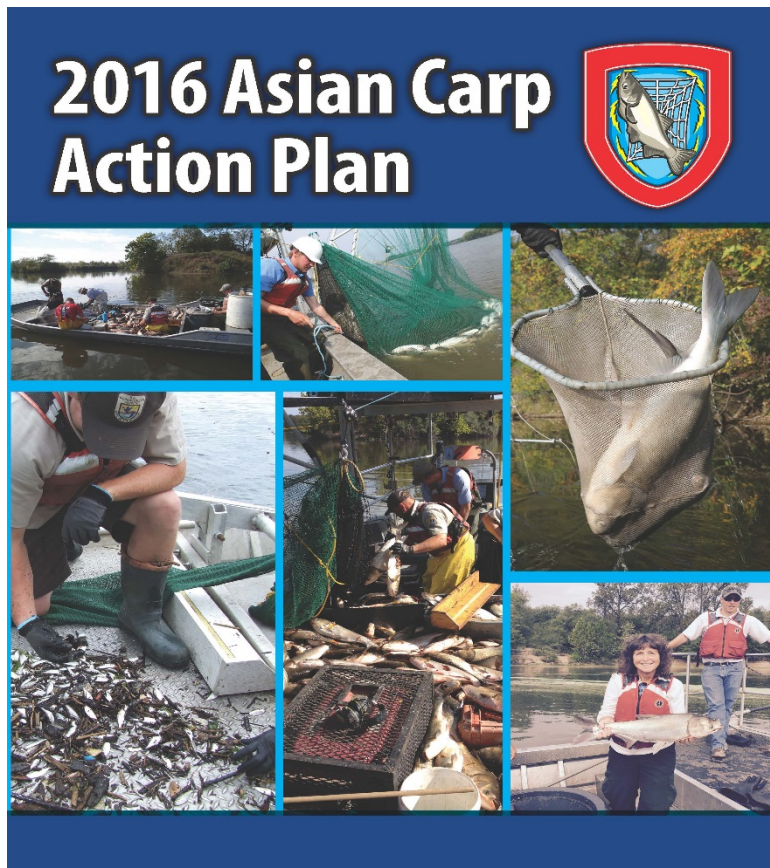


Revised July
2016

2016 Asian Carp Action Plan Amendments



Asian Carp Regional Coordination
Committee

In FY 2016, funding was included of the Asian Carp Action Plan in the USEPA funding line item (Project Number 43) for response actions and development of a Transportation Study, if determined to be necessary. With completion of the Asian Carp Monitoring and Response Plan (MRP), including the Contingency Plan, maintaining the funds for response actions were not necessary. In addition, the development of the Transportation Study was determined not to be necessary. As a result, the reallocation of FY2016 funding identified below has been made to expand current on-going projects efforts as identified in the project descriptions.

The information contained in these pages includes only the amendments to the Action Plan Action Items and the Funding Matrix. The Action Plan Strategy was not changed and is therefore not included as part of this document. Please refer to the 2016 Asian Carp Action Plan found at www.asiancarp.us for additional information.

2016 Asian Carp Action Plan: Amended Funding Matrix

FY 2016 - 2017 GLRI Project Funding*

	#	Title	FY 2016	FY 2017* (\$)	TOTAL Request (2016-2017)
USACE	1	Great Lakes Mississippi River Interbasin Study (GLMRIS) - Brandon Road	973,000	TBD	\$973,000
	2	Lab Experimentation and Modeling to Quantify Response to CO2 in a Flowing Environment	\$971,000	\$300,000	\$1,271,000
	3	Operation and Maintenance of Barriers	\$0	\$0	\$0
	4	Barrier I Constuction	\$0	\$0	\$0
	5	Telemetry - Barrier Efficacy Evaluation	\$0	\$0	\$0
	7	Monitoring and Response Team Support	\$200,000	\$200,000	\$400,000
	39	Ohio-Erie Canal Pathway Closure Assessment	\$258,000	\$1,050,000	\$1,308,000
	44	Laboratory Analysis of Mitigation Measures to Address Barge Entrainment of Fish and Floating Species	\$0	\$0	\$0
	45	Field Deployment of Barriers at Brandon Road Lock	\$450,000	\$380,800	\$830,800
	46	Asian Carp Swim Speed Study	\$200,000	\$0	\$200,000
	47	H & H Support for Eagle Marsh II	\$15,000	\$50,000	\$65,000
		Subtotal	\$3,067,000	\$1,980,800	\$5,047,800

USFWS	6	Great Lakes Asian Carp Monitoring Program	\$350,000	\$350,000	\$700,000
	7	Monitoring and Response Team Support	\$820,000	\$820,000	\$1,640,000
	8	Barge Entrainment and Interaction Study	\$850,000	\$750,000	\$1,600,000
	9	Hydro-Acoustic Assessment of Lock Mediated Fish Passage in the Upper Illinois River	\$160,000	\$160,000	\$320,000
	10	Characterizing Risk of Seasonal Changes on Electric Barrier Operating Parameters	\$0	\$0	\$0
	11	Program Capacity for eDNA Sampling	\$0	\$0	\$0
	12	Fisheries Capacity for eDNA Processing and Technology Refinement	\$0	\$0	\$0
	13	Illegal Transport of Injurious Wildlife Enforcement	\$0	\$0	\$0
	14	Asian Carp Website Operation and Maintenance	\$50,000	\$50,000	\$100,000
	15	Use of Novel Gear: Video Outreach	\$0	\$0	\$0
	16	Registration of Microparticle Technologies	\$125,000	\$225,000	\$350,000
	17	Registration of Carbon Dioxide Technologies	\$125,000	\$125,000	\$250,000
	26	Improving Molecular Techniques for Monitoring, Biomass Estimation, and Correlation with Live Fish	\$60,000	\$0	\$60,000
	43	Program Support for Asian Carp Activities	\$75,000	\$0	\$75,000
	48	Black Carp eDNA Marker Development	\$560,000	\$0	\$560,000
	49	Analysis of Grass Carp in the CAWS	\$200,000	\$200,000	\$400,000
	50	Black Carp Assessment: CAWS and UMRB	\$200,000	\$200,000	\$400,000
	51	Mass Removal and Monitoring of Juvenile Asian Carp	\$100,000	\$100,000	\$200,000
	52	Barrier Defense Using Novel Gear	\$80,000	\$80,000	\$160,000
	53	Use of Complex Sound to Alter Behavior of Asian Carp	\$100,000	\$0	\$100,000
		Subtotal	\$3,855,000	\$3,060,000	\$6,915,000

