Apr 21st, 9:00 AM - Apr 22nd, 4:45 PM

Climate change threatens net energy uptake, maturation, and reproduction of Pacific Sand Lance (Ammodytes personatus) in the central Salish Sea

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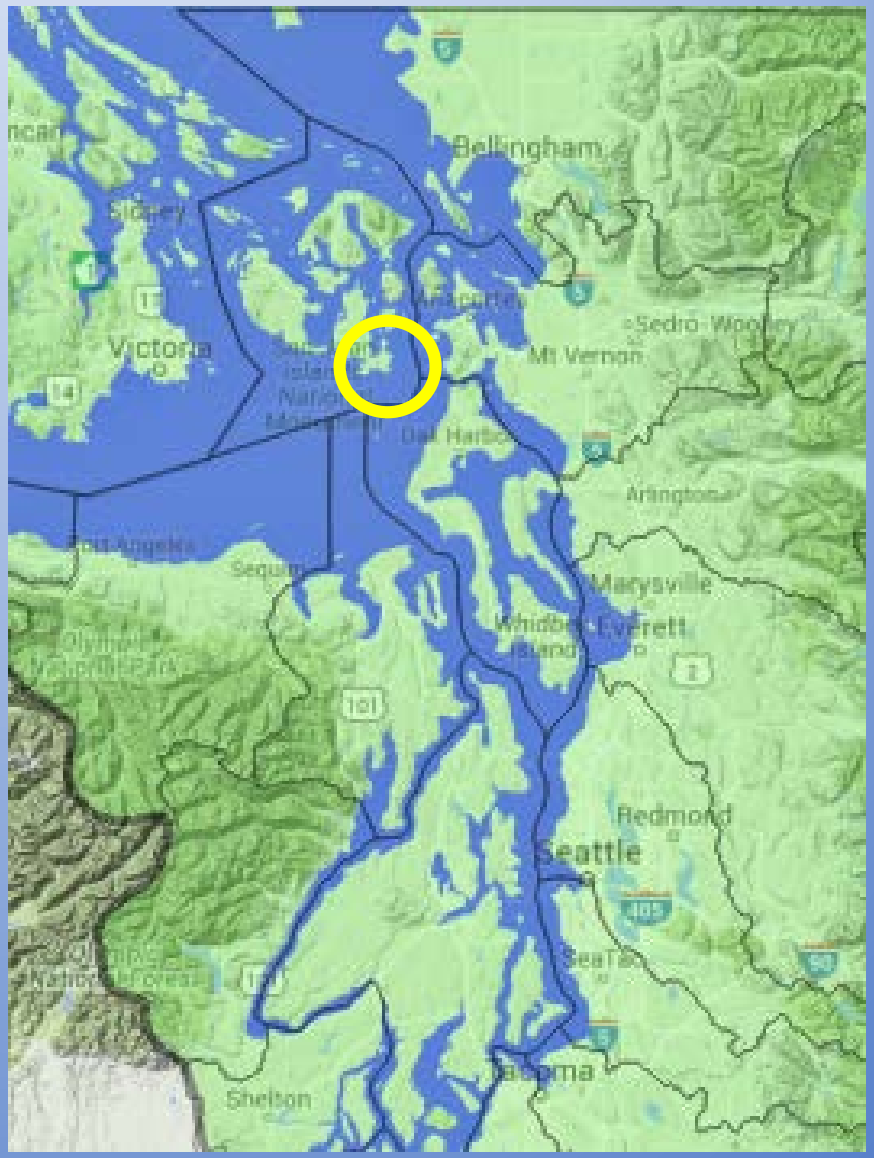
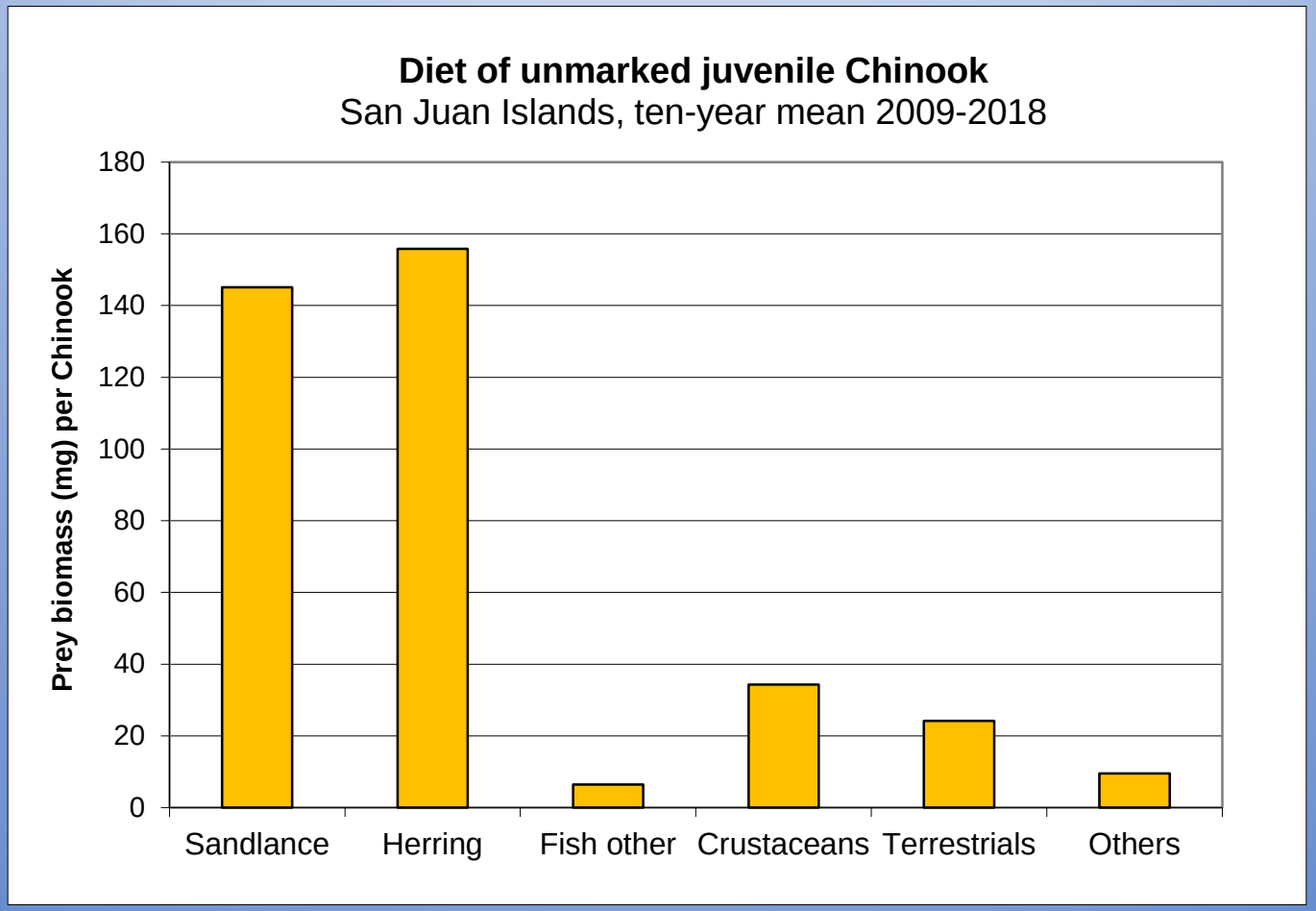
Madrona Murphy, Kwiaht
Julie Keister, University of Washington

