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Intertidal ghost shrimp in Puget Sound: enough for gray whales and a sustainable commercial harvest?

Whidbey Basin, North Puget Sound Washington.



Whidbey Basin, Puget Sound WA



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Photo: Flip Nicklin



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Gray whale presence Puget Sound



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Annual Northern Migration: January – July

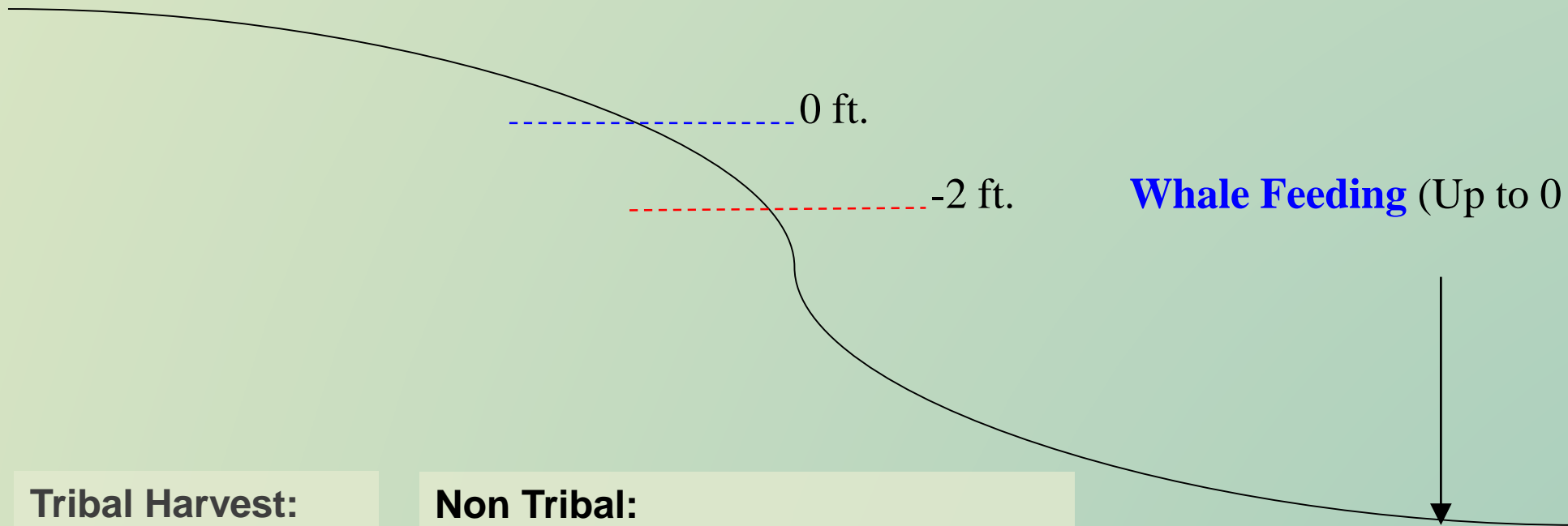
Whidbey Island: Feb – June



ID	Sex	1990	1991	1992	1993	1994	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014*	2015*	Yrs	Other areas	
21	M	1	16	5	2		7	6	4	5			1	13	1	9	3	12	10	1	2	2	3	12-Mar	2-Apr	21		
22	F	1	1	2	1		5	7	4	3			4		2	14		9	7	13		4	11		15-Mar	16	Off Victoria in June 90	
44	M		14	9	3		3		1	1	1		1	15	2		5	1	4	2	2	1	2	7-Apr	4-Apr	19	SPS in 91	
49	M		6	4	2	2	2	5	1	1	5	2	2	11	2	5	5	15	14	12	18	5	8	7-Apr	14-Mar	23	South Vancouver Island May 2012	
53	M		12		2	2	2		1	2		2	5	9	2	9			10	6	22	10	12	18-Mar	8-Mar	18		
56			2					1		5	2		1	6	2	7	2	9	1	1	4	5	12	10-Apr	14-Mar	17		
356									1		1		1	1		1		2	2	2				7-Apr	?	9	OR Oct 99	
383									2		1		1	7	1	7	6	4	9	4	1	3	9	7-Apr	21-Mar	15		
396	F								4	1																	3	Off Victoria April 07
531	F									2					2	3	8	10	4	12	11		1	9-Mar		10	Kod Aug 02, WVI Mar 07	
543										4	3																2	
723	M									1				19	3	5				4	2	11	5		9-Mar	7-Mar	10	
1193																				5	3						2	
1213																					3	4					2	
Count		2	6	4	5	2	5	4	8	10	6	2	8	8	9	9	6	8	12	12	9	8	8	9	8			



Harvest (Down to -2 ft MLLW.)



Tribal Harvest:

➤ Tribal Land

Non Tribal:

Authorized Right Of Entries on
State land 3 harvest operations

Both:

Operate on low tides ~ 0 ft. or lower throughout the year
Catch records reported to WDFW
Reported by the dozen



Project Conception

- Concern that less whales had been returning to feed at specific beaches
- Anecdotal observations from locals indicating that the frequency of Gray whale feeding had diminished, and whales had been returning earlier and staying later.
- Attributed to (*Neotrypaea californiensis*) harvest?
- Complete moratorium on Harvest until a study could be completed **April 2014**
- Lack of data – 1992 Laurie Weitkamp's Gray whale foraging on ghost shrimp (*Callinassa californiensis*) in littoral sand flats of Puget sound



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Project Goals

Determine whether commercial harvest competing with Gray whales for native Ghost shrimp (*Neotrypaea californiensis*)

- 1) Determine most utilized regions in Whidbey basin by Gray whales
- 2) Estimate total standing stock of ghost shrimp in areas whales feed
- 3) Estimate yearly extraction of ghost shrimp by Gray whales
- 4) Estimate yearly extraction of Gray whales by harvest





➤ **Assessment of Ghost shrimp stock and distribution available to whales**

12 beaches surveyed and mapped

(3 site types: '1' *whale feeding*, '2' *harvest*, and '3' *no whale feeding or harvest present*.)

