

## Great Lakes Panel on Aquatic Nuisance Species *Grass Carp Priorities for the Great Lakes*

April 2015

### **Overview**

Grass Carp (*Ctenopharyngodon idella*) is emerging as an aquatic invasive species of concern in the Great Lakes region. Individual captures of Grass Carp have been reported in the Great Lakes since the 1980s, including lakes Michigan, Erie, Huron, and Ontario (Whitmann, et al. 2014, Nico, et al. 2013). Most recently, U.S. Geological Survey research indicates successful spawning activity in the Sandusky River, Ohio (Chapman et al. 2013). Grass Carp poses a threat to the Great Lakes ecosystem due to its ability to rapidly consume large amounts of plants. Significant changes in plant communities can induce changes in invertebrate and fish communities, ultimately altering the food web and trophic structure of aquatic systems (Whitmann, et al. 2014, Bain 1993). Grass Carp presents a unique management challenge for a variety of reasons, including, but not limited to:

- Grass Carp is widely recognized as an effective biological control agent for aquatic macrophytes. Active production and stocking of Grass Carp in the U.S. has been ongoing since the 1960s and continues today for this purpose.
- A type of sterile Grass Carp, known as triploid, was developed to address concerns regarding the potential for non-sterile diploid Grass Carp to develop self-sustaining populations in U.S. river systems (where it is not wanted), while still allowing its use for macrophyte control.
- The development of technology to produce triploid Grass Carp came after Grass Carp had already established populations across the U.S., including the Mississippi River basin (which connects to the Great Lakes basin).
- Recent evidence suggests a potential reproducing population of Grass Carp in the Sandusky River system (Ohio) of the Great Lakes.
- Regulations regarding use, possession, and sale of both triploid and diploid Grass Carp vary by state and province across North America and in the Great Lakes region, as do management philosophies. As a result, preventing the movement of Grass Carp into areas where they are unwanted is challenging. For instance, several states, including Missouri, Kansas, Iowa, Arkansas and Alabama, currently have no restrictions on purchase and stocking of diploid Grass Carp.
- Diploid Grass Carp, while posing an aquatic invasive species concern, are needed for the production of triploid Grass Carp and are less expensive to produce than triploid.
- Intentional and unintentional Grass Carp pathways of introduction include: escape from stocked locations; transport and sale of live fish, including for use in live fish markets; unintentional stocking of triploid stocks contaminated with diploid fish; unintentional stocking with Channel Catfish due to polyculture with Grass Carp; illegal stocking; and sale or release of wild-caught bait fishes unintentionally contaminated with diploid Grass Carp.

The need to address the risks associated with Grass Carp nationally is well documented in the “Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States” (Conover et al. 2007), which includes a series of important recommendations to improve the national management framework and to prevent further introduction and spread of these species. One of those recommendations is to conduct an independent, scientific review of the National Triploid Grass Carp Certification Program to evaluate its effectiveness and to recommend, if necessary, reasonable actions that would improve its integrity, efficiency, and effectiveness at preventing the movement of diploid stocks. This review, led by the Mississippi Interstate Cooperative Resource Association (MICRA), yielded eight recommendations and a report<sup>1</sup> that concludes “a national policy strategy is needed to effectively minimize the risks of additional fertile and sterile grass carp introductions in the Great Lakes” (USFWS 2015). Within the Great Lakes region, Fisheries and Oceans Canada, USGS, and USFWS, in partnership with the Great Lakes Fishery Commission, are currently undertaking a comprehensive binational risk assessment for Grass Carp in the Great Lakes basin. Furthermore, the Governors and Premiers of the Great Lakes states and provinces identified Grass Carp as one of a number of “least wanted” invasive species and committed to taking action to block these species from entering the Great Lakes basin (CGLG 2013).

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<sup>1</sup> Report available online at: <http://www.micrarivers.org/resource-materials/micra-documents/category/15-micra-reports.html>.