Primary study site:
Watmough Bay, Lopez Island

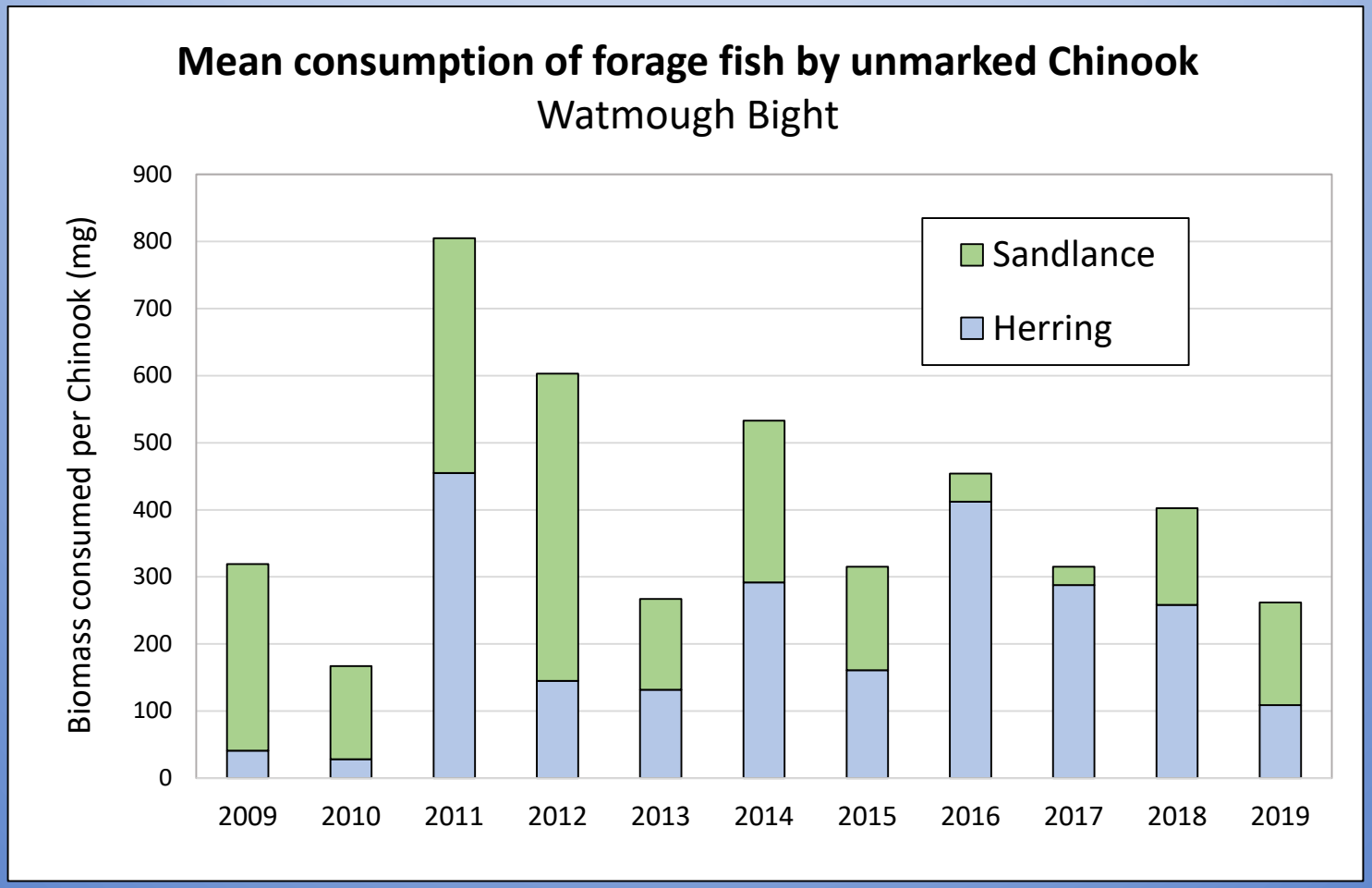
Twice-monthly seines
May to Oct 2009-2019
Year-round 2018-2019



Why Pacific Sand Lance (PSL) matter

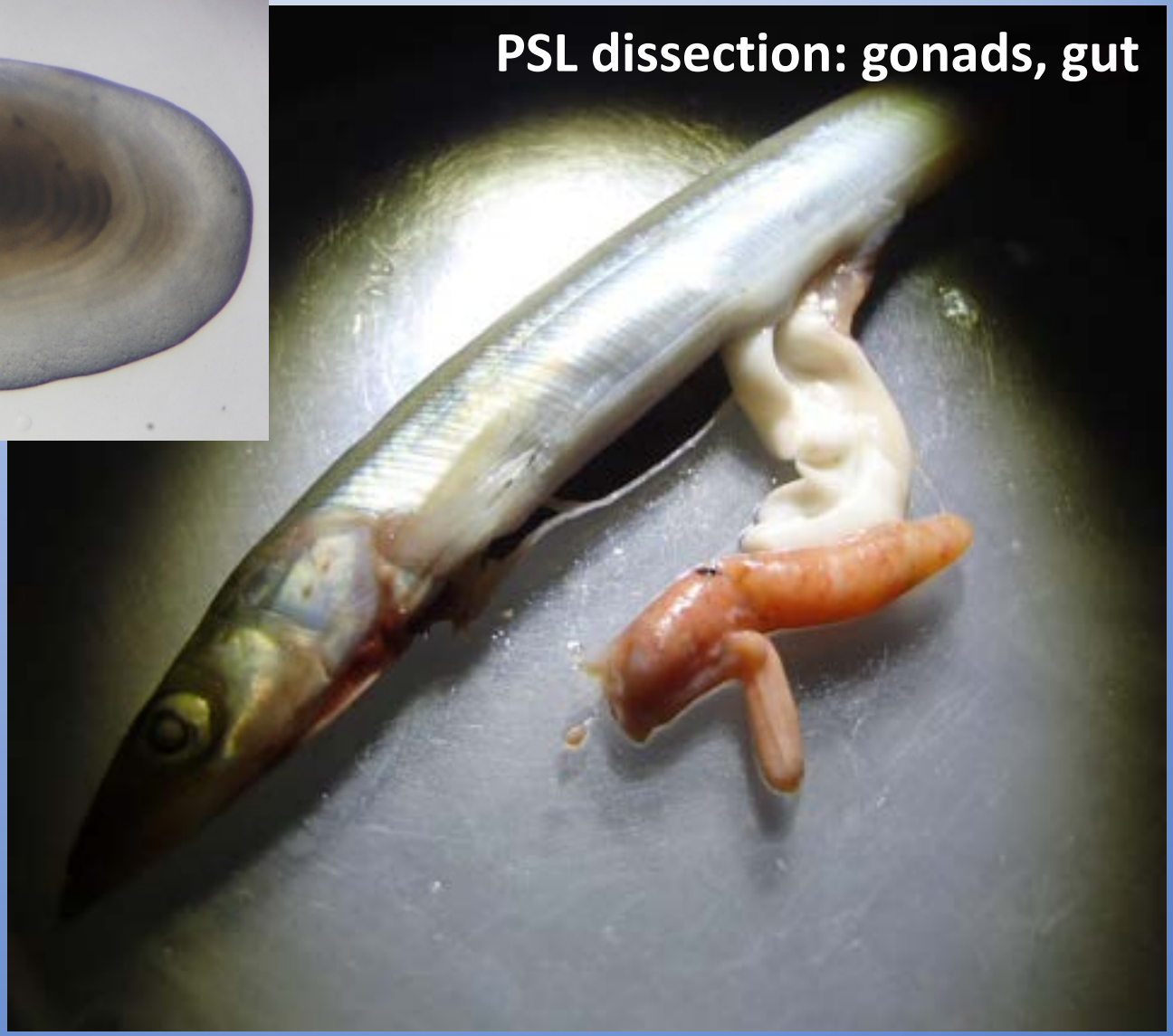


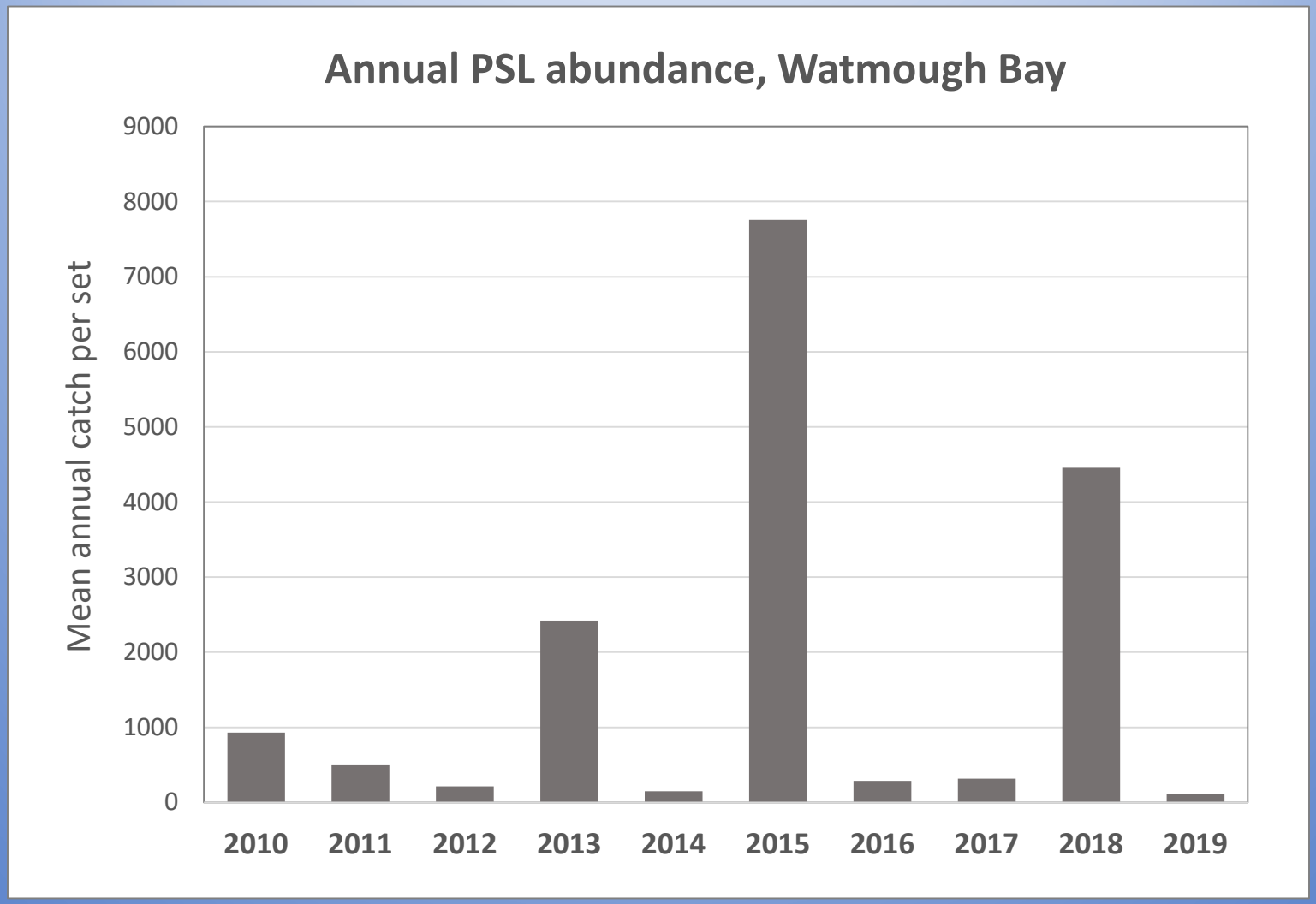
Note the decline in PSL utilization (green) at our study site

