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Survivability of Asian Carp in Barge Tanks in the Illinois River

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Survivability of Asian Carp in Barge Tanks in the Illinois River

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16. Abstract (MAXIMUM 200 WORDS) This study investigated whether Asian carp larvae could be entrained into barge ballast tanks, survive while in these tanks, and survive a single passage through a water pump. Entrainment and survival of eggs and very early larvae could not be assessed because none were available at the time of this study. Larvae available during the study period were 11 days or older. This study took place in the LaGrange Reach of the Illinois River in ballast tanks on a hopper barge during June 2011. Larval entrainment was determined by flooding the tanks, filtering the water pumped from the test tanks, and identifying all collected larval fish. Larval survival was tested by placing known quantities of fish larvae in cages that were then submerged in ballast tanks on the test barge. The potential for larval survival was also determined after a single passage through either a 2-inch or 3-inch portable pump. Water quality parameters measured during this study included temperature, dissolved oxygen, conductivity, pH, and ammonia. Study results indicated the majority of entrained fish were non-Asian carp and mainly gizzard shad. Few Asian carp larvae were entrained during the two trials conducted. Survival of Asian carp larvae in test cages was high, even when water quality conditions were not favorable (low dissolved oxygen concentrations). A very small percentage of Asian carp survived being pumped through either a 2-inch or 3-inch pump. Survival for more than 30 minutes beyond a pump event was not determined. No Asian carp eggs were found during any of the field collections. More studies are needed to determine if 1) Asian carp eggs/very young larvae can survive in ballast tanks and/or passing through a pump, and 2) Asian carp eggs/larvae in a ballast tank could survive transport across the electric fish barrier.			
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EXECUTIVE SUMMARY

The purpose of this study was to investigate the potential for Asian carp early life stages to be entrained into and survive in barge ballast tanks which might allow these fish to bypass the United States (U.S.) Army Corp of Engineers (USACE) electrical dispersal barrier in the Chicago Sanitary and Ship Canal (CSSC). Asian carp are non-native, invasive fish that have been steadily migrating up the Mississippi River and its tributaries since the mid-1990s. Both bighead and silver carp, two Asian carp species, have been found in the Marseilles Pool about 50 miles downriver of the barrier. Environmental deoxyribonucleic acid (e-DNA) from Asian carp has been found on the lake side of the USACE electric dispersal barrier. There is concern that Asian carp eggs, larvae, and fry entrained in towboat and barge ballast tanks could be transported upstream past the dispersal barrier, released above the barrier, then possibly move into Lake Michigan and eventually into the rest of the Great Lakes.

In the early 1960s and 1970s, Asian carp (bighead, silver, grass, and black) were brought to the United States from Asia to control submersed aquatic vegetation, algae, and mollusks, and also to improve water quality of aquaculture ponds and at wastewater treatment facilities. Through pond escapement or by deliberate introductions, these species now occur in many of the rivers and back waters throughout the Upper Mississippi River System (UMRS).

USACE has constructed a permanent electrical barrier to keep invasive fish from moving between the Illinois River and Lake Michigan (and the rest of the Great Lakes). The CSSC Dispersal Barrier now consists of two separate barriers, with Barrier 2 having two sets of electrode arrays consisting of rows of 42 electrodes spanning the entire width of the canal. The electrodes pulse direct current into the water, which causes fish to turn back rather than pass through the electric current. The barrier currently operates as part of an effort to keep Asian carp from passing through the CSSC and into the Great Lakes, but little information exists on potential transport mechanisms for early life stages of bighead carp, including eggs and larvae. In June 2010, the Illinois Department of Natural Resources found one 20-lb live Asian carp in Lake Calumet, a body of water located upstream of the electric barrier and connected to Lake Michigan via the Calumet River. This fish represents the first physical specimen found above the electric barrier system. The total positive findings of Asian carp e-DNA within the Chicago Area Waterway System (CAWS) upstream of the electric barrier has increased to 81 positive samples.

The current study was designed to assess the potential for early life stages of Asian carp to be entrained into barge ballast tanks through either cracks or holes in the hull and then survive there. A hopper barge was modified by installing valves on 3-inch holes cut into the exterior of its four ballast tanks to simulate a barge with a ruptured hull. Valves were opened at set times to entrain water and potentially Asian carp larvae. Survival was investigated by placing caged larvae into the flooded tanks for known periods of time. In addition, an experiment to assess pump effects was conducted to determine whether early life stages of Asian carp could survive a single pass through the type of portable pump normally used during barge and towboat ballasting operations. Water quality parameters, including temperature, dissolved oxygen (DO), conductivity, potential hydrogen (pH), and ammonia were recorded in the Illinois River, as well as in the barge ballast tanks during each experimental trial.

At selected time intervals, tanks were pumped out and the contents retained in a plankton net to determine whether larvae had been entrained. Only three Asian carp larvae were found in the pump-out material during the entrainment trials. However, because the entrainment and survival experiments ran concurrently,



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and because some of the mesh used in the experimental cages was damaged during the study, it is possible that these Asian carp larvae escaped from the damaged cages rather than having been entrained. The majority of the fish entrained into the tanks and later pumped out were non-Asian carp (mainly gizzard shad), which were present in relatively high abundances during some of the river plankton tows prior to the initial tank flooding. Results of the survival experiment indicated high survival (low mortality) rates for containment periods as long as 144 hours in the flooded tanks.

The pump effects portion of this study indicated that if entrained, a very small percentage of Asian carp larvae could survive a single pass through either a 2-inch or 3-inch portable ballasting pump. During normal tank deballasting, no hose is attached to the pump discharge and the discharged water falls several feet from the barge deck level to the river surface. During this study, however, a discharge hose was attached from the pump to below the waterline to allow the pumped water to be directed into and filtered through a submerged plankton net. It is uncertain what additional mortality (if any) might have taken place had no hose been used on the pump's discharge and the larvae fell directly from the pump discharge and impacted the river surface. Likewise it is not possible to determine the effects of impact with the hose wall.

Water quality parameters measured during the experiments showed that Asian carp larvae were able to withstand a wide range of water quality parameters. The most variable water quality parameter was DO, which decreased in the tanks from a maximum of 5.51 milligrams per liter (mg/L) to a level as low as 0.86 mg/L in the tanks. However, even at these depressed levels, larval survival was not adversely affected.

Results of this study indicate that while it may be possible for early life stages to be transported in a barge ballast tank for long periods, there is a low probability that those life stages will survive passage through the pump when the tanks are deballasted. It should be noted the study began an estimated 11-13 days after an Asian carp spawning event based on the age of the collected larvae collected in the river at the beginning of the study. Consequently, no eggs or larvae younger than this age were available for testing. It is possible that had the experiments been conducted in the midst of an Asian carp spawning event (both time and location), entrainment of their eggs and young larvae may have been higher through the 3-inch test openings since their avoidance reaction would be less developed.



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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

$\mu\text{S/cm}$	microSiemens per centimeter
ARTCO	American River Transportation Company
$^{\circ}\text{C}$	degrees Centigrade
CAWS	Chicago Area Waterway System
CSSC	Chicago Sanitary and Ship Canal
DO	dissolved oxygen
e-DNA	Environmental deoxyribonucleic acid
ft	feet
GIS	Geographic Information System
in	inches
INHS	Illinois Natural History Survey
LTRMP	Long Term Resources Monitoring Program
m^3	cubic meter
mg/L	milligrams per liter
mm	millimeter
nc	not collected
pH	potential hydrogen
R	river
RDC	Research & Development Center
TAN	total ammonia nitrogen
U.S.	United States
UMRS	Upper Mississippi River System
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USGS	U.S. Geological Survey
YSI	Yellow Springs Instrument



1 INTRODUCTION

The purpose of this study was to investigate the potential for early life stages (eggs, larvae, or juveniles) of Asian carp to be entrained into and survive in barge ballast tanks. Specifically, this study was designed to address the question of whether barges and towboats can potentially provide a means for these stages to bypass the United States (U.S.) Army Corp of Engineers (USACE) electrical dispersal barrier in the Chicago Sanitary and Ship Canal (CSSC).

Asian carp (bighead, silver, grass, and black) were brought to the United States in the early 1960s and 1970s and now inhabit the waters of the Upper Mississippi River System (UMRS). These species were used to control submersed aquatic vegetation, algae, and mollusks in ponds thereby improving water quality of aquaculture ponds and in wastewater treatment facilities (Chapman & Hoff, 2011) and “to develop nonchemical and environmental friendly control mechanisms” (Kelly et al., 2011). Asian carp invaded nearby rivers through pond escapement or by deliberate release. Asian carp reproduce rapidly when the conditions are favorable. All four species of Asian carp are now well established in the Mississippi River basin (Chapman & Hoff, 2011). Biologists, policy makers, and citizens are deeply concerned about the prospects of Asian carp entering Lake Michigan through the Chicago Area Waterway System (CAWS). According to Cudmore & Mandrak (2011), the probability of bighead and silver carps surviving and reproducing in the Great Lakes is high. Sparks et al. (2011) stated that if bighead and silver carp enter Lake Michigan, they will directly compete for food resources with a number of well-established sport fishes.

As reported by Moy et al. (2011), the United States Army Corps of Engineers (USACE) constructed a permanent electrical barrier (the CSSC Aquatic Nuisance Species Dispersal Barrier) to protect the Mississippi River, Lake Michigan, and the other Great Lakes from invasive species movements between the river and lakes. This electric barrier was originally conceived as a method to prevent the movement of non-native fishes through the CAWS. The round goby was the first target species but it moved out of Lake Michigan and through the proposed barrier location into the Illinois River before construction of the original barrier was complete. The CSSC Dispersal Barrier consists of two electric barriers (Barrier 1 and 2) with Barrier 2 having two independent electrical arrays, each consisting of 42 electrodes spanning the width of the canal. The electrodes pulse direct current into the water at a strength and frequency that causes fish to turn back rather than pass through the electric current. The barrier is operating in an effort to keep Asian carp from moving upstream and possibly entering Lake Michigan.

Bighead and silver carp have recently been found downstream of the CSSC and environmental deoxyribonucleic acid (e-DNA) from these species has been found upstream of the barrier (Moy et al., 2011; Jerde et al., 2011). The total positive findings of Asian carp e-DNA within the CAWS upstream of the electric barrier has increased to 81 samples (USACE website accessed September 2011). In June 2010, the Illinois Department of Natural Resources also captured one 20-lb, 6-year old live Asian (bighead) carp in Lake Calumet, a body of water located upstream of the electric barrier and connected to Lake Michigan via the Calumet River. This fish represents the only physical specimen found above the electric barrier system.

There is concern that Asian carp eggs, larvae, and juveniles may be taken up in ballast or leakage water of towboats and barges and potentially be transported through the dispersal barrier. If the fish are discharged upstream of the dispersal barrier, there is concern that Asian carp could advance into Lake Michigan. While the barrier operates to keep Asian carp from continuing to move upriver, no information exists on potential transport mechanisms for early life stages of Asian carp (Moy et al., 2011).



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Irons et al. (2011) reporting on sampling in the La Grange Reach of the Illinois River from 1990 through 2006 stated that the catch of adult silver and bighead carp began in 2000. The peak in abundance of bighead carp was in 2000 followed by a decline to very low levels in 2005 and 2006. Silver carp abundance peaked in 2004 and then decreased between 2004 and 2006 in the La Grange Reach, however they stated that the sampling equipment was ineffective in the collection of the largest individuals, with individuals being observed swimming away from the capture boat (Irons et al, 2011). They also observed good recruitment of both bighead and silver carp (based on catch of fish less than about 200 millimeter [mm]) during 2000 and 2003. However, recruitment of both species was poor in 2001, 2002, and 2005. Sass et al. (2010) reported that the La Grange Reach of the Illinois River had a conservative estimate of 2,544 silver carp with a biomass of 5.5 metric tons per river kilometer during 2007-2008. They estimated that silver carp made up about 51 percent of the total fish collected by the Long Term Resource Monitoring Program (LTRMP) in the La Grange Reach. No estimate of bighead carp abundance was presented in this paper.

Papoulias et al. (2006) found that bighead and silver carp can have a long annual spawning season each year in the Missouri River and appear to be able to spawn more than one time during each year. They found that from 2003 through 2005, silver carp spawned as early as late March when the water temperature had reached about 14 °C while bighead carp did not begin spawning until about early May when the temperature was about 19-20 °C. Irons et al. (2011) stated that the critical spawning temperature for bigheaded carp was 18 °C. Coulter & Goforth (2011) found Asian carp eggs in the Wabash River, Indiana, from May through July during 2011. Several studies, including Jennings (1988), DeGrandchamp et al. (2007), Kolar et al. (2007), Lohmeyer & Garvey (2009), and Irons et al. (2011) also stated that Asian carp spawning is positively correlated to increasing river flow. DeGrandchamp et al. (2007) also stated that high river flow does not appear to be critical for reproduction to take place but may aid in egg and larval survival.

Yi et al. (1988, as translated in Chapman, 2006) described the characteristics of the 48 early developmental stages of the eggs and larvae of the four species of Asian carp in the Yangtze River. These stages begin with egg fertilization and end with the larvae transition into a juvenile. Egg development to hatching takes place quickly. Yi et al. (1988) reported that bighead carp in the field hatch about 39 hours after fertilization while Chapman & George (2011) found hatching in the laboratory after 31 to 45 hours depending on incubation temperature. Silver carp hatch between 26 to 45 hours after fertilization in the laboratory (Chapman & George, 2011) while Yi et al (1988) reported hatching in the Yangtze River after about 38 hours. Development to the juvenile stage in silver and bighead carp was estimated to take about 60-70 days after fertilization (Yi et al. 1988).

Chapman & George (2011) reported that newly hatched bighead and silver carp larvae immediately begin a vertical swimming motion when they were not resting; this swimming motion changes to a horizontal direction near the water surface at larval Stage 36 (when the eyes become pigmented) which is about 100 hours after fertilization. By Stage 38 at about 146 hours after fertilization (referred to as the one-chamber-gas-bladder stage), larvae swim horizontally at varying depths between resting periods. These authors also reported that larvae began to move out of the river channel into the slower water near shore about 100+ hours post hatching (about Stage 37 when the gas bladder forms).

The current study was designed to evaluate the potential for entrainment of early life stages of Asian carp into barge tanks via leaking hulls and to assess their survival in barge ballast water. Another aspect of the study was to assess survival of these life stages after being pumped through a portable pump. This study was not designed to directly address the question of survival of early life stages being transported across the electric barrier while in a ballast tank.



2 METHODS

2.1 Overview

Two experimental trials, each lasting approximately 7 days, were conducted from June 11-24, 2011, within the La Grange Reach of the Illinois River, just down river (south) of Peoria, IL. River plankton sampling began June 9 in an attempt to locate high concentrations of Asian carp eggs and young larvae. With few exceptions, all field and laboratory methods followed an approved Study Plan (Appendix A). Details concerning minor changes to the approved Study Plan are presented below. Modifications ranged from changes in the experimental locations to changes in cage holding times.

The decision to begin in early June was based on the suggestion of Dr. Greg Sass (pers. comm., June 1, 2011, Director, Illinois Natural History Survey (INHS), Havana Biological Field Station). He felt that the river water temperature was right for spawning and the river was rising due to thunderstorms in the region. He also mentioned that there had been reports of Asian carp swimming at the surface with possible spawning having already taken place. By June 9 when sampling began, the river was 6-8 feet above its average height for that time of year and was considered to be in flood conditions, which had a direct impact on both sampling and testing locations (see Section 4).

2.1.1 Barge Location and Setup

All experiments took place on a hopper barge secured to the outboard side of a deck barge. The barges were provided by American River Transportation Company (ARTCO) and were moored at the ARTCO Fleeting Services dock in Pekin, IL (Figure 1). ARTCO modified the four ballast tanks of the hopper barge by drilling one 3-inch diameter hole below the waterline in the side of each tank and fitting each with a gate valve to allow tank flooding. The modification was intended to simulate a leak for potential entrainment of larvae. Each of the four ballast tanks on the modified barge was filled by opening the valve and then emptied using a Honda WB20X (2-inch hose) or WB30X (3-inch hose) pump. These types of pumps are used by most barge operators during normal operations to fill or empty their ballast tanks. The ballast water was pumped out of each tank and into a plankton net suspended in the river water in a spud well on the adjacent deck barge. The pump's discharge hose emptied below the waterline inside the plankton net..

2.1.2 River Collections and Results

We used plankton tows to identify areas where Asian carp eggs and larvae could be found in the La Grange Reach of the Illinois River. Tows were conducted on 9-10 June prior to Trial 1, on 18 June prior to Trial 2, and on a few days during both trials. The majority of the tows were conducted using a plankton net attached to a wood frame (Figure 2) lowered off the bow of a boat supplied by the INHS, Havana Biological Field Station. In general, tows were run diagonally across the channel from one shore to the other.

Results of these tows and visual observation indicated that no Asian carp eggs and very low concentrations of their larvae were present in the channel location; however, larval Asian carp were present in significantly higher abundances in shallow water habitats along the shoreline, generally between the flooded tree trunks. Consequently, larvae were collected using small dip nets from shallow water locations along the shoreline and were used during both trials for the survival and pump effects studies. All Asian carp larvae collected in the larger nets in the main river channel were generally of the same size as those collected in higher numbers along the shoreline near the flooded tree line.

