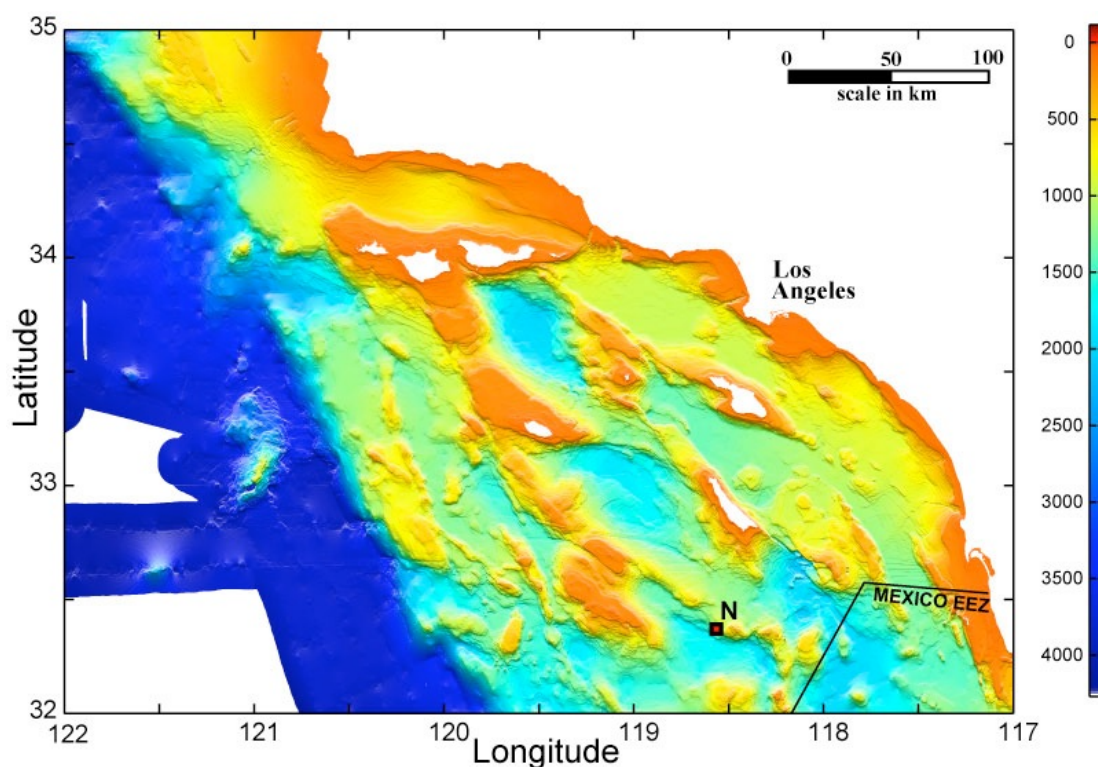


**Marine Physical
Laboratory**

of the Scripps Institution
of Oceanography
University of California,
San Diego



**High Frequency Acoustic Recording Package
Annual Data Summary Report
March 14, 2009 – March 26, 2010
SOCAL Site N**



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Contract Numbers: FISC N00244-08-1-0028 and FISC N00244-10-C-0021
Project Title: Southern California Marine Mammal Studies
Location: Site N, Latitude 33°22 N, Longitude 118°34 W, approx. Depth 1300 m
Deployment Cruises: SOCAL 32-37, R/V Sproul
Recording Period: March 14, 2009 – March 26, 2010
Sample Rate: 200kHz **Recording Interval:** Continuous

Summary

This report summarizes the underwater sounds detected during a series of deployments of a High Frequency Acoustic Recording Package (HARP) in the southern California (SOCAL) offshore region. The HARP records broadband (10 Hz – 100 kHz) acoustic data, including both marine animal and anthropogenic sound. This report summarizes initial analysis to detect the presence of marine mammals by species as well as the occurrence of naval sonar and other anthropogenic sound events.

The HARP deployments were conducted at site N, located south of San Clemente Island (Latitude 33°22 N, Longitude 118°34 W, approx. Depth 1300 m), an area of naval training activity. The HARP at site N was deployed and recovered by the R/V Sproul during cruises SOCAL 32 (March 14, 2009) through SOCAL 38 (April 11, 2010). It recorded acoustic data continuously at a 200 kHz sample rate with data gaps in-between deployments, resulting in a total of 325 days (7744 hours) of recording over a period of 377 days. Table 1 provides a summary of HARP deployment dates, locations, and recording times.

