Final Report

A Three Stage Outreach Transferability Program of a Decision Making Tool to Prevent, Manage, and Control Asian Carp Populations in Lake Michigan Tributaries based on the Evaluation of the Transport of Eggs of Local Asian Carp Populations.

Submitted to

Illinois-Indiana Sea Grant Program Grant

by

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1 Introduction

The Fluvial Egg Drift Simulator (FluEgg) is a decision making tool developed by University of Illinois in collaboration with U.S. Geological Survey (USGS). This simulation tool facilitates the evaluation of major patterns of Asian carp egg transport and the assessment of habitat suitability risk in Lake Michigan tributaries. FluEgg will support decision making on the prevention, control and management of this invasive species in Lake Michigan and its tributaries. Stakeholders and decision makers can use this tool to simulate and track Asian carp eggs as they drift in the current, identify the transport trajectories of not only single carp eggs but also masses of eggs from spawning areas to recruitment areas, estimate potential spawning risk, estimate minimum river lengths for recruitment, and identify possible methods to prevent, control and manage Asian carp at early life stages.

The FluEgg model is in the public domain and easily accessible to all relevant decision makers and/or stakeholders (http://asiancarp.illinois.edu/). This will facilitate its usage and adoption as a decision making tool to develop meaningful management control strategies to limit the impact of aquatic invasive species. The interactive website will support this outreach program, and will allow us to reach a broad audience for years to come.

The main objective of this project was to develop an outreach plan for technology transfer targeting three stakeholder groups: technical and scientific community, decision makers, and K-12 students and general public (Figure 1.1). This outreach plan not only sought to train and instruct the technical and scientific community on how to use and interpret FluEgg as a decision making tool, but also to educate decision makers and the general public on the importance of preventing, controlling and managing Asian carp at early life stages. Here in, the purpose of this project was to release the FluEgg model to the public as a decision-making tool to assess the suitability of Lake Michigan tributaries as spawning grounds. This tool will enable stakeholders (e.g State DNR, USGS, fishery managers, etc.) to develop informed control and management strategies based on fundamental data analysis rather than basic perceptions. Results from this project not only will support smart management decisions, but also will generate a direct impact on decision maker's perception with respect to why a particular tributary is conducive to Asian carp spawning and development, and what criteria is used to determine successful recruitment. The evaluation of potential spawning areas in Lake Michigan tributaries is relevant to managers because it enables stakeholders to develop strategies to prevent the establishment of Asian carp in Lake Michigan. Those rivers deemed suitable will be subject to further study, evaluation, and analysis in order to determine the best and most appropriate course of action.

Asian carp eggs transport in the lower Saint Joseph River a tributary of Lake Michigan, was simulated using the FluEgg model. This simulation present a real case scenario that uses detailed surveyed data. Results are presented in a peer review journal paper, we hope this case scenario will be useful for stakeholders not only to see the capabilities

and functionalities of the FluEgg model, but also to assess the spawning suitability of Asian carp and the eggs' hatching risk in the lower Saint Joseph River.

The ultimate message we wanted to transmit with this project was that the knowledge of Asian carp at early life stages is important in the prevention, control and management of these invasive species. Different tools including, on-site and virtual presentations, focus groups,and an interactive website were used to reach the three outreach groups.