FY 2016 - 2017 GLRI Project Funding*

#	Title	FY 2016	FY 2017* (\$)	TOTAL Request (2016-2017)
8	Barge Entrainment and Interaction Study	\$100,000	\$0	\$100,000
16	Registration of Microparticle Technologies	\$300,000	\$650,000	\$950,000
17	Registration of Carbon Dioxide Technologies	\$175,000	\$175,000	\$350,000
18	Development of Grass Carp Control Technologies	\$325,000	\$325,000	\$650,000
19	Assessment of Hydraulic and Water-Quality Influences on Waterways to Develop Control Options	\$315,000	\$315,000	\$630,000
20	Characterization of Brandon Road Lock for Barrier Implementation	\$450,000	\$300,000	\$750,000
21	Use of Seismic Technology to Divert and Eradicate Asian Carp	\$50,000	\$0	\$50,000
22	Field Deployment of Carbon Dioxide Barrier to Deter Asian Carp	\$500,000	\$400,000	\$900,000
23	Developing Targeted (Microparticle and Piscicide) Control Systems	\$600,000	\$400,000	\$1,000,000
24	Chemical Attractant Investigations to Increase Harvest and Control	\$0	\$0	\$0
25	Use of Acoustic Technology to Determine Behavior	\$0	\$0	\$0
26	Improving Molecular Techniques for Monitoring, Biomass Estimation, and Correlation with Live Fish	\$110,000	\$110,000	\$220,000
27	Integrated Pest Management Program	\$1,000,000	\$850,000	\$1,850,000
28	Advanced Telemetry Techniques for Real-Time Tracking of Asian Carp	\$200,000	\$200,000	\$400,000
29	Assessing Techniques to Enhance Barrier Characteristics of High-Head Navigation Dams on the Upper Illinois River	\$75,000	\$75,000	\$150,000
30	Enhanced Monitoring Above and Below Electric Barriers	\$200,000	\$0	\$200,000
45	Field Deployment of Barriers at Brandon Road Lock	\$450,000	\$900,000	\$1,350,000
53	Use of Complex Sound to Alter Behavior of Asian Carp	\$200,000	\$0	\$200,000
54	Hot Water and Ozone Use for Lock Treatment	\$300,000	\$100,000	\$400,000
55	Other Program Support	\$40,000	\$0	\$40,000
56	Black Carp Control, Bait, and Attractant Use	\$150,000	\$150,000	\$300,000
	Subtotal	\$5,540,000	\$4,950,000	\$10,490,000
30	Enhanced Monitoring Above and Below Electric Barriers	\$1,350,000	\$1,950,000	\$3,300,000
31	Illinois River Stock Assessment/Management Alternatives	\$400,000	\$300,000	\$700,000
32	Contract Fishing for Asian Carp Detection and Removal	\$1,400,000	\$1,200,000	\$2,600,000
33	Interim and Long-Term Strategy and Tactics Development at Starved Rock	\$0	\$0	\$0
34	Reducing the Risk of Asian Carp Upstream Movement: Applying Improved Fishery Gears and Designs at Brandon Road	\$0	\$0	\$0

USGS

FY 2016 - 2017 GLRI Project Funding*

	#	Title	FY 2016	FY 2017* (\$)	TOTAL Request (2016-2017)
USFWS-IL DNR	35	Use of Improved Gear and Novel Designs at Brandon Road	\$350,000	\$150,000	\$500,000
	36	Assessing the Distribution of Apocorophium Lacustre in the Chicago Area Waterway System	\$0	\$0	\$0
	37	Community Action Initiatives to Increase Awareness, Surveillance, and Enforcement of Unlawful Live Asian Carp	\$300,000	\$300,000	\$600,000
	43	Program Support for Asian Carp Activities	\$175,000	TBD	\$175,000
		Subtotal	\$3,975,000	\$3,900,000	\$7,875,000
ODNR	38	Killbuck Creek Pathway Closure Assessment	\$150,000	\$1,000,000	\$1,150,000
	39	Ohio-Erie Canal Pathway Closure Assessment	\$292,000	\$0	\$292,000
	59	Development of Grass Carp Response Capabilities in Ohio	\$180,000	\$100,000	\$280,000
		Subtotal	\$622,000	\$1,000,000	\$1,622,000
USCG	40	Manage Waterway Traffic in Support of Asian Carp Control Activities	\$0	\$105,000	\$105,000
	41	Brandon Road Lock and Dam Risk Assessment	\$100,000	\$600,000	\$700,000
	42	Electric Barrier Construction and Operation Risk Assessment	\$4,000	\$400,000	\$404,000
	63	Asian Carp Barge Entrainment Mitigation Risk Assessment	\$100,000	\$200,000	\$300,000
		Subtotal	\$204,000	\$1,305,000	\$1,509,000
NOAA	61	Food Web Modeling to Support Risk Assessment of Asian Carp in the Great Lakes	\$0	\$184,590	\$184,590
		Subtotal	\$0	\$184,590	\$184,590
MID NR	60	Grass Carp Eradication in Western Lake Erie	\$270,000	\$150,000	\$420,000
		Subtotal	\$270,000	\$150,000	\$420,000
USEI	43	Program Support for Asian Carp Activities	\$0	\$969,610	\$969,610
		Subtotal	\$0	\$969,610	\$969,610
Totals			\$17,533,000	\$17,500,000	\$35,033,000

* Note that this Action Plan is not a commitment to future funding and that all out-year actions are subject to the availability of future appropriations and allocation decisions.

Agency Funding by Agency

	#	Title	FY 2016 (\$)	FY 2017* (\$)	TOTAL Base (FY2016-2017)	
USACE	1	Great Lakes Mississippi River Interbasin Study (GLMRIS) - Brandon Road	\$1,000,000	\$2,600,000	\$3,600,000	
	2	Lab Experimentation and Modeling to Quantify Response to CO2 in a Flowing Environment	\$0	\$0	\$0	
	3	Operation and Maintenance of Barriers	\$11,750,000	\$11,800,000	\$23,550,000	
	4	Barrier I Constuction	\$16,000,000	\$0	\$16,000,000	
	5	Telemetry - Barrier Efficacy Evaluation	\$250,000	\$200,000	\$450,000	
	7	Monitoring and Response Team Support	\$0	\$0	\$0	
	39	Ohio-Erie Canal Pathway Closure Assessment	\$0	\$0	\$0	
	44	Laboratory Analysis of Mitigation Measures to Address Barge Entrainment of Fish and Floating Species	\$0	\$0	\$0	
	45	Field Deployment of Barriers at Brandon Road Lock	\$0	\$0	\$0	
	46	Asian Carp Swim Speed Study	\$0	\$0	\$0	
	47	H & H Support for Eagle Marsh II	\$0	\$0	\$0	
			Subtotal	\$29,000,000	\$14,600,000	\$43,600,000

USFWS	6	Great Lakes Asian Carp Monitoring Program	\$1,150,000	\$1,097,088	\$2,247,088
	7	Monitoring and Response Team Support	\$1,015,000	\$300,000	\$1,315,000
	8	Barge Entrainment and Interaction Study	\$200,000	\$0	\$200,000
	9	Hydro-Acoustic Assessment of Lock Mediated Fish Passage in the Upper Illinois River	\$160,000	\$0	\$160,000
	10	Characterizing Risk of Seasonal Changes on Electric Barrier Operating Parameters	\$0	\$0	\$0
	11	Program Capacity for eDNA Sampling	\$1,100,000	\$1,050,000	\$2,150,000
	12	Fisheries Capacity for eDNA Processing and Technology Refinement	\$1,300,000	\$1,300,000	\$2,600,000
	13	Illegal Transport of Injurious Wildlife Enforcement	\$0	\$0	\$0
	14	Asian Carp Website Operation and Maintenance	\$100,000	\$100,000	\$200,000
	15	Use of Novel Gear: Video Outreach	\$0	\$0	\$0
	16	Registration of Microparticle Technologies	\$0	\$0	\$0
	17	Registration of Carbon Dioxide Technologies	\$0	\$0	\$0
	43	Program Support for Asian Carp Activities	\$75,000	\$0	\$75,000
	48	Black Carp eDNA Marker Development	\$0	\$0	\$0
	49	Analysis of Grass Carp in the CAWS	\$0	\$0	\$0
	50	Black Carp Assessment: CAWS and UMRB	\$0	\$0	\$0
	51	Mass Removal and Monitoring of Juvenile Asian Carp	\$100,000	\$0	\$100,000
52	Barrier Defense Using Novel Gear	\$100,000	\$0	\$100,000	
		Subtotal	\$5,300,000	\$3,847,088	\$9,147,088