Manual coring, 300 m long transects

Hydraulic pumping

Shrimp area available to whales 2015 – Orca Network/ aerial images

➤ **Whale extraction estimate**

Temporal feeding data

Samples taken inside and outside obvious whale feeding pits

Pits counted : aerial images

Tagging of whales

Harvest extraction estimate

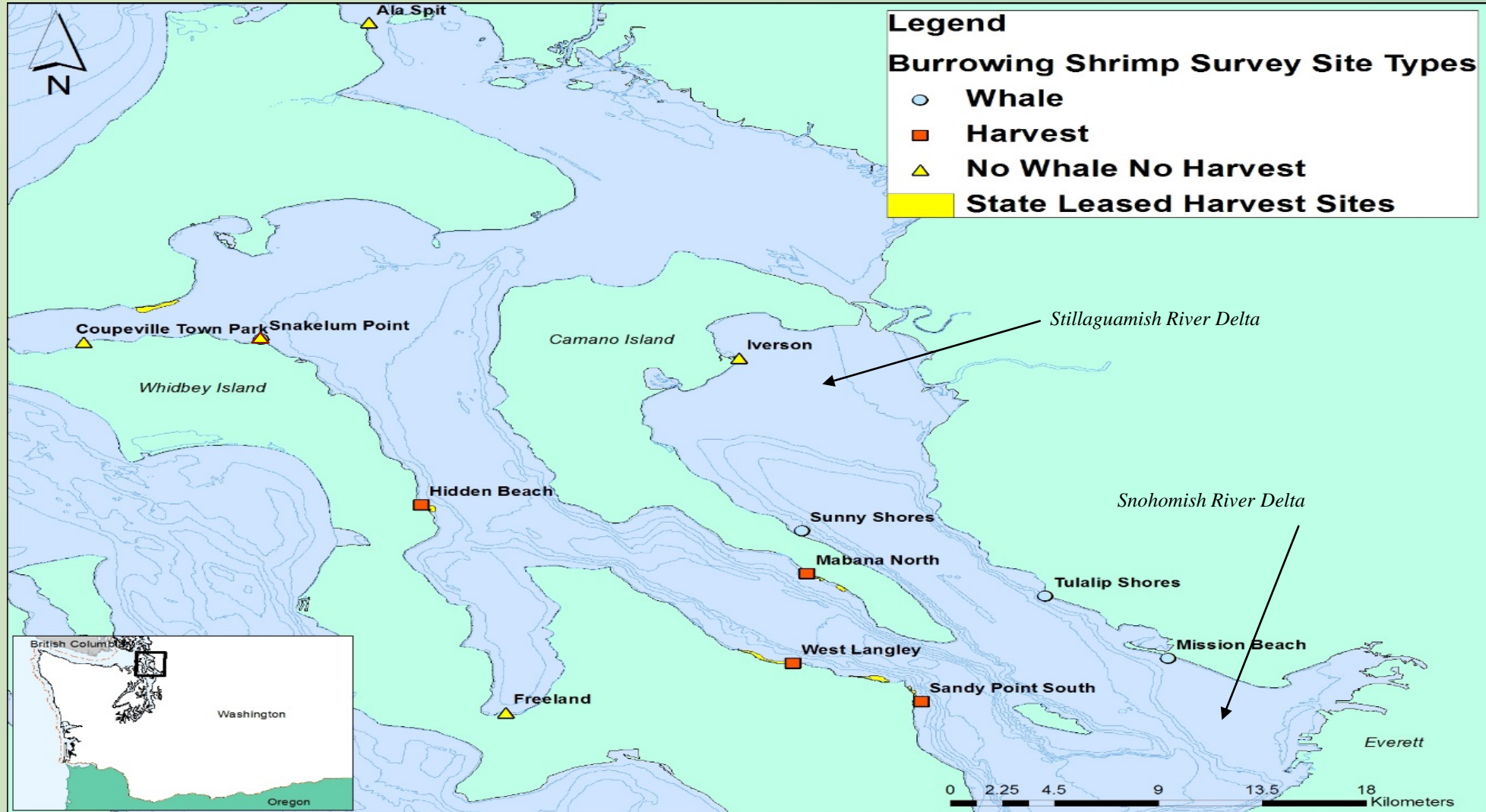
Temporal Harvesting Data

WDFW catch records: 2010 – 2015 tribal , 2010 – 2013 non tribal

12 Surveyed Sites December – May 2015



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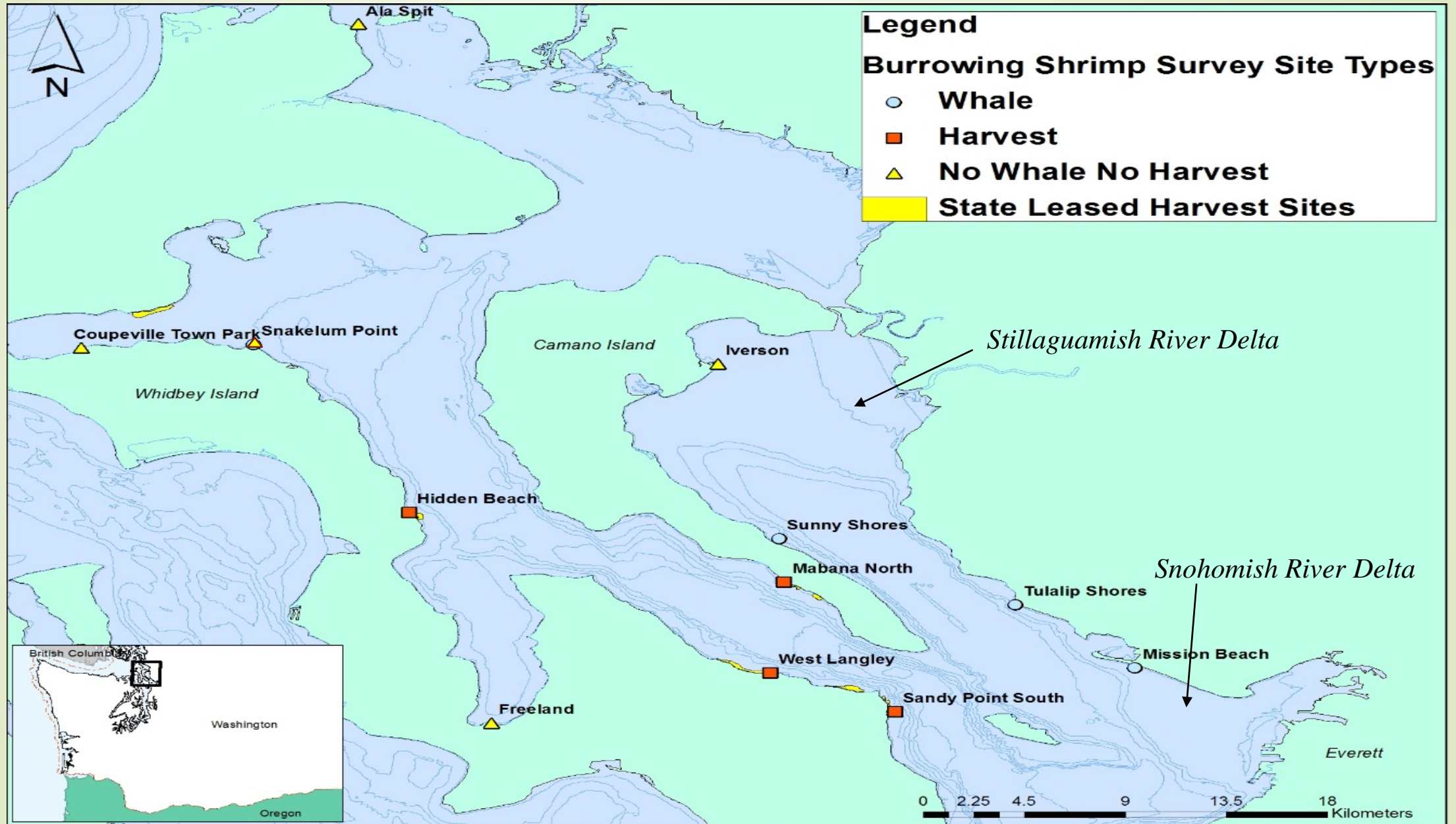


