Toward Selective Removal of Invasive Fishes and Passage of Native Fishes in Rivers

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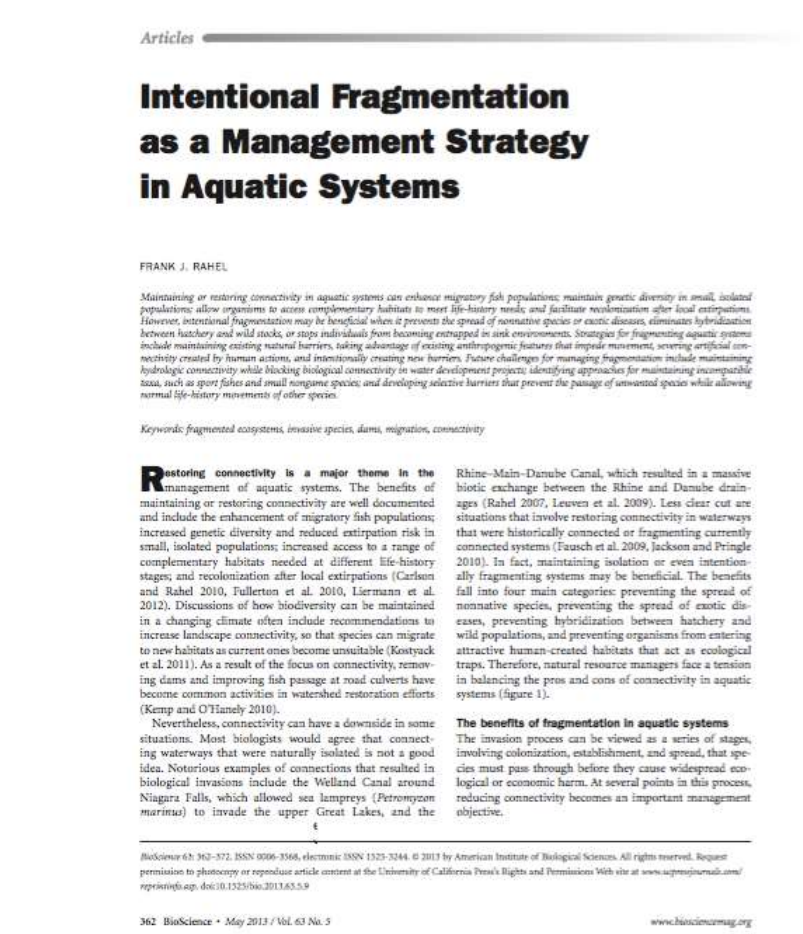
Need For Selective Fish Passage



Articles

Intentional Fragmentation as a Management Strategy in Aquatic Systems

FRANK J. RAHEL

Maintaining or restoring connectivity in aquatic systems can enhance migratory fish populations; maintain genetic diversity in small, isolated populations; allow organisms to access complementary habitats to meet life-history needs; and facilitate recolonization after local extirpations. However, intentional fragmentation may be beneficial when it prevents the spread of nonnative species or exotic diseases, eliminates hybridization between hatchery and wild stocks, or stops individuals from becoming entrapped in sink environments. Strategies for fragmenting aquatic systems include maintaining existing natural barriers, taking advantage of existing anthropogenic features that impede movement, severing artificial connectivity created by human actions, and intentionally creating new barriers. Future challenges for managing fragmentation include maintaining hydrologic connectivity while blocking biological connectivity in water development projects; identifying approaches for maintaining incompatible taxa, such as sport fishes and small nongame species; and developing selective barriers that prevent the passage of unwanted species while allowing normal life-history movements of other species.

Keywords: fragmented ecosystems, invasive species, dams, migration, connectivity

Restoring connectivity is a major theme in the management of aquatic systems. The benefits of maintaining or restoring connectivity are well documented and include the enhancement of migratory fish populations; increased genetic diversity and reduced extirpation risk in small, isolated populations; increased access to a range of complementary habitats needed at different life-history stages; and recolonization after local extirpations (Carlson and Rahel 2010, Fullerton et al. 2010, Liermann et al. 2012). Discussions of how biodiversity can be maintained in a changing climate often include recommendations to increase landscape connectivity, so that species can migrate to new habitats as current ones become unsuitable (Kostyack et al. 2011). As a result of the focus on connectivity, removing dams and improving fish passage at road culverts have become common activities in watershed restoration efforts (Kemp and O'Hanely 2010).