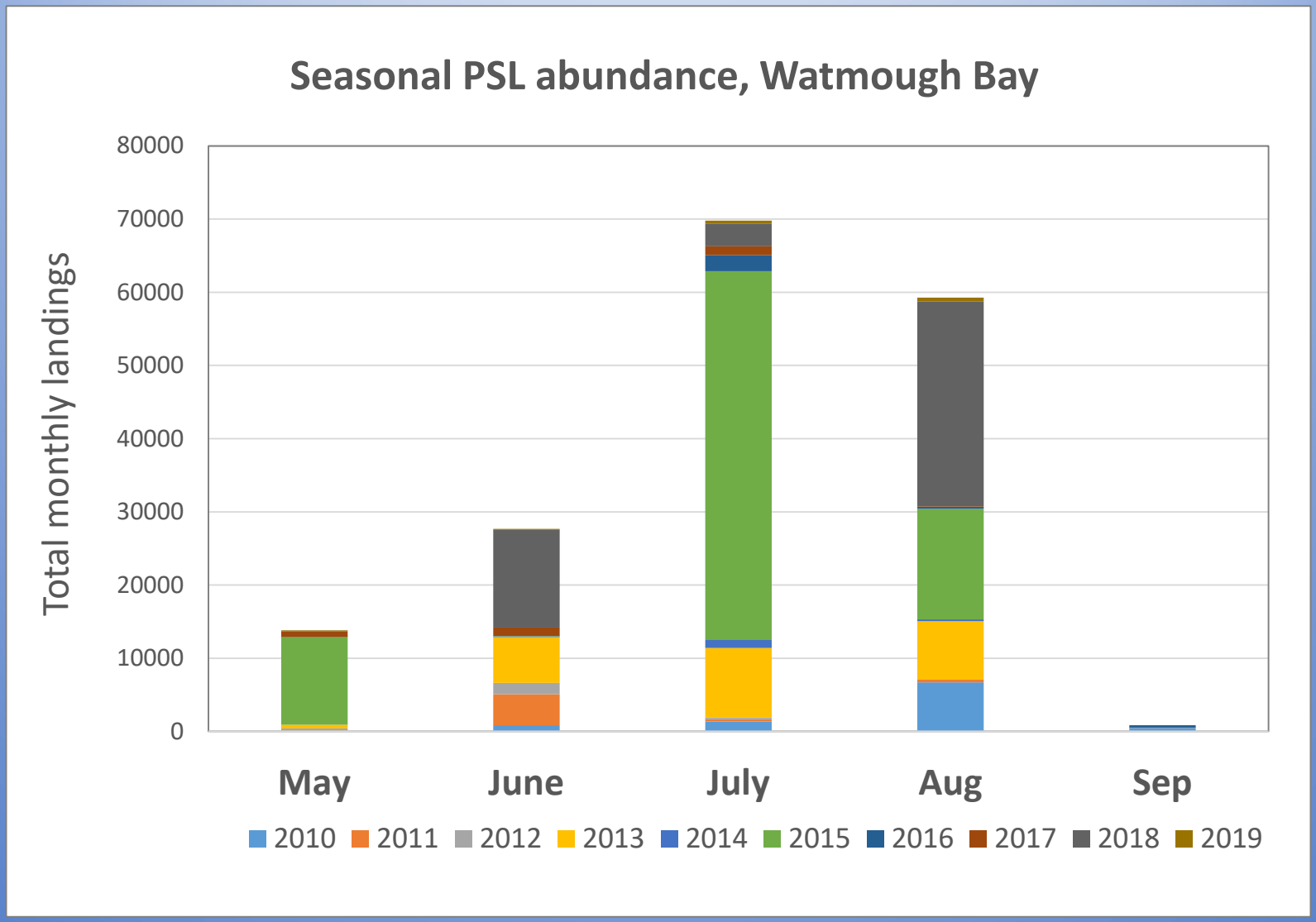



Watmough Bay

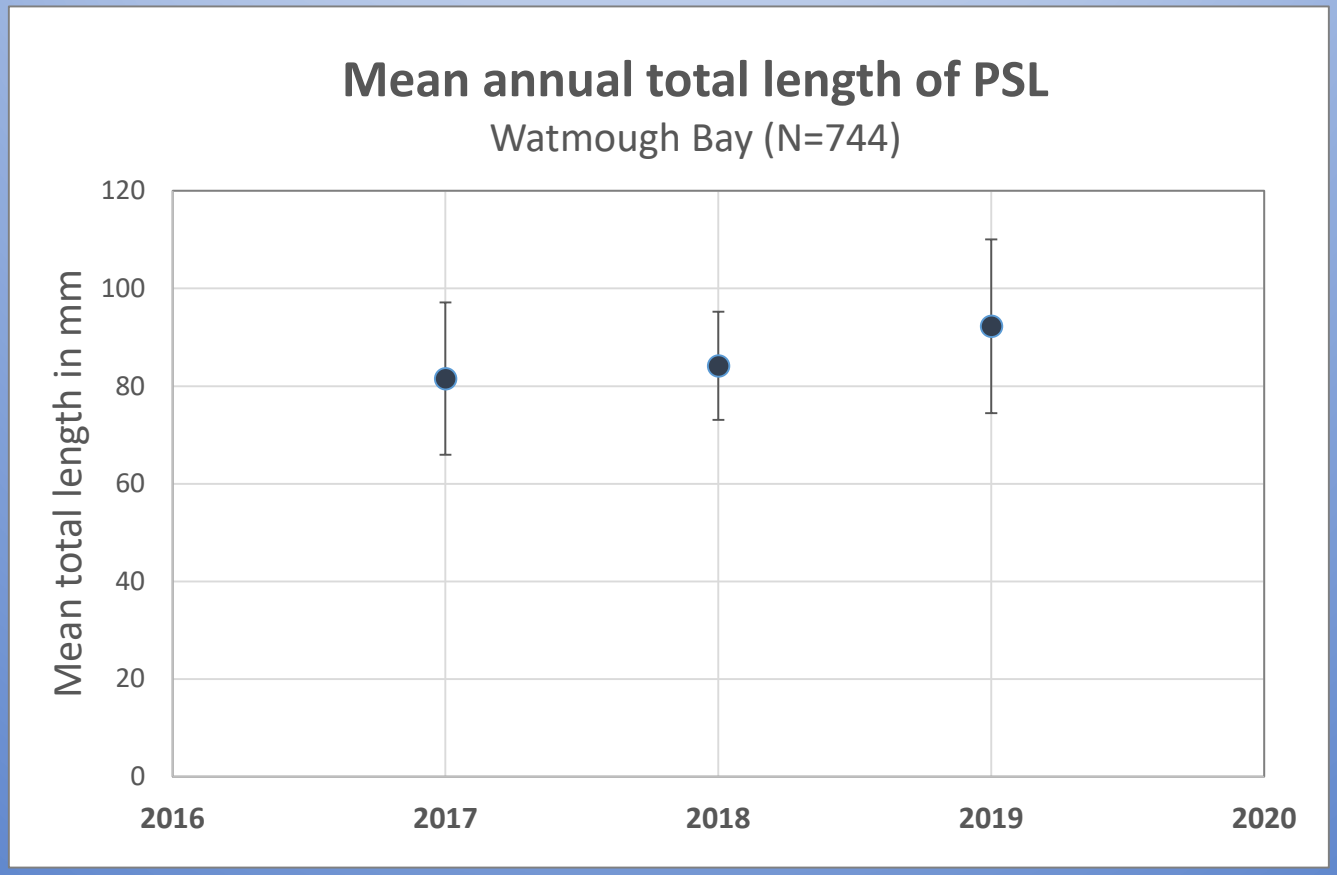
PSL otolith



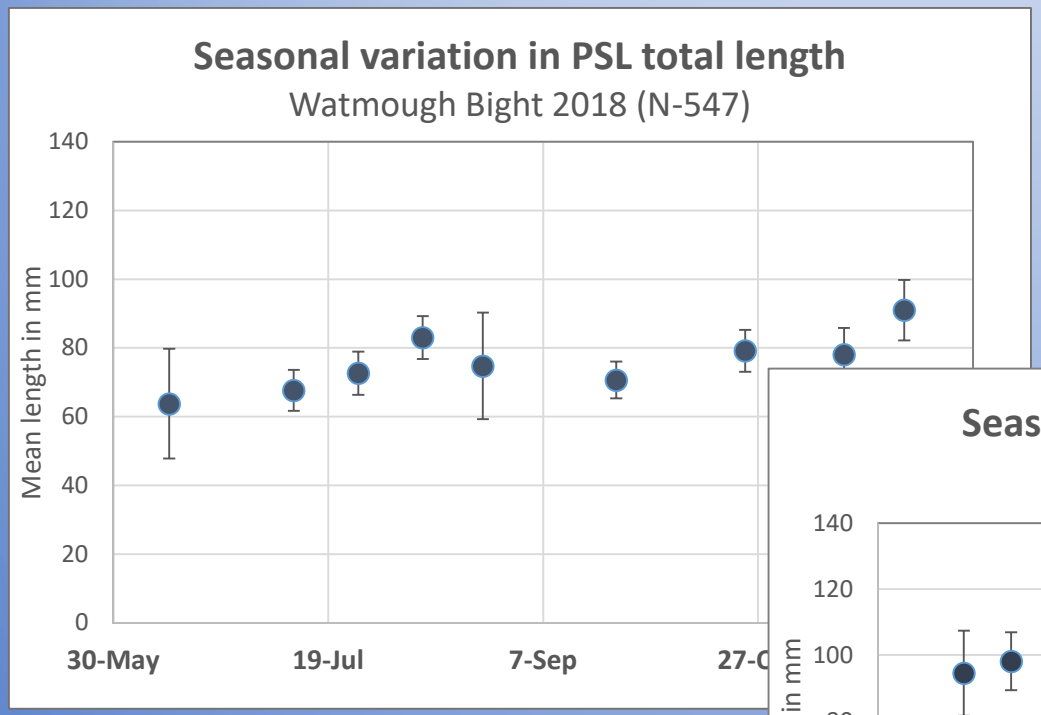

Annual PSL abundance, Watmough Bay
Mean annual catch per set
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019

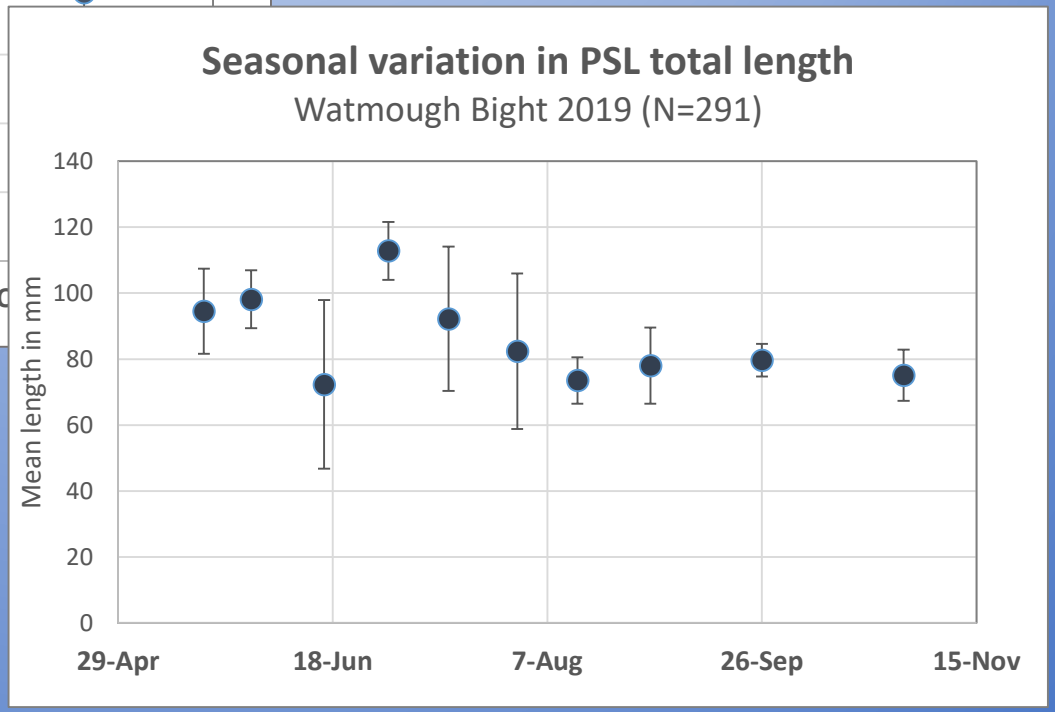

Seasonal PSL abundance, Watmough Bay
Total monthly landings
80000
70000
60000
50000
40000
30000
20000
10000
0
May
June
July
Aug
Sep