### ***Statement of Purpose***

The Great Lakes Panel on Aquatic Nuisance Species (GLP) recommends that action be taken to prevent further introduction, spread and establishment of Grass Carp to protect environmental, recreational and economic sustainability within the Great Lakes-St. Lawrence River basin. Many stakeholders must take part in these actions, including the general public, government agencies and jurisdictions, research scientists, natural resource managers, private industry and policy makers, among others. The GLP offers the following statement of priorities as a resource to guide agencies and funding entities, and to empower stakeholders to take action and support efforts that address priority research, policy, information and education needs related to Grass Carp. These priorities draw on emerging information and research, as well as recommendations from the National Plan. It is expected these priorities will continue to evolve as new information is available. Although work is underway for some of the priorities as described below, further progress is needed.

**Goal:** Prevent establishment and new introductions of Grass Carp into the Great Lakes basin.

### ***Policy Priorities***

Consistent policies to prevent movement of aquatic invasive species (AIS) across political boundaries are needed to reduce the risk to the region where weak regulations of one state or province increase the region-wide risk of species introductions (Peters and Lodge 2009). To this end, the National Plan recommends that states work together to regulate Grass Carp based on a national (or region-wide) strategy as opposed to the current state-by-state approach. Continued stocking of diploid Grass Carp exacerbates undesirable environmental consequences, directly conflicts with efforts to prevent their spread and reduce feral populations, and is counter-productive to natural resource management agencies' efforts to increase public involvement in preventing the introduction and spread of AIS. Triploid Grass Carp are an economical alternative with a reduced risk of establishing self-sustaining populations and fit into a more responsible stewardship model. Consistent state regulations requiring the shipment and stocking of certified triploid Grass Carp only, combined with state enforcement, could contribute to further risk reductions. Possession of diploid Grass Carp can be prohibited or restricted through permits to licensed or authorized triploid Grass Carp producers. This effort could be facilitated and supported if states and provinces develop a shared philosophy for the cooperative management of a commercially traded non-native species using a national (or regional) strategy. That such a philosophy can work is evidenced by the fact that, recently, Kansas and Oklahoma have changed from allowing the stocking of diploid Grass Carp to requiring the use of triploid Grass Carp. Therefore, the Policy Coordination Committee of the GLP recommends that the following policy priorities, which are consistent with the National Plan<sup>2</sup>, be pursued to help achieve the aforementioned goal of preventing Grass Carp establishment and introduction in the Great Lakes basin.

- Strengthen the National Triploid Grass Carp Inspection and Certification Program based on the results of the independent program review.
- Encourage commensurate regulation among states that prohibit the stocking of diploid grass carp and allow only certified triploid grass carp to be shipped or stocked. (Appendix A)
- Natural resources management agencies should require routine and random inspections – which may require collaboration between agencies within a jurisdiction (e.g. Department of Natural Resources and Department of Agriculture) – of known and suspected live grass carp shipments to encourage compliance and deter non-compliance with existing or new regulations.
- Improve understanding of existing shipping and stocking activities to inform enforcement activities and future policy development by
  - developing a list of certified grass carp transporters; and
  - assessing the extent to which grass carp are actively stocked in the Great Lakes region.

### ***Information and Education Priorities***

The GLP recognizes that many U.S. and Canadian agencies and organizations are leading important AIS outreach efforts in the Great Lakes and St. Lawrence River region. Recent information/education (I/E) efforts have targeted Asian carps, including Silver, Bighead, Black and Grass Carp. Asian carp laws and regulations differ among jurisdictions and change over time, continually challenging I/E efforts by the GLP and its

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<sup>2</sup> Refer to the National Plan for additional detail and background.

members. Currently, the Great Lakes Sea Grant Network, led by Ohio Sea Grant, is conducting research to identify and assess current outreach for Asian carp. With a focus on identifying current needs and assessing resources for filling gaps, they will likely develop recommendations for future I/E messaging regarding Asian carps. The U.S. federally led Asian Carp Regional Coordinating Committee (ACRCC) maintains a Communications Working Group to address communication needs related to Asian carps, specifically Silver and Bighead Carp (<http://asiancarp.us/>). In addition, the Asian Carp Canada Project is a centralized resource for Asian carp information in Canada (<http://asiancarp.ca/>). However, I/E needs are not being specifically or adequately addressed for Grass Carp. Therefore, the GLP I/E Committee recommends that the following I/E priorities be pursued to support improved I/E for Grass Carp to help prevent their introduction and establishment in the Great Lakes basin.