Nevertheless, connectivity can have a downside in some situations. Most biologists would agree that connecting waterways that were naturally isolated is not a good idea. Notorious examples of connections that resulted in biological invasions include the Welland Canal around Niagara Falls, which allowed sea lampreys (*Petromyzon marinus*) to invade the upper Great Lakes, and the Rhine–Main–Danube Canal, which resulted in a massive biotic exchange between the Rhine and Danube drainages (Rahel 2007, Leuven et al. 2009). Less clear cut are situations that involve restoring connectivity in waterways that were historically connected or fragmenting currently connected systems (Fausch et al. 2009, Jackson and Pringle 2010). In fact, maintaining isolation or even intentionally fragmenting systems may be beneficial. The benefits fall into four main categories: preventing the spread of nonnative species, preventing the spread of exotic diseases, preventing hybridization between hatchery and wild populations, and preventing organisms from entering attractive human-created habitats that act as ecological traps. Therefore, natural resource managers face a tension in balancing the pros and cons of connectivity in aquatic systems (figure 1).

The benefits of fragmentation in aquatic systems

The invasion process can be viewed as a series of stages, involving colonization, establishment, and spread, that species must pass through before they cause widespread ecological or economic harm. At several points in this process, reducing connectivity becomes an important management objective.

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Unintended consequences and trade-offs of fish passage

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Abstract

We synthesized evidence for unintended consequences and trade-offs associated with the passage of fishes. Provisioning of fish passageways at dams and dam removals are being carried out increasingly as resource managers seek ways to reduce fragmentation of migratory fish populations and restore biodiversity and nature-like ecosystem services in tributaries altered by dams. The benefits of provisioning upstream passage are highlighted widely. Possible unwanted consequences and trade-offs of upstream passage are coming to light, but remain poorly examined and underappreciated. Unintended consequences arise when passage of native and desirable introduced fishes is delayed, undone (fallback), results in patterns of movement and habitat use that reduce Darwinian fitness (e.g. ecological traps), or is highly selective taxonomically and numerically. Trade-offs arise when passage decisions intended to benefit native species interfere with management decisions intended to control the unwanted spread of non-native fishes and aquatic invertebrates, or genes, diseases and contaminants carried by hatchery and wild fishes. These consequences and trade-offs will vary in importance from system to system and can result in large economic and environmental costs. For some river systems, decisions about how to manage fish passage involve substantial risks and could benefit from use of a formal, structured process that allows transparent, objective and, where possible, quantitative evaluation of these risks. Such a process can also facilitate the design of an adaptive framework that provides valuable insights into future decisions.

Keywords Dam removal, fishway, migration, risk, structured decision making, uncertainty

