assessment of bigheaded carps. We first created this review as a report in 2005, then reorganized it and added additional material, and published it as an American Fisheries Society book. “Bigheaded Carps: a biological synopsis and environmental risk assessment” is considered the definitive text on these species. (Pub 28, 34)

Eradication of tilapia in the Galapagos archipelago. In 2006, I traveled to the Galapagos and determined the extent of the tilapia invasion. I created the first draft of an eradication plan. The plan was realized by USGS and Galapagos National Park personnel, and no live tilapia have been found since (TP 106,124). Asian Carp Symposium and Proceedings. In 2006, using a grant from the Mississippi River Basin Panel on Aquatic Nuisance Species (MRBP) and contributions from other sponsors, I organized an independent symposium on invasive Asian carps. The symposium showcased the current knowledge and research on Asian carps at a time when Asian carp research was just beginning in the USA. As part of the symposium, I taught a half-day session on Asian carp biology. I edited the book “Invasive Asian Carps in North America” (2011) which is in part the proceedings of this symposium, although it contains other work (Pub 43).

Asian carp habitat selection and movements in the Missouri River. Using telemetry, I catalogued the movements and habitat selection of adult Asian carps. Results from this study were reported in Kolar et al 2007 (pub 34).

Reproduction of bigheaded carps in the Missouri River. We used gonadosomatic index data and histological analysis to show that bigheaded carps are incremental spawners and reproductively active over a greater portion of the year than was previously believed. We also identified evidence of intersex, possibly resulting from contaminant exposure. (Pub 30)
Piscicides and bigheaded carps. I led this study, which was used to inform the million-dollar rotenone application at the Chicago Ship and Sanitary Canal barrier. (Pub 27)

Contaminants and nutritional content of bigheaded carps, and development of “carp cakes” animal food. In these studies, related to harvest of bigheaded carps as control method, I worked with chemists, nutritionists, and a meat scientist. (Pub 32, 42)

Development of the National Asian Carp Management and Control Plan. I led the drafting team on two (Control and Mitigation) of the seven sections of the plan. I then participated in the extensive review and revision of the entire plan. I was the USGS lead for this effort. Although the section leads are not listed as “editors”, it occupied a substantial portion of my time from 2003 to 2007.


Lisbon Bottom Project. This was an innovative, interdisciplinary project to evaluate ecological dynamics of large-river floodplains. I am first author of three of six chapters of “Ecological Dynamics of Lisbon Bottom, Missouri” and I was responsible for the Executive summary. (Pub 23, 24, 25)

http://infolink.cr.usgs.gov/Science/Lisbon/index.htm

Water quality assessment of Los Alamos National Lab I led the toxicology portion of this 2000-2001 study of streams at LANL. In situ and lab-based toxicity tests were performed. The study was used by the USFWS in litigation, thus required a very high degree of documentation and adherence to protocols (Pub 21).

Development, evaluation, and validation of the porewater toxicity test approach. Dr. Scott Carr and I began work on marine and estuarine sediment porewaters in 1988. I designed, built, and tested the porewater extractor that made this research possible. We performed sediment quality assessments of 12 major estuaries. (Pub 6, 7, 8, 10, 11, 12, 14, 15) Our methods have been used in at least 11 countries, and were included in the Canadian dredged material program. After 1995, I developed and used porewater toxicity tests in fresh waters. (Pub 16, 17, 21, 22). These techniques were incorporated into the Biomonitoring of Status and Trends program. In 2000, the Society of Environmental Toxicology and Chemistry invited me to assist in writing a book describing the state of the science. (Pub 22)

Reservoir limnology research. I led research on eutrophication and mercury in Elephant Butte and Caballo Reservoirs in New Mexico and of Fort Cobb Reservoir in Oklahoma. (Pub26)

Assessing impacts of oil and gas production activities on marine and estuarine ecosystems

Our research is largely responsible for regulations banning the discharge of oilfield produced water into estuaries of Texas and Louisiana. (Pub 7, 8, 12, 15)

Coral larvae early life history and toxicological studies. In 1993, I developed a method to grow coral larvae from eggs (Pub 9). The March 1998 issue of National Geographic briefly discussed Sea Grant’s use of these methods to start new coral colonies.

Research on larval striped bass initial gas bladder inflation. This research provided solutions to the problem of gas bladder inflation failure in culture (Pub 1, 3, 4, 5). In 1989, Patrick Keys, hatchery manager, Ohio DNR, said this research saved his hatchery ten to twenty thousand dollars per year. Other researchers modified these techniques for walleye and barramundi.
13. SCIENTIFIC LEADERSHIP
I have served as the USGS representative to the Mississippi River Basin Panel on Aquatic Nuisance Species (MRBP) since its inception in May, 2003. In January 2006 I was voted Chair of the Research and Risk Assessment Committee and I remain in that position, which is an EXCOM position for the panel. In that time, under my leadership, the committee has funded or produced: A decision support system for aquatic nuisance species, a symposium on the use of genetics to control exotics (and subsequent symposium publication), several conference symposia, a study of the potential for tug and barge traffic to transport Asian carp larvae in the bilge (I drafted the RFP and worked with the Coast Guard and Sea Grant to obtain a grant from GLRI and to evaluate proposals and the product by the contractor), maintained an aquatic nuisance species (ANS) experts database, a preliminary evaluation of fee-fishing operations as ANS vectors, an independent symposium and proceedings on Asian carps, a rapid risk assessment screening tool, an evaluation of the sensitivity of Asian carps to rotenone and antimycin, eDNA marker development for black carp, provided many guidance and direction letters and suggestions for the Aquatic Nuisance Species Task Force (ANSTF), and searched for and provided speakers on diverse topics for the education of MRBP members, ranging from hydrofracking as a vector for ANS to big river commercial navigation as an ANS vector.


Selected to and served on the invasive species team on “Great Lakes Futures”. This team was put together to provide direction for Great Lakes Restoration Initiative funding.

I was US science lead for the Asian carp Binational Risk Assessment, which investigated the risk posed by bigheaded carps to the Laurentian Great Lakes. Project was funded by the Canadian Department of Fisheries and Oceans and the USEPA. Late 2010 to early 2012.

I led the team writing the “Control” and “Minimizing Adverse Impacts” sections of the “Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States”. This diverse team contained members of state agencies, the aquaculture industry, and NGOs.

In 2006, I acquired funding for, and chaired, the independent symposium “The Invasive Asian Carps in North America. I was entirely responsible for arranging the program, and acquisition of funding from the seven different funding sources. I also found funding for, and edited, the proceedings of the symposium which was published as a book by the American Fisheries Society.

Under the “US-Russian Agreement on Cooperation in the Field of Environmental Protection”, I led Project 02.02-15, Assessment of Complex Anthropogenic Impacts on Ecosystems Reservoirs and Rivers, which has a strong invasive species element. I led this project for two years.

14. SCIENTIFIC AND PUBLIC SERVICE
a. CURRENT MEMBERSHIPS IN PROFESSIONAL SOCIETIES.
I have been a member of the American Fisheries Society (AFS) since 1979. I am a member of the Early Life History Section, and I am a very active member of the Introduced Fish Section. I was elected President of theIntroduced Fish Section of the AFS in 2006, an AFS Governing Board position. I served in this capacity for 3 years, and in the IFS EXCOM as “immediate past president” for an additional three years. I also have served on section committees charged with symposia development for several AFS meetings, and I continue to moderate the section’s list serve.
I served as president of the Missouri Chapter of the AFS from 2005 to 2006. In this position I also served on the governing board of the North Central Division of the AFS 2005-2006. As president (2005-2006) I presided over a substantial revision of the bylaws of that organization, to bring the bylaws up-to-date with current activities and with the parent society constitution. I also served as Chair of the Legislative and Environmental Issues committee of the Missouri Chapter of the AFS from 1998 until 2004.

b. TECHNICAL PRESENTATIONS


185. Murphy, E., T. Garcia, P.R. Jackson, D.C. Chapman, and M.H. Garcia. 2014. Using the Fluvial Egg Drift Simulator (FluEgg) in an Integrated Pest Management Approach to Asian Carp Control. American Fisheries Society 144th Annual Meeting, Quebec. BAO approval 7/21/14 IP-


166. Klymus, K., C. Richter, D.C. Chapman, and C.P. Paukert. DNA shedding rates of Asian carps, for use in understanding field collections of eDNA. American Fisheries Society annual meeting, Little Rock, AR, September 8-12, 2013 BAO approval 10/25/12 IP-041784


155. Klymus, K., C. Richter, D. Chapman, and C. Paukert. DNA shedding rates of Asian carps, for use in understanding field collections of environmental DNA. International Conference on Aquatic Invasive Species, Niagara Falls, ON, April 2013 IP-041784


148. Chapman, D.C. Managing undesired and invading species. (Seven 30 minute modules, 1: Intro and reasons to manage 2: Effects 3: Risk assessment 4: Prevention 5: Regulation as a tool 6: Control 7: Emerging control methodologies). Recorded lecture for Kentucky State University on-line Advanced Fisheries Management class. Recorded November 29 and 30 2012. This is designed to be offered in all semesters. INVITED, PRESENTED
149. Chapman, D.C., A.E. George, J. Deters, B. McElroy, and K. Massagounder. Combining biological and physical sciences to understand bigheaded carp spawning and early life history. Upper Midwest Invasive Species Conference, La Crosse, WI. October 30, 2012 (Poster – no author could attend conference, so provided poster was posted by another CERC colleague)
141. Chapman, DC. Challenges and pitfalls in the development of markets for invasive bighead and silver carps. Food Science Department of the University of Missouri Lecture Series. April 11, 2012, INVITED, PRESENTED


137. Chapman, D.C. Uncertainties regarding the establishment and effects of bighead and silver carps in the Great Lakes. Presented at the Coastal Zone Conference, Chicago, IL July 19, 2010, INVITED, PRESENTED


129. Chapman, D.C. Review of bighead and silver carp effects on water quality. Midwest Fish
121. Chapman, D.C. Asian Carp in Missouri, the MRB, and the Great Lakes. Given to students University of Missouri Fish Ecology course, Rob Hayward, professor. April 2010, Columbia, MO.
104. Chapman, D.C. What’s going on with Asian carp? 100th Meridian meeting, Lincoln, NB, October, 2010. INVITED, PRESENTED.
100. Chapman, D.C. Effects of bighead and silver carps on invaded environments. International Association for Great Lakes Research Annual Meeting, St. Petersburg, Canada, May 2008. INVITED, PRESENTED
99. Chapman, D.C. Current research activities on Asian carps. 100th Meridian biannual meeting, Council Bluffs, Iowa, March 2008. INVITED, PRESENTED
98. Chapman, D.C. History and Ecology of the Chinese Major Carps in the United States. Presentation given seven times in China, at venues including Chinese Academy of Science, (Beijing), University of Beijing (Beijing), Chinese Academy of Fisheries Science (Yichang), Chinese Academy of Fisheries Science (Jianli) Institute of Hydrobiology (Wuhan), and Shanghai Fisheries University (Shanghai), May, 2007. INVITED, PRESENTED


83. Chapman, D.C. Bighead and silver carps: invaders of America’s large rivers. Invasion of Species in the Holoarctic Conference, Borok, Russia. September, 2005, INVITED

82. Chapman, D.C. and Jacobson, R.B. Pairing telemetry with hydrodynamic modeling and habitat classification for bighead and silver carp in the Missouri River. Invasive Species in Large Rivers Symposium at the American Fisheries Society annual meeting, Anchorage, AK. September, 2005. INVITED, PRESENTED

Addendum 1


78. Chapman, D.C. Telemetry and habitat characterization of bighead and silver carps in the lower Missouri River. Asian carp symposium at the Southern Division AFS annual meeting. Virginia Beach, VA, February, 2005 INVITED, PRESENTED


75. Chapman, D.C. Current USGS research on Asian carps. MICRA executive board meeting. September 2004. INVITED, PRESENTED


River near a metals refining site, with a discussion of toxic units. USGS National Program Review, Contaminants program, Stevenson, WA, March 2002.


37. Chapman D.C. Sources of sulfide at Elephant Butte Reservoir, Western Reservoir Program Progress meeting, Grand Coulee Dam, WA. November 1999. INVITED, PRESENTED


34. Jacobson R., D. Chapman, and B. Poulton. ECRC research on the Missouri River. Natural


c. RENDERING SCIENTIFIC JUDGMENT

I have provided formal reviews of proposals, as requested by Sea Grant (2) and MRBP (2), USAID, and of state agency and GLFC reports and white papers, as well as FSP reviews of many USGS documents and abstracts.

Represented USGS at Corps of Engineers charrette on Chicago Area Waterway System as a pathway for invasive species transfer between the Great Lakes and the Mississippi River Basin, to provide judgment related to risk of Asian carp passage through the waterway. November 14-16, 2012

Provided briefing on Asian carp to Congresswoman Judy Biggert (IL-13) and her staffers at her request, August 6, 2012. Also, on several occasions I have been called upon to review USGS congressional briefings that pertain to Asian carps.

In 2010, I was asked by the Department of Justice (DOJ) and the Department of Interior liaison to DOJ to provide an extensive declaration on the biology of Asian carps and their risk to the Laurentian Great Lakes to provide to the Supreme Court of the United States for use in evaluation of a suit between several Great Lakes states and the state of Illinois. Later, I was again asked to provide declarations on this subject for use in a later case that went to court. I was then briefly detailed to DOJ in September 2010 to testify in that court case (See Special Assignments below).

In April 2006, at the request of USAID, I reviewed a proposal on the eradication of invasive tilapia from the Galapagos. I was asked to participate in the review because I had recently worked with rotenone (Pub 26), I have worked extensively in the culture of tilapia in Central America, and I am fluent in Spanish, the language of the proposal. After receiving my review, the Ecuador National Park Service and USAID requested that Dr. Leo Nico and I come to the Galapagos to determine the extent of the invasion and plan an eradication. (See Special Assignments below)


Subpoenaed as expert witness in court case on produced water discharge in Nueces Bay. My data on sediment, sediment porewater, produced water effluent toxicity and on the chemistry of effluents and sediments in Nueces Bay was critical to City of Corpus Christi’s case. As a result of this litigation, produced water discharge permits to this bay were canceled.

Subpoenaed as an expert witness in court case on produced water discharges in Galveston Bay. My data on the toxicity of produced waters and of sediments influenced by produced water in the Galveston Bay area, including the large discharge in question, was critical to the Sierra Club’s case. As a result of this litigation, the discharge permit was canceled.

d. LECTURESHPs AND OTHER ACADEMIC SERVICE
Lectureship
Recorded seven-module lecture (each module approximately 30 minutes) on management of nuisance species for repeated use in Kansas State University’s on-line course in Fisheries Management. November, 2012.

I have often served as a guest speaker in university courses, both at the University of Missouri and at Texas A&M Corpus Christi, on topics including aquaculture effluents, environmental toxicology, and invasive species.

Seminars:
Chapman, D.C. Invasion biology of Asian carps: When conventional wisdom lets you down. Graduate seminar at University of Nebraska, Omaha. February 2009.

Biology of Asian Carps: What we know and what we'd like to know. Duane Chapman. One-hour presentation leading off the symposium: The Invasive Asian Carps in North America: A Forum to Understand the Biology and Manage the Problem, August 22, 2006, Peoria, IL.
USGS research on bighead and silver carp in the Missouri River. Duane Chapman. UMC Fish and Wildlife Seminar, October 29, 2004, University of Missouri, Columbia MO.
Current research on the invasive bighead (Hypophthalmichthys nobilis) and silver carps (H. molitrix) and their status in the USA. Duane C. Chapman, Patrick L. Hudson and Amy J. Benson. June 17, Peking University, Beijing, People's Republic of China.
Current research on the invasive bighead (Hypophthalmichthys nobilis) and silver carps (H.
molitrix) and their status in the USA. Duane C. Chapman, Patrick L. Hudson and Amy J. Benson. June 20, Research Center for Eco-environmental Sciences, Wuhan, People's Republic of China.

Other academic services:
I co-chaired the graduate committee of Russell Hooten, master’s degree candidate, Texas A&M University-Corpus Christi (TAMU-CC). His research was in use of algal spores in toxicity testing, including porewater toxicity testing. Defense and graduation in May 1996.
I served as an advisor and committee member for Claude D’Unger, Master’s degree candidate in Environmental Science, TAMU-CC. Thesis title: “An economic evaluation of oil-field produced water disposal alternatives in Nueces Bay”. I also prepared the resulting journal publication, which meshed my toxicology work with his economic study. Defense and graduation May 1995.

d. TECHNICAL TRAINING PROVIDED

In Corpus Christi, 1993-1994, provided several training sessions to persons and agencies interested in the porewater extraction procedure. These included private contracting agencies, state agencies, universities, and Fish and Wildlife Service employees.
I developed a Semi Permeable Membrane Device (SPMD) deployment/retrieval training video that has been distributed by CERC’s inventors of this technology.
I performed yearly training on fish dissection for the Biomonitoring of Status and Trends team, 1996 through 2000
I have been a Department of Interior certified Motorboat Operator Instructor since 1996. I continue to provide training to one or two classes per year.
In January 2001, I twice gave a presentation entitled “In vivo chlorophyll: Measurement and interpretation” at the USGS WRD Water Quality Technical Conference in New Orleans LA. This invited presentation was provided because of concerns that this new technology had a high potential for misuse and misinterpretation.

f. SPECIAL ASSIGNMENTS
In November and early December 2007, I was on assignment to USAID to assist in an assessment of the status of invasive tilapia in the Galapagos, and to develop an eradication plan. Dr. Leo Nico and I traveled to the Galapagos and worked with the Ecuador National Park Service on this effort. We established that tilapia were only present in one body of water, Laguna Junco. This volcanic caldera is said to be the only permanent natural lentic body of water in the archipelago, and is home to endemic invertebrates found nowhere else. The populations of these invertebrates were heavily impacted by the tilapia, to the point that we found none of them during our stay. I drafted (in Spanish) the rotenone application plan for eliminate the tilapia. The plan was implemented less than a year later by Dr. Nico and collaborators (I was unable to make a return trip to the Galapagos.
because of Asian carp duties). The operation appears to have been successful. No live tilapia have been collected or observed there since the eradication.

In September of 2010, I was briefly assigned to the Justice Department to provide declarations and court testimony when Great Lakes States sued the Corps of Engineers regarding closure of Chicago locks as a defense against Asian carp invasion to the Great Lakes. This followed an earlier request by the Justice Department to provide a declaration to the US Supreme Court regarding Asian carp biology and history in the United States, as it relates to the invasion of the Great Lakes.

g. OTHER TECHNICAL ACTIVITIES

By invitation, I was a member of the “Asian Carp Rapid Response Team” from 2006 to 2010. This team, led by Dr. Phil Moy of Sea Grant-University of Wisconsin, was in charge of activities associated with all aspects of potential movement of invasive species, particularly Asian carp, between the Great Lakes and the Mississippi River basin via the Chicago Ship and Sanitary Canal. I provided technical assistance to this team in relation to Asian carp biology.

I developed a powerpoint presentation that describes the difference between grass carp and black carp. These two species are similar in morphology and there was concern by state biologists in Missouri and Illinois that cases of mistaken identity between black and grass carp might occur (dark grass carp and light black carp occur naturally). The presentation was provided electronically to collaborators, and is available on the web at: http://www.cerc.usgs.gov/pubs/center/pdfDocs/carp_compare.pdf

I prepared the briefing paper “Invasive aquatic species in the Missouri River” for the Missouri River Basin Interstate Roundtable in November 2002.


Chapman, D.C. Virtual Fish: SPMD Basics. This is the home page for the national Semi-Permeable Membrane Device website. Updated most recently in February 2006.


15. OUTREACH AND INFORMATION TRANSFER

Asian carp have created a stir in the media, and I respond to an average of more than one media contact weekly. These have resulted in hundreds of newspaper articles, including a front page piece in the Wall Street Journal, and many citations in Dan Egan’s well-known series on the Asian carp invasion in the Milwaukee Journal-Sentinel. Many interviews were either directly taken by international news services or picked up from other outlets by these news services, therefore the total number of articles is very high but cannot be determined. I have also been featured in articles in the National Journal and in several popular magazines, including Discover Magazine. I have had many radio interviews as well, including pieces on both NPR and Canadian Public Radio, and on nationally broadcast hunting and fishing radio shows. My work on Asian carps has also been featured in three television pieces on the National Geographic Channel, one on the Discovery Channel, in the Canadian Broadcasting Company’s “The Nature of Things” and in many national news pieces on
Asian carps on NBC, CBS, ABC, FOX, and ESPN.