Agency Funding by Agency

	#	Title	FY 2016 (\$)	FY 2017* (\$)	TOTAL Base (FY2016-2017)
USGS	16	Registration of Microparticle Technologies	\$100,000	\$100,000	\$200,000
	17	Registration of Carbon Dioxide Technologies	\$50,000	\$25,000	\$75,000
	18	Development of Grass Carp Control Technologies	\$325,000	\$325,000	\$650,000
	19	Assessment of Hydraulic and Water-Quality Influences on Waterways to Develop Control Options	\$625,000	\$610,000	\$1,235,000
	20	Characterization of Brandon Road Lock for Barrier Implementation	\$0	\$0	\$0
	21	Use of Seismic Technology to Divert and Eradicate Asian Carp	\$50,000	\$20,000	\$70,000
	22	Field Deployment of Carbon Dioxide Barrier to Deter Asian Carp	\$300,000	\$300,000	\$600,000
	23	Developing Targeted (Microparticle and Piscicide) Control Systems	\$630,000	\$830,000	\$1,460,000
	24	Chemical Attractant Investigations to Increase Harvest and Control	\$274,000	\$274,000	\$548,000
	25	Use of Acoustic Technology to Determine Behavior	\$144,000	\$50,000	\$194,000
	26	Improving Molecular Techniques for Monitoring, Biomass Estimation, and Correlation with Live Fish	\$800,000	\$800,000	\$1,600,000
	27	Integrated Pest Management Program	\$1,750,000	\$1,750,000	\$3,500,000
	28	Advanced Telemetry Techniques for Real-Time Tracking of Asian Carp	\$100,000	\$100,000	\$200,000
	29	Assessing Techniques to Enhance Barrier Characteristics of High-Head Navigation Dams on the Upper Illinois River	\$0	\$0	\$0
	45	Field Deployment of Barriers at Brandon Road Lock	\$0	\$0	\$0
	53	Use of Complex Sound to Alter Behavior of Asian Carp	\$0	\$0	\$0
	54	Hot Water and Ozone Use for Lock Treatment	\$70,000	\$25,000	\$95,000
	55	Other Program Support	\$10,000	\$10,000	\$20,000
56	Black Carp Control, Bait, and Attractant Use	\$0	\$0	\$0	
		Subtotal	\$5,228,000	\$5,219,000	\$10,447,000
	30	Enhanced Monitoring Above and Below Electric Barriers	\$0	\$0	\$0
	31	Illinois River Stock Assessment/Management Alternatives	\$0	\$0	\$0
	32	Contract Fishing for Asian Carp Detection and Removal	\$0	\$0	\$0
	33	Interim and Long-Term Strategy and Tactics Development at Starved Rock	\$0	\$0	\$0
	34	Reducing the Risk of Asian Carp Upstream Movement: Applying Improved Fishery Gears and Designs at Brandon Road	\$0	\$0	\$0
	35	Use of Improved Gear and Novel Designs at Brandon Road	\$0	\$0	\$0

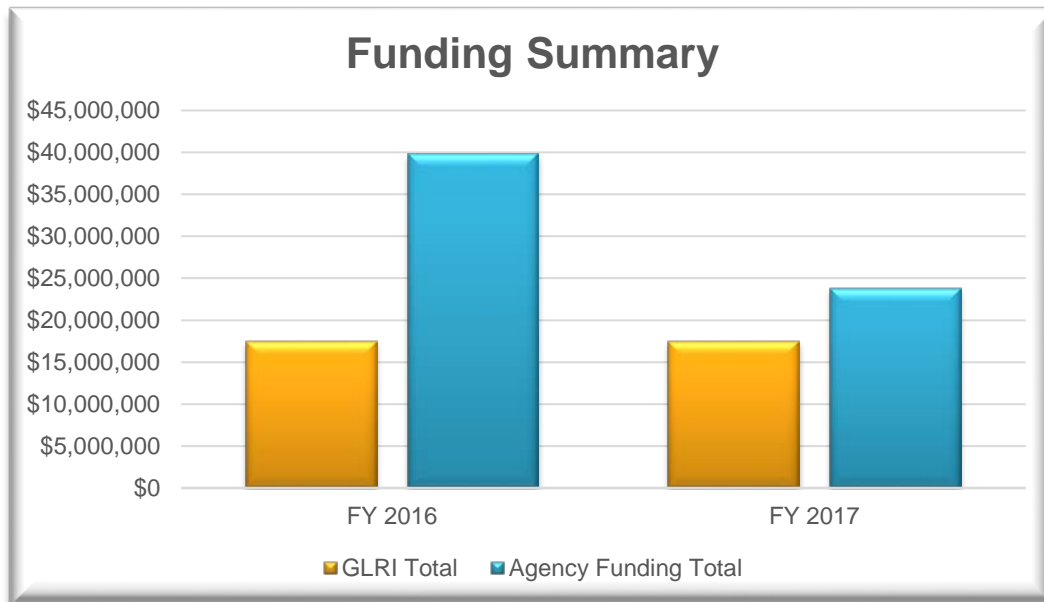
Agency Funding by Agency

	#	Title	FY 2016 (\$)	FY 2017* (\$)	TOTAL Base (FY2016-2017)
USFWS-IL DNR	36	Assessing the Distribution of Apocorophium Lacustre in the Chicago Area Waterway System	\$0	\$0	\$0
	37	Community Action Initiatives to Increase Awareness, Surveillance, and Enforcement of Unlawful Live Asian Carp	\$0	\$0	\$0
	Subtotal		\$0	\$0	\$0
ODNR	38	Killbuck Creek Pathway Closure Assessment	\$0	\$0	\$0
	39	Ohio-Erie Canal Pathway Closure Assessment	\$0	\$0	\$0
	59	Development of Grass Carp Response Capabilities in Ohio	\$0	\$0	\$0
Subtotal		\$0	\$0	\$0	
USCG	40	Manage Waterway Traffic in Support of Asian Carp Control Activities	\$1,600	\$1,600	\$3,200
	41	Brandon Road Lock and Dam Risk Assessment	\$2,000	\$2,000	\$4,000
	42	Electric Barrier Construction and Operation Risk Assessment	\$2,000	\$2,000	
	63	Asian Carp Barge Entrainment Mitigation Risk Assessment	\$2,000	\$2,000	\$4,000
Subtotal		\$7,600	\$7,600	\$15,200	
NOAA	61	Food Web Modeling to Support Risk Assessment of Asian Carp in the Great Lakes	\$152,128	\$0	\$152,128
	Subtotal		\$152,128	\$0	\$152,128
MID NR	60	Grass Carp Eradication in Western Lake Erie	\$150,000	\$150,000	\$300,000
	Subtotal		\$150,000	\$150,000	\$300,000
Base Funding Total			\$39,837,728	\$23,823,688	\$63,661,416

* FY 2016 and FY2017 are estimated requests based on 2015 actions and intended outcomes.

