Juvenile Salmon Migration Dynamics in the Discovery Islands and Johnstone Strait in 2018

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ABSTRACT

The majority of out-migrating juvenile Fraser River salmon pass northwest through the Strait of Georgia, the Discovery Islands, and Johnstone Strait. The Discovery Islands to Johnstone Strait leg of the migration is a region of poor survival for juvenile salmon relative to the Strait of Georgia. The Hakai Institute Juvenile Salmon Program has been monitoring key components of this migration since 2015 to better understand drivers of early marine survival. Here we present key aspects of the 2018 migration in comparison to averages from the 2015—2018 study period, which we use to define 'normal'. In 2018 sockeye, pink, and chum all migrated earlier than normal. The median capture date was May 23rd for sockeye, five days earlier than normal, and June 12 for pink and chum which is five days earlier for pink and three days earlier than normal for chum. Sea lice prevalence was lower than normal for sockeye, pink, and chum. Notably there were no *Lepeoptheirus salmonis* sea lice observed in Johnstone Strait in 2018. Sockeye were longer than normal in 2018 whereas pink and chum were smaller than normal. Sea surface temperature in May and June was the warmest on record in the study period (2015—2018). Pink salmon dominated the catch in 2018, followed by chum and then sockeye.

INTRODUCTION

Pacific salmon (*Oncorhynchus* spp.) traverse a number of aquatic landscapes during different phases of their lifecyle to reach a habitat which ultimately offers some reward. While undergoing these migrations, salmon are subjected to risks associated with each new environemnt they encounter. The risks and associated mortality from the sum of these migrations can be understood in aggregate by quantifying the productivity (recruits per spawner) of a certain stock. Salmon are an excellent indicator species beacuse they act as an integrator of terrestrial, lacustrine, fluvial, estuarine, nearshore marine, and high-seas conditions. A problem in any one of these environments will be reflected in the productivity of salmon stocks. To better manage and predict the producitivty of salmon stocks we need estimates of mortality and an understanding of the factors driving mortality in each landscape that salmon traverse. The early marine environment is one which estimates of mortality and it's drivers, is lacking. Juvenile salmon are particularly vulnerable during the early marine phase of their life history because they are undergoing physiological adaptations to a saline environment.

The Hakai Institute Juvenile Salmon Program has been monitoring juvenile salmon migrations in the Discovery Islands and Johnstone Strait (Figure 1) 2015 in an effort to understand what factors may be influencing early marine survival of sockeye, pink, and chum (Hunt et al. 2018). The effects of pathogens, parasites, predators, and the impacts of climate change on food web dynamics may be amplified during this stressful transition period and are the primary aspects of the salmon migration we are monitoring and reporting on here.