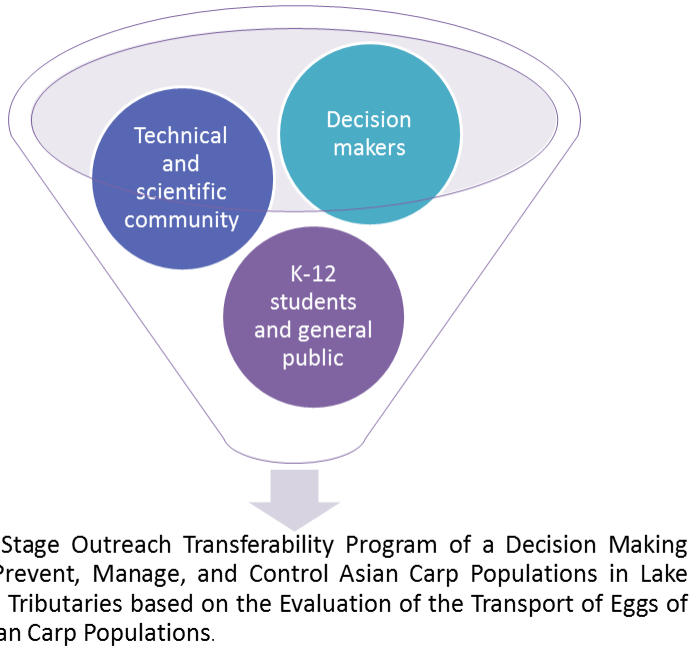

Figure 1.1: Schematic of the three stage transferability program of FluEgg

2 Project summary

Each of the following subsections represents one of the three outreach stages targeted by the FluEgg transferability program that was funded by the Illinois-Indiana Sea Grant Program.

2.1 Technical and scientific community

Technology transfer for the technical and scientific community included activities such as focus groups and WebEx meetings. These activities supported the testing and analysis of the FluEgg tool and the identification of data gaps, and provided feedback on how to improve the FluEgg model. The feedback and knowledge gained from focus groups

was used to improve the FluEgg model. An enhanced version of the FluEgg model was developed, following the feedback gained from focus groups and WebEx teleconferences.

FluEgg new features include the estimation of hatching time, the temperature dependence of biological characteristics of eggs, and the discretization of the transverse distribution of the streamwise velocity. This new features more accurately capture the dispersion and development of Asian carp eggs.

One of the most impactful results and key component of the technology transfer targeting the technical and scientific community is the scientific article entitled " On the Graphical User Interface for FluEgg: An application of transport and dispersion of Asian carp eggs in the Lower Saint Joseph River, a Great Lakes tributary". This scientific article was submitted to the Journal of Great Lakes Research and is currently under review. This paper presents the enhanced version of FluEgg together with its graphical user interface (GUI), and a case study of the simulation of Asian carp eggs in the Saint Joseph River, a tributary of Lake Michigan. The FluEgg GUI facilitates its use and provides a set of post-processing tools for the analysis and interpretation of results.

Presentations in conferences where very important in the process of technology transfer targeting technical and scientific community. These presentations where essential on the dissemination of information about both, the existence of the model and the use and interpretation of FluEgg as a decision making tool.

Another essential part of the technology transfer program was the development of the interactive website http://asiancarp.illinois.edu/. The technical and scientific community section includes an online training module for FluEgg with an instructional video on how to use FluEgg with its GUI and how to use the post-processing tools to analyze FluEgg output in an standard and comparative fashion. The users can access to this website to download the new-enhanced version of FluEgg for windows 64 and windows 32.