Funding Summary

	FY 2016	FY 2017
USACE GLRI Total	\$3,067,000	\$1,980,800
USACE Agency Total	\$29,000,000	\$14,600,000
USEPA GLRI Total	\$0	\$969,610
USEPA Agency Total	\$0	\$0
USCG GLRI Total	\$204,000	\$1,305,000
USCG Agency Total	\$7,600	\$7,600
USFWS GLRI Total	\$3,855,000	\$3,060,000
USFWS Agency Total	\$5,300,000	\$3,847,088
USGS GLRI Total	\$5,540,000	\$4,950,000
USGS Agency Total	\$5,228,000	\$5,219,000
USFWS - ILDNR	\$3,975,000	\$3,900,000
USFWS - ILDNR Agency Total	\$0	\$0
USFWS - ODNR GLRI Total	\$622,000	\$1,000,000
USFWS - ODNR Agency Total	\$0	\$0
USFWS - MIDNR GLRI Total	\$270,000	\$150,000
USFWS - MIDNR Agency Total	\$150,000	\$150,000
NOAA GLRI Total	\$0	\$184,590
NOAA Agency Total	\$152,128	\$0
GLRI Total	\$17,533,000	\$17,500,000
Agency Funding Total	\$39,837,728	\$23,823,688



2016 Asian Carp Action Plan: Amended Action Items

1. Great Lakes and Mississippi River Interbasin Study (GLMRIS) – Brandon Road

Lead Agency: USACE

Agency Collaboration: None

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$1,000,000	\$973,000*
FY 2017	\$2,600,000	TBD

*Original allocation of \$500,000 in GLRI funding was granted to USACE. An additional \$473,000 was allocated for supplemental work described below.

Project Explanation: Work under this template includes the study of aquatic nuisance species (ANS) control technologies, as outlined by the Great Lakes and Mississippi River Interbasin Study (GLMRIS), that could be implemented in the vicinity of Brandon Road Lock & Dam located in Joliet, Illinois. Further evaluation of ANS control measures at this control point constitutes a logical next step based on the range of alternatives identified in the GLMRIS Report and input from stakeholders and the public during the public comment period for the report.

As part of the GLMRIS efforts at Brandon Road, USACE will develop and implement an alternating current electric dispersal barrier to block passage of small bighead and silver carp. Electric dispersal barriers (EDB) are being considered as a means of blocking upstream passage of Asian carp into Lake Michigan. The effectiveness of EDB on very small bighead carp and silver carp is of particular concern, with Brandon Road Lock and Dam selected as a strategic point for preventing upstream passage of these invasive fishes into the CAWS. Recent research related to EDB operating on the Chicago Sanitary Ship Canal (CSSC) indicates the effectiveness for blocking passage of fish with pulsed DC (PDC) to be strongly influenced by fish size (Holliman 2011; Holliman 2014 A; Holliman 2014 B) with electric field parameters demonstrated effective on large fish shown to be less effective on small fish. Recent research also indicates seasonal environmental conditions, specifically water temperature, to strongly influence effectiveness of EDB on the CSSC, with electric field parameters demonstrated effective on bighead carp at lower water temperatures shown to be less effective at summer season (warmer) temperatures.

Electric-field based dispersal barriers can be an efficient method for preventing upstream movement of fish. Edward and Higgins (1972) and Bird and Cowx (1992) reported that maximum susceptibility to PDC may occur at different PDC frequencies among species and that fish of different sizes can exhibit their greatest susceptibility at different pulse frequencies. Typically, smaller fish require greater pulse frequencies and/or greater pulse amplitudes to induce passage-preventing behaviors. Use of higher PDC pulse frequencies and/or amplitudes may lead to increased concern for human safety, greater rates of anode destruction, and greater rates of corrosion of surrounding structures. Alternating current (AC) can be used for EDB and has the potential benefit of reducing concerns over corrosion and anode destruction. Moreover, AC can be manipulated to conserve electrical energy, to have characteristics of PDC but with constant reversals of electrode polarity, which would also prevent galvanotaxis (forced-swimming by fish) to the anode or in some cases the cathode. An AC EDB may have the distinct advantage, over PDC, in simplification of circuitry requiring less specialization in design and maintenance personnel.

FY 2016 Actions: A scaled-model approach will be employed, where a Brett Swim Tunnel will be modified so the field strength at the water surface of an EDB will be simulated under controlled conditions. The field strength applied in the simulations will be determined by modeling EBD electric fields, assuming a water depth of 15 feet and bottom-mounted electrodes (e.g., Holliman et al. 2015). Simulations of Intrusion into the EDB will be conducted with live bighead carp (or silver carp) of 1 to 2 inches total length. The scaled-model of the EDB will be characterized by AC electrical parameters under consideration (e.g., 60 Hz AC). Pilot testing will be conducted with candidate sets of electric field parameters and reliability demonstration testing will be conducted on promising sets of electric field parameters. Water temperature will be at ambient conditions (20 °C) and water conductivity will be selected after conferring with sponsors. Videography will be employed to record fish behavior during the electrical exposures, with automated and manual video review to determine onset of targeted behavioral endpoints and metrics of fish performance during electrical exposures (e.g., loss of posture, tetany, swim velocity, distance traveled by fish during exposure). Reliability demonstration testing will be conducted with an appropriate number of fish, with a 95/95 reliability standard for induction immobility/tetany specified (95% probability at a 95% confidence level). Depth of intrusion (i.e., distance into the EBD) at onset of immobility/tetany will be estimated and reported.

The conceptualization of the AC EDB will include concept drawings, lists of infrastructure and equipment, and cost estimates for construction and operation. When possible, comparisons will be made between the conceptual AC EDB and PDC EDB operating on the CSSC (depending on information made available by the USACE).

Expected Milestones:

- A report summarizing the results of the testing and potential application of results.
- Descriptions, concept drawings, lists of infrastructure and equipment, and preliminary cost estimates for design and construction of an AC EDB power supply and monitoring and control systems having the desired features, and comparison of electrical operating costs of an AC EDB with a PDC EDB.

Outcomes/Outputs:

- Determine sets of AC electric field parameters for EDB that achieve a reliability (probability) of 95% for inducing passage preventing behaviors in very small sizes of bighead carp at a 95% confidence level.
- Conceptualize an AC EDB for the Brandon Road Lock and Dam including desired features and requirements.

References

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- Edwards JL and JD Higgins. 1973. The effects of electric currents on fish. Engineering Experiment Station, Georgia Institute of Technology, Atlanta. Rep. B-397, B-400, and E-200-301.
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- Holliman, FM. 2014A. Reliability demonstration testing of electric field parameters for electric-field based aquatic nuisance species dispersal barriers on the Chicago Sanitary Ship Canal. A report submitted to the ACOE, Chicago District.
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8. Barge Entrainment and Interaction Study

Lead Agency: USFWS and USGS

Agency Collaboration: USACE

Funding Table:

Funding	Agency Funding			GLRI Funding		
	USGS	USFWS	Total	USGS	USFWS*	Total
FY 2016	\$0	\$200,000	\$200,000	\$100,000	\$850,000	\$950,000
FY 2017	\$0	\$0	\$0	\$0	\$750,000	\$750,000

*Original allocation of 750,000 was granted to USFWS. An additional \$100,000 was allocated for supplemental work described below.

Project Explanation: This project encompasses both follow up investigations to studies conducted in 2015 and an evaluation of management actions that could potentially reduce or eliminate fish entrainment by barges in the CAWS. Work completed in 2015 showed that free swimming, surrogate fish could be entrained and retained in a “rake-to-box” junction of a barge tow, as well as through a lockage, across the electric dispersal barriers, and for long distances (~10 river miles). Further details of the 2015 results were shared with the ACRCC member agencies, CEQ, DOJ, and the maritime industry. Initial work was completed in a laboratory setting by the USACE. Field work was completed by USFWS in 2012, 2013, and 2015 which showed that live fish could be entrained across the electrical barriers in the CAWS by passing barges to varying degrees depending on barge configuration. The proposed work for FY 2016 aims to address questions raised by the USFWS, USACE, other agencies, and the maritime industry regarding behavior of fish in barge void spaces and distances fish may be entrained, and potential management actions that can eliminate or reduce the likelihood of entrainment.

