

The Energy-Water Nexus: Thermoelectric Power Plants and Aquatic Ecology

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More water will likely be needed for thermoelectric power plant cooling.


- Energy-water interdependence is present at all levels of the energy supply chain
- Even though power plants are withdrawing water more efficiently, the total energy demand is still growing
- Tradeoffs exist between energy production, resource use, and environmental degradation




Thermoelectric power plant cooling water effluent is a source of pollution in our waterways.

- Cooling water effluent can be as much as 10°C higher than ambient waterway temperatures in extreme cases
- Many aquatic species are sensitive to 1°C changes

Earth Changes

 Temperature shift blamed for fish deaths in Clinton Lake, Illinois

The Pantagraph
Thu, 16 Jan 2014 06:11 CET



© Timothy Knepp
Walleye (*Sander vitreus*)

A large winter fish kill at Clinton Lake near DeWitt has been attributed to recent fluctuations in water temperatures.

A wide selection of species, including walleye, bass, crappie and channel catfish, was among more than 5,300 fish located Tuesday by a fisheries biologist from the Illinois Department of Natural Resources.

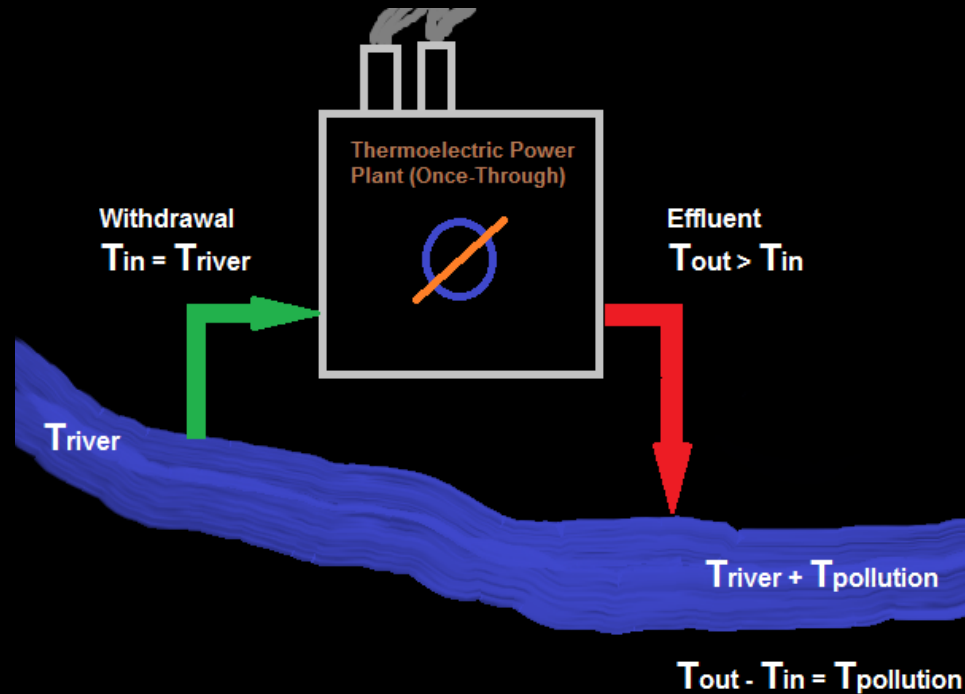
The fish were found between the Illinois 48 and DeWitt bridges, near the hot water channel for the Clinton Power Station, said IDNR spokesman Tim Schweizer.

"Abrupt changes in water temperatures are not uncommon at a power plant lake" and likely caused the fish kill, said Schweizer.

Lake fishing should not be negatively impacted, said Schweizer.



Thermoelectric power plants can have a range of effects on the surrounding environment.



Inflow Issues:

- Ecology
 - Impingement & Entrainment
- Water Quantity
 - Disrupted & Reduced Stream Flow

Outflow Issues:

- Ecology
 - Species Direct & Indirect effects
 - Community Changes
- Water Quality
 - Chemical Pollution
 - Thermal Pollution



Aquatic species can have a range of reactions to thermal pollution.