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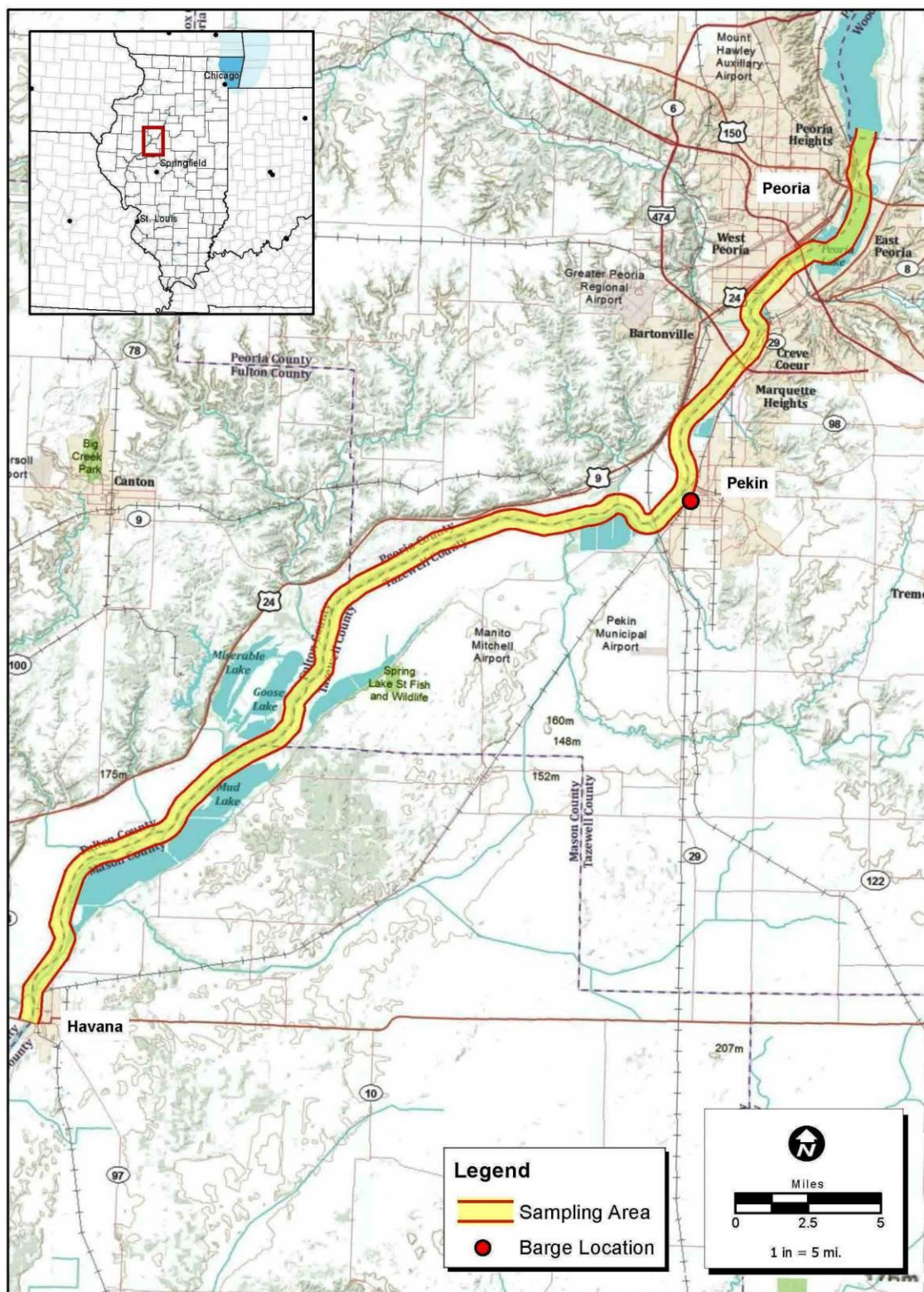


Figure 1. Sampling area and barge location on Illinois River during Trials 1 and 2, June 2011.



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Plankton net frame construction



Plankton net on frame



Plankton net being lower into the water



Identifying organisms collected in plankton net using headband magnifier

Figure 2. Photos of the push plankton net frame construction and sampling during river plankton tows.

A second result of finding few to no larvae in the main channel was that it would not be possible to follow one cohort of larvae as they drifted downriver as was initially planned. We therefore decided to moor the experimental barge and an additional deck barge at the ARTCO facility in Pekin with the valve openings at the edge of the channel thereby allowing river water to flow freely past the openings.

Table 1 presents a summary of the plankton net tow dates, locations, and the main species of fish larvae found on each collection day. For the first two collections (9-10 June), a 500 micron mesh net was towed from the side of the boat in the upper 3-6 ft (feet) of the water column for about 5 minutes. Generally, the rest of the tows were about 5-10 minutes long using a 500-micron mesh net suspended off the front of the boat while it was motored upstream either into or across the river flow. This net setup filtered water from approximately the upper 30 inches (in) of the water column. The majority of the tows were across the river from bank to bank. The volume of water was not determined during the first series of tows, as the emphasis was to try to locate high concentrations of Asian carp eggs or larvae in the main channel and along the shoreline. If a high density had been found, a flowmeter would have been attached to the net to determine volume filtered to find the actual egg or larval concentration. During the 22-23 June tows, a flowmeter was



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added to the net to generate an estimate of the water volume filtered. The volume per tow ranged from about 100 to 235 cubic meters (m³) (~26,000 to 62,000 gallons). As can be seen in the table, no Asian carp eggs and only low abundances of their larvae were found.

Table 1. Date, location, and larval fish in river collections.

Note: The total number of all larvae collected during each tow was not determined*.

Date	Location	Number of Tows	Larval Fish
6/9/11	ARTCO's launch ramp to Pekin Landing. Tows were conducted within the upper 6 ft of the water column either across the channel or along the shore just outside of the tree line.	6	Mainly gizzard shad. Four Asian carp total in all six tows.
6/10/11	ARTCO's launch ramp to Kickapoo Creek and in Copperas Creek area. Main tows were within upper 3-6 ft of the water column either across the channel or along the shore just outside of the tree line.	5	Asian carp found along shoreline in rock rubble and in water around trees. River and creek tows collected mainly gizzard shad, with about 50 Asian carp total for all tows.
6/15/11	Up and down river from Havana (estimate covered 15 miles of river while sampling). Main tows within about the upper 30 inches of the water column either across the channel or along the shore just outside of the tree line.	9	5-50 Asian carp per tow with most of the larvae being gizzard shad. Highest number of Asian carp was near Liverpool.
6/16/11	Sampled from Pekin to Upper Peoria Lake. Main tows within about the upper 30 inches of the water column either across the channel or along the shore just outside of the tree line.	6	2-20 Asian carp per tow with most of the larvae being gizzard shad.
6/22/11	Sampled from Pekin to Peoria Lock and Dam (estimate covered 4-5 river miles while sampling). Main tows within about the upper 30 inches of the water column either across the channel or along the shore just outside of the tree line. Volume per tow varied from about 110 to 235 m ³ (~29,000-62,000 gallons).	5	0-5 Asian carp per tow with most of the larvae being gizzard shad.
6/23/11	Up and down river from Havana (estimate covered 6-8 miles of river while sampling). One sample conducted at Toehead Island which historically has been area with high spawning activity. Main tows within about the upper 30 inches of the water column either across the channel or along the shore just outside of the tree line. Volume per tow varied from about 100 to 130 m ³ (~26,000-34,000 gallons).	5	No Asian carp. Larvae mainly gizzard shad.

*Total number of all larval fish for tows presented in this table ranged from 0 to an estimated 500 per tow. The highest numbers were due mainly to gizzard shad collected between upper and lower Peoria Lakes.



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2.2 Entrainment Experiment Methods

To evaluate potential entrainment of larval Asian carp into barge ballast tanks, four experimental tanks on the hopper barge were flooded, emptied, and contents analyzed during Trials 1 and 2 according to the timing presented in Table 2 (see Appendix A for planned timing). Asian carp entrainment experiments ran concurrently with the survival experiments (see Section 2.3 below). A plankton net (500 micron mesh) was suspended in river water inside a spud well on the adjacent deck barge while each tank was emptied into the net using a portable pump and discharge hose positioned below the water surface inside the net (Figure 3). We used a 2-inch pump during the first pump-out then we used a 3-inch pump to empty the tanks during all other pump-out events. The pump operated at full throttle during pump out process until the tank water level reached approximately 6 inches remaining. The pump rate was then reduced to about half-throttle to avoid losing suction. (Such rate reduction is common practice during normal barge operations.) We emptied and analyzed the plankton net cod ends twice during each tank pump-out. We removed all entrained larvae, live or dead, and placed them in labeled vials for subsequent laboratory identification and staging. The volume of water pumped from each tank was estimated using the dimensions of the tanks supplied by ARTCO and the depth of water prior to and after pumping.

Table 2. Summary of filling/emptying dates and times plus water depths of varying tank fills during Trials 1 and 2.

Start Date	Location	Tank	Fill	Date Filled	Time Filled	Date Emptied	Time Emptied	Filled Water Depth (in.)
Trial 1								
6/11/11	Pekin Dock	T1	F1	6/11/11	9:25	06/11/11	17:30	51
6/11/11	Pekin Dock	T1	F2	6/11/11	21:23	06/17/11	9:30	48
6/11/11	Pekin Dock	T2	F1	6/11/11	9:25	06/12/11	9:30	54
6/11/11	Pekin Dock	T2	F2	6/12/11	12:00	06/17/11	9:15	50.5
6/11/11	Pekin Dock	T3	F1	6/11/11	9:37	06/13/11	9:30	44
6/11/11	Pekin Dock	T3	F2	6/13/11	12:12	06/17/11	10:45	47
6/11/11	Pekin Dock	T4	F1	6/11/11	9:30	06/14/11	9:35	41
6/11/11	Pekin Dock	T4	F2	6/14/11	11:50	06/17/11	11:45	48
Trial 2								
6/18/11	Pekin Dock	T1	F1	6/18/11	11:20	06/24/11	11:45	56
6/18/11	Pekin Dock	T1	F2	No Fill #2				
6/18/11	Pekin Dock	T2	F1	6/18/11	10:35	06/19/11	10:30	59
6/18/11	Pekin Dock	T2	F2	6/19/11	13:32	06/24/11	9:45	45
6/18/11	Pekin Dock	T3	F1	6/18/11	11:00	06/20/11	10:45	48
6/18/11	Pekin Dock	T3	F2	6/20/11	13:10	06/24/11	10:00	48
6/18/11	Pekin Dock	T4	F1	6/18/11	11:10	06/21/11	10:55	49
6/18/11	Pekin Dock	T4	F2	6/21/11	13:00	06/24/11	11:30	48

Due to the low concentration of larvae found during river tows prior to Trial 1, additional plankton tows were not conducted during tank flooding. However, a plankton net was deployed alongside the barge while the ballast tanks were being flooded for the entrainment experiment during Trial 2. The 500 mm mesh plankton net (Figure 3, lower right) was deployed to a depth similar to the tank valve depth to determine if Asian carp or other species of larval fish were present in the water column and could potentially be entrained.



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Pumps for emptying tanks



Pump and hose setup



Emptying tank into plankton net in spud well



Plankton net

Figure 3. Photos from the entrainment experiment.

2.3 Survival Experiment Methods

As mentioned above, we used plankton tows to identify areas in the La Grange Reach where we could obtain Asian carp eggs and larvae. Results of these tows indicated that eggs were absent and larvae were not present in high enough numbers to conduct the survival study in the channel location itself. Larval Asian carp but not eggs were present in shallow water habitats along the shoreline, therefore larvae used in the survival experiments were collected with dip nets from shallow water locations along the shore. For Trials 1 and 2 we placed approximately 30 larvae in each of three cages in each ballast tank (Figure 4) for a range of exposure times as shown in Table 3 and Table 4, respectively. In addition, we placed control cages in the river during both trials for various exposure times, as indicated in Table 3 and Table 4.



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Example cage used in survival experiment



Example of larvae collected for survival experiment



Preparing cages for survival experiment



Cages suspended in ballast tank



Control cages in river (strong current area)



Control cages in river (weak current area)

Figure 4. Photos from the survival experiment.



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Table 3. Proposed and actual exposure times (hours) for survival experiment Trial 1 test cages.

Cage Set	Proposed Exposure Times (hrs)	Actual Exposure Times (hrs)
1	8	8
2	24	24
3	48	48
4	72	72
5	80	72*
6	92	94*
7	104	117*
8	108	132*
Control 1	8	8
Control 2	24	24
Control 3	48	65*
Control 4	72	72
Control 5	96	118*

*Times changed from Final Test Plan (Appendix A)

Table 4. Proposed and actual exposure times (hours) for survival experiment Trial 2 test cages.

Cage Set	Proposed Exposure Times (hrs)	Actual Exposure Times (hrs)
1	8	144*
2	24	144*
3	48	144*
4	72	144*
Control 1	24	143*
Control 2	48	143*
Control 60**	72	120*
Control 90**	72	120*

*Times extended over Final Test Plan (Appendix A)

**The 60 and 90 indicate the total number of larvae that were initially placed in these control cages.

Cages were 5-gallon plastic buckets with lids. Openings cut in the bucket sides and lids were covered with 500-micron mesh netting to allow water circulation (Figure 4). Keeping the mesh attached over the cage opening was a problem once the trials began. Initially, aquarium-grade silicone was used but it was determined that this did not bond securely enough to the bucket walls. Hot glue used along the edge of the mesh generally secured the mesh adequately for the testing. A few cages required repair to the mesh covering more than once.



2.4 Pump Effects Experiment Methods

The pump effects experiments assessed whether larvae were able to survive the pumping process that occurs during ballasting operations (Appendix A). This study occurred in conjunction with the entrainment and survival studies. Larvae for this experiment were collected at shore locations using similar methods to those described above for the survival experiment (Section 2.3). The pump intake hose was placed in the river and a large number of larvae were released from a 5-gallon bucket into the water near the intake hose while the pump was operating. Larvae were sucked through the hose and pump and were discharged into a plankton net suspended in a spud well, similar to methods used for the entrainment study (Figure 5). Two-inch and 3-inch water pumps (Honda WB20X and WB30X pumps, respectively) were tested during both trials. No count was made in the field of the number of larvae initially released near the hose intake or collected in the plankton net cod end during each test run. The number of larvae collected during one pump test was estimated by counting the number of larvae in a photo taken following collection. This estimate of the number of larvae passing through the pump was used for all the other pump effects tests.

Samples collected in the plankton net were placed in water in small plastic containers and the number of live larvae recorded immediately after collection. We then placed the sealed containers in a bucket of water to keep the samples' water temperature stable during a 30-minute holding period. After 30 minutes the number of live larvae was recorded to assess potential effects of pumping on their viability after passing through the pump assembly.

2.5 Lab Analysis

Labeled vials containing the live and dead larvae from the entrainment and survival experiments and the river-collected larvae were returned to the lab for identification, staging, and enumeration. All larvae that survived passing through the pump in the pump effects experiments were also placed in labeled vials and returned to the laboratory for processing. The stage number of each Asian carp larvae (Table 5) was determined based on Yi et al. (1988). Data from the entrainment, survival, and pump effects samples were recorded on laboratory datasheets. The stage and status (live or dead) of each Asian carp larva was recorded for the entrainment and survival trials. The number and status was also recorded for each non-Asian carp larva collected during these experiments. All recorded data were entered into a Microsoft® Office Access® database and verified for completeness and accuracy prior to the development of summary tables.

2.6 Water Quality Analysis

We recorded water quality parameters from the flooded tanks and the Illinois River during the entrainment and survival experiments based on the filling and emptying schedule (Table 1). Water quality data included tank water depth, water temperature, dissolved oxygen (DO), potential hydrogen (pH), and total ammonia nitrogen (TAN). All water quality samples were collected at the water surface in the ballast tanks and the river. A Yellow Springs Instrument (YSI) water quality probe was used to collect temperature and DO. During Trial 1, total ammonia was measured using an API® Freshwater Ammonia Test Kit. No pH testing was conducted during Trial 1. During Trial 2, ammonia and pH were measured using API Freshwater Ammonia and pH Test Kits, respectively.



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Impeller from 3-inch portable water pump



Hose location for pump effects experiment



Example of larvae used for pump effects experiment



Releasing larvae into river near pump intake



Larvae and juvenile fish (approximately 3 inches) condition after going through pump



Figure 5. Photos from pump effects experiment.



Survivability of Asian Carp in Barge Tanks in the Illinois River

Table 5. Summary of stage number, stage name, length, and days post-fertilization for silver carp larvae from translation of Yi et al. (1988) by Chapman (2006). Stages 1-30 were egg development stages.

