Collaboration for Environmental Evidence

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Plain Language Summary
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Systematic Review
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Changes in water flow from hydropower operations can impact fish abundance and biomass, but responses are inconsistent

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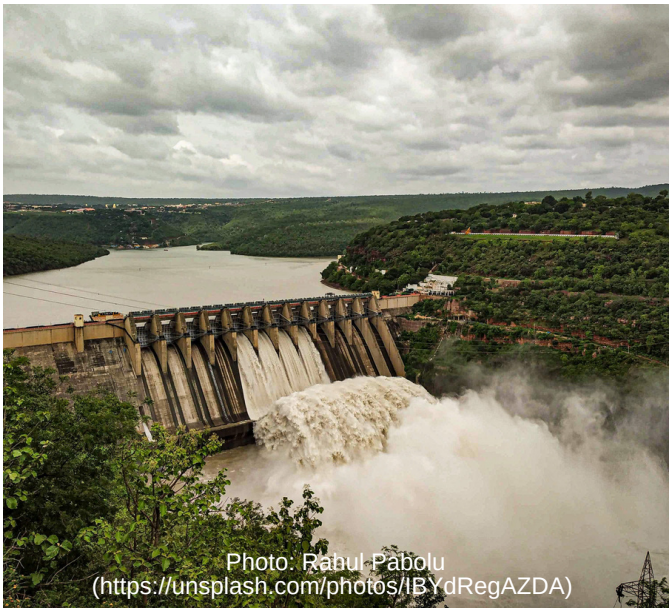

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Hydroelectric power production and operations can affect fish biomass and abundance in systems by changing water flow. Changes may include increases or decreases in water volume and speed, or changes to the timing, frequency and rate of change in water flow. This systematic review was unable to identify consistent changes in fish biomass and abundance when flow volume and speed were changed together. There was limited evidence to conclude that increasing or decreasing flow will always result in negative or positive responses in fish.

Why is this Evidence Synthesis Needed?

Hydroelectric power production provides clean, reliable energy but is a potential threat to freshwater biodiversity and fisheries resources. Hydropower operations can disrupt natural processes in ecosystems by altering flow. It is unclear if fish respond consistently to increases or decreases in flow created by the daily or long-term operations of a hydropower dam. Considering these impacts could help managers balance power production, fishery requirements, and the needs of different families of fish. This systematic review examined the impacts of changes in flow on fish abundance and biomass in hydropower impacted systems. The influence of the type and size of hydropower dams, changes to the timing, frequency or rate of alterations were investigated. The way studies were designed and different fish families were also considered. Fish responses in systems impacted by flow changes were compared to those with no or minimal hydropower. Systems with operational changes (either at new or existing dams) were compared to themselves before and after a change in flow. This helped clearly identify the impacts of flow changes due to hydropower operations.

This Collaboration for Environmental Evidence Systematic Review examines the impact of changes in flow volume and speed, caused by hydropower operations, on fish abundance and biomass in temperate regions, and whether impacts are influenced by features of the study, waterbody, hydropower operation, or fish families. The review summarizes evidence from 133 studies.

Main Findings

What studies are included?

This systemic review includes studies evaluating impacts of flow changes from hydropower operations on fish abundance and biomass. Comparisons of 146 hydropower systems before and after flow changes, and with and without flow changes, were included from 133 primarily North American studies published between 1958 and 2019. Fifty-eight studies allowed for further analysis of fish abundance and biomass. Water volume and speed increased, decreased, or both, in the studies included.

Were impacts on fish abundance and biomass due to flow changes from hydropower operations identified?

There were no consistent changes in fish abundance or biomass (i.e., total combined mass of all fish sampled) due to combined changes in flow volume and speed. When all families were considered together, fish abundance in systems with altered flow was not different than those with no (or minimal) hydropower. Fish biomass in systems with altered flow was decreased compared to those without, but differences were minimal.

When flow after operational changes was compared to the flow before, overall fish abundance and biomass increased, but the changes were minimal.