Standing Stock and Whale Pit Surveys

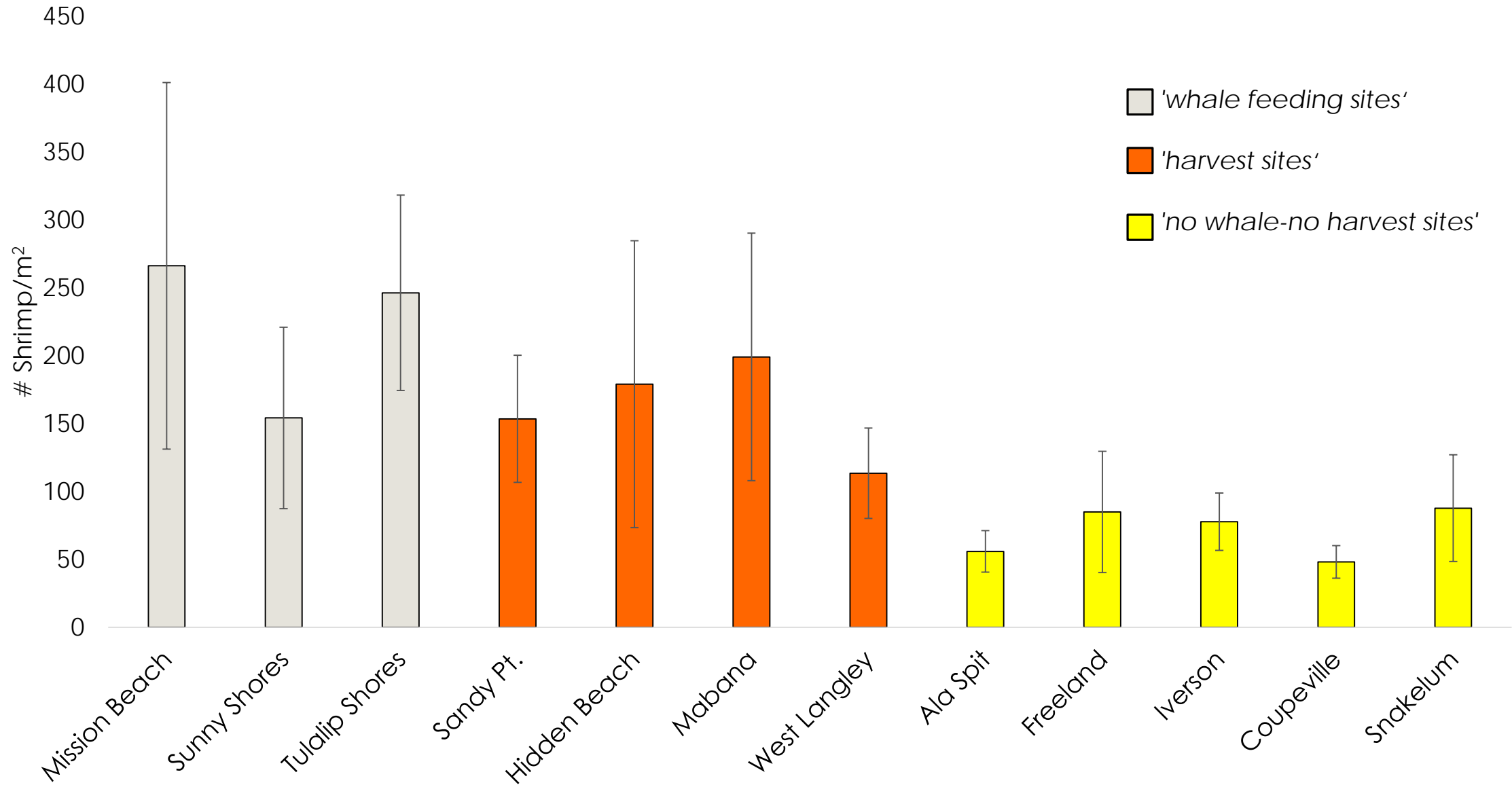
300 m transects

1/2 m² pumped cylinders to relate cores to actual biomass



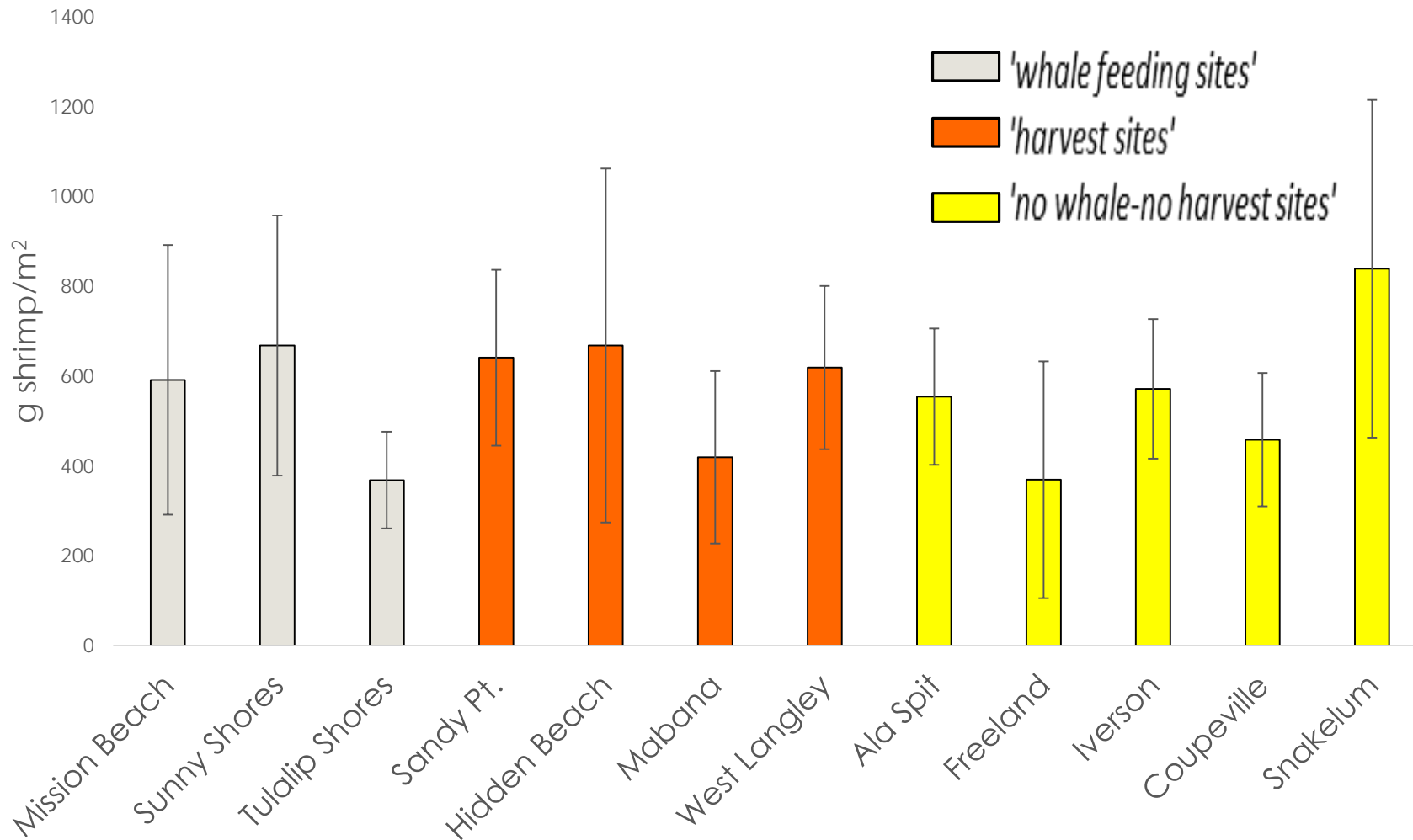


Shrimp density (Number of shrimp per square meter- all sites)

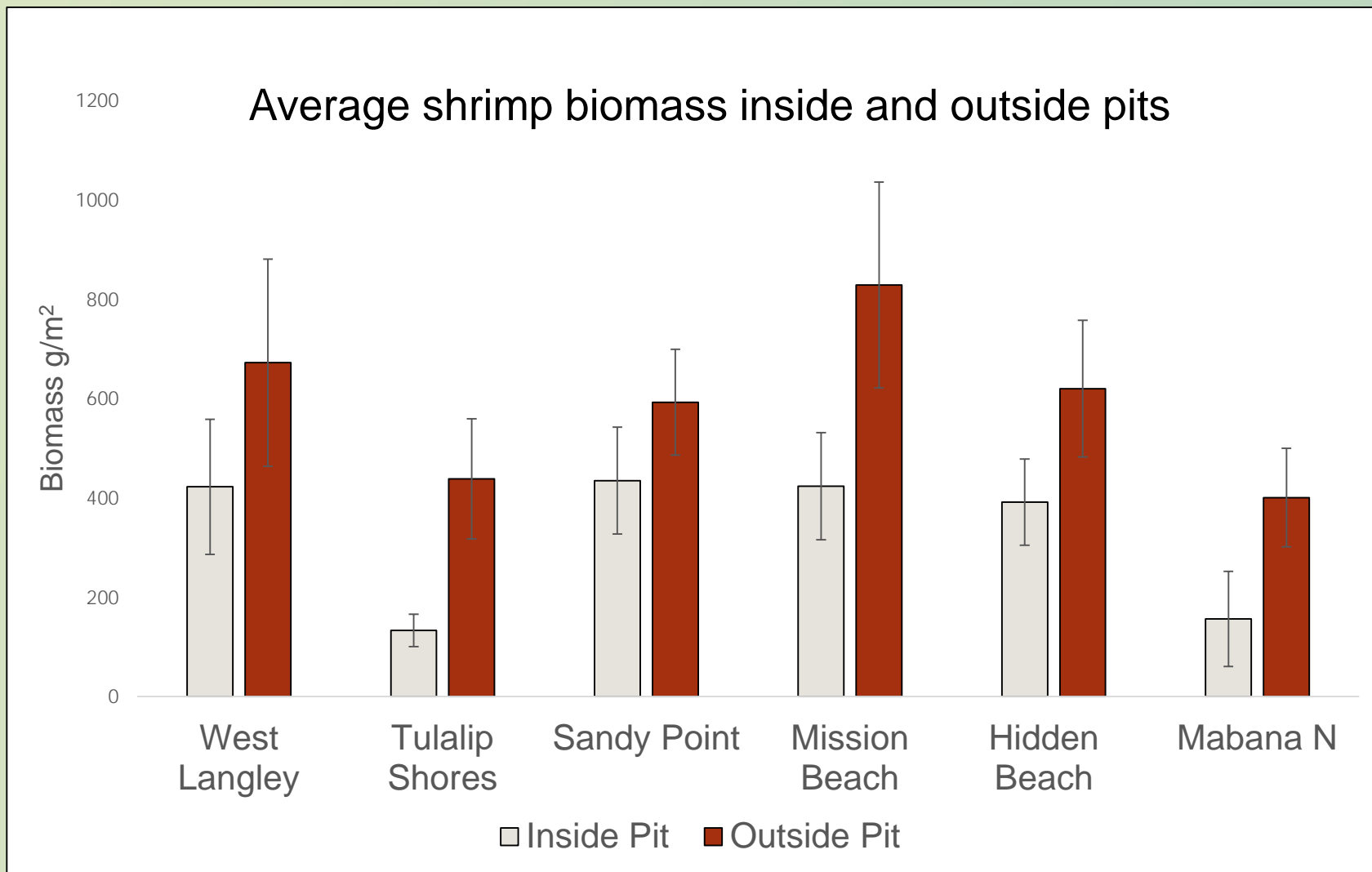




Biomass all sites



- Whale: High density of 'ex. small' – 'medium' shrimp
- Harvest: High density of 'ex. small' – 'medium' shrimp
- No whale feeding or harvest present: Low density of 'large' shrimp