We investigated the temporal occurrence of marine mammal and anthropogenic sound using manual analysis of three frequency bands: 10-1000 Hz (Low); 1000-5000 Hz (Mid); and 5-100 kHz (High). For each of these bands one or more analysts scanned the data using a long-term spectrogram display with approximately one hour of data per display. A MATLAB based software package called *TRITON* was used for data display and event logging. Potential sound events detected in a one-hour or shorter spectrogram were investigated at finer temporal scales to identify the origin of the sound by species or type of anthropogenic sound. Table 2 gives a summary, by species-call type or anthropogenic sound source, of the number of hours and days which sounds were detected, as well as the percentage of hours or days they were detected.

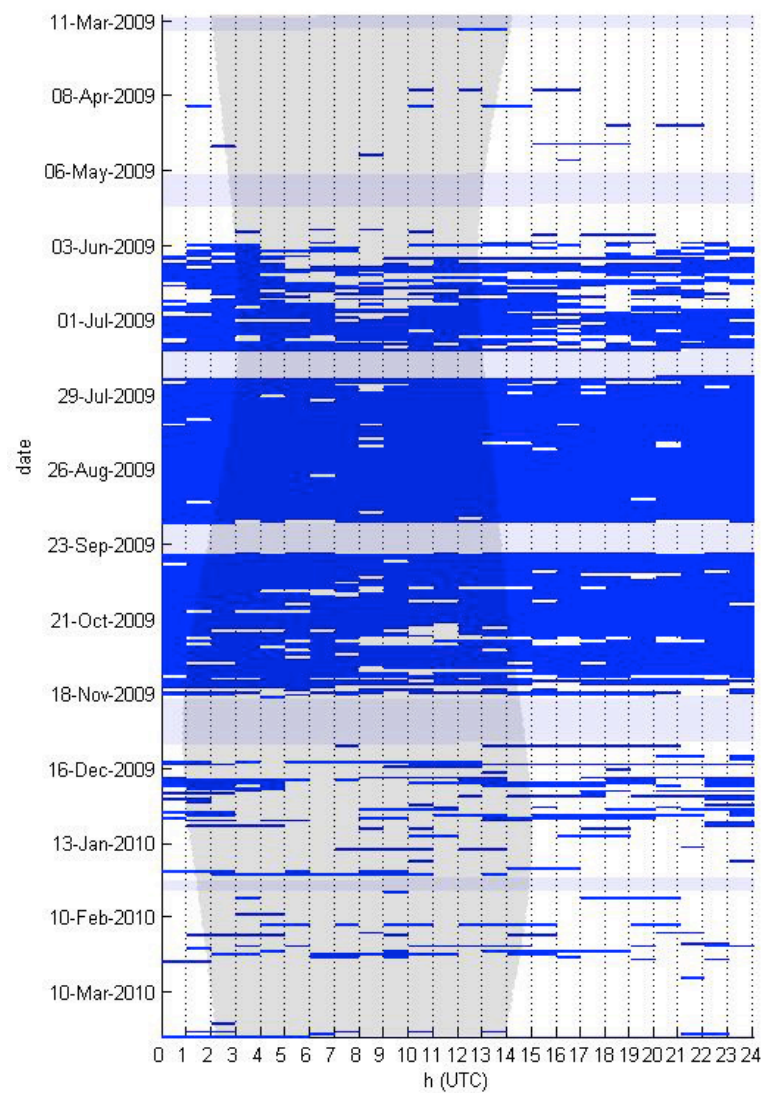
The detections for each call type or anthropogenic sound are also presented as a series of plots below. Sound detections are represented as a solid bar in hourly or minute bins, with each day of data along a horizontal line. Nighttime is indicated in a darker transparent color, and periods of off-effort (no acoustic data) are shown in light blue. Detected marine mammals include: blue whale, fin whale, unidentified whale, Bryde's whale, minke whale, humpback whale, sperm whale, killer whale, unidentified beaked whale, "43 kHz" beaked whale, "50 kHz" beaked whale, Baird's beaked whale, Risso's dolphin, Pacific white-sided dolphin, unidentified odontocete, and pinniped. Anthropogenic sounds include mid-frequency active sonar, echosounder, ship noise and explosion.

