24th Biennial Conference on the Biology of Marine Mammals
Palm Beach, Florida • August 1-5, 2022

Scratching at the Surfacings:

Exploring Extended Surface Intervals in Cuvier's Beaked Whales

Erin A. Falcone[1], Gregory S. Schorr[1], David A. Sweeney[1], Brenda K. Rone[1], Stacy L. DeRuiter[2], Shannon N. Coates[1], Russel D. Andrews[1] , Stephanie L. Watwood[3]

1) Marine Ecology and Telemetry Research
2) Calvin University
3) Naval Undersea Warfare Center

Marine Ecology and Telemetry Research

Calvin University 1876

NAVSEA Warfare Centers Newport

Acknowledgements

Our Funding Agencies

- **US Navy, Living Marine Resources**
- **Office of Naval Research**
- **US Pacific Fleet**

Key Personnel

- **Marine Ecology & Telemetry Research**
  - Erin Keene
  - Alex Zerbini
- **Naval Undersea Warfare Center (M3R)**
  - Ron Morrissey
  - Susan Jarvis
  - Karin Dolan
  - Nancy DiMarzio
  - Dave Moretti
- **Calvin University Student Researchers**

Work conducted under NOAA research permits 20465 and 21163 and associated IACUCs

Supporting Organizations/Individuals

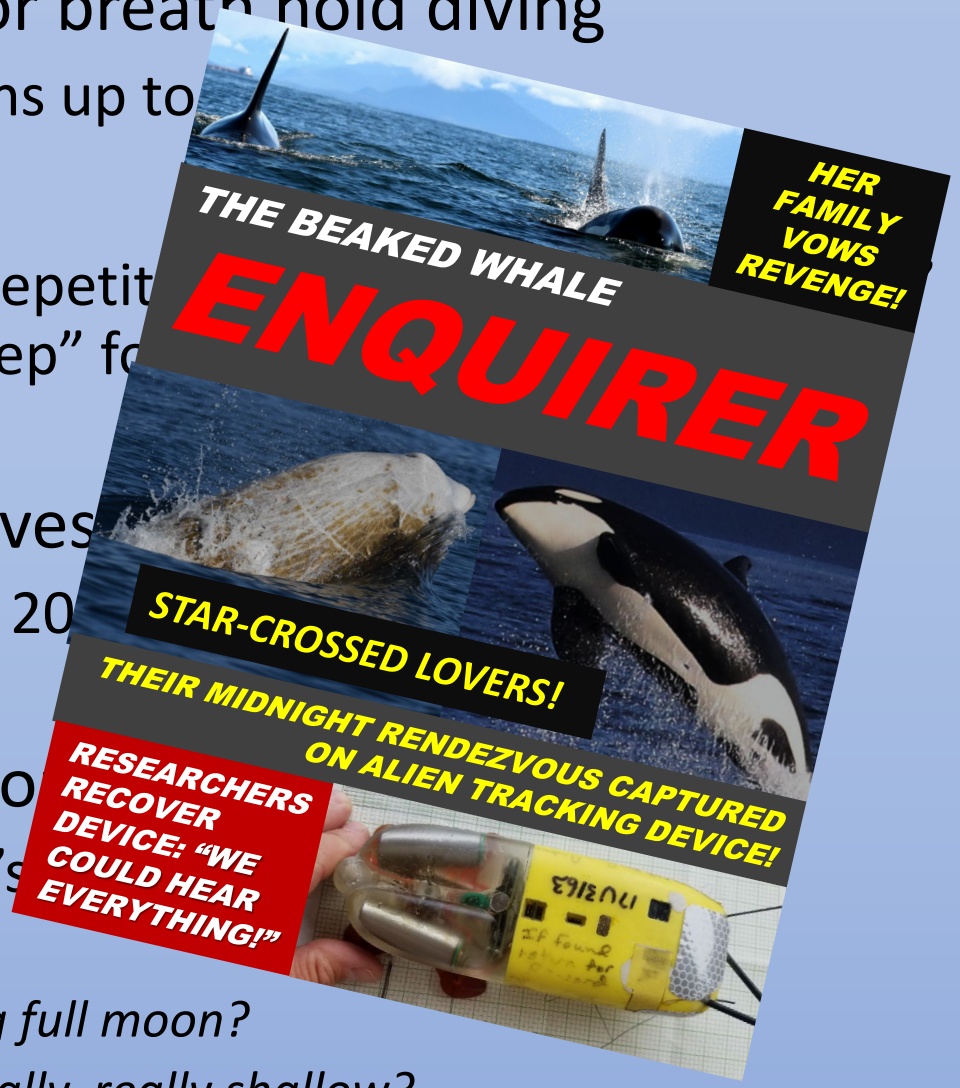
- **Southern California Offshore Range**
- **Wildlife Computers**
- **Frank and Jane Falcone**
- **Peg and Rob Roy**

Leveraged Projects

- **Pacific Fleet:**
  - Beaked whale demographics through photo-ID and biopsy.
- **ONR:**
  - SMRT tag development
- **Calvin University:**
  - Open source tag calibration and analysis tools

Cuvier's Beaked Whale: The Consummate Diver

- Cuvier's hold the depth and duration records for breath hold diving
  - Maximum recorded depths of 3,000 m and durations up to
- Stereotypic diving
  - 90% of their lives are spent below the surface in a repetit
    dives (20-30 min, 400+ m) separated by a "long, deep" fo
    m)
- Very little time at the surface between these dives
  - Whales satellite tagged in Southern California from 20
    minutes between dives (n = 13,710)
- … but very occasionally, they will go hours witho
  - This happened almost exclusively at night, but that's
    - *Were they sleeping?*
    - *Were they feeding on surface swarming squid under a big full moon?*
    - *Were they at the surface the whole time, or just diving really, really shallow?*



Tags (or, how we know anything at all about beaked whales)

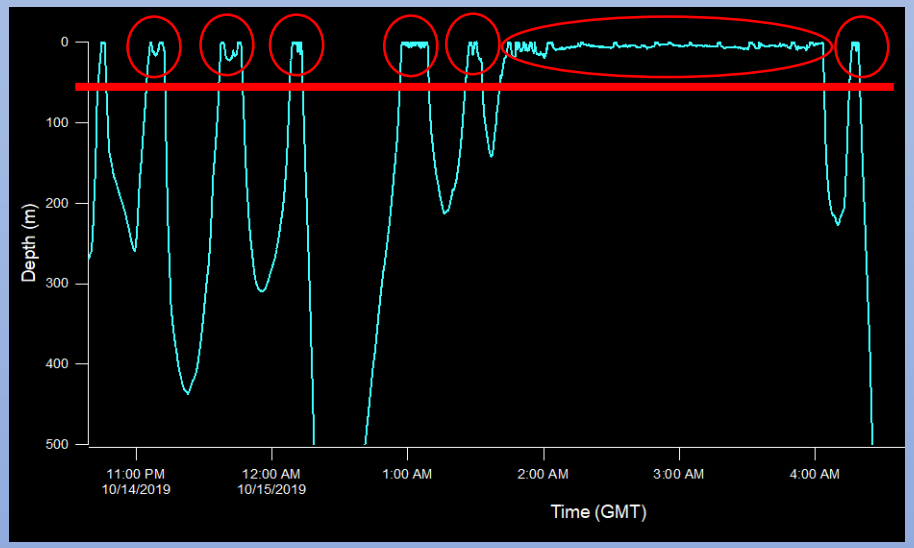
- High-resolution, longer-term tags with GPS location data provide insights into uncommon behaviors, like those extended surfacings

