Discussion re-shimmying.

Current version:

### Discussion

Therefore, there was an interplay between species-specific differences in diet and the prey available for juvenile salmon at each location within the Discovery Islands and Johnstone Strait.

#### 2.4.1 Diets in contrasting foraging conditions

This study examined juvenile pink and chum salmon stomachs to characterize diets during the 2016 peak outmigration through the Discovery Islands and Johnstone Strait routes. In tidally mixed waters, pink and chum salmon had low stomach fullness, prey and niche partitioning between species, with chum occupying a gelatinous niche and pink feeding generally close to the littoral. Although, the northern most site of J02 was shown to be a foraging hot spot for juvenile pink and chum salmon, with high diet overlap between species, the highest diet richness, and high quality of prey species with high fatty acid concentrations, such as large (>2 mm) copepods, euphausiids, chaetognaths and hyperiid amphipods (Costalago et al., 2020).

Zooplankton biomass was considerably low throughout Discovery Islands and Johnstone Strait in June 2016 when juvenile pink and chum salmon were migrating through these regions. The zooplankton community composition was not closely reflected in the stomach contents, due to surface net tows unable to capture all relevant salmon prey such as epibenthic harpacticoid copepods, or fish and euphausiids that tend to avoid zooplankton nets. The zooplankton captured were mainly small (250 μm) cyclopoids and calanoid copepods and the differences between the two regions was not as clear of a prey divide compared to the diets. The most representative way of capturing what prey were available for salmon at each location, was through the diets themselves, viewing salmon as “plankton sampling gear” for the ideal prey type and size. Wherever possible, future research on salmon feeding, health and survival should utilize stomach content analysis over making assumptions about prey availability with the zooplankton tow samples.

In other areas with similar coastal conditions, pink salmon had been found to be nearshore foragers upon small crustaceans, while chum salmon often prey switch from crustacean zooplankton to gelatinous (Godin, 1981; Tadokoro et al., 1996). Previous studies have found harpacticoid and calanoid copepods as primary prey items for both pink and chum salmon (Chebanova et al., 2018; Godin, 1981; Healey, 1979). Recently, a study conducted simultaneously discovered that sockeye salmon diets dominate by *Oikopleura* in the Discovery Islands (James, 2019), which is similar to chum salmon. Furthermore, larger calanoids were dominant sockeye prey in Johnstone Strait (James, 2019), that was similar to the observed pink salmon diet composition. Other research that investigated dietary overlap of multiple species of salmon have found that the pink salmon diet tends to be most similar to either sockeye or chum salmon (Daly et al., 2019).

In addition to stomach fullness being low for migrating juvenile salmon in the Discovery Islands and Johnstone Strait, Fulton’s condition factor K was also low throughout both regions. Since juvenile chum salmon tend to have longer residence times in coastal environments than the short-lived pink salmon (Duffy et al., 2005), the higher condition factor of chum at D07 indicates good feeding in the northern SoG, although this was not seen in the stomach fullness at this site. The good condition (for chum salmon) in NSoG, low feeding and condition in DI-JS, followed by high feeding and condition in QCSt for pink and chum salmon, was mirrored by the study done on juvenile sockeye salmon in the same area in 2015, which found food limitation and similar foraging hot spots (James et al., 2020). However, another study on the growth of juvenile salmon found that pink and chum salmon experienced low growth in the Johnstone Strait and Queen Charlotte Strait area during 2012 – 2014 outmigration (Journey et al., 2018). It may be speculated that it may have occurred due to low feeding opportunities but juvenile pink and chum salmon diets in this area had never been analyzed until this current study.

The size differences were expected between the two regions along the migration route, but chum salmon had a larger range of sizes, potentially indicating longer residence time than pink salmon.

The difference in k between pink and chum salmon conditions at D07 may also indicate differing residence times in the Strait of Georgia, with pink salmon moving more quickly through the area.

While this research study focused on a snapshot of juvenile salmon feeding in June 2016 in this area, trends cannot be extrapolated without a seasonal or interannual component. The dynamics of each of these regions may shift over time, especially the Discovery Islands which naturally had more variability due to the freshwater influence on the ocean conditions. This study characterized salmon species interactions in high and low foraging scenarios, but other unknown factors could be contributing, such as feeding differences by salmon stock or competition with other species not included in the study. More accurate descriptions of these regions require a longer time series on salmon feeding during the outmigration period and across years, which was the focus of the next data chapter.