- Use existing forums, including the GLP I/E Committee, the ACRCC Communications Work Group, and the Great Lakes Sea Grant Network, to coordinate outreach and ensure that efforts in the U.S. and Canada are aligned.
- Through the aforementioned forums, develop clear, concise and consistent messages for use in I/E materials, emphasizing threats, methods of prevention, laws and regulations, and mechanisms to report suspicious sightings to appropriate authorities.
- Encourage partners to join and leverage resources through the *Stop Aquatic Hitchhikers!*<sup>TM</sup> campaign to promote best practices regarding the disposal of unwanted live bait and other activities that will reduce the risk that Asian carps will be released through potentially contaminated live bait.
- Communications strategies and I/E messages and/or materials should acknowledge the differences in each jurisdiction's regulations regarding managing and responding to Grass Carp, including differences relating to diploid and triploid Grass Carp.
- Encourage and work towards consistent policies regarding possession, transport, and use of Asian carps, including Grass Carp.

### ***Research Priorities***

Information on reported collections of Grass Carp is available through the USGS Nonindigenous Aquatic Species Database (<http://nas2.er.usgs.gov/viewer/omap.aspx?SpeciesID=514>). However, the extent of spawning activity, establishment status and risk of further Grass Carp introductions to the basin remain unclear. Without this information, it is difficult to target prevention and control efforts. Thus, the Research Coordination Committee of the GLP recommends that coordinated activities be implemented to assess the current status of Grass Carp in the Great Lakes basin and identify current sources and risk of further introduction to inform surveillance and management activities so these pathways can be closed and establishment prevented. To implement this recommendation, the Committee supports the following priority activities:

- Quantify past stocking introductions to assess the scale and extent of the potential threat
  - Collate data on historic introductions of triploid and diploid Grass Carp into the Great Lakes basin (i.e., sites, numbers, ploidy status) to quantify potential scale of introductions and identify locations with the greatest historic introduction pressure.
- Determine the extent, origin and nature of any natural Grass Carp recruitment within the Great Lakes basin through:
  - Targeted surveillance and outreach/education to maximize collections of any Grass Carp captured through targeted surveys or as incidental bycatch.
  - Record location of capture and determine ploidy status (e.g., diploid versus triploid) of captured Grass Carp.
  - Undertake analysis of otolith microchemistry of captured fish to determine fish origin, where recruitment is occurring (for diploid fish), extent of recruitment and movement within the Great Lakes basin.
  - Record additional life history and reproductive information (per standardized protocols in Appendix B) from all captured Grass Carp to improve understanding of Great Lakes recruitment dynamics.
- Undertake movement studies to identify preferred habitats, home range and seasonal movement patterns to inform management strategies.
- Determine whether diploid Grass Carp are still being imported into the basin:

- Undertake surveillance and monitoring of key pathways of legal and illegal importation of Grass Carp to quantify the level of diploid contamination and movement of diploid stocks into the basin.
- Quantify the levels of diploid contamination of Grass Carp stocks by monitoring importations of certified triploid Grass Carp to assess effectiveness of USFWS National Triploid Grass Carp Inspection and Certification Program.

In addition, the Research Coordination Committee recommends the following priorities related to data coordination and communication.

- Grass Carp data collection should be coordinated and communicated to help federal, state and provincial management and research entities better understand the scale of the problem, to facilitate a regional analysis and ensure information collected from any Grass Carp captures is maximized. \*
  - Develop a guidance document for data sharing and external communication.\*
  - Explore housing this collection information within appropriate regional or national entities that facilitates open access to all the data.
- Broaden the collection of Grass Carp through other means such as commercial fishers, power plants and other industrial facilities to enhance datasets.
- Adopt standardized protocols for collection and analyses of specimens to ensure data standards, quality assurance and that all relevant information is collected from all Grass Carp captured in the basin, including but not limited to information on ploidy, otolith micro-chemistry, reproductive and life history characteristics. (Appendix B)
- Identify which laboratories are available and have capacity and equipment to undertake appropriate elemental analysis of Grass Carp otoliths.\*