Stage #	Stage Name	Length (mm)	Hours or Days Post-Fertilization
31	hatching	6.1	38 hours
32	rudimentary-pectoral-fin	6.3	48 hours
33	gill-arch	6.8	53 hours
34	xanthic-eye	7.2	63 hours
35	gill-filament	7.6	74 hours
36	melanoid-eye	8.0	92 hours
37	gas-bladder-emergence	8.2	106 hours
38	one-chamber-gas-bladder	8.5	146 hours
39	yolk-absorption	8.7	168 hours
40	dorsal-fin-differentiation	9.0	212 hours
41	notochord-tip-lifting	9.4	240 hours
42	two-chamber-gas-bladder	10.3	279 hours
43	pelvic-fin-bud	11.2	312 hours
44	dorsal-fin-formation	14.1	19 days
45	anal-fin-formation	15.7	22 days
46	pelvic-fin-formation	17.0	25 days
47	squamation	20.0	34-55 days
48	juvenile	34.0	60-90 days

3 RESULTS

3.1 Entrainment Experiment Results

The volume of water pumped out of each ballast tank was determined using the dimensions of the tanks provided by ARTCO. The depth of water in the ballast tanks varied from 41 to 59 inches with a mean depth of 49 inches. Due to the presence of large amounts of rust collected in the net cod end during ballast tank pump out, pumping was halted when an estimated average of 4.5 inches of water remained in each tank. The average volume pumped from the tanks during the two trials was calculated to be 9,092 gallons with a minimum of 8,183 gallons and a maximum of 10,203 gallons (Table 6). The water depths used to estimate the volume of water pumped from each tank are provided on field data sheets in Appendix B1. A scan of all other field and laboratory datasheets are presented in Appendices B2 through B9.

The number and type of larvae found in the material pumped out of the ballast tanks during the entrainment studies are also presented in Table 6. In all instances the pump-out material included a large amount of rust particles (Figure 6). All larvae, regardless of species, were found dead when they were removed from the pump-out material from the tanks. It could not be determined if the larvae died in the tanks, were killed by passing through the pump and hose, or were killed by being hit or smothered by rust while in the cod end. Only three Asian carp larvae, one each of stage 41, 44, or 45, were found during these collections. It is not certain if these Asian carp larvae were entrained into the ballast tanks during flooding or if they escaped from a damaged cage from the survival study. The majority of the fish collected during the entrainment study were non-Asian carp, mainly gizzard shad. Gizzard shad were found in relatively high abundance during some of the river tows in the days leading up to the initial flooding for Trial 1. A few damaged



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larvae that could not be visually identified were also collected. The laboratory datasheets for the entrainment experiment are presented in Appendices B3 and B6.

Table 6. Number of fish larvae collected after pump-out of ballast tanks following different exposure periods during Trials 1 and 2. Note that all larvae were dead. A blank cell means no larvae in that category were found.

Tank #	Fill #	Hours Exposed	Asian Carp Larvae by Stage			Non-Asian Carp Larvae	Damaged Larvae	Volume Pumped from Tank (gallon)
			41	44	45			
Trial 1								
1	1	8				2		9,305
2	1	24				1		9,642
3	1	48				13		8,519
4	1	72	1			3	14	8,183
4	2	72				1		8,968
3	2	94				1		8,856
2	2	117						9,249
1	2	132			1			8,968
Trial 1 Total			1	0	1	21	14	71,690
Trial 2								
1	1	144				1		9,866
2	1	24				1	1	10,203
3	1	48				5		8,968
4	1	72		1		2	1	9,080
4	2	70.5				2		8,968
3	2	96						8,968
2	2	115						8,632
1	2	Tank 1 only filled one time during this trial						
Trial 2 Total			0	1	0	11	2	64,685



Figure 6. Example of material (mainly rust) pumped out of ballast tank during Trial 1.



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During Trial 2, ichthyoplankton samples were collected in the river alongside the tug and barge while the ballast tanks were being filled. Two to three samples were collected each day during each of the four filling events (at 0, 24, 48, 72 hours). The volume of water filtered through the plankton net varied from 6,399 to 16,970 gallons with a per sample average of 8,366 gallons. (Scanned field datasheets are in Appendix B9). The density of larval fish collected during these alongside collections was calculated at 33 to 48 individuals per 9,000 gallons (the approximate average volume of water pumped from each ballast tank). No Asian carp larvae were found in any of these river samples. The larval fish concentration in the river was higher than that found in the water pumped from the ballast tanks during this trial. The actual reason for the difference is unknown but could be due to a number of causes including, but not limited to, larval patchiness, avoidance activity by the advanced stage of larvae, and the difference in the capture efficiency of the open plankton net versus the suction created by the 3-inch hole in the ballast tanks.

3.2 Survival Experiment Results

Survival tests were conducted from 11-24 June 2011 using fish larvae collected from near the shoreline, generally from around submerged trees. The larvae were of the same general size as the few found in the channel.

The larvae used for the testing were a mixture of both Asian carp and non-Asian carp larvae. Initial attempts to separate the larval species with the aid of a dissecting microscope subjected the larvae to too much handling and damaged them. Therefore, both Asian carp and non-Asian carp were placed into the test cages to minimize handling of the collected larvae. A higher proportion of Asian carp larvae made up the larval mixture collected during Trial 2 than Trial 1 due to the decrease in the abundance of non-Asian carp larvae in shoreline collection areas.

The target initial count was 30 larvae per test cage. As indicated in Section 2.3, some of the mesh on several cages became loose during the testing due to failure of the adhesive. This potentially allowed some larvae to escape, causing a reduction in the total number of larvae remaining in a cage at the conclusion of the test interval for that cage.

Control cages were placed in two areas in the river near the barge. During the first two days in Trial 1, the control cages were lowered into the river alongside the tug, but the fast river flow and large amount of floating debris in this location caused extensive damage to the mesh of the cages, allowing larvae to escape. Therefore, the location of the control cages was changed to a more “protected” area for the remainder of the survival experiment. All control cages for most of Trial 1 and all of Trial 2 were located in the same protected area where the river current was substantially reduced and there was less large floating debris such as logs and branches. (See Figure 4.)

The control cages in both locations experienced higher sediment loads than cages in the tanks, thus the control larvae were not subjected to the same water conditions as those in cages placed in the ballast tanks. Once the water entered the ballast tanks, there was little water movement and the suspended sediment tended to settle to the bottom of the barge with only a small amount of sediment going into each cage. The control cages in the river, however, had a constant supply of new sediment that could enter the cage through the mesh and then settle out due to the decreased water movement within the cage. Upon inspection, the higher sediment load in the control cages at both locations did not appear to affect larval Asian carp survival.



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The number of larvae at the conclusion of each test interval for each set of three cages in the tanks or as controls are presented in Table 7 and Table 8. The tables also show the number of each type of larvae that were alive and dead at the end of each exposure interval. In addition, Table 7 presents the percent of Asian carp that were alive after these exposures. Larvae from all three cages in each tank were combined and are presented as the total for each exposure interval. Asian carp survival rates during the study ranged from 92 percent to 100 percent in the ballast tank cages and 89 percent to 100 percent in the control cages. The mean percent survival of Asian carp larvae during all test intervals was 97.0 percent in the test cages and 97.6 percent in the control cages. Scanned laboratory datasheets for the survival experiments are presented in Appendices B4, B5, B7, and B8.

During Trial 1, longer exposure intervals did not significantly decrease survival. The lowest survival was after a 48-hour exposure period. Prior to pumping the water out of and then refilling each of the ballast tanks during Trial 2, the test cages were removed from the tanks and a visual assessment was made of the status of the larvae in each cage. Larval survival was always high, therefore the larvae were not removed from the cages. The cages were kept on the deck in the shade during pump out and flooding and were replaced into the ballast tanks once the tank was refilled. This allowed all caged larvae to be submerged in the tanks for about 144 hours. The average survival of Asian carp larvae was slightly lower during Trial 2 (95.7 percent) than during Trial 1 (98.3 percent) which might have been due to the longer exposure interval.

No statistical difference was found between survival of Asian carp larvae in the test versus control cages during Trial 1 ($P=0.622$). Some larvae could not be identified to species, including one live larva that was damaged while being transferred to a storage vial at the end of the cage's test interval (Table 7) and a few dead larvae that had begun to deteriorate. The percent of Asian carp that were alive in control cages after these exposures are presented in Table 8. Larvae from all three cages in each tank for each time interval were combined and presented as the total for each exposure interval.

During Trial 2, the effect of higher densities of larvae was assessed by stocking higher numbers of larvae into two control cages exposed for 119 and 120 hours. Survival at these higher densities was still high (94-97 percent). No statistical difference was found between survival of larval Asian carp in the ballast tanks or in control cages during Trial 2 ($P=0.293$). No attempt was made to determine the density of larval Asian carp in the river locations where the test larvae were collected.



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Table 7. Ballast tank cages: number of alive and dead Asian carp, non-Asian carp, and damaged larvae after varying exposure periods in cages during Trials 1 and 2. The percent alive is based on the number of larvae in the cages at the end of the exposure period. A blank cell means no larvae in that category were found.

Tank #	Fill #	Hrs Exposed	Number in cages after exposure	Asian Carp Larvae				Non-Asian Carp Larvae		Damaged Larvae	
				Total Alive	Total Dead	Grand Total	% Alive	Total Alive	Total Dead	Total Alive	Total Dead
Trial 1											
1	1	8	97	39	2	41	95.1	52	4		
2	1	24	90	24		24	100.0	57	9		
3	1	48	85	30	2	32	93.8	40	13		
4	1	72	65	26		26	100.0	26	12		1
4	2	72	80	66		66	100.0	2	3		9
3	2	94.5	76	32		32	100.0	16	18		10
2	2	117	77	39		39	100.0	28	7	1	2
1	2	132	82	36	1	37	97.3	39	6		
Trial 1 Total			652	292	5	297	98.3	260	72	1	22
Trial 2											
1	1	144	77	72	4	76	94.7	1			
2	1	144	68	60	5	65	92.3	2	1		
3	1	144	75	66	3	69	95.7	5	1		
4	1	144	74	70	1	71	98.6	2			1
Trial 2 Total			294	268	13	281	95.4	10	2	0	1
Average for Asian carp per Trial				280	9	289	96.8				



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Table 8. Control Cages: Number of alive and dead Asian carp, non-Asian carp, and damaged larvae after varying exposure periods during Trials 1 and 2. The percent alive is based on the number of larvae in the cages at the end of the exposure period. A blank cell means no larvae in that category were found.

Hrs Exposed	Number in cages after exposure	Asian Carp Larvae				Non-Asian Carp Larvae		Damaged Larvae	
		Total Alive	Total Dead	Grand Total	% Alive	Total Alive	Total Dead	Total Alive	Total Dead
Trial 1									
8	90	21	2	23	91.3	47	20		
24	63	2		2	100.0	40	16		
48	49	16	2	18	88.9	31			
72	69	47		47	100.0	12	10		
72	81	39		39	100.0	35	7		
Total	352	125	4	129	96.9	165	53	0	0
Trial 2									
143.5	89	87	1	88	98.9	1			
143*	44	42		42	100.0	2			
120**	54	34	1	35	97.1	7	10	2	
119***	63	31	2	33	93.9	12	18		
Total	249	194	4	198	98.0	22	28	2	0
Average for Asian carp (both trials)		160	4	164	97.6				

*began with three cages but one lost an entire mesh panel and many larvae lost so data from this cage was not presented

**only one cage with 60 larvae at start

***only one cage with 90 larvae at start

Larvae from the tank and control cages were preserved and later were classified by stage in the laboratory. Table 9 and Table 10 provide a summary of the number of alive and dead caged Asian carp larvae separated by their stage. Asian carp placed in the cages in Trial 1 were generally younger (lower stage number) than those collected and used during the second trial for this study. During Trial 1, more larvae were stage 43, followed by stage 42, while during Trial 2, more larvae were stage 43 followed by stage 44. Based on Yi et al.'s (1988) description of larval stage and number of days post fertilization, the majority of the larvae placed in the cages on 11 June for the first cage filling for Trial 1 were estimated to be about 11-13 days of age.



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Table 9. Ballast tank cages: summary of number of alive and dead Asian carp larvae of each stage for three test cages deployed for different exposure intervals during Trials 1 and 2. A blank cell means no larvae in that category were found.

Tank #	Fill #	Hours Exposed	Number of Asian Carp Larvae by Stage											
			Alive						Dead					
			40	41	42	43	44	45	40	41	42	43	44	45
Trial 1														
1	1	8		1	27	11					2			
2	1	24		2	12	8	2							
3	1	48	1	3	13	13					2			
4	1	72			4	22								
4	2	72		1	5	46	14							
3	2	94.5				28	4							
2	2	117			6	33								
1	2	132		3	7	26					1			
TOTAL			1	10	74	187	20	0	0	0	5	0	0	0
Trial 2														
1	1	144			1	41	29	1				1	3	
2	1	144				41	19					5		
3	1	144				40	26				1	1	1	
4	1	144				29	41						1	
TOTAL			0	0	1	151	115	1	0	0	0	7	5	0

Table 10. Control cages: summary of number of alive and dead Asian carp larvae of each stage for three cages deployed for different exposure intervals during Trials 1 and 2. A blank cell means no larvae in that category were found.

Hours Exposed	Number of Asian Carp Larvae by Stage											
	Alive						Dead					
	40	41	42	43	44	45	40	41	42	43	44	45
Trial 1												
8		10	10	1					2			
25		1	1									
65			5	11				1	1			
72			4	38	5							
118			7	31	1							
TOTAL	0	11	27	81	6	0	0	1	3	0	0	0
Trial 2												
143.5			1	22	63	1					1	
143*				17	22	3						
120**			2	15		16				1		
119***				10	21				1	1		
TOTAL	0	0	3	65	106	20	0	0	1	2	1	0

*only two cages

**only one cage with 60 larvae at start

***only one cage with 90 larvae at start



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Although nine different taxa of non-Asian carp larvae were used in survival experiments or collected in river sampling, no attempt was made to enumerate the number of individuals of each of these taxa. A list of the non-Asian carp larvae collected during this study is presented in Table 11.

Table 11. List of non-Asian carp larvae used in the survival experiments or collected during river sampling. Note the number of each of these larvae was not determined from either type of collection.

Scientific Name	Common Name
<i>Aplodinotus grunniens</i>	freshwater drum
<i>Carassius auratus</i> *	goldfish
Catostomidae	sucker
Cyprinidae	minnows and carps
<i>Cyprinus carpio</i>	common carp
<i>Dorosoma cepedianum</i>	gizzard shad
<i>Ictiobus</i> spp.	buffalo
<i>Morone</i> spp.	basses
<i>Notropis hudsonius</i>	spottail shiner

*Larvae might be a hybrid with the common carp.

3.3 Pump Effects Experiment Results

A summary of the results from the four sets of trials conducted with two different diameter pumps and hoses is presented in Table 12. Only a few larvae (9 Asian carp plus 3 non-Asian carp) were able to survive passage through either the 2- or 3-inch pump and hose. There was no significant difference between Asian carp survival after passage through the 2-inch or the 3-inch pump. Larvae collected for the pump experiments were darkly pigmented before passing through the pump but virtually colorless when removed from the plankton net (See Figure 5). The larvae that were actively swimming immediately after going through the pump generally survived and continued actively swimming 30 minutes after pumping. This included both Asian carp and non-Asian carp (Table 12). In contrast, those larvae that were swimming erratically after passing through the pump were not alive 30 minutes after pumping. These results indicate that although some Asian carp larvae were able to survive ballast tank pumping, the total number of larvae that survived the pumping was extremely low.

No count was made of the number of larvae that passed through the hose and pump for each of the pump tests. However, an analysis of a photo of the larvae removed from the cod end estimated approximately 130 individual larva had been collected. For the twelve trials, only 9 Asian carp survived out of an estimated 1,560 (130 times 12) larvae sucked through the pump system for an estimated survival rate of 0.56 percent.

We also found an approximately 3-inch long, relatively intact juvenile fish that had passed through the 3-inch pump and hose during one of the entrainment studies. It had been cut into two main pieces plus a somewhat mangled center portion probably from contact with the pump impeller (Figure 5).

During observations of normal operations for pumping water from ballast tanks on a barge in use on the river, it was noted that the discharge water is not generally pumped through a hose back to the river. Instead water exits the pump's discharge port with some of it potentially hitting the metal deck of the barge before free-falling directly into the river. For the present testing, the discharge water was pumped through a hose and discharged below water level into the collection net suspended in one of the barge spud wells. It is uncertain what additional mortality, if any, might have taken place if the water had not been directed through the hose but had free-fallen 3-10 feet from the pump into the river surface. Likewise it is not possible to determine the effects of impact with hose walls on the larvae.



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Table 12. Summary of observations of larvae following passage through a 2-inch or 3-inch pump and hose. Observation were made immediately and 30 minutes after pumping. Test dates are in parentheses. Stage number refers to larval stage based on Chapman (2006).

Pump Test	Description of Larvae
Trial 1	
2-inch pump (6/13/11)	
Run #1	All larvae were dead when initially removed from the plankton net cod end.
Run #2	All larvae were dead when initially removed from the plankton net cod end.
Run #3	Initially, two non-Asian carp were alive and actively swimming; all other larvae were dead. These two non-Asian carp larvae were still actively swimming after 30 minutes.
Run #4	Initially, two Asian carp (stage 43) were alive and actively swimming and one Asian carp (stage 43) was alive but swimming erratically; remaining larvae were dead. After 30 minutes, the actively swimming larvae were still actively swimming but the erratically swimming larva was no longer swimming and appeared dead.
3-inch pump (6/14/11)	
Run #1	All larvae were dead when initially removed from the plankton net cod end.
Run #2	Initially, one Asian carp (stage 43) was alive and actively swimming; all other larvae were dead. After 30 minutes, the actively swimming Asian carp larvae was still actively swimming.
Run #3	Initially, two Asian carp (stage 43) were alive and actively swimming and two Asian carp (stage 43) were alive but swimming erratically; all other larvae were dead. After 30 minutes, the actively swimming larvae were still actively swimming but the erratically swimming larvae were no longer swimming and appeared dead.
Trial 2	
2-inch pump (6/19/11)	
Run #1	All larvae were dead when initially removed from the plankton net cod end.
Run #2	All larvae were dead when initially removed from the plankton net cod end.
Run #3	All larvae were dead when initially removed from the plankton net cod end.
3-inch pump (6/20/11)	
Runs #1, 2, and 3 (combined*)	Initially, four Asian carp (stage 44) and one non-Asian carp were alive and actively swimming; all other larvae were dead. After 30 minutes, the actively swimming larvae were still actively swimming.