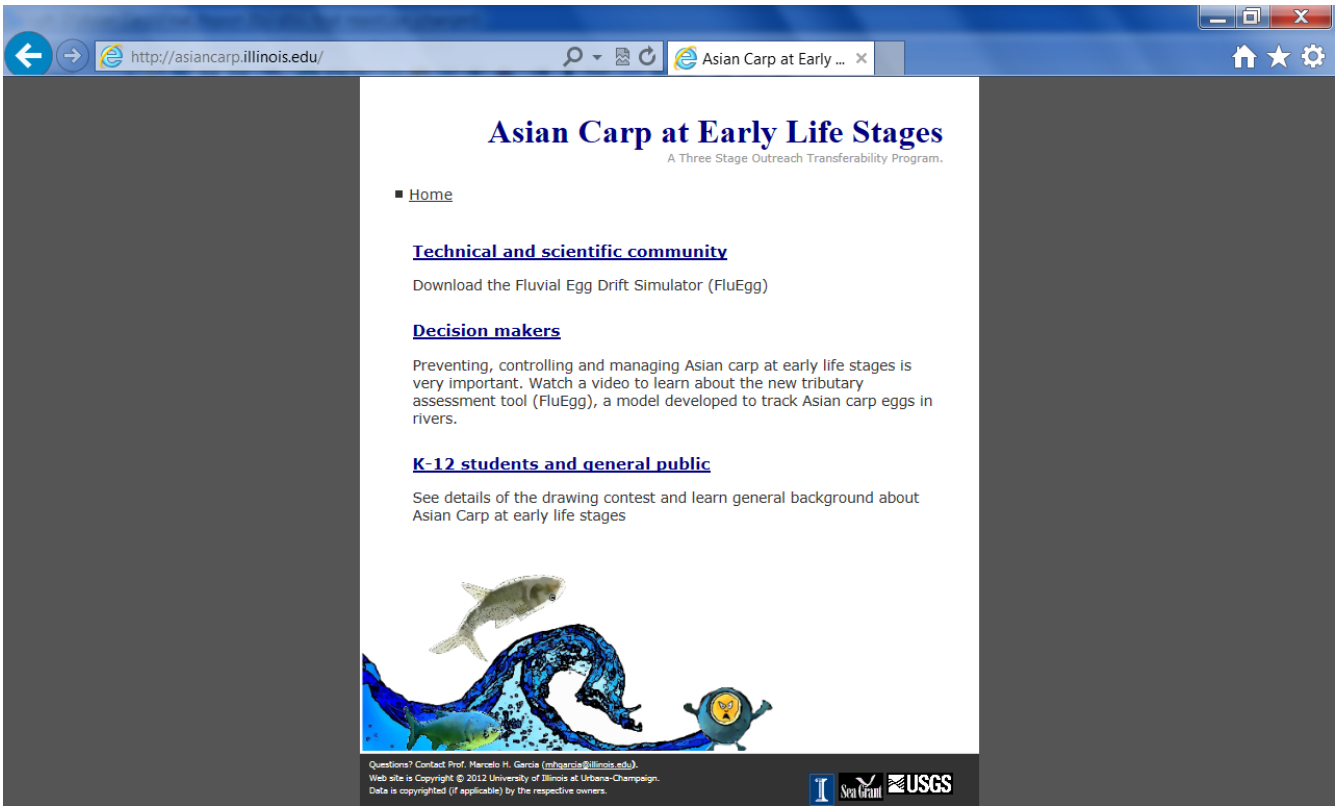

Figure 2.1: Interactive website. Asian carp at early life stages: a three stage outreach transferability program. The main menu of the interactive website is outlined by the three different stages of the outreach program.

2.2 Decision makers

Outreach transferability efforts targeting decision makers sough to generate an impact on decision maker's perception with respect to why a particular tributary is conducive to Asian carp spawning and development, and what criteria are used to determine successful recruitment. This stage of the transferability program included the following activities: a presentation about Asian carp at early life stages to the Mississippi River Basin Panel on Aquatic Nuisance Species (MRBP) and a self-explanatory video available on our interactive website (http://asiancarp.illinois.edu/).

The message we wanted to transmit to decision makers was that the knowledge of Asian carp at early life stages is important in the prevention, control and management of these invasive species. The identification of Lake Michigan tributaries with the optimum conditions that support successful hatching and potential recruitment not only assist the decision making process, but also contribute to a more efficient and effective allocation of monetary resources to the tributaries that possess the most optimum conditions.

For the past three years, the MRBP expressed their needs regarding a tool to evaluate which tributaries present the optimum conditions to successful egg hatching and poten-

tial recruitment of Asian carp primary on Mississippi River Basin reservoirs. As part of this outreach transferability program we performed a presentation in the Mississippi River Basin Panel on Aquatic Nuisance Species (MRBP) meeting in Columbus Ohio. In this presentation we introduced FluEgg to decision makers from different states that belong to the Mississippi river basin.

Based on their needs and interest, we presented to them the FluEgg model as a tool that can be used to access not only the tributaries of the Mississippi River Basin reservoirs but also to access the Great Lakes tributaries. In this presentation, a FluEgg simulation of Asian carp eggs drifting in the Sandusky River, a tributary of Lake Erie was showed as an application example of Asian carp reproduction assessment in a Great Lakes tributary. After the presentation, members of the MRBP showed interest on the tool and commented during panel discussions that are going to use the FluEgg model in future projects as a tool to assess the potential reproduction of Asian carp in reservoirs of the basin. In particular, members were interested on how to use FluEgg on reservoirs of the Mississippi River basin.

Other effective way to transfer the knowledge of Asian carp at early life stages to decision makers is through our interactive website. We developed a self explanatory video of FluEgg, in this video we illustrated the structure of FluEgg, the different assessments can be done using FluEgg, and also an example aplication of FluEgg simulating the transport of Asian carp eggs in the Sandusky River with an assesment of a manager concern. As of October, 2014 the video as been viewed by 349 people. We think this interactive website will continue contributing not only on the transferability of the Asian carp at early life stages knowledge but also will contribute on the managers decision making processess.