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The Great Lakes Example

Overview

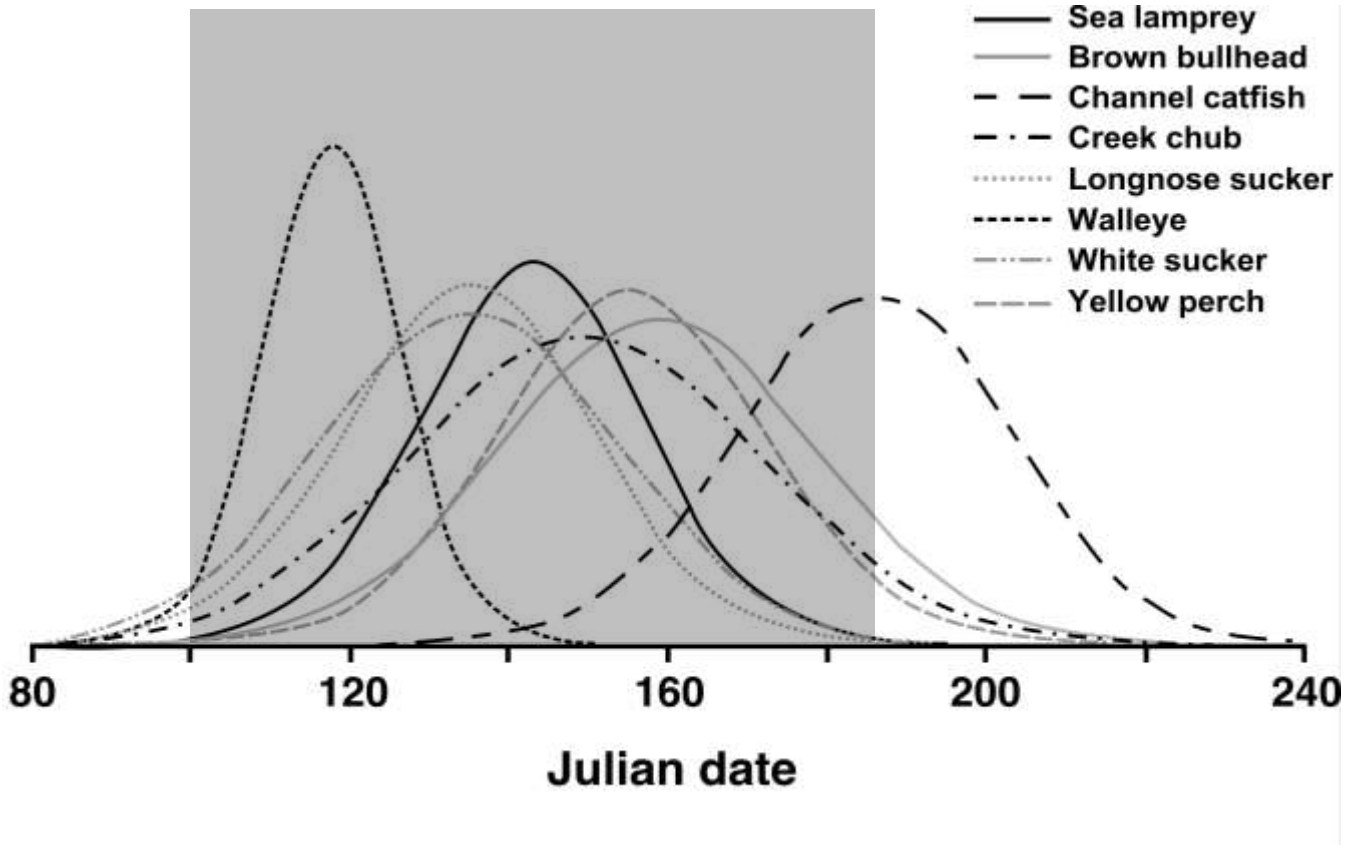
- What have we done?
- What are we doing?
- What are we planning to do?