*larvae from these pump tests were accidentally combined into a single vial in the field.

3.4 Water Quality Results

Although some water quality data were collected during night hours, most water quality data were collected during daytime sampling events following the ballast tank filling and prior to the tank pump-out. Water temperature in the Illinois River averaged 23.5 °C, with a high of 25.6 °C and a low of 22.0 °C (Table 13). Water temperatures in the ballast tanks of the experimental barge were similar to river conditions and averaged 23.4 °C, with a high of 26.8 °C and a low of 22.3 °C.

DO concentrations in the Illinois River averaged 5.30 mg/L, with a high of 5.51 mg/L and a low of 4.90 mg/L (Table 13; Figure 7). In contrast, ballast tank DO concentrations were much lower and more variable, averaging 2.9 mg/L. The highest DO concentration in the ballast tanks during Trials 1 and 2 was 5.51 mg/L, while the lowest DO concentration was 0.86 mg/L. Note that the single very high DO reading (6.55) in the ballast tank (Table 13) was likely an equipment or recorder error and was not included in Figure 7. In all tanks, DO decreased from concentrations near river values to as low as 0.86 mg/L over the 7 days trial periods.



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Table 13. Summary of water quality measurement recorded during Trials 1 and 2, June 2011.

Trial	Tank	Date	Time (24-Hr Clock)	Water Temperature (deg C)	DO (mg/L)	Conductivity (µS/cm)	pH	Total Ammonia
1	T1	6/11/11	9:55	25.2	6.55*	628	nc	0.25
1	T2	6/11/11	9:58	24.9	4.53	550	nc	0.25
1	T3	6/11/11	10:01	25.1	4.01	644	nc	0.25
1	T4	6/11/11	10:03	25.0	4.62	614	nc	0.25
1	R	6/11/11	10:10	25.0	4.99	650	nc	0.25
1	T1	6/11/11	17:25	26.8	4.30	637	nc	0.25
1	R	6/11/11	17:25	25.6	5.20	662	nc	0.25
1	T2	6/12/11	9:30	24.2	3.42	576	nc	0.50
1	R	6/12/11	9:30	24.4	5.23	666	nc	0.25
1	T3	6/13/11	9:30	24.1	1.87	612	nc	0.50
1	R	6/13/11	9:30	23.7	4.90	666	nc	0.25
1	T4	6/14/11	9:30	23.1	2.39	589	nc	0.50
1	R	6/14/11	9:30	23.1	5.07	644	nc	0.50
1	T1	6/15/11	9:00	22.4	2.74	610	nc	0.25
1	T2	6/15/11	9:03	22.3	2.50	606	nc	0.25
1	T3	6/15/11	9:06	22.3	2.55	628	nc	0.25
1	T4	6/15/11	9:08	22.5	2.80	613	nc	0.25
1	R	6/15/11	8:50	22.0	5.50	595	nc	0.25
1	T1	6/17/11	9:20	23.6	1.62	615	nc	0.25
1	T2	6/17/11	9:07	22.5	1.68	604	nc	0.25
1	T3	6/17/11	10:48	23.4	0.95	637	nc	0.25
1	T4	6/17/11	11:40	24.1	1.54	609	nc	0.25
1	R	6/17/11	9:05	22.5	5.42	534	nc	0.25
2	T1	6/18/11	10:28	22.8	5.51	546	nc	0.50
2	T2	6/18/11	10:30	22.8	4.70	549	nc	0.50
2	T3	6/18/11	10:32	22.7	4.87	552	nc	0.50
2	T4	6/18/11	10:35	22.7	5.31	546	nc	0.25
2	R	6/18/11	10:25	22.7	5.42	537	nc	0.50
2	T2	6/19/11	10:30	23.2	2.36	nc	7.0	0.50
2	R	6/19/11	10:15	23.0	5.27	nc	7.2	0.50
2	T3	6/20/11	10:45	23.0	3.09	540	nc	0.25
2	R	6/20/11	10:15	23.5	5.51	565	nc	0.25
2	T4	6/21/11	10:45	24.3	1.14	nc	7.6	0.25
2	R	6/21/11	10:30	24.3	5.39	nc	7.6	0.25
2	T1	6/24/11	11:45	22.6	1.14	nc	7.6	0.25
2	T2	6/24/11	9:45	22.2	1.23	nc	7.6	0.25
2	T3	6/24/11	9:55	22.4	0.86	nc	7.6	0.25
2	T4	6/24/11	11:25	22.6	1.15	nc	7.6	0.25
2	R	6/24/11	9:35	22.4	5.27	nc	7.6	0.50

T1, T2, T3, and T4 correspond to ballast tank numbers 1-4, respectively

R = River

mg/L = milligrams per liter

nc = not collected

C = Centigrade

µS/cm = MicroSiemens per centimeter

*possible equipment error; data not included in Figure 7



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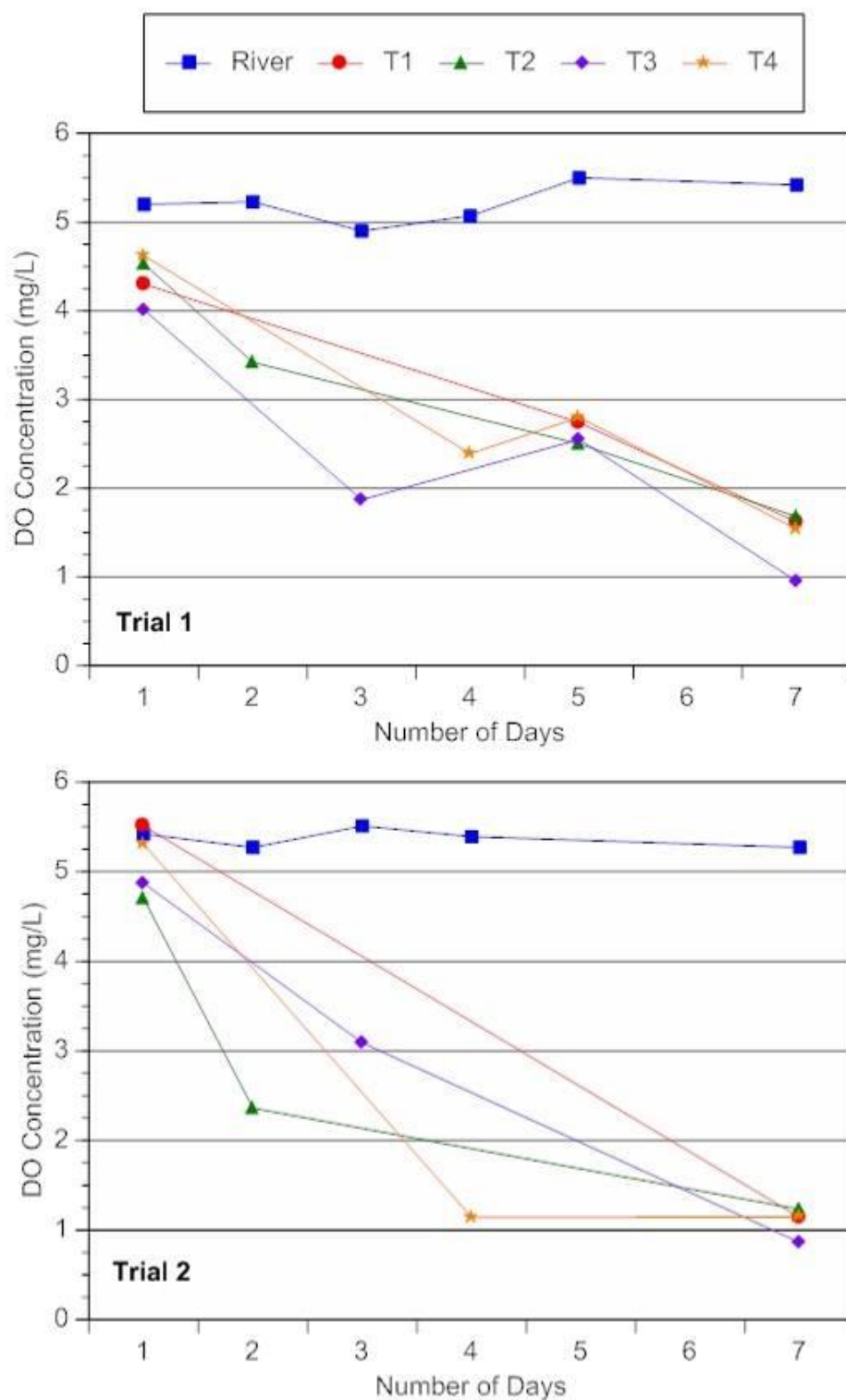


Figure 7. DO concentration in Illinois River and barge ballast tanks during Trial 1 (top) and Trial 2 (bottom). Note: T# refers to the ballast tank number.



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Specific conductance (conductivity) is a measure of the ability of water to conduct an electrical current. It is highly dependent on the amount of dissolved solids (such as salt) in the water (U.S. Geological Survey (USGS) website, accessed September 2011). Specific conductance is an important water quality measurement because it provides an idea of the amount of dissolved material in the water. Conductivity in the Illinois River averaged 613 $\mu\text{S}/\text{cm}$, with a high of 666 $\mu\text{S}/\text{cm}$ and a low of 534 $\mu\text{S}/\text{cm}$ (Table 13). Conductivity in the ballast tanks during Trials 1 and 2 were similar to river conditions and averaged 595 $\mu\text{S}/\text{cm}$, with a high of 644 $\mu\text{S}/\text{cm}$ and a low of 540 $\mu\text{S}/\text{cm}$.

Due to equipment problems, pH was only measured during Trial 2. pH values in the Illinois River averaged 7.5, with a high of 7.6 and low of 7.2 (Table 13). pH values in the ballast tanks closely tracked natural conditions in the Illinois river, with an average of 7.5, high of 7.6, and low of 7.0.

TAN values in the Illinois River and barge ballast tanks were steady, ranging between 0.25 and 0.50 mg/L. No differences in ammonia concentration were observed between river and ballast tanks samples.

4 DISCUSSION/CONCLUSIONS

This study was conducted to determine if Asian carp eggs and larvae could 1) be entrained into barge ballast tanks, 2) survive while in these tanks, and 3) survive a single passage through a pump. The Study Plan (Test Plan in Appendix A) proposed experiments be conducted first in the river channel using Asian carp eggs and young larvae by keeping the barge positioned within the highest concentrations of these individuals during flooding of the tanks while the larvae and possibly new eggs move down the river with the water current. After completing work in the river channel, the plan called for testing with older larvae from the same cohort while the experimental barge was positioned in quieter, slower moving waters. Because initial plankton tows in the river channel showed that no eggs and low larval concentration were available, testing with the eggs and younger larvae in the study could not take place as planned. This was due primarily to a major Asian carp spawn occurring prior to the initiation of these studies and apparently no subsequent spawning taking place in the area. Therefore, no Asian carp eggs or larvae younger than about 11-13 days were available during these tests. By this stage, the larvae had moved out of the main channel towards quieter water.

Spawning of Asian carp is known to take place after the river water temperature reaches 14-18 °C along with an increasing river flow (Papoulias et al., 2006; Jennings, 1988; DeGrandchamp et al., 2007; Lohmeyer & Garvey, 2009; and Irons et al., 2011). Asian carp have also been reported to spawn from as early as March until July (Papoulias et al., 2006) when river temperatures and flow increase, typically from spring and early summer rains. Figure 8 presents the river gage height of the Illinois River at Kingston Mines (about 7.4 miles downriver from Pekin) and Copperas Creek (approximately 16 river miles south of Pekin) from early May through late August 2011. It also shows the 5-year average gage height for these locations between 2005 and 2010. Based on the stage and assumed age (based on Yi et al., 1988) of the Asian carp collected during this study, it was estimated that these larvae were spawned during the period of increasing river (gage) height from May 25 until about June 3.



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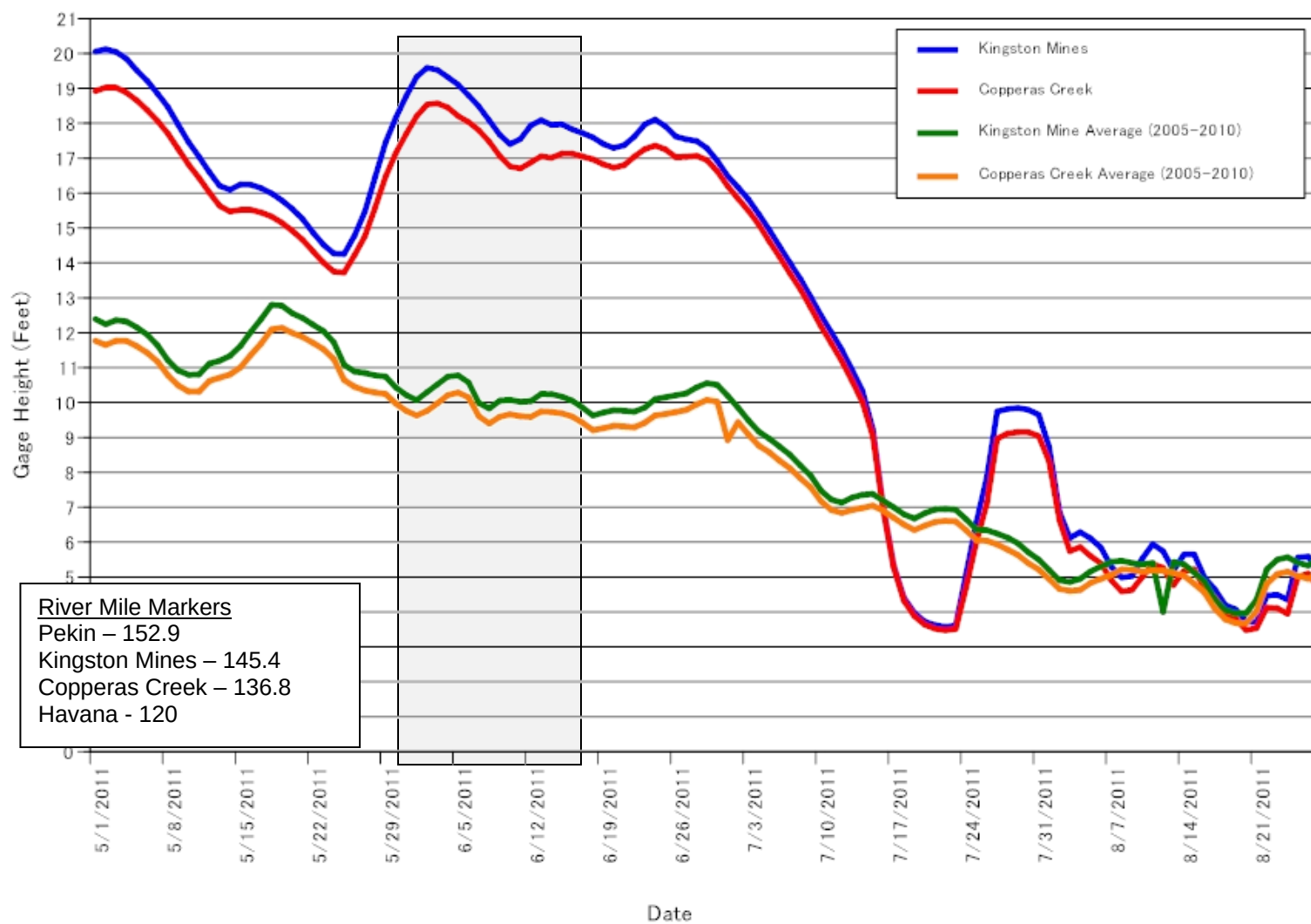


Figure 8. Illinois River Gage Height at Kingston Mines and Copperas Creek. The shaded area represents the time period that this study was conducted. The average river gage height from 2005-2010 for each location is also provided. Data provided by U.S. Geological Survey, WRD, Urbana, IL.



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Papoulias et al. (2006) also stated that Asian carp might be able to spawn more than one time per season. This did not appear to happen in the La Grange Reach during the time period of this study as no eggs or younger larvae were found during any of the collections. Alison Coulter (pers. comm., September 2011; Coulter & Goforth, 2011) stated that during 2011 they found Asian carp eggs in the Wabash River from May through the end of July even though the river flow continued to decrease during this period. They confirmed their visual field egg identifications with DNA analysis. As Figure 8 shows, the Illinois River was in flood-like conditions during the time of this study, with gage heights nearly 6-8 feet over the 5-year (2005-2010) average.

