

## Potential Mechanisms of Ocean Mortality of Juvenile Salmon and Steelhead Due to Ingestion of Plastic Marine Debris

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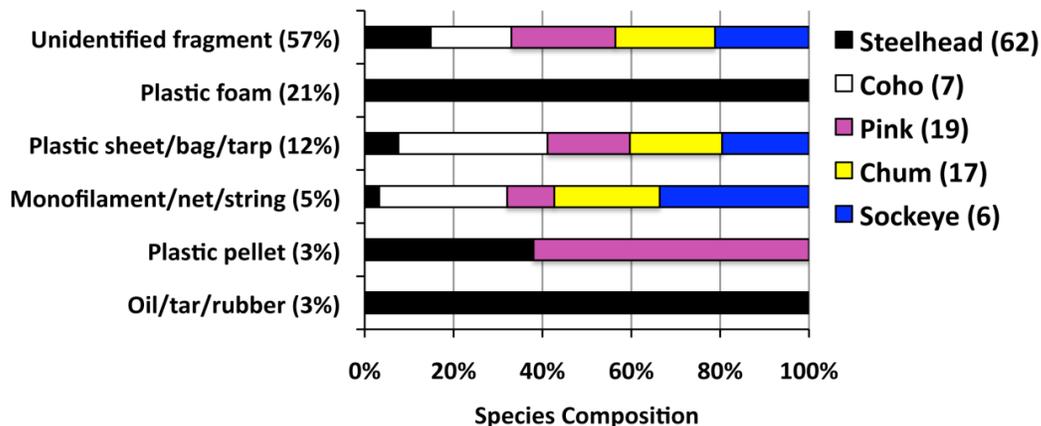
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Is man-made plastic debris a potential cause of ocean mortality of juvenile salmon and steelhead? Plastic debris is a well-known and increasing pollution problem, affecting aquatic food webs worldwide (Derraik 2002). Decomposing plastic debris can leach potentially toxic chemicals such as BPA (bisphenol A), PCBs (polychlorinated biphenyls), and derivatives of polystyrene (Teuten et al. 2009). Plastic debris can also absorb organic pollutants from seawater, e.g., PCBs, DDT (dichlorodiphenyltrichloroethane), and PAHs (polycyclic aromatic hydrocarbons) (Teuten et al. 2009). Chemicals leached and absorbed by plastic debris can bioaccumulate in fish, and anadromous fish can transport these chemicals back to freshwater habitats (Ewald et al. 1998). Some chemicals leached from plastics, e.g., BPA, mimic estrogen, causing endocrine disruption and reproductive effects such as inhibition of testicular growth (Kang et al. 2007). Surfactants used in plastics can also disrupt pituitary functions in fish, thus affecting their ability to osmoregulate (Björnsson et al. 2011). In this paper we reviewed what is known about the ingestion of plastic debris by Pacific salmon and steelhead, presented field data on ingestion of plastic by salmon and steelhead in international waters (high seas) of the North Pacific Ocean and Bering Sea, and discussed potential mechanisms of ocean mortality of juvenile salmon and steelhead due to ingestion of plastic debris. To our knowledge, this issue has never been the focus of directed marine studies on salmon and steelhead, and all available field data were collected incidental to other research. Analyses of available time-series (1990s-2000s) of high-seas food habits data indicated that salmon and steelhead consume a variety of types and forms of plastic, e.g. pellets, foam, sheets (Fig. 1). The occurrence of plastic debris in stomach contents varied by species, age and maturity group, time, and area.



**Fig. 1.** Percent frequency of occurrence of different types of plastic in the stomach contents of Pacific salmon and steelhead for available time-series (1990s-2000s) of high-seas food habits data. Species key shows sample size (number of fish).

Potential mechanisms of marine mortality of juvenile salmon and steelhead due to ingestion of marine plastic debris may be direct, e.g., lethal mechanical injury or toxicity, or delayed, e.g., heritable alterations in gene expression (epigenetic) affecting early marine survival of progeny (Fig. 2). Our results emphasize the need for directed field and laboratory process studies on this important issue.

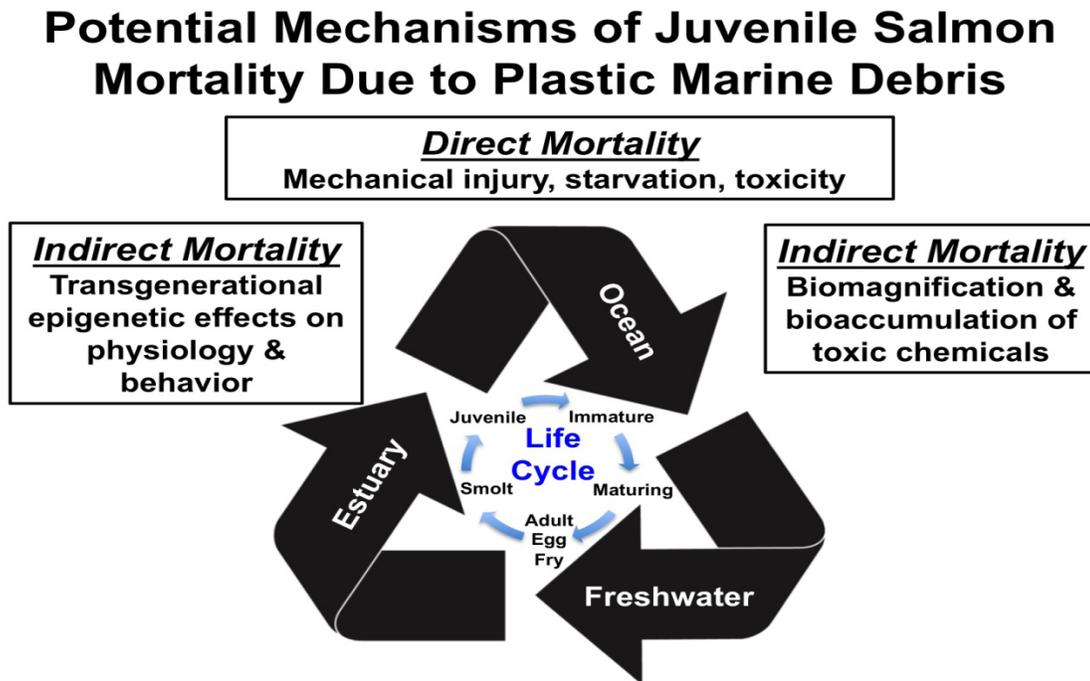


Fig. 2. Potential mechanisms of juvenile salmon mortality due to plastic marine debris.

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