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.

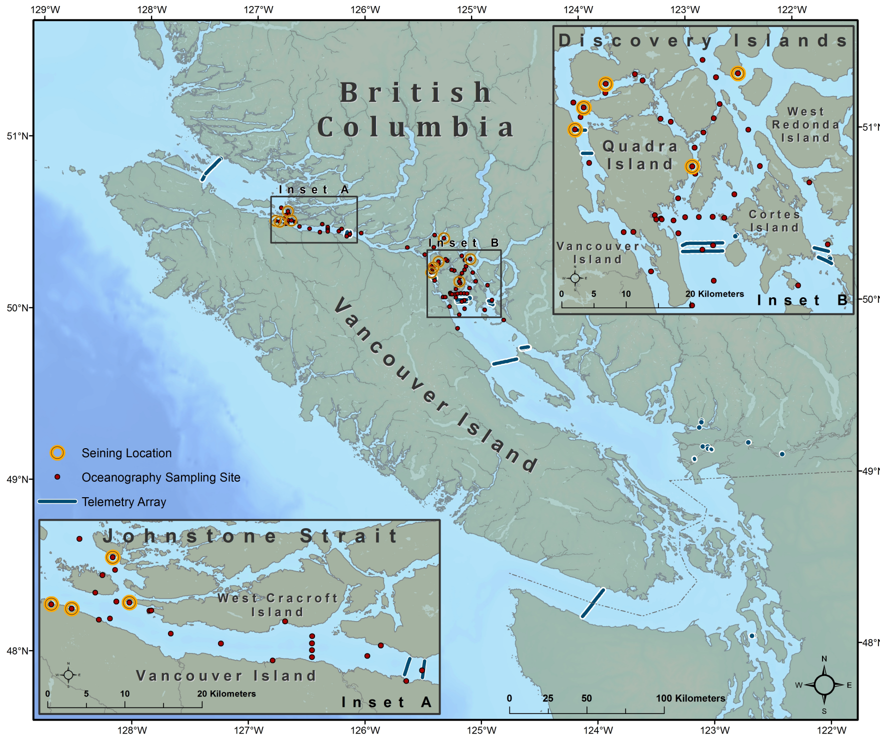

Figure 1. Sampling locations in 2018

METHODS

Field 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*). All animal handling and specimen collection was in accordance with UBC's Animal Animal Care Guidelines under permit A16-0101.

Statistical methods

All metrics reported are in relation to the time series average (2015—2018). The mean for each parameter of interest was calculated for all years combined, and the z-score was calculated for each parameter to determine the number of standard deviations away from the mean a given parameter was in each year.

Annual migration timing for each species was measured by calculating the median date of capture in the Discovery Islands, the date at which the 50 percent of the fish passed through the region. To visualize migration timing we plotted cumulative catch abundance between May 1st and July 9th each year and fit a logistic growth line. Species proportions were calculated by dividing the total number of each species caught that season across all seines by the sum of all species caught that season. Fork length distributions were visualized by calculating density estimates from fork length data. The prevalence of sealice was calculated as the number of individuals of a host species infected with a particular parasite species divided by Number of hosts examined (Margolis et al. 1990). Sea surface temp

For sea-surface temperature anomalies, the average is based on 30 m depth integrated temperature from station QU39 in the northern Strait of Georgia from May and June.