During the entrainment portion of these studies, it was determined that larvae of a variety of taxa could be entrained into the ballast tanks through the experimental valves that were installed in the tanks. The 3-inch valve penetrations were intended to simulate a break in a tank seam or a hole in the barge hull. Discussions with barge operators and Coast Guard personnel indicated that the 3-inch opening was considerably larger than most cracks occurring during normal barge operations. A hole as large as 3 inches would fill a tank to about 50 inches in approximately 90 minutes and would probably be noticed by the crew. However, if the penetrations do represent naturally occurring breaks in barge walls, then fish larvae could be entrained into ballast tanks. There is some potential that eggs or larvae could be inadvertently moved across the barrier during normal barge operations. It is possible that if a hole existed in a barge that Asian carp eggs and larvae could be entrained into the tank or void space if they were present in the water column. If material were then loaded onto the barge, the barge would then sink lower in the river allowing more water and possibly other Asian carp early life stages to enter the tank. If that barge then crossed the electrical barrier going upriver and offloaded its material, the barge would float higher in the river and some of the internally held water and entrained Asian carp early life stages, if present and not killed by the operation of the barrier, could go back into the river without having passed through a pump.

The pump effects experiments showed that if Asian carp larvae were entrained and then pumped out, only a very small percentage of them (0.56 percent) could survive being pumped through either a 2-inch or 3-inch pump. If tanks were actively ballasted (i.e., pumped) and then deballasted, it is highly unlikely that larvae could survive two passages through a pump. During the pump effects testing, a hose was used to pump ballast water from the tanks directly into a suspended plankton net. This is different from normal barge operations when no hose is used on the pump's discharge. These studies could not determine whether Asian carp larvae that survived passage through a pump would then survive free fall into the river if a discharge hose were not used.

Kolar et al. (2007) and King et al. (2010) stated that bighead and silver carp have hybridized in the wild and produced fertile offspring. Blake Ruebush (pers. comm., June 2011, Illinois River Biological Station, Havana, IL) stated that many hybrids of bighead and silver carp have been collected during the Long Term Resources Monitoring Program (LTRMP) in the La Grange Reach of the Illinois River. All individuals referred to in this report as larval Asian carp visually appeared to be silver carp based on figures presented in Yi et al. (1988) and Chapman & George (2011), but some might have been hybrids that showed the same pigmentation patterns characteristic of silver carp.

The original survival study plan (See Appendix A) called for fish in early developmental stages to be suspended in cages in the ballast tanks to document whether larval Asian carp could survive for a maximum of 108 hours in a ballast tank. Based on high (98%) larval survival in Trial 1 (up to 132 hours exposure), all Trial 2 exposure intervals were increased to 144 hours for all tanks. Asian carp larvae in



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Trial 2 also had a high (95.7%) survival rate suggesting that entrained larvae could survive in tanks for at least 6 days. The average Asian carp (stages 40-45) survival in the control cages during both trials was also high (97.7%).

Water quality parameters measured during the trials showed that Asian carp larvae were able to withstand a wide range of the measured water quality parameters, including temperature and DO. The most variable water quality parameter was DO, which decreased to a level of 0.86 mg/L inside one of the ballast tanks but was not low enough to substantially affect survival. It has been reported that grass, bighead, and silver carp can tolerate oxygen levels as low as 0.5 mg/l (Oregon Sea Grant website, accessed August 2011). In addition, Jennings (1988) reported that juvenile bighead carp (average weight = 73 mg) survived DO concentrations of 0.33 mg/L, while smaller individuals (average weight = 23 mg) survived DO concentrations of about 0.40 mg/L. Although the current study used younger individuals, it appears that Asian carp larvae collected in the Illinois River are also able to tolerate low DO levels.

In summary, this study showed that Asian carp larvae could potentially be entrained into ballast tanks through hull cracks and can survive the conditions in these tanks for up to 144 hours. But, if these larvae are then pumped out of the tanks using standard commercial methods, their survival rate is extremely low (less than 1 percent). Survival following intentional ballasting and deballasting (i.e., two passages through a pump) is even less likely.

5 RECOMMENDATIONS FOR FURTHER STUDIES

The results from the current study can serve to guide future research efforts. 1) Dissolved oxygen concentrations in entrained water decreased over time in the ballast tanks to levels slightly below 1.0 mg/L in a 4-7 day period yet Asian carp larvae survived well under these conditions. 2) Larval entrainment into ballast tanks is possible though somewhat unlikely for the larval size available during this study since they are generally near the shoreline rather than in the channel where barges operate. 3) From the current study, only a very small percentage of Asian carp larvae (Stage 40-45) could survive a single passage through either a 2-inch or 3-inch diameter pump normally used to fill or empty barge ballast tanks. Chances of larval survival through two passages (fill and empty) are highly unlikely. The following are suggestions for further research.

Although laboratory studies could be conducted to determine water quality tolerances (particularly DO) over time for early developmental stages of Asian carp, field studies should be conducted to validate lab results. One way to field test survival of eggs and larvae at the low DO levels of this study would be to flood some of the ballast tanks on an experimental barge at least a few days prior to the expected spawning to allow the DO levels to decrease prior to the introduction of early life stages captured at spawning. Again, this would require foreknowledge of anticipated spawning time and location. Another option to field test survival of Asian carp eggs and younger larvae in ballast tanks would be to flood the tanks in an experimental barge positioned or operated near the USGS Columbia Environmental Research Center in Missouri and to introduce eggs and larvae generated from laboratory spawning of adult silver and bighead carp. These known age eggs and larvae could quickly be placed in cages and suspended in test barge tanks that had varying DO levels. It is possible that a barge company would be able to keep two or more tanks flooded for a few weeks and allow access for placement of cages into the tanks. If the barge did not cross state lines and stayed in an area of the river that was already known to have Asian carp, then the problems of transporting them should be less of an issue.



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The absence of eggs and early stage larvae (younger than Stage 40-41) from the channel of the Illinois River in the La Grange Reach during this study made it impossible to determine whether these very early life stages could be entrained into and/or survive in a barge tank. To test eggs and larvae younger than stage 40, a test barge would need to be positioned in the river and individuals would need to be collected when spawning takes place. This is due to the short duration from egg fertilization to hatching, which can be a little over 1 day. In addition, larval growth to stage 40 might take place within about 200 hours after fertilization (Yi et al., 1988; Chapman & George, 2011). This would require foreknowledge of spawning time and location based on river water temperature and rainfall predictions. Entrainment could be studied separately from survival by allowing tanks to fill and then pumping them through a net on a daily basis during anticipated spawning events at probable spawning locations.

Since only a small percentage (less than 1 percent) of larvae survived a single pass through either pump, it is unlikely that a larva could survive two passages. This could be readily tested by using the methods of the pump experiments of this study and collecting the pumped water and larvae in a portable tank after the first pass. The larvae and tank water could be pumped once more and collected in a submerged plankton net. Active swimming for more than 30 minutes would indicate survival potential.

Finally, it is not known whether Asian carp eggs and larvae in tow boat or barge ballast tanks would survive the electric field generated by the electric barrier in the CSSC. As a first step, the characteristics and strength of the electric field should be measured in a partially flooded ballast tank of a working barge and towboat crossing the barrier. This information could then be used to design laboratory studies using live Asian carp larvae and eggs. Laboratory studies could then be conducted to determine survival of larval Asian carp exposed to appropriately varying electric fields. Field studies would also be needed to validate the laboratory results. One way to field-test this would be to place live eggs and/or larvae into test cages or completely sealed holding chambers and suspend them in flooded ballast tanks just as the towboat and/or barge enters the upstream side of the barrier complex. Once the barge exits the downstream portion of the barrier, the cages could be removed and the number of alive and dead eggs and larvae could be determined. Caged eggs and larvae could then be properly disposed of. With the barge and water current moving downstream, the risk of introducing larvae and having them stay above the barrier would be near zero.



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APPENDIX A FINALIZED TEST PLAN

The study plan presented here was developed for use during entrainment and survival experiments to be conducted with Asian carp on the Illinois River in June 2011. As noted in the report, high river stage and lack of Asian carp eggs resulted in modifications to the study plan.





Acquisition Directorate Research & Development Center

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ENVIRONMENTAL CONSULTANTS



TENERA



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Draft Test Plan

Entrainment and Survival of Asian Carp in Barge Ballast Tanks Asian Carp Transport by Tow Boats and Barges

Distribution Statement A: Approved for public release; distribution is unlimited.

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LIST OF ACRONYMS

ARTCO/ADM	American River Transportation Company/Archer Daniels Midland Co.
COTR	Contracting Officer's Technical Representative
CSSC	Chicago Sanitary and Ship Canal
RDC	Research & Development Center
SAIC	Science Applications International Corporation
UMRS	Upper Mississippi River System
USACE	U.S. Army Corps of Engineers
USCG	United States Coast Guard
YSI	Yellow Springs Instrument



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1 INTRODUCTION

The objective of this project is to determine the potential for early life stages of Asian carp to become entrained into and survive in ballast tanks of barges. This project will also test whether barges and towboats can potentially provide a transport mechanism for Asian carp to bypass the U.S. Army Corps of Engineers (USACE) electric dispersal barrier in the Chicago Sanitary and Ship Canal (CSSC). This study will conduct a series of tests to determine if carp eggs, larvae, or small fry can become entrained, transported, and survive in vessel ballast water and bypass the fish barrier.

Science Applications International Corporation (SAIC) has assembled a team of experts to perform this study. The Team includes the following subcontractors: ECORP Consulting, Tenera Environmental, and the University of Illinois (Illinois River Biological Station). Each of these subcontractors has specific expertise for aquatic resources, ichthyoplankton, and/or Asian Carp ecology. See Appendix A for a list of the study participants.

2 BACKGROUND

Bighead and silver carp (collectively, Asian carp) were intentionally introduced to Arkansas in the early 1970's. Shortly thereafter, they escaped aquacultural confinement and are now distributed throughout waters of the Upper Mississippi River System (UMRS). Asian carp were introduced to improve water quality of aquaculture ponds. These species invaded rivers through pond escapement or by deliberate introductions and were first documented in the UMRS in 1982. Asian carp are voracious planktivores and reproduce rapidly. They may grow up to 4 feet in length and weigh up to 100 pounds. Asian carp are now some of the most abundant fish species in some areas of the Mississippi River. Some scientists suggest that Asian carp could become a dominant species in the Great Lakes.

USACE constructed a permanent electrical barrier to protect Lake Michigan and the Great Lakes from Asian carp that are moving up the Illinois River. The CSSC Dispersal Barrier stretches two arrays of electrodes across the canal (approximately 220 feet apart). The electrodes pulse direct current into the water; this causes fish to turn back rather than pass through the electric current. In June 2010, the Illinois Department of Natural Resources captured one 20-pound live Asian carp in Lake Calumet, which sits near the Illinois-Indiana border and is connected to Lake Michigan's canal system. This fish represented the first physical specimen that has been found above the electric barrier system. No information exists on potential transport mechanisms for other stages of Asian carp, including eggs and larvae.

Reproductive needs of adult bighead and silver carp are similar and have been well documented (DeGrandchamp, et al., 2007 (Reference 1)). Generally, these species require water temperatures of at least 17.8 °C, with an optimum range of 21-26.8 °C. River flow is also important for successful spawning; with water velocities of 0.7 m/s (2.3 fps) or higher needed for productive spawning. The length of unimpeded river required for successful spawning by silver carp may be 100 km or more (Gorbach and Krykhtin 1980 (Reference 2)).



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Yi, et. al. (1988, as translated by Duane Chapman 2006 (Reference 3)) have documented the egg and larval stages of grass, black, silver and bighead carps in the Yangtze River. This early paper also reported the development times, but water temperature were not tightly controlled, so it is not certain if the development times they reported are similar to what would be observed in the Illinois River. Chapman (personal communications) stated that they are currently working on growth and development rates at controlled temperatures to better understand the early egg and larval stages of silver and bighead carp. In the Yangtze River, after the eggs are released and fertilized, they undergo development to the larval stage in between about 33-35 hours and then continue larval development. Chapman (personal communications) stated that after about 100-200 hours, the larvae move out of the current and move into generally shallower areas and are then generally found oriented to natural or man-made substrates.

3 TECHNICAL APPROACH

We propose to conduct all experiments in the La Grange Reach of the Illinois River, between La Grange Lock & Dam located south of Beardstown, Illinois, upstream to Peoria Lock & Dam located near Peoria, Illinois (Figure 1). Asian carp spawning has been often observed in this reach over the past 10 years. This stretch of the river likely contains the greatest ambient densities of wild Asian carp in the world (Sass, et al., 2010, Biological Invasions (Reference 4)). Details concerning each experiment are presented below. Appendix B provides data sheets that will be used during these experiments. We will conduct the following testing first in the river current in an area that has been verified to have Asian carp eggs and larvae based on plankton tows. Soon after the first test has been completed, we will conduct a second test period downriver from the start of the first test in an area hopefully containing eggs and larval individuals. If only one spawning event takes place, it is possible that only larger larval stages will be available for this second test based on information from Chapman. It is also possible that these larger larvae might be difficult to catch with the plankton net due to their behavioral change at about 100-200 hours of life. If they cannot be successfully captured using the plankton nets, but can be caught in and around natural and man-made structures using dip nets, then we will use this technique to collect larvae for the second survival experiments that is scheduled to take place in quieter waters. If spawning continues after the first and second tests, an optional third test could be implemented.

3.1 Technical Approach to Evaluate Leakage Effects via Entrainment Experiments (Task 3.4)

For all tests during this study, American River Transportation Company/Archer Daniels Midland Co. (ARTCO/ADM) under contract to the U.S. Coast Guard (USCG) will furnish a barge modified to simulate leakage into ballast tanks. The SAIC Team will coordinate with the barge operator (ARTCO/ADM) and the Contracting Officer's Technical Representative (COTR)/Workgroup to schedule experiments aboard the barge according to the finalized experimental sampling design. Prior to commencing the entrainment experiments, the Team will verify that the barge is located within an area with early life stages of Asian carp by conducting plankton tows in the potential study area. ARTCO/ADM will then position the barge in this area where Asian carp larvae have been located and we will preserve a representative sample of the collected eggs and larvae from that area.



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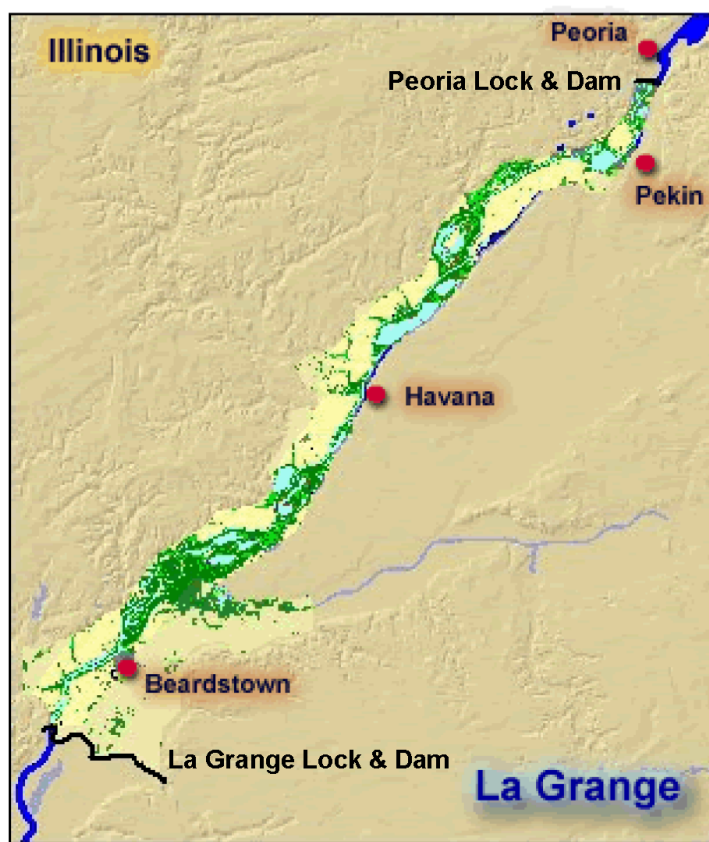


Figure 1. Location of the experiments.

We will conduct plankton tows from a University of Illinois, Illinois River Biological Station research vessel using a 500-micron mesh net deployed at surface water depths. At the conclusion of each tow, we will lift the net from the water and carefully rinse the contents into the cod end (collecting bucket) at the bottom of the net. We will check the collected material for the presence of Asian carp eggs and larvae using a dissecting microscope. When Asian carp eggs and larvae are found, we will mark the location for positioning the test barge. We will preserve a representative sample of the eggs and larvae collected at this location.

The Team will work with ARTCO/ADM to flood four experimental tanks to the depth of approximately 3 feet in the area where Asian carp eggs and larvae were located. At approximately the times defined in the finalized test plan (Table 1), the Team will sequentially pump out the appropriate tank using a 3" water pump. We will adjust this schedule in the field based on the timing of the initial flooding of the tanks. We will filter this pump-out water through a plankton net suspended in the river to help minimize the impact of the eggs and larvae striking the net mesh. We will position the top of the net above the water surface so that water and its contents will be filtered through the net. The Team will immediately analyze each resulting sample following the pump-out to determine the number, life stage, and initial viability of Asian carp eggs



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and larvae. We will preserve all viable eggs and larvae in a labeled vial; we will preserve all dead eggs and larvae in a separate labeled vial. We will send all preserved samples to the laboratory at the conclusion of the field testing. The laboratory will record the number of individuals in each life stage number based on the stage numbering system presented by Yi, et al. (1988) (Reference 3).

Table 1. Expected fill and empty times in hours.

Tank #	Fill	Empty	Refill	Empty
1	0	8	12	120
2	0	24	28	132
3	0	48	52	144
4	0	72	76	156

We will record all field-collected data on data sheets (see Appendix B) and enter the data into an electronic database (Microsoft® Office Access®) for data analyses.