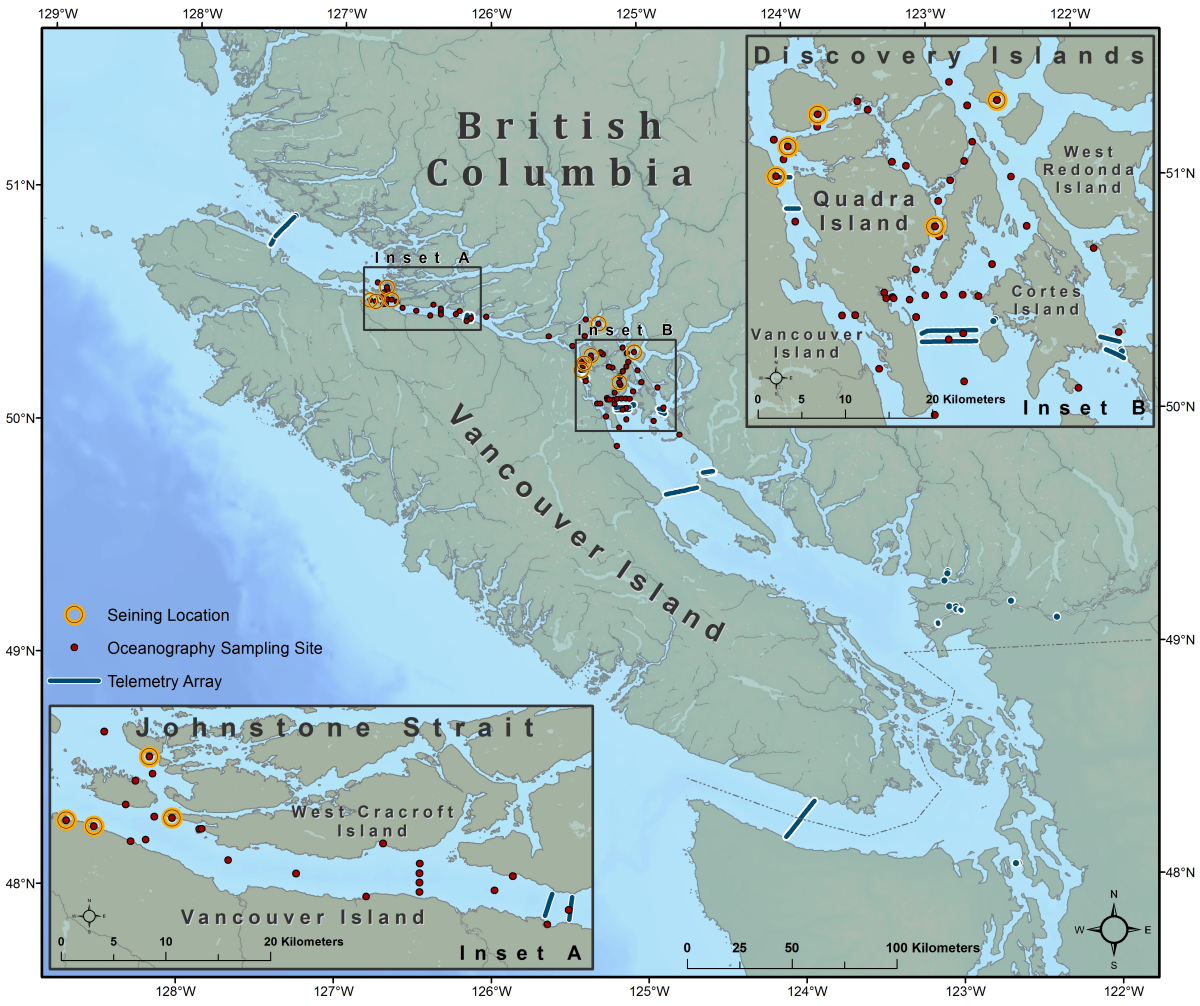

Figure 1. Sampling locations in 2018

Figure 2. An example image.

METHODS

See Hunt et al. (2018) for a detailed description of field and lab methods. Briefly, we collect juvenile salmon weekly from the Discovery Islands and Johnstone Strait during their northward migration from the Strait of Georgia to Queen Charlotte Strait near northern Vancouver Island, British Columbia. Sampling is conducted from May to July each year since 2015 using purse seine nets (bunt: 27 m x 9 m with 13 mm mesh; tow: 46 m x 9 m with 76 mm mesh). We sample in nearshore marine habitats with depth $>$ 10 m and effectively sample sockeye (*Oncorhynchus nerka*), pink (*O. gorbuscha*), chum (*O. keta*) and invidentally capture coho (*O. kisutch*), chinook (*O. tshawytschya*) and pacific herring (*Clupea pallasii*)

RESULTS

0.1 Migration Timing

SOME LATEX EXAMPLES

Use section and subsection commands to organize your document. LaTeX handles all the formatting and numbering automatically. Use ref and label commands for cross-references.

Figures and Tables

Use the table and tabular commands for basic tables — see Table 1, for example. You can upload a figure (JPEG, PNG or PDF) using the project menu. To include it in your document, use the includegraphics command as in the code for Figure 2 below.

