

# Innovative Approach for Using Built Water Resources Infrastructure for Ecosystem Restoration

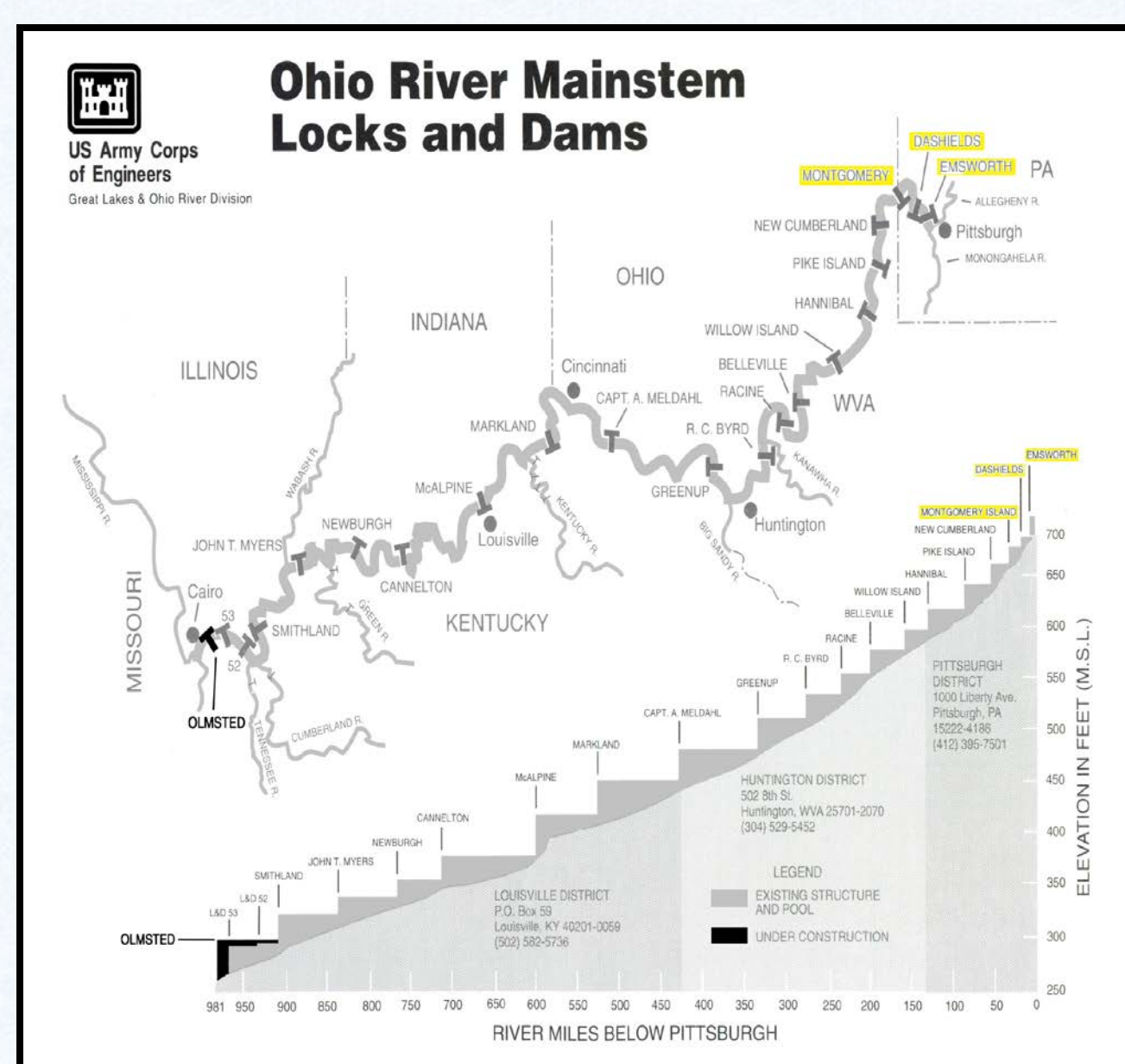
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**ABSTRACT** – The Army Corps of Engineers’ Pittsburgh District recently evaluated fish passage project feasibility at the three Ohio River lock and dam navigation facilities in Pennsylvania. Traditional fish passage structures were determined infeasible for a variety of structural, hydrologic and economic issues; yet, the District is considering whether replacement lock chambers can be redesigned to increase the passage of native fish, while reducing the spread of aquatic nuisance species (ANS), such as Asian carp. Literature searches revealed little prior consideration of lock design modification to favor fish passage. Any lock modifications facilitating fish passage through normal lock operations would benefit longitudinal connectivity. Application of any improvement in fish passage through navigational lock chambers could extend across the majority of the Corps’ 238 locks at 192 lock and dam navigation facilities on over 12,000 miles of the nation’s rivers.