Provided lecture “Asian carp: History, effects, and what do we do now?” to two Chapters of Missouri River Relief, in Kansas City (July 2012) and Saint Louis (November 2012).

At the request of the Mississippi River Basin Panel on aquatic nuisance species, I starred in a training video on Asian carp fileting and bone removal in 2009. The video was distributed widely on DVD by Sea Grant and is available in three parts on Youtube, where the first part alone has had over 45,000 views. http://www.youtube.com/watch?v=T1NVUV8yhmU

Science Magazine Published the Article "Expanding Trade with China Creates Ecological Backlash" in the Nov. 5 2005 edition of News Focus, which featured my research program on invasive Asian carps. This was largely a result of my presentation at the BISOBI conference in Beijing, China.

At the request of the Missouri Department of Conservation, I wrote the following article for publication in the Department’s public outreach magazine: “Carp Lemonade: Making the Best of Some Bigheaded Invaders”, Missouri Conservationist, July 2004, pp. 8-13. This is an article on bighead and silver carp effects on native fishes with information on how to capture and prepare the fish for human consumption. Available on the web at: [http://mdc.mo.gov/documents/conmag/20040701.pdf](http://mdc.mo.gov/documents/conmag/20040701.pdf)


I have provided photographs of Asian carps for many individuals and agencies performing research and/or outreach on Asian carps. These include Science Magazine, Michigan Environmental Educators, Missouri Department of Conservation, Missouri Stream Teams, Minnesota DNR, FishPro Environmental Consultants, Environmental Journalism, TCI Inc. (for a high school biology text), Buffalo (OH) News, Native Fish Conservancy, Illinois Natural History Survey, Illinois-Indiana Sea Grant, Louisiana Sea Grant, US Fish and Wildlife Service, MICRA, and others.

I contributed formatted datasets and prepared figures and maps of water quality, productivity, fish assemblages, and zooplankton assemblages to the Arcview Lisbon Bottom Decision Support System (DSS) generated by the Center. The objective of this DSS was to be both an aid to the USFWS in management of Lisbon Bottom, and as a demonstration of the use of DSS in conservation lands management. The resulting application was the first decision support tool for the Big Muddy Refuge and the first tool available through the NBII-2 network being established through the Missouri River InfoLINK for sharing Missouri River information from multiple sources.

16. INVENTIONS, PATENTS HELD

I invented a sediment pore water extractor which has now been used by many researchers in several countries. It has become a standard for extracting pore waters for sediment quality assessment surveys, because it works well with almost any sediment type. (Pub 10)

I made substantial modifications to a sediment coring device originally invented by Dr. Christopher Onuf. (Pub 13)

17. HONORS, AWARDS, RECOGNITION, ELECTED MEMBERSHIPS

- Special Achievement Award, December 1986. For conducting striped bass toxicity tests.
- Special Achievement Award, January 1989. For research and publications on striped bass and grass carp.
- Special Achievement Award, September 1991. For design, and testing of porewater extraction device.
- Special Achievement Award, August 1992. For high level of performance in sediment research.
- On-the-Spot Award, September 1992. For completion of several amphipod sediment toxicity tests. Each of these tests included more than 45 simultaneous treatments, five replicates each, a probable world record.
- Special Commendation, National Park Service, for efforts in restoring native live oaks to Padre Island National Park. January 1992
- On-the-Spot Award, June 1993. For successful completion of sediment extractions of hundreds of samples from several bay systems around the US. All extractions completed within ten days of field collection, a logistical feat.
- Quality Performance Award, August 1993. For high level of performance in conducting sediment quality assessment surveys in several bay systems.
- Special Achievement Award, August 1994. For high level of performance in continued sediment quality assessment surveys, and managing field station during leader’s absence abroad for nearly half the year.
- Star Award, for excellence in motorboat operator training. September 1996
- Star Award, for compilation, summary and presentation of Lisbon Bottoms Symposium. October 2001
- Letter of Recognition from the Missouri Chapter of the American Fisheries Society, for efforts involved with the Missouri Natural Resources Conference. January 2003
- Star Award, August 2003, for outreach efforts related to Asian carp.
- Elected and served in Vice President – President – Immediate Past-President series of the Missouri Chapter of the American Fisheries Society beginning January 2004.
- Elected Chair of the Research and Risk Assessment Committee of the Mississippi River Basin Panel on Aquatic Nuisance Species, January, 2006. I still occupy this Excom position.
- Professional Conservationist of the Year, from the Conservation Federation of Missouri. The Conservation Federation of Missouri [http://www.confedmo.org/] is a federation of 70 non-
governmental organizations such as sportsmen’s groups (Missouri Trout Unlimited, Missouri Wild Turkey Federation), environmental organizations (Ozark Wilderness Waterways, Forest Releaf of Missouri) and conservation professional groups (Missouri Conservation Agents Association, Missouri Chapter Soil & Water Conservation Society). March 2007.

- Elected President of Introduced Fishes Section of the American Fisheries Society (three year term beginning 2007, plus two years as past president)

- Star award, February 2007, for being chosen as the recipient of the MOAFS Funk Award and the CFM Professional Conservationist of the year.
- On-the-Spot Award, for media work associated with Asian carp and the Chicago Ship and Sanitary Canal, December 2009
- Star Award, for demonstrated leadership in Asian carp research, May 2010
- Star Award, for outstanding work pursuing and publishing fundamental science on Asian carp biology. September 2012.
- Department of the Interior Honor Award for superior service in Asian carp research. October 3, 2013
- USGS Excellence in Leadership Award. Group award for the Asian Carp Science Team.

18. BIBLIOGRAPHY
a. PUBLISHED REPORTS
Toxicity and elemental contaminant concentrations of groundwater, sediment pore waters, and surface waters of the Missouri River associated with a metals refining site in Omaha, NB. USGS Biological Resources Division Technical Report to the USEPA under IAG DW14952122-01-1, Columbia Environmental Research Laboratory, Columbia, MO. 43. pp plus appendices.


http://pubs.er.usgs.gov/usgspubs/bsr/bsr000001


37) Chapman, D.C. 2009. Flying Fish Great Dish. DVD produced by Louisiana State University Ag Center. Also available in three parts on youtube: http://www.youtube.com/watch?v=T1NVUV8yhmu
Addendum 1
Brandon Road Lock & Dam Feasibility Study
Probability of Establishment

Great Lakes Research 38(1):159-166 BAO approval 12/8/11 IP-033299
63) Cudmore et al. binational risk assessment of grass carp. BAO approval 12-17-15 IP-066352

b. REPORTS ACCEPTED FOR PUBLICATION
Larson et al. 2016 Asian carp eggs cannot be distinguished from other cyprinid species on the basis of morphology alone

19. PUBLICATIONS

This article reports on the first evidence of recruitment by any Asian carp in the Great Lakes Basin. In this study, we combined otolith microchemistry, water quality, fish aging techniques, river hydrographic data, and ploidy analysis to provide multiple lines of evidence that grass carp captured in the Sandusky River were the result of natural recruitment in that river. I acquired the fish, organized the team with the skills required to address the multiple lines of evidence, and led the development of the manuscript. I have long identified the potential for grass carp establishment in the Great Lakes to be both a potential (and nearly overlooked) problem and an opportunity, because grass carp have reproductive requirements that are very similar to bigheaded carps, in that they are
broadcast spawners with drifting eggs that are thought to remain in the drift until hatching. The required drift time and turbulences required are roughly similar. Publication of this document has spurred a flurry of research on both of these fronts, including the Binational Risk Assessment of Grass Carp, adaptation of egg drift models for grass carp (in part for comparison to bigheaded carps), a further assessment of grass carp origin via otoliths and ploidy, and other research on grass carp status in the Great Lakes including larval collections and telemetry of adults by USGS and states bordering Lake Erie.


This book is partly the proceedings of a symposium which I chaired in Peoria, IL, but it also contains other research developed after the symposium. I acquired funding for the symposium, planned the program, invited the speakers, and acquired funding for the proceedings. I enlisted Mike Hoff as co-editor to provide for peer review for the introduction and the chapter I authored, invited additional authors to fulfill gaps in information on black carp, history of the Asian carp invasion, and history and use of the electric barrier that were not covered in symposium. I acted as editor for the remainder of the chapters, including providing for multi-reviewer peer review and including rejection of some chapters that were deemed inadequate through peer review. There are seventeen chapters, plus the introduction. Topics covered range from black carp status in the Mississippi River basin, to a history and an evaluation of the electric barrier in the Chicago Ship and Sanitary Canal, to stock-recruit and dispersal models, to contaminants in carp, to control methods. The topics in the symposium and the book are the topics of highest interest to agencies represented in the Mississippi River Basin Panel on aquatic nuisance species. For example, Dr. Papoulias' chapter on accuracy of ploidy measurement was important to the recent evaluation of the triploid grass carp certification program. The information in Dr. Orazio's chapter on contaminants in bigheaded carps (of which I am second author) has already been extensively used by entrepreneurs in development of markets for bigheaded carps.


This book is the most comprehensive source of information on bighead, silver, and large-scale silver carps in any language, and is considered the definitive text on these species. In addition to being a thorough review of the Asian carp literature and a comprehensive risk assessment for bigheaded carps in North America, it also contains substantial results from my research and field observations of Asian carp. I was the only one of the authors with substantial experience working directly with these fishes, I contributed strongly to the drafting and editing of all the chapters, but I drafted nearly all the original text for chapters 3, 5, 9, and 11, with Chapter 5 (Biology and Natural History of Bighead Carp) and Chapter 6 (Biology and Natural History of Silver Carp) being the largest and most centrally important chapters to the biosynopsis. I did not provide the first draft of Chapter 6, but it was patterned after my Chapter 5, used much of the same information, and I assisted strongly with editing that chapter. In addition, because of other demands on the first author at that time, I took charge of answering the reviews and editing the book after the book was sent out for peer review.
20. REFERENCES FOR DUANE CHAPMAN
Supervisor
Robert Jacobson
Branch Chief, Supervisory Hydrologist,
Columbia Environmental Research Center
4200 New Haven Road
573-876-1844
rjacobson@usgs.gov Customer/Collaborator
Michael Hoff
U.S. Fish and Wildlife Service
Fisheries Program
Norman Pointe II
5600 American Blvd. West
Suite 990
Bloomington, MN 55437-1458
612-713-5114
Michael_Hoff@fws.gov

Becky Cudmore
Division Manager, Great Lakes Laboratory for
Fisheries and Aquatic Sciences
Manager, Asian Carp Program
Fisheries and Oceans Canada
867 Lakeshore Rd. Burlington ON L7S 1A1 Canada
ph: 905-336-4474
Becky.Cudmore@dfo-mpo.gc.ca
**Greg Conover**  
9053 Route 148  
Marion, Illinois 62959  
ph. 618-997-6869 ext. 18  
email: Greg_Conover@fws.gov

**EDUCATION**  

**EXPERIENCE**  
Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, Large Rivers Fisheries Coordination Office, Midwest Region  
Coordinator, Mississippi Interstate Cooperative Resource Association  
Assistant Project Leader, U.S. Fish and Wildlife Service, Carterville Fish and Wildlife Coordination Office, Midwest Region  
Chair, Asian Carp Working Group, Aquatic Nuisance Species Task Force  
Fishery Biologist, U.S. Fish and Wildlife Service, Carterville Fish and Wildlife Coordination Office, Midwest Region  

**INVITED PRESENTATIONS**


SELECTED PRESENTATIONS


Caswell, N., C. Wrasse, and G. Conover. 2004. Evaluation of fisheries response to dredged material placement at Senate Island (IWW RM 130.0 - 133.1 L) and Hogback Island/Long Island (UMR RM 331.7 - 333.5 L) - Year 3. United States Fish and Wildlife Service, Carterville Fishery Resources Office, 9053 Route 148, Marion, IL 62959. 158pp + appendices.

Caswell, N., G. Conover, C. Wrasse, and C. Hilliard. 2003. 2002 Annual Report: Evaluation of fisheries response to dredged material placement at Senate Island (IWW RM 130.0 - 133.1 L) and Hogback Island/Long Island (UMR RM 331.7 - 333.5 L) - Year 2. United States Fish and Wildlife Service, Carterville Fishery Resources Office, 9053 Route 148, Marion, IL 62959. 224pp + appendices.


PROFESSIONAL MEMBERSHIPS
Illinois Chapter, American Fisheries Society
Kevin Irons
ph. 217-557-0719
email: kevin.irons@illinois.gov
EDUCATION
B.A. Biology (1987). Northland College, Duluth, MN.
EXPERIENCE
October Aquatic Nuisance Species Program Manager at Illinois Department of Natural 2010-
present Resources (IDNR)
1991- Large River Ecologist, Illinois Natural History Survey/University of Illinois October 2010
As the Program Manager for Aquatic Nuisance Species (ANS) and Aquaculture Kevin has a wide a
variable course of duties. As the lead for Asian carp work in Illinois, he oversee the Illinois
contributions to the Asian Carp Regional Coordinating Committee (ACRCC) where multiple federal
and state agencies collaborate to bring the best solutions to control and management of Asian carp
with the overall directive to keep reproducing populations of Asian carp from Lake Michigan, and
thus the Great Lakes Basin. Additionally, he serves as co-chair of the AIS Task force for Council of
Great Lakes Governors (and Premiers), representative of the Midwest Governors Association, Illinois
representative on the Mississippi, and Great Lakes panels on ANS. In addition to carp work, Kevin
strives to support relevant management and policy in regards to other ANS. Aquaculture duties
revolve around permits and policy to maintain healthy Illinois aquatic life. Prior to coming to the
IDNR, his responsibilities were as a large river ecologist at the Illinois Natural History Survey’s
Illinois River Biological Station as well as a fisheries specialist for the Long-Term Resource
Monitoring Program. He has worked at the Survey’s Illinois River Biological Station, in Havana,
Illinois, from 1991 until 2010. Over these years Kevin’s research has focused on the strengths of the
LTRMP to answer research questions as well topics of invasive species in the Illinois River. These
invasives include: white perch Morone americana, round goby Neogobius melanostomus, and Asian
carp species (bighead carp Hypophthalmichthys nobilis, silver carp Hypophthalmichthys molitrix,
and grass carp Ctenopharyngodon idella). In addition to the day to day monitoring on large rivers,
my research has focused on largemouth bass population dynamics, winter habitat preference, and age
and growth of several riverine species. He also provides much of the GIS support for the field
station; which includes development of a decision-support syste
PROFESSIONAL MEMBERSHIPS
American Fisheries Society
Southeastern Fishes Council
REUBEN P. KELLER

Assistant Professor
Department of Environmental Science
Loyola University Chicago
Chicago, IL 60660. USA.

ACADEMIC POSITIONS:

<table>
<thead>
<tr>
<th>Institution</th>
<th>Position</th>
<th>Start Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loyola University Chicago, Institute of Environmental Sustainability</td>
<td>Assistant Professor</td>
<td>August 2011-present</td>
</tr>
<tr>
<td>University of Chicago, Program on the Global Environment</td>
<td>Assistant Professor</td>
<td>September 2009-August 2011</td>
</tr>
<tr>
<td>University of Cambridge, Department of Zoology, Cambridge, UK</td>
<td>Affiliated Researcher, working with Dr. David Aldridge</td>
<td>October 2006-August 2011</td>
</tr>
<tr>
<td>University of Notre Dame, Center for Aquatic Conservation</td>
<td>Post-doctoral Research Associate with Prof. David M. Lodge</td>
<td>November 2006-August 2009</td>
</tr>
</tbody>
</table>

EDUCATION:

University of Notre Dame, Department of Biological Sciences, Notre Dame, IN, USA
Dissertation: *Ecological and Bioeconomic Risk Assessment for Invasive Species* (Ph.D. October 2006)
Committee: DM Lodge (Advisor), GA Lamberti, JL Tank, G Belovsky

Monash University, Melbourne, Australia
BA & BSc(Hons), November 2000 (majors: Biology, Statistics, Geography, Philosophy).
Honors thesis: *An Experimental Study of the Ecological Effects of the Introduced Freshwater Fish Oriental Weatherloach* (*Misgurnus anguillicaudatus*).
Advisor Prof. P.S. (Sam) Lake.

EDITED VOLUMES:


PEER REVIEWED PUBLICATIONS (* = student):


PUBLICATIONS IN REVIEW:

PUBLICATIONS IN PREPARATION:
Keller RP, J Deines* & DM Lodge. High accuracy of rapid risk assessment for fish introductions to the United States. For submission to Biological Invasions.

Keller RP & R Thomas*. Differential impacts of invasive species on human welfare in developed and developing countries. For submission to Conservation Biology.

Grey EK, RP Keller, C. Gantz & D.M. Lodge. Predicting the establishment and impact risk of non-native crayfish. For submission to Fisheries.


Scheiwiller K* & RP Keller. Historical patterns of zebra mussel spread across inland waterways in the Great Lakes Basin. For submission to Diversity and Distributions.

OTHER PUBLICATIONS (SELECTED):

Keller RP. Chicago River is due for a change. Commentary article in Chicago Tribune, 1 September 2010, p. 40.


INVITED ORAL PRESENTATIONS (SELECTED):


Keller RP. October 3, 2014. Risk Assessment for Invasive Species in the Great Lakes. 20 minute presentation via Webinar as part of a session co-organized by the Environmental Law Institute and the National Invasive Species Council. 235 people from across the US and Canada registered for the Webinar.

Keller RP. September 24, 2014. Differential Impacts of Invasive Species in Developing and Developed Countries, and Economic Outcomes From Applying Risk Assessment for Invasive Species. One hour presentation via Skype to the EU funded COST Workshop on the Socio-Economic Impacts of Invasive Species, held in Cyprus. I was invited as an international participant but was not able to attend. I was then asked to present my results from these two projects to the group, which I was able to do.


Addendum 1


Keller RP. June 2010. Bioeconomics of invasive species. 16th Annual German-American Frontiers of Science Symposium (organized and funded by the National Academies of Science). Potsdam, Germany.


Keller RP, DM Lodge, K Frang & DC Finnoch. 2007. Ecological and economic theory in analyzing risk in biological invasions. Symposium presentation at Ecological Society of America annual meeting, San Jose, CA, USA.

OTHER RECENT PRESENTATIONS (SELECTED):

Keller RP, E Cole* and K Garbach. May 18, 2015. Outreach to Prevent Spread of Invasive Species: Tracing Messages to Action. Oral presentation at Society of Freshwater Science annual meeting in Milwaukee, WI.


TEACHING

Professor, Loyola University Chicago

- Developed and taught: Environmental Sustainability (Fall 2011 & Spring 2012)
  - Each of these sections satisfied the LUC requirement for students to take an ‘engaged learning’ course. This required me to work with students to develop large projects, outside of class. A number of these are detailed in the following section (Student Engagement).
- Developed and taught: The Scientific Basis of Environmental Issues (Fall 2012 – Fall 2015)
- Developed and taught capstone class for Environmental Science majors (Fall 2015)

Lecturer, University of Chicago

- Developed and taught: Human Impacts on the Global Environment (Fall 2009 and 2010)
- Developed and taught: Freshwater ecosystems of the Calumet region (Spring 2010 & 2011)

Teaching Fellow, University of Notre Dame

- Taught upper level General Ecology with Prof. Jennifer Tank.

Laboratory course coordinator, University of Notre Dame

- Wrote labs for upper level Biostatistics lab course and coordinated 10 teaching assistants.
Teaching Assistant, University of Notre Dame  Spring 2003 & 2004

- Taught upper level Biostatistics lab course section

STUDENT ENGAGEMENT

- During my time at Loyola University I have had both formal and informal opportunities to encourage student projects that engage with the community. Many of these have been through the Engaged Learning sections that I have taught. Three representative projects (out of >20 completed or underway) are:
  - **Student Operation for Avian Relief (SOAR):** I worked with students in Spring 2012 to investigate the problems of migratory bird deaths resulting from window collisions on campus. The project has continued to the present, and involves students searching campus before dawn every morning to locate dead and injured birds. Injured birds are transported to a sanctuary for rehabilitation. Dead birds are identified and transferred to the Field Museum where they become part of their collection. Working with external bird experts and LUC facilities we have made two of the most dangerous buildings on campus safe by having blinds closed. We are continuing to work to make other buildings more safe. Students have been leaders in this project throughout, from collecting birds, liaising with the Field Museum and other science partners, to developing multilingual outreach posters to thank and inform LUC housekeeping staff about the project and why they are asked to close blinds. Students working on this project were awarded the 2014 Community Engagement Award for Innovation in Sustainability by the Loyola University Research Opportunities Program. Additionally, I was awarded Chicago Audubon Society’s 2015 Protector of the Environment award for the work done to reduce bird deaths.
  - **Invasive Species and Environmental Justice:** This continuing project with undergraduate students has investigated the impacts of invasive species on human welfare and environmental justice. Four undergraduates have now worked on this project, and we have an active collaboration with an academic in Kashmir, India, where we are investigating some recent invasions and their impacts on fisheries, water availability, and poverty. Undergraduate Reana Thomas was awarded a fellowship by the Pulitzer Center on Crisis Reporting. This funded her to travel to Kashmir to investigate and write about these issues. Her work is published at: [http://pulitzercenter.org/people/reana-thomas](http://pulitzercenter.org/people/reana-thomas)
  - My students worked with an after school program affiliated with Gale Elementary School to develop curriculum for growing vegetables in the school’s greenhouse. The greenhouse was otherwise underused, and the curriculum developed enabled the program to easily leverage the resources available. The class lessons were given in both paper form and in videos created by the students, and included a visit to Loyola’s urban gardens by Gale Elementary students.