Table 1. HARP Deployment Dates, Locations and Recording Times.

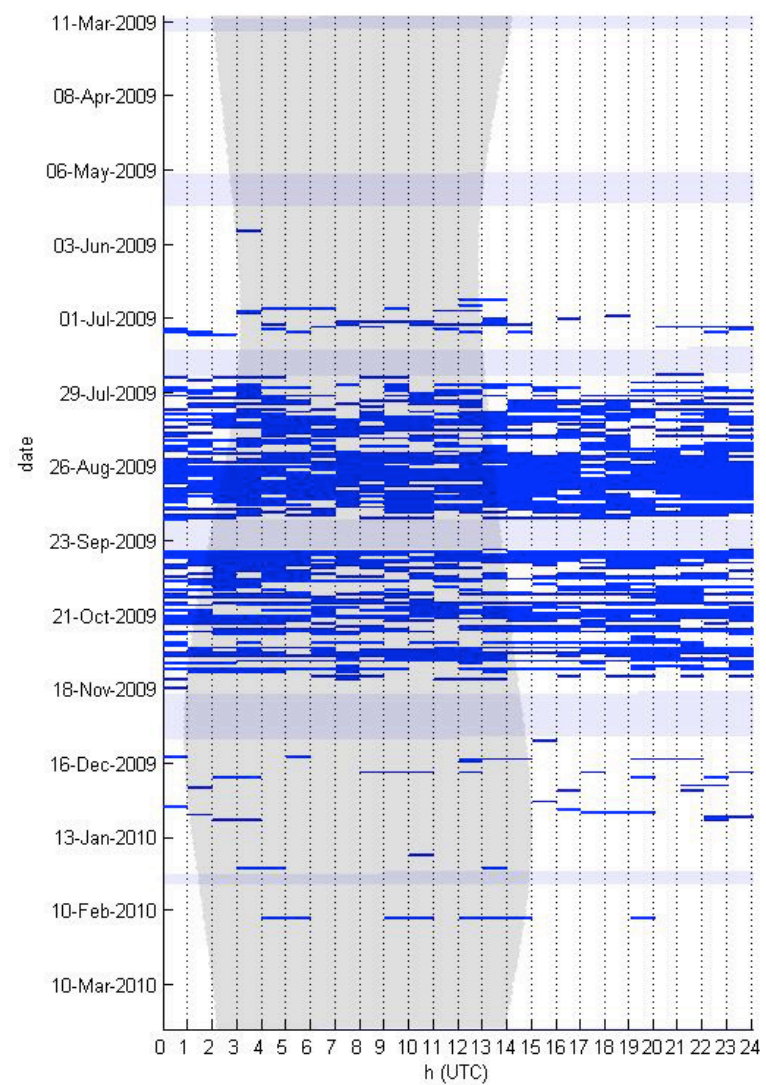
Site/Cruise	Deployment Date	Recovery Date	Deployment Latitude N	Deployment Longitude W	Depth	Recording Start	Recording End	Days	Hours
SOCAL32N	3/14/2009	5/19/2009	32-22.205	118-33.905	1295	3/14/2009	5/7/2009	54	1302
SOCAL33N	5/19/2009	7/22/2009	32-22.197	118-33.893	1295	5/19/2009	7/12/2009	54	1302
SOCAL34N	7/22/2009	9/25/2009	32-22.186	118-33.885	1287	7/22/2009	9/15/2009	55	1303
SOCAL35N	9/25/2009	12/6/2009	32-22.191	118-33.887	1295	9/26/2009	11/19/2009	55	1313
SOCAL36N	12/5/2009	1/30/2010	32-22.186	118-33.769	1282	12/6/2009	1/26/2010	52	1221
SOCAL37N	1/30/2010	4/11/2010	32-22.184	118-33.768	1280	1/31/2010	3/26/2010	55	1303

Table 2. Detections of Marine Mammal Species and Anthropogenic Sound Sources.