**BACKGROUND** – Because navigation lock/dam systems (L/D) on large rivers are known to impair long-distance fish movements, the Corps’ Environmental Operating Principles mandate consideration of fish passage. Pittsburgh District considered fish passage in planning the replacement of aging navigation locks on the three uppermost facilities on the Ohio River: Emsworth, D.A. Shields and Montgomery L/Ds (**Fig. 1**).

Figure 1 – Emsworth, Dashedields and Montgomery Locks & Dams (upper right-hand corner), relative to Ohio River system.



With assistance from U.S. Fish and Wildlife Service biologists, engineers and others, we determined that separate fish passage facilities were infeasible, but continue to ask if native fish passage might be improved by the modification of navigation locks. Further consideration will focus on design features that facilitate movement of commercial traffic and native fishes, while limiting the movement of aquatic nuisance species, such as Asian carp.

**METHODS** – We searched peer-reviewed literature and reports produced by government agencies for previous engineering or biological research, focusing on structural lock or gated dam design modifications and lock or gated dam operational modifications for fish passage. We also queried other biologists and hydrologists involved in ongoing fish passage work.

Three possible up-river passage routes were considered:

- through the lock chamber, similar to tow and barge lockage,
- through the lock filling and emptying culverts (see **Fig. 2**; including combination with lock chamber passage) and,
- through the dam gate bays (roller gates, lift gates or Tainter gates) when water velocities are sufficiently slowed.

Seven native fish species (*Scaphirhynchus platyrhynchus*, *Polyodon spathula*, *Sander canadensis*, *Alosa chrysochloris*, *Hiodon tergisus*, *Ictiobus cyprinellus*, and *Aplodinotus grunniens*) were initially selected to assess their behavior in regard to their entering and leaving lock chambers. These species are Pennsylvania state-listed and/or mussel hosts, and use different strata within water columns. Consideration was also given to native planktivores to provide them the opportunity to compete with Asian carp.