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019

PSL at Watmough tend to be relatively small (mean 80-90 mm) and rarely have ripe gonads; hence this is a rearing habitat where out-migrating Chinook consistently find eating-size PSL

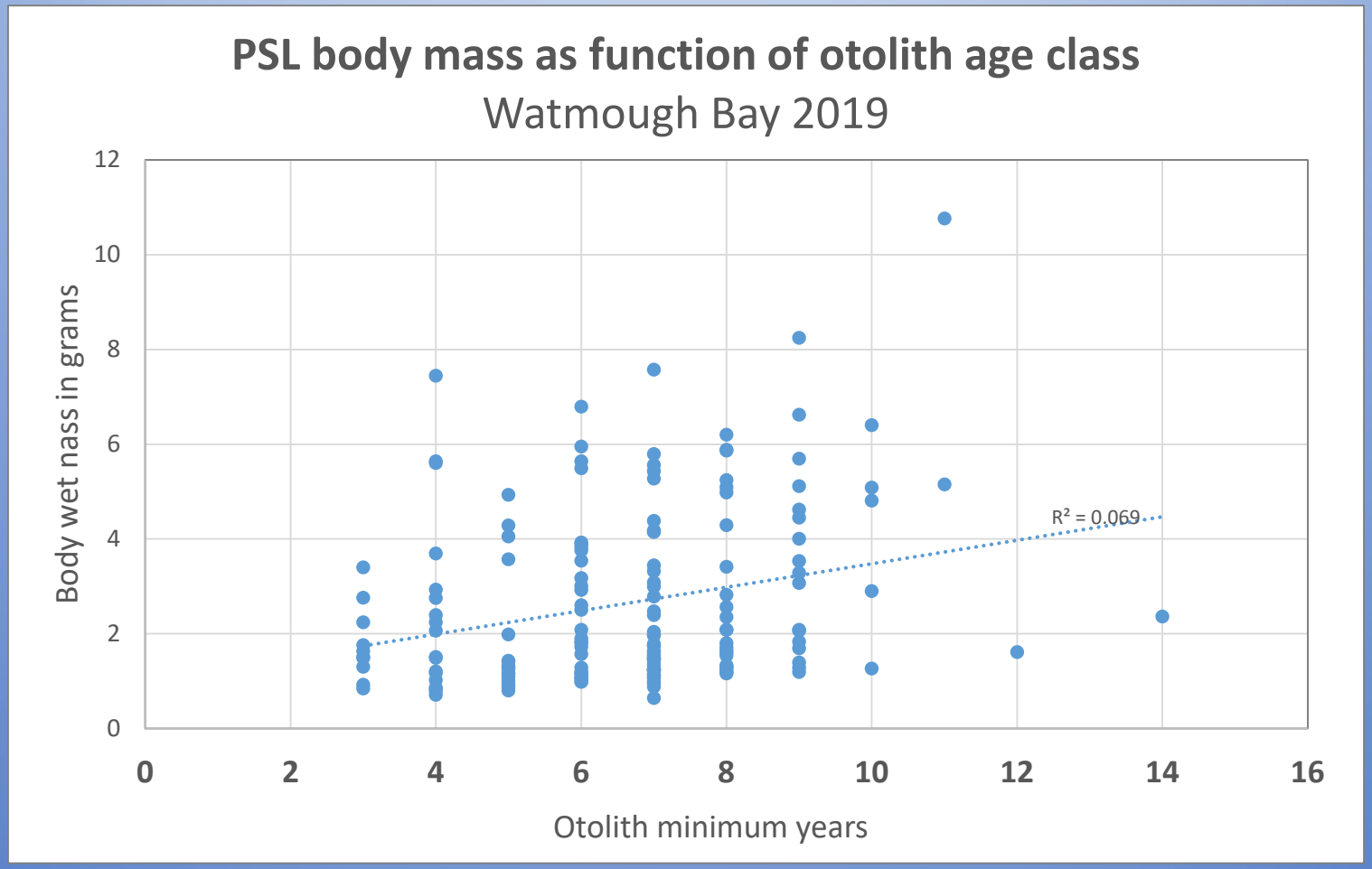


Week-to-week variation in mean PSL size suggests however that Watmough Bay hosts many different aggregations of PSL; hence aggregations migrate through the islands as they grow