- Temperature tolerance is affected by many factors
- Thermal stress can induce changes in metabolism and reproductive success and timing
- Functional imbalances can occur, leading to molecular-level changes in individuals
 - In rare cases, such changes can lead to evolution and/or mutation



Effects to species can be direct, indirect, or chronic.

Direct Effects

stress

behavioral changes

mortality

Indirect Effects

decline in food supply

attraction of predators

niche alteration

Chronic Effects

altered life cycle processes

metabolic rate changes

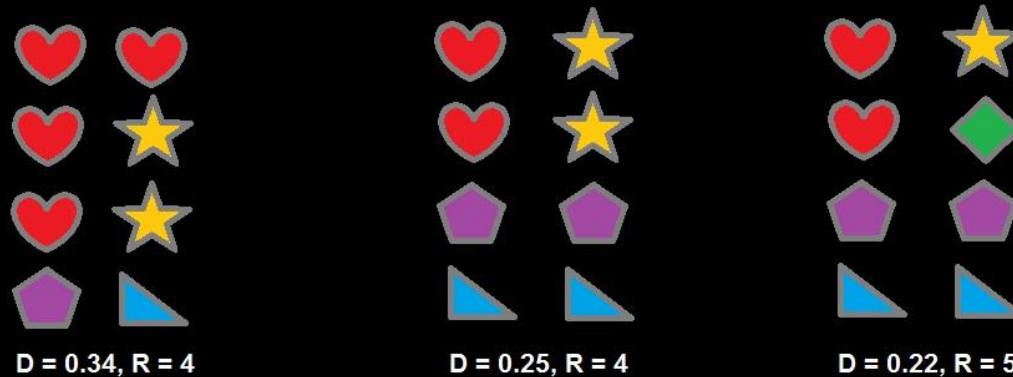
increases rates of disease



The effects of thermal pollution can alter population and community level dynamics.

- Species diversity, abundance, and richness can all be impacted by thermal pollution

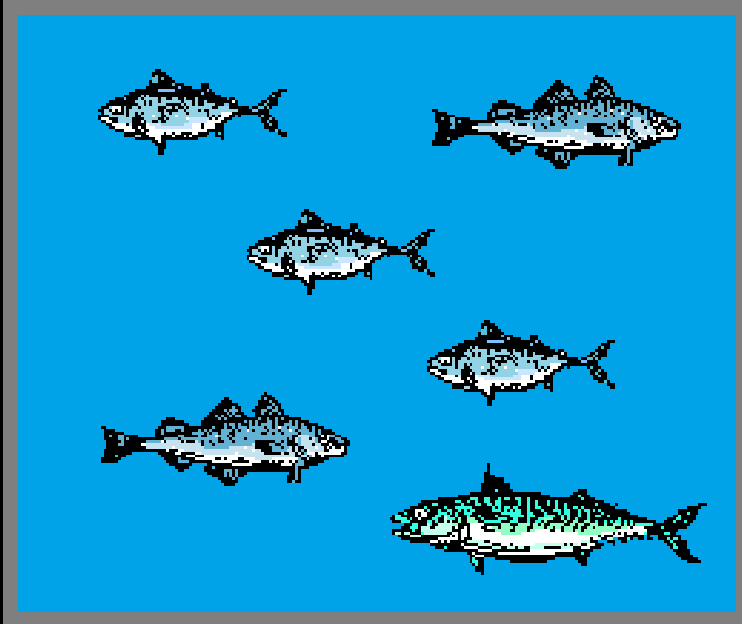
Species Diversity and Richness within a Community