#### 2.4.2 Competition in contrasting foraging conditions

Juvenile pink and chum salmon were found to have extreme values of stomach fullness in the DI-JS, relative to other locations along the coastal migration routes in the Pacific Northwest. For example, juvenile pink and chum mean gut fullness was found to be 2-4% body weight (BW) in the nearby Broughton Archipelago in 2003 and 2006 (Gulbransen, 2014), 1% BW in Northern B.C. in 2000-2002 (Brodeur et al., 2007), 1-4% BW in Southeast Alaska in 2001 (Sturdevant et al., 2002), and 1.7-1.9% BW in the eastern Gulf of Alaska (Daly et al., 2019). Comparatively, in this study juvenile pink and chum salmon gut fullness averaged < 0.5 % BW in the first five sites (0.35% pink; 0.40% chum) and >5% BW in QCSt (7.5% pink; 6.2% chum). This foraging refuge of Queen Charlotte Strait may help juvenile salmon meet their energetic demands for outmigration after a period of potential food limitation and poor food quality.

However, if ocean conditions change and these refuge areas become unproductive, it can have devastating effects on salmon survival (Beamish et al., 2012; Mckinnell et al., 2014).

In these low foraging conditions, juvenile pink and chum salmon were likely competing for limited resources and employ species-specific strategies in response to challenging conditions. Chum salmon had been shown to adapt and switch to gelatinous prey in response to inter-specific competition with pink salmon at the adult phase. This study indicated that chum salmon prey switching may occur as early as juvenile stage. The specialization under low foraging conditions was reflected in the low prey richness, low stomach fullness and low dietary overlap between pink and chum salmon along the DI-JS route. In contrast, the site at Queen Charlotte Strait had the opposite trend, with high prey richness, high gut fullness and high dietary overlap between species, indicating a lack of competition likely due to high prey availability (refs??). Therefore, salmon species potential to compete for limited food resources during early marine migration was dynamic, may shift over time and requires further in-depth research.

#### 2.4.3 Trophic niches of juvenile pink and chum salmon

Juvenile pink and chum salmon had similar diets when prey availability was high but utilized different foraging strategies when prey availability was low, which was indicative of resource partitioning. Throughout most of the study sites, chum salmon appeared to forage within the gelatinous predator niche, while pink salmon switched to the littoral niche utilizing nearshore insects, harpacticoids, caprellids and gammarids. These niche strategies shifted with the foraging intensity, since at the Queen Charlotte Strait site with ~7% body weight stomach fullness, both species fed very similarly. Therefore, pink and chum salmon were observed to both consume similar and likely higher quality prey, such as euphausiids and large calanoids, in regions of high prey availability but clearly portion the resource space when prey was limited. This strategy would be expected to limit any potential competition but had not yet been explored in nearshore coastal environments for young salmon.

The trophic niche of juvenile salmon in the Discovery Islands and Johnstone Strait can also be related to the habitat niche when pink salmon forage in the nearshore and chum salmon in the pelagic environment, on gelatinous or crustacean prey. Each sampling set captured salmon likely travelling within the same school(s), however nearshore prey items were found more frequently and in higher proportions in pink salmon diets, including higher prey richness of harpacticoids, insects, arachnids, barnacle larvae, cumaceans, caprellid and gammarid/corophiid amphipods. Pink salmon may consume these smaller, reliable and easy to catch prey since they need to constantly feed in order to achieve growth rates of up to 3.5-7% body weight per day (Beamish et al., 2003; LeBrasseur & Parker, 1964). Since gelatinous prey are often lower in nutritional content than other zooplankton, chum salmon have evolved larger stomachs than other salmon to consume more biomass of jellyfish to benefit off that specific prey source (Welch, 1997). Therefore, it seems pink and chum salmon were genetically predisposed to littoral and gelatinous niches (respectively) when food was scarce. However, niche switching was a norm, when foraging conditions improved and higher quality prey, such as large calanoids and euphausiids, became more readily available. This adaptive flexibility of the trophic and habitat niches of juvenile salmon could be an area for further research and should be investigated for other species, in other areas, at different life phases, and compared across seasons and years to understand better and to include into life-history models of salmon species.