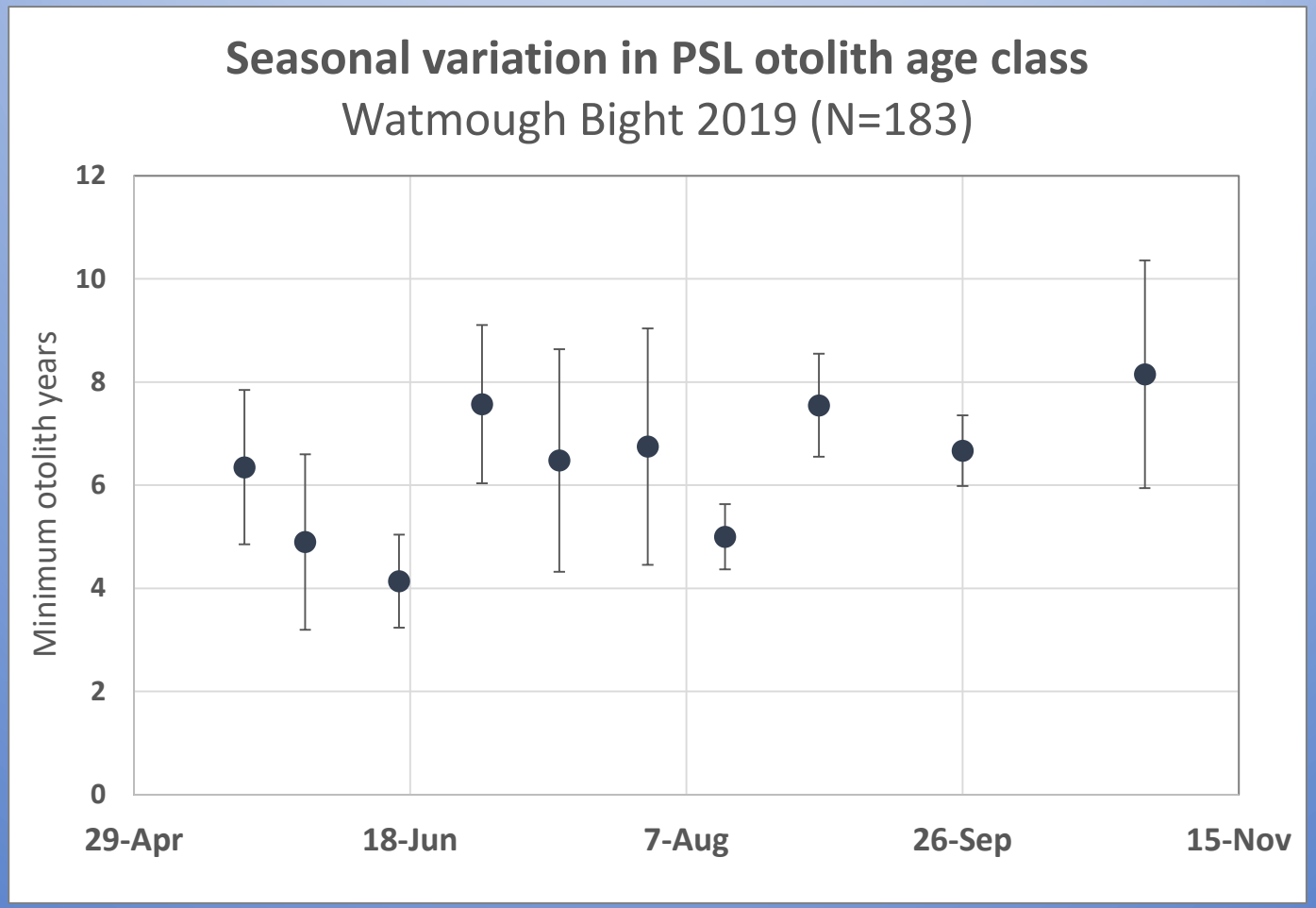




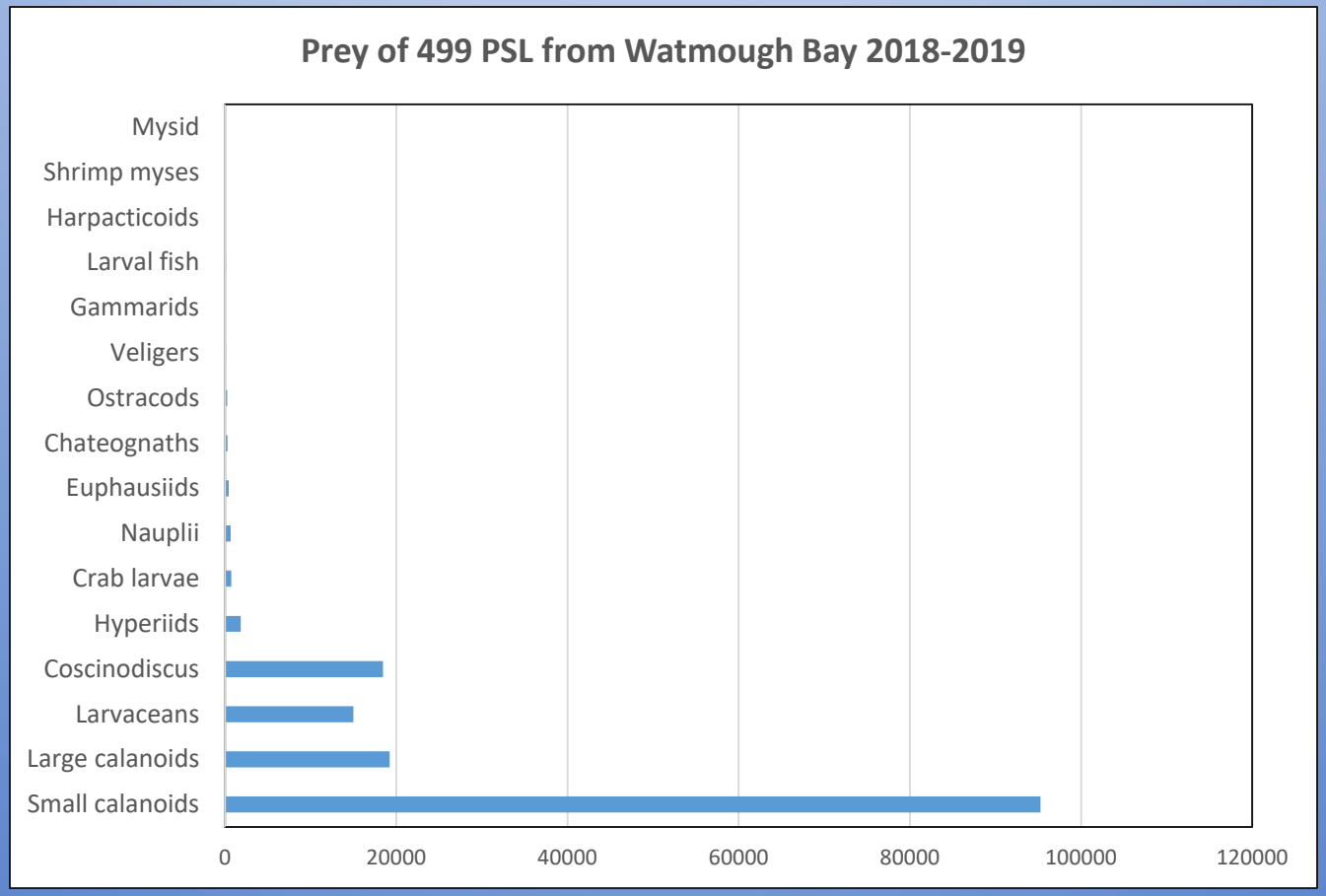
Length is not a good predictor of age, however, indicating that growth rates may differ widely within an age class



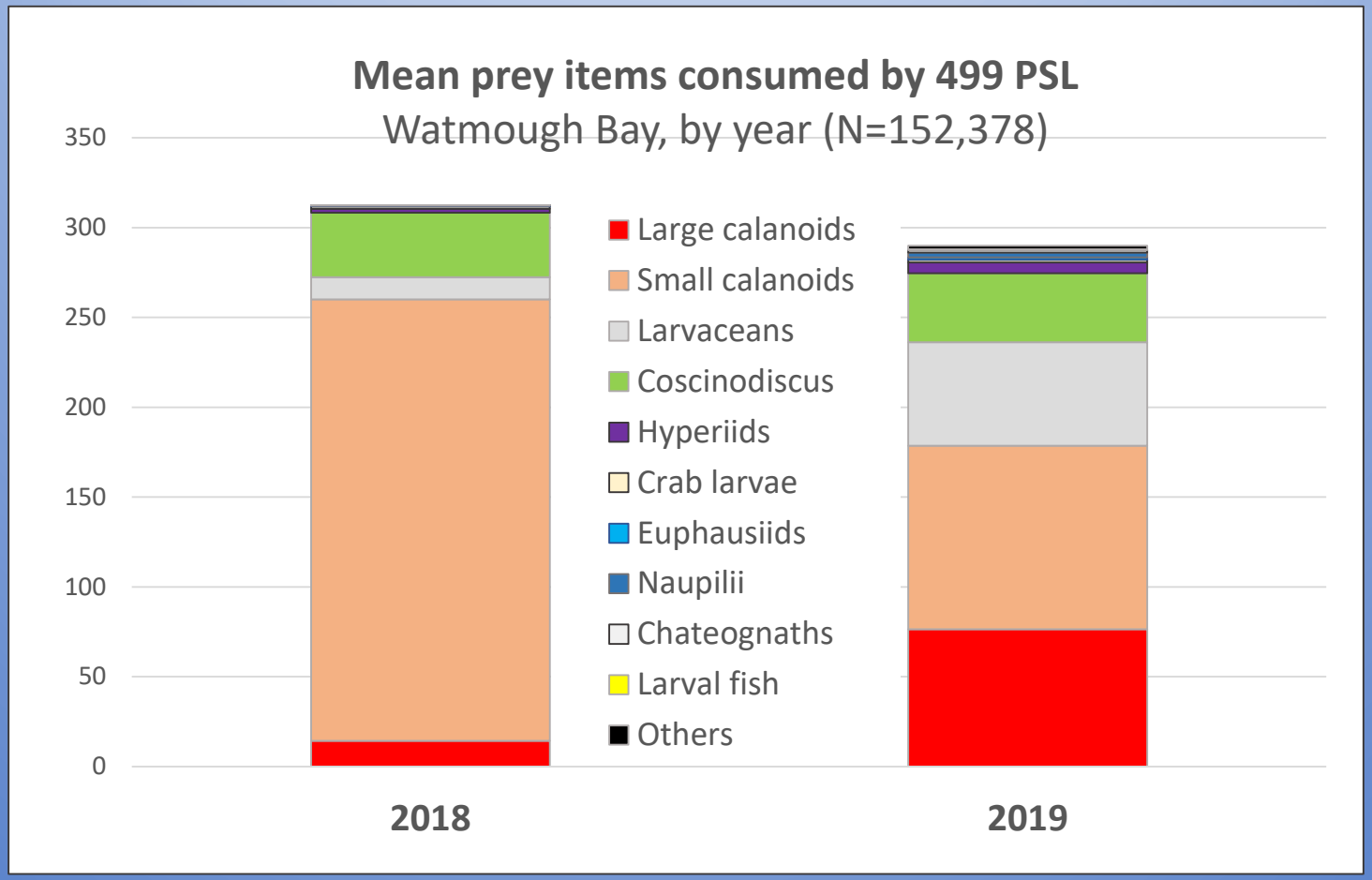
If we look at mean age rather than mean length, there is still evidence that different aggregations of PSL visit Watmough Bay over the course of a year