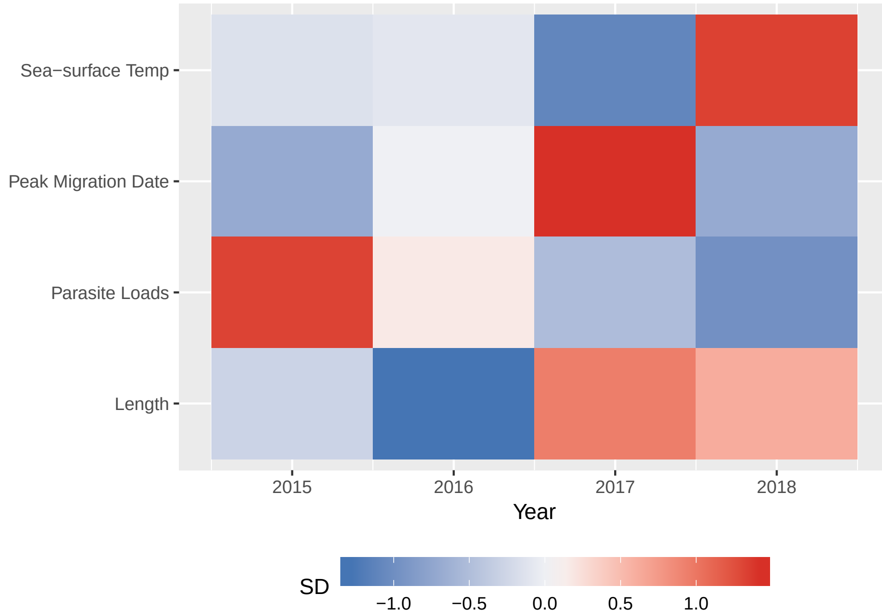

Figure 2. This heatmap indicates the number of standard deviations (Z-score) from the time series average (2015-2018) for key migration parameters. Blue colour indicates less than average, white indicates average, red indicates greater than average, and grey indicates insufficient data. Mean sea-surface temperature is 30 m depth integrated temperature from station QU39 in the Northern Strait of Georgia from May and June. Peak migration date is based on the median date of fish capture in the Discovery Islands. Parasite load is the average prevalence of all sea lice species in their motile life stage for both the Discovery Islands and Johnstone Strait regions combined.

RESULTS

The sea-surface temperature in May and June was higher than normal, and sockeye peak migration date in the Discovery Islands was earlier than normal in 2018. Parasite loads were less than normal, and lengths were longer than normal (Figure 2).

Migration Timing

Sockeye migration timing to the Discovery Islands in 2018 was: earlier than normal for sockeye (Figure 3), later than normal for pink, and later than normal for chum.

Species Proportions

Pink salmon dominated the catch in the Discovery Islands and Johnstone Strait in 2018 (Figure 4).

Length

Fish lengths varied between regions, species and year (Figure 5). Sockeye were longer than average in 2018…

Parasite Loads

The prevalence of sea lice in 2018 was the lowest recorded in the time-series (Figure 6)

Sea Surface Temperature

Sea surface temperature was warm (Figure 7)

DISCUSSION

Margolis, L., G. W. Esch, A.M. Kuris, and G.A. Schad. 1990. “The Use of Ecological Terms in Parasitology (Report of an Ad Hoc Committee of the American Society of Parasitologists).” *The Journal of Parisitology* 68 (1): 131–33. doi:10.2307/3281335.

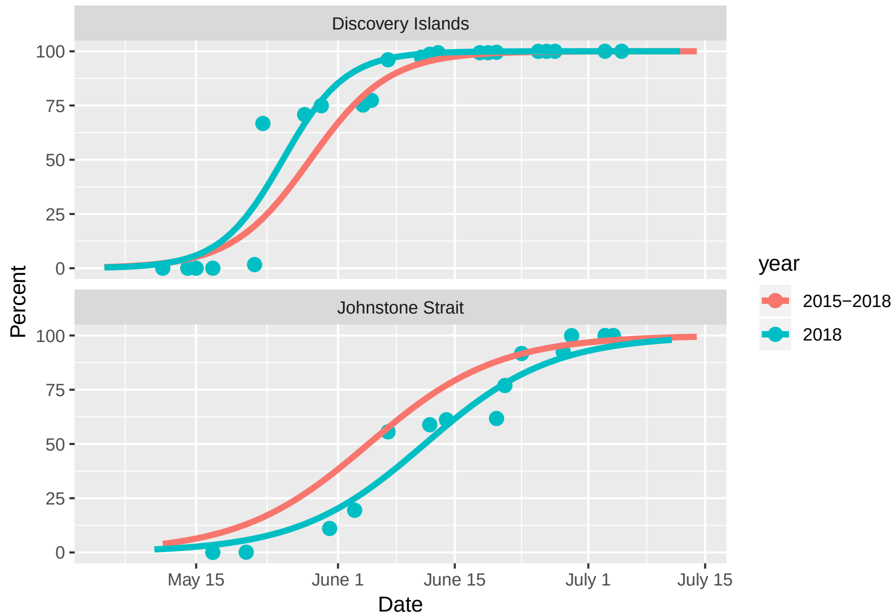

Figure 3. Cumulative catch of the selected juvenile salmon migrating through the Discovery Islands compared to the average for 2015—2018. Migration curves were predicted by fitting a logistic growth equation to the cumulative percent the selected fish caught. The points (circles) for the year being compared to the time-series is the cumulative catch percent

