Applications of a New Satellite-Linked Tag for Long-Term Monitoring of Large Whale Diving and Feeding Behavior

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Oregon State University

Assessing Marine Mammals in the High Seas
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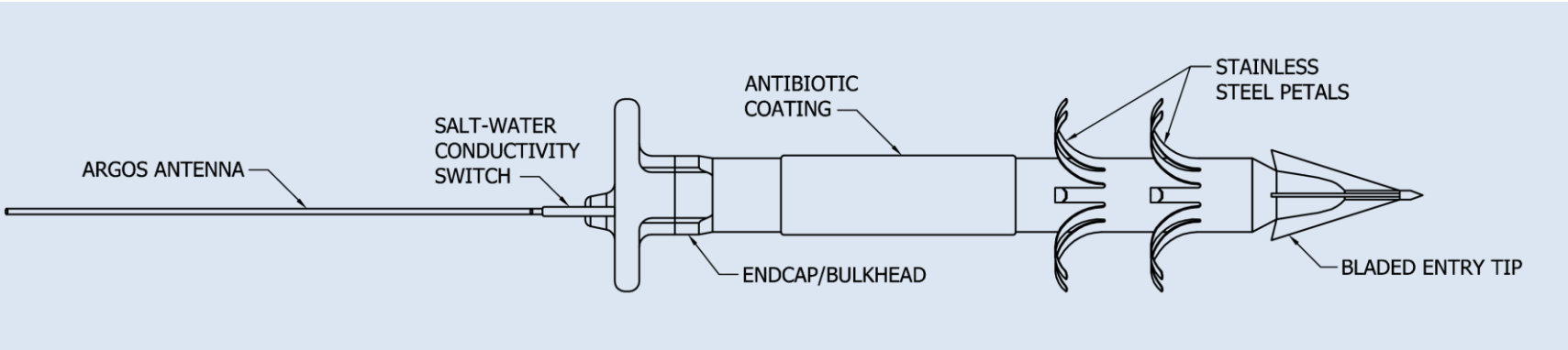
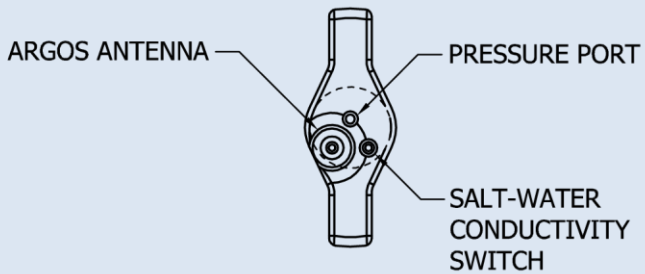
Craig Hayslip

A new satellite-linked radio tag

- Latest design based on “traditional” **location-only implantable** Argos tag in use since 1997 (Mate et al. 2007)
- Sensors: conductivity (saltwater switch), pressure, tri-axial accelerometer
- Onboard **software** detects **dives** (SWS, pressure sensor) and **feeding events** (peaks in accelerometer-derived metrics; Allen et al. 2016)
- Generate summary messages for **every dive** for **transmission** via Argos: duration, maximum depth, and number of feeding events
- Can stay attached for periods of several months

