Project Title: Efficacy of electrofishing to reduce recruitment of common carp at Malheur National Wildlife Refuge 2014-2015

Station: Malheur National Wildlife Refuge (NWR); research conducted in collaboration with Abernathy Fish Technology Center (AFTC)

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Project Description: Our goal is to investigate the efficacy of using a portable electrofishing system to help control common carp by killing their eggs and embryos at Malheur National Wildlife Refuge. There are few data available on the strength of electrical field needed to cause high mortality in invasive Asian and common carp species, but it is evident from studies of other cyprinids that the effect of electricity can depend on water chemistry, egg size, and type of electrical system used. Our objective is to determine the optimal electrofishing setting to kill the eggs and embryos of common carp under environmental conditions similar to those expected in Malheur Lake. With these data, we can evaluate whether it is feasible to develop a portable system for use in the field.

Invasive Species Targeted: common carp (Cyprinus carpio)

Project Completion Date or Estimated Completion Date: February 15, 2016

Project Results:

A. Research & development of electrical delivery device for carp experiment

During early 2015, AFTC completed construction and testing of an electrical delivery device capable of generating multiple waveforms with voltage gradients up to 40 V/cm in water conductivity up to 1500 μS/cm (Figure 1). The device was made by Kurt Steinke, AFTC Electronics Engineer, from a combination of a 240V to 480V step up transformer and an adjustable transformer connected to a 35 amp bridge rectifier fitted with a rectifier switch. The device produced sine-shaped alternating current (AC) waveform and a pulsed direct current (PDC) waveform with a ½-sine shape.
Figure 1. Electrical transformer device used to generate high voltage gradients in high-conductivity water.

B. Pilot study to determine waveforms for carp experiment

During January-March 2015, AFTC conducted a pilot experiment to verify operation of the electrical delivery device (see Figure 1), test the experimental shocking procedure, and evaluate which waveforms should be used for the experiment with common carp. We did not have access to common carp eggs, so instead used eggs and embryos from a hatchery population of steelhead (anadromous form of *Oncorhynchus mykiss*) as a surrogate. We exposed developing steelhead embryos to three different waveforms commonly emitted by electrofishing devices—alternating current (AC), square pulsed direct current (PDC), and ½-sine PDC—at different electrical field intensities ranging from 1.5-8.0 V/cm and across six developmental stages ranging from blastula to swim-up fry. We found that sensitivity to electroshock varied by developmental stage and that AC and square PDC caused greater mortality in steelhead embryos than ½-sine PDC. Based on these results, we selected AC and square PDC as the waveforms to test with common carp.
Figure 2. electrical exposure chamber (30cm L × 15cm W × 18.5cm H) connected to electrical delivery device. Eggs placed in a mesh basket that is then exposed to an electrical current between two aluminum plates.

Figure 3. Steelhead eggs used in pilot study. Eggs at bottom left are alive, whereas those at top and right that appear more opaque have died following exposure to an electric field.
C. Field experiment with common carp at Malheur NWR

At the end of May 2015, AFTC and Malheur NWR conducted the field experiment with common carp to estimate mortality of embryos as a function of developmental stage, electrical waveform, and voltage gradient (field intensity). We set up a mobile lab at Malheur NWR (Figure 4), captured and spawned carp, reared developing embryos (Figure 5), exposed sets of embryos to electrical fields (Figures 6-8), and enumerated live/dead embryos following electrical treatments (Figure 9).

We exposed carp embryos to electricity (for 30 sec) at five developmental stages – blastula, gastrula, organogenesis, movement, and pigmentation – using two waveforms (AC and square PDC) and across four voltage gradients (10, 15, 20, 25 V/cm) plus a control (sham-exposure). We conducted 6 replicates of each treatment combination plus a replicated control for each developmental stage, so in all there were 270 experimental units (egg baskets).

Preliminary analyses indicate that sensitivity of carp embryos varies by developmental stage, with the pigmentation stage most resistant to electrical shock (mean survival 70%). Across all developmental stages, mortality increased as a function of voltage gradient. The carp embryos appear to be slightly more sensitive to square PDC waveforms (mean survival 15%) than AC waveforms (mean survival 22%). Data analyses are ongoing, and expected to be completed January 2016. Final results will inform the feasibility of portable electrical delivery system that could kill carp eggs and embryos in Lake Malheur as one element in a carp control strategy.
Figure 5. Carp embryos in aerator from which samples were selected for treatment.

Figure 6. Timing electrical exposure of carp embryos.
Figure 7. Carp egg basket placed within electrical exposure tank. Oscilloscope at right indicates embryos are being exposed to square pulsed direct current (PDC).

Figure 8. Carp egg baskets in one of the two holding tanks shown in Figure 4. Each basket held 15 carp embryos.
Figure 9. Left: Carp embryos were enumerated and developmental stages determined using dissecting microscopes. Right: enumerating live carp embryos at the end of the experiment

Number of Acres Treated: NA

Number of Acres Inventoried and/or Mapped: NA

Number of Acres Restored: NA

Total Grant Amount: $53,000 (FY2014: $9,000, FY2015: $44,000)

Breakdown of Expenditures (FY2015):

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