MENTORING

- Three undergraduate students (Trent Henry, Abby Jahn, Gabrielle Habeeb) are conducting research in my lab during academic year 2015-16. Henry & Jahn have LUROP Mulcahy Fellowships
  Aug 2015 - present
- Undergraduates Trent Henry, Gabrielle Habeeb, and Jon Brenner worked with me over summer 2015 sampling aquatic invertebrates from the Chicago River and Lake Michigan. Henry had a LUROP Provost Fellowship.
  May 2015 - present
- Masters student Ellen Cole. Cole has presented at regional and national meetings  Aug 2013 - present
- Masters student Abigail Jacobs. Jacobs has presented at local, national and international meetings, and defended in October 2014. We are working on two publications.  Aug 2012 – October 2014
- Undergraduate Kevin Scheiwiller looked at the history of spread of zebra mussel across the Great Lakes region. He was supported by a LUROP Mulcahy Fellowship. We are currently working to finalize a manuscript.
  Aug 2013 – present

Addendum 1

Brandon Road Lock & Dam Feasibility Study
Probability of Establishment
• Mentored several undergraduate students looking at the international environmental justice issues presented by invasive species, Loyola University Chicago. One of these students was Reana Thomas who worked with the project for five semesters. She and I successfully applied for a fellowship from the Pulitzer Center on Crisis Reporting. This funded Reana to visit Kashmir, India, during summer 2014 to interview scientists, policy-makers, and water users, about the effects of invasive plants in Wular Lake. Her journalism is published at: http://pulitzercenter.org/people/reana-thomas

Jan 2012 – Dec 2014

• Mentored undergraduate project titled Impacts of Invasive Plants in the United States, and Adequacy of the Federal Response, University of Chicago

Aug. 2010 - present

• Mentored NSF Research Experience for Teachers fellow Summer 2005 (co-author Frang on Keller et al. 2008)

• Mentored NSF Research Experience for Undergraduates student Summer 2004

• Undergraduate research students (>5) during graduate and post-doc career 2001-2009

GRANT WRITING:


• **RP Keller (lead PI) & J Bossenbroek (Co PI, University of Toledo).** May 2015. Determining the Potential of Recreational Boats to Vector Invasive Species Throughout the Great Lakes. Submitted to combined US-EPA/USFWS Great Lakes Restoration Initiative RFP in conjunction with IL DNR. Total request of $215,143 ($96,235 of this to U Toledo as a sub-contract). Not funded.

• **RP Keller.** April 2014. Distribution of Native and Invasive Crayfish in the Chicago Area Waterways System and Near Shore Lake Michigan. Submitted to IL Department of Natural Resources. Total request of $15,689.97. Fully funded.

• **RP Keller.** April 2015. Assessing the Distribution of *Apocorophium lacustre* in the Chicago Area Waterway System. Submitted to IL Department of Natural Resources. Total request of $23,532.07. Fully funded.

• **RP Keller.** January 2015. Monitoring And Control Strategies To Respond To Growing Threats From Invasive Species In The Southern Basin Of Lake Michigan. Submitted to IL-IN SeaGrant with a total budget of $121,781. Not funded.


• **Sab, A & RP Keller.** November 3, 2014. Assisted tree migration risks, feasibility and implementation guidance: an evaluation of species ecology, landscape structure, and partners. Proposal submitted to SESC for Autumn Sabo to be a resident post-doc at SESYNC, with RP Keller acting as mentor. Total budget to Loyola, if funded, would be two months of summer salary for Keller, and travel funds. Not funded.


Addendum 1

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Brandon Road Lock & Dam Feasibility Study

Probability of Establishment

• Keller RP (PI), T Hoellein, J Kelly, C Peterson, T Hoang, C Putonti, D Treering (March 2012). The Effects of Spatial and Temporal Variation of Measured Abiotic and Biotic Attributes on Ecosystem Health in the Chicago Area Waterways System: Building the Foundation for Scientific Inquiry. Submission to Loyola University Chicago internal grant program “Stimulating Multidisciplinary Research at Loyola’s Lakeside Campuses”. Funded at $20,000.


• Lead author of Preventing Invasions from Trade in Live Aquatic Organisms, submitted to EPA in January 2010. Proposal successful and fully funded at $997,364.


• Successful application to Program on the Global Environment (University of Chicago) competition for funds to support undergraduate research. $2,500 for academic year 2010-11.

• Co-author of funding proposals to National Science Foundation (3), US Environmental Protection Agency, National Oceanic and Atmospheric Administration (3), National Center for Ecological Analysis and Synthesis (2), Great Lakes Commission.

ACADEMIC SERVICE:

• Proposed and organized session at the biennial Chicago Wilderness Congress (organized by Chicago Wilderness, November 15th, 2012) titled “Reimagining the Chicago and Calumet Rivers for the 21st Century and Beyond”. The session included four presentations; myself, Debra Shore (elected Commissioner for the Metropolitan Water Reclamation District of Greater Chicago), David St. Pierre (Executive Director of the MWRD), and Josh Ellis (Program Director at the Metropolitan Planning Council). The session was a great success with >200 attendees.

• Proposed and organized session at the June 2013 International Association of Great Lakes Research conference, held at Purdue University.

• Organized Invasive Species in a Globalized World Conference, May 2011. This brought researchers together from a range of disciplines, and from across the globe.

• Associate editor for journal Diversity and Distributions. July 2010 – December 2015.


OUTREACH:

Keller RP. October 3, 2014. Risk Assessment for Invasive Species in the Great Lakes. 20 minute presentation via Webinar as part of a session co-organized by the Environmental Law Institute and the National Invasive Species Council. 235 people from across the US and Canada registered for the Webinar.
Keller RP. 20 June, 2012. Economic and Environmental Benefits from Risk Assessment for Invasive Species. Presentation given as part of a Congressional Briefing held in the House Office Building, Washington DC.

Keller RP. 1 November, 2011. Economic and Environmental Benefits of Risk Assessment for Invasive Species. Presentation given as part of a Congressional Briefing, sponsored by Great Lakes United and the Northeast Midwest Institute, in the Senate Building, Washington DC.

Lessons from the Gulf Oil Spill November 3, 2010
- Organized public event at Shedd Aquarium, Chicago, with three expert speakers.

Asian carp invasion: potential economic and ecological impacts in the Great Lakes April 6, 2010
- Organized public event at Shedd Aquarium, Chicago, with five expert speakers.

Developing aquatic species risk assessment tools for U.S. National Invasive Species Council
- Working with Risk Assessment Working Group to update tools September 2009 – March 2011

Advisor to City of Chicago program on invasive species 2006-present
- Advised City as to which species should be banned from sale (many of these species identified through research reported in Keller & Lodge 2007).
- Presented expert testimony at City Council meeting in support of new invasive species ordinance (ordinance passed).

Member of Indiana Department of Natural Resources working group on risk assessment for aquatic invasive plants 2007-present
- Developed risk assessment tool for predicting which aquatic plant species proposed for trade are likely to cause harm. Tool is now being used for state policy.

WORKING GROUP AND POLICY REVIEW GROUP MEMBERSHIP:
Invited participant in Commonwealth Scientific and Industrial Research Organization (CSIRO, Australia) expert elicitation on Invasion Risk from Global Shipping and biofouling. Consisted of me working through and ranking risk for different shipping scenarios, and two hours of followup phone calls with the full expert group. Five experts were chosen from North America. March – May, 2015.

Member expert peer review panel for Canada’s proposed National Biological Risk Assessment Guidelines, June 2008.


UNIVERSITY SERVICE:
- Member of University’s Academic Council, 2014-16.
- Member of Institute of Environmental Sustainability Masters Degree committee, and IES Academic Council.
- Developed new B.S. in Environmental Science concentration in Concentration and Restoration. This included developing several new courses.
- Prepared and presented University Seminar Living on the Roof of the World: Relationships between Humans and the Environment in Tibet as part of Loyola University Chicago celebration of the Dalai Lama’s campus visit.
- Department of Environmental Science representative on the Loyola University Academic Council, August 2011 – present
- Member of four LUC faculty search committees during 2011-14

AWARDS:
• Awarded inaugural Kolvenbach Award for Engaged Teaching by Loyola University Chicago. One LUC faculty is selected for this award annually.
• Awarded the Protector of the Environment award by Chicago Audubon Society, 2015. This award is in recognition of the work I’ve done with students to reduce bird deaths at Loyola’s campus.
• Designated a Master Researcher by the Suijack Awards Committee, Loyola University Chicago, 2013. Three faculty from across Loyola received this award in 2013.
• Outstanding Graduate Student Teacher Award for Excellence in Teaching. Kaneb Center for Teaching and Learning, University of Notre Dame. 2006.
• Fisher Fellowship (one semester of stipend) awarded by Department of Biological Sciences in Fall, 2003, in recognition of contributions made to non-academic department life (in particular, establishing and serving as founding president of the Biology Graduate Student Organization).

PRESS COVERAGE

(SELECTED):

Interviewed for:
• Online Magazine Hakai by Geogg Giller, for an article about potential marine invasions of the Arctic region. 11/24/15.
• U.S. Catholic Magazine, for a profile of me in the December 2015 issue.
• Nature Magazine article, interviewed by Boer Deng, and quoted by her, for article about artificial intelligence applications to modeling the spread of diseases. http://www.nature.com/news/artificial-intelligence-joins-hunt-for-human-animal-diseases-1.17568
• Article about SOAR bird program for article in DNAinfo. http://www.dnainfo.com/chicago/20141119/rogers-park/loyolas-buildings-are-beautiful-but-deadly-for-migrating-birds-researchers
• Radio WILL (NPR station in Champaign, IL) Focus program, May 25, 2011. Audio online at http://will.illinois.edu/focus/interview/focus110525b/


Research described in press releases from: Union of Concerned Scientists, The Nature Conservancy, Illinois-Indiana SeaGrant, University of Notre Dame, University of Wyoming, the Australian Weeds Co-operative Research Center.
Jack Killgore
3909 Halls Ferry Road,
Vicksburg, MS 39180
ph. 601-634-3397
e-mail: jack.killgore@usace.army.mil

EDUCATION
M.Sc. Fisheries (1979). Sam Houston State University, Huntsville, TX.
B.A. Zoology (1976). University of Arkansas, Fayetteville, AR.

EXPERIENCE
Team Leader, Environmental Laboratory, U.S. Army Engineer Research and Development Center (ERDC). Dr. Killgore directs an interdisciplinary team conducting research on environmental biology of fishes, threatened (sturgeon) and invasive (Asian carp) fish species, ecosystem restoration in rivers and floodplains, and environmental impact assessment of U. S. Army Corps of Engineers flood control and navigation projects.

SELECTED PRESENTATIONS AND PUBLICATIONS
2015
2014

2012

2011

2010
AWARDS AND FELLOWSHIPS
Herbert D. Vogel award for Scientist of the Year, Summer 2009
Engineer Research and Development Center
USFWS Southeast Region, Regional Director’s Spring 2011
Conservation Award
ERDC Research and Development Awards 2011, 20013, 2015

PROFESSIONAL MEMBERSHIPS
American Fisheries Society
Southeastern Fishes Council
Andrew M. Kramer

**EDUCATION**

Ph.D., Fisheries and Wildlife / Ecology, Evolutionary Biology and Behavior (dual degree), 2007, Michigan State University  
Advisor: Orlando Sarnelle  
Dissertation title: Copepodology in alpine lakes: limitations to recovery of *Hesperodiaptomus shosone* after exotic fish eradication

**Bachelor of Science**, 2000, Saint Louis University  
Honors degree, Biology (*summa cum laude*)

**GRANTS AND AWARDS**

**Research Grants**


*Edward and Phyllis Reed Endowment*, “Pheromone specificity between closely and distantly related species in the genus *Hesperodiaptomus*”. 2010. **(Kramer co-PI, collaborative with Jeannette Yen, Georgia Institute of Technology, $5900)**

**Valentine/Eastern Sierra Reserve Graduate Student Grant**, University of California Reserve System, 2006 ($1500)

**Sigma Xi Grant-in-Aid of Research**, 2006 ($580)

**National Science Foundation Graduate Research Fellowship**, 2001-2005 (~$100,000)

**Michigan State University Graduate School Research Enhancement Award**, 2005 ($1000)

**Research Experience for Undergraduates Supplement** to NSF award "Recovery of ecosystem structure and function following exotic species eradication" (co-authored with PIs Orlando Sarnelle and Roland Knapp), 2002 ($6000)

**Scholarships, Honors and Awards**

Ecological Dissertations in the Aquatic Sciences participant (Eco-DAS VIII, formerly DIALOG) (2008)

Michigan State University Dissertation Completion Fellowship, 2007  
Michigan State University Ecology, Evolutionary Biology and Behavior Fellowship, 2006  
Michigan State University Distinguished Fellowship, 2000 and 2004  
Fisheries and Wildlife Department Graduate Student Organization travel grant, 2005 and 2007  
Ecology, Evolutionary Biology and Behavior program travel grant, 2005 and 2007  
Saint Louis University, Outstanding Senior in Department of Biology, 2000

**PEER-REVIEWED PUBLICATIONS**  
*indicates undergraduate author*


Papers in review
Wittman, M.E., G. Annis, A.M. Kramer, L. Mason, C. Riseng, E. Rutherford, W.L. Chadderton,

**RESEARCH POSITIONS**

*Assistant Research Scientist*, Odum School of Ecology, University of Georgia, Aug 2013 – present.

*Postdoctoral researcher*, Odum School of Ecology, University of Georgia, Sept. 2009 – April 2013. Microscopic islands: theory of island biogeography for aquatic pathogens. Mentor: Dr. John Drake

*Postdoctoral researcher*, Odum School of Ecology, University of Georgia, Oct. 2007-March 2009. Dynamics of low density populations, including the impact of Allee effects on colonization success in freshwater zooplankton. Mentor: Dr. John Drake

*Ph.D. candidate*, Michigan State University, Department of Fisheries and Wildlife, Aug. 2000-Aug. 2007. Copepodology in alpine lakes: limitations to recovery of Hesperodiaptomus shosone after exotic fish eradication, advisor Dr. Orlando Sarnelle

**TEACHING POSITIONS (Year/# of students)**

*Co-Instructor*, ECOL 4500 Evolutionary Ecology, University of Georgia (Spring 2015 / 13).

*Instructor*, BIOL 1101 Biology: the Human Experience, Gainesville State College, Gainesville, GA. (Summer 2009, 2 sections of lecture and laboratory, 20 students each)

*Co-Instructor*, ECOL 4000/6000 Population and Community Ecology, University of Georgia (Fall 2008 / 20).

*Instructor*, ECOL 3500 Ecology, University of Georgia (Summer 2008 / 28).

Guest Lecture, ECOL 4000/6000 Population and Community Ecology, University of Georgia (2015/35), predator-prey interactions.

Guest Lecture, FYOS 1001: The Structure of Scientific Revolutions, University of Georgia (2013/10), led discussion about what scientists do for this freshman odyssey course.

Guest Lecture, ECOL 8310 Population Ecology, University of Georgia (2011 / 25), one lecture, one discussion.

Guest Lecture, ECOL 8310 Population Ecology, University of Georgia (2009 / 16), one lecture, two discussions, lab exercise.

Guest Lecture, ECOL 8310 Population Ecology, University of Georgia (2008 / 12)


Guest Lecture, FW 109 Conservation of Freshwater Ecosystems, Michigan State University (2002 / 40)

Teaching Assistant, ISP 217L Water and the Environment Laboratory, Michigan State University (2007, 2006, 2005 / 80 each semester)

Teaching Assistant, MMG 426 Biogeochemistry, Kellogg Biological Station, Michigan State University (2006 / 12)

**MENTORING EXPERIENCE**

*Advisor for NSF Research Experience for Undergraduates* students

Summer 2015: Annakate Schatz

  Project: Model accuracy in forecasting pathogen spread using climatic data

Summer 2002: Blair Wilson

  Project: Detecting mating pheromones in *Hesperodiaptomus shosone*

*Mentoring undergraduate research:*

Spring 2014: Navdeep Patel: Predicting spatial spread of non-stationary wildlife disease
Summer 2013 – Summer 2014: Deenan Patel: Predicting spatial spread of non-stationary disease using species distribution models
Spring 2010-Spring 2012: Tierney O’Sullivan and Theresa Stratmann, experimental and theoretical research on Daphnia population dynamics.

**Advisor for undergraduates** assisting with my Ph.D. research and the High Sierra Experimental Lakes Project
- Summer 2004: Chris Brownfield
- Summer 2003: Greg Goldsmith
  - Project: *Dispersal of limnetic zooplankton via streams in Humphreys Basin, Sierra Nevada*

**Active in providing statistical and modeling consultation and/or tutoring** for several graduate students: Mike Buchalski, Western Michigan University; Trip Armstrong, UC Davis; Tad Dallas, UGA; Reni Kaul, UGA; Jason Lang, UGA; Keri Goodman, UGA; Sarah Heisel, UGA; Rachel Lasley, Georgia Tech, Larisa Pender-Healey, Georgia Tech and others in a more limited role.

**PRESENTATIONS AND WORKSHOPS**

**Invited:**
- Leibniz Institute for Freshwater Ecology and Inland Fisheries (IGB), Berlin, Germany. April 2014.
- Kennesaw State University, Ecology and Evolution seminar series, September 2013.
- Leadership without Limits! Presentation on species interactions and species conservation in aquatic systems. Program is for high school students that are children of migrant farm workers, will be developing community projects on water issues. June 2013.
- Computational Ecology and Epidemiology Study Group, University of Georgia, tutorial on using R to produce high quality figures and graphics. February 2012
- Mammoth Lakes Academy (high school), research and career seminar, August 2011
- University of South Carolina, Biological Sciences seminar, March 2011
- Ohio State University, School of Environment and Natural Resources, February 2011
- Oceans and Human Health, Gordon Research Seminar, June 2010
- Eco-DAS symposium, University of Hawaii-Manoa, October 2008
- Auburn University, Fisheries and Allied Aquaculture seminar, September 2008
- Michigan State University, Fisheries and Wildlife Graduate Student Organization seminar April 2006

**Contributed:**

Addendum 1
mussel and killer shrimp in the Great Lakes. Joint Aquatic Sciences Meeting, May 2014, Portland, OR.


Kramer, A.M. and O. Sarnelle. Allee effect on population growth rate in sexually reproducing zooplankton. American Society of Limnology and Oceanography 2007 Aquatic Sciences meeting, Santa Fe, NM


* indicates undergraduate author

Workshops:


PROFESSIONAL AND LEADERSHIP ACTIVITIES

Limnology and Oceanography (1), Ecological Applications (2), Evolution (1), Journal of Animal Ecology
(3), Biology Letters (1), Ecosphere (1), Oecologia (1), Genetics (2), Conservation Biology (1), Bulletin of
Mathematical Biology (1), Biological Invasions (1), Diversity and Distributions (1), Methods in Ecology
and Evolution (1), Ecography (1), Ecological Modelling (1), Journal of Applied Ecology (1), Behavioral
Ecology (1), Ecological Entomology (1), Behaviour (1), Behavioral Ecology and Sociobiology (1),
Transactions American Fisheries Society (1), Journal of Mammalogy (1).

Proposal reviews: NSF (4), Oregon Sea Grant.