Standard LaTeXreferences will work as well (e.g. Fig. 2).

Table 1. An Example Table.

Item	Quantity
Widgets	42
Gadgets	13

Citations

LaTeX formats citations and references automatically using the bibliography records in your .bib file, which you can edit via the project menu. Use the cite command for an inline citation, like Figueredo and Wolf (2009), and the citep command for a citation in parentheses (Figueredo and Wolf 2009).

Mathematics

LaTeX is great at typesetting mathematics. Let $X_1, X_2, \ldots, X_n$ be a sequence of independent and identically distributed random variables with $\mathrm{E}[X_i] = \mu$ and $\mathrm{Var}[X_i] = \sigma^2 < \infty$, and let

$$\bar{X}_n = \frac{X_1 + X_2 + \cdots + X_n}{n} = \frac{1}{n}\sum_{i=1}^{n} X_i$$

- **Word** Definition
- **Concept** Explanation
- **Idea** Text

We hope you find writeLaTeX useful for your PeerJ submission, and please let us know if you have any feedback. Further examples with dummy text are included in the following pages.

METHODS

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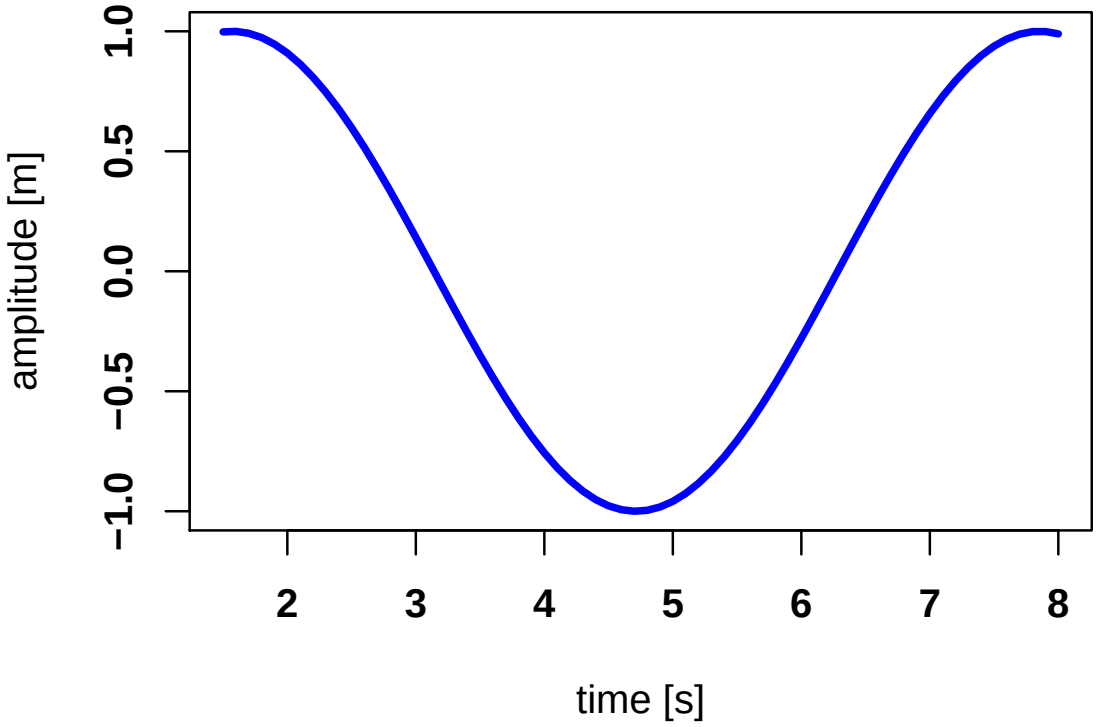

Figure 3. In-text Picture

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Reference to Figure 3.

RESULTS AND DISCUSSION

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ACKNOWLEDGMENTS

So long and thanks for all the fish.

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