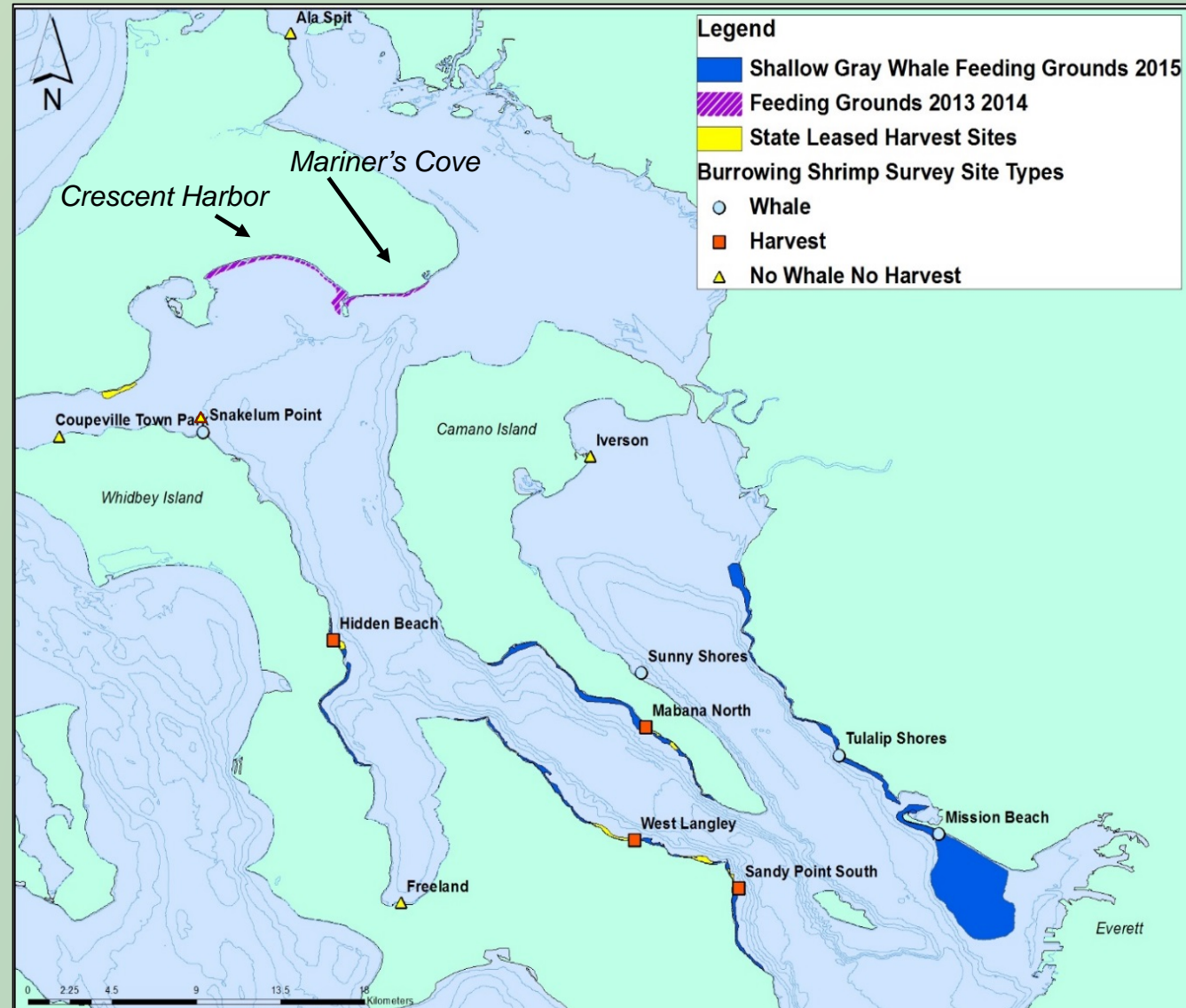


Ghost shrimp biomass extrapolated



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- *2015 whale feeding grounds criteria:* Tideland where whales had been seen **feeding in 2015, shallower than -10 MLLW**. When present, eelgrass acted as a lower boundary.
- Whale feeding grounds delineated based on presence of pits in aerial images, Orca Network sighting data, and dedicated small boat surveys
- Harvested regions account for roughly 8.2% of total Gray whale feeding grounds in 2015
- *Additional stock held in feeding grounds utilized in 2013, and 2014.*



Harvest



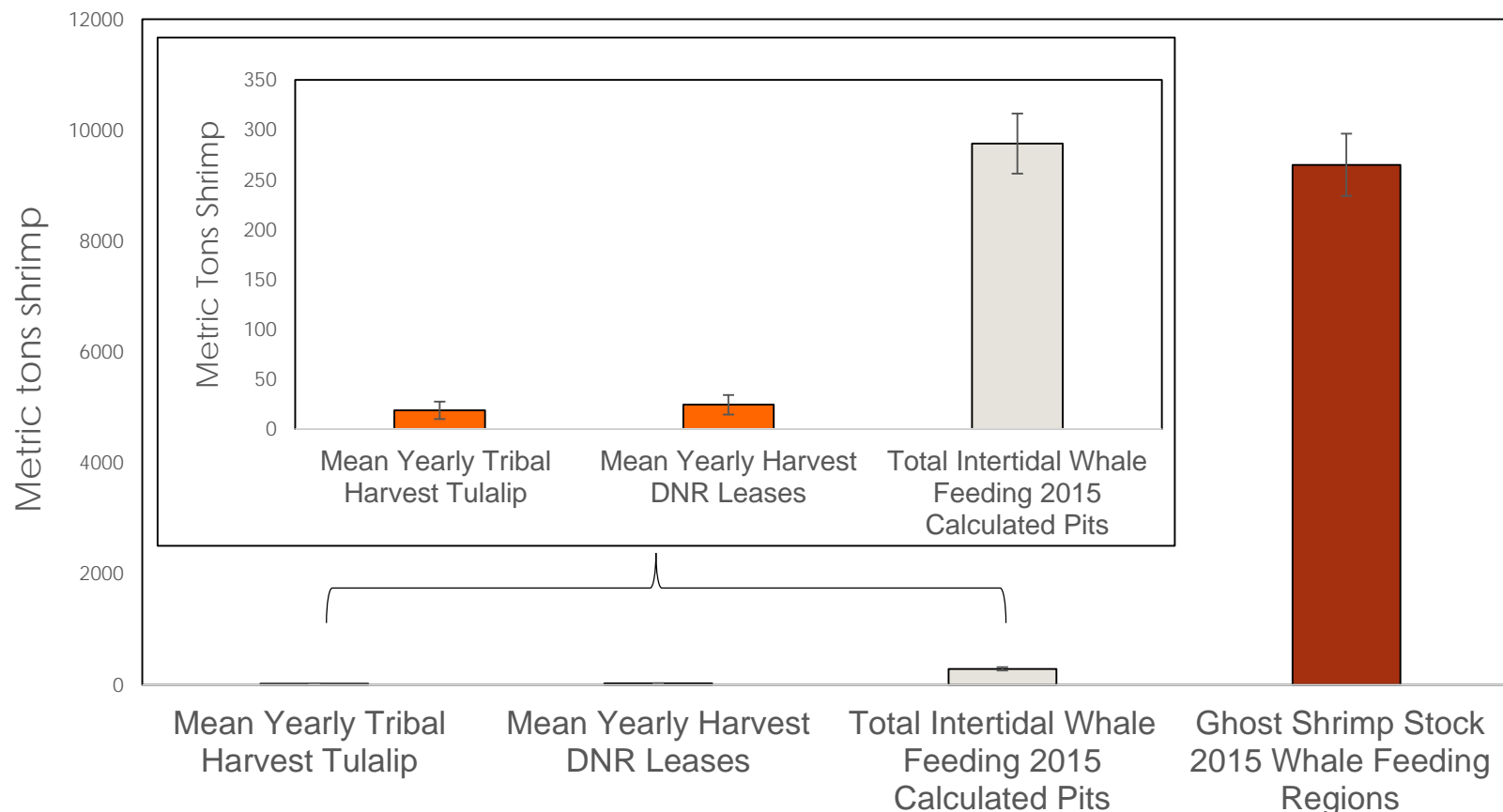
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- **Beaches Harvested from 90 – 130 times per year**
- **Mean yearly harvest Tribal: ~ 5 million shrimp or 18.55 metric tons**
- **Mean yearly harvest non- tribal: ~ 7 million shrimp or 24.23 metric tons**