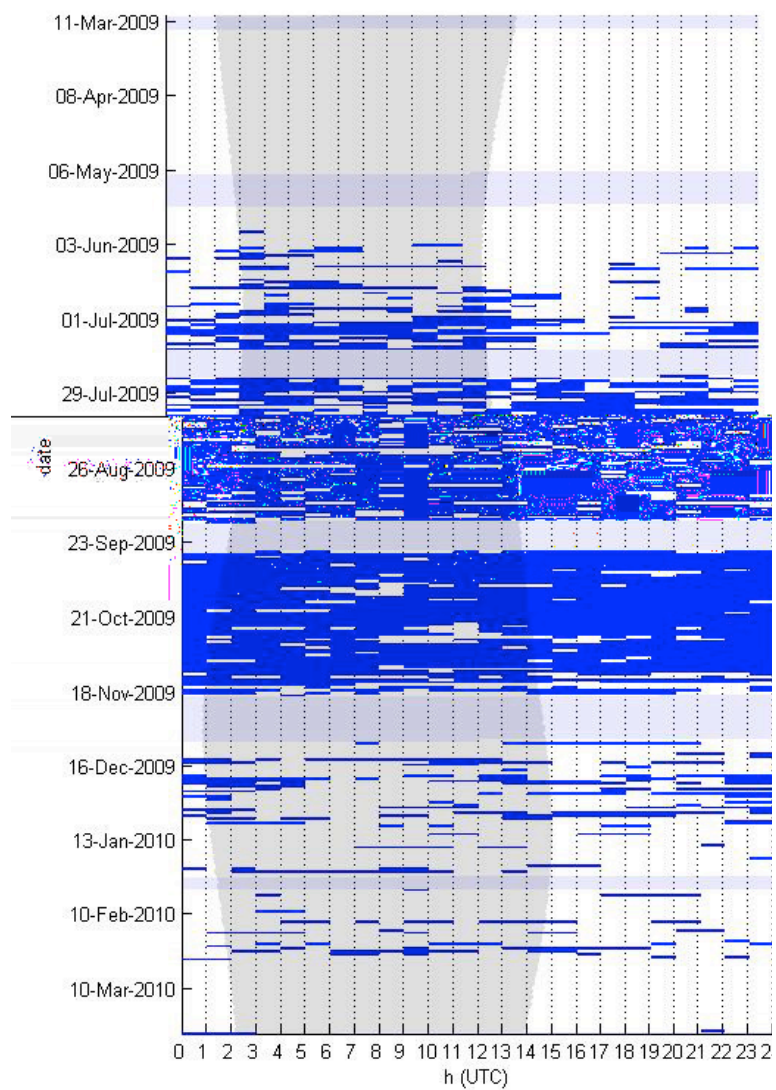
Species/Source	Call Type	Hour Bins	Percent Hours	Daily Bins	Percent Days
Blue Whale	All	3362	43	217	67
Blue Whale	A	1574	20	139	43
Blue Whale	B	2674	35	201	62
Blue Whale	D	1677	22	146	45
Blue Whale	Song	530	7	93	29
Fin Whale	All	5848	76	322	99
Unidentified Whale	50 Hz	872	11	224	69
Bryde's Whale	All	272	4	57	18
Minke Whale	All	2	0.03	2	1
Humpback Whale	All	1548	20	209	64
Humpback Whale	Song	472	6	105	32
Odontocete	Clicks	4548	59	325	100
Sperm Whale	Clicks	65	1	18	6
Killer Whale	Whistles/ Clicks	19	0.2	10	3
Unidentified Odontocete	Low-Freq. Whistles/ Clicks	41	1	18	6
Beaked Whale	Clicks	882	11	259	80
43 kHz Beaked Whale	Clicks	2	0.0	2	1
50 kHz Beaked Whale	Clicks	5	0.1	5	2
Baird's Beaked Whale	Clicks	18	0.2	12	4
Risso's Dolphin	Whistles/ Clicks	91	1	37	11
Pacific White-sided Dolphin	Whistles/ Clicks	49	1	26	8
Pinniped	All	25	0.3	18	6
Anthropogenic	All	4462	58	325	100
Anthropogenic	Mid-Frequency Active Sonar	816	11	131	40
Anthropogenic	Echosounder Ping	258	3	81	25
Anthropogenic	Ship Engine Noise	3914	51	320	98
Anthropogenic	Explosion	252	3	94	29