Satellite-linked radio tags



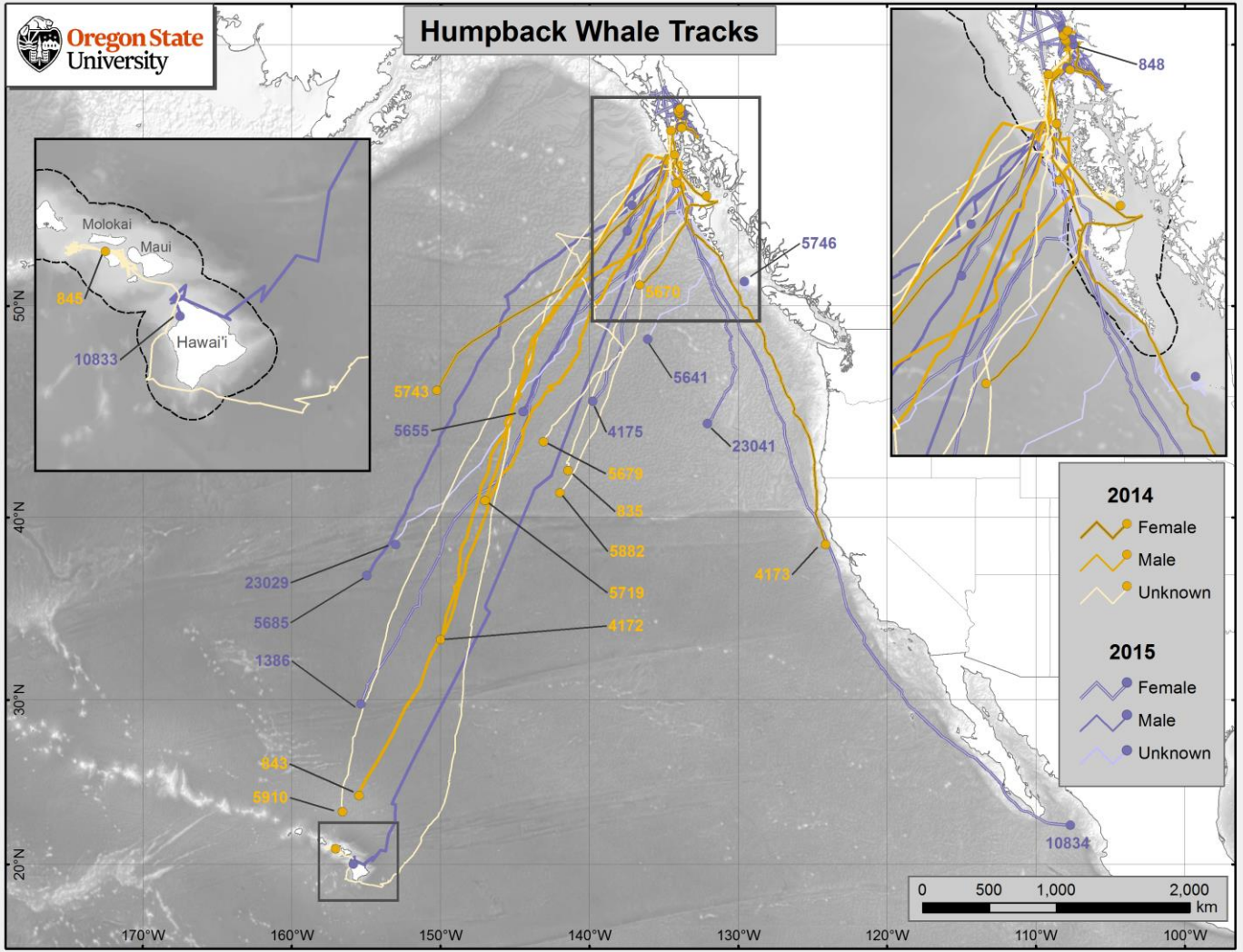


- Telonics RDW-640 (**DUR**) and RDW-665 (**DM**)
- Conductivity sensor (SWS)
- Pressure sensor for depth
- Tri-axial accelerometer for motion detection (feeding events)
- 6 V lithium battery pack
- 1.9 × 20.7 cm

Humpback whale tag deployment summary

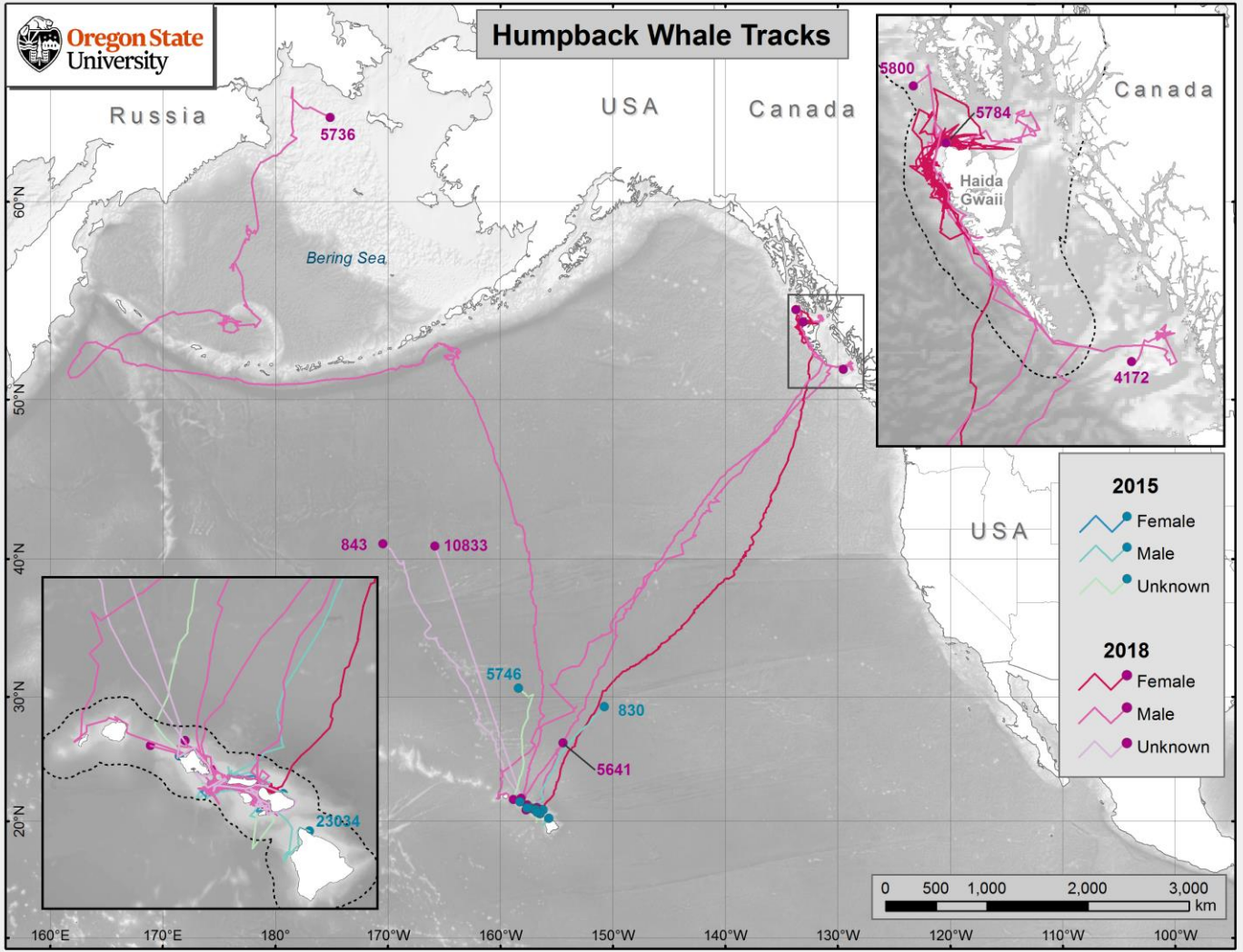
Year	Deploy Area	Tag Type	N	Mean Duration (days)	Max Duration (days)
2015	SEAK	DUR	7	30.6	55.7
2016	OR	DM	2	12.9	18.6
2017	CA	DM	7	12.7	51.6
2017	OR	DUR	4	61.7	150.1
2018	HI	DUR+ DM	5 19	104.5 22.5	44.1 147.2
2018	OR	DUR	5	23.2	60.2
2018	WA	DUR+ DM	10 9	41.0 24.2	110.6 52.1
		Total	68		