Curriculum reviews: SEPUP/Science Education for Public Understanding Program, Lawrence
Hall of Science, UC Berkeley

Presentation judge, Odum School of Ecology Graduate Student Symposium, 2010, 2011, 2013,

Professional Societies: Ecological Society of America, American Society of Limnology and
Oceanography

Graduate representative, Fisheries and Wildlife Department Graduate Committee, Fall 2004- Spring 2006

Responsible Conduct of Research:
- 6 part seminar series on research ethics, completed in 2005 (Michigan State University)
- CITI online research ethics module, 2010, 2015 (University of Georgia)
A. BIOGRAPHICAL INFORMATION

1. PERSONAL
Nicholas Edward Mandrak (DOB: April 12, 1963)
Department of Biological Sciences 2069 Waterbridge Drive
University of Toronto Scarborough Burlington, ON
1265 Military Trail L7M 3W2
Toronto, ON M1C 1A4 (905)331-4400
(416)208-2248 mandrak4@cogeco.ca
nicholas.mandrak@utoronto.ca

2. DEGREES
Thesis Title: Biogeographic patterns of freshwater fishes in relation to historical and environmental processes in Ontario lakes and streams.
Graduate Supervisor: Dr. Edwin J. Crossman.
Minors: Geographic Information Systems; Multivariate Statistics.
M.Sc.: University of Toronto, March 1990.
Thesis Title: The zoogeography of Ontario freshwater fishes.
Graduate Supervisor: Dr. Edwin J. Crossman.
Minor: Environmental Factors.
B.Sc.: University of Toronto, June 1986.
Biogeography Specialist, Anthropology Minor.

3. EMPLOYMENT
2013 - Associate Professor, Department of Biological Sciences, University of Toronto present Scarborough. Toronto, ON.
2006 - Executive Director, DFO National Centre of Expertise for Aquatic Risk 2013 Assessment (CEARA), Great Lakes Laboratory for Fisheries and Aquatic Sciences, Department of Fisheries and Oceans, Burlington, ON.
2005 - Section Head, Biodiversity Science Section, Great Lakes Laboratory for Fisheries and Aquatic Sciences, Department of Fisheries and Oceans, Burlington, ON.
2001 - Research Scientist, Great Lakes Laboratory for Fisheries and Aquatic Sciences, Department of Fisheries and Oceans, Burlington, ON.
1999 - Assistant Professor, Department of Biological Sciences, Youngstown State University, Youngstown, OH.
1997 - Assistant Professor, Department of Biology, Trent University, Peterborough, ON.
Curriculum Vitae – Nicholas Edward Mandrak
1994 - Assistant Professor and Associate Curator of Fishes, Department of
1997 Biological Sciences, Fort Hays State University, Hays, KS.
1986 - Teaching Assistant, Department of Zoology, University of Toronto.
1993
4. HONOURS
2010. Personal letter from DFO Minister Shea commending good work being done on AIS file.
2010. DFO Immediate Award for participation in Asian Carp Control in Chicago Sanitary Canal project.
1997. Outstanding Scholarship Award, College of Health and Life Sciences, Fort Hays State University.
1997. Outstanding Mediated Classroom Teacher Award, College of Health and Life Sciences, Fort Hays State University.
5. PROFESSIONAL AFFILIATIONS AND ACTIVITIES
Adjunct Professor: Trent University, Queen’s University, University of Guelph, University of Windsor.
Research Associate: Ichthyology, Royal Ontario Museum; South Africa Institute for Aquatic Biodiversity.
Grant reviewer: Great Lakes Fishery Commission, Hudson River Foundation, National Oceanic and Atmospheric Agency (NOAA), Natural Sciences and Engineering Research Council of Canada (NSERC), North Carolina Sea Grant, Ontario Living Legacy Trust, South African National Research Foundation.
Testified before the Parliamentary Standing Committee on Fisheries and Oceans. May 2012, October 2012.
Member. 2012-2013. Deputy Ministers’ National Research Scientist Promotion Committee.
Chair, Canadian Science Advisory Secretariat Meeting National Science Peer Review of risk assessment of Ship-mediated introductions of AIS in the Atlantic and Pacific regions of Canada. CSAS Meeting, Burlington, ON, March 2012.
Member. Board of Directors, 2012-present. Canadian Conference for Fisheries Research.
Curriculum Vitae – Nicholas Edward Mandrak


Member, Canadian Aquatic Invasive Species Team, Great Lakes Water Quality Agreement, 2010-2012.

Member, Canadian Species and Habitat Team, Great Lakes Water Quality Agreement, 2010-2012.


Member, Research Committee, Great Lakes Commission. 2010-present.

Member, Scientific Committee. 2010-2012. Canadian Aquatic Invasive Species Network II.


Member, Steering Committee, ICAIS, 2008-2009.

Member, Steering Committee, NSERC Network Workshop on Conservation in Canada. April 2009.

Associate Editor, Biological Invasions, 2009 to present.


Chair, Canadian Science Advisory Secretariat Regional Science Peer Review of the redside dace (Clinostomus elongatus) recovery potential assessment. CSAS Meeting, Burlington, ON. December 2007.

Chair, Canadian Science Advisory Secretariat Regional Science Peer Review of the Atlantic salmon (Salmo salar) recovery potential assessment. CSAS Meeting, Burlington, ON. March 2007.

Chair, CSAS Regional Science Peer Review of the silver lamprey (Ichthyomyzon unicuspis) prior to assessment by COSEWIC. CSAS Meeting, Burlington, ON. March 2007.

Member, Ontario Biodiversity Strategy Science Forum. 2007-2012.


Chair, CSAS National Science Peer Review of the Quantitative Biological Risk Assessment Tool (QBRAT). CSAS Meeting, Ottawa, ON. November 2006.

Program Chair, Canadian Conference for Fisheries Research, 2007.


Member, DFO Tunicate Working Group, 2006-2007.

Member, DFO National RPA Working Group, 2006-2013.

Member, Organizing Committee, State of Lake Huron Conference, 2006.

Member, Planning Committee, Lake Erie Millenium Project Habitat Classification and Binational Map Project, 2005-6.

Member, Advisory Committee, Huron-Erie Corridor Committee, 2006-2013.

Project Team Member, Barcoding Life: Canadian Freshwater Fishes, 2005-2009.

Writing Team Member, Development of harmonized guidelines and a decision support tool for cage culture site applications in Ontario. DFO-FHM-OMNR Species at Risk Act Discussion Paper. 2005.

Chair, CSAS Zonal Science Peer Review of the American eel (Anguilla rostrata) prior to assessment by COSEWIC. CSAS Meeting, Quebec City, PQ. October 2005.


Member, Planning Committee, State of Lake Huron Symposium, 2005-6.

Session Organizer and Chair, "Aquatic Species at Risk in the Great Lakes Basin". International Association for Great Lakes Research Annual Meeting, May 2005.

Committee Member. Lake Erie Millenium Project Habitat Classification and Binational Map Project, 2005.

Member, Goby Working Group, Ontario Ministry of Natural Resources, 2004-2013.

Member, Joint American Fisheries Society- American Society of Ichthyologists and Herpetologists, Names Committee, 2004-present.

Member, American Society of Ichthyologists and Herpetologists, Endangered Species Committee, 2004-present.

Brandon Road Lock & Dam Feasibility Study
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Editorial Board Member, Journal of Aquatic Ecosystem Health and Management, 2004-present.


Special Session Organizer and Chair, “Celebrating the 30th Anniversary of the Freshwater Fishes of Canada”, Canadian Conference for Fisheries Research, January 2003.

Invited Member of Organizing Committee, Chair of Aquatic Biodiversity and Invasive Species Session. DFO National Science Workshop, November 2003.


Member, Freshwater Fishes Specialists’ Subcommittee, COSEWIC, April 2002-present.

Founding Member, Canada-Ontario Introductions and Transfers Committee. September 2001-present.


Member, Great Lakes Fishery Commission Board of Technical Experts. September 1999-2012.


Thesis Defence Examiner: Fort Hays State University (10); Trent University (2); Youngstown State University (4).

B. ACADEMIC HISTORY

6. A. RESEARCH ENDEAVOURS

Biogeography, Biodiversity, and Conservation of Freshwater Fishes

B. RESEARCH AWARDS (grants, contracts, fellowships) during preceding 5 years

Canada Foundation for Innovation. 2015-2019. Biodiversity and conservation of freshwater fishes laboratory. $80,000.


Asian Carp Programme, DFO. 2013-2014. Tracking fish movement through the Welland Canal and St. Marys River. $150,000.
Species at Risk Programme, DFO. 2013-2014. Evaluation of habitat use by, and effects of drain maintenance on Pugnose Minnow and Blackstripe Topminnow in agricultural drains. $85,000.
Species at Risk Programme, DFO. 2013-2014. Evaluation of habitat use by, and effects of drain maintenance on Grass Pickerel in agricultural drains. $37,500.
Species at Risk Programme, DFO. 2013-2014. Targeted survey to determine the spatial extent of Lake Chubsucker within Long Point Bay. $85,000.
Species at Risk Programme, DFO. 2013-2014. Spatiallyexplicit population viability analysis of Pugnose Shiner in the Bay of Quinte and St. Lawrence River. $37,500.
Species at Risk Programme, DFO. 2013-2014. Identifying YOY and juvenile Spotted Gar habitat in Rondeau Bay. $37,500.
Aquatic Invasive Species Programme, DFO. 2012-2013. Tracking fish movement through the Welland Canal. $39,000.
Aquatic Invasive Species Programme, DFO. 2012-2013. Centre of Expertise for Aquatic Risk Assessment (CEARA). $240,000.
Asian Carp Programme, DFO. 2012-2013. Tracking fish movement through the Welland Canal and St. Marys River. $50,000.
Species at Risk Programme, DFO. 2012-2013. Critical habitat of Channel Darter: instream flow needs in the Trent River. $50,000.
Species at Risk Programme, DFO. 2012-2013. Critical habitat of Lake Chubsucker: spatial extent in the Lake Huron drainage and upper Niagara watershed. $75,000.
Species at Risk Programme, DFO. 2012-2013. Critical habitat of Northern Madtom: spatial extent in Lake St. Clair and the Sydenham River. $100,000.
Species at Risk Programme, DFO. 2012-2013. Critical habitat of Pugnose Shiner: spatial extent in St. Lawrence River and Trent River. $50,000.
Species at Risk Programme, DFO. 2012-2013. Critical habitat of Spotted Gar: spatial extent in Long Point Bay. $50,000.
Species at Risk Programme, DFO. 2012-2013. Development of eDNA methods to detect Spotted Gar in historic, current, and adjacent sites. $50,000.
Species at Risk Programme, DFO. 2012-2013. Spatially explicit population viability analysis of Pugnose Shiner in the St. Lawrence River. $37,500.
Species at Risk Programme, DFO. 2012-2013. Evaluation of habitat use by, and effects of drain maintenance on, Grass Pickerel in agricultural drains. $50,000.
Aquatic Invasive Species Programme, DFO. 2011-2012. Determining the magnitude of impact of round goby on benthic fish species at risk in riverine systems. Co-PI: S. Reid. $8,000.
Great Lakes Fishery Trust. 2011-2012. Human dimensions of the baitfish industry. $18,000.
Curriculum Vitae – Nicholas Edward Mandrak
Ontario Invasive Species Centre Partnership Fund. 2011-2012. Tracking fish movement through the Welland Canal and St. Marys River. $100,000.
Ontario Invasive Species Centre Partnership Fund. 2011-2012. Determining the magnitude of impact of round goby on benthic fish species at risk in riverine systems. Co-PI: S. Reid. $25,000
Species at Risk Programme, DFO. 2011-2012. Identifying the critical habitat, limiting factors and threats of Spotted Gar. $118,000.
Species at Risk Programme, DFO. 2011-2012. Critical habitat of Channel Darter populations in Ontario: understanding population structure and fragmentation effects using genetics and implications for population re-establishment. $38,000.
Species at Risk Programme, DFO. 2011-2012. Critical habitat of Pugnose Shiner in Canada: population structure, detectability, habitat preferences, and the effects of turbidity and oxygen depletion. $100,000.
Species at Risk Programme, DFO. 2011-2012. Evaluation of habitat use by, and effects of drain maintenance on, Grass Pickerel in agricultural drains. $25,000.
Committee on the Status of Endangered Wildlife in Canada. 2010-2012. COSEWIC Status Reports. $18,000.
Aquatic Invasive Species Programme, DFO. 2010-2011. Critical habitat of Channel Darter populations in Ontario: understanding population structure and fragmentation effects using genetics and implications for population re-establishment. $54,800.
Species at Risk Programme, DFO. 2010-2011. Critical habitat of Pugnose Shiner and Spotted Gar: the effect of turbidity on physiology and behaviour. $60,000.
Species at Risk Programme, DFO. 2010-2011. Critical habitat of Pugnose Shiner, Northern Madtom, and Lake Chubsucker: distribution, abundance, and habitat preferences. $130,000.
Species at Risk Programme, DFO. 2010-2011. Evaluation of habitat use by, and effects of drain maintenance on, Grass Pickerel in agricultural drains. $25,000.
Species at Risk Programme, DFO. 2010-2011. Pugnose Minnow, Bridle Shiner and Blackstripe Topminnow in Canada: determining population size, distribution, abundance, and habitat preferences. $78,000.
C. PATENTS awarded during past 5 years.
C. SCHOLARLY AND PROFESSIONAL WORK*
7. Refereed publications
A. Articles

Brandon Road Lock & Dam Feasibility Study
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Curriculum Vitae – Nicholas Edward Mandrak


Curriculum Vitae – Nicholas Edward Mandrak


Addendum 1

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Curriculum Vitae – Nicholas Edward Mandrak
B. Books and/or Chapters
Curriculum Vitae – Nicholas Edward Mandrak
C. Books edited
8. Non-Refereed Publications
Curriculum Vitae – Nicholas Edward Mandrak


Curriculum Vitae – Nicholas Edward Mandrak
Curriculum Vitae – Nicholas Edward Mandrak


Curriculum Vitae – Nicholas Edward Mandrak
Reid, S.M., N.E. Mandrak, and J. Barnucz. 2005. Inventory and habitat characterization for the north-
Curriculum Vitae – Nicholas Edward Mandrak

shore Lake Erie populations of the channel darter. Annual Report to COA.
Holm, E. and N.E. Mandrak. 2003. Updated status of the Silver Chub, Macrhybopsis storeriana, in Canada. Submitted to COSEWIC.
Holm, E. and N.E. Mandrak. 2002. Updated status of the Silver Chub, Macrhybopsis storeriana, in Canada. Submitted to COSEWIC.

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Curriculum Vitae – Nicholas Edward Mandrak

9. Manuscripts/publications, etc. in preparation and submitted to publishers but not yet accepted.
10. Papers presented at meetings and symposia (2002-present)
Curriculum Vitae – Nicholas Edward Mandrak
Curriculum Vitae – Nicholas Edward Mandrak


Balasingham, KB*, Mandrak, NE., Walter, RP., Barnucz, J., and Heath, DD. 2013. eDNA and Next-generation sequencing to detect species at risk in southern Ontario. Poster presented at the State of Strait (SOS) conference at GLIER and Lake Erie Millennium Network (LEMN) conference, University of Windsor, ON, CA.


Curriculum Vitae – Nicholas Edward Mandrak
Hedges*, K.J., N.E. Mandrak, M.A. Koops and O.E. Johannssonuly If you build it, will they come (or stay)? Summary and assessment of Great Lakes Aquatic Protected Areas Canadian Conference for Fisheries Research, Winnipeg, MB. January 2010.
Curriculum Vitae – Nicholas Edward Mandrak


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Curriculum Vitae – Nicholas Edward Mandrak


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Curriculum Vitae – Nicholas Edward Mandrak


Curriculum Vitae – Nicholas Edward Mandrak

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Curriculum Vitae – Nicholas Edward Mandrak
11. Invited Lectures


Curriculum Vitae – Nicholas Edward Mandrak


Mandrak, N.E. 2013. The role of DFO in protecting aquatic species at risk. Fisheries Class, Queen’s University, Kingston, ON. March 7, 2013.


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Brandon Road Lock & Dam Feasibility Study
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Curriculum Vitae – Nicholas Edward Mandrak


Mandrak, N.E. 2009. CEARA. Extended National Science Directors Committee meeting, Montreal, QC. February 27-28, 2009.
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Brandon Road Lock & Dam Feasibility Study
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Curriculum Vitae – Nicholas Edward Mandrak


Curriculum Vitae – Nicholas Edward Mandrak
Mandrak, N.E. Biogeography, biodiversity and conservation biology of freshwater fishes. Department of Biological Sciences, Youngstown State University, Youngstown, OH. April 1999.
Mandrak, N.E. Biogeographic patterns of freshwater fishes in relation to historical and environmental factors. Division of Biology, Kansas State University, Manhattan, KS. December 1997.
Mandrak, N.E. Threats to the biological diversity of freshwater fishes. Division of Biology, Kansas State University, Manhattan, KS. December 1997.
Mandrak, N.E. Threats to the biological diversity of freshwater fishes. Department of Biology, Trent University, Peterborough, ON. June 1997.
Mandrak, N.E. Russian waters: an ichthyological expedition in Russia’s Far East. Department of Systematics and Ecology, University of Kansas, Lawrence, KS. March 1996.
Mandrak, N.E. Threats to the fish diversity of Khanka Lake, Russia. Department of Biological Sciences and Allied Health, Fort Hays State University, Hays, KS. December 1994.

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Curriculum Vitae – Nicholas Edward Mandrak

D. LIST OF COURSES (in preceding 5 years)
12. Indicate in each case whether you had major responsibility for design of course.

A. Undergraduate courses taught
2014/15
BIOD54H - Applied Conservation Biology (new course designed by NEM)
BIOD98H - Directed Research Course in Biology

B. Graduate courses taught
2014/15
EES1100Y - Advanced Seminar in Environmental Science (modified by NEM)
EES3000H - Applied Conservation Biology (new course designed by NEM)
EES3003H - Topics in Applied Biodiversity (new course designed by NEM)

C. Theses supervised
Masters Students
Yiminxue Zheng. 2015-present. Effects of multiple stressors on Brook Trout (Salvelinus fontinalis) in Greater Toronto Area streams. University of Toronto.
Monica Granados. 2008-2010. Is the IBI an appropriate measure of fish habitat rehabilitation in areas of concern? University of Toronto. Co-supervised by D. Jackson.

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**Doctoral Students**


**Postdoctoral Fellows**

William Glass, 2013-present. Identifying the critical habitat of the Threatened Spotted Gar.
Jaewoo Kim, 2012-present. Quantifying and controlling the movement of invasive fishes.
Andrew Drake, 2010-present. Modelling AIS movement through bait, boating, and shipping pathways.
Kevin Hedges, 2007-2010. Aquatic protected areas in the Great Lakes basin: inventory, evaluation and gap analysis.
Curriculum Vitae – Nicholas Edward Mandrak

D. Other teaching and lectures given (in preceding 5 years)

E. ADMINISTRATIVE POSITIONS

13. A. Positions held and service on committees and organizations within the University.
   Chair, PhD Examination Committee. Maude Therberge, School of Public Health, University of Toronto. June 2015.
   Member, Aquatic Ecology Search Committee, Department of Ecology and Evolutionary Biology, University of Toronto, 2014, 2015.
   Member, Conservation Biology Lecturer Search Committee, Department of Biological Sciences, University of Toronto Scarborough, 2015.
   Member, PhD Examination Committee. Aaron Hall, Department of Ecology and Evolutionary Biology, University of Toronto. January 2015.
   Member, PhD Examination Committee. Pasan Samarasin-Dissanayake, Department of Ecology and Evolutionary Biology, University of Toronto. August 2015.
   Director, Master’s of Environmental and Physical Sciences Conservation and Biodiversity Stream, University of Toronto Scarborough. 2014-present.
   Member, Conservation Biology Search Committee, Department of Biological Sciences, University of Toronto Scarborough, 2014.
   Member, MSc Committee. Simone Yasui, Department of Ecology and Evolutionary Biology, University of Toronto, 2014-present.
   Member, MSc Committee. Lindsay Ogston, Department of Ecology and Evolutionary Biology, University of Toronto, 2013-2015.

B. Positions held and service on committees and organizations outside the University of scholarly and academic significance.

   Associate Editor, Biological Invasions, 2009 to present.
   Member, Board of Directors, Canadian Conference for Fisheries Research, 2013-present.
   Member, Research Committee, Great Lakes Commission. 2010-present.
   Editorial Board Member, Journal of Aquatic Ecosystem Health and Management, 2004-present.
   Member, Joint American Fisheries Society- American Society of Ichthyologists and Herpetologists, Names Committee, 2004-present.
   Member, American Society of Ichthyologists and Herpetologists, Endangered Species Committee, 2004-present.
   Member, Freshwater Fishes Specialists’ Subcommittee, COSEWIC, April 2002-present.
CURRICULUM VITAE
Linda S. Nelson, Ph.D.
U.S. Army Engineer Research & Development Center
Environmental Laboratory, EM-W
3909 Halls Ferry Road
Vicksburg, MS 39180-6199
Phone: 601-634-2656
E-mail: Linda.S.Nelson@usace.army.mil

Education
1982 - B.S., Biology. University of South Dakota, Vermillion, SD
1985 - M.S., Crop Production and Physiology. Iowa State University, Ames, IA
Thesis: Isolating potential allelochemicals from soybean-soil residues
2001 - Ph.D., Botany/Weed Science. Purdue University, West Lafayette, IN
Thesis: Phytoremediation of TNT-contaminated water by the submersed aquatic macrophyte Potamogeton pectinatus

Employment History and Professional Experience
2010-present: Assistant Technical Director, Civil Works, Environmental Engineering and Sciences and Program Manager, Aquatic Nuisance Species Research Program and the Aquatic Plant Control Research Program, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS.