Pink salmon consumption of microplastics, glass, and rocks also reflected nearshore feeding, these foreign objects were found in 5% of all salmon stomachs analyzed. These objects were found at sites D07, D09, D11 and J06, the four sites with empty stomachs. Other studies have found Chinook salmon to have consumed microplastic fibers (Collicutt et al., 2019), none of which were present in this study. The microplastic pieces (0.3 – 2.8 mm) in salmon stomachs in the Discovery Islands and Johnstone Strait were irregularly shaped, which had been shown to impact the fitness of other fish species (Choi et al., 2018). Quantifying the impacts of plastics on salmon and exploring the relationship with plastic consumption to empty stomachs and nearshore foraging holds incredible potential for a new branch of salmon health and conservation research.

Ideas:

1. Diets
2. Niche
3. Competition
4. GFI

🡪 ALTERNATIVE. Don’t do order of aims (address 1st paragraph), but in order of results!!! Yea?

Would need to come up with subsections afterword that would fit the new layout the best...

Need to think up longer titles and how this relates to previous a. diets, b. competition, c. niche.

Even should think up subsections (that won’t be listed) but will be helpful for organizing paras.

* Summary
* Diets
* Niche
* Competition
* GFI

To dos:

Edit wording + restructure

add refs (cope avoidance; physical fronts; J02 prey availability; and everything described below)

Summary paragraph, oceanography of regions, species and site interplay, generalist/specialist

Link to zoop data (even Natalie’s work for more details) + attach to description on sampling bias

Speculate on how salmon would deal with J02 hypothetically not being productive, what impact

Size/condition differences, possible residence time, possible different stocks being sampled

Fatty acid paragraph and references (like Boldt and Costalago and others … emphasize sign.)

Condition – “Interesting that K does not seem to improve even when better feeding in JS” (CL)

Summary of what’s currently written (by paragraphs)

1. Diets

~ Summary. Low GFI in mix waters, prey partitioning, gelatinous/littoral niche, J02 hot spot, FA.

Zooplankton. Low biomass overall, didn’t match diets, shortcomings of sampling.

Previous studies (diet composition/sockeye/diet overlap🡪move?).

Condition. GFI low and K low, residence times, feeding opportunities, sockeye\*, growth, novelty

Shortcomings. Needs temporal component – to tie into next chapter.

1. Competition

GFI. Comparison to pink and chum other areas. (Should move sock GFI here? Polina’s data?)

Competition. Prey switching under diff feeding conditions (tie it in with richness + overlap, etc.)

1. Niches

Niches (gelatinous, littoral, when food low, then switching, limits competition, novelty) 🡪 need to name niche for large pelagic crustacean zooplankton at J02? (some of this seems redundant.)

Niche – more details. Habitat niche, same schools, nearshore items, speculate why (pink active, chum big tummies), needs further research. (this paragraph is much too long and meandering.)

Microplastics. In pink – also reflects nearshore feeding. Lit. compare, requires further research.

New layout needs (current + comments to be added) – in no particular order yet

Summary (re-state aims and how I answered them)

Oceanography (how regions are different)

Diets (include niche in here?)

Results order:

Environmental conditions and zooplankton

Environment

Zoop biomass

Zoop composition

Salmon size and condition (combine into one paragraph?)

Size

Condition

Salmon diet composition

DI diets

JS diets

NMDS

Cluster

Salmon stomach fullness

GFI

Empties

Diet overlap between pink and chum salmon

Overlap

Richness

Diff ideas for discussion layout

* Summary (not listed)
* Diets – AND niche
  + Comp
  + Niche
  + Zoops
  + Plastics
  + Etc. …
  + Fatty acids somewhere in here
* GFI – rename to something more inclusive like salmon health?
  + GFI impacts
  + GFI comparison to lit.
  + (^ or vice versa)
  + Condition
  + Size
  + Residence time
  + Potential impacts of starvation
  + 🡪 figure out subsection order later!
* Competition
  + Overlap and richness compared to GFI
  + Generalist vs specialist talk?
  + Interplay b/t sp. diff and prey availability (connect to temporal?)
  + Prey partitioning when food is limited
  + Limitations and connection to next chapter
  + Speculating on if hot spots ever fail

🡪 Changed my mind, niche will not have its own section but included throughout diff sections.