Migrations in the high seas



Palacios *et al*. (2019)

Migrations in the high seas



Palacios *et al*. (2019)

Movement behavior in the high seas

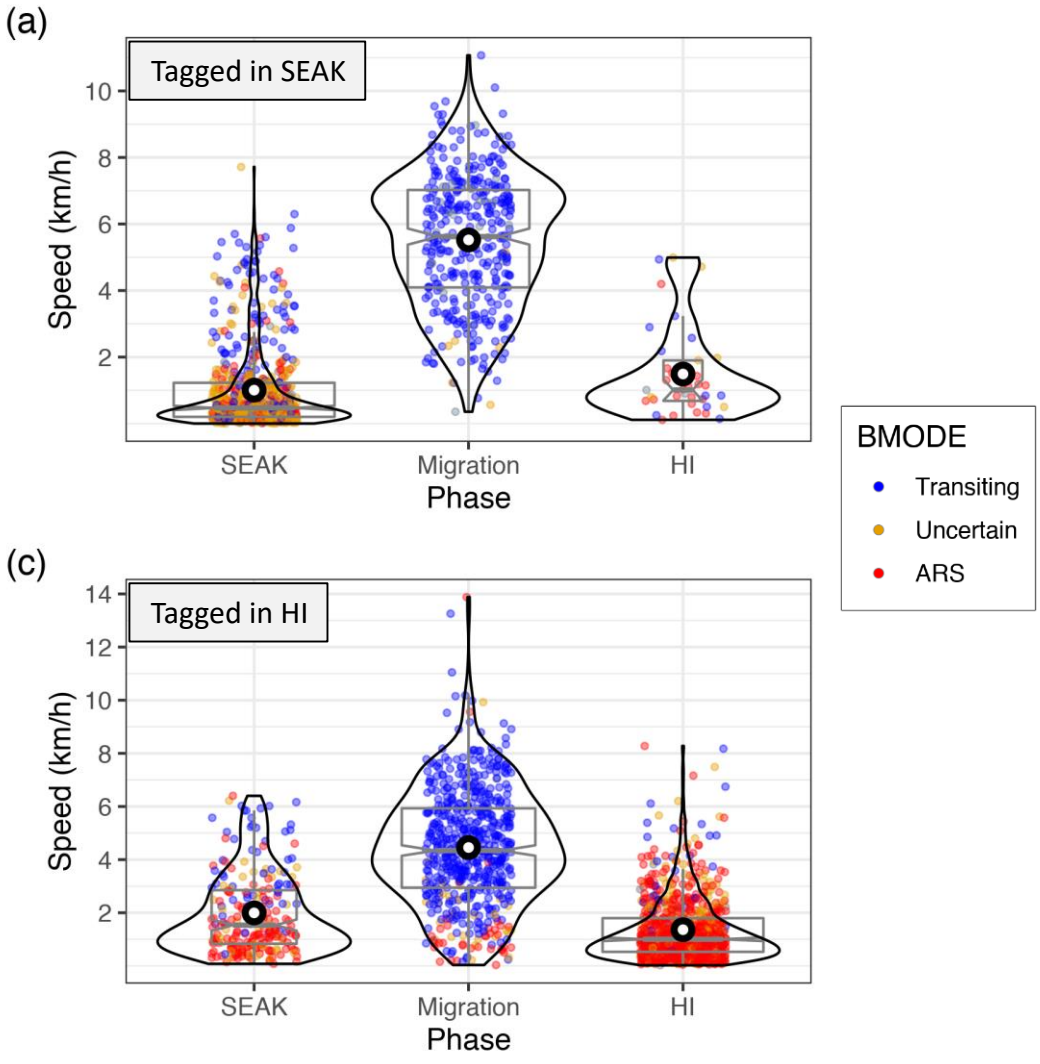
Southeast Alaska

- SEAK: 0.5 km/h
- Mig: 5.6 km/h
- HI: 1.0 km/h
- ARS: 0.6 km/h
- Trans: 4.7 km/h