1988-2010: Plant Physiologist, Chemical Control Technology Team and Program Manager (since 2009), Aquatic Nuisance Species Research Program, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS.

2005-present: Adjunct Professor. Department of Plant and Soil Sciences, Mississippi State University, Mississippi State, MS.

1985-1988: Research Associate. Iowa State University - U.S. Army Corps of Engineers Waterways Experiment Station, Intergovernmental Personal Agreement (IPA), Vicksburg, MS.

Current Job Responsibilities
Provide technical and program support to the Technical Director and Environmental Laboratory Director on all issues related to environmental engineering and sciences within the Corps of Engineers Civil Works Business Area. Assist in planning, programming, and budget execution of major multidisciplinary environmental quality research.

Serve as Program Manager for the Aquatic Plant Control Research Program ($3.375M budget in 2015) and the Aquatic Nuisance Species Research Program ($670K budget in 2015) and other invasive species R&D initiatives within the Corps of Engineers. Program management responsibilities include: reviewing and developing the direction of current and future research; managing, distributing and monitoring funding execution; maintaining program websites; reviewing report and program documentation; interfacing with program Technical Monitors at Corps Headquarters level; and providing technical guidance to requesting Corps Districts/Divisions and the Invasive Species Leadership Team on issues related to aquatic nuisance species. Serve as the Army representative on the Technical Advisory Committee for the Resource Conservation and Climate Change Program Area of the Strategic Environmental Research and Development Program (SERDP).

**Peer-Reviewed Publications**


Government Reports, Miscellaneous Publications


Invited Presentations (2003-present)

Aquatic Plant Management Training Seminars for the municipalities of Arecibo, Mayaguez, Guayama, and Toa Baja in Puerto Rico. Training seminars sponsored by Jacksonville District Corps of Engineers and the Puerto Rico Department of Environment and Natural Resources. April-May 2010. “Chemical control of aquatic plants”

Invasive Species Control Summit, Scottsbluff, NE, May 2008. “Integrating herbicides and burning to restore a phragmites-dominated wetland”

186th Meeting, Armed Forces Pest Management Board, Natural Resources Committee,
February 2008. “Biology and Management of Cogongrass (Imperata cylindrica) and giant reed (Arundo donax)”

Puerto Rico Department of Natural Resources, August 2007. “Managing aquatic weeds with herbicides”

Mississippi Exotic Pest Plants Council Meeting, Jackson, MS, November, 2006. “Chemical Control Research at the Engineer Research & Development Center”


Mississippi Exotic Pest Plants Council Meeting, Vicksburg, MS, December 2004. “Chemical control of aquatic plants”

Salvinia molesta – Lake Wilson Meeting sponsored by Hawaii Department of Land Management, Hawaii Department of Agriculture, Corps of Engineers Honolulu District and Pacific Ocean Division, Honolulu, HI, February 2003. “Chemical management of giant salvinia”


Professional Presentations (2003–present)

51st Annual Meeting, Aquatic Plant Management Society, Baltimore, MD, July 2011. “Presidential Address: Balancing emerging threats with strategic goals”

29th Annual Meeting, Mid-South Aquatic Plant Management Society, October 2010. “Corps of Engineers Invasive Species Initiatives and Research Programs”

16th International Conference on Aquatic Invasive Species, April, 2009. “Integrating herbicides with Mycoleptodiscus terrestris to control hydrilla”
“Integrating herbicides with Mycoleptodiscus terrestris to control hydrilla”
27th Annual Meeting, Mid-South Aquatic Plant Management Society, October 2008.

“Invasive plant research at USAERDC-Environmental Lab: past, present, future”

“Integrated weed management strategies for control of hydrilla”

“Mesocosm evaluation of fluridone and Mycoleptodiscus terrestris for control of hydrilla”
25th Annual Meeting, Mid-South Aquatic Plant Management Society, October 2006.

“Activity of flumioxazin on giant salvinia”

“Effect of glyphosate rate, spray volume, and adjuvant addition for control of giant salvinia”

“Interactive effects of diquat and Mycoleptodiscus terrestris on hydrilla”

“Impact of herbicides and burning for management of Phragmites”
“Integrated weed management strategies for improved hydrilla control”

“Integrating 2,4-D and triclopyr with a fungal pathogen Mycoleptodiscus terrestris for control of Eurasian watermilfoil”

“Evaluating herbicide strategies to control Hydrilla verticillata and minimize injury to the native plant, Sagittaria kurziana”
“Integrating triclopyr and a fungal pathogen (Mycoleptodiscus terrestris) for control of Eurasian watermilfoil (Myriophyllum spicatum)”

“Herbicides and prescribed burning for control of Phragmites at St. John’s Marsh, Michigan”

“Pathogen Research on Aquatic Plants”
Professional Activities/Service
2011-2012: Immediate Past President, Aquatic Plant Management Society  
2010-2011: President, Aquatic Plant Management Society  
2009-2010: President-Elect Aquatic Plant Management Society  
2008-2009: Vice President, Aquatic Plant Management Society  
2008-2010: Board of Directors, Mid-South Aquatic Plant Management Society  
2007-2010: Board of Directors, Weed Science Society of America  
2004-2011: Pesticide Committee and Natural Resources Committee, Armed Forces Pest Management Board  
2001-2007: Secretary and Newsletter Editor, Aquatic Plant Management Society  
1999-2001: Chair, Student Affairs Committee, Aquatic Plant Management Society  

Professional Development Activities
May 2011: Eckerd College Leadership Development Program  
November 2003: Corps of Engineers Leadership Education and Development Program  
August 1996: U.S. Army Engineer Waterways Experiment Station Long-term Training Program  

Honors and Awards
July 2015 – President’s Award, Aquatic Plant Management Society  
May 2014 – Superior Civilian Service Award, U.S. Department of the Army  
July 2011 – Outstanding Service as President (2010-2011), Aquatic Plant Management Society  
May 2008 – Federal Laboratory Consortium Award for Excellence in Technology Transfer  
May 2007 – ERDC Research and Development Achievement Award  
May 2007 – Achievement Medal for Civilian Service, U.S. Department of the Army  
July 2007 – T. Wayne Miller Distinguished Service Award, Aquatic Plant Management Society  
July 2005 – Best Technical Poster Award, Aquatic Plant Management Society  
May 2004 – Commander’s Award for Civilian Service, U.S. Department of the Army  
July 2004 – Best Technical Poster Award, Aquatic Plant Management Society
Professional Affiliations
Aquatic Plant Management Society, 1991-present
Weed Science Society of America, 1996-present
South Carolina Aquatic Plant Management Society, 2005
Mid-South Aquatic Plant Management Society, 2000-present
Gamma Sigma Delta, 1985-present
Phi Sigma, 1982-present
CURRICULUM VITAE
12/03/15
Gregory G. Sass
Born: 10/16/76, Sheboygan, WI

Office Address:
Escanaba Lake Research Station
Wisconsin Department of Natural Resources
3110 Trout Lake Station Drive
Boulder Junction, Wisconsin 54512
(715)-891-1875
gregory.sass@wisconsin.gov

Professional Employment
- Adjunct Professor, Department of Biology, University of Minnesota-Duluth, 2015-present
- Northern Unit Fisheries Research Team Leader, Wisconsin Department of Natural Resources, 2014-present
- University Associate, University of Wisconsin-Stevens Point, 2012-present
- Honorary Fellow, Center for Limnology, University of Wisconsin-Madison, 2011-present
- Northern Lakes Fisheries Research Scientist, Wisconsin Department of Natural Resources, 2011 - 2014
- Research Affiliate, Illinois Natural History Survey, Prairie Research Institute, University of Illinois at Urbana-Champaign, 2011 - present
- Interim Director, Forbes Biological Station, Illinois Natural History Survey, 2011
- Adjunct Associate Professor, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign, 2010 - present
- Assistant Research Professor, Illinois Natural History Survey, Prairie Research Institute, University of Illinois at Urbana-Champaign, 2010-2011
- Adjunct Professor, Department of Biological Sciences, Eastern Illinois University, 2009-present
- Academic Professional, Illinois Natural History Survey, Prairie Research Institute, University of Illinois at Urbana-Champaign, 2008-2011
- Affiliate, Program for Ecology, Evolution, and Conservation Biology, University of Illinois at Urbana-Champaign, 2008-present
- Adjunct Assistant Professor, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign, 2008-2010
- Adjunct Professor, Department of Biological Sciences, Western Illinois University, 2007 – present
- Director, Illinois River Biological Station, Illinois Natural History Survey, 2006 – 2011
- Research Associate with Stephen R. Carpenter and James F. Kitchell, Center for Limnology, University of Wisconsin – Madison, 2004 – 2006
- Research Assistant, Center for Limnology, University of Wisconsin – Madison, 1999-2004
- Teaching Assistant, University of Wisconsin – Madison, Spring 2002 and 2003
- National Science Foundation IGERT Trainee, University of Wisconsin – Madison, 1999-2003
- Project Assistant, University of Wisconsin – Madison, Summer 1999

**Academic Degrees:**
- Doctor of Philosophy in Zoology, University of Wisconsin-Madison, 2004
- Master of Science in Zoology, University of Wisconsin-Madison, 2001

**Teaching Experience:**
- Ecology of Fishes Lecture and Laboratory (ZOO 510, 511) Teaching Assistant, spring 2002 and spring 2003

**Professional Memberships:**
- Wisconsin Chapter of the American Fisheries Society, 2016-2017 (President)
- Wisconsin Chapter of the American Fisheries Society, 2015-2016 (President-elect)
- Wisconsin Chapter of the American Fisheries Society, 2011 - present
- Illinois Chapter of the American Fisheries Society, 2006 - 2011
- Organization of Biological Field Stations, 2006 - present
- Ecological Society of America, 1999 - present
- American Fisheries Society, 1999 - present
- Phi Kappa Phi National Honor Society, 1998 - present
- Golden Key National Honor Society, 1997 – present

**Certifications:**
- Mega-surgery, Research Animal Resources Center, University of Wisconsin-Madison
- PADI open water, advanced open water, ice, night, deep, rescue SCUBA diver
Peer-reviewed Publications:


Addendum 1

Brandon Road Lock & Dam Feasibility Study
Probability of Establishment


Theses:

Books:

Book Chapters:


Reports:


Addendum 1

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Brandon Road Lock & Dam Feasibility Study
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**Manuscripts in Draft Form:**

**Extramural Funding:**

**2007**

1. Environmental Monitoring and Assessment Program – Great Rivers Ecosystems (EPA) - $67,047
2. Long-term Illinois River fish population monitoring program (USFWS, Federal Aid in Sportfish Restoration) - $58,500
3. Fish and aquatic vegetation monitoring of The Nature Conservancy’s Emiquon Preserve (TNC) - $49,084
4. National Great Rivers Research and Education Center Undergraduate Internship (NGRREC) - $6,000
6. Biotic assessment of the Ten Mile Creek watershed (USACE, IDNR) - $35,000

**2007 totals = $512,678**

**2008**

1. Factors supporting or limiting submersed aquatic vegetation in the Starved Rock reach of the Illinois River (USACE) - $40,874
2. Setting quantitative fish management objectives for the Upper Mississippi River System (USACE) - $45,588
3. Long-term Illinois River fish population monitoring program (USFWS, Federal Aid in Sportfish Restoration) - $60,000
5. Factors supporting or limiting submersed aquatic vegetation in the Illinois River (USACE) - $105,772
6. Purchase of the Illinois River Biological Station through the Federal Aid in Sportfish Restoration Program (USFWS, IDNR) - $277,708
7. National Great Rivers Research and Education Center Undergraduate Internship

Addendum 1

Brandon Road Lock & Dam Feasibility Study
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2008 totals = $870,865

2009
1. Long-term Illinois River fish population monitoring program (USFWS, Federal Aid in Sportfish Restoration) - $87,150
3. Ecosystem-scale testing of sound-bubble barriers to prevent range expansions of Asian carp (NOAA Sea Grant) - $200,000
4. National Great Rivers Research and Education Center Undergraduate Internship (NGRREC) - $6,000
5. Supplemental work: effectiveness of the existing electric barriers in the Chicago Sanitary and shipping canal (U.S. EPA) - $10,000
6. Long-term Illinois and Mississippi River fish population monitoring program (USFWS, Federal Aid in Sportfish Restoration) - $148,760
7. Long-term Illinois and Mississippi River fish population monitoring program – Supplemental Funding for Segment 21 (USFWS, Federal Aid in Sportfish Restoration) - $238,950

2009 totals = $1,052,093

2010
1. Long-term Resource Monitoring Program on the La Grange reach of the Illinois River (USACE) - $385,993
2. National Great Rivers Research and Education Center Undergraduate Internship (NGRREC) - $6,000
3. Floodplain Restoration Monitoring of the Aquatic Vegetation and Fish Communities of the Nature Conservancy’s Emiquon Preserve, 2010-2013 (TNC) - $67,367
4. The Long-term Illinois, Mississippi, Ohio, and Wabash River Fish Population Monitoring Program – Segment 22 (USFWS, Federal Aid in Sportfish Restoration) - $571,333
6. The Long-term Illinois, Mississippi, Ohio, and Wabash River Fish Population Monitoring Program – Amendment to Segment 22 (USFWS, Federal Aid in Sportfish Restoration) - $18,000

2010 totals = $1,263,469

8. Biotic assessment of the Crow Creek West watershed (USACE, IDNR) - $20,000
2011
1. Long-term Resource Monitoring Program on the La Grange reach of the Illinois River (USACE) - $396,227
2. National Great Rivers Research and Education Center Undergraduate Internship (NGRREC) - $6,000
3. An Analysis of RiverWatch Data (National Great Rivers Research and Education Center) - $8,000
5. The Long-term Illinois, Mississippi, Ohio, and Wabash River Fish Population Monitoring Program – Segment 23 (USFWS, Federal Aid in Sportfish Restoration) - $569,393
6. Entrainment and Survival of Asian Carp in Barge Ballast Tanks (SAIC) - $28,273

2011 totals = $1,009,798

2007 – 2011 totals = $4,708,903

Graduate Students, Post-docs, and Graduate Committees:
1. Daisuke Goto, Ph.D., Post-Doctoral Research Associate, Center for Limnology, University of Wisconsin-Madison (co-advised with Dr. Andrew Rypel and Dr. M. Jake Vander Zanden)
2. Jim Lamer, Ph.D. 2015, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign (co-advised with Dr. John Epifanio)
   - Janice Lee Fenske Memorial Award finalist, 2009
3. Kirsten Nelson, M.S. 2014, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign (co-advised with Dr. Dave Wahl)
4. Todd Van Middlesworth, M.S. 2014, Department of Biological Sciences, Western Illinois University (co-advised with Dr. Tim Spier)
5. Ed Culver, M.S. 2014, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign (graduate committee)
6. Mike Wilson, M.S. 2014, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign (graduate committee)
7. Maureen Ferry, M.S. 2013, College of Natural Resources, University of Wisconsin-Stevens Point (graduate committee)
8. Cassi Moody, M.S. 2013, Department of Biological Sciences, Eastern Illinois University (co-advised with Dr. Robert Colombo)
9. Stephanie Liss, M.S. 2013, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign (co-advised with Dr. Cory Suski)
Addendum 1

Brandon Road Lock & Dam Feasibility Study
Probability of Establishment
Duluth, Minnesota, October 9, 2015
Title of Talk: Current knowledge of the relationships between fish and coarse woody in Wisconsin lakes
2. UWSP Student Subunit of the American Fisheries Society
Stevens Point, Wisconsin, September 16, 2015
Title of Talk: Current knowledge of the relationships between fish and coarse woody in Wisconsin lakes
3. Vilas County Lakes & Rivers Association – Celebrating Lakes and Rivers Day
Conserve School, Land O’ Lakes, Wisconsin, June 12, 2015
Title of Talk: Current knowledge of the relationships between fish and coarse woody in Wisconsin lakes
4. University of Wisconsin – Stout
Menomonie, Wisconsin, May 7, 2015
Title of Talk: The Escanaba Lake Research Station: the past, present, and future of Wisconsin’s experimental fisheries research lakes
5. North Lakeland Discovery Center, Nibbles and Knowledge Program
Manitowish Waters, Wisconsin, June 19, 2014
Title of Talk: Managing Fish Habitat: What Can we Learn from Wildlife Ecology?
6. International Conference on Engineering and Ecohydrology for Fish Passage
Madison, Wisconsin, June 9-11, 2014
Title of Talk: The Effects of Visual and Acoustic Deterrents to Prevent the Upstream Movement of Asian Carps
7. 143rd Meeting of the American Fisheries Society
Little Rock, Arkansas, September 8-12, 2013
Title of Talk: Largemouth Bass Management in Wisconsin: Intra- and Inter-specific Implications of Abundance Increases
8. Southern Division of the American Fisheries Society Annual Meeting
Black Bass Diversity: Multidisciplinary Science for Conservation Symposium
Nashville, Tennessee, February 8-10, 2013
Title of Talk: Largemouth Bass Management in a Multi-species Sport Fishery: Implications for Intra-specific Growth and Walleye Populations in Northern Wisconsin
Madison, Wisconsin, November 7, 2012
Title of Talk: Fish Population Dynamics in a Northern Wisconsin Lake Following a Whole-lake Addition of Coarse Woody Habitat
10. South Dakota State University Fisheries and Wildlife Departmental Seminar Series
Brookings, South Dakota
Title of Talk: Is there a native recipe for controlling invasive common carp?
11. University of Wisconsin-Stevens Point American Fisheries Society Student Subunit
Stevens Point, Wisconsin
Title of Talk: The Escanaba Lake Research Station: the past, present, and future of Wisconsin’s experimental fisheries research lakes
12. Wisconsin Lakes Partnership Convention
Green Bay, Wisconsin
Title of Talk: The Escanaba Lake Research Station: the past, present, and future of
Wisconsin’s experimental fisheries research lakes
13. UW-Madison, Center for Limnology, Brownbag Seminar
Madison, Wisconsin
Title of Talk: The Escanaba Lake Research Station: the past, present, and future of
Wisconsin’s experimental fisheries research lakes
14. Illinois Department of Natural Resources Brownbag Seminar
Springfield, Illinois
Title of Talk: The Nature Conservancy’s Emiquon Preserve: fish and waterfowl
responses to the restoration of two former Illinois River floodplain lakes
15. University of Tennessee at Martin, 2011
Martin, Tennessee
Title of Talk: The Nature Conservancy’s Emiquon Preserve: fish and waterfowl
responses to the restoration of two former Illinois River floodplain lakes
16. 71st Midwest Fish and Wildlife Conference, 2010*
Minneapolis, Minnesota
Title of Talk: Zooplankton community composition across a gradient of Asian carp
densities and pre- and post-invasion within the Illinois River, USA
*Talk given by Duane Chapman due to weather related cancellation for GGS
17. Asian Carp Marketing Summit, September 20-21, 2010
Alton, Illinois
Title of Talk: Status of Asian carp in the Midwestern United States
18. 17th International Conference on Aquatic Invasive Species, 2010
San Diego, California
Title of Talk: Capture Efficiency of Asian Carp in the La Grange Pool of the Illinois
River Using Traditional Gear
19. 17th International Conference on Aquatic Invasive Species, 2010
San Diego, California
Title of Talk: The Effects of Visual and Acoustic Deterrents to Prevent the
Upstream Movement of Asian Carps
20. University of Illinois at Urbana-Champaign, 2010 – NRES Departmental Seminar
Champaign, Illinois
Title of Talk: Characterizing the Illinois River in the Context of the Upper
Mississippi River System: Fish and Submersed Aquatic Vegetation Communities
21. Western Illinois University, 2010 – Plenary Speaker for Graduate Student
Symposium
Macomb, Illinois
Title of Talk: Environmental and Economic Impacts of Asian Carps on the Illinois
River
22. University of Florida, 2010
Gainesville, Florida
Title of Talk: Fish community and food web responses to a whole-lake removal and
addition of coarse woody habitat
23. Kent State University, 2009
Kent, Ohio
Title of Talk: Fish community and food web responses to a whole-lake removal and
addition of coarse woody habitat
   The 57th Annual Meeting of the North American Benthological Society, 2009
   Grand Rapids, Michigan
   Title of Talk: Asian carps in the mid-continent great rivers
25. Illinois Lake Management Association Annual Meeting
   2009
   Peoria, Illinois
   Title of Talk: Environmental and Economic Impacts of Asian Carps on the Illinois River
26. Upper Mississippi River Conservation Committee, Fall Fish Technical Meeting, 2008
   Wyalusing State Park, Wisconsin
   Title of Talk: Setting Management Objectives for UMRS Fisheries
27. Program in Ecology, Evolution, and Conservation Biology Seminar; University of Illinois at Urbana-Champaign
   2008
   Urbana, Illinois
   Title of Talk: Fish Community Responses to Reciprocal Whole-lake Manipulations of Coarse Woody Habitat in Two Northern Wisconsin Lakes
   Peoria, Illinois
   Title of Talk: Environmental and Economic Impacts of Asian Carps on the Illinois River
   Chicago, Illinois
   Title of Talk: Environmental and Economic Impacts of Asian Carps on the Illinois River
30. Wisconsin Lakes Convention, 2006
   Green Bay, Wisconsin
   Title of Talk: Lessons Learned from Two Whole-lake Manipulations of Coarse Woody Habitat: Implications for Fisheries Management
   Madison, Wisconsin
   Title of Talk: Fish Community and Food Web Responses to a Whole-lake Removal of Coarse Woody Habitat
32. Wisconsin Lakes Convention, 2005
   Green Bay, Wisconsin
   Title of Talk: Fish Community and Food Web Responses to a Whole-lake Removal of Coarse Woody Habitat
33. Virginia Polytechnic Institute and State University (Virginia Tech), 2005
   Blacksburg, Virginia
   Title of Talk: Fish community and Food Web Responses to a Whole-lake Removal of Coarse Woody Habitat
34. Wisconsin Department of Natural Resources Lake Leaders Conference, 2004
Minocqua, Wisconsin
Title of Talk: Biomanipulation as a Tool to Mitigate Negative Effects of Exotic Rainbow Smelt Introductions; Fish Community and Food Web Responses to a Whole-lake Removal of Coarse Woody Habitat
Minocqua, Wisconsin
Title of Talk: Fish Community Responses to a Whole-lake Manipulation of Littoral Zone Coarse Woody Habitat: Implications for Esocid Management
Salt Lake City, Utah
Title of Talk: Fish Community Responses to a Whole-lake Manipulation of Littoral Zone Coarse Woody Debris in a Northern Wisconsin Lake
37. Annual Meeting of the Wisconsin Chapter of the American Fisheries Society, 2003*
Madison, Wisconsin
Title of Talk: Fish Community Responses to a Whole-lake Manipulation of Littoral Zone Coarse Woody Debris
*Best Student Paper Award