Fixed Crest Barriers

Velocity Barriers

Seasonal Barriers

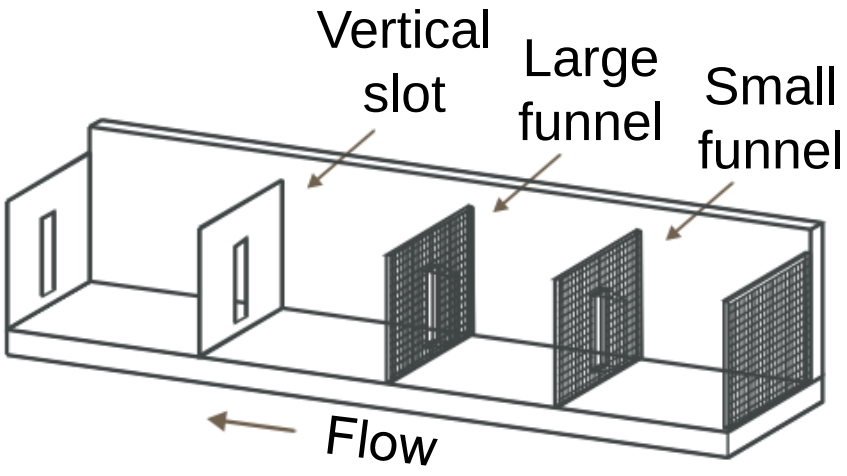
Seasonal Barriers



McLaughlin et al. 2008. Great Lakes Fishery Commission Project Completion Report

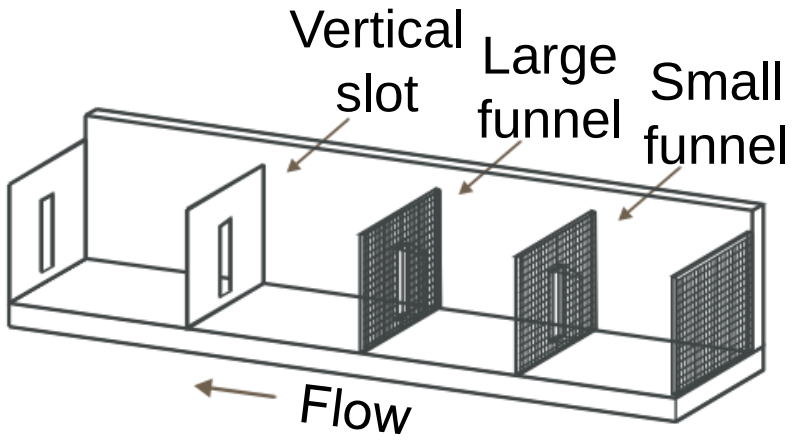
Vélez-Espino et al. 2010. Biological Conservation 144:1068

Trap-and-Sort Fishway



Sea Lamprey Traps

Eel Ladders



Sorting an Assortment of Things

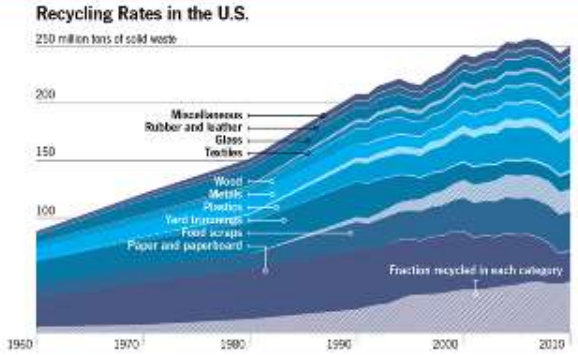
HOW IT WORKS

STORY BY KATIE PEEK | ILLUSTRATION BY GRAHAM MURDOCH

SINGLE-STREAM RECYCLING

The most annoying aspect of recycling—and one of the biggest hurdles to its widespread adoption—is having to separate paper, glass, and plastic before they hit the curb. Now recycling machines are changing that. With single-stream recycling, recyclables go into one bin, which a truck delivers to a materials-recovery facility, such as Willimantic Waste Paper in Willimantic, Connecticut. There, a largely automated system of conveyor belts, screens, magnets, and lasers separates materials so that they can be sold to metal and plastic recyclers and paper mills.

Of the 570 recycling facilities in the U.S., 240 now have single-stream operations, according to Eileen Berenyi, of the solid-waste research-and-consulting firm Governmental Advisory Associates. While the system isn't perfect—its high-speed operation can lead to contamination from broken glass—the simplicity of it means households actually recycle more. "If people want a higher recycling rate, it has to be convenient," says Chaz Miller, of the National Solid Wastes Management Association. "And I think the technology is only going to improve."



STATS

2.4
Tons of carbon dioxide kept out of the atmosphere per ton of solid waste recycled, whether by single-stream or otherwise

One third
Fraction of municipal solid waste in the U.S. that's currently recycled

