

# Carbon Dioxide-Carp

A new tool in the invasive species toolbox

# Background

- Need for barriers/deterrents
  - CO<sub>2</sub> could be a non-physical fish barrier
  - Non-selective deterrent
- Recent research
  - Lab studies
  - Pond studies
  - Field study
- Next steps (**2019 projects**)
  - Registration of CO<sub>2</sub> with USEPA
  - Engineering feasibility study



Carbon dioxide treatments at a water control structure on the Illinois River (Lewistown, IL)

# Carbon Dioxide-Carp

- U.S. EPA registered on April 2019
- Current label
  - Restricted to USGS, USFWS, USACE, State Resource Managers, or those under their direct supervision
- Approved uses:
  1. Asian Carp deterrent
  2. Under-ice lethal control

**Precautionary Statements:**  
Hazards to Humans and Domestic Animals

**WARNING:** May be fatal if inhaled. Do not breathe vapor.

**Environmental Hazards**  
This chemical is toxic to aquatic vertebrates and invertebrates. Non-target organisms may be killed at rates recommended on this label. Directions for use must be strictly followed to minimize hazards to non-target organisms.

**DIRECTIONS FOR USE**  
It is a violation of Federal Law to use this product in a manner inconsistent with its labeling. Read entire label and follow use directions carefully before applying.

**Product Information:**  
This product is used as an Asian carp deterrent or as an under ice lethal control for aquatic nuisance species. Before applying carbon dioxide to water, ensure infusion equipment is in good working condition and there are no leaks. All persons working with this product must be trained in the product hazards, the use of respiratory devices when required, detection instruments, emergency procedures, and product application procedures. Obtain any permits required by Local, State, or Federal authorities before application.

**Behavioral Deterrent:**  
Specific areas within waterways may be treated to induce avoidance behavior to limit the localized occupancy, movement, and spread of invasive carp.

Amount of product applied will depend on water volume to be treated. Target carbon dioxide concentration to induce avoidance behaviors ranges between 100–150 mg/L. To determine weight (W) of product (in kilograms; kg) to infuse, use:

$$W = (C \times V) \times f$$

where C is target concentration (in mg/L); where V is treatment area volume (expressed in liters); and, where f is unit conversion factor for mg to kg (0.000001).

Amount of product applied may vary slightly depending on gas transfer efficiency due to potential loss from biological uptake, effervescence, and other atmospheric losses. With target treatment concentrations ranging between 100–150 mg/L, temporary pH suppression to not less than 5.5 is expected.

For use only by U.S. Fish and Wildlife Service, U.S. Geological Survey, U.S. Army Corps of Engineers, State natural resource managers, or persons under their direct supervision

**Carbon Dioxide-Carp**

Active Ingredient:	
Carbon dioxide	100%
Total	100%

**KEEP OUT OF REACH OF CHILDREN**

**WARNING**

FIRST AID	
IF INHALED	<ul style="list-style-type: none"> <li>• Move person to fresh air</li> <li>• If the person is not breathing, call 911, then give artificial respiration, preferably mouth to mouth if possible</li> <li>• Call poison control center or doctor immediately for treatment advice</li> </ul>

Have the product container or label with you when calling a poison control center, doctor, or going for treatment. For non-emergency information concerning this product, call the National Pesticides Information Center (NPIC) at 1-800-858-7378 seven days a week, 6:30 am to 4:30 pm Pacific Time (NPIC Web site: [www.npic.orst.edu](http://www.npic.orst.edu))

Net Weight: 50 LBS

EPA Reg. No. 6704-95  
EPA Est. No. 6704-WI-1

Manufactured for:  
U.S. Fish and Wildlife Service  
United States Department of Interior  
18th and C Streets NW  
Washington, DC 20240

**Lethal Control:**  
All vertebrate and some invertebrate species under the ice in the treatment area are expected to die. Amount infused will depend on water volume to be treated. Maintain carbon dioxide concentration of 200 mg/L for a minimum of 96 hours for lethal control. To determine weight (W) of product (in kilograms; kg) to infuse, use:

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where C is target concentration (in mg/L); where V is treatment area volume (expressed in liters); and, where f is unit conversion factor for mg to kg (0.000001).

Ponds/lakes/impoundments can be restocked after pH returns to pretreatment level.

**Storage and Disposal**

**PESTICIDE STORAGE**  
Store in cool, well-ventilated and secure area. Post as a pesticide storage area. The product may be stored in portable cylinders, portable bulk storage tanks, or permanent bulk storage tanks. Store cylinders upright, secured to a wall to prevent tipping. Do not subject cylinders to rough handling or mechanical shock such as dropping, bumping, dragging, or sliding. Do not use rope slings or hooks to unload cylinders. Transport cylinders using hand truck or fork truck to which the cylinder can be firmly secured.

Bulk storage tanks must be in a cool, well-ventilated and secure area. Post as a pesticide storage area. Do not allow vehicles or other large equipment to bump or collide with bulk storage tanks.

Do not store carbon dioxide containers in areas where there is a potential for electrical discharge. Electrical discharge into the container will cause carbon dioxide to decompose into carbon monoxide and oxygen.

**PESTICIDE DISPOSAL**  
If carbon dioxide cannot be used, vent to open air in an area with restricted access away from people ensuring concentrations don't exceed 5000 ppm.

**CONTAINER HANDLING**  
Return cylinders for reuse or disposal. When the cylinder is empty, close the valve and screw the safety cap onto the valve outlet before returning to shipper or allowing it to be refilled. Only the registrant is authorized to refill containers. Do not use cylinders or bulk storage containers for any other purpose.