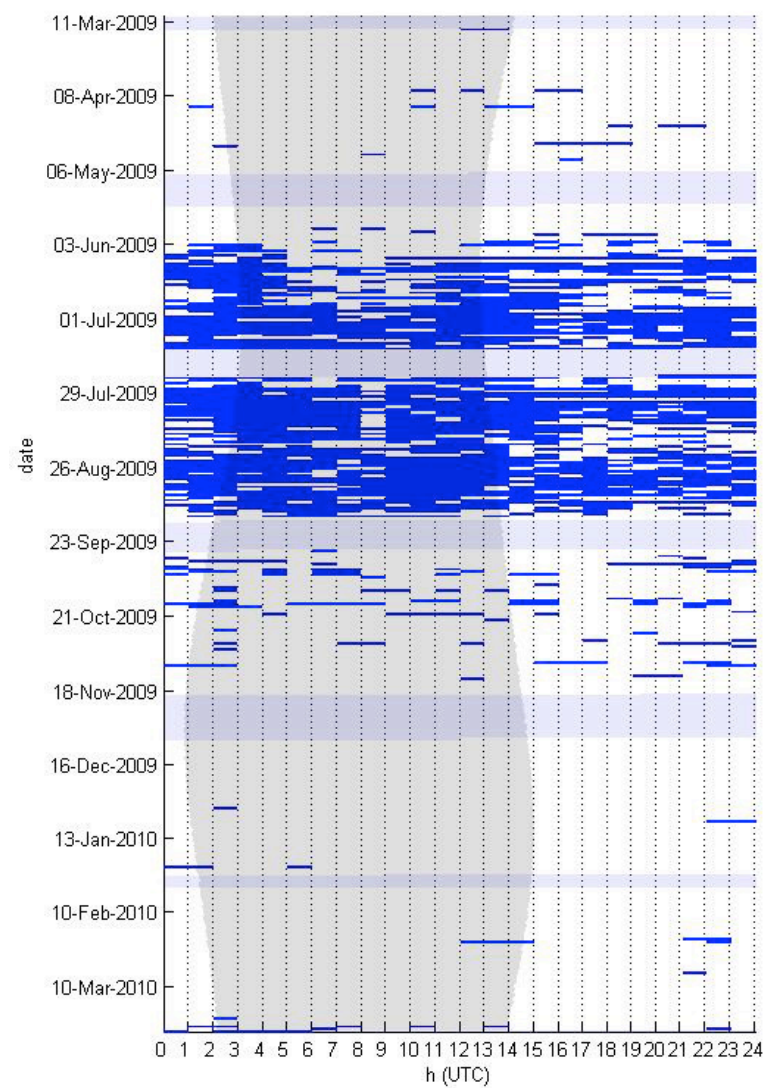
Blue Whale – All Call Types in Hourly Bins