Contributed Presentations:

Parks, T. et al.
44th Annual Meeting of the Wisconsin Chapter of the American Fisheries Society
Eau Claire, Wisconsin, February 24-26, 2015
Title of Talk: The status of ciscoes in Wisconsin’s inland lakes
44th Annual Meeting of the Wisconsin Chapter of the American Fisheries Society
Eau Claire, Wisconsin, February 24-26, 2015
Title of Talk: Cisco population characteristics in Wisconsin lakes
Noring, A., et al.
44th Annual Meeting of the Wisconsin Chapter of the American Fisheries Society
Eau Claire, Wisconsin, February 24-26, 2015
Title of Talk: Relationships between growth trajectories of walleye and cisco in northern Wisconsin lakes
44th Annual Meeting of the Wisconsin Chapter of the American Fisheries Society
Eau Claire, Wisconsin, February 24-26, 2015
Title of Talk: Fish production and ecotone responses to long-term additions of coarse woody habitat
Johnson, G., et al.
44th Annual Meeting of the Wisconsin Chapter of the American Fisheries Society
Eau Claire, Wisconsin, February 24-26, 2015
Title of Poster: Biotic and abiotic factors influencing walleye recruitment in Escanaba Lake, Wisconsin from 1958-2013
Levengood, J.M., D.J. Soucek, G.G. Sass, and J.M. Epifanio
75th Midwest Fish and Wildlife Conference
Indianapolis, Indiana, February 8-11, 2015
Title of Talk: Spatial and Inter-specific patterns of contaminant burdens in bighead and silver carp from the Illinois River
Nelson, K., D.H. Wahl, and G.G. Sass
144th Annual Meeting of the American Fisheries Society
Quebec City, Canada, August 17-21, 2014
Title of Talk: Competitive interactions between common carp and bighead carp
144th Annual Meeting of the American Fisheries Society
Quebec City, Canada, August 17-21, 2014
Title of Talk: Selective harvest effects on body size and productivity of exploited walleye stocks in north temperate lakes
Isermann, D.A., N. Nate, G. Hansen, and G.G. Sass
144th Annual Meeting of the American Fisheries Society
Quebec City, Canada, August 17-21, 2014
Title of Talk: Evaluation of biological performance indicators for monitoring exploitation of walleye populations in northern Wisconsin
144th Annual Meeting of the American Fisheries Society
Quebec City, Canada, August 17-21, 2014
Title of Talk: The feeding habits and relative abundances of bowfin, spotted gar, and largemouth bass: can native piscivores control invasive common carp?
52nd Annual Meeting of the Illinois Chapter of the American Fisheries Society
Bloomington, Illinois, March 4-6, 2014
Title of Talk: The feeding habits of native piscivorous fishes: Can they control common carp?
Sass, G.G., S.P. Newman, B.M. Roth, and I. Tsehaye
Wisconsin Chapter of the American Fisheries Society Annual Meeting
Green Bay, Wisconsin
Title of Talk: Abundance and growth responses of walleye (Sander vitreus) to 35% annual exploitation on Big Crooked Lake, Wisconsin, 1998-2008
Nelson, K., D.H. Wahl, and G.G. Sass
Midwest Fish and Wildlife Conference
Kansas City, Missouri
Title of Talk: Competitive interactions between bighead carp and bluegill
5th Society For Ecological Restoration World Conference on Ecological Restoration
Madison, Wisconsin, October 6-11
Title of Poster: Relative abundance and feeding habits of native piscivorous fishes at The Nature Conservancy’s Emiquon Preserve and Reelfoot Lake: Can native fish control common carp?
143rd Annual Meeting of the American Fisheries Society
Little Rock, Arkansas, September 8-12
Title of Talk: Flathead catfish gear assessments and demographics in the Wabash
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Brandon Road Lock & Dam Feasibility Study
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Gilbert, S. and G.G. Sass
Wisconsin Chapter of the American Fisheries Society Annual Meeting
Rothschild, Wisconsin, February 5-7, 2013
Title of Talk: Trends in Wisconsin’s Muskellunge Fishery Based on 47 Years of
Angler Entries from a Single Countywide Contest
Ferry, M., T. Ginnett, G.G. Sass, and K. Gauthier
Upper Midwest Invasive Species Conference, October 29-31, 2012
LaCrosse, Wisconsin
Title of Talk: Examining zebra mussel habitat preference and population dynamics
in northeast Wisconsin and Upper Michigan
Prairie Lightning Mini-Symposium, 2012
Urbana, Illinois
Title of Poster: Relative abundance and feeding habits of bowfin, spotted gar, and
largemouth bass at the Emiquon Preserve and Reelfoot Lake: can native fish species
control invasive common carp?
142nd Annual Meeting of the American Fisheries Society, 2012
St. Paul, Minnesota
Title of Poster: Relative abundance and feeding habits of bowfin, spotted gar, and
largemouth bass at the Emiquon Preserve and Reelfoot Lake: can native fish species
control invasive common carp?
Lamer, J.T., G.G. Sass, J. Epifanio, B.C. Ruebush, T.L. Tobias, and M.A. McClelland
142nd Annual Meeting of the American Fisheries Society, 2012
St. Paul, Minnesota
Title of talk: Asian carp hybridization: prevalence, distribution, and fitness in the
Mississippi River Basin.
142nd Annual Meeting of the American Fisheries Society, 2012
St. Paul, Minnesota
Title of Talk: Demographic differences of silver carp, Hypophthalmichthys molitrix,
populations between impacted and unimpacted Midwestern river ecosystems
Catalano, M.J., I. Tsehaye, B.M. Roth, and G.G. Sass
142nd Annual Meeting of the American Fisheries Society, 2012
St. Paul, Minnesota
Title of Talk: Forecasting the responses of bighead and silver carp populations to
commercial harvest in the Illinois River
142nd Annual Meeting of the American Fisheries Society, 2012
St. Paul, Minnesota
Title of Talk: Effects of climate-driven water level loss on fish habitat availability,
predator-prey interactions, population dynamics, and behavior in two north temperate
lake basins
142nd Annual Meeting of the American Fisheries Society, 2012
Title of Talk: A tale of the Wabash River flathead catfish: sampling inefficiencies and demographics
Chick, J.H., C. Dolan, and G.G. Sass
142nd Annual Meeting of the American Fisheries Society, 2012

St. Paul, Minnesota
Title of Talk: As assessment of the relationship between electrofishing catch-per-unit-effort data and fish abundance
44th Annual Meeting of the Mississippi River Research Consortium
LaCrosse, Wisconsin
Title of Talk: Relative abundances and feeding habits of bowfin, gar, and largemouth bass at the Emiquon Preserve and Reelfoot Lake: Can particular native fish species assemblages control invasive common carp?
Liss, S.A., G.G. Sass, and C.D. Suski
44th Annual Meeting of the Mississippi River Research Consortium
LaCrosse, Wisconsin
Title of Poster: Nutrition and condition of invasive silver carp across large Illinois rivers: Can stress and nutrition influence establishment?
Van Middlesworth, T.D., N.N. Michaels, and G.G. Sass
5th Annual Emiquon Science Symposium
Lewistown, Illinois
Title of Talk: The Nature Conservancy’s Emiquon Preserve: fish community Monitoring, 2007-2011
Liss, S., G.G. Sass, and C.D. Suski
50th Annual Meeting of the Illinois Chapter of the American Fisheries Society
Utica, Illinois
Title of Poster: Nutrition and condition of invasive silver carp across large Illinois rivers: can stress and nutrition influence establishment?
Tyszko, S.M., M.A. McClelland, N.N. Michaels, and G.G. Sass
50th Annual Meeting of the Illinois Chapter of the American Fisheries Society
Utica, Illinois
Title of Poster: Fish community indices of biotic integrity applied to the large rivers of Illinois
American Fisheries Society 141st Annual Meeting
Seattle, Washington
Title of Talk: The long-term Illinois River fish population monitoring program, 1957-2010
American Fisheries Society 141st Annual Meeting
Seattle, Washington
Title of Talk: Ichthyofauna of the Great Lakes Basin
Lamer, J.T., G.G. Sass, J.M. Epifanio, M.A. McClelland, A. Hernandez, and J. Thimmapuram

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Brandon Road Lock & Dam Feasibility Study
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American Fisheries Society 141st Annual Meeting
Seattle, Washington
Title of Poster: Nuclear and mitochondrial SNP development for molecular
Discrimination of bighead carp, silver carp, and their hybrids
Irons, K.S., G.G. Sass, M.A. McClelland, and T.M. O’Hara
American Fisheries Society 141st Annual Meeting
Seattle, Washington
Title of Talk: Bigheaded carp invasion of the La Grange Reach of the Illinois River:
Insights from the Long-term Resource Monitoring Program
American Fisheries Society 141st Annual Meeting
Seattle, Washington
Title of Poster: Demographics of a commercially exploited population of flathead
catfish in the Wabash River
American Fisheries Society 141st Annual Meeting
Seattle, Washington
Title of Poster: Monitoring the population demographics of invasive silver carp in the
Illinois River
Tyszko, S.M., M.A. McClelland, N.N. Michaels, and G.G. Sass
American Fisheries Society 141st Annual Meeting
Seattle, Washington
Title of Poster: Fish community indices of biotic integrity applied to the large rivers
of Illinois
Michaels, N.N., G.G. Sass, T.W. Spier
American Fisheries Society 141st Annual Meeting
Seattle, Washington
Title of Poster: Biomanipulation of the largemouth bass population to control
invasive species and eutrophication at The Nature Conservancy’s Emiquon Preserve
Ruebush, B.C., G.G. Sass, and J.H. Chick
American Fisheries Society 141st Annual Meeting
Seattle, Washington
Title of Poster: In-situ tests of sound-bubble-strobe light barrier technologies to
prevent range expansions of Asian carp
Ruebush, B.C., G.G. Sass, and J.H. Chick
43rd Annual Mississippi River Research Consortium
La Crosse, Wisconsin
Title of Poster: In-situ evaluation of sound-bubble-strobe light barrier technologies to
prevent the range expansions of Asian carp
Michaels, N.N., G.G. Sass, and T.W. Spier
43rd Annual Mississippi River Research Consortium
La Crosse, Wisconsin
Title of Poster: The Nature Conservancy’s Emiquon Preserve: largemouth bass diet
response to restoration
McClelland, N.N. Michaels, S.M. Tyszko, and T.R. Cook
43rd Annual Mississippi River Research Consortium
La Crosse, Wisconsin
Title of Poster: Aquatic vegetation and fish community monitoring at the Nature
Conservancy’s Emiquon Preserve: testing for regime shifts in ecosystem state
Bushman, B., G.G. Sass, and M.A. McClelland

43rd Annual Mississippi River Research Consortium
La Crosse, Wisconsin
Title of Poster: Common carp in the Illinois River
Van Middlesworth, T.D., G.G. Sass, T.W Spier, M.A. McClelland, N.N. Michaels,
S.M. Tyszko, and T.R. Cook

3rd Midwest-Great Lakes Society for Ecological Restoration Chapter Meeting
Springfield, Illinois
Title of Talk: Aquatic vegetation and fish community monitoring at the Nature
Conservancy’s Emiquon Preserve: testing for regime shifts in ecosystem state
Michaels, N.N., G.G. Sass, and T.W. Spier

3rd Midwest-Great Lakes Society for Ecological Restoration Chapter Meeting
Springfield, Illinois
Title of Talk: The Nature Conservancy’s Emiquon Preserve: largemouth bass diet
response to restoration
Michaels, N.N., G.G. Sass, and T.W. Spier*

Illinois Lake Management Association and Illinois Chapter American Fisheries
Society Joint Annual Conference
Peoria, Illinois
Title of Talk: The Nature Conservancy’s Emiquon Preserve – Largemouth bass
Micropterus salmoides diet response to restoration
*IL AFS Best Student Paper Award
Spacapan, M.R., B.C. Ruebush, S. Lischka, and G.G. Sass
Illinois Lake Management Association and Illinois Chapter American Fisheries
Society Joint Annual Conference
Peoria, Illinois
Title of Talk: A human-dimensions evaluation of river usage in the La Grange reach
of the Illinois River following the invasion of Asian carp
Ruebush, B.C., G.G. Sass, J.H. Chick, and C.D. Suski
Illinois Lake Management Association and Illinois Chapter American Fisheries
Society Joint Annual Conference
Peoria, Illinois
Title of Talk: In-situ evaluation of sound-bubble-strobe light barrier technologies to
prevent the range expansions of Asian carp
Sass, G.G., A.C. Erickson, and M.A. McClelland

140th Annual Meeting of the American Fisheries Society
Pittsburgh, Pennsylvania
Title of Talk: Zooplankton community composition across a gradient of Asian carp
densities and pre- and post- invasion within the Illinois River, USA
Ruebush, B.C., G.G. Sass, and J.H. Chick
140th Annual Meeting of the American Fisheries Society
Pittsburgh, Pennsylvania
Title of Talk: Ecosystem-scale evaluation of sound bubble barrier technologies to prevent range expansions of Asian carps
Michaels, N.N., G.G. Sass, and T.W. Spier
140th Annual Meeting of the American Fisheries Society
Pittsburgh, Pennsylvania
Title of Talk: The Nature Conservancy’s Emiquon Preserve: The emerging food web in a newly restored floodplain lake
140th Annual Meeting of the American Fisheries Society
Pittsburgh, Pennsylvania
Title of Poster: Catfishes in the Upper Mississippi River System: distribution and trends as noted by the long term resource monitoring program
140th Annual Meeting of the American Fisheries Society
Pittsburgh, Pennsylvania
Title of Poster: Fifty years of the long term Illinois fish population monitoring program
O’Hara, T.M., K.S. Irons, M.A. McClelland, and G.G. Sass
St. Louis, Missouri
Title of Talk: Assessment of channel catfish (Ictalurus punctatus) populations in the Upper Mississippi River system
St. Louis, Missouri
Title of Poster: Catfishes in the Upper Mississippi River System: Distribution and trends as noted by the Long Term Resource Monitoring Program
Michaels, N.N., G.G. Sass, and T.W. Spier
42nd Annual Mississippi River Research Consortium
La Crosse, Wisconsin
Title of Talk: The Nature Conservancy’s Emiquon Preserve: the emerging food web in a newly restored floodplain lake
Ruebush, B.C., G.G. Sass, and J.H. Chick
42nd Annual Mississippi River Research Consortium
La Crosse, Wisconsin
Title to Talk: Ecosystem-scale evaluation of sound bubble barrier technologies to prevent range expansions of Asian carps
42nd Annual Mississippi River Research Consortium
La Crosse, Wisconsin
Title of Talk: Catfishes in the Upper Mississippi River System. Distribution and trends as noted by the Long Term Resource Monitoring Program
**Sass, G.G., A.C. Erickson,** and M.A. McClelland
48th Meeting of the Illinois Chapter of the American Fisheries Society
Whittington, Illinois

Title of Talk: Zooplankton community composition across a gradient of Asian carp Densities and pre- and post-invasion within the Illinois River, USA
Irons, K.S., D.C. Chapman, M.A. McClelland, T.M. O’Hara, **G.G. Sass,** J.A. Thomas, T.R. Cook, and M.S. Pearson
48th Meeting of the Illinois Chapter of the American Fisheries Society
Whittington, Illinois

Title of Poster: Asian carps in the mid-continent great rivers
48th Meeting of the Illinois Chapter of the American Fisheries Society
Whittington, Illinois

Title of Poster: The Nature Conservancy’s Emiquon Preserve: resetting and restoring the Thompson Lake fish community
48th Meeting of the Illinois Chapter of the American Fisheries Society
Whittington, Illinois

Title of Poster: Status and trends of channel catfish in the UMRS: explaining variability in year class strength and relative abundances
Michaels, N.N., **G.G. Sass,** T.M. O’Hara, M.A. McClelland, K.S. Irons, and T.R. Cook
70th Annual Midwest Fish and Wildlife Conference
Springfield, Illinois

Title of Talk: The Nature Conservancy’s Emiquon Preserve: fish and aquatic vegetation monitoring, 2007-2009
70th Annual Midwest Fish and Wildlife Conference
Springfield, Illinois

Title of Poster: Long-term trends in Illinois River water quality: reflective of global changes?
Ruebush, B., **G.G. Sass,** and J.H. Chick
70th Annual Midwest Fish and Wildlife Conference
Springfield, Illinois

Title of Poster: Ecosystem-scale evaluation of sound bubble barrier technologies to prevent range expansions of Asian carps
Irons, K.S., D. Chapman, M.A. McClelland, T.M. O’Hara, and **G.G. Sass**
70th Annual Midwest Fish and Wildlife Conference
Springfield, Illinois

Title of Poster: Asian carps in the mid-continent great rivers
Title of Poster: Status and trends of channel catfish in the UMRS: identifying mechanisms determining year class strength and relative abundances


Title of Talk: Fish population dynamics in a northern Wisconsin lake following a whole-lake addition of coarse woody habitat


Title of Poster: The Nature Conservancy’s Emiquon Preserve: resetting and restoring the Thompson Lake fish community

Baerwaldt, K., G.G. Sass, and J.E. Garvey

Title of Poster: Asian carps in the mid-continent great rivers


Mississippi River Research Consortium 41st Annual Meeting

La Crosse, Wisconsin

Title of Talk: The Nature Conservancy’s Emiquon Preserve: resetting and restoring the Thompson Lake fish community


Title of Poster: Growth rates of silver carp in different regions of the world: higher growth in non-native habitats


Mississippi River Research Consortium 41st Annual Meeting

La Crosse, Wisconsin

Title of Poster: Asian carps: big rivers, big fish, big problems?


