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Life Cycle Assessment of products from Alaskan salmon processing wastes: Implications of coproduction, intermittent landings, and storage time

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ABSTRACT

This research examines the gate-to-grave life cycle of salmon processing wastes (offal) management options in Sitka, Alaska using Life Cycle Assessment. The bases for comparison are the management of 1 kg of offal and the management of ~33,000 metric tons of offal generated intermittently throughout the 2010 fishing season in Southeast Alaska. Management options are (a) grind and discharge disposal, (b) two types of fresh processing, and (c) stabilized/ensiled offal processing. It is found that the contributions to eutrophication, acidification, and climate change are consistently reduced by assuming product displacements of meal, oil, and gelatin coproducts as compared to grind and discharge disposal. Further, increasing the allowable storage time by stabilizing the offal feedstock provides additional benefit by reducing the amount of offal ground and discharged.

1. Introduction

In 2010, approximately 82,000 metric tons of salmon were processed in the Southeastern-Yakutat Alaskan region into a variety of products (as thermally processed products, fresh headed and gutted products, fresh fillet products, frozen headed and gutted products, and frozen fillet products) (Alaska Salmon Product Report, 2010). Much of this processing occurred in July through September (Fig. 1), approximately following peaks in Southeast Alaskan salmon landings as accounted by the Alaska Department of Fish and Game Division of Commercial Fisheries.[1] Interestingly, fisheries outside of the region appear to be supplying Southeast processing facilities, particularly early and late in the year, but even when landings are high (assuming an offset of about 1 month which is likely attributable to accountings on a monthly basis). The temporal variability in salmon lands in Southeast Alaska is large and depends strongly open season dates, weather, and other factors. Landings are reported on a monthly basis for a specific group of fish and delivery condition. Monthly information based on less than three companies is considered confidential and is not reported except for in yearly totals.

Fish processing waste (or offal) consists of viscera, heads, tails and trim wastes and it is typically assumed to be equal to 40% of the wet weight of salmon processed. Based on 82,000 metric tons of fish processed in Southeast Alaska in 2010 and a 40% offal yield, approximately 33,000 metric tons offal was produced (Fig. 2). Much of this offal was ground and discharged into the ocean. For example in March 2013, two Alaska Seafood Processors settled with the US Environmental Protection Agency for failing to comply with their Clean Water Act permits. The Clean Water Act requires processing facilities to grind seafood waste to a maximum size of ½ in. in order to increase dispersion of solids into the ocean (Kader, 2013).

This seafood processing waste consists of biodegradable materials containing high concentrations of soluble organic material (Hanson et al., 2003). The U.S. Clean Water Act allows Alaska seafood processors to deposit fish offal in a “zone of deposit” (Environmental Protection Agency, 2001). Deposits in areas without enough flushing can have at least three types of impacts. First, discharges can remove benthic habitat from the environment,

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[1] Landings data are based on 2010 as provided by the Alaska Department of Fish and Game Division of Commercial Fisheries (Shellene Hutter, PO Box 115526, Juneau, AK 99811-5526, P. 907.465.6131, shellene.hutter@alaska.gov) and based on the Zephy, Triton, and Neptune database as downloaded on 8/24/2011.

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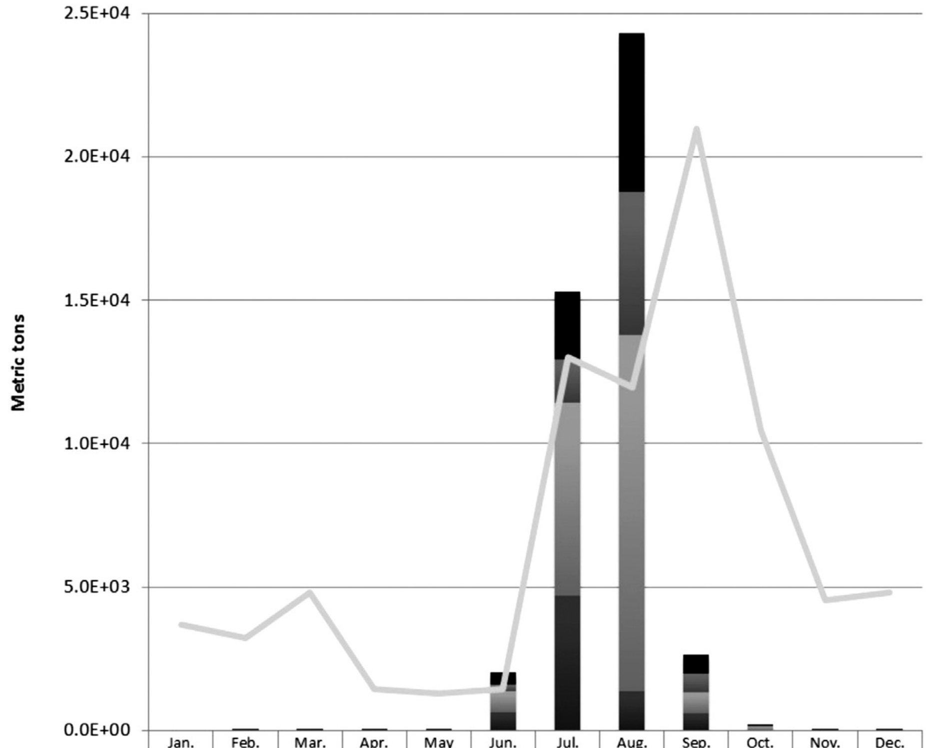