2.4 Discussion ~~(copied and pasted into a better order 🡪 still needs editing to flow better …)~~

~~(Note: doing rearranging by subsection but paragraphs still need rearranging in like major ways)~~

~~… Oceanography + Zoop / Summary TBD (see Brian’s comments on how to best do this)~~

~~… sum.~~

This study examined juvenile pink and chum salmon stomachs to characterize diets during the 2016 peak outmigration through the Discovery Islands and Johnstone Strait routes. Contrasting ocean conditions were observed in the temperature and salinity properties of the regions and the zooplankton biomass was higher in Discovery Islands than Johnstone Strait (James et al 2020). The aims of this research were to compare (a) diets, (b) niches, (c) foraging success, and (d) competition, of pink and chum salmon under these varying foraging conditions. The regional differences in oceanography and zooplankton resulted in clear diet separation for both pink and chum salmon between each of the two major regions of study. The dietary overlap between pink and chum salmon varied from low to high overlap of prey composition in relation to the amount of stomach fullness, with low overlap when foraging levels were low, indicating resource partitioning. These specific points are discussed in more details below.

2.4.1 Pink and chum salmon feeding strategies

~~This study examined juvenile pink and chum salmon stomachs to characterize diets during the 2016 peak outmigration through the Discovery Islands and Johnstone Strait routes.~~ In tidally mixed waters, pink and chum salmon had low stomach fullness, prey and niche partitioning between species, with chum occupying a gelatinous niche and pink feeding generally close to the littoral. Although, the northern most site of J02 was shown to be a foraging hot spot for juvenile pink and chum salmon, with high diet overlap between species, the highest diet richness, ~~and high quality of prey species with high fatty acid concentrations, such as large (>2 mm) copepods, euphausiids, chaetognaths and hyperiid amphipods (Costalago et al., 2020).~~

~~🡪 Insert the FA para here right away?~~

Prey quality is an important factor for juvenile salmon diets and growth during the early marine phase, and fatty acid contents is a good measure of prey quality. Recent research in the Strait of Georgia on zooplankton quality found large copepods, euphausiids, chaetognaths and hyperiid amphipods to have high fatty acids contents (Costalago et al 2020). Whereas, meroplankton, small zooplankton, and gelatinous zooplankton were lower in nutritional content, and poorer quality prey (Boldt, 2001). Therefore, both the amount of food consumed by salmon and the prey types are important for salmon growth and survival. In this study, salmon consumed higher quality prey at the most northern site near Queen Charlotte Strait and lower quality prey throughout the other study sites.

In other areas with similar coastal conditions, pink salmon had been found to be nearshore foragers upon small crustaceans, while chum salmon often prey switch from crustacean zooplankton to gelatinous (Godin, 1981; Tadokoro et al., 1996). Previous studies have found harpacticoid and calanoid copepods as primary prey items for both pink and chum salmon (Chebanova et al., 2018; Godin, 1981; Healey, 1979). Recently, a study conducted simultaneously discovered that sockeye salmon diets dominate by *Oikopleura* in the Discovery Islands (James, 2019), which is similar to chum salmon. Furthermore, larger calanoids were dominant sockeye prey in Johnstone Strait (James, 2019), that was similar to the observed pink salmon diet composition. Other research that investigated dietary overlap of multiple species of salmon have found that the pink salmon diet tends to be most similar to either sockeye or chum salmon (Daly et al., 2019).

~~🡪 Do include a section on niche? Otherwise too much in diet comp section…~~

The trophic niche of juvenile salmon in the Discovery Islands and Johnstone Strait can also be related to the habitat niche when pink salmon forage in the nearshore and chum salmon in the pelagic environment, on gelatinous or crustacean prey. Each sampling set captured salmon likely travelling within the same school(s), however nearshore prey items were found more frequently and in higher proportions in pink salmon diets, including higher prey richness of harpacticoids, insects, arachnids, barnacle larvae, cumaceans, caprellid and gammarid/corophiid amphipods. Pink salmon may consume these smaller, reliable prey since they need to constantly feed in order to achieve growth rates of up to 3.5-7% body weight per day (Beamish et al., 2003; LeBrasseur & Parker, 1964). Since gelatinous prey are often lower in nutritional content than other zooplankton, chum salmon have evolved larger stomachs than other salmon to consume more biomass of jellyfish to benefit off that specific prey source (Welch, 1997). Therefore, it seems pink and chum salmon were genetically predisposed to littoral and gelatinous niches (respectively) when food was scarce. However, niche switching was a norm, when foraging conditions improved and higher quality prey, such as large calanoids and euphausiids, became more readily available. This adaptive flexibility of the trophic and habitat niches of juvenile salmon could be an area for further research and should be investigated further. For example, niche flexibility of other species, in other areas, at different life phases, and compared across seasons and years to understand better its benefits and to include into life-history models of salmon species.