Specific study objectives of the follow up investigations portion of this study are to: (1) continue to evaluate behavior of wild fish near and in the void spaces of barges as they traverse different sections of the CAWS; (2) determine the length of time and distance wild fish may be entrained in areas and void spaces of barges; (3) determine the size in which fish can vacate, of their own volition, the void spaces of a rake to box barge; (4) evaluate entrainment probabilities under different barge configurations; and (5) determine entrainment potential within the pocket eddy created in a rake to box barge junction. To answer questions related to the possibility of wild fish (free swimming, non-tethered) entering areas around barges, nets will be designed and deployed in the void spaces between the barges while barges traverse the CAWS. USFWS will deploy DIDSON (Dual-frequency identification sonar) units and video cameras around the barges. The images from the DIDSON or underwater cameras will be used to view and count wild fish in barge junctions over time and distance traveled. Additional data on temperature, flow, speed of the barges, location, electrical measurements, and distances traveled by the barges will also be collected and compared to the images collected. Surrogate live, untethered fish may also be collected and dropped into the areas in order to collect additional images of fish behavior under simulated entrainment conditions if warranted.

In an effort to calculate the potential probability of commercial barges inadvertently entraining Asian carp juveniles, larvae, or eggs, the USFWS and USGS wish to develop a predictive model and decision

support tool. This model will make it possible for managers to predict the likelihood of barges encountering and affecting movement of small Asian carp. This model could likewise lead to advising managers on possible control efforts. The Service will conduct field sampling and specimen identification of juvenile, larval, and egg life stages in a scientifically tenable fashion to support the data needs of the modeling process conducted by USGS researchers. Sampling and identification of these early life stages is labor intensive, but is critical to the modeling process.

Summary of Actions to Date: In 2013, USACE completed a laboratory based model study using a scaled down flume version of the CAWS barrier system and model fish and barges at its ERDC lab. This study showed that model fish assumed to be incapacitated by the barriers could be entrained beyond the barriers in void spaces between the barges. Further USACE studies of electric field strength around barges traversing the barriers showed distortion of the electric field and weakening of the electric field in some cases, particularly in the void space of a rake-to-box barge configuration. Field studies conducted by USFWS in 2012 and 2013 used tethered and wild surrogate fishes to test if barges would entrain these fish and propel them through the barrier system. Two general methods were used, one where fish were placed directly in the spaces around barges as they traversed the barrier, and another where fish were placed across the canal in front of north bound barges crossing the barrier. These studies (<http://www.fws.gov/midwest/fisheries/carterville/didson-barge.html>) found that live fish were entrained across the barriers by passing barges, to varying degrees depending barge configuration.

Proposed Actions:

FY 2016 Actions: Field sampling to identify larval and egg life stages was conducted in June. Sampling conducted in August will be focused on juvenile fish. Both sampling events will occur in the middle and lower Illinois River where Asian carp presence and establishment is high and capture of larval, egg, and juvenile Asian carp is likely. Other sampling as needed to support model input as directed by USGS. When individual models have been developed, FluEgg model outputs will be combined with spatial and temporal data on barge traffic and larval habitat. Various maps, graphics, data, metadata and methodologies will be developed for future use.

FY 2017 Actions: Sampling may continue into early 2017, as directed by USGS per model needs.

Expected Milestones:

- Data allowing agencies to determine the relative frequency of wild fish entering void spaces of barge tows.
- Data allowing agencies to determine the relative time spent and distance traveled by fish in void spaces of barge tows.
- Written project report(s) describing project results.

Outcomes/Outputs:

- Enhanced knowledge of behavior of fishes near barges and in void spaces of barge tows that could influence future operations in a manner that minimizes fish entrainment.
- Support of Government/Barge Workgroup.
- Satisfaction of USFWS partners in addressing potential entrainment issues at the barriers.
- A model and decision support tool capable of predicting the likelihood of barges encountering and affecting movement of small Asian carps that can be used by managers to develop potential control options.

26. Improving Molecular Techniques for Monitoring, Biomass Estimation, and Correlation with Live Fish

Lead Agency: USGS and USFWS

Agency Collaboration: Purdue University, Minnesota Department of Natural Resources (MN DNR) and Wisconsin Department of Natural Resources (WI DNR) for field assistance and University of Minnesota (UM), University of Wisconsin (UW), Illinois Natural History Survey, South Dakota State University, University of Illinois at Urbana-Champaign, University of Missouri – Columbia (UMC)

Funding Table:

Funding	Agency Funding			GLRI Funding		
	USGS	USFWS	Total	USGS	USFWS*	Total
FY 2016	\$800,000	\$0	\$800,000	\$110,000	\$60,000	\$170,000
FY 2017	\$800,000	\$0	\$800,000	\$110,000	\$TBD	\$110,000

*Original allocation of \$110,000 was granted to USGS. An additional \$60,000 was allocated to USFWS for supplemental work described below.

Project Explanation: Early detection is a vital part of managing any invasive species. Significant efforts have been made to detect Asian Carp at low abundances and identify their invasion front, but since these fish avoid traditional capture gear, traditional gears have limited utility in finding Asian Carp at low density. An alternative method for monitoring Asian Carp is the detection of molecular signals (such as mitochondrial DNA – often termed eDNA) of Asian Carp in water samples.

The eDNA method has proven effective for detection of Asian Carp at low densities. Further improvements to eDNA technology will offer managers a “molecular toolbox” for detection and characterization of Asian Carp occurrence. Current applications include detection of spawning events, fish movement, habitat utilization, and evaluation of the effectiveness of management actions. Applications of eDNA technology under development include estimation of fish biomass and methods for determination of time since eDNA was shed from a live fish. Refinements to eDNA methodology are also being pursued to improve detection sensitivity, prevent false negatives caused by PCR inhibition, increase cost-effectiveness, and decrease time between sampling and results.

Sequencing the entire genome of an Asian carp species is advantageous, because it would provide detailed information on the mapped species that is useful in multiple applications, from designing future eDNA markers for detection programs, to development of potential molecular or genetic control mechanisms. The Midwest Fisheries Center’s Whitney Genetics Lab (WGL) has a Next Generation sequencing instrument (Illumina NextSeq500) that can make this process relatively rapid and affordable to generate the raw data needed to map the genome. Processing the data is labor and time intensive, but the computational needs are available for WGL staff at USGS Upper Midwest Environmental Science Center. Work would be conducted by USFWS to map the whole genome of Silver carp. Some economy could be gained from mapping all four Asian carp species of concern (Silver, Bighead, Grass, Black) at once.

FY 2016 Actions:

USFWS will obtain samples of tissue from fresh silver carp tissue by coordinating with carp monitoring field teams and extract DNA, N=4 animals, 2 males and 2 females. Purchase reagents and supplies for Illumina NextSeq500 instrument and collect raw data. Each of the 4 specimens will be processed individually to maximize depth and coverage of the entire genome, each run will generate about 400 million sequence reads which will be stored digitally.

FY 2017 Actions:

USFWS plans to analyze raw data with various analysis programs, and map the genome using the published grass carp genome (Wang et al. 2015) as a reference.

Outcomes/Outputs:

- Sequence Silver Carp genome to provide data as baseline information available to researchers for monitoring and control work.