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Sitka/Pelican (73 km to Port of Sitka)	0.0E+00	1.3E-01	2.0E-01	6.1E-01	7.4E-01	4.0E+02	2.3E+03	5.5E+03	6.9E+02	6.0E+01	2.3E-01	1.8E-01
Petersburg/Wrangell (305 km to Port of Sitka)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.2E-01	2.6E+02	1.5E+03	5.0E+03	6.3E+02	1.2E+01	0.0E+00	0.0E+00
Ketchikan/Craig (341 km to Port of Sitka)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.3E+02	6.7E+03	1.2E+04	7.5E+02	1.3E+02	0.0E+00	0.0E+00
Juneau/Yakutat (364 km to Port of Sitka)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.2E+02	4.7E+03	1.4E+03	5.9E+02	6.3E+00	0.0E+00	0.0E+00
Estimated fish used in salmon processing	3.7E+03	3.2E+03	4.8E+03	1.4E+03	1.3E+03	1.4E+03	1.3E+04	1.2E+04	2.1E+04	1.0E+04	4.5E+03	4.8E+03

Fig. 1. 2010 salmon landings and processing in Southeast Alaska. Landings are intermittent, with most arriving from June through September. Processing lags on a monthly basis, with most processed from July through October.

reduce locally associated invertebrate populations, and lower dissolved oxygen levels in overlying waters. Second, severe anoxic and reducing conditions can occur adjacent to effluent piles, resulting in the potential for increased predation on juvenile fish species by fish, diving seabirds, and marine mammals drawn to the food source. Third, scum and foam from seafood waste deposits can occur on the water surface and can increase turbidity, the latter having the potential to reduce primary production. Hanson et al. (2003) also note that processing stickwater discharges (water expressed from cooked fish meal cake) can take the form of a fine gel or slime that can concentrate on surface waters and move onshore to cover intertidal areas.

Hanson et al. (2003) recommend processing and recovery of fish processing wastes. Production of meal and oil from offal has been practiced to some extent, but such conventional processes still emit substantial amounts of organic material in the form of stickwater and process operation is limited by the intermittency of landings and processing limitations. In times when landings are not large enough quantities to warrant processing or exceed processing capacity, a substantial amount of offal is still ground and discharge.

Nicklason et al. (2010) describes an offal processing system developed at the Northwest Fisheries Science Center (NWFSC) to address these processing limitations. The Montlake processes (named after the Montlake district in Seattle in which the NWFSC is located) have two main features. First, the Montlake process achieves greater product recovery by coproducing a gelatin feedstock in addition to salmon meal and oil. This reduces the organic materials in stickwater discharges. Second, there are two versions of the Montlake process: one based on continuous processing of fresh offal that must be processed within 2 days of receipt and one that chemically stabilizes the offal to allow processing over a 21 days period. After 2 days storage, the quality of fishmeal and oils produced from unrefrigerated offal is significantly reduced.

In the Montlake 21-day process, stabilization (or ensilation) is accomplished by the addition of acids to reduce the pH and inhibit the growth of mold and bacteria (FAO, 1986; Hall, 2010; Nicklason et al., 2010). Common chemicals used include sodium nitrite, sodium sulfite, ascorbic acid, formic acid, propionic acid, and benzoic acid (FAO, 1986; Hall, 2010; Nicklason et al., 2010). The most common acid used is formic acid, but use of this acid is not allowed in animal feed in the U.S. As such, Nicklason[2] suggests the use of a mixture of propionic and phosphoric acids followed by neutralization with sodium hydroxide for U.S. bound feeds.

The intermittency of offal production in Southeast Alaska has important implications to our understanding of the impact of salmon offal management at the local, regional, and global levels. This includes consideration of not only offal processing in Southeast Alaska but also of the impacts of grinding and discharging offal that is not processed, the production of the fuel and stabilization chemicals used in processing, related logistics, and the impacts and benefits provided by the various coproducts.

[2] Personal communication on April 22, 2013 with Nicklason, P., National Marine Fisheries Service, Northwest Fisheries Science Center, National Oceanic and Atmospheric Administration, 2725 Montlake Boulevard East, Seattle, Washington 98112 USA.