Hawaii

- HI: 1.0 km/h
- Mig: 4.3 km/h
- SEAK: 1.5 km/h
- ARS: 1.0 km/h
- Trans: 4.4 km/h

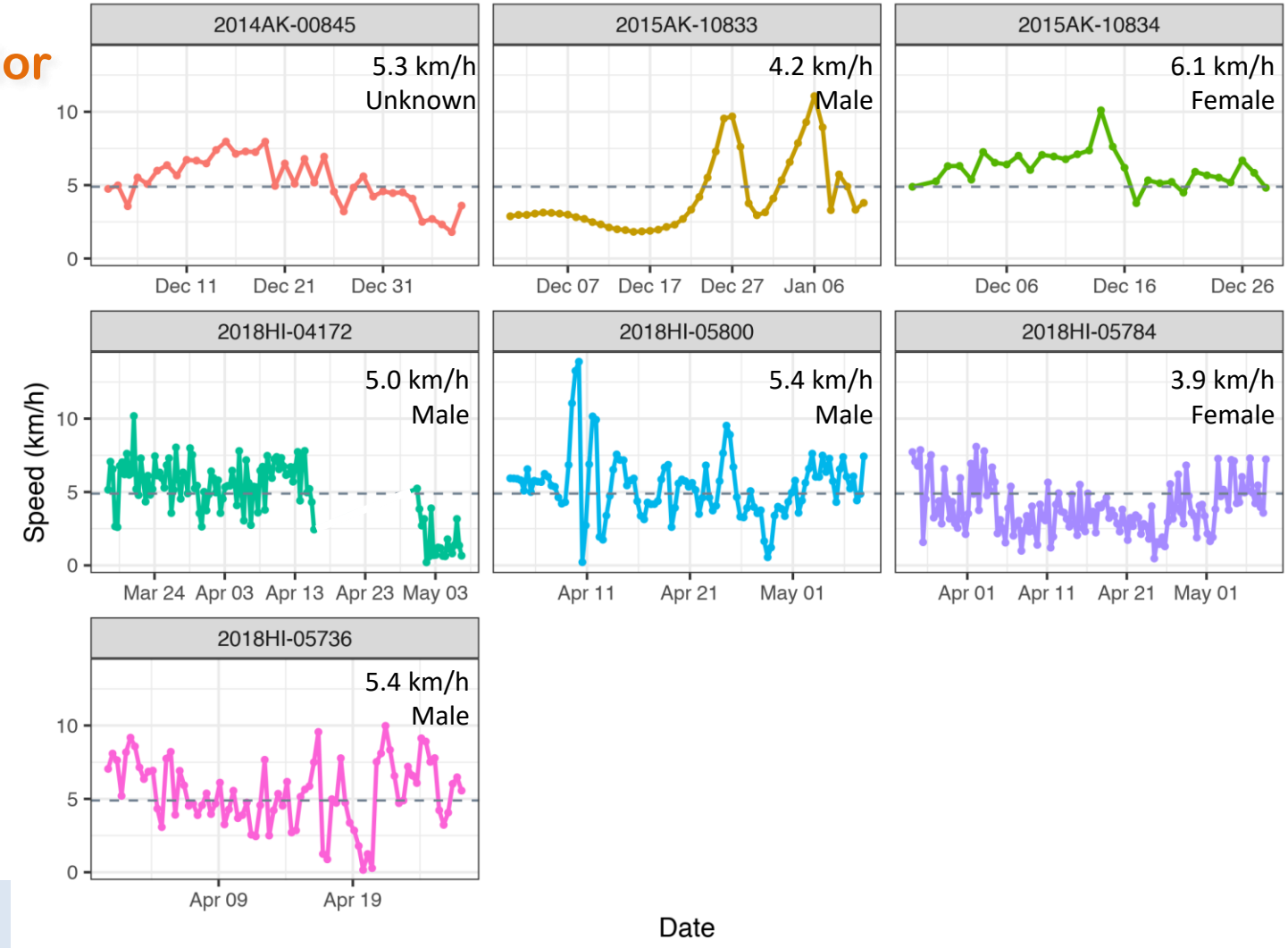
Palacios *et al*. (2019)



