

eDNA OVERVIEW

Environmental DNA (eDNA) is a surveillance tool used to monitor for the genetic presence of an aquatic species by sampling the environment for traces of genetic material left by a particular species. All fish, including Asian carp, release DNA into the environment. The potential presence of individual species can be detected by collecting water samples, then DNA is extracted from those samples and identified using species specific genetic markers. Currently, eDNA is used to monitor for the genetic presence of Bighead Carp and Silver Carp, two species of Asian carp, as an early detection tool for many state and federal monitoring programs. By sampling waters that could potentially be invaded by these species, the detection of their DNA can indicate the potential presence of the fish itself.

Compared to traditional methods for surveying of aquatic species (netting, electrofishing, rotenone application, etc.), the increased sensitivity of this method could be a valuable asset not only for invasive species but for threatened and endangered species, as well. Other benefits of this method are the elimination of potential harm to other species during collection, and the ability to sample a relatively large area in a short amount of time. As new markers for other species are developed and published, the use and application of eDNA is expected to be integrated as a regular, standardized surveillance tool for aquatic science and species management.

USACE began using eDNA in cooperation with the University of Notre Dame (UND) in August 2009 to monitor waters for Asian carp in the Illinois Waterway above the Aquatic Nuisance Species barrier operated by USACE. UND collected and analyzed samples for the presence of Bighead Carp and Silver Carp DNA throughout the Chicago Area Waterway System (CAWS) until June 2010. From June 2010 to November 2012, USACE was the lead agency for collection and processing of eDNA samples. All eDNA samples were processed by the Engineer Research and Development Center Environmental Lab, Center for Environmental DNA Application and Research (ERDC-CEDAR), located in Vicksburg, MS. Following a **transition plan** and two-year partnership, the lead for the eDNA surveillance program seamlessly transitioned from ERDC-CEDAR to the USFWS's new Whitney Genetics Lab in Onalaska, Wisconsin in spring 2013.

Previous eDNA monitoring in the CAWS, as well as the transition to USFWS, was accomplished utilizing Great Lakes Restoration Initiative (GLRI) funding through the **Asian Carp Control Strategy Framework**.

QAPP

The **Quality Assurance Project Plan (QAPP): eDNA Monitoring of Bighead and Silver Carps** provides standard quality control/quality assurance procedures for the collection, processing, and data reporting for eDNA sampling. The document outlines detailed procedures for Asian carp eDNA sample collection, sample processing (including filtering, centrifuging, DNA extraction, PCR, biomarker analysis, DNA sequencing), data reporting, and quality control/quality assurance protocols to ensure that data are as technically defensible, consistent, and usable as possible. The QAPP ensures continuity among all agencies involved in eDNA sampling activities by setting the same protocols for the collection and processing of eDNA samples. The QAPP was developed by the USACE-USFWS team based on initial protocols from UND, and has been peer-reviewed; the processes and methods have been **audited** by the U.S. Environmental Protection Agency, verified in at least three independent federal labs as well as academic labs, and the methods have been evaluated by an Independent External Peer Review (**IEPR**). Released fall of 2011, the eDNA IEPR, conducted by objective panelists with technical expertise in genetics and population ecology, confirmed eDNA sampling and testing methodology is sound for detecting silver and bighead carp DNA but cannot indicate the source of Asian carp DNA (information on the size, gender, number and age of individuals present and cannot distinguish between pure silver or bighead carp and their hybrids). The USACE and UND response to these concerns can be found **here**.

Based on the levels of peer review, collaboration, and federal oversight, it is strongly recommended that all users of eDNA for bighead and silver carp monitoring follow the QAPP.

LINKS:

USFWS: this website houses the entire current Midwest region eDNA sampling results processed by the USFWS Whitney Genetics Lab. The USFWS is the lead Federal agency for the processing of eDNA samples collected in the Great Lakes, Ohio River, Upper Mississippi, and Illinois Waterway basins. You can find previous eDNA sample results from the CAWS on the **USACE webpage**.

ADDITIONAL RESEARCH:

As discussed above, eDNA has been used as an early detection surveillance tool for Asian carp since 2009. It provides information about whether Asian carp DNA is present in water samples (reported as a positive detection). What it doesn't tell researchers and managers is if the genetic material came from a live or dead fish, one fish or several, or if the eDNA may have been transported from other sources (e.g., navigation vessels or fish-eating birds). Due to the two-week sample processing time, eDNA cannot yet provide precise, real-time, information about where Asian carp might be.