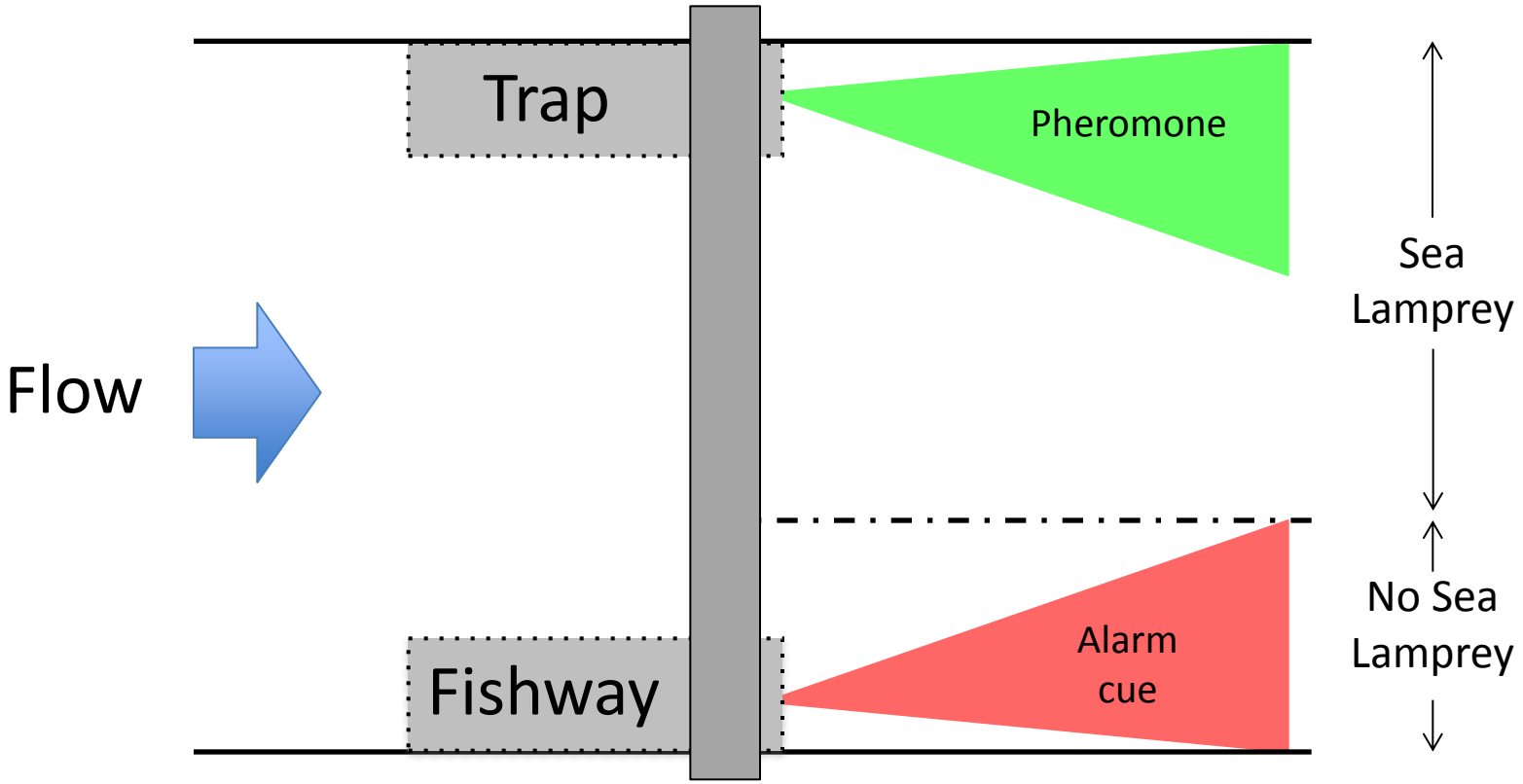
100 million
Number of U.S. residents served by single-stream recycling programs