3 K-12 students and general public

Outreach efforts targeting the third stakeholder group, K-12 students and general public included the following activities: (i) educational mini-workshops and presentations in local schools, (ii) participation on programs of the Orpheum Children's Science Museum in Champaign, Illinois, (iii) an online educational module on Asian carp at early life stages targetted to K-12 students and general public, (iv) an online art contest for K-12 students on how to protect Lake Michigan from Asian carp invasion, and (v) the display of two exhibits at the University of Illinois Engineering Open House (EOH 2013, University of Illinois).

3.1 Online educational module

The online training module was our primary platform to target the K-12 students and general public stage of the outreach program. This interactive website was used not only to disseminate all the information regarding to the drawing contest, but also was used to

provide information about Asian carp at early life stages. The background information about Asian carp at early life stages was written in language understandable to K-12 students and the general public. We included colorful cartoons not only to facilitate the learning process but also to get the children's attention.

Figure 3.1: Interactive website. Asian carp at early life stages: a three stage outreach transferability program. K-12 students and general public stage of the outreach program.

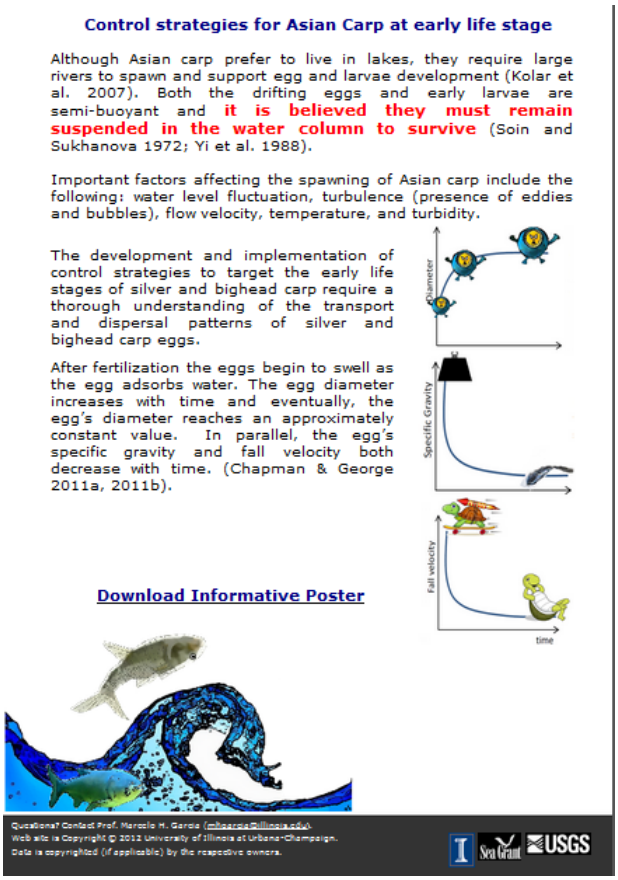

Figure 3.2: Interactive website. Asian carp at early life stages: a three stage outreach transferability program. Background.

3.2 Educational workshops and presentations

As part of our outreach program we visited several schools, primary and secondary, and learning centers with the purpose of educating K-12 students about the problematic of Asian carp and how the knowledge of Asian carp at early life stages can help on the development of prevention, management and control mechanisms targeting these invasive species. We visited grade 9 of the Urbana High School, and three Kindergarten classes of the Booker T. Washington Elementary School. We also visited The Orpheum Children's Science Museum, where we participated on the DIY time and carry on a short program with Girls do Science Club (2nd to 5th grade) about invasive species with emphasis on Asian carp.

The educational workshops and presentations covered basic knowledge about invasive species and focused in particular on the problematic of Asian carp. During our workshops we explained to the students why we care about Asian carp, where Asian carp spawn, how eggs are transported in rivers and how we can control Asian carp at early life stages.

3.3 Engineering Open House

Two exhibits about Asian carp at early life stages were presented at the University of Illinois Engineering Open House (EOH). One of them won first place on the real world category. More than 1,000 people had the opportunity to visit this exhibit and learn more about the dynamics of Asian carp eggs.