To improve the understanding of eDNA results, the ACRCC funded (with GLRI) a study known as the eDNA Calibration Study (**ECALS**). This interagency effort (USACE, USGS, USFWS) is aimed to improve the application of eDNA and interpretation of eDNA results, and ultimately to provide managers a context of how to use eDNA as a more precise monitoring tool. The entire study with objectives, results, and peer-reviewed reports can be found [here](#). ECALS investigates alternative sources and pathways for eDNA detections beyond a live fish. The study also examines how environmental variables such as light, temperature and water velocity impact eDNA detections; explores the effects of degradation and persistence of eDNA in the environment; and is developing more efficient eDNA markers to cut the sampling processing time in half and models eDNA transport specific to the CAWS.

ECALS has indicated that other sources of DNA beyond a live fish include fishing gear and barges that travel from areas with high numbers of Asian carp. Bird-tagging studies show that some carp-eating birds can travel 800 miles, which may lead to positive detection of Asian carp eDNA from bird feces. The team also found that although there is no correlation between water temperature and eDNA shedding rates, fish that are fed shed about ten times more DNA than non-fed fish. And that although the majority of DNA seems to degrade rapidly in the environment over a few days, there is still a small portion that can persist in the environment for up to a month.

eDNA notable presentations:

September 2013 Briefing to Congress hosted by the Northeast Midwest Institute. Honorary cosponsors of this briefing are Senate and House Great Lakes Task Force Co-Chairs Senator Carl Levin, Senator Mark Kirk, Congresswoman Miller, Congressman Dingell, Congressman Duffy, & Congresswoman Slaughter

FULL SUMMARY

PRESENTATIONS

November 2013 eDNA session presented to the Aquatic Nuisance Species Task Force hosted by USEPA.

PRESENTATIONS

Section for current eDNA literature – Kelly has a sep doc for this

What do to if you want to start sampling for eDNA?

- Contact the USFWS Whitney Genetics Lab
Kelly Baerwaldt, eDNA Program Manager ([link to email](#))
- Contact the USACE Center for eDNA Application and Research (Environmental Laboratory, US Army Engineer Research & Development Center, Vicksburg, MS 39180)

The Center for eDNA Application and Research (CeDAR) is a cutting-edge facility focused on basic and applied research, consultation, and application of environmental DNA (eDNA) to a broad array of challenges. Our dedicated lab facilities and lab practices are modeled around quality assurance practices developed in the fields of forensic and ancient DNA. With advanced capabilities, including next generation sequencing, high-throughput capillary sequencing, real-time PCR, and cutting edge methodologies, CeDAR provides state-of-the-art capabilities for working with aquatic eDNA and other challenging DNA resources.

The CeDAR team was tasked in 2010 with assisting the USACE Lakes and Rivers Division and their partners with processing large numbers of eDNA samples from the Chicago Area Waterways System and analyzing them for DNA from invasive silver and bighead carp. CeDAR successfully implemented a high-throughput eDNA processing capability with stringent quality assurance measures to meet that demand. In 2011 CeDAR was a leader in a major multiagency research effort, funded by the Great Lakes Restoration Initiative, to study a wide variety of factors surrounding the nature and use of eDNA data for Asian carp. The results of these studies have been improved eDNA sample processing methods and detection tools, as well as new insights into vectors for eDNA transport and fate in the environment. The establishment of CeDAR was a direct outgrowth of this important work.

In addition to studies and application of eDNA to Asian carp challenges, CeDAR has developed approaches or tools for the use of eDNA in monitoring invasive Dreissenid mussels and endangered sturgeon. Additionally, CeDAR has been conducting pioneering research into the use of aquatic eDNA sampling for characterizing the faunal communities that utilize limited water resources in desert landscapes, scat-based eDNA approaches for characterizing food resources utilized by endangered or sensitive species, and nectar-based eDNA approaches for understanding pollination community dynamics.

CeDAR can be contacted by e-mailing or calling Dr. Richard Lance at richard.f.lance@us.army.mil and 601-634-3971