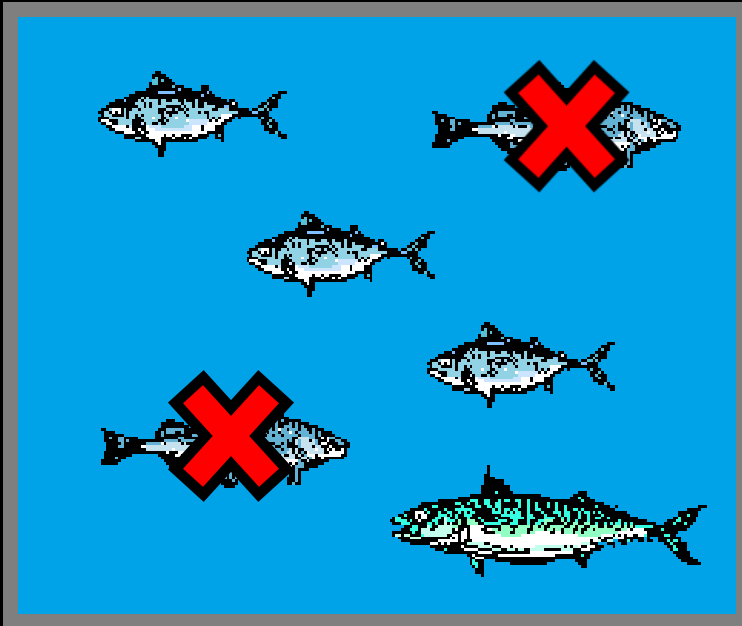
*Simpson Diversity

- Shifting dominance patterns can create favorable conditions for invasive species

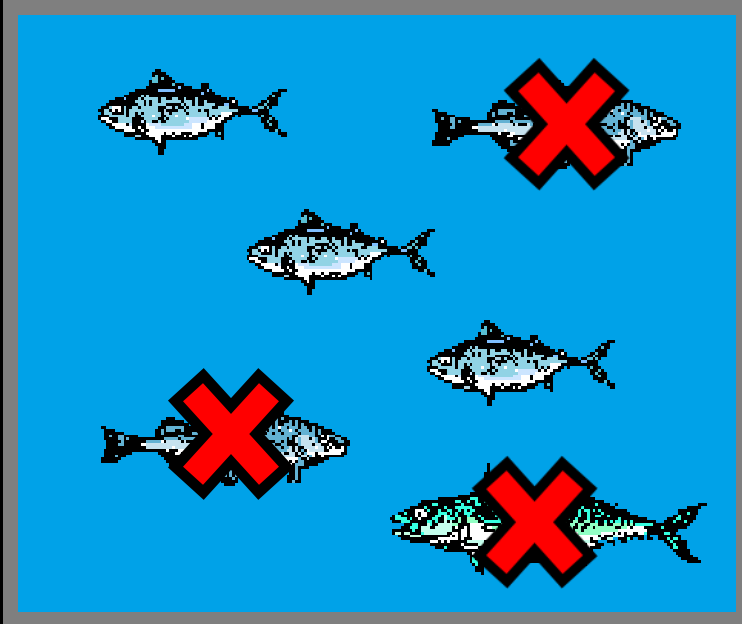
Why should we care about aquatic ecosystems?