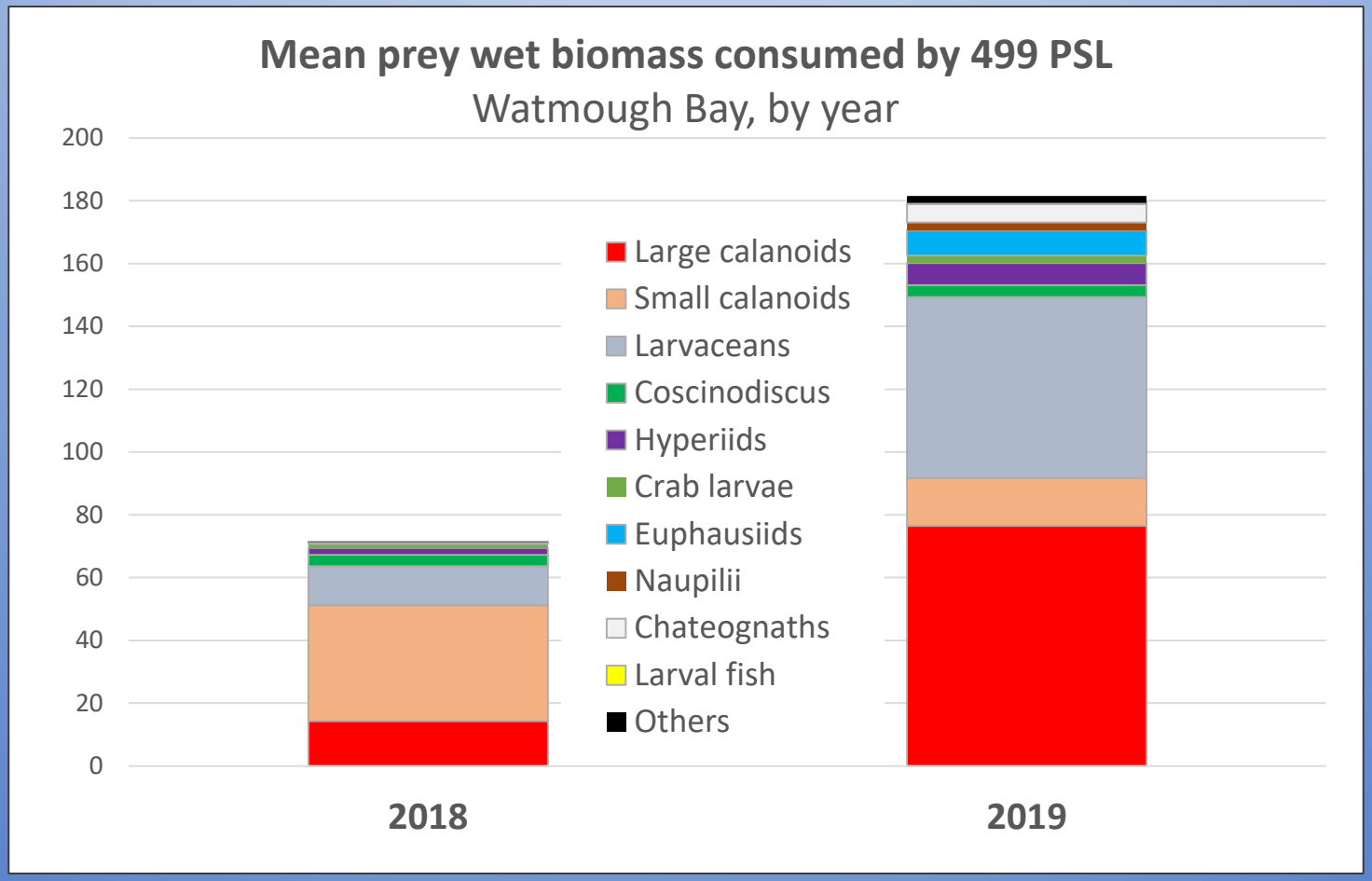
On the whole, PSL ate a wide variety of invertebrates but mainly calanoid copepods and secondarily larvaceans. It is useful to distinguish Eucalanus and Neocalanus (2-5 mm length) from other calanoids (generally under 1 mm)



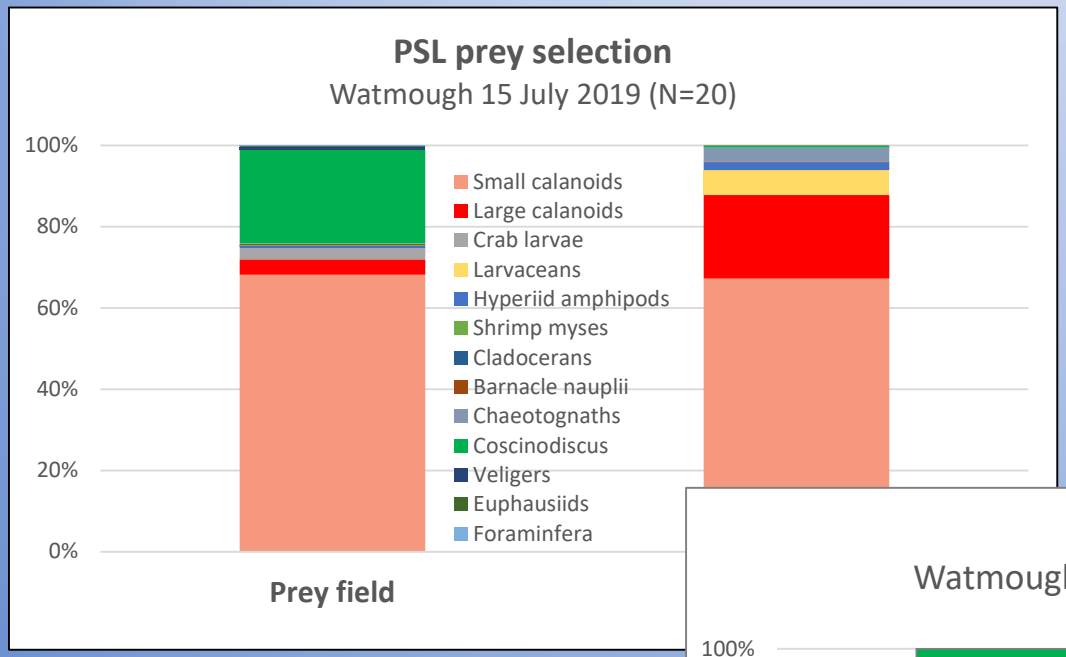
PSL were much less abundant in 2019 than 2018, and each fish on average ate more large calanoids and larvaceans in 2019: evidence suggesting prey limitation in 2018