- *Estimated Ghost shrimp standing stock ~ 28.5 times greater than the yearly estimate of shrimp extracted from Gray whale feeding and harvest combined.*

Estimated ghost shrimp taken yearly : harvest and gray whale

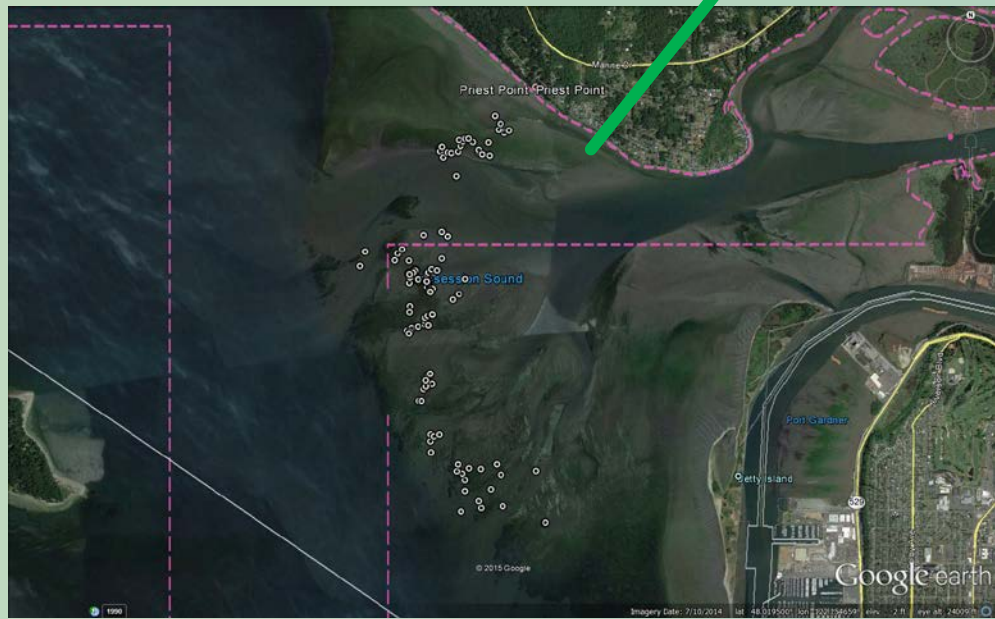
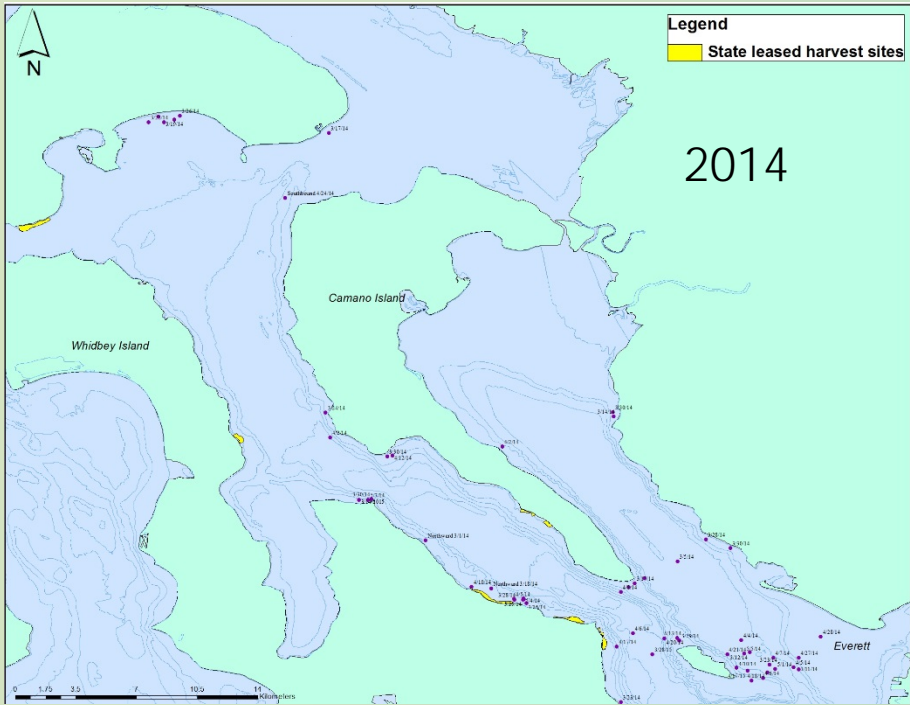
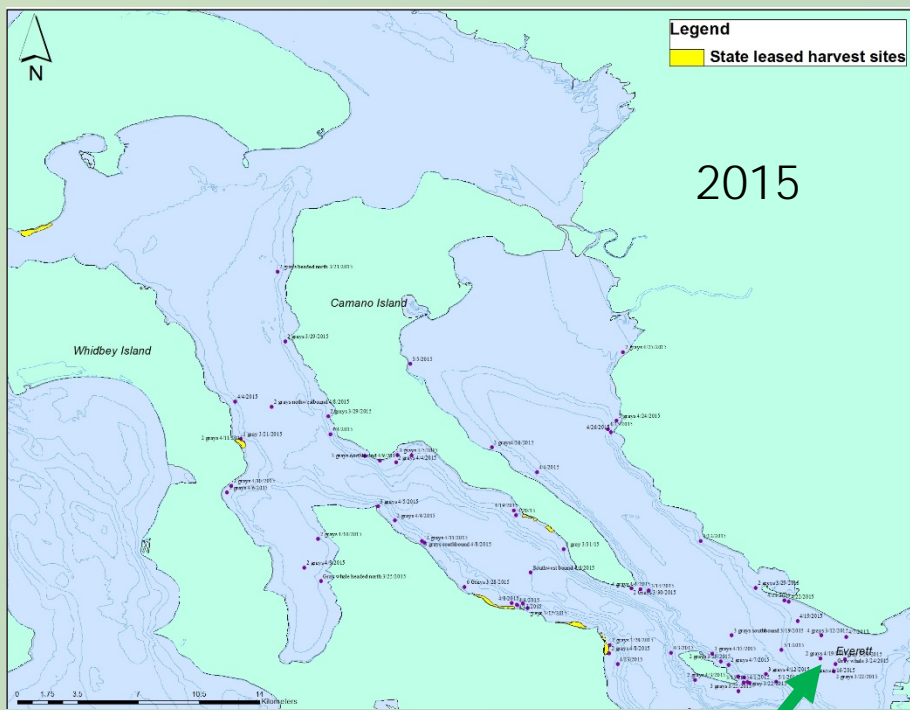
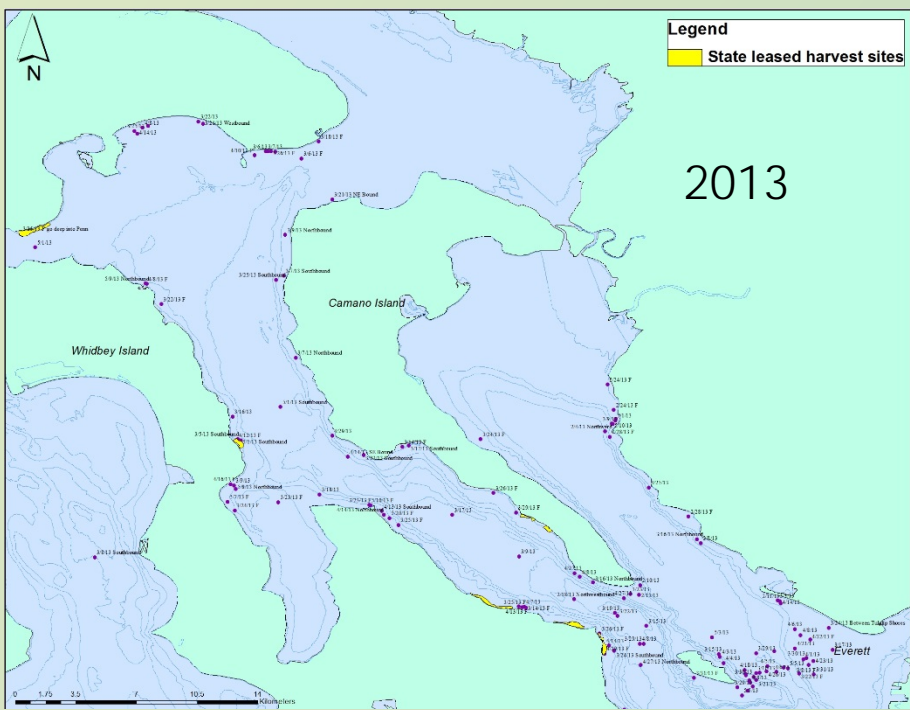