The barge will drift down the river and try to maintain its proximity to the group of larval carp from which the original plankton tows were collected. Prior to re-flooding each tank after pump-out, we will use additional plankton tows during daylight hours to verify that the barge is in the water mass containing Asian carp eggs and larvae. The Team will then empty and re-flood the appropriate tank. We will analyze the eggs and larvae contained in the pumped-out water soon after collection based on the proposed preliminary schedule in Table 2. We will adjust the times in this table in the field based on the actual time of the first flooding of the barge tanks. In addition to larval fish data, the Team will collect water quality data throughout the study in both the experimental tanks and ambient (river) locations. Water quality parameters to be recorded include water depth, water temperature, dissolved oxygen, pH, and ammonia (total and unionized). We will use a Yellow Springs Instrument (YSI) water quality probe to collect all parameters except ammonia, which will be collected using a Turner Fluorometer. We will collect data at a minimum in early morning and late afternoon for the duration of the experiment. We will record all water quality data on separate sequenced data sheets (see Appendix B).

3.2 Technical Approach to Evaluate Asian Carp Survival in Tanks (Task 3.5)

We will run Asian carp survival experiments concurrently with entrainment experiments (Section 3.1). The barge will already be located in an area confirmed by plankton tows to have Asian carp for the entrainment experiments. After the barge tanks are flooded, the Team will deploy three cages containing a known number of eggs and larvae into each flooded tanks. We will construct the cages from 5-gallon buckets with lids. We will cut openings in the sides and lids and will cover the openings with 500-micron mesh netting held in place by aquarium-grade silicone. We will collect Asian carp eggs and larvae using the same plankton net setup used for Task 3.4, but we will limit the tow length to approximately 2-5 minutes to decrease the time the eggs and larvae are in the net. We are targeting 20 eggs and 30 larvae in each cage but, if fewer individuals are available in the river tows, we will adjust this number.



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Table 2. Preliminary proposed sampling schedule for Tasks 3.4 - 3.5.

Note: Times are based on flooding and pump-out each taking 2 hours. Task 3.6 will be conducted after Day 1.

running time (hrs)	day	time	Tank 1	Tank 2	Tank 3	Tank 4	Control A cages	Control B cages
	0	0800	preliminary collection of eggs and larvae and placement into test cages to help determine handling times. Also determine initial location for barge placement					
-3	1	0500	begin egg/larval collections [A]	begin egg/larval collections [A]	begin egg/larval collections [A]	begin egg/larval collections [A]	begin egg/larval collections [A]	begin egg/larval collections [A]
0	1	0800	tank empty, filling begins	tank empty, filling begins	tank empty, filling begins	tank empty, filling begins		
2	1	1000	filling completed	filling completed	filling completed	filling completed		
8	1	1600	begin egg/larval collections [B]				cages w/ larvae suspended in river	cages w/ larvae suspended in river
10	1	1800	pump out begins (8 hr)				begin egg/larval collections [B]	
12	1	2000	pump out end, filling begins				larvae removed (8 hr) and replaced	
14	1	2200	filling completed					
24	2	0800		begin egg/larval collections [C]				begin egg/larval collections [C]
26	2	1000		pump out begins (24 hr)				larvae removed (24 hr) and replaced
28	2	1200		pump out end, filling begins				
30	2	1400		filling completed				
48	3	0800			begin egg/larval collections [D]			
50	3	1000			pump out begins (48 hr)			
52	3	1200			pump out end, filling begins			
54	3	1400			filling completed			
72	4	0800				begin egg/larval collections [E]	begin egg/larval collections [E]	
74	4	1000				pump out begins (72 hr)	larvae removed (72 hr) and replaced	
76	4	1200				pump out end, filling begins		
78	4	1400				filling completed		
98	5	1000	pump out (108 hr)					
120	6	0800						
122	6	1000					larvae removed (48 hr)	larvae removed (96 hr)
134	6	2200		pump out (104 hr)				
146	7	1000			pump out (92 hr)			
158	7	midnight				pump out (80 hr)		



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At the conclusion of each tow, we will lift the net from the water and carefully rinse the contents into the cod end. We will transfer the collected material to a holding chamber from which we will remove the Asian carp eggs and larvae and place them in a container of river water that was filtered through 500-micron mesh net. We will place these eggs and larvae in the test cages with three test cages being suspended in each barge tank water soon after they have been flooded. We will record the number of eggs and larvae placed in each numbered cage on a data sheet (Appendix B). Just prior to the tanks being pumped out, we will remove the three test cages and record the number of live and dead eggs and larvae in each cage. To determine the effects of ballasting operations and residence time on the viability and survival of Asian carp early life stages, we will analyze the eggs and larvae in each cage for number, life stage, and viability. We will remove eggs considered nonviable and any dead larvae, preserve them in labeled vials, and archive for later analysis in the laboratory. We will preserve all live eggs and larvae in a separate labeled vial. Each vial label will contain at a minimum the date, survey, tank number, fill number, and cage number to allow tracking of the results of each test. We also plan to set up two sets (three each) of control cages each containing live eggs and larvae. We will suspend the control cages in the river off the side of the barge. These controls as set up will allow a determination of viability after 8, 24, 48, 72, and 96 hours of being submerged in the river. We will check the larvae in these cages for viability on the schedule presented in Table 2.

The Team will measure the same water quality parameters as collected in the entrainment study above (Section 3.1), including water depth, water temperature, dissolved oxygen, pH, and ammonia. We will record measurements in the ballast tanks and alongside the barge at least twice daily.

3.3 Technical Approach to Evaluate Pump Effects on Asian Carp (Task 3.6)

We will carry out this task in conjunction with both the entrainment (Section 3.1) and survival (Section 3.2) experiments. With the barge in an area known to have Asian carp eggs and larvae (as verified with plankton tows) and with the assistance of ARTCO/ADM, the Team will pump a known volume of river water (at least 100 gallons) with a 3" water pump into a plankton net submerged in the river in the same manner as is conducted for Task 3.4 (Section 3.1). The Team may also use a 2" water pump to for this testing to compare pump effects with the two pump sizes available on the barge. We will analyze samples collected during this task in the field soon after collection to determine viability of the carp life stages and to assess potential effects of pumping on their viability after a single pass through the pump assembly. We will handle these samples using the same methods described above for the entrainment (Section 3.1) and survival (Section 3.2) experiments to verify number of individuals in each life stage number.

Results of all three experiments and the finalized Test Plan will be presented in the Final Report.



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3. Yi, B., Z. Liang, Z. Yu, R. Lin, and M. Hee, 1988, as translated by Duane Chapman 2006, Gezhouba Water Control Project and four famous fishes in Yangtze River, Hubei Science and Technology Press, Wuhan, China.
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APPENDIX A STUDY PARTICIPANTS

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APPENDIX B DATA SHEETS

Figure B-1 through Figure B-3 show the data sheets for the experiments.



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Coast Guard/SAIC Entrainment and Survival of Asian Carp in Ballast Tanks - FILL/EMPTY Datasheet			
Survey #: _____		Survey Start Date: _____	
Location: _____		Sheet #: _____	
(T1 - T4) (F1 - F2) Tank #: _____ Fill # for Tank: _____ <u>FILLED</u> <u>EMPTIED</u> Date: _____ Time: _____ Water Depth (ft): _____ # Hours Filled (Target): _____ (Actual): _____		(T1 - T4) (F1 - F2) Tank #: _____ Fill # for Tank: _____ <u>FILLED</u> <u>EMPTIED</u> Date: _____ Time: _____ Water Depth (ft): _____ # Hours Filled (Target): _____ (Actual): _____	
(T1 - T4) (F1 - F2) Tank #: _____ Fill # for Tank: _____ <u>FILLED</u> <u>EMPTIED</u> Date: _____ Time: _____ Water Depth (ft): _____ # Hours Filled (Target): _____ (Actual): _____		(T1 - T4) (F1 - F2) Tank #: _____ Fill # for Tank: _____ <u>FILLED</u> <u>EMPTIED</u> Date: _____ Time: _____ Water Depth (ft): _____ # Hours Filled (Target): _____ (Actual): _____	
(T1 - T4) (F1 - F2) Tank #: _____ Fill # for Tank: _____ <u>FILLED</u> <u>EMPTIED</u> Date: _____ Time: _____ Water Depth (ft): _____ # Hours Filled (Target): _____ (Actual): _____		(T1 - T4) (F1 - F2) Tank #: _____ Fill # for Tank: _____ <u>FILLED</u> <u>EMPTIED</u> Date: _____ Time: _____ Water Depth (ft): _____ # Hours Filled (Target): _____ (Actual): _____	
(T1 - T4) (F1 - F2) Tank #: _____ Fill # for Tank: _____ <u>FILLED</u> <u>EMPTIED</u> Date: _____ Time: _____ Water Depth (ft): _____ # Hours Filled (Target): _____ (Actual): _____		(T1 - T4) (F1 - F2) Tank #: _____ Fill # for Tank: _____ <u>FILLED</u> <u>EMPTIED</u> Date: _____ Time: _____ Water Depth (ft): _____ # Hours Filled (Target): _____ (Actual): _____	
NOTES		Review By / Date: _____	
		Entered By / Date: _____	

Figure B-1. Entrainment Fill/Empty Data Sheet.



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Coast Guard/SAIC Entrainment and Survival of Asian Carp in Ballast Tanks - WATER QUALITY Datasheet										Sheet #: _____				
Survey #:		Survey Start Date:				Location:								
Site	Date (m m / d d / y y)	Time	AM				PM							
			Water		DO	pH	Ammonia		Ammonia					
Depth (ft)	Temp (°C)	Depth (ft)	Temp (°C)	DO			pH	Total	Un-ionized	Depth (ft)	Temp (°C)	DO	pH	Total
T1														
T2														
T3														
T4														
R														
T1														
T2														
T3														
T4														
R														
T1														
T2														
T3														
T4														
R														
T1														
T2														
T3														
T4														
R														

NOTES

Review By / Date: _____
Entered By / Date: _____

Site: T# - Tank #; R - River

Figure B-3. Water Quality Data Sheet.



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APPENDIX B ASIAN CARP FIELD AND LABORATORY DATA SHEETS

Appendix B1: Times for Fill and Empty of each Tank during Entrainment and Survival Testing

Appendix B2: Water Quality Measurement Datasheets

Appendix B3: Trial 1. Asian carp entrainment/leakage (Task 3.4) laboratory datasheet

Appendix B4: Trial 1. Asian carp survival (Task 3.5) laboratory datasheets – in tank cages

Appendix B5: Trial 1. Asian carp survival (Task 3.5) laboratory datasheets – control cages

Appendix B6: Trial 2. Asian carp entrainment/leakage (Task 3.4) laboratory datasheets

Appendix B7: Trial 2. Asian carp survival (Task 3.5) laboratory datasheets – in tank cages

Appendix B8: Trial 2. Asian carp survival (Task 3.5) laboratory datasheets – control cages

Appendix B9: Trial 2. Plankton Tow Datasheets during Tank Filling

NOTE: The word “Survey” in the following datasheets is referred to as “Trial” in the report text. Two (2) trials were conducted for the entrainment, survival, and pump effects experiments.



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Appendix B1: Times for Fill and Empty of each Tank during Entrainment and Survival Testing

Coast Guard/SAIC Entrainment and Survival of Asian Carp in Ballast Tanks - FILL/EMPTY Datasheet

Survey #: Run #1 Survey Start Date: 11 June 2011 Sheet #: 1
Location: Peoria Dock

(T1 - T4)	(F1 - F2)	(T1 - T4)	(F1 - F2)
Tank #: <u>T1</u> Fill # for Tank: <u>F1</u> Date: <u>11 June 11</u> Time: <u>0925</u> Water Depth (ft): <u>3.64</u> → <u>51" actual</u> # Hours Filled (Target): <u>8 hrs</u> (Actual): <u>8 hr</u>	Tank #: <u>T1</u> Fill # for Tank: <u>F2</u> Date: <u>11 June 11</u> Time: <u>9:23 pm</u> Water Depth (ft): <u>48"</u> # Hours Filled (Target): <u>108</u> (Actual): <u>132</u>		
Tank #: <u>T2</u> Fill # for Tank: <u>F1</u> Date: <u>11 June 11</u> Time: <u>0925</u> Water Depth (ft): <u>3.64</u> → <u>54" actual</u> # Hours Filled (Target): <u>24 hrs</u> (Actual): <u>24</u>	Tank #: <u>T2</u> Fill # for Tank: <u>F2</u> Date: <u>6/12/11</u> Time: <u>12:00 noon</u> Water Depth (ft): <u>50.5"</u> # Hours Filled (Target): <u>104 hrs</u> (Actual): <u>117</u>		
Tank #: <u>T3</u> Fill # for Tank: <u>F1</u> Date: <u>11 June 11</u> Time: <u>0937</u> Water Depth (ft): <u>3.64</u> → <u>44"</u> # Hours Filled (Target): <u>48 hrs</u> (Actual): <u>48 hrs</u>	Tank #: <u>T3</u> Fill # for Tank: <u>F2</u> Date: <u>13 June 11</u> Time: <u>12:12</u> Water Depth (ft): <u>47"</u> # Hours Filled (Target): <u>92 hrs</u> (Actual): <u>94.5</u>		
Tank #: <u>T4</u> Fill # for Tank: <u>F1</u> Date: <u>11 June 11</u> Time: <u>0930</u> Water Depth (ft): <u>3.64</u> → <u>41" actual</u> # Hours Filled (Target): <u>72 hrs</u> (Actual): <u>72 hrs</u>	Tank #: <u>T4</u> Fill # for Tank: <u>F2</u> Date: <u>14 June 11</u> Time: <u>11:50 am</u> Water Depth (ft): <u>48" actual</u> # Hours Filled (Target): <u>80</u> (Actual): <u>72</u>		
NOTES		Review By / Date: <u>Q 6/28/11</u> Entered By / Date: <u>8/06-28-11</u>	

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Coast Guard/SAIC Entrainment and Survival of Asian Carp in Ballast Tanks - FILL/EMPTY Datasheet

Survey #: 2 run #2 Survey Start Date: 6/18/11 Sheet #: 2
 Location: Pekin

(T1 - T4)	(F1 - F2)	(T1 - T4)	(F1 - F2)
Tank #: <u>T1</u> Fill # for Tank: <u>F1</u> Filled Date: <u>6/18/11</u> Empty Date: <u>6/24/11</u> 1st cage → Time: <u>11:20</u> Time: <u>11:45</u> Water Depth (ft): <u>56</u> # Hours Filled (Target): <u>156</u> (Actual): <u>144</u>		Tank #: <u> </u> Fill # for Tank: <u> </u> Filled Date: <u> </u> Empty Date: <u> </u> Time: <u> </u> Time: <u> </u> Water Depth (ft): <u> </u> # Hours Filled (Target): <u> </u> (Actual): <u> </u>	
Tank #: <u>T2</u> Fill # for Tank: <u>F1</u> Filled Date: <u>6/18/11</u> Empty Date: <u>6/19/11</u> 1st cage → Time: <u>10:35</u> Time: <u>10:30</u> Water Depth (ft): <u>59</u> # Hours Filled (Target): <u>24</u> (Actual): <u>24</u>		Tank #: <u>T2</u> Fill # for Tank: <u>F2</u> Filled Date: <u>6/19/11</u> Empty Date: <u>6/24/11</u> Time: <u>13:32</u> Time: <u>09:45</u> Water Depth (ft): <u>45</u> # Hours Filled (Target): <u> </u> (Actual): <u>115</u>	
Tank #: <u>T3</u> Fill # for Tank: <u>F1</u> Filled Date: <u>6/18/11</u> Empty Date: <u>6/20/11</u> 1st cage → Time: <u>11:00</u> Time: <u>10:45</u> Water Depth (ft): <u>48</u> # Hours Filled (Target): <u>48</u> (Actual): <u>48</u>		Tank #: <u>T3</u> Fill # for Tank: <u>F2</u> Filled Date: <u>6/20/11</u> Empty Date: <u>6/24/11</u> Time: <u>13:10</u> Time: <u>10:00</u> Water Depth (ft): <u>48</u> # Hours Filled (Target): <u> </u> (Actual): <u>93</u>	
Tank #: <u>T4</u> Fill # for Tank: <u>F1</u> Filled Date: <u>6/18/11</u> Empty Date: <u>6/21/11</u> 1st cage → Time: <u>11:10</u> Time: <u>10:55</u> Water Depth (ft): <u>49</u> # Hours Filled (Target): <u>72</u> (Actual): <u>72</u>		Tank #: <u>T4</u> Fill # for Tank: <u>F2</u> Filled Date: <u>6/21/11</u> Empty Date: <u>6/24/11</u> Time: <u>13:00</u> Time: <u>11:30</u> Water Depth (ft): <u>48</u> # Hours Filled (Target): <u> </u> (Actual): <u>70.5</u>	
NOTES		Review By / Date: <u>CE 6/20/11</u> Entered By / Date: <u>SOB-28-11</u>	



Recorder: D. Heilprin (Scorp)

Coast Guard/SAIC Entrainment and Survival of Asian Carp in Ballast Tanks - WATER QUALITY Datasheet

Survey #: 1-22 Survey Start Date: 6/11/11 Location: Pt

Sheet #:

Location: Pekin, IL (Arco Fleetings)