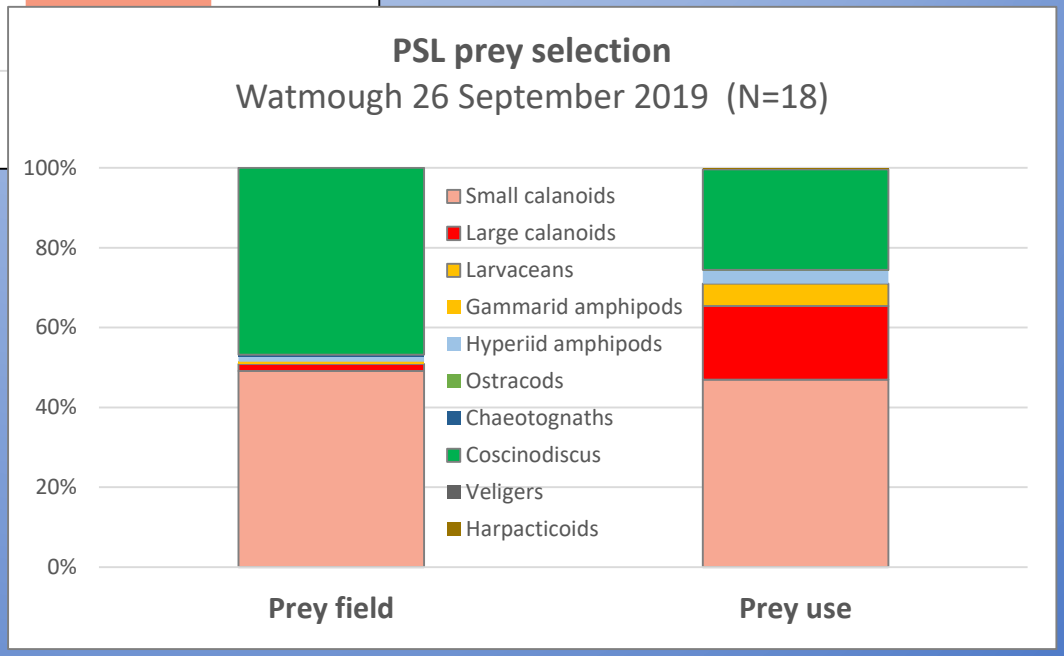


Adjusting for relative body mass makes the difference between these years greater, and highlights the importance of the larger calanoids and larvaceans in PSL diets

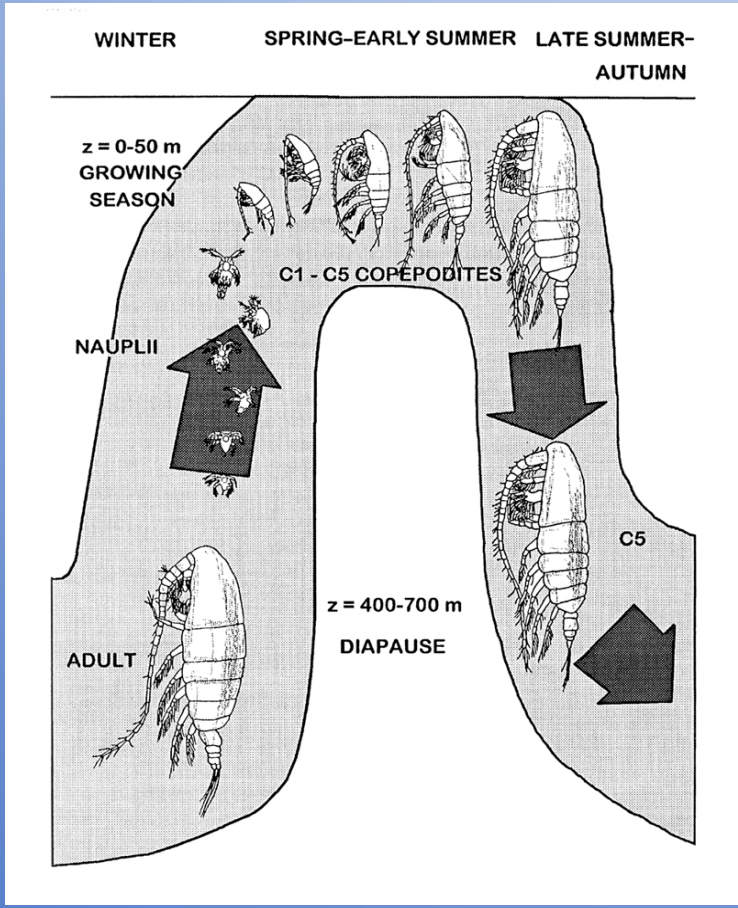


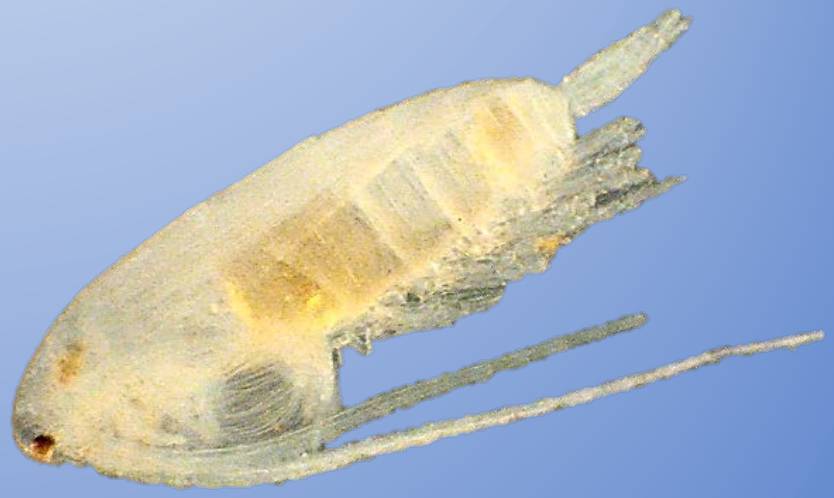
PSL target large copepods (red) even when they are scarce.





Eucalanus and Neocalanus feed intensively on spring phytoplankton blooms, storing energy as fat droplets to sustain them in winter diapause. They represent more biomass net calories per peck than smaller Calanoid genera.