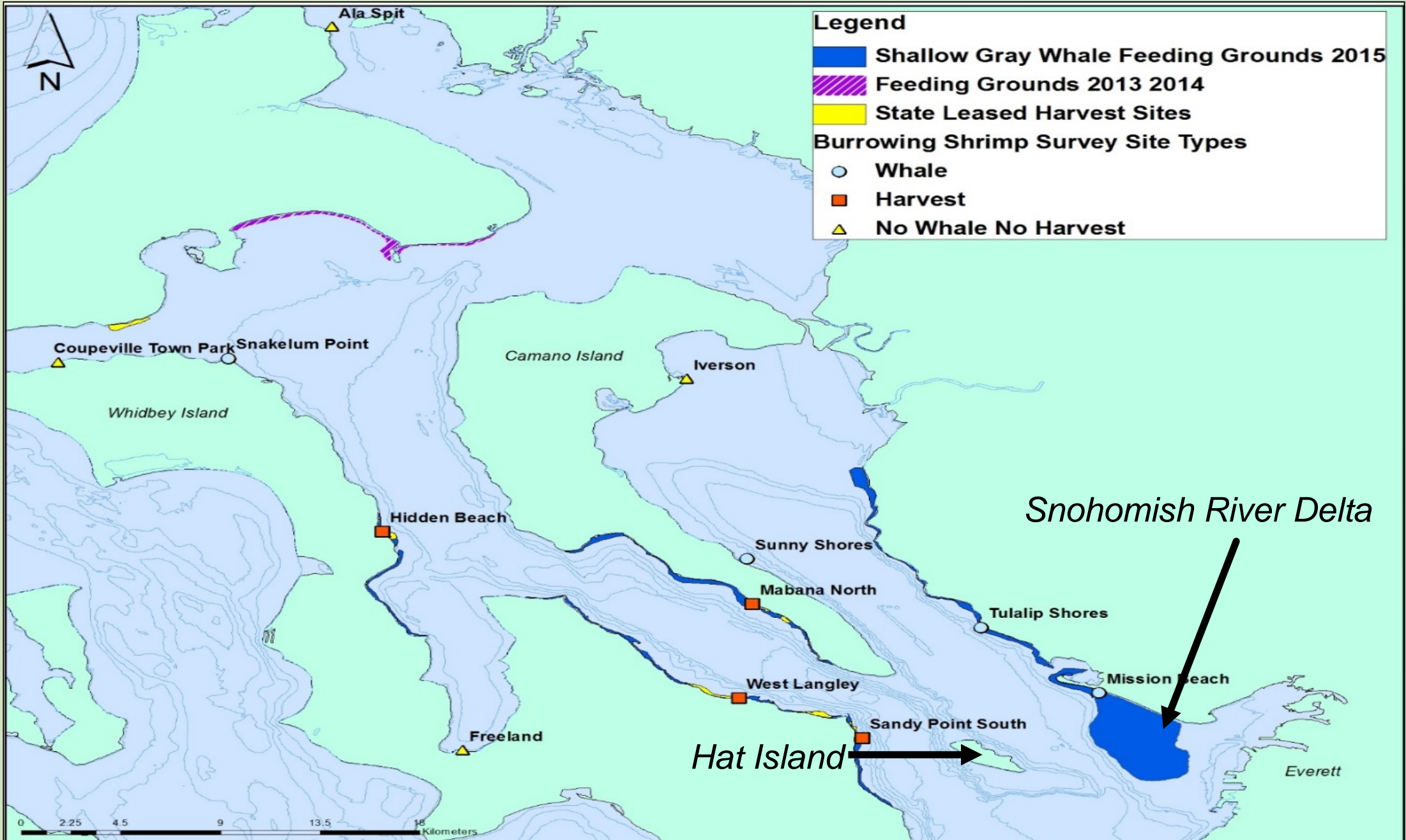
Biomass Estimated Taken Yearly From:	Total Biomass (Metric Tons)	St. Error
Mean Yearly Tribal Harvest Tulalip	18.55	8.81
Mean Yearly Harvest DNR Leases	24.23	9.74
Total Intertidal Whale Feeding 2015 Calculated Pits	286.29	30.03
Available Ghost Shrimp Stock 2015 Whale Feeding Regions	9377.31	562.49