3.4 Drawing contest: protect Lake Michigan from Asian carp invasion

The protect Lake Michigan from Asian carp invasion drawing contest provided K-12 students an opportunity to investigate Asian carp at early life stages. Participants learned about Asian carp and the hydrodynamic characteristics of Lake Michigan's tributaries, and submitted original and inspiring drawings on how to protect Lake Michigan from Asian carp invasion. This drawing contest targeted primary (grades k-5), middle (grades 6-8), and high school (grades 9-12) students. The drawing contest was promoted in the

interactive website, EOH, and at the end of the special presentations organized at The Orpheum Children's Science Museum (Champaign, IL), Urbana High School (grade 9), and Booker T. Washington Elementary School (Kindergarten program).

Three winning students were selected and received an Amazon Kindle Fire. The awards went to Kylie Jackson, a third grader from Mahomet, and Lindsay Donovan and Nicole Dudley, both kindergarteners from Champaign. Each of their drawings (Figures depicted different ways to control the spread of Asian carp by keeping eggs from hatching. Kyle, Lindsay, and Nicole were chosen from 67 entries. Drawings were judged on creativity, artistic design, and relevancy to the topic. The panel of experts that evaluated the contest's entries was integrated by University of Illinois graduate students (Viviana Morales, Nam Jeong Choi), post-doctorate researchers (Sujin Kim, Blake Landry) and staff (Andrew Waratuke). A selection of participating entries including the winning drawings is displayed in the web site http://asiancarp.illinois.edu/Winners.html

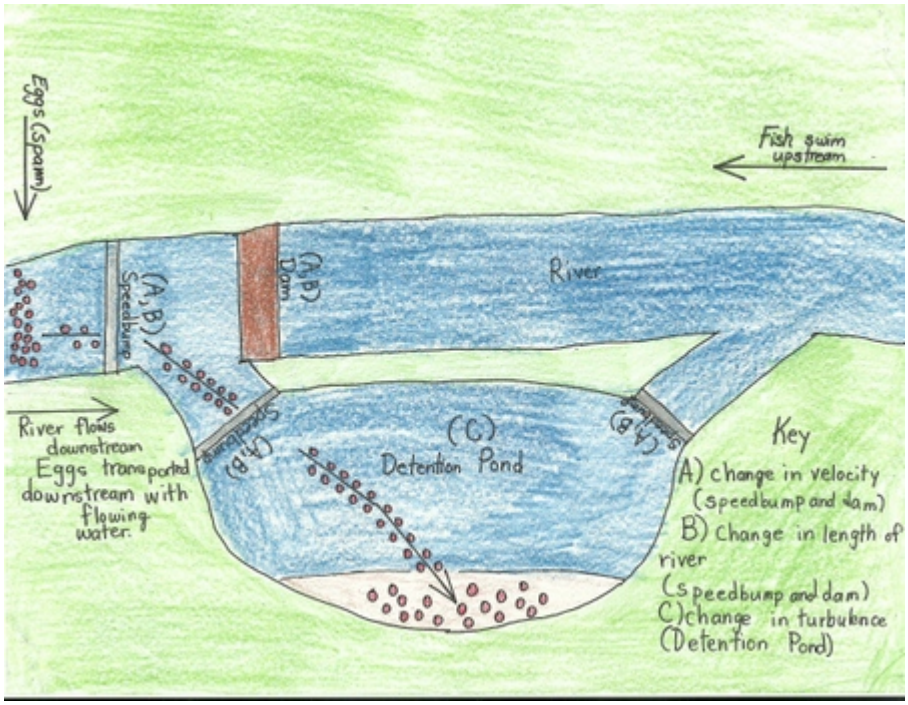

Figure 3.3: Winning Drawing. Kylie Jackson, Lincoln Trail School, Mahomet, IL, 3rd Grade, 8 years old