*\*Indicates a possible activity for the Research Coordination Committee to undertake.*

## References

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## APPENDIX A: Grass Carp regulations by Great Lakes jurisdiction

*Adapted from information prepared by Jill Wingfield, Great Lakes Fishery Commission*

	<b>DIPLOID</b>	<b>TRIPLOID</b>
<b>ILLINOIS</b>	All activities banned	May be imported, transported, or stocked with Restricted Species Transportation Permit from DNR <sup>3</sup>
<b>INDIANA</b>	Can be permitted in a closed aquaculture facility but only for the production of triploids (no facilities currently permitted).	May be cultured and sold with permit and reporting requirements
<b>MICHIGAN</b>	All activities banned <sup>4</sup>	All activities banned <sup>4</sup>
<b>MINNESOTA</b>	All activities banned	All activities banned
<b>NEW YORK</b>	All activities banned	May be imported, possessed and stocked by permit only <sup>5</sup>
<b>ONTARIO</b>	Live sale and possession banned; not approved for culture	Live sale and possession banned; not approved for culture
<b>OHIO</b>	Importation prohibited; commercial harvest permitted	May be imported, stocked and sold with permit from Chief, Ohio DNR Division of Wildlife <sup>5</sup> ; commercial harvest permitted
<b>PENNSYLVANIA</b>	All activities banned	May be sold and possessed by permit from the Fish and Boat Commission <sup>5</sup>
<b>QUEBEC</b>	All activities banned	All activities banned
<b>WISCONSIN</b>	All activities banned <sup>6</sup>	All activities banned <sup>6</sup>
<b>CANADA</b>	Live importation banned <sup>7</sup>	Live importation banned <sup>7</sup>

*Note: The MICRA report on Grass Carp includes a summary of regulations across the U.S.*

<http://www.micrarivers.org/resource-materials/micra-documents/category/15-micra-reports.html>

<sup>3</sup> Must be greater than four inches

<sup>4</sup> Listed as a prohibited species M.C.L.A. 324.41301; regulations technically allow possession under certain circumstances and with a permit under M.C.L.A. 324.41303 (e.g., research, education, eradication activities)

<sup>5</sup> Must be certified

<sup>6</sup> Listed as a prohibited invasive species NR40.04 (2)(c)(2); regulations technically allow transportation, possession, transfer, and introduction with permit from DNR but a permit has never been issued for such activities

<sup>7</sup> Canada's proposed Aquatic Invasive Species Regulations pursuant to subsections 34(2), 36(5) and 43(1) of the Fisheries Act. <http://www.gazette.gc.ca/rp-pr/p1/2014/2014-12-06/html/reg1-eng.php#reg>

## APPENDIX A: Grass Carp regulations by Great Lakes jurisdiction

SOURCE: National Analysis of Grass Carp (*Ctenopharyngodon idella*) Regulation, Production, Triploid Certification, Shipping and Stocking. August 15, 2014. Prepared for: Mississippi Interstate Cooperative Resource Association (MICRA). Agreement #: MICRA-12-001. Prepared by: HDR Engineering, Inc.  
Available at: <http://www.micrivers.org/resource-materials/micra-documents/category/15-micra-reports.html>