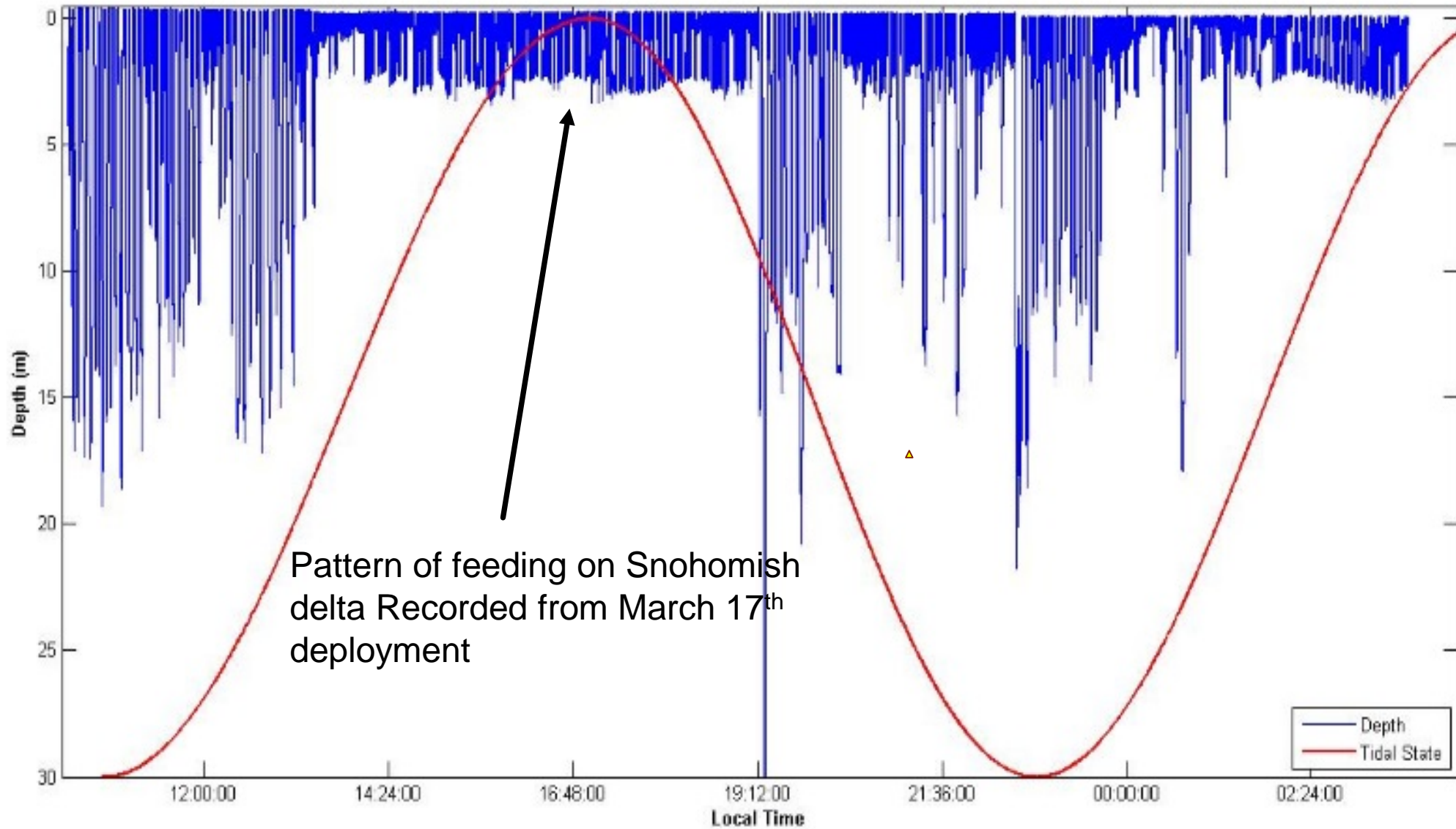


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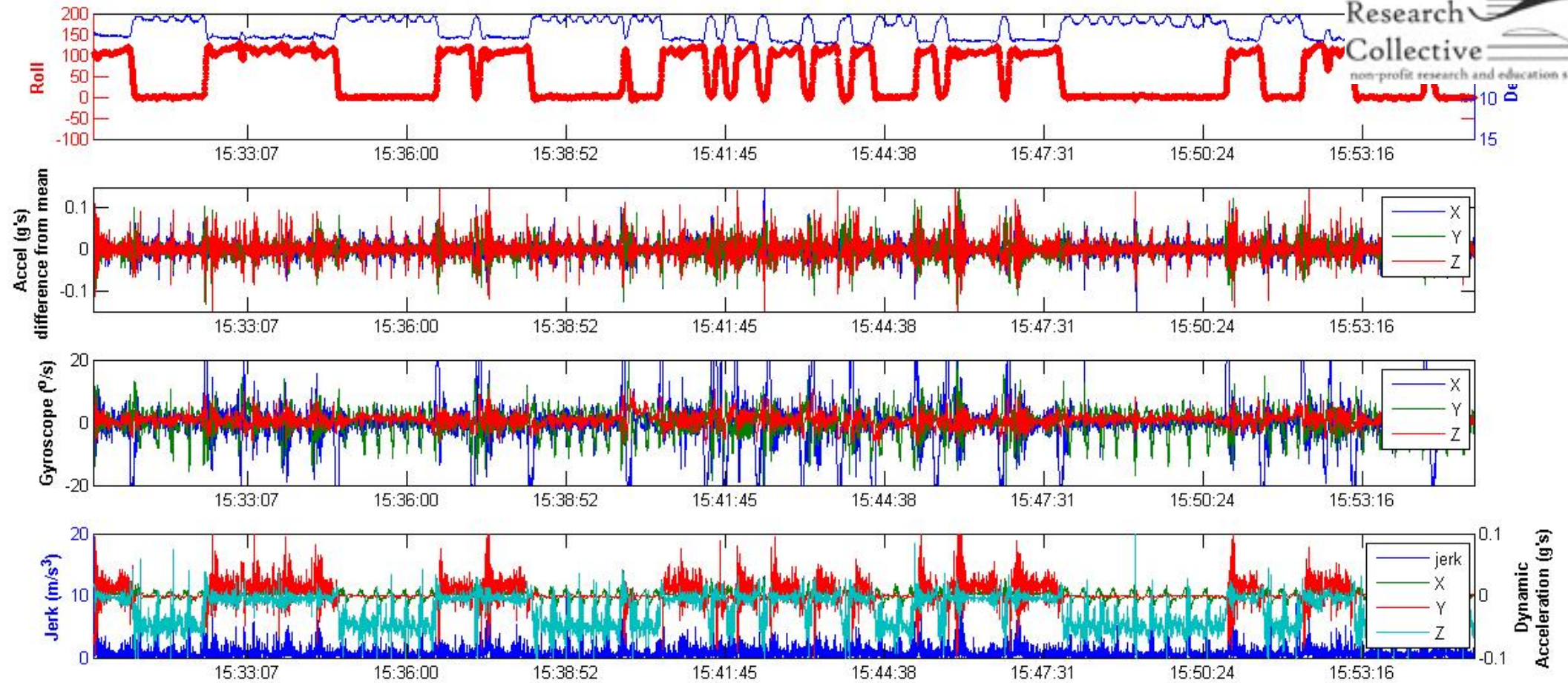


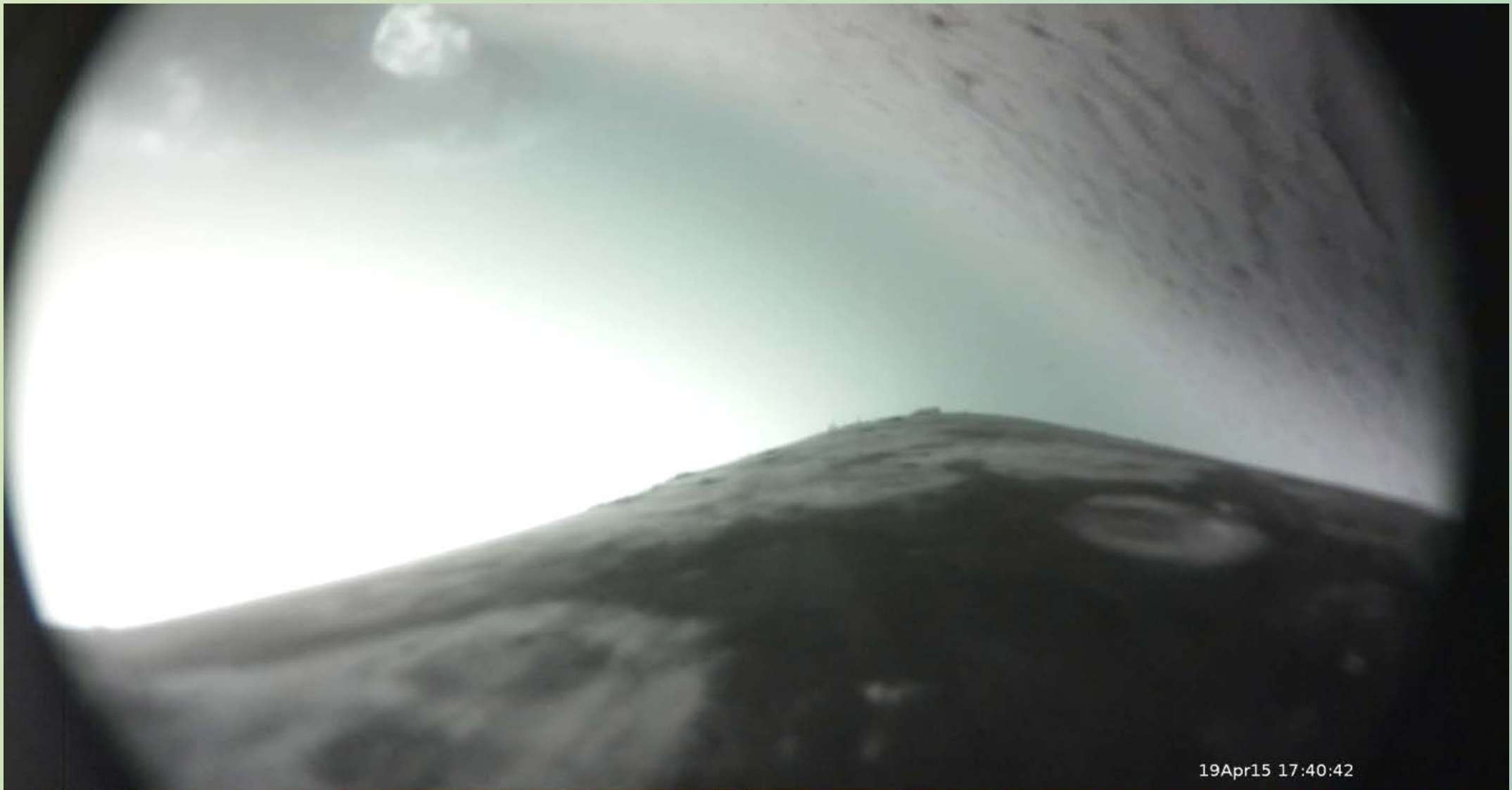


Roll, accelerometer, and gyro sensors



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- <https://www.youtube.com/watch?v=05pxUpRAKsU>
- <https://www.youtube.com/watch?v=gUwNZHAQgtw> 22 seconds