Movement behavior in the high seas

Migration speed

- Mean: 4.9 km/h
- Highly variable:
  - among individuals
  - in time



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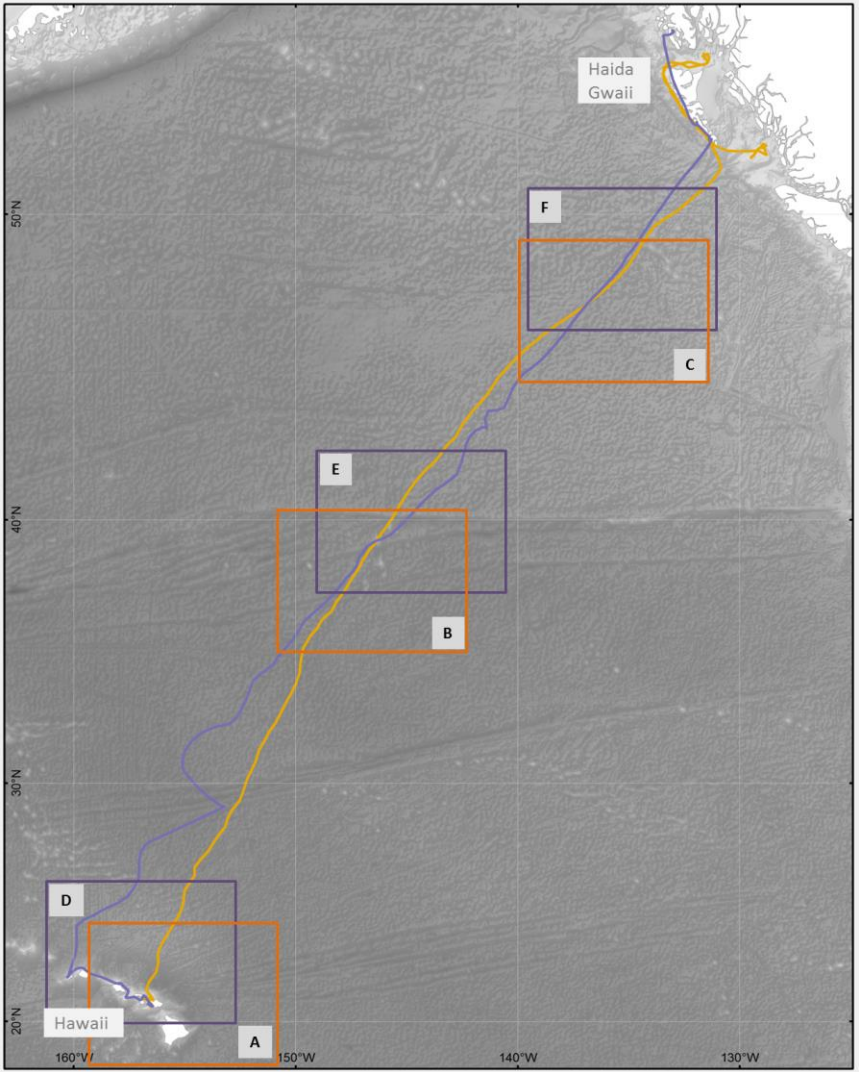
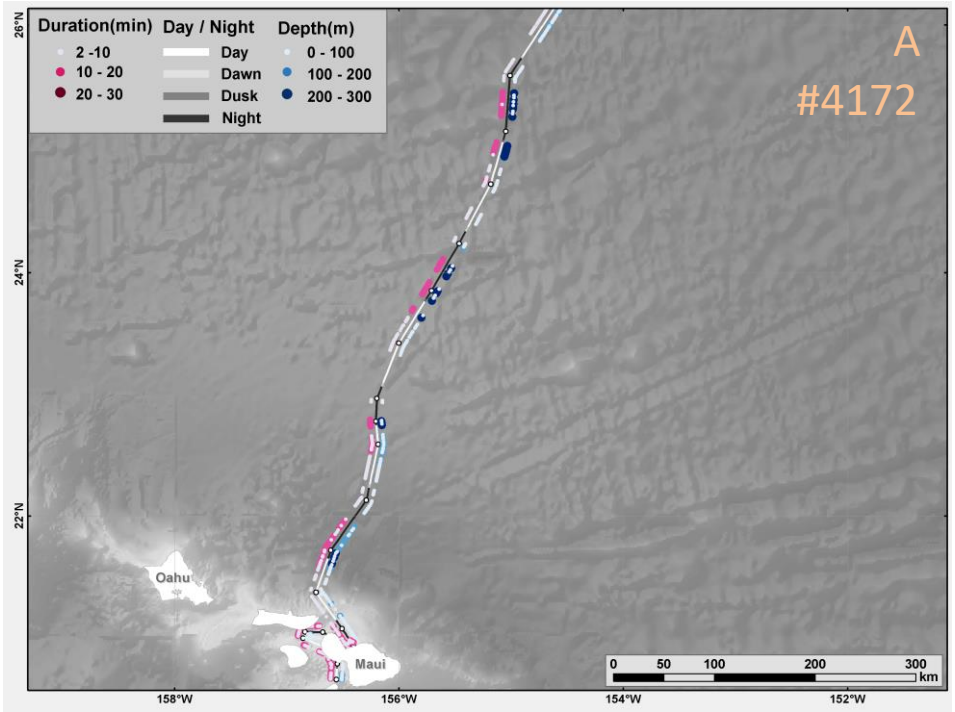
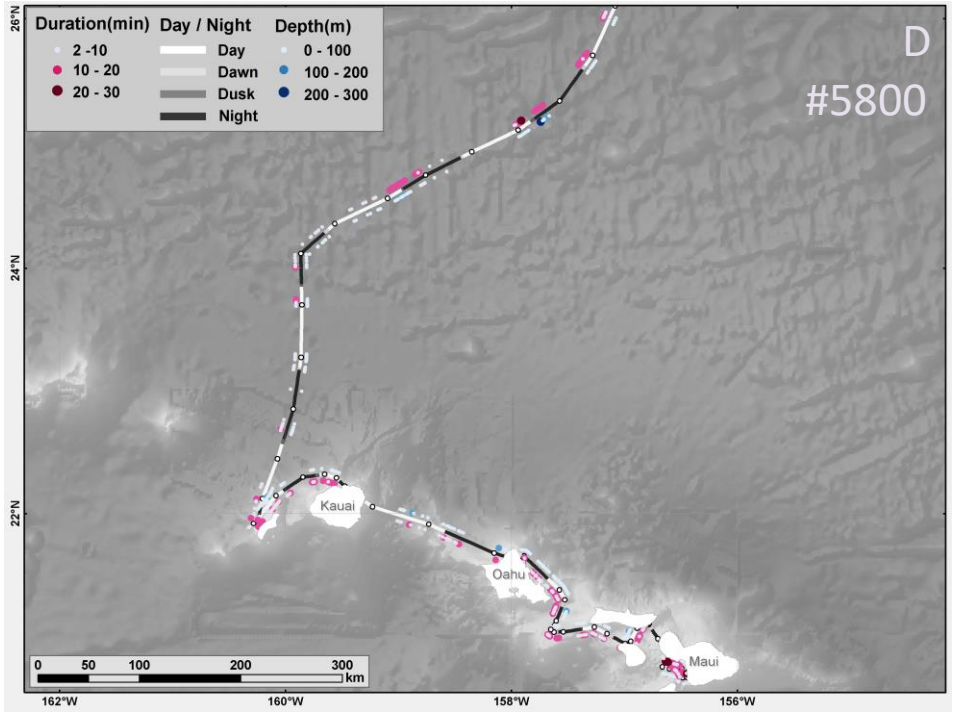