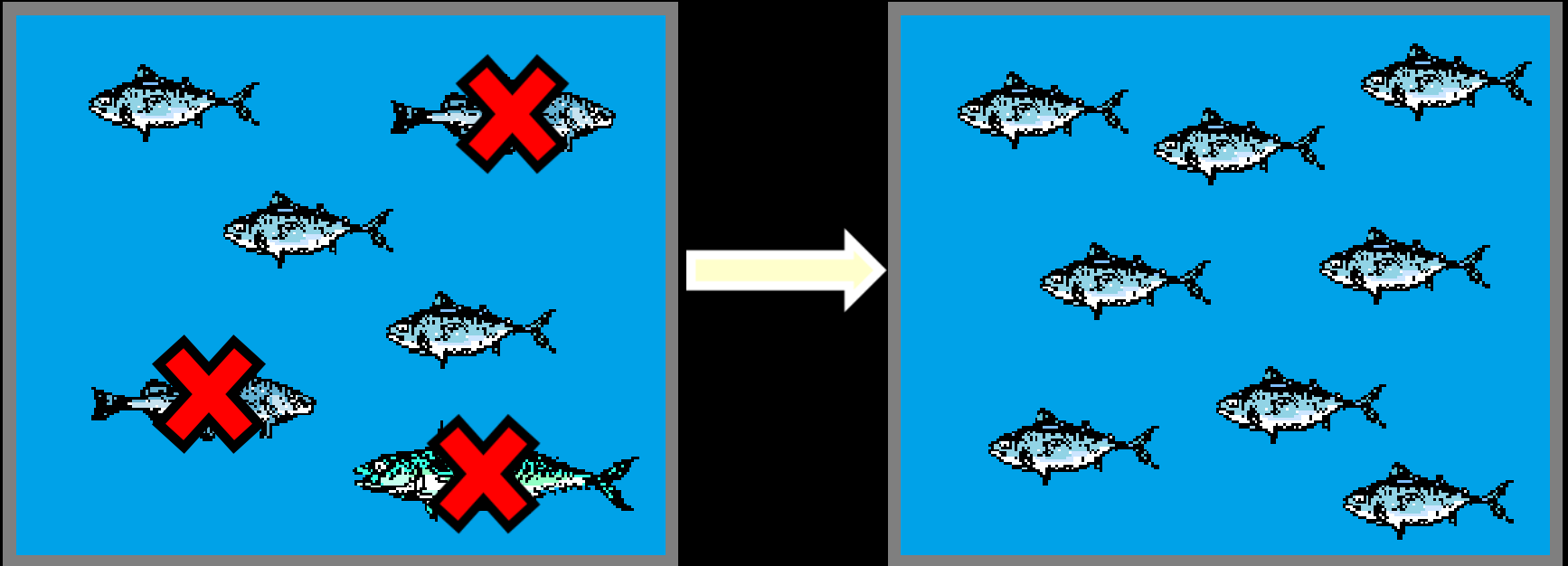
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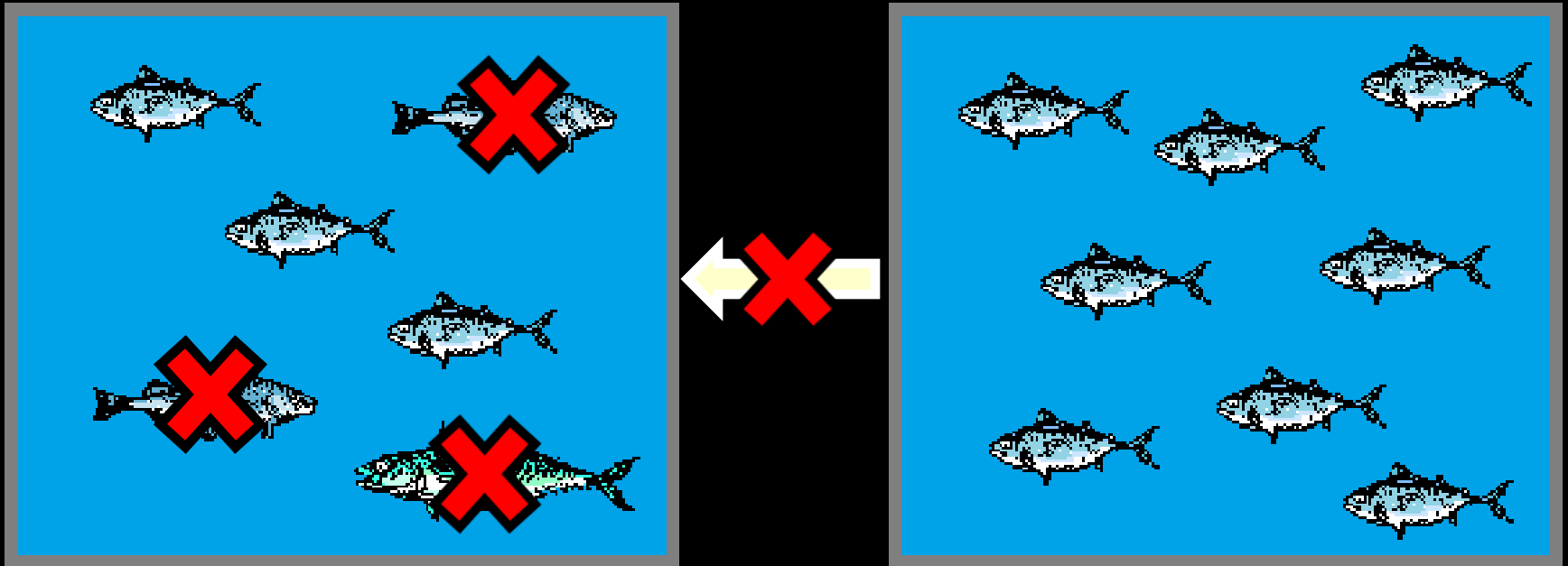
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Currently, the Clean Water Act regulates thermal pollution in waterways.