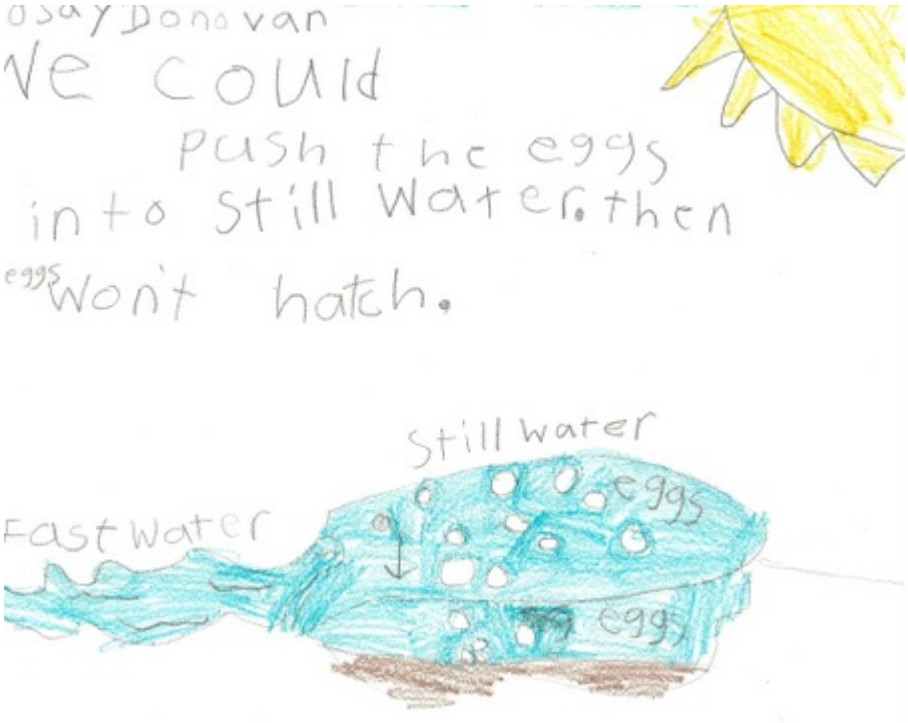

Figure 3.4: Lindsay Donovan, Booker T. Washington STEM Academy, Champaign, IL, Kindergarten

Figure 3.5: Nicole Dudley, Booker T. Washington STEM Academy, Champaign, IL, Kindergarten, 6 years old

4 Results

Products from this project include:

- An interactive website targeting to the three stages groups of the outreach program: technical and scientific community, decision makers, and K-12 students and general public. This website is available at asiancarp.illinois.edu .
- The identification of data gaps obtained from webinars, training sessions and focus groups with stakeholders and managers.
- A stable version of the enhanced FluEgg model available to the public in the website: http://asiancarp.illinois.edu.
- An instructional video on how to use FluEgg with its GUI.

4.1 Publications and presentations

A scientific paper about the Graphical User Interface for FluEgg was submitted to a peer-reviewed journal. This paper is going to act as a user manual to facilitate FluEgg's usage. See the reference below:

T. Garcia, P.R. Jackson, E.A. Murphy, M.H. Garcia. (2014). On the Graphical User Interface for FluEgg: An application of transport and dispersion of Asian carp eggs in the Lower Saint Joseph River, a Great Lakes tributary [under revision].

Results of this project have been presented in the following events:

1. T. Garcia, P.R. Jackson, E.A. Murphy, A.J. Valocchi, M.H. Garcia. (2013). FluEgg: A Lagrangian Tool to Simulate the Transport of Asian Carps Eggs. Presented at American Fisheries Society 143rd Annual Meeting. Little Rock, AR.

2. T. Garcia, P.R. Jackson, E.A. Murphy, M.H. Garcia. (2012). Transport and dispersal of Silver and Bighead Carp Eggs using a Lagrangian Model. Presented at 2012 Illinois Water. University of Illinois at Urbana-Champaign.

Outreach presentations and participation in events:

- The Orpheum Children's Science Museum: DIY time and short program with Girls do Science Club (2nd to 5th grade)
- Urbana High School (grade 9)
- Booker T. Washington Elementary School (Kindergarten program).
- Presented two exhibits at EOH, University of Illinois
- MRBP meeting in Columbus, Ohio

4.2 Students supported with funding

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4.3 Partnerships with other institutions and related projects

The outreach project presented in this report was performed in parallel with the project Fate and Transport of Asian Carp Eggs, Phase II (2012-2013) funded by US. Geological Survey. An extension of this project (Fate and Transport of Asian Carp Eggs, Phase III (2013-2014)) funded also by the USGS resulted in part from this Sea-Grant sponsored research.

4.4 Media Coverage

One of the greatest recognition that this project has received is that our research on Asian carp was highlighted by the Canadian show Daily Planet (Discovery Channel). The mini-documentary is available online at: http://watch.discoverychannel.ca/#clip1082326.