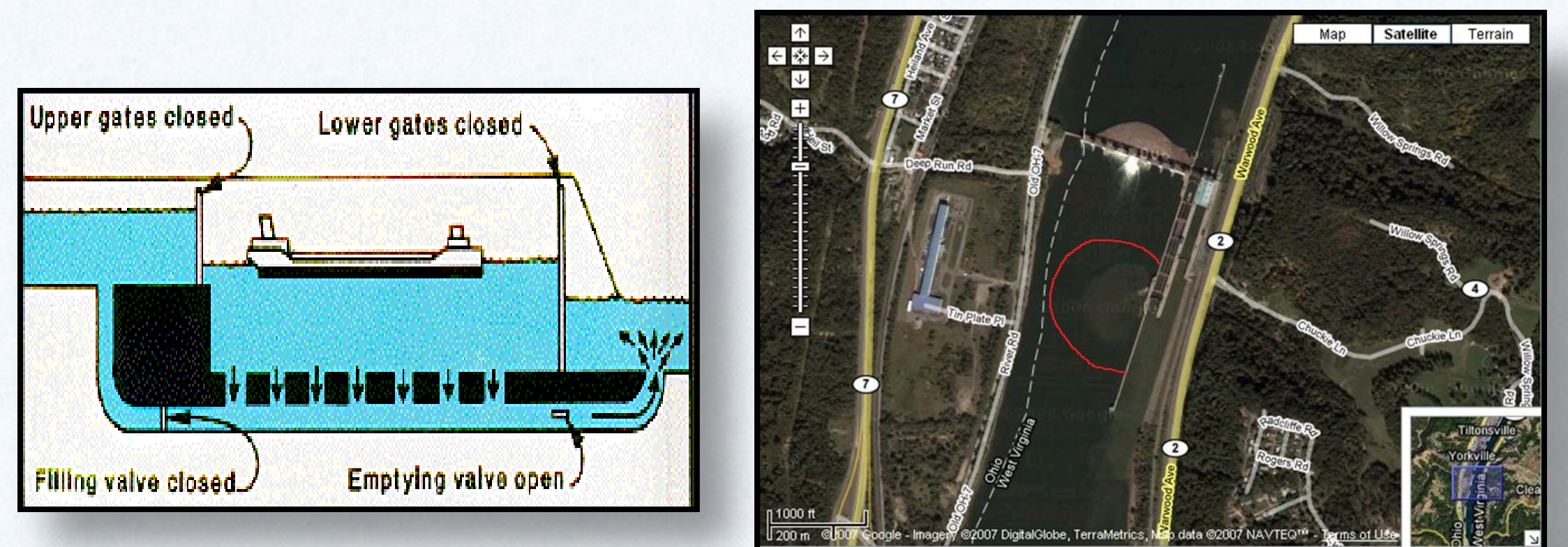


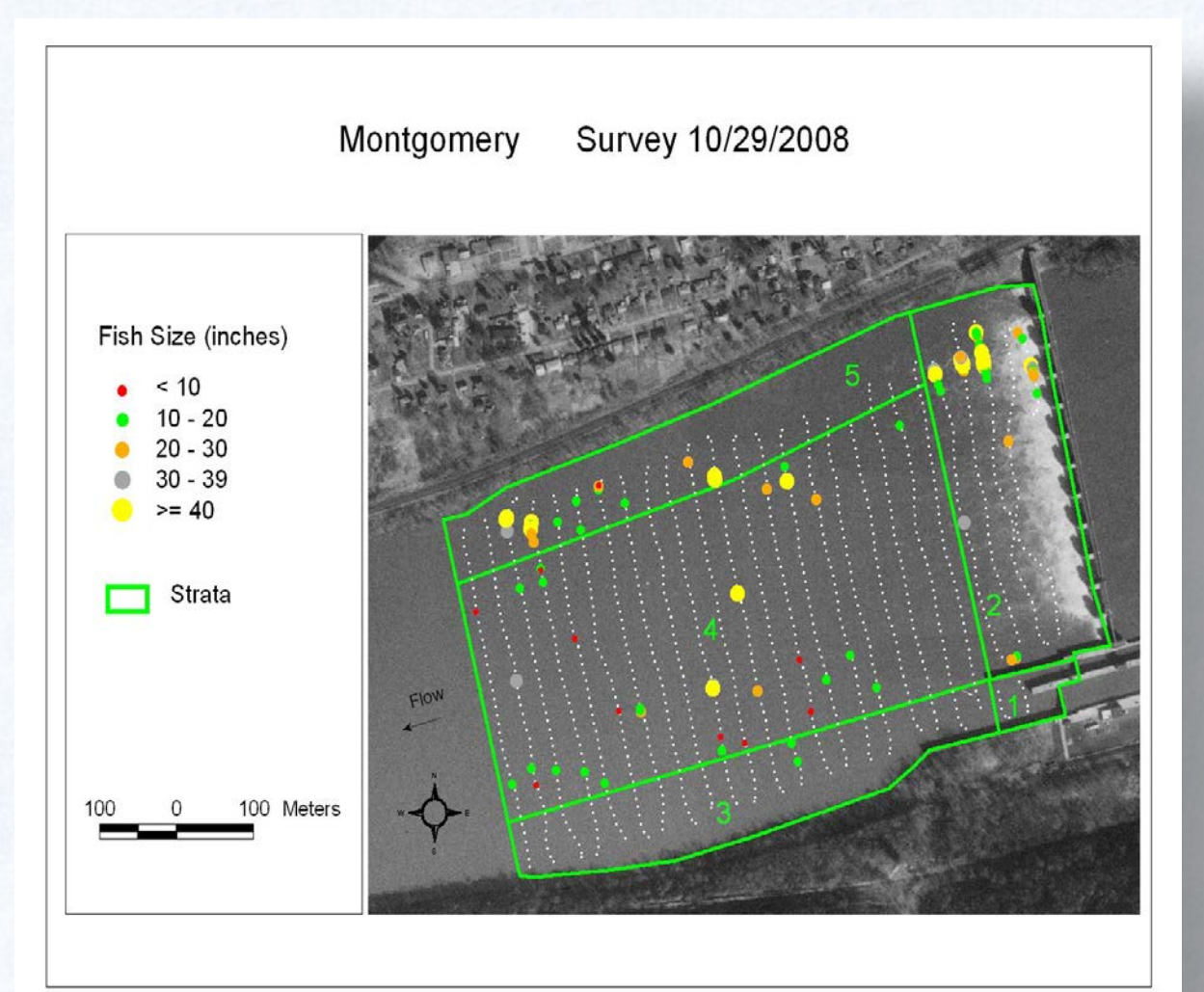
Figure 2 – Left: simplified side-view of descending cargo ship in navigation lock with gates, valves and emptying culvert. Right: satellite imagery of descending tow and raft of barges passing the Pike Island L/D, near Wheeling, WV. Note position of sediment plume in tailwaters from navigation chamber’s emptying culvert (circled in red).