92
Percentage recycling rates increased when Florida's Miami-Dade County implemented single-stream recycling in 2008

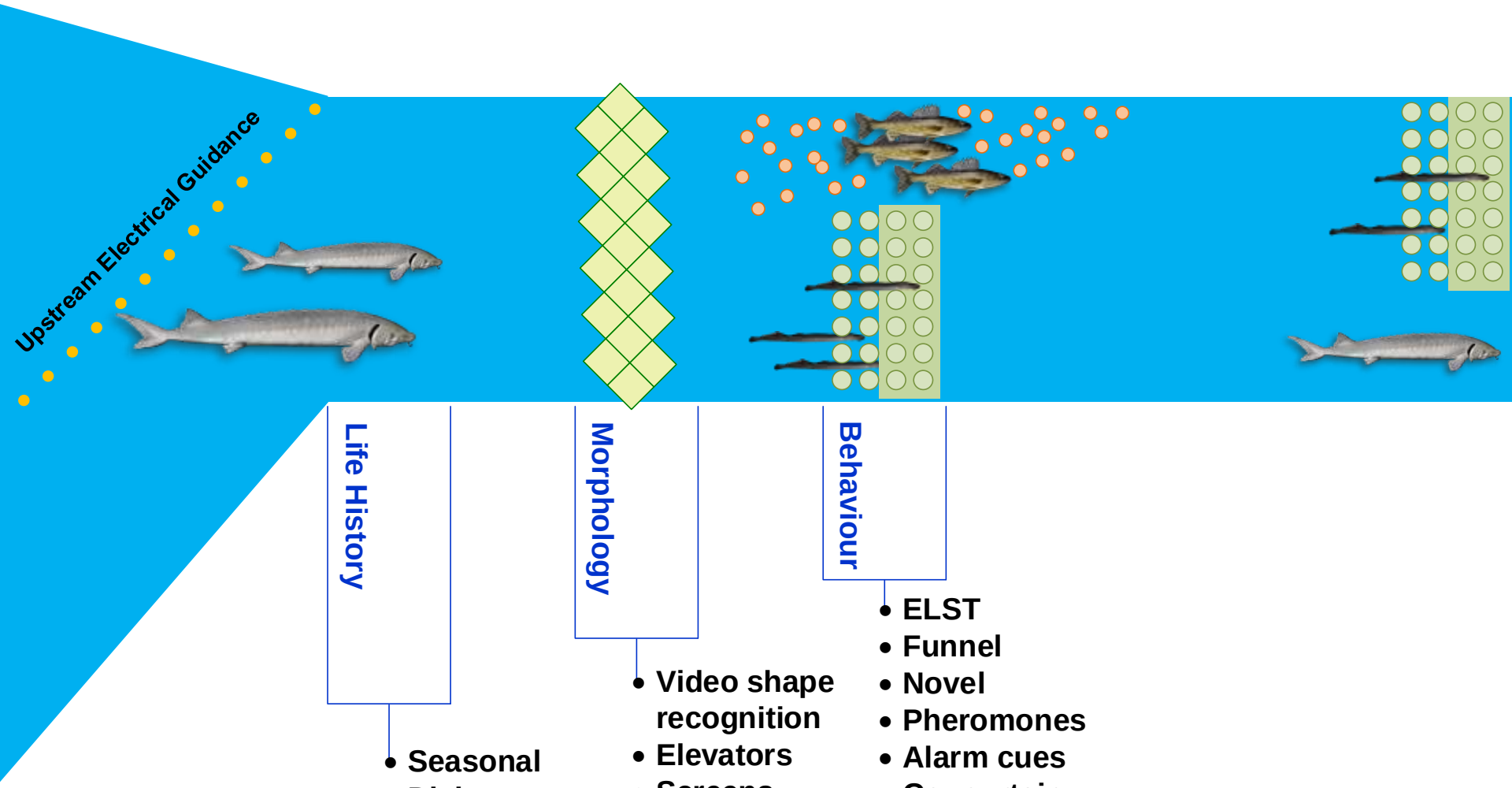
Integration

A. Muir, GLFC

Behavioural Guidance (Push-Pull)



Integrating Technologies



A. Muir, GLFC

Larry's acute sense of awareness served him well…

Selective Bycatch

Fishing Gear and Risks to Protected Species

Fishermen use many different types of fishing gear and catch a wide variety of species. Usually, fishermen use certain types of fishing gear to target specific species. However, these different fishing methods can accidentally capture or injure other non-target species, called **"bycatch."**

Shrimp Trawler
Credit: NOAA

How can we reduce bycatch?

We work with the fishing industry and our other partners to develop regulations and fishing gear modifications to reduce **bycatch** of sea turtles, marine mammals, sea birds, and non-target fish.