Dive behavior in the high seas

						Depth (m)		Dur (min)	
Tag	Seg	Start	End	# Days	# Dives	Mean	SD	Mean	SD
4172	A	2018-03-17	2018-03-27	10.0	788	50.7	61.5	7.0	3.9
	B	2018-03-27	2018-04-06	10.0	602	28.0	19.6	7.1	3.1
	C	2018-04-06	2018-04-15	9.4	303	33.8	25.6	5.9	2.3
	NBC	2018-04-16	2018-05-06	19.8	1,756	27.8	23.7	6.8	4.5
5800	D	2018-04-03	2018-04-13	10.0	214	39.6	51.7	11.3	4.5
	E	2018-04-13	2018-04-23	10.0	225	42.3	36.7	10.4	5.2
	F	2018-04-23	2018-05-03	10.0	251	24.4	17.0	6.7	3.6
	NBC	2018-05-08	2018-05-16	7.9	418	21.2	10.8	6.5	2.9

- Highly variable # dives between animals
- Deeper, longer diving at the start of migration?





	Depth (m)		Dur (min)	
# Dives	Mean	SD	Mean	SD
788	50.7	61.5	7.0	3.9

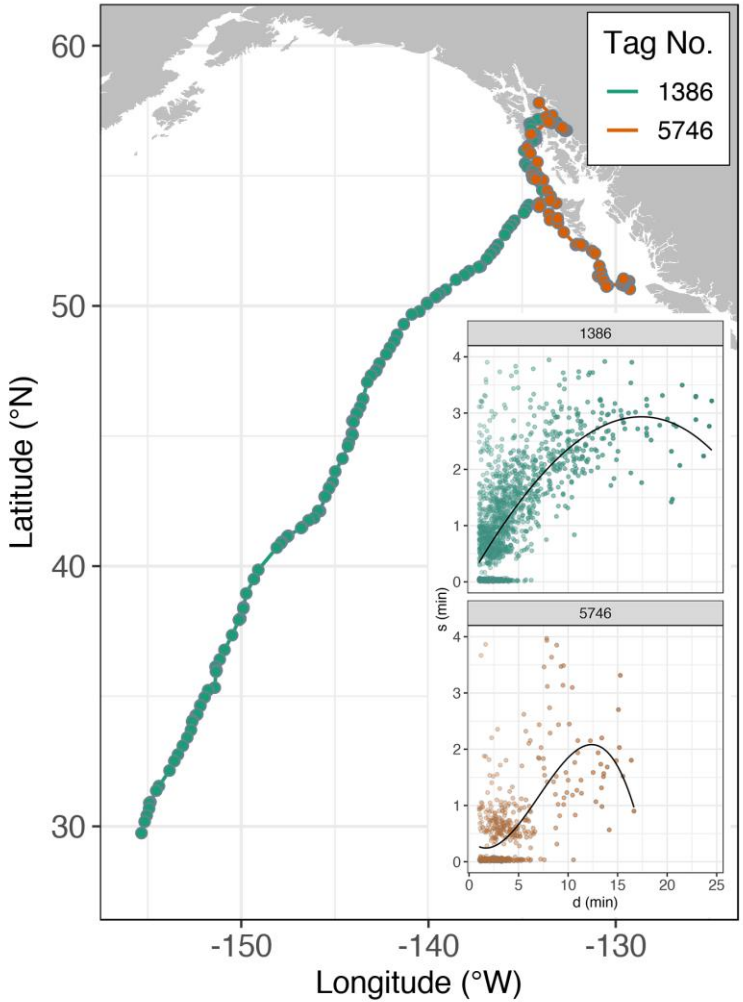
	Depth (m)		Dur (min)	
# Dives	Mean	SD	Mean	SD
214	39.6	51.7	11.3	4.5