Gray whale first and last sightings Whidbey Basin 2002 - 2015

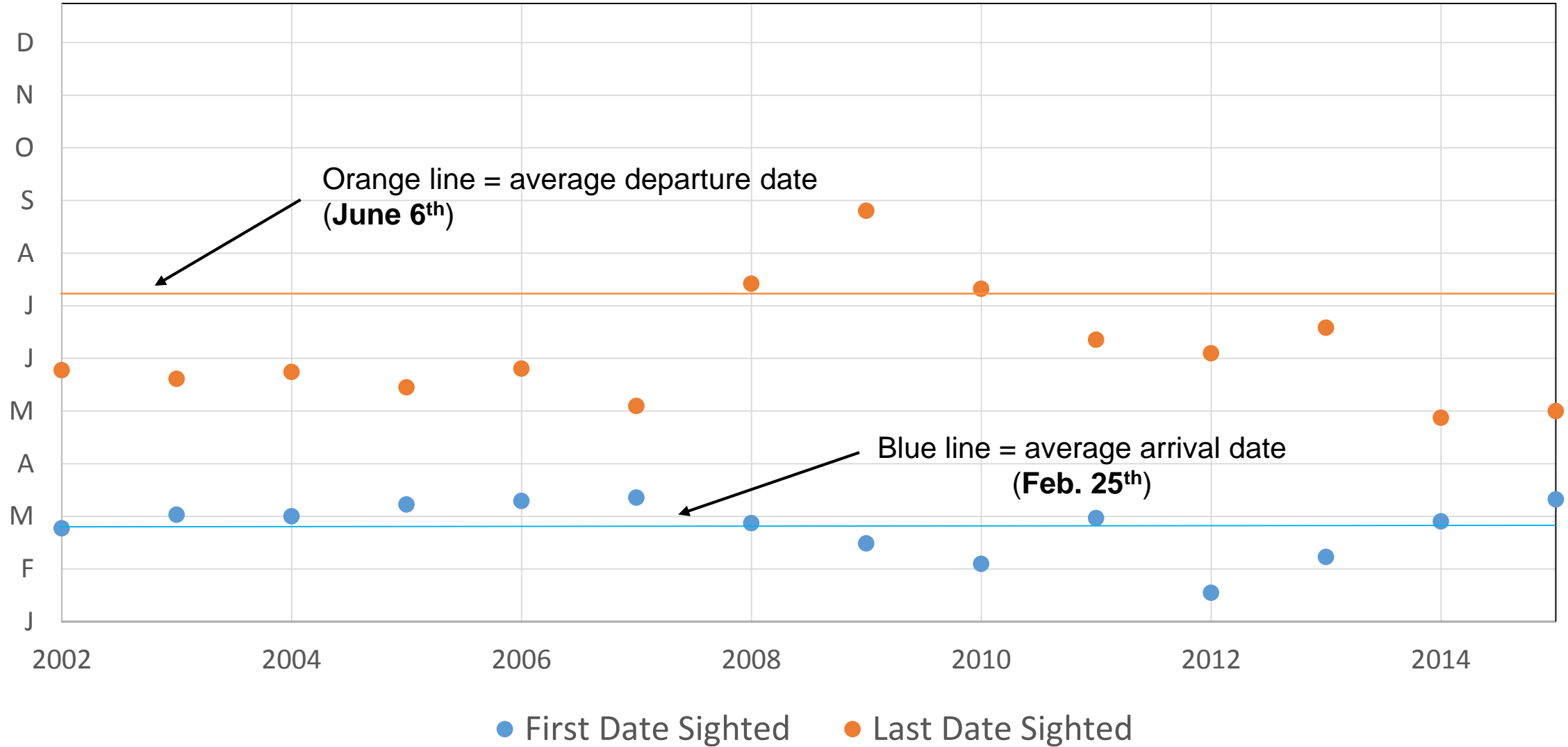
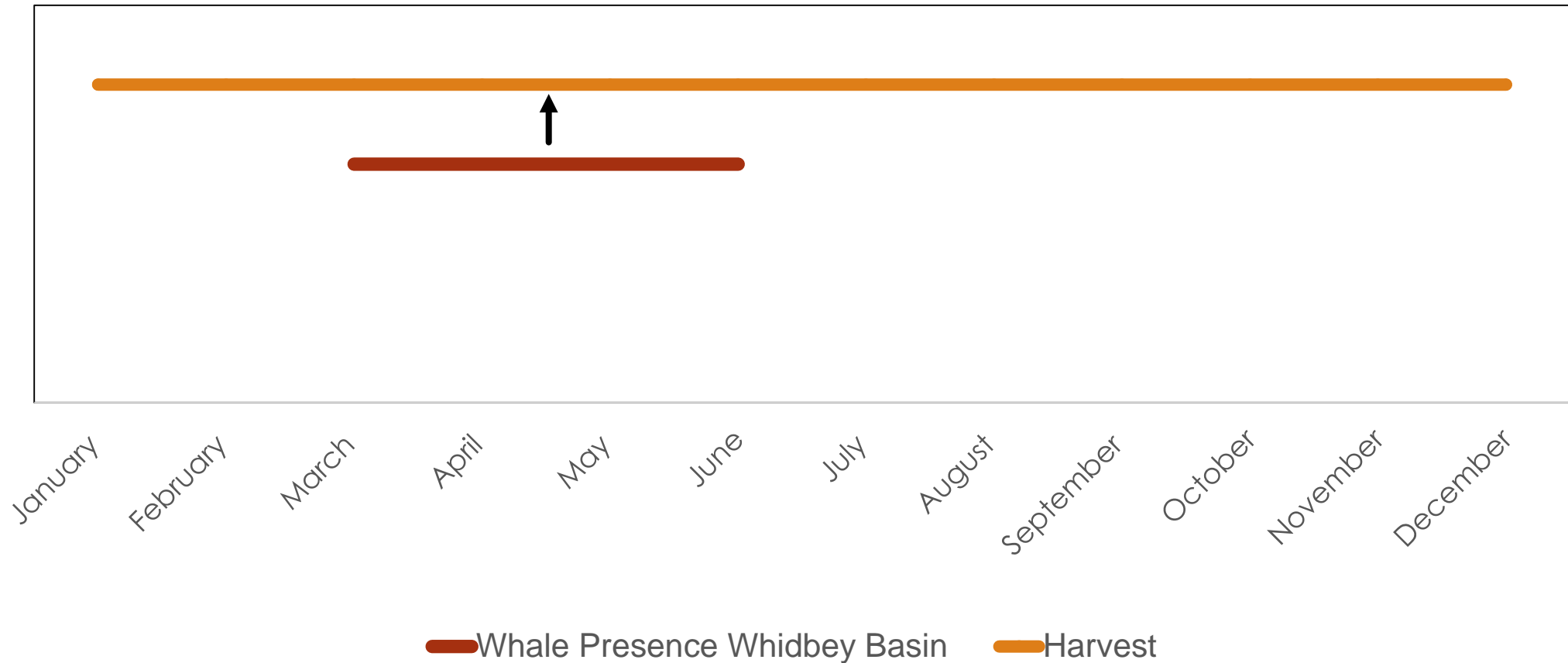


Table 1. Annual sightings of identified gray whales seen multiple years in N Puget Sound. Number times seen shown and for 2010-13 first date identified.

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- Restricted Harvest February 1st – June 1st
- Continued Monitoring

Whale Presence and Harvest Overlap





Continued Monitoring

- ▶ Pit density from harvest sites for years where harvest is prohibited vs. years with unregulated harvest
- ▶ Shrimp recolonization rates post harvest
- ▶ Sampling of existing whale feeding and harvest beaches
- ▶ Recruitment surveys of newly settled shrimp
- ▶ Multibeam and video surveys to determine extent of subtidal pits

- ▶ Continued involvement with Cascadia Research to accomplish::

Tagging

Whale fecal sample collection for qPCR DNA analysis