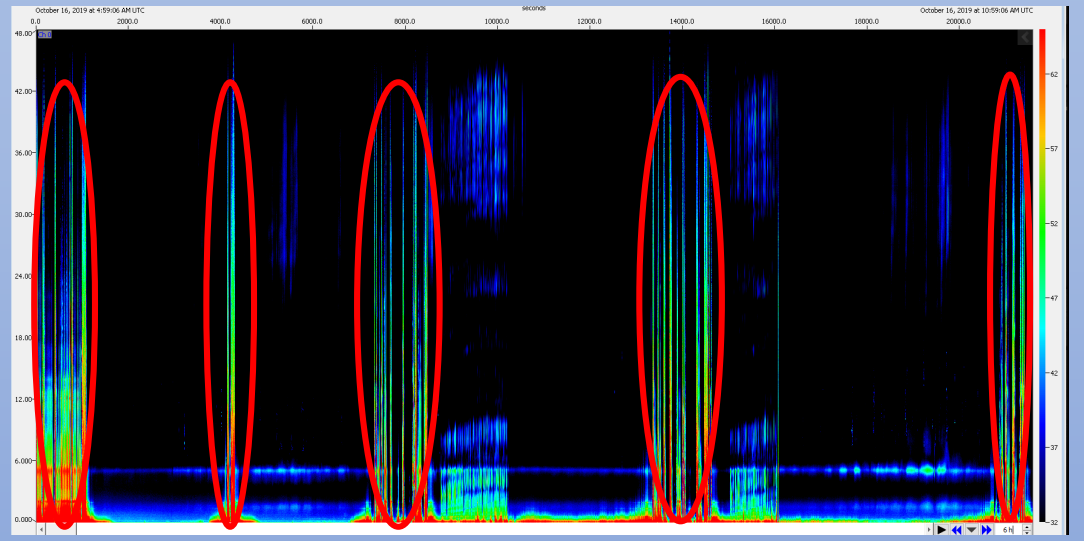
Telemetry Devices for Cuvier's Beaked Whales in Southern California

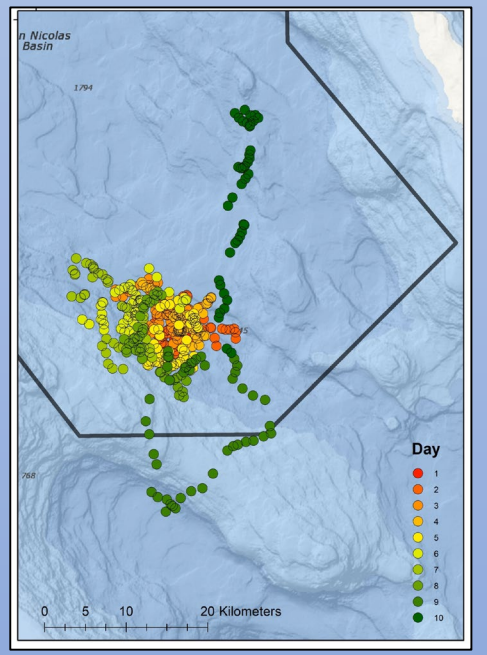
	 **Suction-cup Archival**	 **Dart-attached Satellite**	 **Dart-attached Satellite-Archival**
Commercial name	*DTAG*	Wildlife Computers *LIMPET*	Wildlife Computers *SMRT*
Primary Years	2010-2012	2010-2017	2018-present
Location Data	None	(Mostly) Low resolution (Argos)	High resolution (GPS)
Diving Data	High resolution	Low Resolution	High Resolution
Kinematic Data	High resolution	-	High Resolution
Acoustics	Stereo	-	Mono
Duration	Hours	Weeks to Months	Days to Weeks
Application	**Fine scale diving and foraging over short periods**	**Coarse scale diving and movements over long periods**	**Fine scale diving, foraging, and movements over long periods**

Summarizing high-resolution surfacing data

- Depth data from SMRT tags was classified into “dives” and the “surface intervals” using the same definitions as LIMPET tags from the region
  - Dives were any submergence to deeper than 50 m for longer than 30 sec
- The acoustic record from each tag was audited for the following:
  - **Respiratory bouts**: the timing and total number of breaths within each surface interval
  - Military sonar use: these whales change their behavior in response to sonar use so we excluded intervals when sonar was detected
- GPS data were used to assess horizontal displacement rates between, and sometimes within, surface intervals when available







Surface Intervals from five SMRT Tags in 2019

TagID	Total Tag Duration (hours)	Surface Intervals	Median Duration (minutes)	Max Duration (minutes)	Mean Resp. Rate (Resps per minute, RPM)	Mean Depth (meters)	Mean Disp. Rate (km/hr)	Max Disp. Rate (km/hr)
Zica-20190113-151361	9.2	18	1.9	21.6	6.8	1.9	1.4	2.8
Zica-20191012-144029	126.1	249	1.4	101.4	7.9	1.4	2.7	9.9
Zica-20191012-145101	121.4	287	1.7	139.1	7.3	2.0	2.2	9.1
Zica-20191111-94810	287.4*	512	1.9	114.6	6.9	1.2	2.1	10.0
Zica-20191117-195993	5.8	11	2.1	2.6	8.3	0.6	3.2	5.0

* Only 134.4 hours of acoustic data due to duty cycling

- The vast majority of trips to the surface were efficient gas exchange missions
  - Take 10-15 breaths, and get back to diving
  - Remain within 2 m of the surface from first to last breath
- However, all whales but one conducted at least one unusually long surface bout during the deployment

The top 5% of durations consisted of 34 surface intervals lasting 18 - 139 minutes

- All but two occurred at night
- Respirations were usually clustered into discrete bouts
- There was considerable variation in all metrics considered