**Spill or Leak Procedures**  
In case of leak, evacuate area immediately. Move leaking or damaged cylinders outdoors or to an isolated and ventilated location, observing strict safety precautions. Do not allow entry into spill area by unprotected persons until concentration of carbon dioxide is less than 5,000 ppm. When cylinder is completely empty, return to manufacturer.

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# How Resources Managers Can Obtain Label

- Web-enabled system available January 2020?
- Modeled after FWS Investigational New Animal Drug (INAD) Program Management System
- What's being done now?
  - Developing website content
  - Developing user web site access process
  - Developing user data entry process to report information required for annual EPA reporting
    - State registration, NPDES
    - Location of application
    - Species
    - Adverse event/Unexpected outcomes
  - Developing process to track label access
  - Assessing costs

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Frost/ice/ice encasements can be restricted after pH returns to pretreatment level.

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# Engineering feasibility study

- Multi-agency research project
- Fox River Navigational System Authority
- WI Department of Natural Resources
- August-September 2019

## Testing objectives:

1. Engineering and economic assessment
2. Effects on water quality
3. Air quality (human safety)
4. Non-target effects
5. Fish behavioral responses



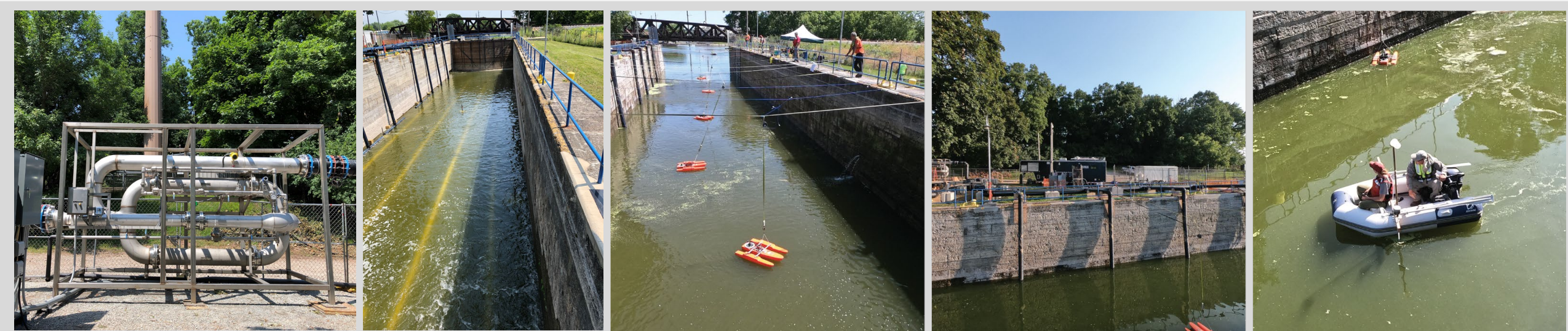
Fox River Lock #2 (Kaukauna, WI)

Approx: 144' x 33' x 7'

# Engineering feasibility study

## Preliminary observations

- Treatments to 100-150 mg/L CO<sub>2</sub> took ~10 min
  - At warm water temperatures and high algal biomass
- pH at target concentration for this water body is 6.2-6.4
- Atmospheric levels much less than OSHA standard (8-h, 5,000 ppm)
- Low CO<sub>2</sub> concentrations leaving the lock after filling and flushing



# Cost estimates

Estimated cost for 1 acre-foot of water						
Target Concentration (mg/L)	Cost (\$/lb CO <sub>2</sub> )	Gas-transfer efficiency (%)				
		50	75	90	95	99
100	0.05	\$27.18	\$18.12	\$15.10	\$14.31	\$13.73
	0.10	\$54.37	\$36.24	\$30.20	\$28.61	\$27.46
	0.15	\$81.55	\$54.37	\$45.30	\$42.92	\$41.19
150	0.05	\$40.77	\$27.18	\$22.65	\$21.46	\$20.59
	0.10	\$81.55	\$54.37	\$45.30	\$42.92	\$41.19
	0.15	\$122.32	\$81.55	\$67.96	\$64.38	\$61.78
200	0.05	\$54.37	\$36.24	\$30.20	\$28.61	\$27.46
	0.10	\$108.73	\$72.49	\$60.41	\$57.23	\$54.91
	0.15	\$163.10	\$108.73	\$90.61	\$85.84	\$82.37

Estimated cost for one lock volume (low water)	
Lock volume (cubic meters)	30,100
Target (mg/L)	150
CO <sub>2</sub> cost (\$/lb)	0.05
Gas-transfer efficiency (%)	0.95
Estimated Cost	\$524
Total CO <sub>2</sub> (lb)	10,478

# Next steps

- CO<sub>2</sub> is not currently in TSP at BRLD
- Potential applications for CO<sub>2</sub>
  - Intermittent use in lock or approach channel
  - Supplement existing deterrents (e.g., electricity, acoustics)
  - Backup plan during scheduled or unscheduled maintenance
- Next steps
  - Data analysis and summaries from Kaukauna lock project
  - State registrations
  - A&E for management installations



# Acknowledgements and Contacts

- Primary Contacts:
  - Kim Fredricks, [kfredricks@usgs.gov](mailto:kfredricks@usgs.gov), 608-781-6287
  - Teresa Lewis, [teresa\\_lewis@fws.gov](mailto:teresa_lewis@fws.gov), 608-783-8420
  - Mark Gaikowski, [mgaikowski@usgs.gov](mailto:mgaikowski@usgs.gov), 608-781-6221
- Collaborators
  - WI Department of Natural Resources
  - Fox River Navigational System Authority
  - U.S. Army Corps of Engineers
  - U.S. Fish and Wildlife Service
  - U.S. Geological Survey
    - Upper Midwest Environmental Sciences Center
    - Upper and Central Midwest Water Science Centers
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