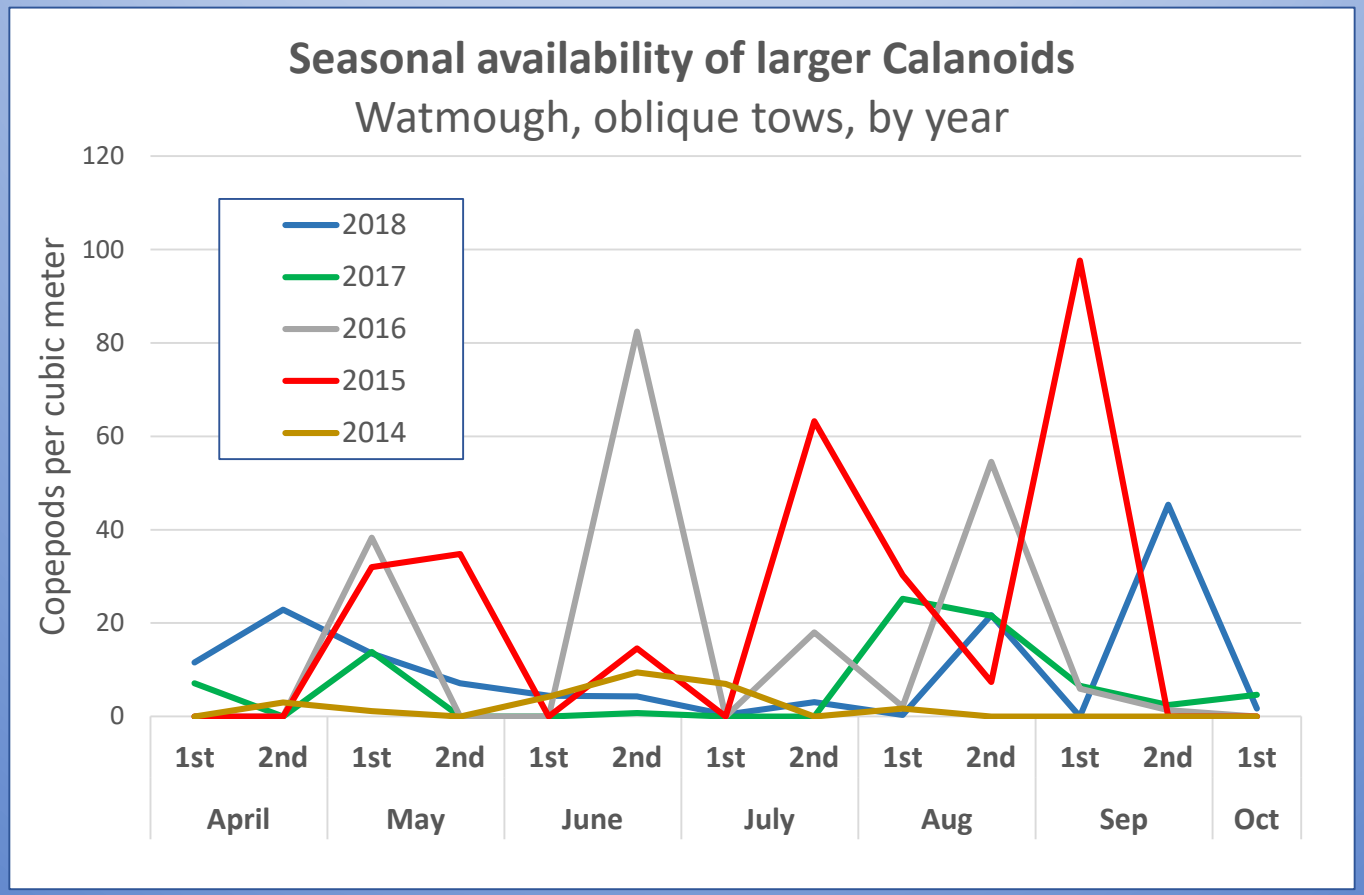




Neocalanus

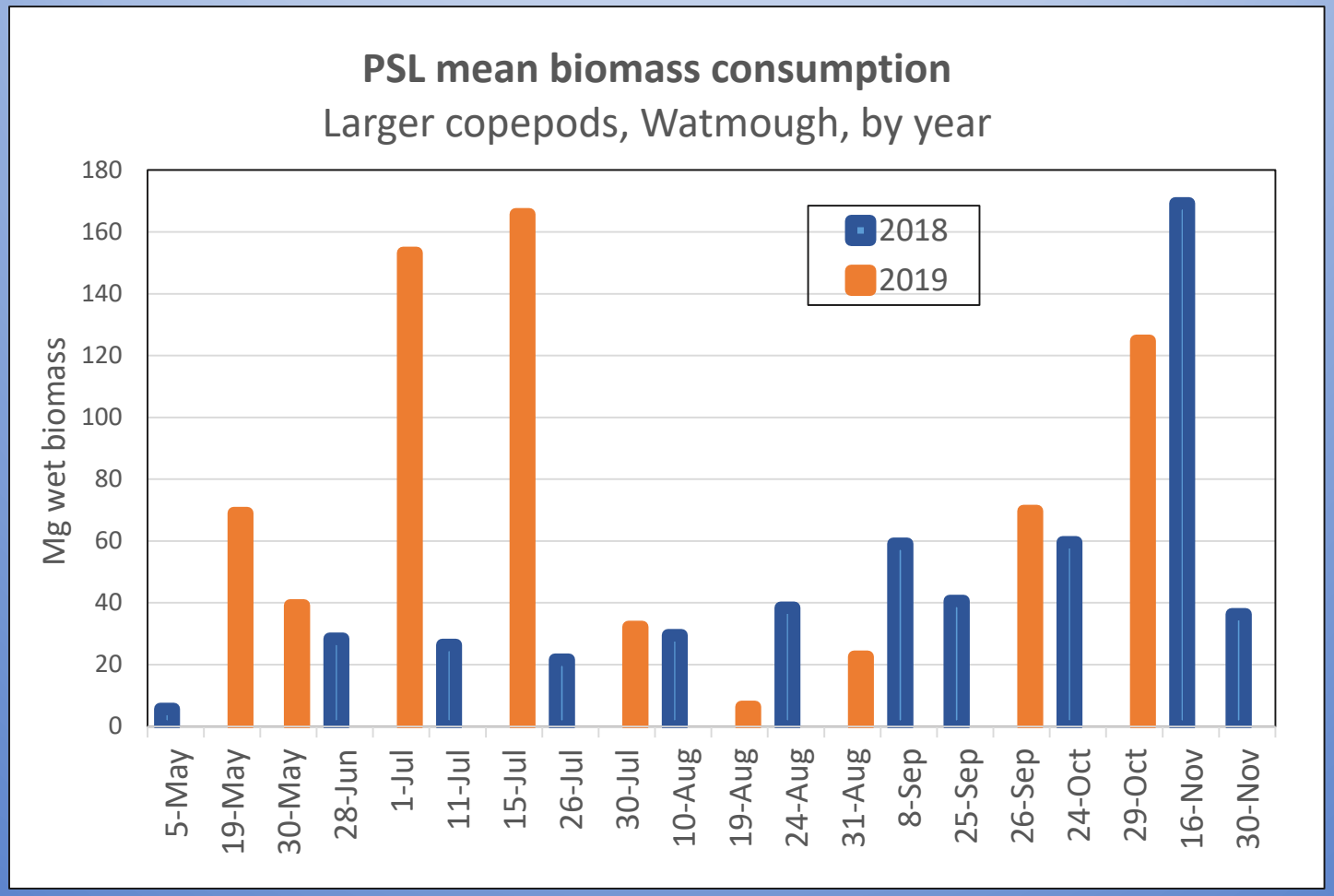
Razouls et al., 2020

Prey field samples using “bongo” nets reveal that larger calanoids can peak at Watmough Bay any time from early summer to early autumn.

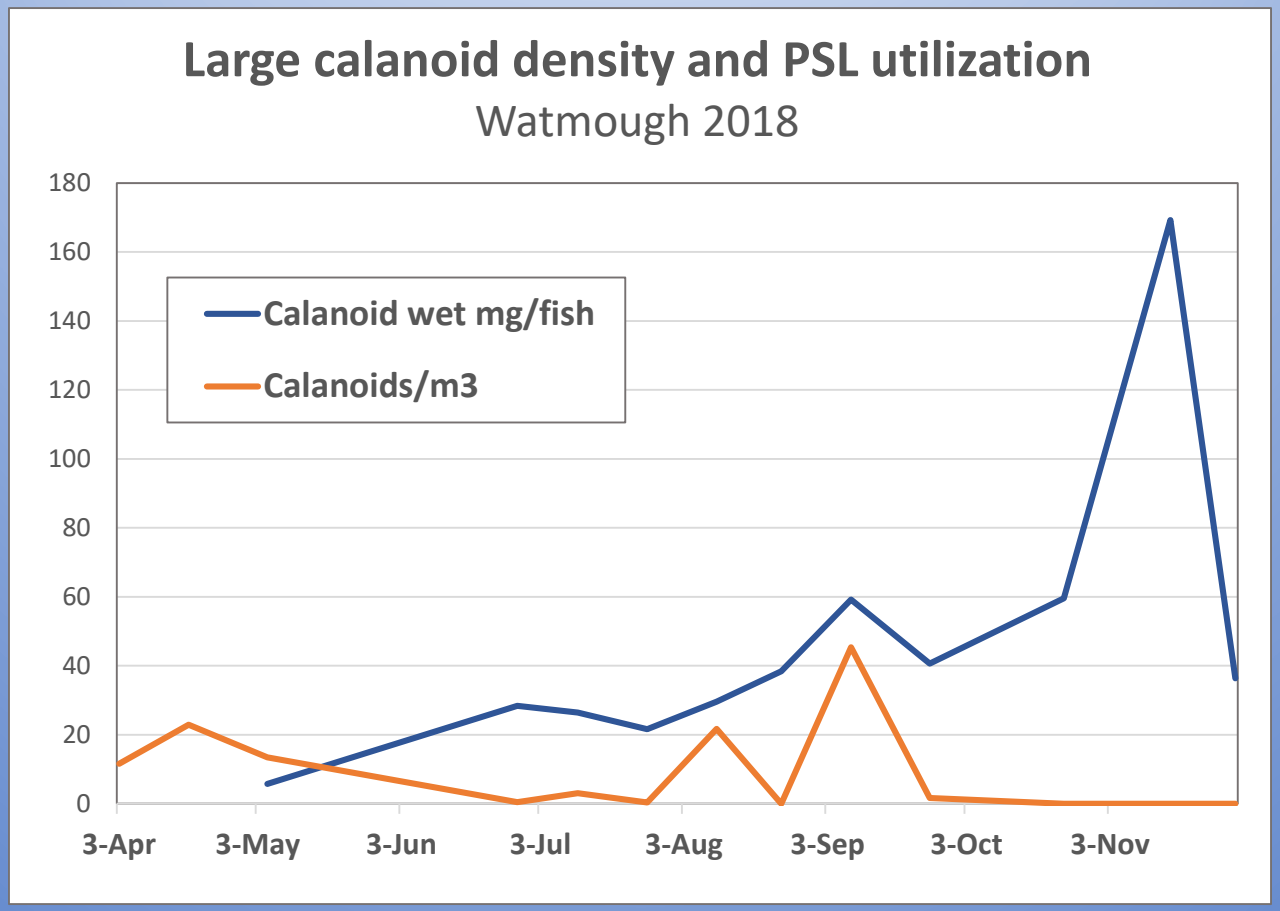


Data courtesy of Julie Keister

PSL utilization of larger calanoids peaked twice in 2019 (summer and fall) but only a single peak (fall) in 2018



There is no simple correlation between seasonal abundance of larger calanoids and seasonal PSL utilization of these species; nor between annual abundance of larger calanoids and PSL abundance



Prey field data courtesy of Julie Keister

Neocalanus biology has been relatively well-studied and offers clues.

Neocalanus development while feeding on phytoplankton near the sea surface is later and slower at higher latitudes (Batten et al, 2003). Inter-annual variation in Neocalanus growth and recruitment is correlated with SST (Kobari et al, 2003); as are regional variations in abundance (Terui et al, 2012). A warming ocean should accelerate development. However, Batten and Mackas (2009) have shown that, while Neocalanus biomass in the northeastern Pacific is peaking earlier in the year than it did in the 1990s, the duration of these peaks has decreased from several months to several weeks in Georgia Strait.

We may infer that Neocalanus are swarming near the surface—and thus available to PSL—for less time each year as the Salish Sea continues to warm, with the result of reducing the net caloric advantage that PSL gain by targeting larger calanoids.

Acknowledgments

Anna Kagley, NOAA
Salmon Recovery Funding Board
San Juan Islands National Monument
Community volunteers, Lopez and Waldron Islands