Pink salmon consumption of microplastics, glass, and rocks also reflected nearshore feeding, these foreign objects were found in 5% of all salmon stomachs analyzed. These objects were found at sites D07, D09, D11 and J06, the four sites with empty stomachs. Other studies have found Chinook salmon to have consumed microplastic fibers (Collicutt et al., 2019), none of which were present in this study. The microplastic pieces (0.3 – 2.8 mm) in salmon stomachs in the Discovery Islands and Johnstone Strait were irregularly shaped, which had been shown to impact the fitness of other fish species (Choi et al., 2018). Quantifying the impacts of plastics on salmon and exploring the relationship with plastic consumption to empty stomachs and nearshore foraging holds incredible potential for a new branch of salmon health and conservation research.

2.4.2 Feast or famine: salmon feeding and condition

Juvenile pink and chum salmon were found to have extreme values of stomach fullness in the DI-JS, relative to other locations along the coastal migration routes in the Pacific Northwest. For example, juvenile pink and chum mean gut fullness was found to be 2-4% body weight (BW) in the nearby Broughton Archipelago in 2003 and 2006 (Gulbransen, 2014), 1% BW in Northern B.C. in 2000-2002 (Brodeur et al., 2007), 1-4% BW in Southeast Alaska in 2001 (Sturdevant et al., 2002), and 1.7-1.9% BW in the eastern Gulf of Alaska (Daly et al., 2019). Comparatively, in this study juvenile pink and chum salmon gut fullness averaged < 0.5 % BW in the first five sites (0.35% pink; 0.40% chum) and > 5% BW in QCSt (7.5% pink; 6.2% chum).

This foraging refuge of Queen Charlotte Strait may help juvenile salmon meet their energetic demands for outmigration after a period of potential food limitation and poor food quality. The same site was found to be productive for juvenile sockeye salmon in 2015 (James et al 2020), however, chum salmon experienced low stomach fullness (~1%) elsewhere in Queen Charlotte Strait in 2015 (Orlov, unpublished data). Therefore, there was likely a physical oceanographic front, where mixed and stratified water masses meet, thereby accumulating zooplankton to form this forage “hot spot” (Perry et al 1983, Franks 1992). However, if ocean conditions change and these refuge areas become unproductive, it can have devastating effects on salmon survival (Beamish et al., 2012; Mckinnell et al., 2014). If juvenile salmon experience an extended starvation period of two weeks, they will not be able to fully recover afterwards (Kuzmenko, unpublished data).

The migration time to get through these regions was around 11 days for sockeye salmon (James et al 2020), and pink and chum are likely comparable but haven’t been studied yet. Pink salmon tend to migrate more quickly than other salmon species due to their shorter life spans, whereas chum tend to remain in estuaries longer (Duffy et al 2005). In this study, there were salmon size differences between regions, as Johnstone Strait is further north than Discovery Islands, however, chum salmon occupied a wider range of sizes, which potentially indicated longer residence periods. Further studies on the migration timing and pathways of pink and chum salmon in this area are required to properly investigate benefits and costs of quick or long migrations on salmon health in areas of food gauntlets and hot spots.

In addition to stomach fullness being low for migrating juvenile salmon in the Discovery Islands and Johnstone Strait, Fulton’s condition factor K was also low throughout both regions. ~~Since juvenile chum salmon tend to have longer residence times in coastal environments than the short-lived pink salmon (Duffy et al., 2005),~~ Although there was higher condition factor for D07 chum that indicated good feeding in the northern SoG, although this was not seen in the stomach fullness at this site. The difference in K between pink and chum salmon conditions at D07 may also indicate differing residence times in the Strait of Georgia, with pink salmon moving more quickly through the area. The good condition (for chum salmon) in NSoG, low feeding and condition in DI-JS, followed by high feeding and condition in QCSt for pink and chum salmon, was mirrored by the study done on juvenile sockeye salmon in the same area in 2015, which found food limitation and similar foraging hot spots (James et al., 2020). However, another study on the growth of juvenile salmon found that pink and chum salmon experienced low growth in the Johnstone Strait and Queen Charlotte Strait area during 2012 – 2014 outmigration (Journey et al., 2018). It may be speculated that it may have occurred due to low feeding opportunities but juvenile pink and chum salmon diets in this area had never been analyzed until this current study.