The intent of providing fish passage in the face of advancing Asian carp is to provide native fishes a “leg-up,” since Asian carp are expected to pass through L/Ds in some numbers anyway.

Given the complexity of rivers, the diverse behaviors of target species and our consideration of a system of multiple pathways per L/D, entire suites of uncertainties exist, greatly complicating effective fish passage design. To address uncertainties we will use Adaptive Environmental Assessment & Management (Walters & Holling 1990) a recursive, stepwise process that optimizes decisions over time. Eulerian-Lagrangian-Agent Methods (ELAM) will also be used to reduce uncertainty, by connecting fish behavior and flow patterns in designing aquatic pathways .

Earlier preliminary hydroacoustic surveys at our sites (**Fig. 3**) may be expanded upon to provide higher resolution data for the above methods. We are also considering the installation of high resolution split-beam sonar (e.g., DIDSON) above locks to establish baseline fish passage.

Figure 3 – Hydroacoustic survey done below Montgomery L/D on 29 Oct 2008. Data portrayed here as fish size, but also provided as fish density for study.



**RESULTS** – To date, we have found few papers that have addressed or even considered non-assisted fish passage through navigation locks; yet, these few papers, along with other behavioral work, suggest that carefully engineered fish passage systems may be constructed that facilitate the passage of desirable fish at the expense of ANS, such as Asian carp. Such systems would likely take advantage of small design and/or operation features, alone or in combination, that would favor one fish species or groups of species over others.

**STATUS** – Navigation lock and fish-passage design are multidisciplinary activities, both requiring considerable effort and investment. We continue to develop our approach strategy and a multi-organization work team to address this problem. Suggested cooperative efforts will be considered. If favorable recommendation is made to pursue this work, next steps would include the pursuit of appropriations under current authorities.

Poster based upon: Smith *et al.* 2013. USACE-ERDC Technical Note WQTN-AM-16: *Planning Guide for Fish Passage at Pittsburgh District Dams*.

Literature Cited:  
Walters & Holling.1990. *Large-scale management experiments...* Ecology 71:2060