Likely more than one underlying behavior state is occurring

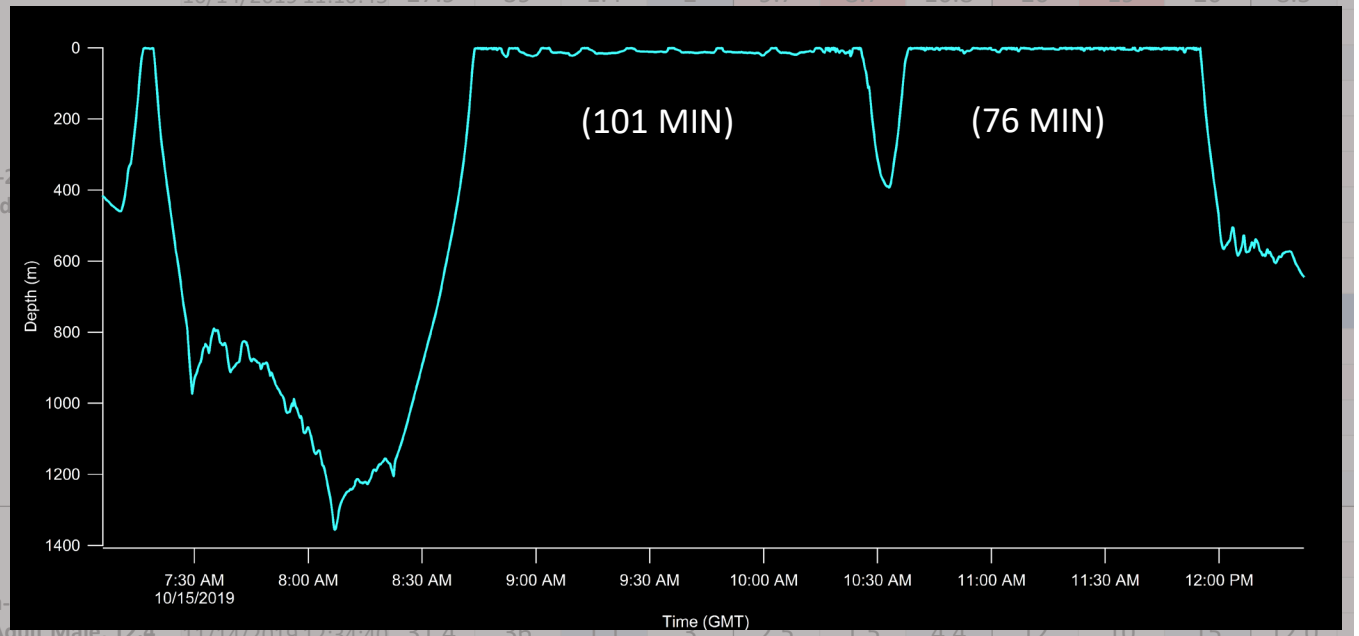
						Resp Bout Dur			Resps per Bout			Resp Bout Interval			RPM Bout				
TagID	Start Time	Dur	Resps	RPM	Bouts	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean Depth	Mean Disp
Zica-20190113-151361	1/14/2019 4:03:03	21.6	30	1.4	2	6.1	3.7	8.5	15	14	16	9.4	9.4	9.4	3.8	3.8	3.8	4.3	2.8
Zica-20191012-144029 (Subadult of unknown sex, no prior sighting history, 5.9 days)	10/13/2019 10:52:08	22.4	39	1.7	3	3.9	0.6	10.3	13	6	26	5.4	5.4	5.4	9.9	9.9	10.0	10.9	2.8
	10/14/2019 11:46:48	20.4	33	1.6	9	0.5	0.0	1.3	4	1	9	2.0	0.8	4.3	15.2	7.1	60.0	3.9	2.7
	10/15/2019 8:44:00	101.4	108	1.1	9	2.4	1.0	10.4	12	8	28	9.9	7.1	12.8	6.8	2.7	8.2	9.7	3.7
	10/15/2019 10:38:24	76.6	80	1.0	3	20.6	0.9	51.9	27	7	58	7.4	7.0	7.8	4.6	1.7	7.5	2.5	5.6
	10/16/2019 4:59:22	18.1	26	1.4	5	0.6	0.1	1.6	5	2	12	3.7	2.0	5.9	9.6	7.7	13.3	1.8	9.9
	10/16/2019 7:01:30	19.4	35	1.8	6	0.8	0.4	1.4	6	4	9	2.9	1.6	4.0	7.3	5.6	9.6	5.2	3.4
	10/17/2019 1:36:02	22.8	38	1.7	3	2.8	0.8	6.4	13	7	21	7.1	6.2	7.9	8.0	7.8	8.3	16.4	4.0
	10/17/2019 8:29:24	29.2	48	1.6	7	0.8	0.3	1.3	7	3	11	4.0	1.8	7.0	9.0	7.5	10.0	3.9	5.8
	10/17/2019 11:05:54	21.0	51	2.4	7	1.2	0.2	4.3	7	2	19	2.1	0.7	3.5	8.7	7.6	12.0	3.6	4.0
Zica-20191012-145101 (Adult Female with 2-year-old calf in attendance, 5-year sighting history, 6.9 days)	10/14/2019 4:25:53	30.2	30	1.0	3	1.0	0.9	1.2	10	9	11	13.6	12.7	14.4	10.0	9.5	10.5	19.0	2.4
	10/14/2019 7:26:57	28.8	46	1.6	2	5.5	1.9	9.0	23	18	28	17.9	17.9	17.9	9.4	9.4	9.4	12.1	1.9
	10/14/2019 11:10:45	27.9	39	1.4	2	9.7	8.7	10.8	20	19	20	8.5	8.5	8.5	1.8	1.8	1.8	10.8	
	10/14/2019 12:26:37	25.3	39	1.5	3	1.7	1.1	2.8	13	11	16	10.1	9.0	11.1	9.6	9.3	9.8	9.9	1.2
	10/15/2019 1:44:13	139.1	116	0.8	11	2.2	0.2	6.7	11	3	17	11.5	6.8	17.1	8.5	2.5	13.5	4.9	4.6
	10/15/2019 6:58:15	18.0	37	2.1	2	4.5	0.9	8.0	19	9	28	9.1	9.1	9.1	9.7	9.7	9.7	11.9	1.8
	10/15/2019 8:26:07	86.4	88	1.0	6	3.7	1.0	16.3	15	10	30	12.8	10.7	16.2	8.0	1.8	10.1	8.3	4.0
	10/15/2019 10:11:57	30.8	46	1.5	3	2.1	1.5	3.0	15	13	17	12.2	12.0	12.5	9.0	9.0	9.0	7.4	2.7
	10/15/2019 12:03:55	54.9	69	1.3	5	1.7	1.2	3.2	14	11	20	11.6	8.2	15.8	9.3	9.0	9.5	8.1	3.4
	10/15/2019 18:59:41	31.8	39	1.2	3	1.4	1.2	1.5	13	11	15	13.8	11.6	16.0	9.4	9.0	9.8	19.0	1.6
	10/15/2019 21:34:57	21.2	37	1.7	2	5.1	1.4	8.7	19	11	26	11.1	11.1	11.1	3.0	3.0	3.0	8.7	
	10/16/2019 1:56:31	20.3	39	1.9	6	0.7	0.1	1.5	7	2	13	3.2	1.2	6.7	10.6	8.6	15.0	2.2	7.1
	10/16/2019 3:13:47	20.7	22	1.1	2	4.2	1.3	7.2	11	10	12	12.3	12.3	12.3	1.7	1.7	1.7	5.5	3.6
	10/16/2019 8:13:33	24.8	36	1.4	2	4.5	1.1	7.9	18	11	25	15.8	15.8	15.8	9.8	9.8	9.8	16.5	4.1
	10/17/2019 2:21:45	32.2	53	1.6	3	4.2	1.5	9.6	18	12	28	9.8	7.9	11.7	8.3	8.2	8.3	5.0	3.5
	10/17/2019 8:35:09	20.4	36	1.8	2	5.9	5.4	6.5	18	16	20	8.5	8.5	8.5	2.5	2.5	2.5	8.0	0.0
	10/17/2019 10:45:35	101.3	122	1.2	5	13.1	2.4	29.6	24	12	54	9.0	6.3	12.1	2.9	1.1	5.1	3.6	8.4
Zica-20191111-94810 (Adult Male, 17-year sighting history, 5.6 days)	11/13/2019 11:27:20	20.2	24	1.2	2	4.5	1.7	7.2	12	11	13	11.2	11.2	11.2	6.5	6.5	6.5	17.0	
	11/14/2019 6:17:02	19.1	29	1.5	2	2.8	1.5	4.1	15	12	17	13.6	13.6	13.6	8.1	8.1	8.1	21.1	0.7
	11/14/2019 9:11:25	32.7	31	0.9	3	2.0	1.1	3.6	10	9	11	13.4	10.7	16.0	8.1	8.0	8.2	21.4	
	11/14/2019 12:34:40	31.4	36	1.1	3	2.5	1.5	4.4	12	10	15	12.0	11.2	12.7	6.7	6.6	6.7	17.7	0.7
	11/15/2019 1:14:36	23.0	32	1.4	3	2.1	0.9	3.8	11	8	14	8.4	8.1	8.8	7.6	6.5	8.7	9.6	1.8
	11/15/2019 10:17:04	29.8	29	1.0	3	2.0	1.3	3.5	10	9	10	11.8	10.6	13.1	7.2	6.7	7.8	19.2	
	11/16/2019 7:30:28	19.1	28	1.5	2	2.7	1.8	3.7	14	14	14	13.7	13.7	13.7	8.0	8.0	8.0	16.8	2.0
Mean of upper 5% of Duration		36.5	47	1.4	4	3.8	1.5	7.7	13	9	20	9.7	8.6	11.0	7.6	6.4	9.9	10.2	3.5
Mean of lower 95% of Duration		2.4	14	7.7	1	2.4	2.4	2.4	14	14	14	44.9	44.7	45.0	7.7	7.7	7.7	1.3	2.3