139th Annual Meeting of the American Fisheries Society

Nashville, Tennessee

Title of Talk: Fish population dynamics in a northern Wisconsin lake following a whole-lake addition of coarse woody habitat


139th Annual Meeting of the American Fisheries Society

Nashville, Tennessee

Title of Talk: Hybridization between silver and bighead carp in the Mississippi and Illinois rivers


139th Annual Meeting of the American Fisheries Society

Nashville, Tennessee

Title of Poster: The Nature Conservancy’s Emiquon Preserve: resetting and restoring the Thompson Lake fish community

Baerwaldt, K., G.G. Sass, and J.E. Garvey

139th Annual Meeting of the American Fisheries Society

Nashville, Tennessee

Title of Poster: Growth rates of silver carp in different regions of the world: higher growth in non-native habitats


Mississippi River Research Consortium 41st Annual Meeting

La Crosse, Wisconsin

Title of Talk: The Nature Conservancy’s Emiquon Preserve: resetting and restoring the Thompson Lake fish community


Mississippi River Research Consortium 41st Annual Meeting

La Crosse, Wisconsin

Title of Poster: Asian carps in the mid-continent great rivers


Midwest Fish and Wildlife Conference, 2008

Columbus, Ohio

Title of Talk: Fish population dynamics in a northern Wisconsin lake following a whole-lake addition of coarse woody habitat
93rd Ecological Society of America Annual Meeting
Milwaukee, Wisconsin
Title of Talk: Coarse woody habitat density and largemouth bass (*Micropterus salmoides*) growth rates
Mississippi River Research Consortium, 2008
Dubuque, Iowa
Title of Talk: Environmental and economic impacts of Asian carps in the Illinois River
Mississippi River Research Consortium, 2008
Dubuque, Iowa
Title of Talk: Identification of habitat conditions influencing non-native Asian carps reproduction in the Upper Mississippi River system
Mississippi River Research Consortium, 2008
Dubuque, Iowa
Title of Talk: Fifty years of the long-term Illinois River fish population monitoring program
Mississippi River Research Consortium, 2008
Dubuque, Iowa
Title of Poster: Long-term trends in Illinois River water quality: reflective of global changes?
Mississippi River Research Consortium, 2008
Dubuque, Iowa
Title of Poster: The Nature Conservancy’s Emiquon Preserve: resetting and restoring the Thompson Lake fish community
Stroub, M.R. and G.G. Sass
Mississippi River Research Consortium, 2008
Dubuque, Iowa
Title of Poster: Fish population dynamics of an annually-flooded seasonally-isolated backwater lake of the Illinois River
Mississippi River Research Consortium, 2008
Dubuque, Iowa
Title of Poster: Asian carps!
Illinois Chapter of the American Fisheries Society 46th Annual Meeting
Rockford, Illinois
Title of Talk: Fish population dynamics in a northern Wisconsin lake following a whole-lake addition of coarse woody habitat

Illinois Chapter of the American Fisheries Society 46th Annual Meeting
Rockford, Illinois
Title of Talk and Poster: An overview of the Illinois River Biological Station’s Asian carps research

Illinois Chapter of the American Fisheries Society 46th Annual Meeting
Rockford, Illinois
Title of Talk: Identification of habitat conditions influencing non-native Asian carps reproduction in the upper Mississippi River system

Illinois Chapter of the American Fisheries Society 46th Annual Meeting
Rockford, Illinois
Title of Talk: Fifty years of the long-term Illinois River fish population monitoring program, 1957-2007
Midwest Fish and Wildlife Conference, 2007
Madison, Wisconsin
Title of Talk: Environmental and economic impacts of Asian carps in the Illinois River
Irons, K.S., G.G. Sass, M.A. McClelland, and J.D. Stafford.
Fisheries Society of the British Isles Annual Symposium, 2007
Exeter, England
Title of Talk: Reduced condition factor of two native fish species coincident with invasion of non-native Asian carps in the Illinois River, USA: evidence for competition and reduced fitness?
Mississippi River Research Consortium, 2007
LaCrosse, Wisconsin
Title of Talk: Active versus passive management of common and grass carp for backwater lake native fish restoration: a case study from the Nature Conservancy’s Emiquon Preserve
Mississippi River Research Consortium, 2007
LaCrosse, Wisconsin
Title of Talk: The effect of a recently completed habitat rehabilitation and Enhancement project (HREP) on fish abundances in the La Grange Reach of the
Illinois River using Long Term Resource Monitoring Program (LTRMP) data
Irons, K.S., G.G. Sass, M.A. McClelland, and J.D. Stafford
Mississippi River Research Consortium, 2007
LaCrosse, Wisconsin
Title of Talk: Reduced condition factor of two native fish species coincident with invasion of of non-native Asian carp in the Illinois River: evidence for competition and reduced fitness?
McClelland, M.A. and G.G. Sass
Mississippi River Research Consortium, 2007
LaCrosse, Wisconsin
Title of Talk: Trends in largemouth bass and bluegill populations among the upper and lower Illinois River, 1957-2006
Michaels, N.N., G.G. Sass, and K.S. Irons
Mississippi River Research Consortium, 2007
LaCrosse, Wisconsin
Stroub, M.R., G.G. Sass, and K.S. Irons
Mississippi River Research Consortium, 2007
LaCrosse, Wisconsin
Title of Poster: Fish population dynamics of an annually-flooded seasonally-isolated backwater lake of the Illinois River
Findlay, Illinois
Title of Talk: Active versus passive management of common and grass carp for backwater lake native fish restoration: a case study from the Nature Conservancy’s Emiquon Preserve
Findlay, Illinois
Title of Talk: The effect of a recently completed habitat rehabilitation and Enhancement project (HREP) on fish abundances in the La Grange Reach of the Illinois River using Long Term Resource Monitoring Program (LTRMP) data
Irons, K.S., G.G. Sass, M.A. McClelland, and J.D. Stafford
Findlay, Illinois
Title of Talk: Reduced condition factor of two native fish species coincident with invasion of of non-native Asian carp in the Illinois River: evidence for competition and reduced fitness?
McClelland, M.A. and G.G. Sass
Findlay, Illinois
Title of Talk: Trends in largemouth bass and bluegill populations among the upper and lower Illinois River, 1957-2006
Michaels, N.N., G.G. Sass, and K.S. Irons
Findlay, Illinois

Stroub, M.R., G.G. Sass, and K.S. Irons
Findlay, Illinois
Title of Poster: Fish population dynamics of an annually-flooded seasonally-isolated backwater lake of the Illinois River
49th Annual Conference of the International Association for Great Lakes Research 2006
Windsor, Ontario, Canada
Title of Talk: Priority Management Recommendations for Exotic Sea Lamprey (Petromyzon marinus) Control in Distinct Thermal Regions of Lake Superior
135th Meeting of the American Fisheries Society, 2005
Anchorage, Alaska
Title of Talk: Fish Community and Food Web Responses to a Whole-lake Removal of Coarse Woody Habitat
National Science Foundation Biocomplexity in the Environment Awardees Meeting, 2005
Arlington, Virginia
Title of Poster: Biocomplexity. Divergent Dynamics: Complex Interactions of Riparian Land, People, and Lakes
134th Meeting of the American Fisheries Society, 2004
Madison, Wisconsin
Title of Talk: Bioindicators of Walleye Population Collapse
89th Meeting of the Ecological Society of America, 2004
Portland, Oregon
Title of Talk: Yellow Perch Population Collapse: Effects of a Whole-lake Removal of Coarse Woody Habitat
PERCIS III: The Third International Percid Fish Symposium, 2003
Madison, Wisconsin
Title of Talk: Yellow Perch Population Collapse: Distribution and Abundance Responses Associated with a Whole-lake Removal of Littoral Zone Coarse Woody Habitat
87th Meeting of the Ecological Society of America, 2002
Tucson, Arizona
Title of Talk: Bioenergetic Explanations for Sexually Dimorphic Walleye Growth: the Influences of Sex-specific Reproductive and Activity Costs
131st Meeting of the American Fisheries Society, 2001
Phoenix, Arizona
Title of Talk: Predicting Adult Walleye, Stizostedion vitreum, Densities Across Northern Wisconsin Lakes: Can Within-Lake Population Dynamics be Expanded to Regional Scale Management?
86th Meeting of the Ecological Society of America, 2001
Madison, Wisconsin
Title of Talk: Whole-lake Patterns of Predation Mortality: The Influence of Littoral Zone Structural Complexity and Depth on Fish Predator-prey Interactions
62nd Midwest Fish and Wildlife Conference, 2000
Minneapolis, Minnesota
Title of Talk: Growth Dynamics of Walleye in Ceded Territory Lakes of Northern Wisconsin 1990-1999
American Society of Ichthyologists and Herpetologists 79th Annual Meeting, 1999
The Pennsylvania State University
Title of Poster: The Effects of Satiation on Prey Capture Kinematics in the Largemouth Bass, Micropterus salmoides

**Invited Guest Lectures:**
1. University of Wisconsin – Stevens Point
   Course: Fish Management
   February 13, 2015
   Title: Aquatic Invasive Species Management: Case Studies and Lessons
2. University of Wisconsin – Stevens Point
   Course: Fish Management
   February 17, 2014
   Title: Aquatic Invasive Species: Characteristics, Management, and Prevention of Spread
3. University of Wisconsin – Stevens Point
   Course: Fish Management
   February 20, 2013
   Title: Aquatic Invasive Species: Characteristics, Management, and Prevention of Spread
4. University of Wisconsin – Stevens Point
   Course: Fish Management
   April 18, 2012
   Title: Environmental and Economic Impacts of Asian Carps in the Illinois River
5. University of Illinois at Urbana-Champaign
   Course: Fisheries Ecology and Management
   October 28, 2009
   Title: Environmental and Economic Impacts of Asian Carps in the Illinois River
6. University of Minnesota – Duluth
   Course: Fisheries Ecology
   October 5, 2005
   Title: Fish Community and Food Web Responses to a Whole-lake Removal of Coarse Woody Habitat
7. University of Wisconsin – Madison
   Course: General Ecology
   November 15, 2004
   Title of Lecture: Physiological Ecology: Fundamental and Applied Uses of Bioenergetics Models
8. University of Wisconsin – Madison  
Course: Ecology of Fishes  
March 4, 2003  
Title of Lecture: Human Effects on Fish Predator-prey Interactions and Population Dynamics  
9. University of Minnesota – Duluth  
Course: Fisheries Ecology  
September 26, 2002  
Title of Lecture: Human Effects on Fish Predator-prey Interactions and Population Dynamics  
10. University of Wisconsin - Madison  
Course: Ecology of Fishes  
March 21, 2002  
Title of Lecture: Applicability of Fish Ecology to Fisheries Management  
11. University of Minnesota - Duluth  
Course: Fisheries Ecology  
September 14, 2001  
Title of Lecture: Linear and Non-linear Techniques for Estimating Fish Growth Parameters  

Workshops and Symposia:  
1. The Nature Conservancy’s Emiquon Preserve: Ecological Lessons Learned from a Large-scale Floodplain Restoration Effort Symposium (Co-organizer)  
70th Annual Midwest Fish and Wildlife Conference  
Springfield, Illinois  
2. Integrated Management of the Illinois and Mississippi River Backwaters Workshop  
(Con-Organizer)  
Forbes Biological Station, Havana, IL, June 18-19, 2007.  
3. Littoral Zone Structural Complexity Workshop (Organizer)  
Center for Limnology, Trout Lake Station, Boulder Junction, WI, September 21-23, 2003. Representatives from: University of Washington, Minnesota Department of Natural Resources, Department of Fisheries and Oceans – Canada, Ontario Ministry of Natural Resources, Wisconsin Department of Natural Resources, University of Wisconsin – Stevens Point, University of Wisconsin – Madison  

Manuscript, Book Chapter, and Report Reviews:  
A Handbook of Global Freshwater Invasive Species (book chapter review)  
Canadian Journal of Fisheries and Aquatic Sciences  
Current Zoology  
Ecology  
Ecology of Freshwater Fish  
Ecology Letters
Ecology and Society
Fisheries
Fisheries Management and Ecology
Freshwater Biology
Hydrobiologia
Journal of Fish Biology
Journal of Great Lakes Research
Landscape Ecology
Marine Ecology Progress Series
North American Journal of Fisheries Management
Northeastern Naturalist (Guest Editor)
Oikos
Restoration Ecology
The American Midland Naturalist
Transactions of the American Fisheries Society
United States Geological Survey

Proposal Reviews:
Minnesota Sea Grant
National Science Foundation
National Sea Grant

Awards and Honors:
-U.S. Department of the Interior, Cooperative Conservation Award, LTRMP, 2007
-DIALOG VII Symposium Awardee, Dauphin Island, AL, December 3-10, 2005

University of Wisconsin - Madison
-2003 WI Chapter of the American Fisheries Society Annual Meeting – Best Student Paper
-National Science Foundation Integrated Graduate Education and Research Traineeship (IGERT), Human Dimensions of Social and Aquatic System Interactions, 1999 – 2003

University of South Florida
-College of Arts and Sciences, Non-Resident Tuition Waiver Scholarship, 1997 - 1999
-Biology Honors Program, 1996 - 1999
-College of Arts and Sciences, Deans List of Scholars, 1996 - 1999
- Honors Convocation, 1995 - 1999
- College of Arts and Sciences Deans List, 1995 - 1996
- Presidential Fee Waiver Scholarship, 1995 - 1997

**Service Activities:**
- President-Elect, Wisconsin Chapter of the American Fisheries Society, 2015-2016
- Chair, INHS Forbes Biological Station Directorship search, 2011
- Chair, INHS Field Station Committee, 2010-2011
- Asian Carp Monitoring and Rapid Response Workgroup, 2010-2011
- INHS Human Resources Committee, 2009-2011
- President, Mississippi River Research Consortium, 2009-2010
- Vice-President, Mississippi River Research Consortium, 2008-2009
- Illinois Chapter of the American Fisheries Society Executive Committee Member at Large, 2007-2008
- INHS Division of Ecology and Conservation Science Recorder, 2007
- Mentor, Alternative Breaks Program, University of Wisconsin - Madison
- Chair, Graduate Student Activities Committee, Madison Ecology Group, University of Wisconsin – Madison
- Program mentor for an undergraduate minority student (SEEDS), Ecological Society of America
- College for Kids Program, University of Wisconsin - Madison
- Saturday Enrichment Program, University of Wisconsin - Madison

**Grades:**
University of South Florida, 1995 - 1999:
GPA in Major - 3.913/4.0
Overall GPA - 3.851
University of Wisconsin-Madison, 1999-2004
GPA in Major – 4.0/4.0
Overall GPA – 3.966

**Research Interests:**
My research interests within the field of aquatic ecology have primary emphasis
on fish ecology, ichthyology, and fisheries biology. Specific interests involve predator-prey interactions, bioenergetics, population dynamics, and ecosystem-based fisheries management. Ongoing research focuses on long-term resource monitoring of the large rivers of Illinois, invasive species ecology and management, and floodplain lake restoration ecology. In addition, I study the response of fish communities and food webs to whole-lake manipulations of coarse woody habitat in several northern Wisconsin lakes, the ecosystem effects of a whole-lake removal of an exotic fish and crayfish, and exotic sea lamprey and lake trout interactions and food web dynamics in Lake Superior. Current research is aimed at better understanding walleye exploitation in northern Wisconsin lakes and the influences of invasive species and environmental variability on aquatic ecosystems in Wisconsin.

References:
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Dr. John Chick – Colleague
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Illinois Natural History Survey
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Champaign, Illinois 61820
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Boulder Junction, WI 54512
(715)-356-9494
tkkritz@wisc.edu
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University of South Florida
4202 East Fowler Avenue
Tampa, FL 33620
(813)-974-2878
motta@cas.usf.edu
Addendum 2

Sensitivity Analysis for Asian Carp Population Sizes
Context

Currently, the population of Bighead and Silver Carp (hereafter referred to as Asian carp) below Brandon Road Lock and Dam (BRLD) is negligible. Asian carp management activities to reduce the Asian carp population downstream of BRLD are subject to the availability of future appropriations and allocation decisions. Therefore it is possible that future funding for current activities could be reduced or discontinued. Consequently, it is appropriate to examine how the efficacy of the GLMRIS-BR Alternatives would be affected by changes in the population size of Asian carp in Dresden Island Pool located directly below BRLD.

For the GLMRIS-Brandon Road Study, USACE utilized a 50-year period of analysis. However, in order to most realistically represent ANS establishment, the probability of establishment model incorporated all years beginning in 2015 (when the elicitation was conducted) through 2071. This sensitivity analysis explores the impacts of two hypothetical, extreme scenarios on the estimates of \( P(\text{establishment}) \) of Asian Carp in the Great Lakes Basin (GLB). One scenario assumes the Asian Carp population in Dresden Island Pool is always large for the entire period of analysis through 2071. The second scenario assumes the population of Asian Carp below BRLD is small during the entire 50-year period of analysis. Small is defined as the Asian carp population density found in the Dresden Island Pool (Figure 1). Medium is defined as the Asian carp population density in the Starved Rock pool, and large is defined as the Asian carp population density in the Peoria Pool. The population densities were based on monitoring data collected between 2012 and 2014. The baseline population scenarios are based on the actual estimates of Asian carp population density below Dresden Island Pool that were provided by the experts during the elicitation (Figure 1). These estimates included population sizes of Asian carp for the period of analysis that vary based on the opinion of the individual experts. Thus, the baseline represents the \( P(\text{establishment}) \) values used to evaluate the Alternatives.

To simplify the comparison of sensitivity analysis results only composite expert results are presented. The composite expert was obtained by averaging the cumulative distribution function for each of the six experts for the No New Action Alternative, the Nonstructural Alternatives, and for each Technology Alternatives that were the subject of an expert elicitation. A similar process was followed for the sensitivity scenarios.
All Large Populations

The first sensitivity scenario assumes the population of Asian carp downstream of Brandon Road Lock and Dam is large from the present through 2071. This assumption provides an upper limit bound on P(establishment) estimates. The analysis addresses the following questions.

Questions:
1) What happens to P(establishment) under the No New Action Alternative if the population of Asian carp downstream of Brandon Road Lock and Dam is always large?
2) What happens to the efficacy of the alternative plans, i.e., P(establishment), if the population of Asian carp downstream of Brandon Road Lock and Dam is always large?
No New Action Alternative
Compared to the baseline scenario, the $P(\text{establishment})$ by 2071 for the No New Action Alternative increases if the Asian carp population in Dresden Island Pool is always large. A numerical summary of the changes is shown in Table 1.

Table 1: Composite Expert Summary for $P(\text{establishment})$ of Asian carp by 2071 for Baseline and Continuous Large Population Scenarios with the No New Action Alternative

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>1st Quartile</th>
<th>Median</th>
<th>3rd Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.22</td>
<td>0.26</td>
<td>0.29</td>
<td>0.32</td>
<td>0.36</td>
</tr>
<tr>
<td>Large Population</td>
<td>0.29</td>
<td>0.35</td>
<td>0.40</td>
<td>0.45</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Figure 2 shows the results graphically. The red (left) distribution is the baseline estimate of $P(\text{establishment})$ and the blue (right) distribution assumes a continuous large population. The center of mass for the $P(\text{establishment})$ distributions increases about 10 percentage points under the large population scenario.

![Composite P( Establishment) for the No New Action Alternative in 2071](image)

Assumes the population of Asian carp below BRLD is large during the entire period of analysis.

Figure 2: Composite Expert Asian carp Establishment Probability Distributions for the No New Action Alternative. The red distribution is the baseline scenario and the blue distribution is the continuous large population scenario.

This comparison shows that the probability of establishment of Asian carp in the GLB will rise if circumstances arise that result in a large population of Asian carp downstream of BRLD for the entire period of analysis. $P(\text{establishment})$ increases by about one third from 22-36% to 29-50%.
**Nonstructural Alternative**
The Nonstructural Alternative performs significantly differently if a continuous large population is present, as seen in Table 2. The P(Establishment) roughly doubles in the sensitivity scenario shown in Figure 3.

**Table 2 Composite expert summary for P(establishment) of Asian carp by 2071 for Baseline and Continuous Large Population Scenarios with the Nonstructural Alternative**

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>1st Quartile</th>
<th>Median</th>
<th>3rd Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.15</td>
<td>0.18</td>
<td>0.20</td>
<td>0.22</td>
<td>0.26</td>
</tr>
<tr>
<td>Large Population</td>
<td>0.29</td>
<td>0.35</td>
<td>0.40</td>
<td>0.45</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**Figure 3: Composite Expert Asian carp Establishment Probability Distributions for the Nonstructural Alternative.** The red distribution is the baseline scenario and the blue distribution is the continuous large population scenario.
Technology Alternative - Electric Barrier
The sensitivity analysis indicates that the efficacy of this alternative would be greatly compromised by the continued presence of a large population of Asian carp in Dresden Island Pool during the 50-year period of analysis. Compared to the baseline, the P(establishment) roughly triples for the large Asian carp population scenario (Table 3). Figure 4 shows a blue (right) probability distribution for P(establishment) with the electric barrier alternative in place with continuously large populations of Asian carp.