This collaborative work is conducted through gear research in our **Bycatch Reduction Engineering Program** and stakeholder-based processes such as our **Marine Mammal Take Reduction Program**, which helps reduce incidental serious injury or mortality of marine mammals from commercial fishing

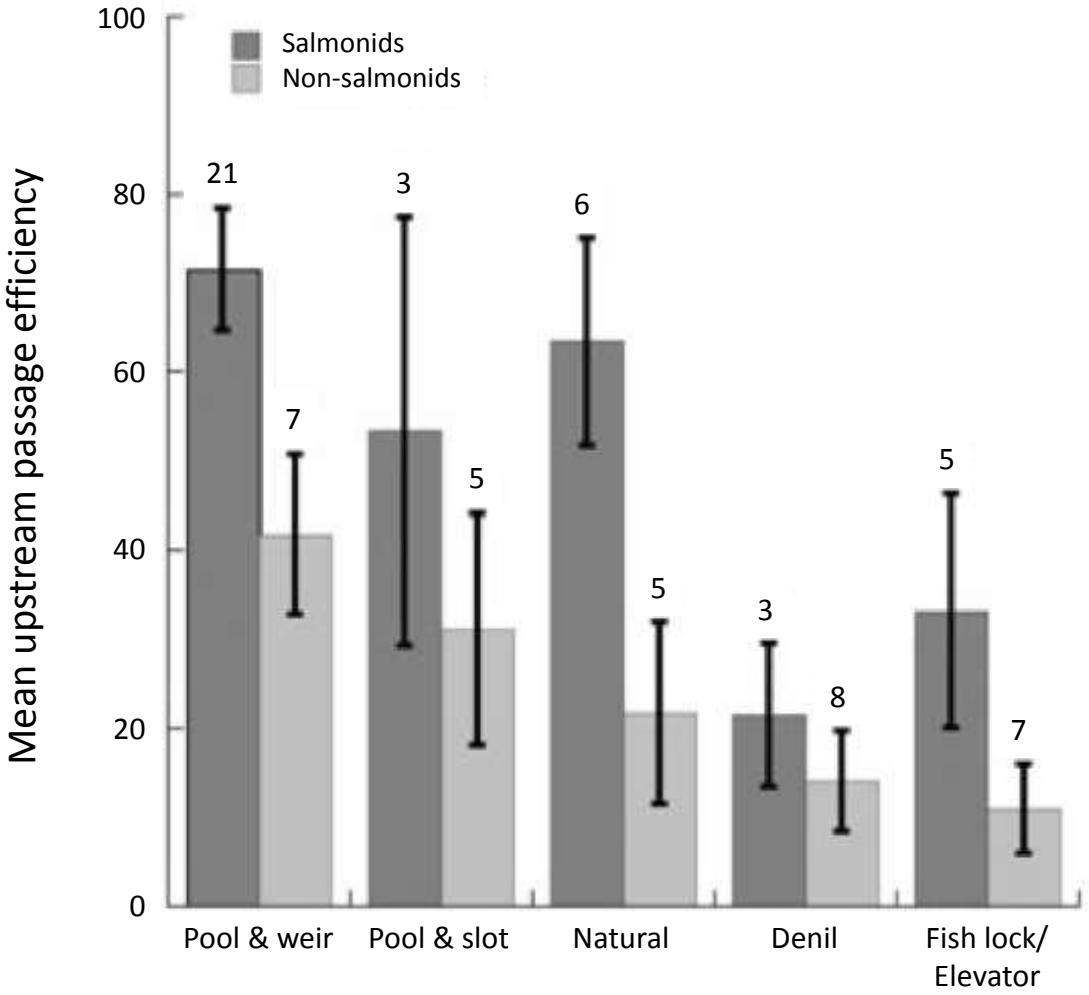
Our ability to reduce bycatch depends on data collected by our **National Observer Program**. Fisheries observers track where, when, and how many protected species become hooked or entangled in fishing gear. Once bycatch reduction measures are implemented, observers also help to monitor their success.

Passage Innovations

http://www.abc.net.au/news/2015-12-09/christmas-island-crab-bridge/7014528


Answers?
Questions

Our Success at Selective Fish Passage



Noonan et al. 2012. Fish + Fisheries 13:450