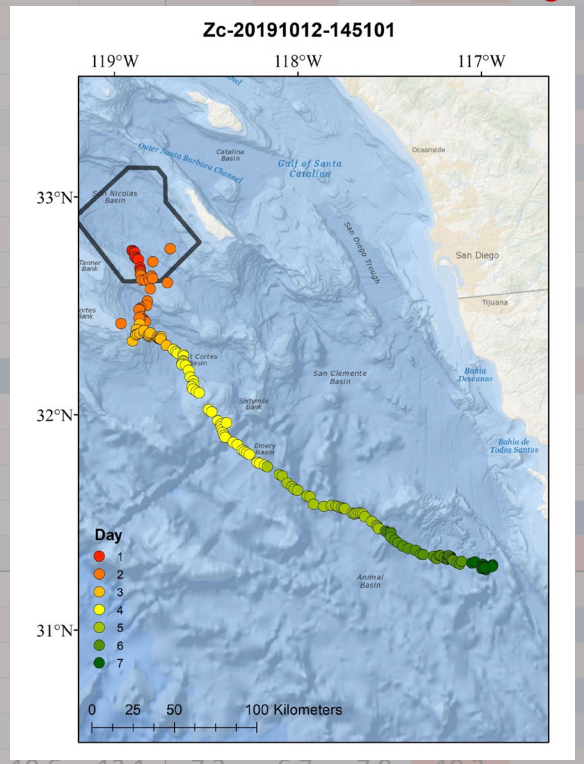
Individual variation in long surface intervals

- This whale tended to conduct frequent, brief respiratory bouts
- Its respiratory rate during these bouts was often elevated
- Typically remained within 10 m of the surface
- Displaced at higher than average rates

THE TRAVELER (*LA VIAJERA*)