- Section §316(a) governs effluent temperature
 - Must be at or below 32°C unless a variance is granted
- Variances are granted through NPDES
 - Requires proof of “projection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife”



Determining the damages to ecosystems is difficult.

- Benefit transfer methodology is useful in putting a price on ecosystem damages
 - Economic losses to fisheries
 - Reduction in tourism revenue
 - Increased cost to produce public drinking water
- Benefits based management provides a more qualitative look at ecosystem services
 - Intrinsic value of diverse aquatic ecosystems

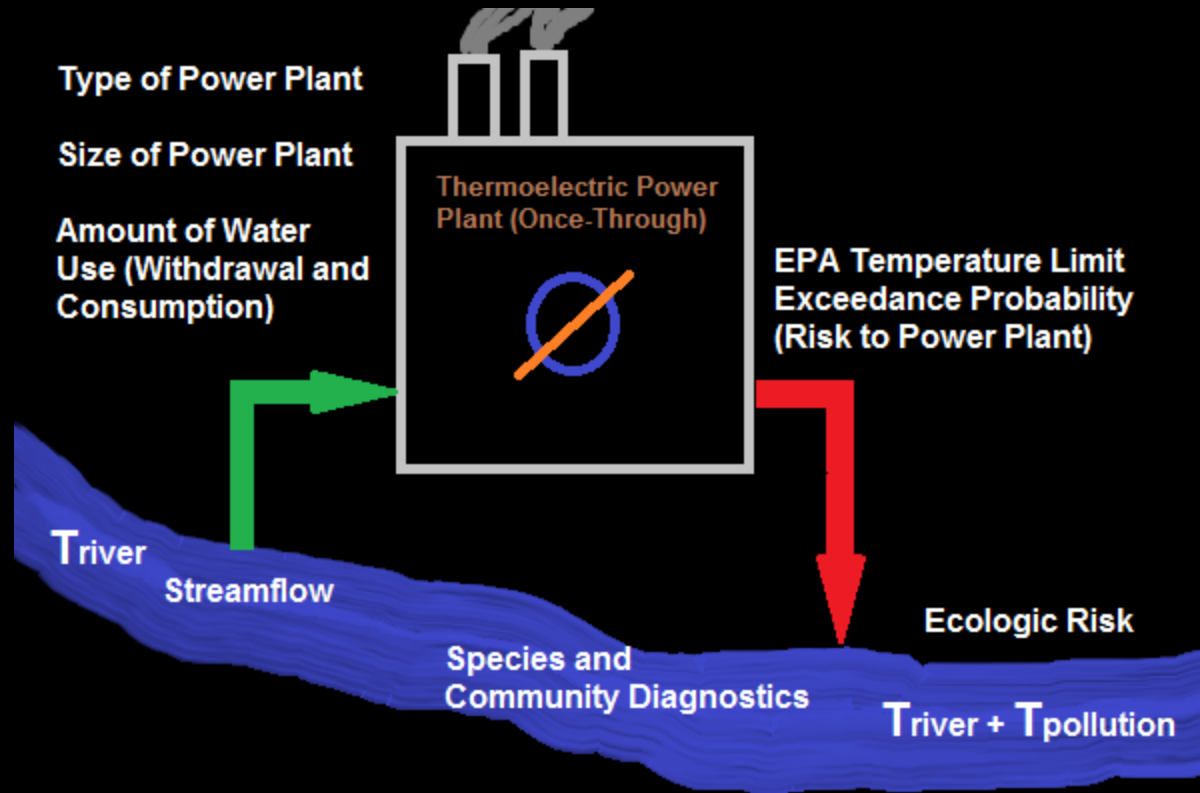


Policy makers, engineers, and scientists can work together to influence environmental policy.