Reference:

Wang Y, L Ying, Y Zhang, Z Ning, L Yan, Q Zhao, L Hengyun, H Rong, X Xiaoqin, F Qi, L Zufang, L Kunyan, Z Lei, L Tingting, H Tao, F Danlin, W Qijun, Z Chuanrang, L Yiqi, L Wenjun, W Ziruo, Z Congcong, T Qilin, K Xiaojun, S Mijuan. 2015. The draft genome of the grass carp (*Ctenopharyngodon idellus*) provides insights into its evolution and vegetarian adaptation. *Nature Genetics* 47:625-631.

30. Enhanced Monitoring Above and Below Electric Barriers

Lead Agency: Illinois DNR

Agency Collaboration: USGS, USACE, and USFWS worked continually and extensively on the creation of the MRRP and monitoring efforts and plans.

Funding Table

Funding	Agency Funding			GLRI Funding		
	IL DNR	USGS	Total	IL DNR	USGS	Total
FY 2016	\$0	\$0	\$0	\$1,350,000	\$200,000	\$1,550,000
FY 2017	\$0	\$0	\$0	\$1,950,000	\$0	\$1,950,000

*Original allocation of \$1,350,000 was granted to IL DNR. An additional \$200,000 was allocated to USGS for supplemental work described below.

Project Explanation: Work will include a continuation of extensive monitoring efforts in elevated risk areas to detect the presence of Asian carp and remove them, as necessary. These areas are those previously identified through waterway characterization as preferable Asian carp habitat, extensive sampling, or where previous eDNA sampling indicated the presence and persistence of Asian carp DNA in the area at the time of sample collection.

To expand on the monitoring efforts initiated by IL DNR, USGS will develop a monitoring database for Asian carp to further support an integrated management approach. Over the past 5+ years, large amounts of data have been collected in the Illinois River by multiple agencies to monitor Asian carp populations and help inform management and control efforts. However, there is not currently a comprehensive and standardized database for all GLRI and Asian carp data. This creates challenges for researchers in their efforts to summarize data, discern trends (over longer time periods), create quantitative models, and make predictions about future conditions. Thus, we propose to develop a comprehensive database for all standardized fish data collected as part of the Monitoring and Response Plan for the Illinois River.

Additional decision support tools and visualizations can be developed from this database to further aid management. Some possibilities include:

- Heat maps of commercial catch data and habitat type to increase catch or plots,
- Bycatch estimates for presentations and reports,
- Identifying proper gear types for a specific time of year or environmental condition.

FY 2016 Actions:

- Develop a non-rigid database to ingest multiple datasets
- Initial focus will be on gathering data that were collected with standardized methods as reported in the Monitoring and Response Plan for the Illinois River
- Make database available to select researchers for evaluation

Expected Milestones:

- Gather data outlined in the Monitoring and Response Plan for the Illinois River

- Using the gathered data, develop a non-rigid database structure that is flexible and can be added to in the future
- Develop a functioning dbase structure for collaborator review
- Have a functioning database reviewed by collaborators

Outcomes:

- Functional web-enabled database able to be expanded to meet future invasive and decision support tool needs

Potential Hurdles:

- Getting data from other sources
- Having staff and hardware available to start project at or near the beginning of the fiscal year

31. Illinois River Stock Assessment/Management Alternatives

Lead Agency: Illinois DNR

Agency Collaboration: Greater Peoria Economic Development Council, Southern Illinois University, Feeding Illinois

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$400,000*
FY 2017	\$0	\$300,000

*Original allocation of \$300,000 was granted to USFWS for IL DNR work. An additional \$100,000 was allocated for supplemental work described below.

Project Explanation: Illinois DNR will advance its work monitoring and developing insights into the strategies for addressing Asian carp in the Illinois River. The primary objective is to understand population dynamics of Asian carp that would give insight into ability of directed harvest and other control measures to reduce overall populations within waters connecting to the Great Lakes, and reduce movement of Asian carp upstream toward the CAWS. Population-level effects and capabilities of harvest as a control strategy are outlined in the Management and Control Plan for Bighead, Black, Grass, and Silver Carp in the United States. Using best science and understanding the harvest and stock/recruitment variables in the upper Illinois River, Illinois DNR is further developing dynamic models to forecast and predict effects of harvest, other control efforts, and breadth of Asian carp populations. This will provide science based direction for harvest and control strategies and regional regulatory oversight to achieve goals for (1) prevention of spread toward the CAWS and (2) further reduction of Asian carp populations. Through 2014, these efforts have documented significant decrease in the population of Asian carp through the contracted fisher removal program. Most significantly, Dresden Island Pool Asian carp population has declined to 2014 levels that are just 32% of levels found in 2012 as a result of the carp removal.

Comprehensive management and control is needed for Asian carp control strategies to be most effective. As successes of focused removal efforts in the Upper Illinois Waterway are realized, e.g. 68% reduction in Asian carp populations in most upstream pool, the importance of upstream immigration from the lower Illinois River becomes more important. While this scope may exceed sole capabilities of the GLRI Asian Carp Action Plan, Illinois recognizes the important role that business may play in removing Asian Carp from the Illinois River and further driving down the risk of carp movement towards Lake Michigan. While commercial fishing on the Illinois River was a pride of a great Nation around 1900 (only behind the Great Lakes and Columbia River freshwater fish landings) the processing and technology to do so has not developed significantly since that time in this region. At the center of the downriver population, Illinois DNR seeks to assist the Greater Peoria Economic Development Council (GPEDC) in seeking experts to advise both the Council and then key public and/or private partners to review proposals, and assist in development of facilities, identifying locations and needs for the development of appropriate industry to assist in a broader removal of Asian Carp from the river to further bolster IDNR and other agencies efforts in the upper Illinois River. These services have been identified as a need by GPEDC to expedite the development of businesses that will use Asian Carp and thus increase removal efforts from

the river. GPEDC has identified several business plans that show promise and this investment can assist in putting the best the industry has to bear on this important topic. GPEDC efforts will benefit multiple inquiries and will be shared (as prudent and confidentiality requirements permit). These efforts are needed to expedite plant/industry development and increase success of such planning and leverage private/public resources to assist in control and management of the Asian carp threat to the Great Lakes region.

FY 2016 Actions: Support GPEDC in contracting with a technical expert(s) to position business investments for success and have access to leading edge technologies in the fish processing business.

Outcomes:

- Identify needs for further development and/or additional technical support which may need supported in upcoming years.
- Identify appropriate information for sharing to other basins and/ or jurisdictions to facilitate additional development and communication strategies.

43. Program Support for Asian Carp Activities

Lead Agency: USEPA and USFWS

Agency Collaboration: USFWS-Illinois DNR

Funding Table:

Funding	Agency Funding				GLRI Funding			
	USEPA	USFWS	IL DNR	Total	USEPA	USFWS	IL DNR*	Total
FY 2016	\$0	\$75,000	\$0	\$75,000	\$0	\$75,000	\$175,000	\$250,000
FY 2017	\$0	\$0	\$0	\$0	\$969,610	\$0	\$0	\$969,610

*The original allocation of \$75 was provided to USFWS. An additional \$175,000 was allocated to IL DNR for supplemental work described below.

Project Description: Support for Great Lakes National Program Office, and federal agency activities. The threat of Asian carp introduction into the Great Lakes directly affects the Great Lakes ecosystem, the eight Great Lakes states, and the economics of several associated industries. A variety of actions and activities are contained in this Action Plan item. Program support activities such as contractor support to the agencies in developing reports, tracking activities, and providing field support as necessary; development and deployment of training and exercises throughout the basin to enhance agencies’ rapid response capabilities; continued support of USEPA’s Asian carp director and deputy to enhance collaborations among the federal, state, local, and tribal agency partners; and provision to senior executives and the ACRCC of continued communication and outreach support activities are coordinated through USFWS and USFWS-Illinois DNR. Additional support of constituent groups to review content of plans or provide guidance from those groups (e.g. Chicago Area Waterways Advisory Group) and otherwise facilitate meetings, logistics, and planning for gatherings.