						Resp Bout Dur			Resps per Bout			Resp Bout Interval			RPM Bout				
TagID	Start Time	Dur	Resps	RPM	Bouts	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean Depth	Mean Disp
Zica-20190113-151361	1/14/2019 4:03:03	21.6	30	1.4	2	6.1	3.7	8.5	15	14	16	9.4	9.4	9.4	3.8	3.8	3.8	4.3	2.8
Zica-20191012-144029 (Subadult of unknown sex, no prior sighting history, 5.9 days)	10/13/2019 10:52:08	22.4	39	1.7	3	3.9	0.6	10.3	13	6	26	5.4	5.4	5.4	9.9	9.9	10.0	10.9	2.8
	10/14/2019 11:46:48	20.4	33	1.6	9	0.5	0.0	1.3	4	1	9	2.0	0.8	4.3	15.2	7.1	60.0	3.9	2.7
	10/15/2019 8:44:00	101.4	108	1.1	9	2.4	1.0	10.4	12	8	28	9.9	7.1	12.8	6.8	2.7	8.2	9.7	3.7
	10/15/2019 10:38:24	76.6	80	1.0	3	20.6	0.9	51.9	27	7	58	7.4	7.0	7.8	4.6	1.7	7.5	2.5	5.6
	10/16/2019 4:59:22	18.1	26	1.4	5	0.6	0.1	1.6	5	2	12	3.7	2.0	5.9	9.6	7.7	13.3	1.8	9.9
	10/16/2019 7:01:30	19.4	35	1.8	6	0.8	0.4	1.4	6	4	9	2.9	1.6	4.0	7.3	5.6	9.6	5.2	3.4
	10/17/2019 1:36:02	22.8	38	1.7	3	2.8	0.8	6.4	13	7	21	7.1	6.2	7.9	8.0	7.8	8.3	16.4	4.0
	10/17/2019 8:29:24	29.2	48	1.6	7	0.8	0.3	1.3	7	3	11	4.0	1.8	7.0	9.0	7.5	10.0	3.9	5.8
	10/17/2019 11:05:54	21.0	51	2.4	7	1.2	0.2	4.3	7	2	19	2.1	0.7	3.5	8.7	7.6	12.0	3.6	4.0
	10/14/2019 4:25:53	30.2	30	1.0	3	1.0	0.9	1.2	10	9	11	13.6	12.7	14.4	10.0	9.5	10.5	1.0	0.0
	10/14/2019 7:26:57	28.8	46	1.6	2	5.5	1.9	9.0	23	18	28	17.9							
	10/14/2019 11:10:45	27.9	39	1.4	2	9.7	8.7	10.8	20	19	20	8.5							
Zica-(Adult Male, 12.4 days)	11/14/2019 12:34:40	31.4	36	1.1	3	2.5	1.5	4.4	12	10	15	12.0							
	11/15/2019 1:14:36	23.0	32	1.4	3	2.1	0.9	3.8	11	8	14	8.4							
	11/15/2019 10:17:04	29.8	29	1.0	3	2.0	1.3	3.5	10	9	10	11.8	10.6	13.1	7.2	6.7	7.8	19.2	
	11/16/2019 7:30:28	19.1	28	1.5	2	2.7	1.8	3.7	14	14	14	13.7	13.7	13.7	8.0	8.0	8.0	16.8	2.0
Mean of upper 5% of Duration		36.5	47	1.4	4	3.8	1.5	7.7	13	9	20	9.7	8.6	11.0	7.6	6.4	9.9	10.2	3.5
Mean of lower 95% of Duration		2.4	14	7.7	1	2.4	2.4	2.4	14	14	14	44.9	44.7	45.0	7.7	7.7	7.7	1.3	2.3





Individual variation in long surface intervals

- Fewer long intervals and fewer respiratory bouts per interval
  - These bouts were similar to typical surface intervals
- Deeper depths between respiratory bouts and slower displacement than other long intervals

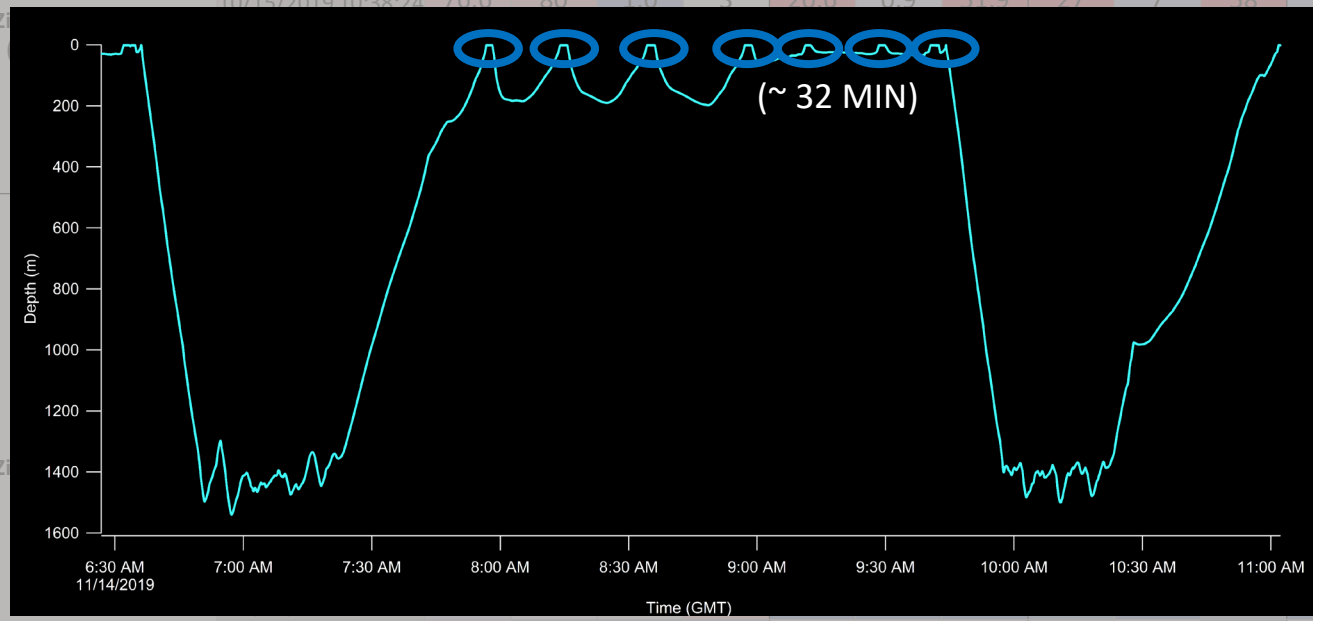
THE SLACKER?

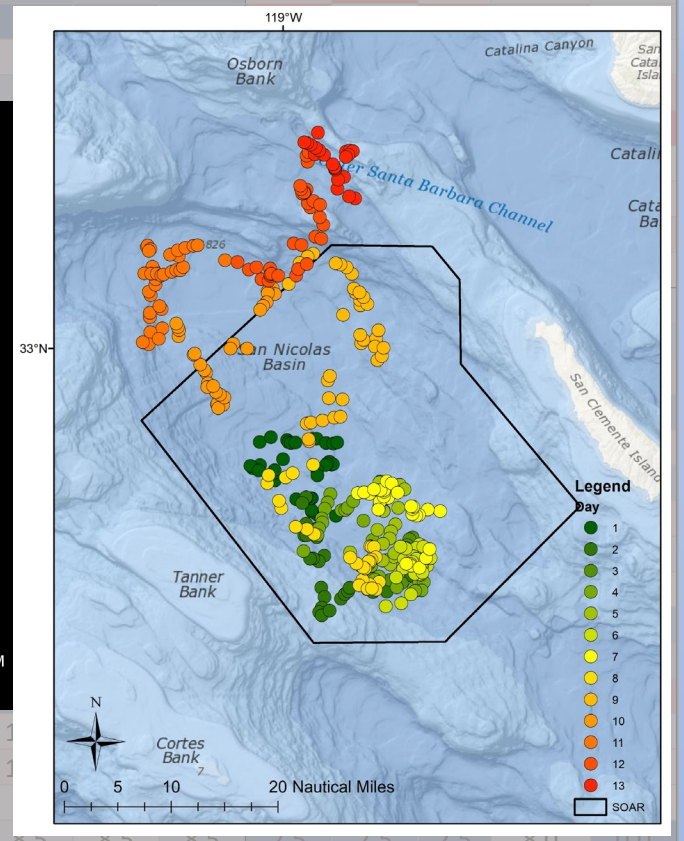
Why dive to 200 m when you can just dive to 20?