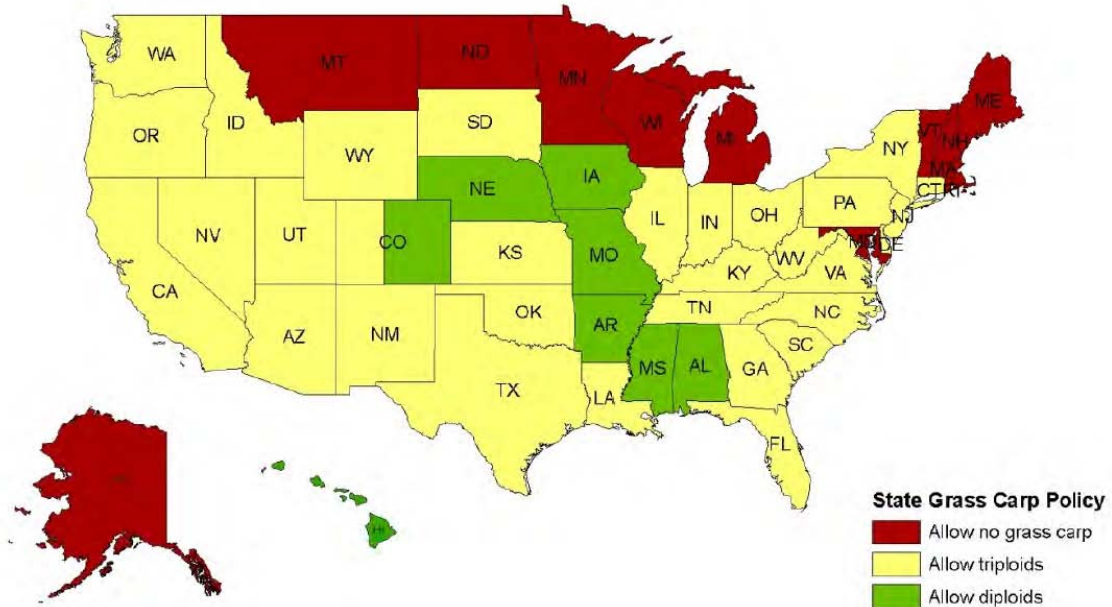


Figure A. Type of Grass Carp Allowed for Each State

## **APPENDIX B: Shipping, Handling, and Data Protocols for Wild Captured Black Carp and Grass Carp**

*Development of the following protocols was coordinated by the Mississippi River Basin Regional ANS Panel as way to maximize and standardize the information gathered from Grass Carp and Black Carp specimens in the Mississippi River and Great Lakes basins. The protocols have also been adopted as part of the Asian Carp Regional Coordinating Committee's Monitoring and Rapid Response Plan. Any agency or entity working in the Great Lakes basin that collects one of these fish is encouraged to follow these protocols, working with their state, provincial or federal resource management agency as needed.*

## Shipping, Handling, and Data Protocols for Wild Captured Black Carp and Grass Carp

Any suspect black carp collected in the wild in the United States and grass carp collected in the Great Lakes Basin, or other novel locations in the U.S., should be immediately reported to the appropriate resource management agency in the state where the fish was collected. These protocols are **not** intended for grass carp collected from established populations in the Mississippi River Basin or authorized stocking locations. Do **not** release any suspect black carp, or grass carp collected in the Great Lakes Basin, unless required by state laws or instructed to do so by the resource management agency.

Differentiating black carp from grass carp using diagnostic external characteristics can be very challenging, especially when the two species are not being compared side-by-side. An identification fact sheet is attached for your reference. Careful attention should be given in waters where grass carp are known to occur to confirm that captured individuals are indeed grass carp and not black carp. If you are not positive of the species identification you should report the collection to the appropriate resource management agency to get assistance and further instructions.

Collection information, basic biological data, and digital images should be collected for any suspect black or grass carp as soon as possible after capture. In addition to collection and basic biological data, we are interested in collecting multiple structures and organs from each fish for management and research purposes. Protocols are provided for 1) collection information, basic biological data, and digital images; 2) removal, preparation, and shipment of eyes for ploidy analysis; and 3) preparation and shipment of black and grass carp carcasses.

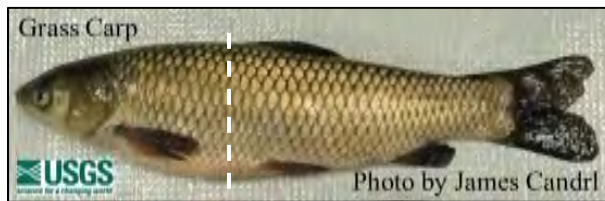
These protocols are intended to provide resource management agencies, or authorized personnel, with complete instructions for the proper collection, preparation, and shipping of data, samples, and carcasses for the collection of as much biological information as possible. It is important that all collections of black and grass carp (from the identified locations above) are immediately reported to the appropriate resource management agency in the state where the fish was collected.

