Pacific Northwest
NATIONAL LABORATORY

PNNL-30968

Fisheries Technology Associates, Inc. – Sweeping CHIRPs, Looming Darkness: In-Sync Stimuli – Fish Protection Prize

CRADA 498

February 2021

Geist, David R.

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Richland, Washington 99354

Cooperative Research and Development Agreement (CRADA) Final Report

Report Date: February 6, 2021

In accordance with Requirements set forth in the terms of the CRADA, this document is the CRADA Final Report, including a list of Subject Inventions, to be provided to PNNL Information Release who will forward to the DOE Office of Scientific and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

Parties to the Agreement:

PNNL/Battelle Memorial Institute

Fisheries Technologies Associates, Inc.

PNNL CRADA Number: 498

CRADA Title: Fisheries Technology Associates, Inc. – Sweeping CHIRPs, Looming Darkness: In-Sync Stimuli – Fish Protection Prize

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Joint Work Statement Funding Table showing DOE funding commitment:

Estimated Costs	**PNNL** Shared Resources	**Participant** Shared Resources	**Participant** Funds In	**Totals**
Year 1	$11,000	$13,125	$ 0	$24,125
TOTALS	$11,000	$13,125	$ 0	$24,125
Fed Admin Charge on Funds-in	----	----	----	

Executive Summary of CRADA Work: In FY2020, the National Renewable Energy Laboratory (NREL) initiated a Prize competition with support from Pacific Northwest National Laboratory (PNNL), and sponsored by the U.S. Department of Energy Water Power Technologies Office (DOE WPTO), to support the development of innovative methods for excluding fish from water diversions and intakes: the Fish Protection Prize. Proposed solutions can include new ideas for addressing fish exclusion or improvements to existing technologies. Solutions can be applied to river and canal diversions, unscreened diversion pipes, or intakes at dams.

The Fish Protection Prize competition under this phase had three stages:

1. Concept stage (January - June 2020): WPTO announced the Prize competition, solicited submittals, and worked with NREL and PNNL to select up to 10 Finalists to advance to the second stage.
2. Incubation stage (June - September 2020): Nine finalists received up to 50 hours of voucher support each from PNNL as they prepared for the third stage.
3. Pitch Contest stage (September 2020): The 9 finalists competed in a “Pitch Contest” that occurred during the America Fisheries Society Annual Meeting in September (a virtual meeting in 2020). At the end of the Pitch Contest, the DOE WPTO Prize judges selected three Grand Prize Winners to receive up to $700,000 of combined cash prizes and additional voucher support from PNNL to develop their proposals in FY21.

Summary of Research Results:

- In FY20 PNNL provided voucher support in the form of technical reviews and support, as well as graphics and presentation support, in helping the 9 finalists prepare for the Pitch Contest at the American Fisheries Society (AFS) virtual meeting.
- No subject inventions, patent applications, copyrights, and trademarks under this CRADA.
- Products Developed: Abstract and link to American Fisheries Society presentation (attached).

Abstract Copied From AFS 2020 Meeting Website: Pulsating low-frequency (<20kHz), and ultrasonic (20-200kHz) frequency modulation ("CHIRP" technology) can deter many species, sizes, and ages of fish from water diversions and intakes. Mechanosensory lateral lines, otolith-inner ear, and air bladder sensory systems of fish detect tactile (pressure) and acoustical stimuli, synchronized with pulsating LED lights, which mimic predatory threat with a light pattern of an approaching dark moving object. This stimulates "looming" visual perceptions and subsequent innate, reflexive avoidance and escape behavior. Together, synchronized multi-sensory stimuli induce obligate, instinctive avoidance and escape behavior. Research results show multiple stimuli, of synchronized light and sound act together as non-physical barriers (NPB) to enhance fish exclusion. "Behavioral" barriers induce fish exclusion from designated areas without significantly obstructing water flow or navigation, with lower capital and operating costs, compared to other, physical, barriers to fish entrainment. A behavioral avoidance or exclusion barrier, compared to a screen barrier, requires volitional or innate reflex action by fish to avoid and to escape entrainment. The proposed behavioral barrier device may also induce fish exclusion at locations that would otherwise be difficult to screen, such as penstock entrances at great depths in a reservoir.

Link to presentation video at AFS 2020 Meeting website:

https://afs.confex.com/afs/2020/meetingapp.cgi/Paper/44441

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