OR, PERHAPS,

THE SOCIAL BUTTERFLY?

All these intervals coincide with a period of changing social affiliations





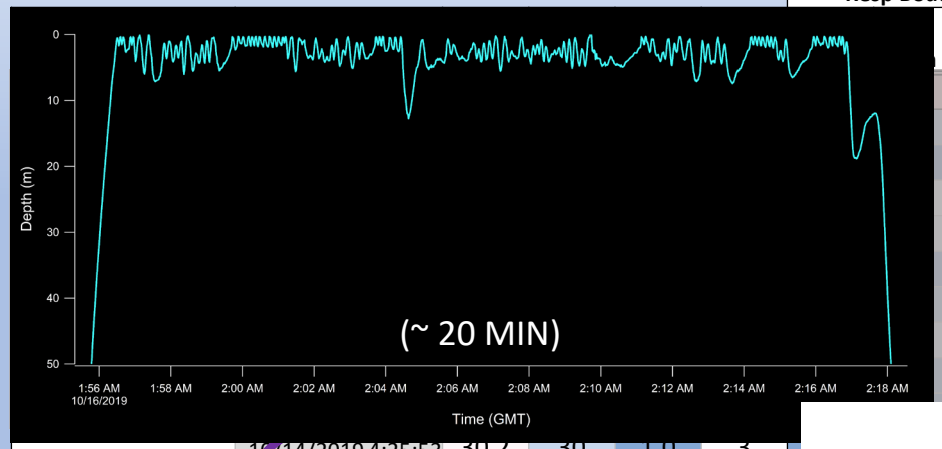
TagID	Start Time	Dur	Resps	RPM	Bouts	Resp Bout Dur Mean	Resp Bout Dur Min	Resp Bout Dur Max	Resps per Bout Mean	Resps per Bout Min	Resps per Bout Max	Resp Bout Interval Mean	Resp Bout Interval Min	Resp Bout Interval Max	RPM Bout Mean	RPM Bout Min	RPM Bout Max	Mean Depth	Mean Disp
Zica-20190113-151361	1/14/2019 4:03:03	21.6	30	1.4	2	6.1	3.7	8.5	15	14	16	9.4	9.4	9.4	3.8	3.8	3.8	4.3	2.8
	10/13/2019 10:52:08	22.4	39	1.7	3	3.9	0.6	10.3	13	6	26	5.4	5.4	5.4	9.9	9.9	10.0	10.9	2.8
	10/14/2019 11:46:48	20.4	33	1.6	9	0.5	0.0	1.3	4	1	9								
	10/15/2019 8:44:00	101.4	108	1.1	9	2.4	1.0	10.4	12	8	28								
	10/15/2019 10:38:24	76.6	80	1.0	3	20.6	0.9	51.9	27	7	58								
	10/16/2019 3:13:47	20.7	22	1.1	2	4.2	1.3	7.2	11	10	12								
	10/16/2019 8:13:33	24.8	36	1.4	2	4.5	1.1	7.9	18	11	25								
	10/17/2019 2:21:45	32.2	53	1.6	3	4.2	1.5	9.6	18	12	28								
	10/17/2019 8:35:09	20.4	36	1.8	2	5.9	5.4	6.5	18	16	20								
	10/17/2019 10:45:35	101.3	122	1.2	5	13.1	2.4	29.6	22	12	54	9.0	6.3	12.1	2.9	1.1	5.1	3.6	8.4
Zica-20191111-94810 (Adult Male, 17-year sighting history, 5.6 days)	11/13/2019 11:27:20	20.2	24	1.2	2	4.5	1.7	7.2	12	11	13	11.2	11.2	11.2	6.5	6.5	6.5	17.0	
	11/14/2019 6:17:02	19.1	29	1.5	2	2.8	1.5	4.1	15	12	17	13.6	13.6	13.6	8.1	8.1	8.1	21.1	0.7
	11/14/2019 9:11:26	32.7	31	0.9	3	2.0	1.1	3.6	10	9	11	13.4	10.7	16.0	8.1	8.0	8.2	21.4	
	11/14/2019 12:34:40	31.4	36	1.1	3	2.5	1.5	4.4	12	10	15	12.0	11.2	12.7	6.7	6.6	6.7	17.7	0.7
	11/15/2019 1:14:36	23.0	32	1.4	3	2.1	0.9	3.8	11	8	14	8.4	8.1	8.8	7.6	6.5	8.7	9.6	1.8
	11/15/2019 10:17:04	29.8	29	1.0	3	2.0	1.3	3.5	10	9	10	11.8	10.6	13.1	7.2	6.7	7.8	19.2	
	11/16/2019 7:30:28	19.1	28	1.5	2	2.7	1.8	3.7	14	14	14	13.7	13.7	13.7	8.0	8.0	8.0	16.8	2.0
Mean of upper 5% of Duration		36.5	47	1.4	4	3.8	1.5	7.7	13	9	20	9.7	8.6	11.0	7.6	6.4	9.9	10.2	3.5
Mean of lower 95% of Duration		2.4	14	7.7	1	2.4	2.4	2.4	14	14	14	44.9	44.7	45.0	7.7	7.7	7.7	1.3	2.3

Individual variation in long surface intervals

- Frequent long intervals, up to seven in 24 hrs, including two during daylight hours
- Respiratory behavior was highly variable among intervals

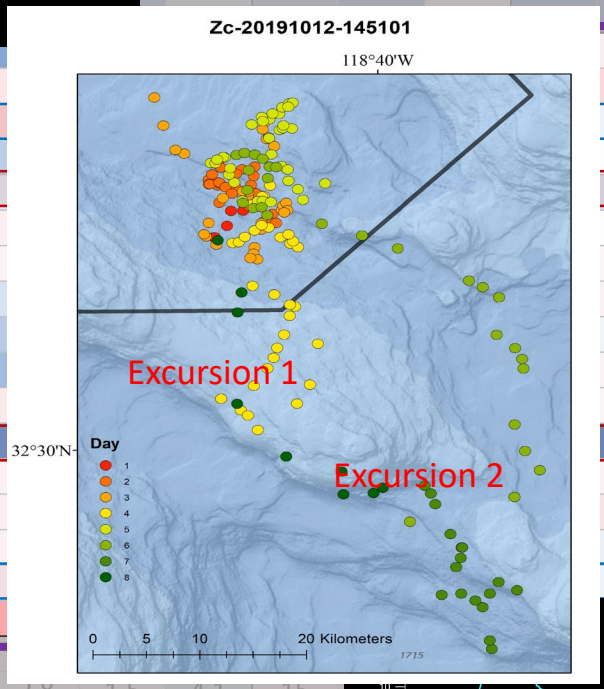
THE SUPERFICIAL TYPE?