Any questions regarding these protocols may be direct to Jennifer Bailey ([jennifer\\_bailey@fws.gov](mailto:jennifer_bailey@fws.gov) or 608-518-0128) or Greg Conover ([greg\\_conover@fws.gov](mailto:greg_conover@fws.gov) or 618-889-9600).



**Step 1: Data Collection**

1. Record GPS Location (if available, otherwise a description of collection location);
2. Record date of capture, method of capture, and collecting individual or agency. Record fish weight, girth (Figure 1), total and fork lengths, and species (number samples if necessary);
3. Take high resolution digital pictures:
  - a. Lateral view of fish's entire left side (Figure 1),
  - b. Close-up lateral view of head (Figure 2),
  - c. Dorsal view of head with mouth **fully** closed taken from directly above the fish's head (Figure 3);
4. Record name, telephone number, and/or email address for point of contact;
5. E-mail data and digital images to Jennifer Bailey at [jennifer\\_bailey@fws.gov](mailto:jennifer_bailey@fws.gov) (data will be provided to USGS NAS database managers);
6. Proceed to Step 2.



**Figure 1. Example of step 4.a: Lateral view of fish's entire left side. Dashed white line indicates location for girth measurement.**



**Figure 2. Example of step 4.b: Close-up lateral view of head.**



**Figure 3. Example of step 4.c: Dorsal view of head with mouth fully closed.**

## **Step 2: Eyeball Removal, Sample Preparation, and Shipping Procedures for Ploidy Analysis**

### **Materials:**

- Forceps; scalpel; blunt or curved scissors
- Permanent marking pen
- 50-100 ml plastic containers with leak-proof screw top cap
- Sealable plastic bags to fit several 50-100 ml containers
- Contact lens solution or saline (0.8-1.0% NaCl in DI water)
- MS-222 or other means of euthanasia
- Optional: methanol if freezing and storing samples longer than 8 days
- Cooler or insulated container with ice packs, packing tape to seal cooler

*NOTE: Contact the Whitney Lab if you have questions regarding the materials needed or to request assistance with preparing a kit for sample preparation and shipment.*

### **Procedure for Removing Carp Eyeballs:**

1. Euthanize fish with an overdose of tricaine methanesulfonate (MS-222) or sharp blow to head.
2. Label a small, plastic container with collection date, species, and sample number if applicable (e.g. 25MAR13, black carp, #12).
3. Use forceps to hold the eyeball steady. Taking care not to puncture the eyeball, insert scalpel blade between the eyeball and socket wall with the blade pointed outward toward the socket wall. Cut around the circumference of the eyeball until the eyeball moves freely in the socket.
4. Use the blunt or curved scissors to reach behind the eyeball and cut the optic nerve. Once the optic nerve is cut, you should be able to remove the eyeball and trim off any excess tissue.
5. Remove the other eyeball from the same fish and place both eyeballs in the same labeled container.
6. Follow appropriate Eyeball Sample Preparation and Shipping Procedures below.

### **Eyeball Sample Preparation for Overnight Shipment or Storage up to 8 Days:**

Shipment of eyeballs on day of collection or as soon as possible will provide the highest quality of samples for analysis.

1. Pour contact lens solution or saline into the labeled container until full. Both eyeballs should be completely immersed. Close lid tightly. Maintain at 4 to 8°C.
2. Place container(s) in a sealable plastic bag to contain leaks and keep refrigerated or on ice until shipping arrangements can be made with Whitney Genetics Lab staff.
3. Follow Eyeball Shipping Procedures below.
4. Proceed to Step 3.

### Eyeball Sample Preparation for Storage Longer than 8 Days:

If samples cannot be shipped within 8 days, or if many samples will be collected over a known period of time, you can store and ship all together.

1. Fill labeled container to top with 20% methanol in contact lens solution or saline. Both eyeballs should be completely immersed. Close lid tightly. Maintain at 4 to 8°C.
2. Place container(s) in a sealable plastic bag to contain leaks and refrigerate overnight to allow methanol to diffuse into eyeballs.
3. Move samples to a freezer (-20°C). Store frozen until overnight shipment can be arranged. Sample quality will not degrade as long as sample remain frozen (-20°C) until shipment.
4. Follow Eyeball Shipping Procedures below.
5. Proceed to Step 3.