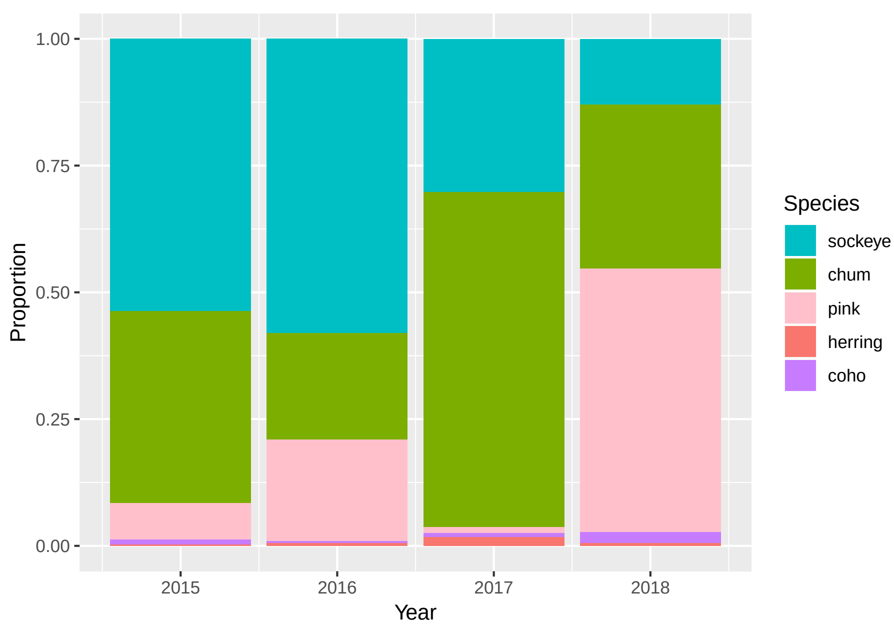

Figure 4. The annual proportion of fish captured in the Discovery Islands and Johnstone Strait combined.

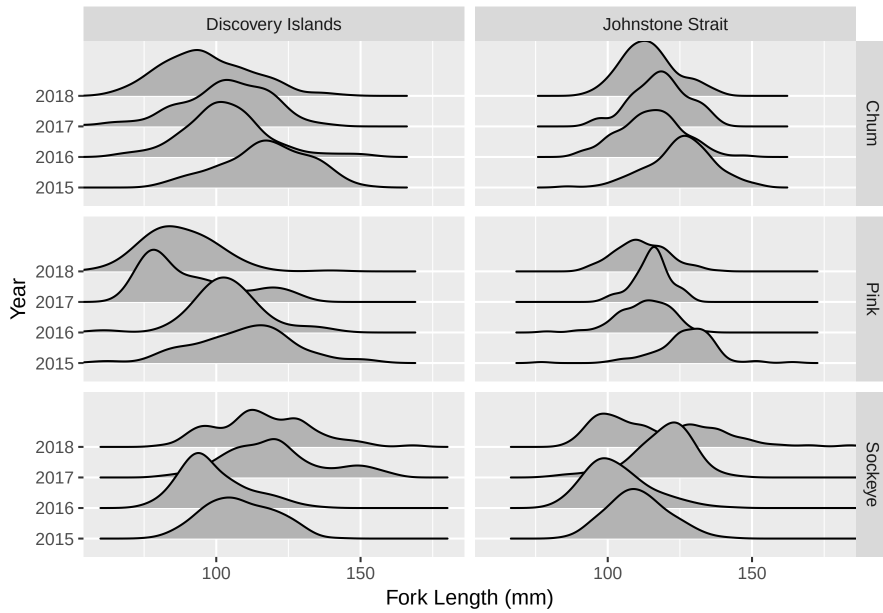

Figure 5. Kernel density distributions of juvenile salmon fork lengths for each year in the selected region. Note that these distributions contain multiple age-classes.