2.4.3 Species competition or coexistence?

In those low foraging conditions, juvenile pink and chum salmon were likely competing for limited resources and employed species-specific strategies in response to the challenging conditions. Chum salmon had been shown to adapt and switch to gelatinous prey in response to inter-specific competition with pink salmon at the adult phase. This study indicated that chum salmon prey switching may occur as early as juvenile stage. The specialization under low foraging conditions was reflected in the low prey richness, low stomach fullness and low dietary overlap between pink and chum salmon along the DI-JS route. In contrast, the site at Queen Charlotte Strait had the opposite trend, with high prey richness, high gut fullness and high dietary overlap between species, indicating a lack of competition likely due to high prey availability (Graham, 2020). Therefore, salmon species potential to compete for limited food resources during early marine migration was dynamic, may shift over time and requires further in-depth research.

Juvenile pink and chum salmon had similar diets when prey availability was high but utilized different foraging strategies when prey availability was low, which was indicative of resource partitioning. Throughout most of the study sites, chum salmon appeared to forage within the gelatinous predator niche, while pink salmon switched to the littoral niche utilizing nearshore insects, harpacticoids, caprellids and gammarids. These niche strategies shifted with the foraging intensity, since at the Queen Charlotte Strait site with ~7% body weight stomach fullness, both species fed very similarly. Therefore, pink and chum salmon were observed to both consume similar and likely higher quality prey, such as euphausiids and large calanoids, in regions of high prey availability but clearly portion the resource space when prey was limited. This strategy would be expected to limit any potential competition but had not yet been explored in nearshore coastal environments for young salmon.

Zooplankton biomass was considerably low throughout Discovery Islands and Johnstone Strait in June 2016 when juvenile pink and chum salmon were migrating through these regions. The zooplankton community composition was not closely reflected in the stomach contents, due to surface net tows unable to capture all relevant salmon prey such as epibenthic harpacticoid copepods, or fish and euphausiids that tend to avoid zooplankton nets. The zooplankton captured were mainly small (250 μm) cyclopoids and calanoid copepods and the differences between the two regions was not as clear of a prey divide compared to the diets. The most representative way of capturing what prey were available for salmon at each location, was through the diets themselves, viewing salmon as “plankton sampling gear” for the ideal prey type and size. An alternative possibility is the potential for a feeding effect, where salmon or other predators are exerting top down controls on the zooplankton communities, and in years of high pink salmon abundance, this has been shown in other areas (Batten et al 2018). Although, trophic cascades caused by pink salmon had only been shown for adults, it is unlikely juveniles in 2016 had such a large impact since abundance was not exceptionally high that year (Johnson et al 2019). ~~Wherever possible, future research on salmon feeding, health and survival should utilize stomach content analysis over making assumptions about prey availability with the zooplankton tow samples.~~

There was an interplay between species-specific differences in diet and the prey available for juvenile salmon at each location within the Discovery Islands and Johnstone Strait. It appears that chum salmon tended to specialize on gelatinous prey, specifically, *Oikopleura spp.* appendicularians in the Discovery Islands and Cnidaria or Ctenophora jellyfish in the Johnstone Strait, with low prey richness of other species. Whereas, pink salmon were more generalist feeders in comparison, with much higher prey richness by both prey species and taxonomic groups. Other research has also reflected chum’s tendency to specialize whereas pink salmon feed more broadly (Graham 2020). In fact, the prey accumulation curves show that a sample size of 10 pink salmon does not sufficiently capture the entire prey field of juvenile pink, emphasizing their diet diversity throughout these regions.

~~🡪 Expand upon that point? Discuss general/special? Link to zoops as caveat or feeding effect. \*\*\* last para to add~~

While this research study focused on a snapshot of juvenile salmon feeding in June 2016 in this area, trends cannot be extrapolated without a seasonal or interannual component. The dynamics of each of these regions may shift over time, especially the Discovery Islands which naturally had more variability due to the freshwater influence on the ocean conditions. This study characterized salmon species interactions in high and low foraging scenarios, but other unknown factors could be contributing, such as feeding differences by salmon stock or competition with other species not included in the study. More accurate descriptions of these regions require a longer time series on salmon feeding during the outmigration period and across years, which was the focus of the next data chapter.