Site: T# - Tank #; R - River

Ammonia by API Test kit
Tank #3 had oil sheen

Time	Depth Survey (ft)	Temp (°C)	DO	pH	Cond µS	Ammonia	
						Total	Un-ionized
1725	51"	26.8	4.30	6.37			0.25
1725	Surf	25.6	5.20	6.62			0.25

Review By / Date: U 6/28/11

Entered By / Date: 84 06-28-11



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Coast Guard/SAIC Entrainment and Survival of Asian Carp in Ballast Tanks - WATER QUALITY Datasheet

Location: Peekin, IL

Sheet #: 7

[illegible]

Site: T# - Tank #; R - River

Review By / Date:

Entered By / Date:

87-06-28-11



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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6-11-2011

Sheet #: 93

Location: PERIN

[illegible]

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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6.11.11

Sheet #: 56

Location: PERLIN

[illegible]

7/10/15



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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6/1/11

Sheet #: 49

Location: Pekin

[illegible]

Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6.11.17

Sheet #: 66

Location: PERIN

[illegible]

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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6/11/11

Sheet #: 93

Location: PERIN

[illegible]

Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6/1/11

Sheet #: 39

Location: 624N

[illegible]

Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6/1/2011

Sheet #: 46

Location: PERIN

[illegible]

Survivability of Asian Carp in Barge Tanks in the Illinois River

Appendix B4: Trial 1. Asian carp survival (Task 3.5) laboratory datasheets – in tank cages

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 1 Survey Start Date: 6-11-2011 Sheet #: 5
Location: PEKIN

FIELD DATA			
Tank # (1-4): <u>TT</u>	0930-1730 6-11-2011	Fill # for Tank (1-2): <u>F1</u>	
Task: <u>B-10</u>	(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21]) CT - (CONTAINER)		
If Ballast or Pump then Volume: _____	Task #: <u>SOAK TIME</u>		
If Cage then (# Eggs Inserted): _____	(# Larvae Inserted): <u>15 + 15</u>		
<u>DEAD</u>	<u>ALIVE</u>	<u>DEAD</u>	<u>ALIVE</u>
Number of EGGS: _____	Number of LARVAE: <u>5</u> <u>29</u>		

LAB DATA

Vial Information			Egg / Larv.	Life Stage #	Cond.	Count	Vial Information			Egg / Larv.	Life Stage #	Cond.	Count
Tank	Fill	Task					Tank	Fill	Task				
(T1-T4)	(F1-F2)	(B, P#, C#)	(E or L)	(1-48)	(A/D)		(T1-T4)	(F1-F2)	(B, P#, C#)	(E or L)	(1-48)	(A/D)	
		CATADROMIDAE	L		D	12							
		CYPRINID-NONAC	L		D	33	3900		NON-AC	L		D	4
		AC	L	42	D	13	3899		AC	L	42	D	1
		CATADROMIDAE	L		A	13	3900		NON-AC	L		A	15
		CYPRINID C			A	1	3899		AC	L	42	A	12
		AC		42	A	12	3899		AC	L	43	A	2
		AC		43	A	2							
		CYPRINID ?			A	1							

NOTES

* - 2 damaged that made ID difficult - RES. AC but
LARGER POSSIBLY SINCE 41 ALSO FOR 2 OF THEM.

1 alive SPOT TAIL TO VOUCHER

Review By / Date: CE 8/16/11

Entered By / Date: ST 08-18-11



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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 1

Survey Start Date: 6-11-2011

Sheet #: 4

Location: Pekin

FIELD DATA													
Tank # (1-4):		<u>T1</u>		<u>0930-1730</u>		<u>6-11-11</u>		Fill # for Tank (1-2): <u>F1</u>					
Task:		<u>B-13</u>		(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21]) (T- CONTROL)									
If Ballast or Pump then Volume:				Task #: <u>SOAK TIME</u>									
If Cage then (# Eggs Inserted):				(# Larvae Inserted): <u>16+2+16</u>									
				<u>DEAD</u>				<u>ALIVE</u>					
Number of EGGS:								Number of LARVAE: <u>1</u>					
LAB DATA													
Vial Information			Egg / Larv.	Life Stage #	Cond.	Count	Vial Information			Egg / Larv.	Life Stage #	Cond.	Count
Tank	Fill	Task	(E or L)	(1-48)	(A/D)		Tank	Fill	Task	(E or L)	(1-48)	(A/D)	
(T1-T4)	(F1-F2)	(B, P#, C#)					(T1-T4)	(F1-F2)	(B, P#, C#)				
<u>T1</u>	<u>F1</u>	<u>B13</u>											
<u>3899</u>	<u>AC</u>		<u>L</u>	<u>42</u>	<u>D</u>	<u>1</u>							
<u>3900</u>	<u>NON-AC</u>		<u>L</u>		<u>A</u>	<u>19</u>							
<u>3899</u>	<u>AC</u>		<u>L</u>	<u>41</u>	<u>A</u>	<u>2</u>							
<u>1</u>	<u>AC</u>		<u>L</u>	<u>42</u>	<u>A</u>	<u>9</u>							

NOTES

* - Damaged at out - but was fixed. bladder damaged

- Some ALIVE fish to VOUCHER

Review By / Date: CE 8/16/11

Entered By / Date: SH 8-18-11



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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 1

Survey Start Date: 6-11-2011

Sheet #: 3

Location: PEKIN

FIELD DATA													
Tank # (1-4):		<u>T1</u>		<u>0930-1730</u>		<u>6-11-11</u>		Fill # for Tank (1-2):		<u>F1</u>			
Task:		<u>B-16</u>		(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21]) CT-CONTROL									
If Ballast or Pump then Volume:				Task #:		<u>30</u>		SOAK TIME					
If Cage then (# Eggs Inserted):		<u>0</u>		# Larvae Inserted:		<u>30</u>							
DEAD		ALIVE		DEAD		ALIVE							
Number of EGGS:				Number of LARVAE:		<u>0</u>		<u>32</u>					

LAB DATA													
Vial Information							Vial Information						
Tank	Fill	Task	Egg / Larv.	Life Stage #	Cond.	Count	Tank	Fill	Task	Egg / Larv.	Life Stage #	Cond.	Count
(T1-T4)	(F1-F2)	(B, P#, C#)	(E or L)	(1-48)	(A/D)		(T1-T4)	(F1-F2)	(B, P#, C#)	(E or L)	(1-48)	(A/D)	
<u>T1</u>	<u>F1</u>	<u>B16</u>											
		<u>CAROTENOID</u>	<u>L</u>		<u>A</u>	<u>11</u>							
		<u>AC</u>	<u>L</u>	<u>42</u>	<u>A</u>	<u>13</u>	<u>3899</u>		<u>AC</u>	<u>L</u>	<u>42</u>	<u>A</u>	<u>13</u>
		<u>AC</u>	<u>L</u>	<u>41</u>	<u>A</u>	<u>1</u>	<u>1</u>		<u>AC</u>	<u>L</u>	<u>41</u>	<u>A</u>	<u>1</u>
		<u>UNKNOWN - STAINED - L</u>		<u>?</u>	<u>A</u>	<u>2</u>	<u>3900</u>		<u>NONAC</u>	<u>L</u>		<u>A</u>	<u>18</u>
		<u>CYPRIUS B</u>			<u>A</u>	<u>3</u>							
		<u>CYPRIUS C</u>			<u>A</u>	<u>2</u>							
		<u>NON-AC</u>			<u>A</u>	<u>18</u>							

NOTES

* DAMAGED PUTTING INTO VIAL

- CYPRIUS B - CANNOT COUNT MYOSES NO VENTRAL FINFOLD PIG

but body looks correct ~ 11.0-11.5 mm

- CYPRIUS C - MYO 2627+9 - PIG SIMILAR TO AC

VENTRAL BUT MISSING, NO VENTRAL FINFOLD PRESENT

Review By / Date: CE 8/16/11

Entered By / Date: SH 08-18-11



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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6.11.2011

Sheet #: 22

Location: PEKIN

FIELD DATA		FIELD DATA	
Tank # (1-4):	<u>T1</u>	IN: <u>2125 (725fm) 6-11-11</u>	<u>(1084642)</u>
Task:	<u>B-6</u>	OUT: <u>0920 6/17/11</u>	Fill # for Tank (1-2): <u>F2</u>
(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21]) (Cr. to Animal)			
If Ballast or Pump then Volume:	_____	Task #:	<u>SOAK TIME</u>
If Cage then (# Eggs Inserted):	_____	(# Larvae Inserted):	<u>30</u>
	<u>6-16-2011-0910 - 1111111111</u>		
<u>DEAD</u>	<u>ALIVE</u>	<u>DEAD</u>	<u>ALIVE</u>
Number of EGGS:	_____	Number of LARVAE:	<u>2</u>
			<u>26</u>

[illegible]

NOTES

Review By / Date: 02/16/11

Entered By / Date: *2H 08-12-11*



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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #:

Survey Start Date: 6-11-2011

Sheet #: 23

Location: YEKIN

FIELD DATA

Tank # (1-4): T1 IN-2125 6-11-2011 (108425) Fill # for Tank (1-2): F2

Task: B-13 (B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21]) 005 0920 6/17/11 CONTROL

If Ballast or Pump then Volume: _____ Task #: _____ SOAK TIME

If Cage then (# Eggs Inserted): _____ (# Larvae Inserted): 30

6-16-11 0910 (most alive)

<u>DEAD</u>	<u>ALIVE</u>	<u>DEAD</u>	<u>ALIVE</u>
Number of EGGS:		Number of LARVAE:	<u>2</u>

LAB DATA

[illegible]

NOTES

Review By / Date: 08/16/11

Entered By / Date: 8H00-18-11



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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6-11-2011

Sheet #: 24

Location: PERKIN

FIELD DATA			
Tank # (1-4):	T1	40-2125(6-11-2011)	(108#2)
Task:	B-16	OUT 0920 6/17/11	Fill # for Tank (1-2): F2
If Ballast or Pump then Volume:		Task #:	
If Cage then (# Eggs Inserted):		Task #:	
DEAD		ALIVE	
Number of EGGS:		Number of LARVAE:	

[illegible]

NOTES

Review By / Date: CC 8/16/11

Entered By / Date: 84 08-15-11



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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6-11-2011

Sheet #: _____

Location: Taken

FIELD DATA			
Tank # (1-4):	<u>12</u>	DU: 0930 6-11-2011 Out: 0920 6-12-2011	Fill # for Tank (1-2): <u>F1</u>
Task:	<u>B-7</u>	(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21]) CT-CONTROL	
If Ballast or Pump then Volume:	<u> </u>	#7	Task #: <u> </u>
If Cage then (# Eggs Inserted):	<u>0</u>	(# Larvae Inserted):	<u>30</u>
	<u>DEAD</u>	<u>ALIVE</u>	
Number of EGGS:	<u> </u>	Number of LARVAE:	<u>6</u> <u>23</u>

[illegible]

NOTES

Review By / Date: CE 6/16/11

Entered By / Date: Sgt 08-18-11



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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #:

Survey Start Date: 6-11-2011

Sheet #: 9

Location: FXW

FIELD DATA			
Tank # (1-4):	<u>12</u>	IN: 0930 6-11-11 OUT: 0920 6-12-11 24 HOUR	Fill # for Tank (1-2): <u>F1</u>
Task:	<u>B-18</u>	(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21]) CT - CONTROL	
If Ballast or Pump then Volume:	_____	Task #:	<u>34</u> SOAK TIME <u>24</u>
If Cage then (# Eggs Inserted):	_____	(# Larvae Inserted):	<u>30</u>
<u>DEAD</u>	<u>ALIVE</u>	<u>DEAD</u>	<u>ALIVE</u>
Number of EGGS:		Number of LARVAE:	<u>2</u> <u>20</u>

[illegible]

NOTES

Review By / Date: CE 8/16/11

Entered By / Date: 2/08/11



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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #:

Survey Start Date: 6-11-2011

Sheet #: 6

Location: Perkins

FIELD DATA			
Tank # (1-4):	<u>TZ</u>	IN 0930 6-11-2011 OUT 0920 6-12-2011	Fill # for Tank (1-2): <u>F1</u>
Task:	<u>B-17</u>	(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21])	CT - CONTROL
If Ballast or Pump then Volume:	_____	Task #:	<u>SOAK TIME 24</u>
If Cage then (# Eggs Inserted):	<u>Ø</u>	(# Larvae Inserted):	<u>31 (ASSL SIZES)</u>
	<u>DEAD</u>		<u>ALIVE</u>
Number of EGGS:	_____	Number of LARVAE:	<u>1</u> <u>30</u>

[illegible]

NOTES

Review By / Date: CE 5/16/11

Entered By / Date: SK 08-18-11



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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6-18-11

Sheet #: 26

Location: PEKIN

[illegible]

NOTES

2 LIVE fish NOT doing well
NOTES 1 dead BEHIND MESH
Inner label says: T2/F1/B17. (Arrive 6-17)

Inner label says: T2/F1/B17. (Active 6-17)

T2/F1/B17 (Dead 6-17)

? = In Alice violent
in very bad shape

} moved to D EAE
Review

Review By / Date: CE 8/16/11

Entered By / Date: 8H 08-18-11



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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 1

Survey Start Date: 6-18-11

Sheet #: 27

Location: PEKIN

[illegible]

Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Sheet #: 28

Location: ALBANY

[illegible]

Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6/1/2019

Sheet #: 19

Location: PERIN

FIELD DATA			
Tank # (1-4):	T3	30 0930 6-11-97	48 HOUR
Task:	B-3	04 0930 6-13-2011	Fill # for Tank (1-2): F1
If Ballast or Pump then Volume: _____		Task #: _____	
If Cage then (# Eggs Inserted): _____		(# Larvae Inserted): _____	
DEAD ALIVE		DEAD ALIVE	
Number of EGGS:	_____	Number of LARVAE:	4

[illegible]

NOTES - SOME NON-AC RPTED FOR WHEA ID
- AC #40 TO VOUCHER

Review By / Date: CE 8/16/11

Entered By / Date: *EH 00-15-11*



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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6-11-2011

Sheet #: 15

Location: PEKIN

FIELD DATA			
Tank # (1-4):	<u>T3</u>	<u>ID 0930 6:13 11</u>	<u>48 Hour</u>
Task:	<u>B-9</u>	<u>OUT: 0930 6:13 2011</u>	Fill # for Tank (1-2): <u>F1</u>
(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21]) CP-05-17201			
If Ballast or Pump then Volume:	_____	Task #:	<u>SOAK TIME 48</u>
If Cage then (# Eggs Inserted):	_____	(# Larvae Inserted):	_____
	<u>DEAD</u>	<u>ALIVE</u>	
Number of EGGS:	_____	Number of LARVAE:	<u>5</u>
			<u>23</u>

[illegible]

NOTES

Some non-AC pulled for Inter-IO

Review By / Date: 02/08/16/11

Entered By / Date: 2/7/08-CP-1



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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6-11-2011

Sheet #: 8

Location: 18 km

[illegible]

Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6.15.2011

Sheet #: 33

Location: PEKIN

[illegible]

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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6.13.2011

Sheet #: 35

Location: PEKIN

FIELD DATA			
Tank # (1-4):	T3	NO: 1212 6-13-2011 OUT 1030 6/17/11	92 HR EXPOSURE
Task:	B-11	Fill # for Tank (1-2): F2	
(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21])			
If Ballast or Pump then Volume:	_____	Task #:	_____
If Cage then (# Eggs Inserted):	_____	(# Larvae Inserted):	_____
	<u>DEAD</u>	<u>ALIVE</u>	
Number of EGGS:	_____	Number of LARVAE:	1
			23

[illegible]

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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 1

Survey Start Date: 6-13-2011

Sheet #: 34

Location: PEKIN

FIELD DATA			
Tank # (1-4): <u>T3</u>	<u>40-1212</u>	<u>613-201</u>	Fill # for Tank (1-2): <u>F2</u>
	<u>009-1013</u>	<u>617-201</u>	
Task: <u>B-19</u>	(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21])		
If Ballast or Pump then Volume: _____	Task #: _____		
If Cage then (# Eggs Inserted): _____	(# Larvae Inserted): _____		
<u>DEAD</u>	<u>ALIVE</u>	<u>DEAD</u>	<u>ALIVE</u>
Number of EGGS: _____	Number of LARVAE: <u>7</u> <u>19</u>		

[illegible]

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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 1

Survey Start Date: 6/11/2011

Sheet #: 17

Location: PEKIN

FIELD DATA							
Tank # (1-4): <u>T4</u>		W: 0930 6/11/11		72 Hours		Fill # for Tank (1-2): <u>F1</u>	
Task: <u>B.1</u>		(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21]) <u>CF-control</u>					
If Ballast or Pump then Volume: _____				Task #: <u>SOAK TIME</u>			
If Cage then (# Eggs Inserted): _____				(# Larvae Inserted): _____			
<u>DEAD</u>		<u>ALIVE</u>		<u>DEAD</u>		<u>ALIVE</u>	
Number of EGGS: _____				Number of LARVAE: <u>12</u> <u>19</u>			