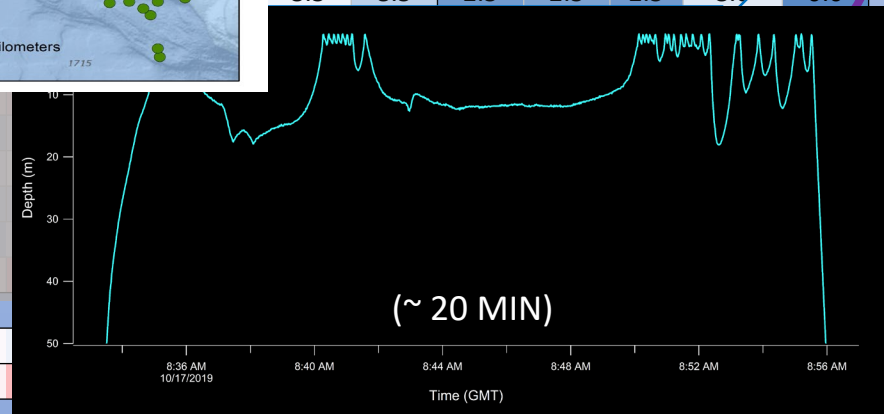
But of course, this behavior may be more common in mothers with calves



		Resp Bout Dur			Resps per Bout			Resp Bout Interval			RPM Bout			Mean Depth	Mean Disp
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max		
	10/14/2019 4:25:53	30.2	30	1.0	3										
	10/14/2019 7:26:57	28.8	46	1.6	2										
Surface Rest?	10/14/2019 11:10:45	27.9	39	1.4	2										
	10/14/2019 12:26:37	25.3	39	1.5	3										
Surface Travel?	10/15/2019 1:44:13	139.1	116	0.8	11										
	10/15/2019 6:58:15	18.0	37	2.1	2										
Zica-20191012-145101 (Adult Female with 2-year-old calf in attendance, 5-year sighting history, 6.9 days)	10/15/2019 8:26:07	86.4	88	1.0	6										
	10/15/2019 10:11:57	30.8	46	1.5	3										
	10/15/2019 12:03:55	54.9	69	1.3	5										
	10/15/2019 18:59:41	31.8	39	1.2	3										
	10/15/2019 21:34:57	21.2	37	1.7	2										
Surface Travel?	10/16/2019 1:56:31	20.3	39	1.9	6										
	10/16/2019 3:13:47	20.7	22	1.1	2										
	10/16/2019 8:13:33	24.8	36	1.4	2										
	10/17/2019 2:21:45	32.2	53	1.6	3										
Surface Rest?	10/17/2019 8:35:09	20.4	36	1.8	2										
	10/17/2019 10:45:35	101.3	122	1.2	5										
	11/13/2019 11:27:20	20.2	24	1.2	2										
	11/14/2019 6:17:02	19.1	29	1.5	2	2.8	1.5	4.1	15						
Zica-20191111-94810 (Adult Male, 12.4 days)	11/14/2019 9:11:26	32.7	31	0.9	3	2.0	1.1	3.6	10						
	11/14/2019 12:34:40	31.4	36	1.1	3	2.5	1.5	4.4	12						
	11/15/2019 1:14:36	23.0	32	1.4	3	2.1	0.9	3.8	11						
	11/15/2019 10:17:04	29.8	29	1.0	3	2.0	1.3	3.5	10						
	11/16/2019 7:30:28	19.1	28	1.5	2	2.7	1.8	3.7	14						
Mean of upper 5% of Duration		36.5	47	1.4	4	3.8	1.5	7.7	13						
Mean of lower 95% of Duration		2.4	14	7.7	1	2.4	2.4	2.4	14						

	12.7	14.4	10.0	9.5	10.5	19.0	2.4								
	17.9	17.9	9.4	9.4	9.4	12.1	1.9								
	8.5	8.5	1.8	1.8	1.8	10.8									
	9.0	11.1	9.6	9.3	9.8	9.9	1.2								
	6.8	17.1	8.5	2.5	13.5	4.9	4.6								
	9.1	9.1	9.7	9.7	9.7	11.9	1.8								
	10.7	16.2	8.0	1.8	10.1	8.3	4.0								
	12.0	12.5	9.0	9.0	9.0	7.4	2.7								
	8.2	15.8	9.3	9.0	9.5	8.1	3.4								
	11.6	16.0	9.4	9.0	9.8	19.0	1.6								
	11.1	11.1	3.0	3.0	3.0	8.7									
	1.2	6.7	10.6	8.6	15.0	2.2	7.1								
	12.3	12.3	1.7	1.7	1.7	5.5	3.6								
	15.8	15.8	9.8	9.8	9.8	16.5	4.1								
	7.9	11.7	8.3	8.2	8.3	5.0	3.5								
	8.5	8.5	2.5	2.5	2.5	8.0	0.0								