### Eyeball Shipping Procedures:

1. Contact Whitney Genetics Lab personnel on day of collection or as soon as possible to make Overnight Priority shipping arrangements.
2. Do **NOT** ship samples until arrangements have been made for receipt of package.
3. Pack samples in a Ziploc bag to prevent leakage and then enclose in a sealed, insulated container with ice packs to maintain 4 to 8°C. Do **NOT** use dry ice for shipping. Include collection data and GPS sampling locations (and sample number if necessary) with package. If using a cooler for shipping, make sure lid is taped securely.
4. Ship priority overnight to the attention of Whitney Genetics Lab Contact.
5. Email confirmation of shipment and tracking numbers to recipient. You may include collection data, digital images, and GPS sampling location with this email.

### Contact Information:

Jennifer Bailey – fish biologist  
608-783-8451  
608-518-0128 (mobile)  
[jennifer\\_bailey@fws.gov](mailto:jennifer_bailey@fws.gov)

Nikolas Greuneis - fish biologist  
608-783-8404  
608-518-0129 (mobile)  
[nikolas\\_grueneis@fws.gov](mailto:nikolas_grueneis@fws.gov)

### Shipping Address:

Whitney Genetics Lab – La Crosse Fish Health Center  
U.S. Fish and Wildlife Service Resource Center  
555 Lester Ave, Onalaska, WI, 54650  
608-783-8444

### **Step 3: Carcass Preparation and Shipping Procedures**

Several external and internal samples will be analyzed from both black carp and grass carp collections. Fish may be shipped whole to the USGS lab for processing, however for large specimens it may be necessary to ship only the head (Figure 4). When possible, the entire gut from all black carp and gonads from Great Lakes Basin grass carp should accompany head shipments.

*Note: The USGS lab may be contacted to discuss shipping options, instructions for the collection of gut or gonad samples, and payment of shipping fees as needed.*



**Figure 4.** Dashed white line indicates approximate location for severing head from large specimens. Cut should be made far enough behind the head to include several vertebrae and pectoral fins.

#### **Carcass Sample Preparation for Overnight Shipment:**

If possible, *ship samples immediately on ice on same day of catch*. Otherwise, freeze the carcass before shipping. *Note: Prior to freezing Great Lakes Basin grass carp, gonads should be pulled and weighed whole when possible. Include a subsample of the pulled gonads that have been maintained at 4C – 8C (refrigerated, not frozen) with the carcass shipment.*

1. Pack entire specimen (with eyes extracted) in an insulated container with plenty of ice packs, frozen water bottles, or ice to keep cool. Do **NOT** use dry ice for shipping.
2. Include collection data (and sample number if necessary) in double ziplock bag in container.
3. Seal container to contain leaks. If using a styrofoam cooler within a box, make sure the lid is taped and sealed securely.
4. Ship immediately or keep frozen until Overnight Priority shipping arrangements are made.

#### **Carcass Shipping Procedures:**

1. Contact Columbia Environmental Research Center personnel to make Overnight Priority (for morning delivery) shipping arrangements.
2. Do **NOT** ship samples until arrangements have been made for receipt of package.
3. Ship specimen in sealed, insulated container (see sample preparation instructions above) priority overnight to the attention of Duane Chapman or Joe Deters.
4. Email confirmation of shipment and tracking numbers to ([dchapman@usgs.gov](mailto:dchapman@usgs.gov)).

Contact Information:

Duane Chapman  
573-875-5399  
573-289-0625 (mobile)  
[dchapman@usgs.gov](mailto:dchapman@usgs.gov)

Joe Deters  
573-875-5399  
573-239-9646 (mobile)  
[jdeters@usgs.gov](mailto:jdeters@usgs.gov)

Shipping Address:

Duane Chapman or Joe Deters  
Columbia Environmental Research Center  
U.S. Geological Survey  
4200 New Haven Road  
Columbia, MO 65201  
573-875-5399