If considered separately, some families showed stronger responses than others. Some families of fish always increased in abundance after flow changes (i.e., salmonid and sculpin) while other families did not respond consistently. There was only sufficient information to consider salmonids in terms of biomass, which saw a minimal increase with flow changes.

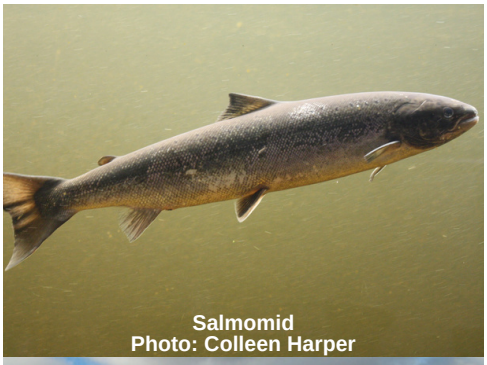
When fish abundance and biomass were compared among systems with and without hydropower, no additional factors were found to influence fish responses. In systems where operational changes occurred, fish abundance was influenced by sampling seasons and methods, fish life stage, and changes to the timing, frequency or rate of change in water flow. Whether the volume and speed of water flow went up or down during the change also influenced fish abundance. These variables did not influence fish biomass

What are the Implications of the Review Findings?

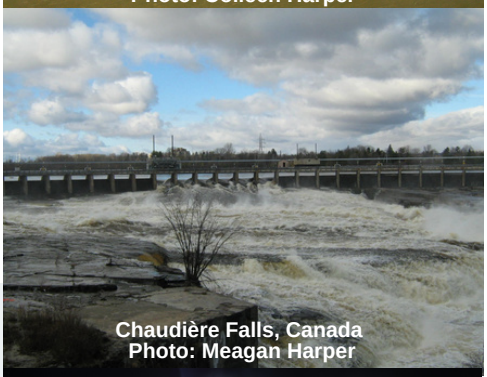
Our synthesis did not find consistent patterns in fish responses to combined changes in flow volume and speed. This is consistent with previous reviews and suggests that other factors may influence fish responses. It may not be possible to generalize fish abundance and biomass responses to hydropower-influenced flow changes across systems or among species. Because system-level features (i.e., size, underlying hydrology, community dynamics) may be highly influential, adaptive management of hydropower operations and site-specific studies to determine impacts are likely necessary. To improve study reliability and interpretability, long-term continuous monitoring is needed. Future studies should work to include temporal and spatial replication and sufficient quantitative data for comparators. Future studies should attempt to fill knowledge gaps including but not limited to:

- non-salmonid species
- sampling multiple seasons
- systems outside North America
- lagged responses to flow changes

It was not possible to determine consistent fish responses across all species and scenarios through this systematic review. However, water resource and fisheries managers can use the systematic review and associated database of articles to assess available evidence relevant to their specific contexts and/or regions.



Salmomid
Photo: Colleen Harper



Chaudière Falls, Canada
Photo: Meagan Harper

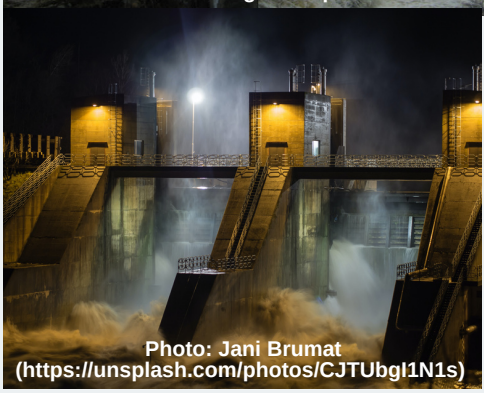


Photo: Jani Brumat
(https://unsplash.com/photos/CJTUbgI1N1s)

Synthesis Time Frame

The review authors updated the search of the systematic map (which included studies from 1940 to 2017) to capture additional studies published until December 2019. This CEE Systematic Review was published in February 2022.

Full Citation

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