Actions Undertaken to Date: USEPA has continued to work closely with its Asian carp stakeholder partners since 2009 to mitigate the effects that Asian carp may have on local ecosystems and to decrease potential for the species to spread to new waterways. With GLRI funding, USEPA has supported ACRCC activities to ensure agency collaboration and program support for Asian carp-related activities, including the following:

- Development and refinement of the Asian Carp Action Plan since 2010.
- Development and delivery of rapid-response training courses and exercises for increased agency capability.
- Contractor support to provide technical expertise and services.
- Facilitation of meetings and outreach activities to keep the public and ACRCC member agencies aware and engaged in the control process.
- Expansion of the monitoring and response support program to allow for increased capacity and for response activities by USFWS, Great Lakes’ States, USGS, and other ACRCC partners.
- Funding to allow continuation of engagement of White House-appointed staff in these efforts.

FY 2016 Actions: Funding will be used for Asian carp efforts to include the following:

- Response Actions, if determined necessary.
- Continuation of the CAWS Advisory Committee efforts.
- Contract support for USEPA.
- Contract support for ACRCC.

FY 2017 Actions: To be determined.

Expected Milestones: None

Outcomes:

- Action Plan development
- Monitoring and Response Plan development and Contingency Plan support.
- Contingency Plan exercises and response training.

Potential Hurdles: None

48. Black and Grass Carp eDNA Marker Development

Lead Agency: USFWS - Whitney Genetics Laboratory (WGL)

Agency Collaboration: USACE ERDC

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$560,000
FY 2017	\$0	\$0

*Original allocation of \$300,000 was granted to USFWS. An additional \$260,000 was allocated for supplemental work described below.

Project Explanation: Black Carp (*Mylopharyngodon piceus*) are an emerging invasive species threat within the Mississippi River drainage. Specimens have been collected as far north as Pool 24 of the Mississippi River, have been collected in the Missouri and Illinois Rivers, and are annually taken further south in the lower Mississippi and associated drainages. As of 2013, the USFWS ascertains that the species is already established or on the verge of establishment in the US. Black Carp are molluscivores and the United States has the greatest diversity of freshwater mussels in the world, with nearly 300 named mollusk species, many (~ 70) of which are Federally-listed threatened or endangered species. If North American Black Carp eventually undergo extreme population growth and subsequent rapid spread, the rich diversity of freshwater mussels found in North America will be significantly harmed. Tracking the geographic spread and changing population levels of Black Carp in North America will be essential for understanding associated ecological and economic impacts and for successful control efforts. As a tool, eDNA is the most sensitive means available for detecting new introductions or range expansions in aquatic organisms.

Adding screening for Grass carps is a priority of our State and Provincial partners, but doing so requires additional expense, since the current Grass carp qPCR eDNA marker cannot be complexed with existing markers for Silver and Bighead carps and must be analyzed separately. Additional funding would be used to conduct early detection monitoring of Grass carp using eDNA water samples already scheduled for collection in the Great Lakes and slated to be screened for Bighead and Silver carp. Development and validation of a new qPCR eDNA marker for Grass Carp that could be multiplexed with our existing Bighead and Silver Carp markers will increase efficiency for available funding. Completion of this project would allow us to screen for Grass, Bighead, and Silver carps in one reaction in the lab and provide cost savings in the future versus running multiple reactions for all 3 species using existing markers.

Sequencing the entire genome of an Asian carp species is advantageous, because it would provide detailed information on the mapped species that is useful in multiple applications, from designing future eDNA markers for detection programs, to development of potential molecular or genetic control mechanisms. The Midwest Fisheries Center's Whitney Genetics Lab (WGL) has a Next Generation sequencing instrument (Illumina NextSeq500) that can make this process relatively rapid and affordable to generate the raw data needed to map the genome. Processing the data is labor and time intensive, but the computational needs are available for WGL staff at USGS Upper Midwest Environmental Science Center. Work would be conducted by USFWS to map the whole genome of Silver carp. Some economy

could be gained from mapping all four Asian carp species of concern (Silver, Bighead, Grass, Black) at once.

Summary of Actions to Date: A Grass Carp eDNA marker was developed in the Wilson lab at the Ontario Ministry of Natural Resources, and was used in the 2013 sampling season in Canadian waters (Wilson et al. 2014), it is presumably still used in Canadian waters. The Whitney Lab (WGL) has been working on validating this marker for use in American waters as part of the current monitoring program for Bighead and Silver Carp.

The current WGL program utilizes a combination of several qPCR markers and relies on detection of at least three different sections of the mitochondrial genome (mtDNA) in at least two genes, with the ability to detect three genes (QAPP), to detect and confirm carp DNA in water samples. This combination of results can be achieved in three qPCR assays, allowing for rapid and cost effective sample processing.

Alternatively, the grass carp marker only detects one mtDNA gene, and must be confirmed with traditional sequencing, similar to the original methods from the QAPP. Even so, if this marker is found to be reliable in WGL, it is a good pilot marker to gather preliminary data on the overall detection of grass carp across the region using the 2016 bighead and silver carp samples.

FY 2016 Actions:

Grass carp marker development:

1. Goal: Attempt to multiplex the marker into the general Asian carp assay from the QAPP. This would save time and cost if it works.
Results: This did not work, due to interactions among grass carp marker primers and the ACTM 3 primers and Internal Positive Control (IPC) primers.
2. Goal: Optimize sequence confirmation assay in WGL to save time and cost.
Result: Complete.
3. Goal: Optimize grass carp qPCR marker in WGL lab.
Results: assay is optimized to provide a limit of quantification of 10 copies, but these settings create spurious data results that require further testing with sequencing the lab. This sequencing work will be undertaken the weeks of June 6 and 13, pending instrument repair. This is needed to assess false negative and false positive results of the qPCR marker.
4. Goal: Determine fidelity of qPCR results with sequencing results to determine the rate of sequence confirmation required.
Results: In progress, work will be undertaken the weeks of June 6 and 13, pending instrument repair.
5. Goal: Use optimized qPCR assay and sequencing assay to test archived cases from 2015 in areas expected to be negative and areas expected to be positive. Assess overall fidelity of qPCR marker and sequencing results to determine optimal confirmation assay usage in each case (how many presumptive positive results must be sequenced?). This will allow for maximum confidence in results and minimize cost and time.
Results: In progress, work will be undertaken the weeks of June 6 and 13, pending instrument repair.
6. Goal: Apply optimized marker in limited scope to 2016 samples to determine overall presence of grass carp DNA in systems of interest (to be defined via partners and FWS Asian carp Regional and National coordinators). Use results to determine course of action to either pursue further

grass carp marker development for markers that can be multiplexed with current AC markers or with alternate AC markers or otherwise if detections are found at a high rate within cases and found in a wide spatial area in several cases.

Result: In progress. qPCR assays are complete, awaiting sequence confirmation which is in progress, pending instrument repair.

Genome Sequencing:

Obtain samples of tissue from fresh silver carp tissue by coordinating with carp monitoring field teams and extract DNA, N=4 animals, 2 males and 2 females. Purchase reagents and supplies for Illumina NextSeq500 instrument and collect raw data. Each of the 4 specimens will be processed individually to maximize depth and coverage of the entire genome, each run will generate about 400 million sequence reads which will be stored digitally.