LAB DATA													
Vial Information			Egg / Larv.	Life Stage #	Cond.	Count	Vial Information			Egg / Larv.	Life Stage #	Cond.	Count
Tank	Fill	Task					Tank	Fill	Task				
(T1-T4)	(F1-F2)	(B, P#, C#)	(E or L)	(1-48)	(A/D)		(T1-T4)	(F1-F2)	(B, P#, C#)	(E or L)	(1-48)	(A/D)	
T4	F1	B1	L	42	A	1	3899		AC	L	42	A	1
"	"	"	"	43	A	10	1		AC	L	43	A	10
NON-AC						2	3900		NON-AC	L		A	8
CATASTROPHE						6	3899		AC		43	D	1
							3900		NON-AC			D	10
							1456		3/ DAMAGE			D	1
T4	F1	B1	L	43	D	1							
NON-AC - damaged						1							
CATASTROPHE						10							

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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 1

Survey Start Date: 6-11-2011

Sheet #: 18

Location: PEKIN

FIELD DATA													
Tank # (1-4): <u>T4</u>		<u>SW 0930 6-11-11</u>		<u>72 HOURS</u>		Fill # for Tank (1-2): <u>F1</u>							
Task: <u>B-2</u>		(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21]) <u>GT-DART</u>											
If Ballast or Pump then Volume: _____						Task #: <u>SOAK TIME</u>							
If Cage then (# Eggs Inserted): _____						(# Larvae Inserted): _____							
DEAD ALIVE						DEAD ALIVE							
Number of EGGS: _____						Number of LARVAE: <u>4</u> <u>2130</u>							
LAB DATA													
Vial Information			Egg / Larv.	Life Stage #	Cond.	Count	Vial Information			Egg / Larv.	Life Stage #	Cond.	Count
Tank	Fill	Task					Tank	Fill	Task				
(T1-T4)	(F1-F2)	(B, P#, C#)	(E or L)	(1-48)	(A/D)		(T1-T4)	(F1-F2)	(B, P#, C#)	(E or L)	(1-48)	(A/D)	
<u>T4</u>	<u>F1</u>	<u>P2</u>	<u>L</u>	<u>42</u>	<u>A</u>	<u>2</u>							
		<u>AC</u>	<u>L</u>	<u>42</u>	<u>A</u>	<u>2</u>	<u>3819</u>		<u>AC</u>	<u>L</u>	<u>42</u>	<u>A</u>	<u>2</u>
		<u>L</u>	<u>L</u>	<u>43</u>	<u>A</u>	<u>12</u>	<u>1</u>		<u>L</u>	<u>L</u>	<u>43</u>	<u>A</u>	<u>12</u>
							<u>3900</u>		<u>NONAC</u>	<u>L</u>	<u>-</u>	<u>A</u>	<u>16</u>
<u>UNID CYPRINIDS</u>													
<u>(A) STOMIDAE</u>													
				<u>(2 VIALS)</u>	<u>A</u>	<u>13</u>	<u>3900</u>		<u>NONAC</u>	<u>L</u>	<u>-</u>	<u>D</u>	<u>4</u>
		<u>NONAC</u>			<u>D</u>	<u>4</u>							
NOTES <u>DEAD AC MUTILATED SO CANNOT STAGE</u> Review By / Date: <u>CE B/16/11</u> Entered By / Date: <u>ST 08-16-11</u>													



Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 1

Survey Start Date: 6-11-2011

Sheet #: 16

Location: PEKIN

FIELD DATA															
Tank # (1-4):		<u>T4</u>		IO: 0930 6-11-11		<u>F2 HOCUS</u>		Fill # for Tank (1-2):		<u>F1</u>					
Task:		<u>B-B</u>		(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21])		<u>OUT 0930 6-11-11</u>		C# - Control							
If Ballast or Pump then Volume:								Task #:		<u>SOAK TIME</u>					
If Cage then (# Eggs Inserted):								(# Larvae Inserted):							
				<u>DEAD</u>				<u>ALIVE</u>							
Number of EGGS:								Number of LARVAE:				<u>8</u> <u>22</u>			

LAB DATA													
Vial Information			Egg / Larv.	Life Stage #	Cond.	Count	Vial Information			Egg / Larv.	Life Stage #	Cond.	Count
Tank	Fill	Task	(E or L)	(1-48)	(A/D)		Tank	Fill	Task	(E or L)	(1-48)	(A/D)	
(T1-T4)	(F1-F2)	(B, P#, C#)					(T1-T4)	(F1-F2)	(B, P#, C#)				
T4	F1	B-B	L	42	A	2	3899		AC	L	42	A	2
T4	F1	BB	L	43	A	10	L		AC	L	43	A	10
							3900		NONAC	L	—	A	10
		NON-AC			A	2							
		CINASTOMIDIZ			A	8							
							3900		NON-AC	L		D	8
		NON-AC	L	—	D	8							

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6/1/11

Sheet #: 41

Location: FEKIN

FIELD DATA			
Tank # (1-4):	<u>T4</u>	IN: <u>1150</u> <u>6/14/2011</u> <u>POULP FRI</u>	Fill # for Tank (1-2): <u>F2</u>
Task:	<u>B-2</u>	cor: <u>1130</u> <u>6/17/11</u>	
(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21])			
If Ballast or Pump then Volume:	_____	Task #:	_____
If Cage then (# Eggs Inserted):	_____	(# Larvae Inserted):	<u>30</u>
<u>DEAD</u>	<u>ALIVE</u>	<u>DEAD</u>	<u>ALIVE</u>
Number of EGGS:	_____	Number of LARVAE:	<u>2</u>
			<u>28</u>

[illegible]

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 1

Survey Start Date: 6/11/11

Sheet #: 40

Location: PELIN

FIELD DATA													
Tank # (1-4): <u>T4</u>		IN: <u>1150</u> <u>6/14/11</u> <u>Pull FU</u>		Fill # for Tank (1-2): <u>F2</u>									
Task: <u>B-5</u>		(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21])											
If Ballast or Pump then Volume: _____				Task #: _____									
If Cage then (# Eggs Inserted): _____				(# Larvae Inserted): <u>30</u>									
<u>DEAD</u>		<u>ALIVE</u>		<u>DEAD</u>		<u>ALIVE</u>							
Number of EGGS: _____		Number of LARVAE: <u>8</u>		Number of LARVAE: <u>21</u>									

LAB DATA													
Vial Information			Egg / Larv.	Life Stage #	Cond.	Count	Vial Information			Egg / Larv.	Life Stage #	Cond.	Count
Tank	Fill	Task	(E or L)	(1-48)	(A/D)		Tank	Fill	Task	(E or L)	(1-48)	(A/D)	
(T1-T4)	(F1-F2)	(B, P#, C#)					(T1-T4)	(F1-F2)	(B, P#, C#)				
3900		NON AC	L	-	A	1							
3899		AC	L	41	A	1							
I		I	L	42	A	2							
I		I	L	43	A	11							
I		I	L	44	A	5							
3900		NON AC	L	-	D	1							
1456		DAMAGED	L	-	D	7							

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 1 Survey Start Date: 6-11-11 Sheet #: 42
Location: Pekin

[illegible]

Survivability of Asian Carp in Barge Tanks in the Illinois River

Appendix B5: Trial 1. Asian carp survival (Task 3.5) laboratory datasheets – control cages

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 1

Survey Start Date: 6.11.2011

Sheet #: 2

Location: PEXIN

[illegible]

Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 01

Survey Start Date: 6-11-2011

Sheet #: 10

Location: PERIN

[illegible]

Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6-11-2011

Sheet #: 7

Location: PERIN

[illegible]

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6-11-2011

Sheet #: 12

Location: TEKIN

[illegible]

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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6.11.2011

Sheet #: 13

Location: PEKIN

[illegible]

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6-11-2011

Sheet #: 11

Location: PERIN

[illegible]

Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6.11.2011

Sheet #: 20

Location: PEKIN

65 Hours

FIELD DATA

Tank # (1-4): CONTROL (65/10) 1930-01-11 OUT 6/11/11 72HR Fill # for Tank (1-2): 1/2 7-165

Task: CT-14 (B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21]) G-Combs

If Ballast or Pump then Volume: _____ Task #: _____

If Cage then (# Eggs Inserted): _____ (# Larvae Inserted): 30

DEAD

ALIVE

DEAD

ALIVE

Number of EGGS: _____ Number of LARVAE: 0 1920

LAB DATA

[illegible]

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 1 Survey Start Date: 6.11.2011 Sheet #: 21
 Location: PERNN 65 HOURS

FIELD DATA													
Tank # (1-4):		<u>CONTROL (65) 183D - 005 6.11.11 721R</u>										Fill # for Tank (1-2):	
Task:		<u>CF-22</u> (B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21]) <u>CF-CONTROL</u>										Task #:	
If Ballast or Pump then Volume:												SOAK TIME #	
If Cage then (# Eggs Inserted):												(# Larvae Inserted): <u>30</u>	
		<u>DEAD</u>		<u>ALIVE</u>				<u>DEAD</u>		<u>ALIVE</u>			
Number of EGGS:						Number of LARVAE:		<u>2</u>		<u>27</u>			

LAB DATA													
Vial Information			Egg / Larv.	Life Stage #	Cond.	Count	Vial Information			Egg / Larv.	Life Stage #	Cond.	Count
Tank	Fill	Task					Tank	Fill	Task				
(T1-T4)	(F1-F2)	(B, P#, C#)	(E or L)	(1-48)	(A/D)		(T1-T4)	(F1-F2)	(B, P#, C#)	(E or L)	(1-48)	(A/D)	
<u>1L</u>													
<u>3819</u>		<u>AC</u>	<u>L</u>	<u>42</u>	<u>D</u>	<u>1</u>							
<u>1</u>		<u>AC</u>	<u>L</u>	<u>43</u>	<u>D</u>	<u>1</u>							
<u>3819</u>		<u>AC</u>	<u>L</u>	<u>42</u>	<u>A</u>	<u>4</u>							
<u>1</u>		<u>AC</u>	<u>L</u>	<u>43</u>	<u>A</u>	<u>8</u>							
<u>3900</u>		<u>NON-AC</u>	<u>L</u>	<u>-</u>	<u>A</u>	<u>15</u>							

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6/11

Sheet #: 38

Location: PERIN

[illegible]

Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6.11.11

Sheet #: 56

Location: PEKIN

[illegible]

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6.7.17

Sheet #: 37

Location: PERU

[illegible]

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: _____

Survey Start Date: 6/2/2011

Sheet #: 29

Location: PERIN

[illegible]

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 8

Survey Start Date: 6/12/2011

Sheet #: 30

Location: 7E61N

[illegible]

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 1

Survey Start Date: 6.12.2011

Sheet #: 31

Location: PSKIN

[illegible]

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Survivability of Asian Carp in Barge Tanks in the Illinois River

Appendix B6: Trial 2. Asian carp entrainment/leakage (Task 3.4) laboratory datasheets

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6-18-11

Sheet #: 73

Location: PERIN

[illegible]

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2 Survey Start Date: 6-18-2011 Sheet #: 70
Location: Pekin

[illegible]

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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6/9/11

Sheet #: 79

Location: PERKIN

FIELD DATA

Tank # (1-4): T2

IN
OUT 0945 6/24/11

Fill # for Tank (1-2): F2

Task: P2 (B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21])

If Ballast or Pump then Volume: _____

Task #: _____

If Cage then (# Eggs Inserted): _____

(# Larvae Inserted): _____

DEAD

ALIVE

DEAD

ALIVE

Number of EGGS: _____

Number of LARVAE: 0

LAB DATA

[illegible]

NOTES

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2 Survey Start Date: 16.18.2011 Sheet #: 71
Location: PERIN

[illegible]

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6/18/2011

Sheet #: 15

Location: PEKIN

[illegible]

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Survivability of Asian Carp in Barge Tanks in the Illinois River

RIVER mile 150-155

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6.18.2011

Sheet #: 72

Location: PERU

[illegible]

NOTES

NON-AC TO VOUCHER

Review By / Date: CE 5/16/11

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6.18.11

Sheet #: 76

Location: PEKH

[illegible]

NOTES

Review By / Date: CE 8/16/11

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Survivability of Asian Carp in Barge Tanks in the Illinois River

Appendix B7: Trial 2. Asian carp survival (Task 3.5) laboratory datasheets – in tank cages

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Sheet #: 38

Location: TEXAS

[illegible]

Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6/18/11

Sheet #: 57

Location: 134N

[illegible]

NOTES

Review By / Date: CE 8/16/11

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6/8/2011

Sheet #: 56

Location: PERU

FIELD DATA			
Tank # (1-4):	<u>T1</u>	IN: 1120 6/19/11 6/21/11	Fill # for Tank (1-2): <u>51</u>
Task:	<u>B21 B21</u>	(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21])	
If Ballast or Pump then Volume:	_____	Task #:	_____
If Cage then (# Eggs Inserted):	<u>0</u>	(# Larvae Inserted):	<u>30</u>
<u>DEAD</u>	<u>ALIVE</u>	<u>DEAD</u>	<u>ALIVE</u>
Number of EGGS:	_____	Number of LARVAE:	<u>0</u> <u>28</u>

[illegible]

NOTES

Review By / Date: CE 8/16/11

Entered By / Date: Slt 08-17-11



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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6.8.2011

Sheet #: 97

Location: PERIN

[illegible]

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6-18-2011

Sheet #: 48

Location: PERIN

[illegible]

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6/18/2011

Sheet #: 49

Location: PERIN

[illegible]

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6.18.2011

Sheet #: 50

Location: EXIN

[illegible]

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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6/18/2011

Sheet #: 51

Location: Peyton

[illegible]

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6/18/2011

Sheet #: 52

Location: PERIN

[illegible]

Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6/8.2011

Sheet #: 2

Location: PERIN

[illegible]

NOTES

ES ALIVE NON-AC TO VOUCHER
ALIVE BACK IN 95% ETH

Review By / Date: 10/16/11

Entered By / Date: SA 08/17/11



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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6/18/2011

Sheet #: 5

Location: PERIN

[illegible]

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6/13/11

Sheet #: 2

Location: PERIN

[illegible]

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Survivability of Asian Carp in Barge Tanks in the Illinois River

Appendix B8: Trial 2. Asian carp survival (Task 3.5) laboratory datasheets – control cages

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6-18-2011

Sheet #: 61

Location: PERKIN

[illegible]

Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6/18/2011

Sheet #: 59

Location: PERIN

[illegible]

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Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6-18-2011

Sheet #: 60

Location: Packman

[illegible]

Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6-13-2011

Sheet #: 63

Location: PCUN

[illegible]

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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 7

Survey Start Date: 6-18-2011

Sheet #: 62

Location: PERM

[illegible]

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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6-18-2011

Sheet #: 64

Location: PEKIN

FIELD DATA													
Tank # (1-4): <u>CONTROL-60</u>				SW: <u>1110</u> 6-19-2011				Fill # for Tank (1-2): <u>—</u>					
Task: <u>C-12</u>				(B - Ballast Tank Water; P# - Pump RUN Number [1 or 2]; C# - Cage Number [1-21])									
If Ballast or Pump then Volume: <u>—</u>				Task #: <u>—</u>									
If Cage then (# Eggs Inserted): <u>—</u>				(# Larvae Inserted): <u>60</u>									
NOT FIELD <u>DEAD</u> <u>ALIVE</u>				NOT COLLECTED <u>DEAD</u> <u>ALIVE</u>									
Number of EGGS: <u>0</u>				Number of LARVAE: <u>13</u> <u>41</u>									

LAB DATA													
Vial Information			Egg / Larv.	Life Stage #	Cond.	Count	Vial Information			Egg / Larv.	Life Stage #	Cond.	Count
Tank	Fill	Task	(E or L)	(1-48)	(A/D)		Tank	Fill	Task	(E or L)	(1-48)	(A/D)	
(T1-T4)	(F1-F2)	(B, P#, C#)					(T1-T4)	(F1-F2)	(B, P#, C#)				
3900		NON-AC	L		A	7							
3899		AC	L	43	A	16							
1		AC	L	44	A	16							
1		AC	L	42	A	2							
3899		AC	L	43	D	1							
3900		NON-AC	L		D	10							
1456		MUTATED	L		D	2							

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Review By / Date: CE 8/16/11

Entered By / Date: SA 08-16-11



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Survivability of Asian Carp in Barge Tanks in the Illinois River

Coast Guard/SAIC Entrainment and Survival of Asian Carp Survival - FIELD/LAB Datasheet

Survey #: 2

Survey Start Date: 6.18.2011

Sheet #: 63

Location: VEGN

[illegible]

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Review By / Date: CE 8/16/11

Entered By / Date: SH 03/16/11



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Survivability of Asian Carp in Barge Tanks in the Illinois River

Appendix B9: Trial 2. Plankton Tow Datasheets during Tank Filling

[illegible]

Coast Guard / SAIC Asian Carp - Plankton Tow

Mesh: 0.500 mm

Conversion C: 0.005570648

Conversion R:

Sheet #: 2

Reviewed By / Date: De 6/20/11

Entered By / Date: ST 06-28-11

Recorder(s):



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Coast Guard / SAIC Asian Carp - Plankton Tow

Survey #: A C 0 2

Mesh: 0.500 mm

Conversion C: 0.005570642

Sheet #: 3
Conversion R: _____

THANKS follow

[illegible]

Reviewed By / Date: OC 6/28/11

Entered By / Date: SA 06-28-11

Recorder(s):



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Coast Guard / SAIC Asian Carp - Plankton Tow

A C 07

Mesh: 0.500 mm

Conversion C: 0.005706449

Conversion R:

Sheet #: 4

Reviewed By / Date: _____

20

Entered By / Date:

87-06-26-11

Recorder(s):



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