Table 3: Composite Expert Summary for P(establishment) of Asian carp by 2071 for Baseline and Continuous Large Population Scenarios with the Technology Alternative - Electric Barrier P(establishment).

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>1st Quartile</th>
<th>Median</th>
<th>3rd Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.08</td>
<td>0.10</td>
<td>0.11</td>
<td>0.12</td>
<td>0.14</td>
</tr>
<tr>
<td>Large Population</td>
<td>0.26</td>
<td>0.30</td>
<td>0.34</td>
<td>0.37</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Figure 4: Composite Expert Asian carp Establishment Probability Distribution for the Technology Alternative-Electric Barrier. The red distribution is the baseline scenario and the blue distribution is the continuous large population scenario.
Technology Alternative-Acoustic Fish Deterrent
Compared to the baseline, the P(establishment) value for this alternative increases by a factor of about 2.2 if a continuous large population of Asian carp is assumed to be present in Dresden Island Pool (Table 4 and Figure 5).

Table 4: Composite expert summary for P(establishment) of Asian carp by 2071 for baseline and continuous large population scenarios with the Technology Alternative - Acoustic Fish Deterrent P(establishment)

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>1st Quartile</th>
<th>Median</th>
<th>3rd Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.11</td>
<td>0.14</td>
<td>0.15</td>
<td>0.17</td>
<td>0.19</td>
</tr>
<tr>
<td>Large Population</td>
<td>0.28</td>
<td>0.33</td>
<td>0.38</td>
<td>0.42</td>
<td>0.47</td>
</tr>
</tbody>
</table>

Figure 5 Composite expert Asian carp establishment probability distributions for the Technology Alternative-Acoustic Fish Deterrent. The red distribution is the baseline scenario and the blue distribution is the continuous large population scenario.
Technology Alternative-Acoustic Fish Deterrent with Electric Barrier

Compared to the baseline, the \( P(\text{establishment}) \) value for this alternative increases by a factor of about 2.5 if a large population of Asian carp is assumed to be present in Dresden Island Pool for the entire 50-year period of analysis (Table 5 and Figure 6).

Table 5: Composite Expert Summary for \( P(\text{Establishment}) \) of Asian carp by 2071 for Baseline and Continuous Large Population Scenarios with the Technology Alternative-Acoustic Fish Deterrent with Electric Barrier.

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>1(^{\text{st}}) Quartile</th>
<th>Median</th>
<th>3(^{\text{rd}}) Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.10</td>
<td>0.12</td>
<td>0.13</td>
<td>0.14</td>
<td>0.17</td>
</tr>
<tr>
<td>Large Population</td>
<td>0.26</td>
<td>0.31</td>
<td>0.34</td>
<td>0.38</td>
<td>0.42</td>
</tr>
</tbody>
</table>

Figure 6: Composite expert Asian carp Establishment Probability Distributions for the Technology Alternative - Acoustic Fish Deterrent with Electric Barrier. The red distribution is the baseline scenario and the blue distribution is the continuous large population scenario.

This alternative was presented to the experts as having operating conditions that included having the electric barrier turned off when a vessel was immediately downstream of the approach channel, in the approach channel and in the lock. At the close of the elicitation, the panel was asked how a Technology Alternative - Acoustic Fish Deterrent with Electric Barrier alternative would compare in effectiveness if the electric barrier was assumed to operate continuously. The experts assumed the effectiveness would be identical to the Technology Alternative – Electric Barrier. Values for its performance were not separately elicited for this reason. Therefore, the \( P(\text{establishment}) \) of this alternative with these operating conditions is identical to that presented above for the Technology Alternative - Electric Barrier. Refer to the Table 3 and Figure 3 for how the alternative would be impacted by an all large population.
Lock Closure Alternative

Compared to the baseline, $P(\text{establishment})$ for this alternative increases over ten-fold if a large Asian carp population is assumed to be present in Dresden Island Pool during the entire 50-year period of analysis (Table 6 and Figure 7). The $P(\text{establishment})$ was higher because the greater population of carp increased the passage rate and, subsequently, $P(\text{establishment})$ before the lock could be closed.

Table 6 Composite Expert Summary for $P(\text{establishment})$ of Asian carp by 2071 for Baseline and Continuous Large Population Scenarios with the Lock Closure Alternative.

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>1st Quartile</th>
<th>Median</th>
<th>3rd Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.01</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>Large Population</td>
<td>0.24</td>
<td>0.26</td>
<td>0.29</td>
<td>0.31</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Figure 7 Composite Expert Asian carp Establishment Probability Distributions for the Lock Closure Alternative. The red distribution is the baseline scenario and the blue distribution is the continuous large population scenario.

Continuous Large Population Sensitivity Conclusion

The presence of a large population downstream of BRLD seriously reduces the efficacy of the nonstructural and all of the technology alternatives in preventing the establishment of Asian carp in the GLB. The $P(\text{establishment})$ for lock closure depends on whether enough Asian carp move into the GLB to establish before the lock is closed, because, once the lock is closed, passage into Lake Michigan falls to zero. The $P(\text{establishment})$ increases over ten-fold for the Lock Closure Alternative if a large Asian carp population is assumed to be present in Dresden Island Pool prior to closure. Overall, the results of the sensitivity analysis indicate the importance of including efforts to prevent an increase in the current Asian carp population size in Dresden Island Pool as part of any alternative plan.
Continuous Small Population

Context
The second sensitivity scenario assumes a small population of Asian carp could be maintained in Dresden Island Pool located below BRLD through 2071. This assumption provides a lower limit bound on P(establishment) estimates. The analysis addresses the following questions:

1) What happens to P(establishment) under the No New Action Alternative if the population of Asian carp downstream of Brandon Road Lock and Dam is always small?
2) What happens to the efficacy of the alternative plans, i.e., P(Establishment) if the population of Asian carp downstream of Brandon Road Lock and Dam is always small?

Answers
What happens to P(establishment) under the No New Action Alternative if the population of Asian carp downstream of Brandon Road Lock and Dam is always small?

Compared to the baseline, P(establishment) for the No New Action Alternative decreases to about a third of the baseline if a small Asian carp population is assumed to be present in Dresden Island Pool for the entire 50-year period of analysis (Table 7).

Table 7: Composite expert summary for P(establishment) of Asian carp by 2071 for baseline and continuous small population scenarios with the No New Action Alternative.

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>1st Quartile</th>
<th>Median</th>
<th>3rd Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.22</td>
<td>0.26</td>
<td>0.29</td>
<td>0.32</td>
<td>0.36</td>
</tr>
<tr>
<td>Large Population</td>
<td>0.08</td>
<td>0.09</td>
<td>0.10</td>
<td>0.11</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Figure 8 shows the results graphically. The red (right) distribution is the baseline estimate of P(establishment) and blue (left) shows P(establishment) for the continuous small population scenario. The center of mass for the distributions has decreased almost 20 percentage points from 29 to 10%. Overall the P(establishment) distribution decreases about two-thirds if a small population of Asian carp is assumed in Dresden Island Pool for the entire period of analysis.
3) What happens to the efficacy of the alternative plans, i.e., P(Establishment) if the population of Asian carp downstream of Brandon Road Lock and Dam is always small?
Nonstructural Alternative
The nonstructural plan’s effectiveness increases, if the downstream Asian carp population size can be held to a small size (Table 8). The baseline estimate of $P(\text{establishment})$ is the red (right) distribution shown in Figure 9. The small population sensitivity scenario shifts this distribution to the left, representing a significant improvement in effectiveness.

Table 8: Composite Expert Summary for $P(\text{establishment})$ of Asian carp by 2071 for Baseline and Continuous Small Population Scenarios with the Nonstructural Alternative

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>1$\text{st}$ Quartile</th>
<th>Median</th>
<th>3$\text{rd}$ Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.15</td>
<td>0.18</td>
<td>0.20</td>
<td>0.22</td>
<td>0.26</td>
</tr>
<tr>
<td>Large Population</td>
<td>0.08</td>
<td>0.09</td>
<td>0.10</td>
<td>0.11</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Figure 9: Composite Expert Asian carp Establishment Probability Distributions for the Nonstructural Alternative. The red distribution is the baseline scenario and the blue distribution is the continuous small population scenario.
Technology Alternative- Electric Barrier
The efficacy of the electric barrier alternative improves if a small population of Asian carp can be maintained in Dresden Island Pool. The P(establishment) is roughly one-third of the baseline P(establishment) that used the population sizes based on the actual inputs from the expert elicitation (Table 9 and Figure 10). Note this alternative was presented as having operating conditions that included having the electric barrier turned off when a vessel was immediately downstream of the approach channel, in the approach channel and in the lock.

Table 9: Composite Expert Summary for P(establishment) of Asian carp by 2071 for Baseline and Continuous Small Population Scenarios with the Technology Alternative-Electric Barrier.

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>1st Quartile</th>
<th>Median</th>
<th>3rd Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.08</td>
<td>0.10</td>
<td>0.11</td>
<td>0.12</td>
<td>0.14</td>
</tr>
<tr>
<td>Large Population</td>
<td>0.03</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Figure 10: Composite Expert Asian carp Establishment Probability Distributions for the Technology Alternative- Electric Barrier. The red distribution is the baseline scenario and the blue distribution is the continuous small population scenario.
**Technology Alternative - Acoustic Fish Deterrent**

Compared to the baseline, the P(establishment) value for the acoustic fish deterrent alternative decreases by about two-thirds if a continuous small population of Asian carp is assumed to be present in Dresden Island Pool for the period of analysis (Table 10 and Figure 11).

**Table 10: Composite Expert Summary for P(establishment) of Asian carp by 2071 for Baseline and Continuous Small Population Scenarios with the Technology Alternative-Acoustic Fish Deterrent.**

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>1st Quartile</th>
<th>Median</th>
<th>3rd Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.11</td>
<td>0.14</td>
<td>0.15</td>
<td>0.17</td>
<td>0.19</td>
</tr>
<tr>
<td>Large Population</td>
<td>0.04</td>
<td>0.05</td>
<td>0.06</td>
<td>0.06</td>
<td>0.07</td>
</tr>
</tbody>
</table>

**Figure 11: Composite Expert Asian carp Establishment Probability Distributions for the Technology Alternative-Acoustic Fish Deterrent.** The red distribution is the baseline scenario and the blue distribution is the continuous small population scenario.
Technology Alternative - Acoustic Fish Deterrent with Electric Barrier
Compared to the baseline, the P(establishment) value for the Technology Alternative – Acoustic Fish Deterrent with Electric Barrier Alternative decreases by a factor of about two-thirds if a continuous small population of Asian carp is assumed to be present in Dresden Island Pool for the period of analysis (Table 11 and Figure 12).

Table 11: Composite Expert summary for P(establishment) of Asian carp by 2071 for Baseline and Continuous Small Population Scenarios with the Technology Alternative-Acoustic Fish Deterrent with Electric Barrier.

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>1st Quartile</th>
<th>Median</th>
<th>3rd Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.10</td>
<td>0.12</td>
<td>0.13</td>
<td>0.14</td>
<td>0.17</td>
</tr>
<tr>
<td>Large Population</td>
<td>0.04</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Figure 12: Composite Expert Asian carp Establishment Probability Distributions for the Technology Alternative-Acoustic Fish Deterrent with Electric Barrier. The red distribution is the baseline scenario and the blue distribution is the continuous small population scenario.
Lock Closure Alternative
The probability of establishment for the Lock Closure Alternative depends on whether enough Asian carp could enter the GLB to establish before the lock could be closed. This value is small in the baseline estimate and falls about one-third if a small population of Asian carp is assumed to be present in Dresden Island Pool from now until the lock can be closed (Table 12 and Figure 13). This scenario is more realistic than assuming a large Asian carp population in Dresden Island Pool for the time period from now lock closure, simply because the current population is small.

Table 12: Composite Expert Summary for P(establishment) of Asian carp by 2071 for Baseline and Continuous Small Population Scenarios with the Lock Closure Alternative

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Minimum</th>
<th>1st Quartile</th>
<th>Median</th>
<th>3rd Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.01</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>Large Population</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Figure 13: Composite Expert Asian carp Establishment Probability Distributions for the Lock Closure Alternative. The red distribution is the baseline scenario and the blue distribution is the continuous small population scenario.
Additional Analysis

The Technology Alternative – Acoustic Fish Deterrent with Electric Barrier was presented with operating conditions that included having the electric barrier turned off when a vessel was immediately downstream of the approach channel, in the approach channel and in the lock. As noted in the large population discussion, at the close of the elicitation, the panel was asked how a Technology Alternative - Acoustic Fish Deterrent with Electric Barrier alternative would compare in effectiveness if the electric barrier was assumed to operate continuously. The values for estimating P(establishment) using the model were not elicited from the experts. The expert panel members rated the efficacy of the Technology Alternative – Acoustic Fish Deterrent with Electric Barrier assuming the electric barrier ran continuously to be similar to the Technology Alternative - Electric Barrier. The Technology Alternative- Electric Barrier values are presented in Table 9 and Figure 10.

Continuous Small Population Sensitivity Conclusion

The results of the sensitivity analysis indicate that the efficacy of all of the GLMRIS-BR Alternatives can be significantly enhanced if a small population of Asian carp can be maintained downstream of BRLD. Considered in concert with the results of the large population scenario, these results highlight the importance of a continuous and successful effort to control the population of carp downstream of BRLD.

Conclusions

The probability of establishment of Asian carp in the GLB grows larger over time. Figure 14, reproduced from the P(Establishment) Appendix, shows that the longer the period of time considered the greater the P(Establishment).

As summarized in Table 13, these sensitivity analyses reveal useful insights into the range of expected performance of the various alternatives in comparison to the No Action Alternative. The P(Establishment)
used for plan evaluation is based on each expert’s characterization of the uncertainty associated with the population density of Asian carp (small, medium or large) developing in Dresden Island Pool. The results of the large population scenario analysis indicate that the P(establishment) value rises to 26-41% if the Technology Alternative-Electric Barrier is implemented, but the Asian carp population in Dresden Island Pool is large throughout 2071 (Table 13). That is higher than the experts’ estimated P(establishment) for the baseline best estimate No New Action Alternative of 22-36%. Furthermore, the small population sensitivity analysis indicates that if the nonstructural measures included in the alternatives are effective in keeping population density small through 2071, the efficacy of all of the technology alternatives would be significantly enhanced. For example, the Technology Alternative- Electronic Barrier has a range of 3-5% for the small population scenario compared to 8-14% in the baseline scenario (Table 14). Thus, if the Asian Carp population density remains small in Dresden Island Pool, the P(establishment) for the Technology Alternative – Acoustic Fish Deterrent with Electric Barrier would be even lower than the baseline composite expert estimate. These comparisons highlight the importance of a sustained and successful nonstructural plan.

The Nonstructural Alternative differs from the No New Action Alternative only based on the way in which it affects the probability of arrival of different sized Asian carp populations. Because the small and large population scenarios eliminate those variations the two scenarios are equivalent if a continuous population in Dresden Island Pool is assumed. When populations sizes are uncertain and varied these two scenarios have different values.

The P(establishment) values for the Lock Closure Alternative reflect the probabilities of establishment only in the years leading up to lock closure. Once the lock is actually closed these probabilities drop to zero. As with the Nonstructural and Technology Alternatives, P(establishment) is highest for the large population scenario (Table 14).

For Table 13 and 14, the No New Action is the No New Federal Action. The Nonstructural is the Nonstructural Alternative. Electric Barrier is the Technology Alternative – Electric Barrier. Acoustic Fish Deterrent is Technology Alternative – Acoustic Fish Deterrent. Acoustic Fish Deterrent & Electric Barrier is Technology Alternative – Acoustic Fish Deterrent with Electric Barrier, and Lock Closure is the Lock Closure Alternative.
Table 13: Comparison of Five Number Summaries for Future Without Condition and With Plan Conditions 2071 for Three Scenarios—Small Population, Best Estimate, Large Population.

<table>
<thead>
<tr>
<th>Small Population of Asian Carp Always Present</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No New Action</td>
<td>Nonstructural</td>
<td>Electric Barrier</td>
<td>Acoustic Fish Deterrent</td>
<td>Acoustic Fish Deterrent &amp; Electric Barrier</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.08</td>
<td>0.08</td>
<td>0.03</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>1st Quartile</td>
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<td>0.09</td>
<td>0.04</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Median</td>
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<td>0.1</td>
<td>0.04</td>
<td>0.06</td>
<td>0.05</td>
</tr>
<tr>
<td>3rd Quartile</td>
<td>0.11</td>
<td>0.11</td>
<td>0.04</td>
<td>0.06</td>
<td>0.05</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.13</td>
<td>0.13</td>
<td>0.05</td>
<td>0.07</td>
<td>0.06</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Best Estimate (Baseline) - With Variation in Arrival Population Size Based on Expert Inputs</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>No New Action</td>
<td>Nonstructural</td>
<td>Electric Barrier</td>
<td>Acoustic Fish Deterrent</td>
<td>Acoustic Fish Deterrent &amp; Electric Barrier</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.22</td>
<td>0.15</td>
<td>0.08</td>
<td>0.11</td>
<td>0.1</td>
</tr>
<tr>
<td>1st Quartile</td>
<td>0.26</td>
<td>0.18</td>
<td>0.1</td>
<td>0.14</td>
<td>0.12</td>
</tr>
<tr>
<td>Median</td>
<td>0.29</td>
<td>0.2</td>
<td>0.11</td>
<td>0.15</td>
<td>0.13</td>
</tr>
<tr>
<td>3rd Quartile</td>
<td>0.32</td>
<td>0.22</td>
<td>0.12</td>
<td>0.17</td>
<td>0.14</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.36</td>
<td>0.26</td>
<td>0.14</td>
<td>0.19</td>
<td>0.17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Large Population of Asian Carp Always Present</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No New Action</td>
<td>Nonstructural</td>
<td>Electric Barrier</td>
<td>Acoustic Fish Deterrent</td>
<td>Acoustic Fish Deterrent &amp; Electric Barrier</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.29</td>
<td>0.29</td>
<td>0.26</td>
<td>0.28</td>
<td>0.26</td>
</tr>
<tr>
<td>1st Quartile</td>
<td>0.35</td>
<td>0.35</td>
<td>0.3</td>
<td>0.33</td>
<td>0.31</td>
</tr>
<tr>
<td>Median</td>
<td>0.4</td>
<td>0.4</td>
<td>0.34</td>
<td>0.38</td>
<td>0.34</td>
</tr>
<tr>
<td>3rd Quartile</td>
<td>0.45</td>
<td>0.45</td>
<td>0.37</td>
<td>0.42</td>
<td>0.38</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.5</td>
<td>0.5</td>
<td>0.41</td>
<td>0.47</td>
<td>0.42</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Small Population</th>
<th>Best Estimate</th>
<th>Large Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>No New Action Alternative</td>
<td>8-13%</td>
<td>22-36%</td>
<td>29-50%</td>
</tr>
<tr>
<td>Nonstructural Alternative</td>
<td>8-13%</td>
<td>15-26%</td>
<td>29-50%</td>
</tr>
<tr>
<td>Technology Alternative-Electric Barrier</td>
<td>3-5%</td>
<td>8-14%</td>
<td>26-41%</td>
</tr>
<tr>
<td>Technology Alternative-Acoustic Fish Deterrent</td>
<td>4-7%</td>
<td>11-19%</td>
<td>28-41%</td>
</tr>
<tr>
<td>Technology Alternative-Acoustic Fish Deterrent and Electric Barrier</td>
<td>4-6%</td>
<td>10-17%</td>
<td>26-42%</td>
</tr>
<tr>
<td>Lock Closure Alternative</td>
<td>1-2%</td>
<td>1-3%</td>
<td>24-42%</td>
</tr>
</tbody>
</table>

Figure 15 provides an explanation for the importance of population size in Dresden Island Pool on $P(\text{establishment})$. Note the vertical scale is logarithmic, thus each horizontal gridline is another order of magnitude. The numbers on the horizontal axis correspond to one of the six experts elicited. With a small population in place, an average of 69 fish could pass through the CAWS annually. If the population is large, the mean is 14 times larger at 950 fish annually. It is these larger numbers of fish passing that account for the increases in $P(\text{Establishment})$.

Figure 15: Comparison of the Maximum Number of Fish That Could Pass Annually From Below Brandon Road Lock and Dam Into Lake Michigan Under the No New Action Alternative.