Outcomes:

- Grass Carp eDNA marker to be used as part of eDNA surveillance program.
- Sequence Silver Carp genome to provide data as baseline information available to researchers for monitoring and control work.

53. Use of Complex Sound to Alter Behavior of Asian Carp

Lead Agency: USGS

Agency Collaboration: USFWS, University of Minnesota-Duluth

Funding Tables:

Funding	Agency Funding			GLRI Funding		
	USGS	USFWS	Total	USGS	USFWS	Total
FY 2016	\$0	\$0	\$0	\$200,000	\$100,000	\$300,000
FY 2017	\$0	\$0	\$0	\$0	\$0	\$0

*Original allocation of \$100,000 was granted to USFWS. An additional \$200,000 was allocated to USGS for supplemental work described below.

Project Description: Currently, prevention of the movement of both Bighead carp (*Hypophthalmichthys nobilis*) and Silver Carp (*H. molitrix*) from the Illinois River into southern Lake Michigan relies on an electric barrier. This barrier has been found to be less effective on small fish and its’ effectiveness is dependent on water quality so additional barriers and/or supplements to the electric barrier are highly desired. The use of multiple barrier technologies would improve the efficacy of deterring Asian carp movement into the Great Lakes through redundancy and create a ‘buffer zone’, which should offer greater confidence in their containment.

Some work has been done to identify potential biological and physical techniques that are candidates for barriers that may serve to deter the movement of Bighead Carp and Silver Carp while allowing for shipping to continue. One candidate barrier that has received a great deal of attention has been the use of complex sound. Previous studies have indicated that both species react negatively to sound. These studies have indicated that the Asian carp will repeatedly respond to complex sound while many native fish respond little to that same sound, but some basic questions still need to be answered. For example, no studies have assessed whether Asian carp can hear high frequencies that are outside of the hearing range of most native fishes. Nor has the optimal sound level been determined to ensure minimal to no damage occurs with the deployment of an acoustic barrier. Therefore, the goal of this project is to determine the optimal sound frequencies and amplitudes to optimize repulsion while preventing injury to native species.

In collaboration with USGS, USFWS will field test sound and bubble arrays to further deter Asian carp movement throughout the Illinois Waterway. Efforts will take place within the Illinois Water Way at locations such as Copperas Creek or Peoria Lock and Dam. These two sites have been determined to be ideal sites for pilot investigations on the use of complex sound and/or BAFF technology, to test the ability of these technologies to deter AC movements. Work will be conducted by the USFWS, in collaboration with the ILDNR and the USGS, to install, assess, and evaluate the efficacy of these tools in a field setting. This project will be conducted using a proof of concept approach, and is being completed to gain expertise in using these technologies. Additional support could be provided to an existing USGS sound investigation at the Starved Rock Lock and Dam.

FY 2016 Actions: Initial implementation of sound deterrent technology at an IWW site (such as Copperas Creek or Peoria Lock and Dam) as a proof of concept study. Support may also be given to the USGS to assist in their planned sound investigation work at Starved Rock Lock and Dam.

FY 2017 Actions: Studies could be continued as needed based on preliminary data collection in 2016.

Expected Milestones:

- Report on effectiveness of sound as a deterrent technology at locations specific to the IWW.

60. Grass Carp Eradication in Western Lake Erie

Lead Agency: Michigan Department of Natural Resources (Michigan DNR)

Agency Collaboration: Ohio Department of Natural Resources (Ohio DNR), Department of Fisheries and Wildlife; USGS, and USFWS

Additional agency supporters: Pennsylvania Fish and Boat Commission, New York Department of Environmental Conservation, Ontario Ministry of Natural Resources and Forestry

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$150,000*	\$270,000*
FY 2017	\$150,000*	\$150,000

*State match is salary and travel, etc. support of Michigan DNR Fisheries Division Aquatic Invasive Species Coordinator who will lead this effort.

*Original allocation of \$200,000 was granted to USFWS for MI DNR. An additional \$70,000 was allocated for supplemental work described below.

Project Explanation: Grass carp are the only species of Asian carp that are currently captured in the Great Lakes, Lake Erie in particular. This species of Asian carp poses a high risk to the Great Lakes and has the ability to greatly alter habitats that are critical for many native fish and other organisms. Recent evidence from Lake Erie indicates that the majority of grass carp are fertile and have the ability to reproduce in tributaries of Lake Erie. The presence of fertile fish that are being captured more frequently by commercial fishers in recent years highlights the need to use a scientifically based approach for developing an eradication plan for grass carp in Lake Erie.

Recent research projects funded through the GLRI have provided information that can be used to inform an eradication management strategy. Although some population demographic information exists, information remains limited and therefore the need to complete a structured decision analysis exists to guide difficult decisions related to developing and implementing a grass carp adaptive management framework for Lake Erie. As part of this project a decision analysis will be completed with input from Lake Erie fisheries managers, scientific experts, and regional stakeholders with facilitation from Michigan State University's Quantitative Fisheries Center. The decision analysis will consist of conducting workshops where participants will identify objectives related to eradicating grass carp from Lake Erie and discuss the control options available and uncertainties that might limit eradication success. The objectives will then be used to inform and construct a grass carp population model that can be used to evaluate the effectiveness of different eradication action plans, which will ultimately inform the Grass Carp Adaptive Management Framework for Lake Erie. The process will also highlight what additional information might be critical to collect to increase the likelihood of success eradication. The decision analysis process that is proposed here has been used successfully to inform the invasive sea lamprey control program in the Great Lakes and can greatly advance grass carp eradication efforts in Lake Erie. In addition, the decision analysis process can also be applied to potential future scenarios in the Great Lakes or other regions where Asian carp are established or might be introduced, which will ultimately increase agency response abilities in the future because it provides a process to scientifically guide and if needed adapt eradication/control efforts to achieve desired outcomes.

Multiple Structured Decision Analysis workshops will be hosted by the Michigan DNR in partnership with the Quantitative Fisheries Center at Michigan State University. The workshops will be an inclusive process that will be needed to determine regionally agreeable objectives for grass carp control in Lake Erie. The results of the workshops will then be used to develop a science based Adaptive Management Framework for grass carp eradication in Lake Erie. The additional funding for this project will be used to host the workshops, provide travel assistance to participants, provide highly skilled facilitators, and provide financial assistance for the grass carp model development that will be used to evaluate the effectiveness of various potential control actions.

FY 2016 Actions:

- Host structured decision analysis workshops facilitated by Michigan State University's Quantitative Fisheries Center. Participants will include Lake Erie fisheries managers, Asian carp experts, and interested stakeholder groups from various agencies throughout the Great Lakes Basin.

Expected Milestones:

- Completion of structured decision analysis workshops to determine grass carp objectives and a population model to evaluate control actions in Lake Erie. The inclusivity of the decision analysis process will ensure objectives and model structure are widely agreed upon.
- Results from structured decision analysis will be used to develop, implement, and evaluate the Adaptive Management Framework for grass carp eradication in Lake Erie.

Outcomes/Outputs:

- All existing grass carp data summaries will be presented to all interested parties during decision analysis workshops and will be used to develop an Adaptive Management Framework for the eradication of grass carp in Lake Erie.
- Fisheries managers will be better informed and have a science based strategic document to guide eradication efforts in Lake Erie.
- Fisheries agencies will participate in a formal Structured Decision Analysis process and be better prepared to conduct a similar analysis if bighead and/or silver carp were detected in the Great Lakes.

Potential Hurdles:

- Future funding to implement and evaluate strategies developed during the structured decision analysis workshops and drafted in the Adaptive Management Framework document.