Deep, long dives, especially at night

Diving physiology in the high seas

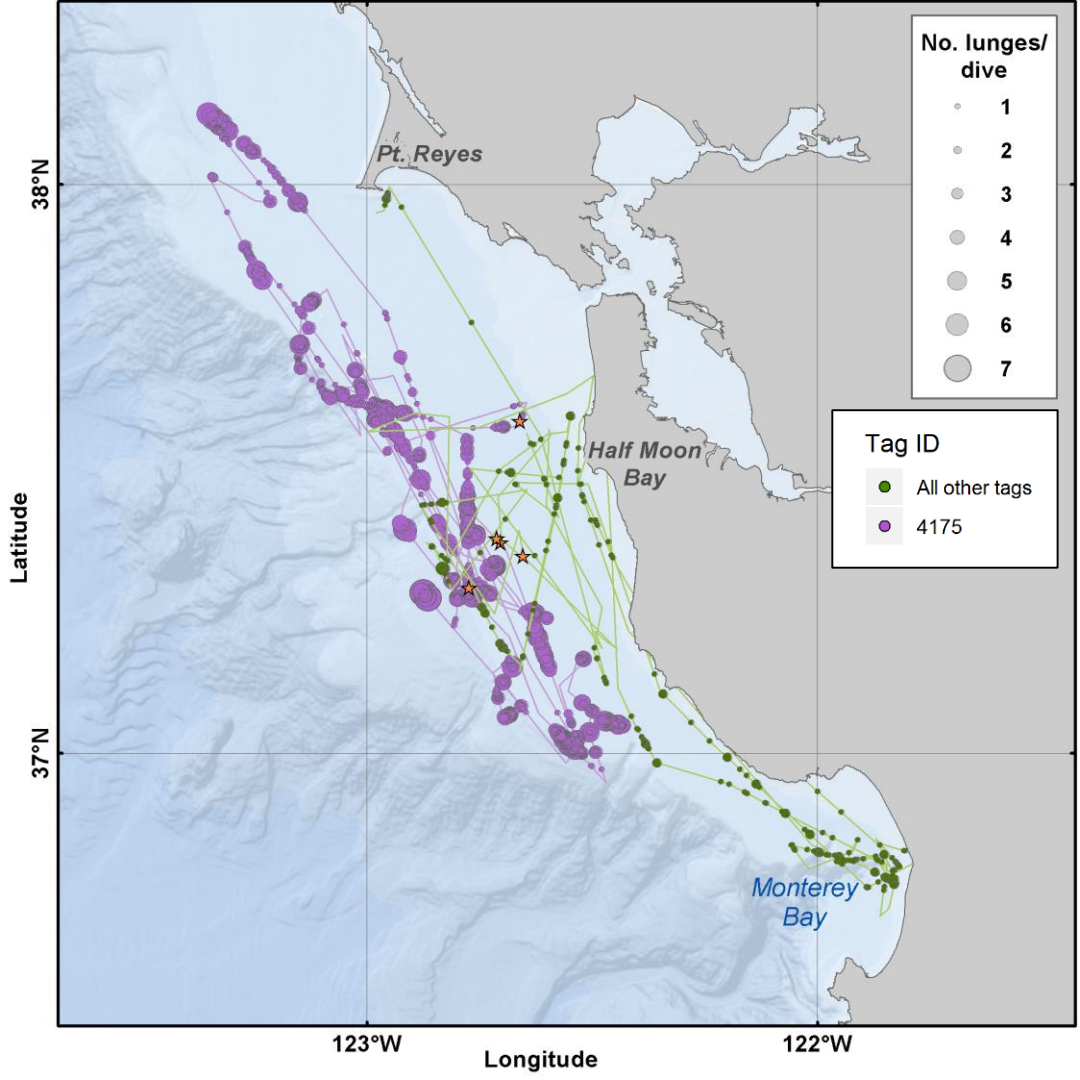
Derive values for:

