How do zebra mussels affect walleye recruitment, food webs, and mercury concentrations?

Introduction:
- Zebra mussels (Dreissena polymorpha) filter feed, diminishing the amount of phytoplankton in a waterbody.
- Additional impacts of zebra mussels are not understood as well.
- Over 400 lakes in Minnesota are invaded with zebra mussels or closely connected to an invaded lake.
- Previous work (Hansen et al. 2020) has shown that age-0 walleye were smaller in size at the end of the summer in lakes invaded with zebra mussels.

Recruitment:

Methods
Electrofishing survey data from the Minnesota Department of Natural Resources (DNR) were collated and filtered based upon recommended electrofishing conditions and practices for targeting age-0 walleye. Additional input from MN DNR Fisheries Area Offices further validated survey data, and target species. Age-0 walleye catch rates post zebra mussel invasion were then compared to walleye catch rates prior to zebra mussel invasion. Uninvaded lakes walleye catch rates were also assigned a "pseudo zebra mussel invasion year" so we could learn if factors besides zebra mussels were potentially influencing walleye catch rates throughout the state. A Bayesian Hierarchical Model was also developed to help quantify how zebra mussels changed walleye catch rates, and allowed us to account for other variables known to influence walleye recruitment such as lake size, temperature, and water clarity.

Results
- Post zebra mussel invasion, recruitment declined by ~ 39%
- Recruitment in stocked lakes is 2.5 times higher than in unstocked lakes
- Over 400 lakes in Minnesota are invaded with zebra mussels or closely connected to an invaded lake.
- Uninvaded lakes saw a slight increase in recruitment success, making us more confident that the decline in recruitment is caused by zebra mussels and not other factors such as lake temperature, land use change, etc.

Discussion
This research will help inform fisheries managers about how invasive zebra mussels influence walleye, Minnesota’s most popular sport fish. Additionally, knowing lakes that are stocked show higher recruitment than lakes that are not stocked may garner support for stocking walleye fly in zebra mussel infested lakes.

Food web structure:

Methods
Organisms from across the food web were collected in 14 study lakes throughout Minnesota between 2019-2020. Zooplankton, nearshore invertebrates, nearshore and juvenile fish, and offshore fish were collected by our lab and in collaboration with our MN DNR partners for stable isotope analysis to quantify trophic positions and proportion of nearshore and offshore energy sources. To date, 2,613 samples have been analysed for carbon-13 and nitrogen-15 stable isotopes. Isotope data are being analysed using the Riphic Position R package, which uses a Bayesian model along with isotope data and up to two baselines to determine the trophic position of a given population. For this study, we are focusing on walleye and yellow perch.

Results
Preliminary analysis indicates that both walleye and perch have a greater reliance on nearshore energy in zebra mussel invaded lakes versus uninvaded lakes. This is in line with our hypothesis that a reduction in offshore food availability due to zebra mussels is leading walleye to consume more nearshore prey.

Discussion
Whether or not walleye shift their food sources from offshore to nearshore, there are impacts to walleye populations and/or human health. If walleye don’t adapt to more nearshore food sources, they likely won’t have access to enough food to successfully recruit to the fishery due to depletion of offshore resources (plankton) by zebra mussels. This means fewer walleye for people to catch.

If walleye are able to capitalize on more nearshore prey, they may be exposed to greater amounts of mercury, a heavy metal that bioaccumulates in fish tissue and is harmful to humans. This means walleye from zebra mussel lakes may be hazardous for humans to eat.

Mercury concentrations and sources:

Methods
A subset of walleye and perch from our isotope samples were sent to the USGS Mercury Research Lab in Middleton, WI. They were tested for mercury concentrations to evaluate differences in mercury accumulation in fish tissue relative to food web structure and zebra mussel invasion status. In the future, a selection of this sample set will be analysed for more isotopes to help determine the original source of the mercury in the fish tissue.

Results
Preliminary results show that mercury concentrations in zebra mussel lakes are higher in walleye and perch than in uninvaded lakes. Analysis is still being carried out on how this correlates with food web structures between zebra mussel and uninvaded lakes.

Discussion
Mercury is a heavy metal contaminant that negatively affects human health. It is bioaccumulated up the food web, so older, larger, predatory fish naturally accumulate more mercury, posing a greater health risk to humans. Our hypothesis is that shifts in nutrient availability due to zebra mussels lead walleye to rely more on nearshore prey, where mercury exposure is higher. Our preliminary results indicate that zebra mussel invaded lakes are more likely to produce walleye with higher mercury concentrations.

With this information, fisheries managers can be proactive in monitoring for mercury and informing the public of higher exposure risk after zebra mussel invasion.