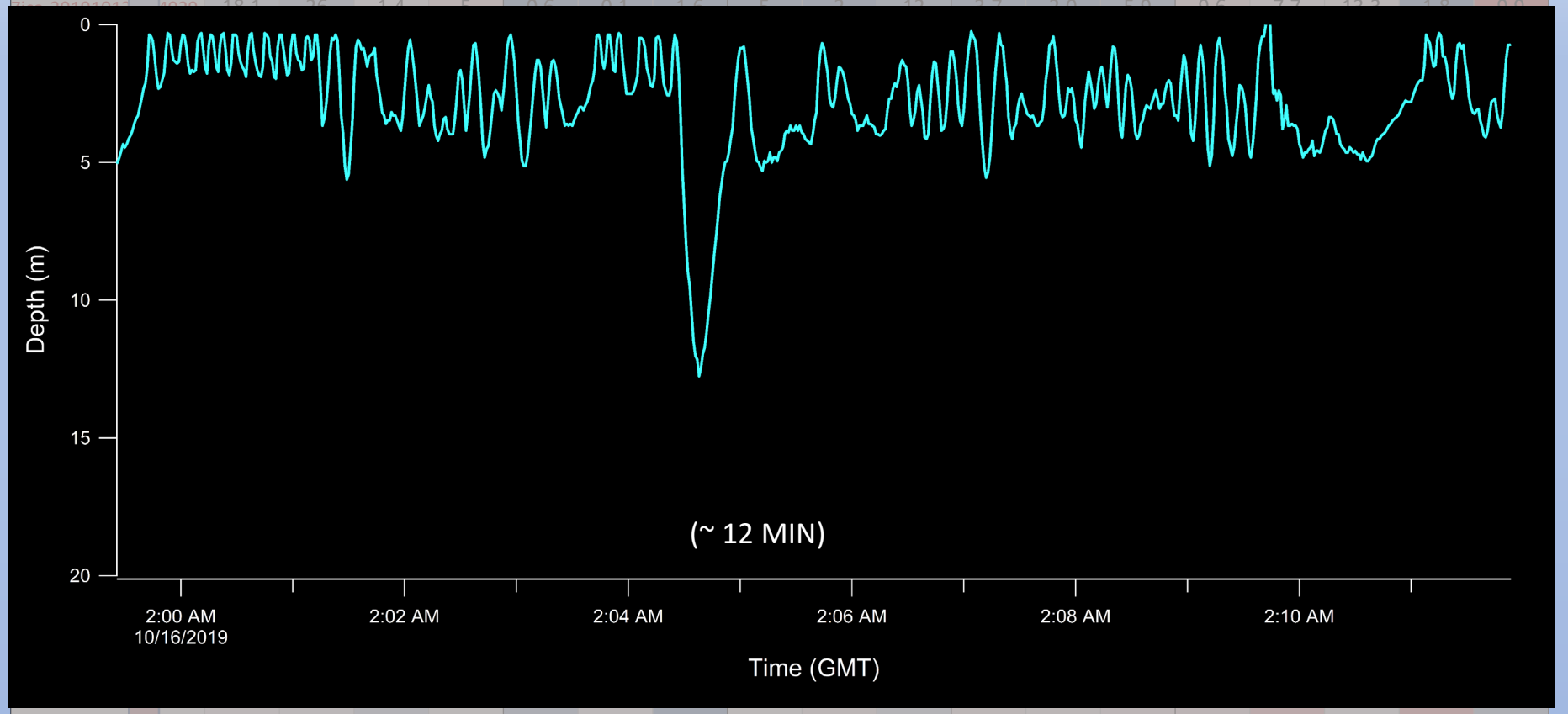




The longest intervals were associated with shallow depths and elevated displacement rates

- Respiratory bouts were often highly variable, even within an interval, but included some of the lowest overall respiratory rates
- These rates occurred during long respiratory bouts where whales remained above 10 m depth, breathing every 20-40 sec.

Efficient, near-surface traveling



TagID	Dur	Resps	RPM	Bouts	Resp Bout Dur Mean	Resp Bout Dur Min	Resp Bout Dur Max	Resps per Bout Mean	Resps per Bout Min	Resps per Bout Max	Resp Bout Interval Mean	Resp Bout Interval Min	Resp Bout Interval Max	RPM Bout Mean	RPM Bout Min	RPM Bout Max	Mean Depth	Mean Disp
Zica-20191012-145101	18.0	37	2.1	2	4.5	0.9	8.0	19	9	28	9.1	9.1	9.1	9.7	9.7	9.7	11.9	1.8
Zica-20191012-145101	31.8	39	1.2	3	1.4	1.2	1.5	13	11	15	13.8	11.6	16.0	9.4	9.0	9.8	19.0	1.6
Zica-20191012-145101	32.2	53	1.6	3	4.2	1.5	9.6	18	12	28	9.8	7.9	11.7	8.3	8.2	8.3	5.0	3.5
Zica-20191111-[illegible]810	32.7	31	0.9	3	2.0	1.1	3.6	10	9	11	13.4	10.7	16.0	8.1	8.0	8.2	21.4	
Zica-20191012-145101	54.9	69	1.3	5	1.7	1.2	3.2	14	11	20	11.6	8.2	15.8	9.3	9.0	9.5	8.1	3.4
Zica-20191012-144029	76.6	80	1.0	3	20.6	0.9	51.9	27	7	58	7.4	7.0	7.8	4.6	1.7	7.5	2.5	5.6
Zica-20191012-145101	86.4	88	1.0	6	3.7	1.0	16.3	15	10	30	12.8	10.7	16.2	8.0	1.8	10.1	8.3	4.0
Zica-20191012-145101	101.3	122	1.2	5	13.1	2.4	29.6	24	12	54	9.0	6.3	12.1	2.9	1.1	5.1	3.6	8.4
Zica-20191012-144029	101.4	108	1.1	9	2.4	1.0	10.4	12	8	28	9.9	7.1	12.8	6.8	2.7	8.2	9.7	3.7
Zica-20191012-145101	139.1	116	0.8	11	2.2	0.2	6.7	11	3	17	11.5	6.8	17.1	8.5	2.5	13.5	4.9	4.6
Mean of upper 5%	36.5	47	1.4	4	3.8	1.5	7.7	13	9	20	9.7	8.6	11.0	7.6	6.4	9.9	10.2	3.5
Mean of lower 95%	2.4	14	7.7	1	2.4	2.4	2.4	14	14	14	44.9	44.7	45.0	7.7	7.7	7.7	1.3	2.3

In conclusion

- Occasional prolonged surface intervals occur almost exclusively at night, and appear to support a variety of underlying behavior states
  - There was no evidence of foraging (or killer whales) at or near the surface
- The longest surface intervals appear to be associated with near-surface traveling
  - Whales may use these intervals to efficiently relocate without investing time and energy in vertical displacement at times when risk from visual predators is lower
- Nine more SMRT tags have been deployed in 2021-2022
  - Larger sample size will support quantitative analyses of surface behaviors
  - These fine-scale movement, diving, and respiratory records will used to better understand physiology in this difficult to study species

Related Presentations

- Coates et al. "**Insights into Foraging Behavior from Multi-day Sound Recording Tag Deployments on Cuvier's Beaked Whales (Ziphius cavirostris) in the Southern California Bight"**
  Conference Speed Talk –
  Behavior I (F3), Wednesday, 13:30 – 15:30

- Keene et al. "**Re-sighting Histories of Dart- Attached Tags in Cuvier's Beaked Whales (*Ziphius cavirostris*) and Fin Whales (*Balaenoptera physalus*) in the Eastern Pacific Ocean**"
  Conference Speed Talk –
  Ecology - Abundance, Distribution, Occurrence- oh my! (B1), Monday, 13:30 – 15:30

- Schorr et al. "**Context Matters: Multi-day to Multi-week Sound and Movement Tag Recordings Reveal Individual Variation in Responses of Cuvier's Beaked Whales to Navy Sonar**"
  Conference Presentation – Room 2ABC
  Behavior – Human Impacts II (D3), Tuesday, 17:00 – 17:15

- Sweeney et al. "**Cuvier's Beaked Whale Behavioral Responses Persist After Conclusion of Some Navy Sonar Exposures"**
  Conference Poster – Exhibit Hall
  Behavior Group A, Tuesday, 10:30 - 12:00

- Watwood et al. "**Probability of detection of beaked whale clicks on a distributed bottom-mounted hydrophone array based on data from acoustic recording animal-borne tags**"