- dive duration
- surface post-dive interval
- proportion of time underwater
- cumulative ratios over weeks/months



Monitoring feeding effort

- Tracks of five whales tagged off central California in 2017 recorded different behaviors
- One animal fed intensively over the outer continental shelf/slope (51 d)
- Four other tags recorded less feeding during movements over inner continental shelf (4-16 d)

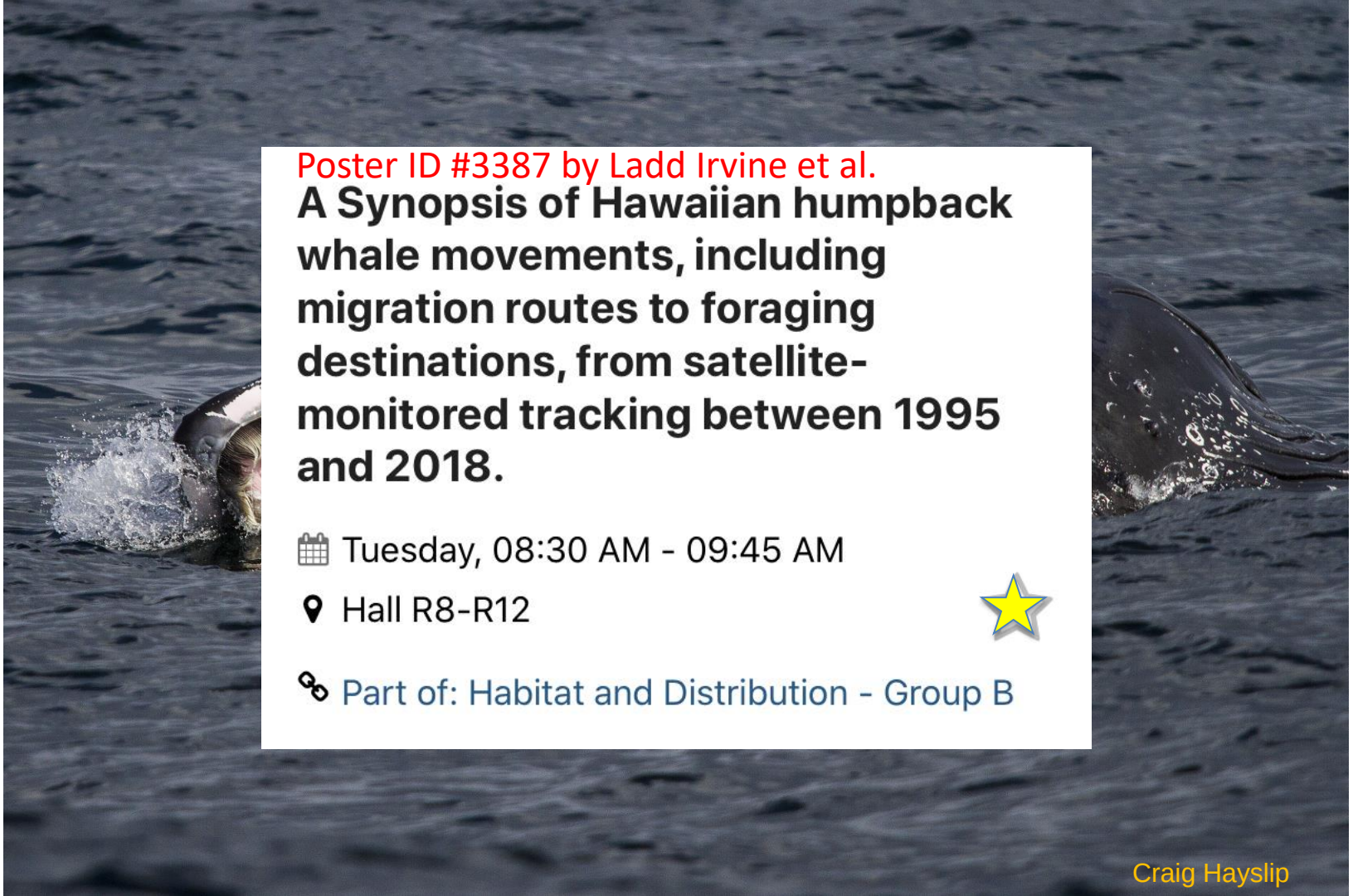


Monitoring feeding effort

Feeding on krill vs. fish?

Conclusions

- Dive-level metrics have been rarely reported, but contain key information
- SWS and pressure sensors have been present in previous whale tags, but data have been *mostly* summarized as binned summaries (6-h)
- Tri-axial accelerometer is new in whale tags
- Integration of dive-level metrics from these sensors opens new windows into long-term behavioral monitoring of large whales in the high seas


Poster ID #3387 by Ladd Irvine et al.
A Synopsis of Hawaiian humpback whale movements, including migration routes to foraging destinations, from satellite-monitored tracking between 1995 and 2018.
Tuesday, 08:30 AM - 09:45 AM
Hall R8-R12
Part of: Habitat and Distribution - Group B
Craig Hayslip

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