Microplastic Bioaccumulation in Invertebrates, Fish, and Cormorants in Lake Champlain

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Introduction
- Microplastics are ubiquitous in aquatic ecosystems, as well as their inhabitants ranging from invertebrates to whales (Bauh et al. 2014).
- Microplastics are defined as plastic particles < 5mm diameter.
- Primary microplastics are most commonly used in cosmetics or produced for industrial use (nurdles). These are typically discharged into watersheds through wastewater treatment plant (WWTP) effluent and onward into waterbodies.
- Secondary microplastics are microsized fragments derived from the breakdown of larger plastic debris by processes such as mechanical, biological, and photo degradation (Galloway et al. 2011). They are also comprised of marine debris (e.g., lures, line/rope, nets).
- Microplastics can be synthetic fibers, which readily pass through WWTP filtration and into local watersheds and up the food chain.
- Microplastics can absorb a wide range of pollutants (Besseling et al. 2012) and are able to leach out plasticizers such as phthalate and BPA which can enter the tissues of aquatic species and pose a threat to humans.
- Microplastics are hydrophobic particles that behave like DDT and PCBs, acting as chemical inhibitors within living organisms and bioaccumulate within the food web (Stevens 2010).

Field Methodology
- Sources of organisms:
  - Rainbow smelt, alewife = Vermont Fish & Game monitoring surveys at Double-crested cormorant = NYS DEC removal project
  - Mysis, amphipods, zebra mussels, and fish = Lake Champlain Research Institute (LCRI) via 250µm Bongo net and kick nets

Laboratory Methodology
- All species were found to contain microplastics with the exception of terrestrial isopods and zebra mussels.
- Presence of microplastics was noted in many of our fish and cormorant specimens, as well as in organisms lower in the food chain. Our results (Figs. 7, 8) indicate that microplastic bioaccumulation is occurring, as other research has noted (Wright et al. 2013).

Discussion
- Synthetic fibers were the most common type of particulate found in organisms.
- It was determined that the most abundant plastics in North Sea fish digestive tracts were rayen and polyamide textile fibers (Lusteil et al. 2013).
- Many organisms mistake these microplastics for food (Foekema et al. 2013) and bioaccumulate up the food chain (Eriksson and Burton 2003).
- Studies have shown that microplastics adhere to algae (Gutow et al. 2016).
- 61% surveyed zooplankton contained microplastics (Frias et al. 2014).
- 19.8% of fish, across 17 species, ingested microplastics and 32.7% of them had more than one microplastic (Newes et al. 2015).
- 45% sunfish consumed microplastics. Of particulate, size ranged from macro (i.e., >5 mm) (4%) and microplastic fibers (96%).
- Fish length/growth and urbanization resulted in increased particulate load.
- American black ducks (46%) and mallards (6.9%) were found to have ingested plastics (English et al. 2015).
- Negative impacts of microplastics exposure in benthic aquatic systems have been reported, including reduced feeding activity, enhanced absorption of contaminants (Ressing et al. 2012), and reduced energy reserves following consumption (Wright et al. 2013).
- Human risks range from consumption of seafood (Van Cauwenberghes and Janssen 2014) to beer (Liese and Liebesch 2014), and sea salt (Yang et al. 2015) to pathogenic spread (Kostawa et al. 2016).

Future Directions
- Characterize microplastics to polymer type using FTIR (Fourier Transform Infrared) microscopy.
- Continue processing fish digestive tracts to increase fish diversity across guilds.
- Survey for presence of microplastics in zooplankton.
- Analyze bass tournament stomach contents for marine debris (e.g., plastic lures, lines).

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References
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