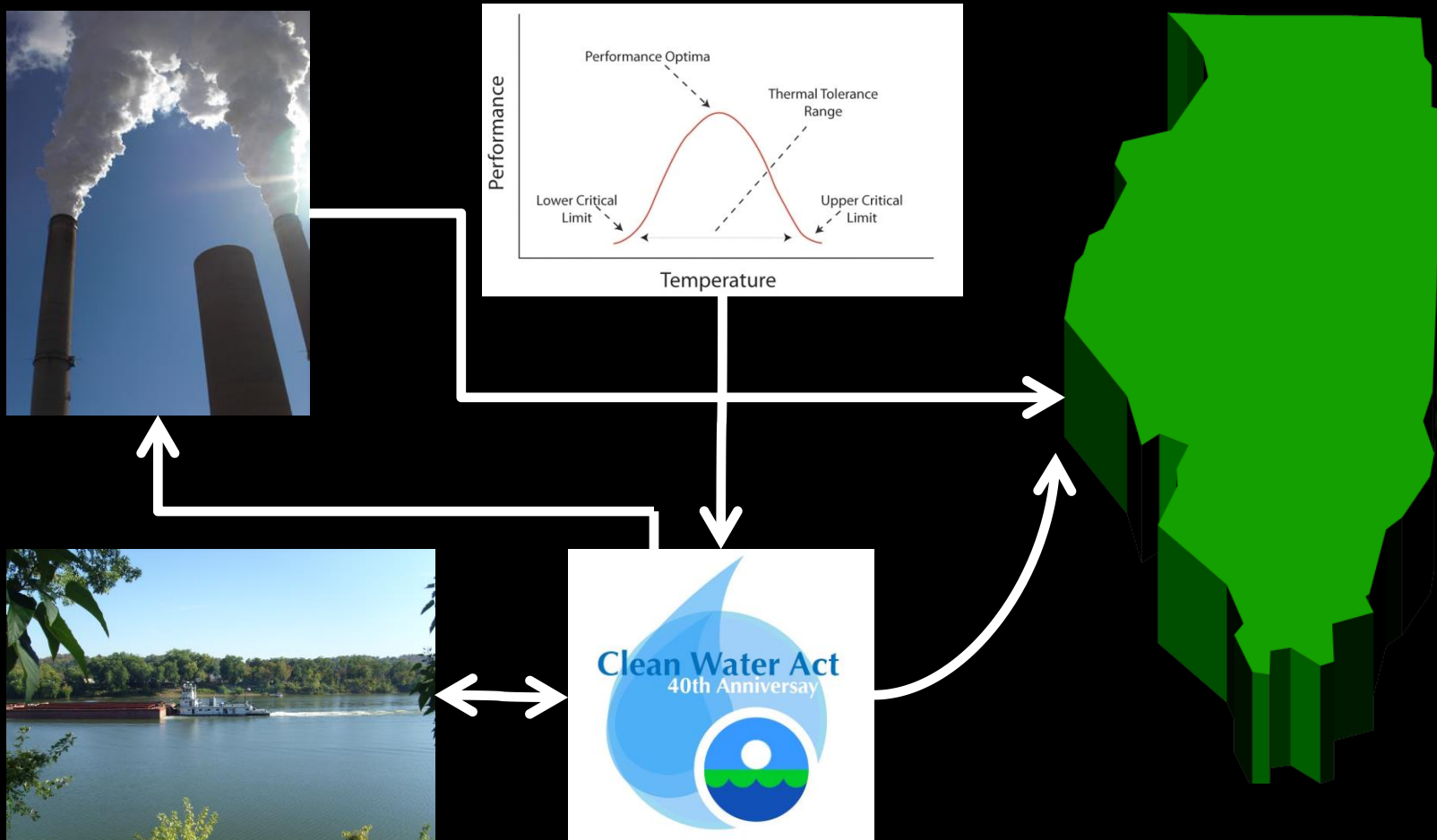
- Knowledge brokers facilitate the connection between policy makers and researchers
- Sustainability is both a process and a goal
 - Combines risk assessment and sustainability evaluation



Individual power plant assessment can help build a larger network of regional and national knowledge.



How do we bridge the gap and promote meaningful outcomes for policy-makers and researchers?



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QUESTIONS?



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