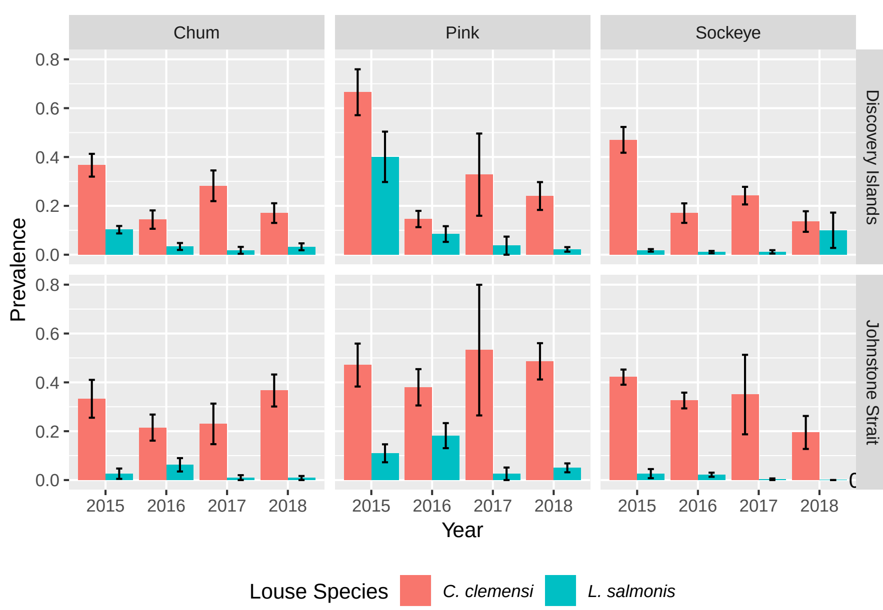

Figure 6. The prevalence (+/-SE) of motile sea lice on juvenile salmon in the Discovery Islands and Johnstone Strait.

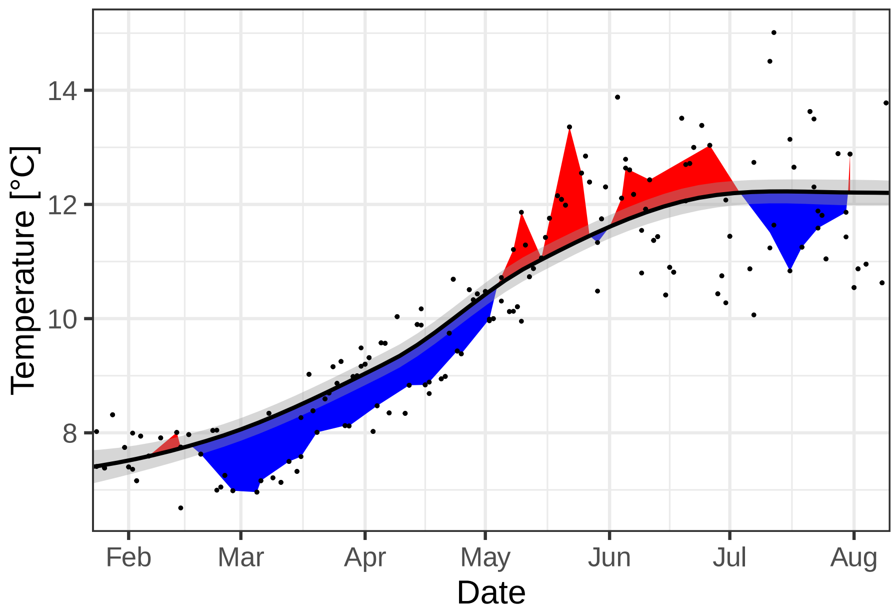

Figure 7. Time series of 30 m depth integrated temperature anomalies, blue areas represent temperatures that are below normal, red areas represent above normal temperatures at the selected station in 2018. Normal is the solid black line which is a loess regression based on temperatures from 2015-2018. The shaded grey area is 1 SE of the loess regression. The black dots are the daily minimum and maximum temperatures observed over the time series.