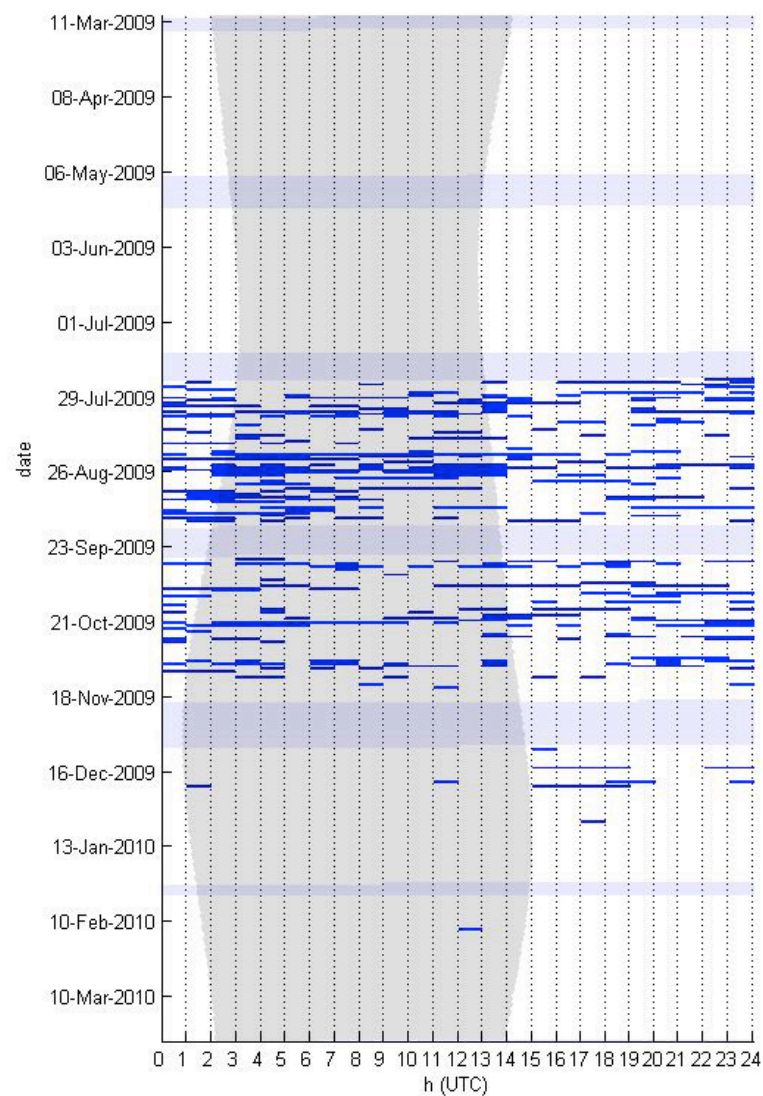
Blue Whale - "A" Call in Hourly Bins



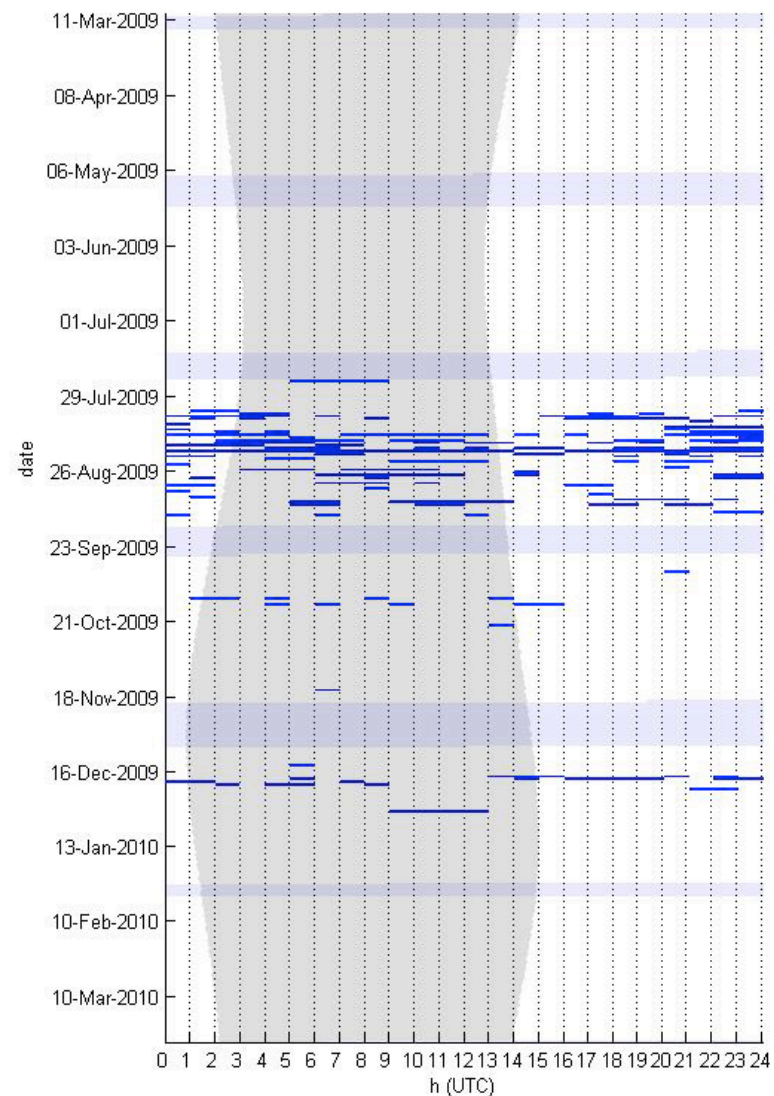
Blue Whale - "B" Call in Hourly Bins



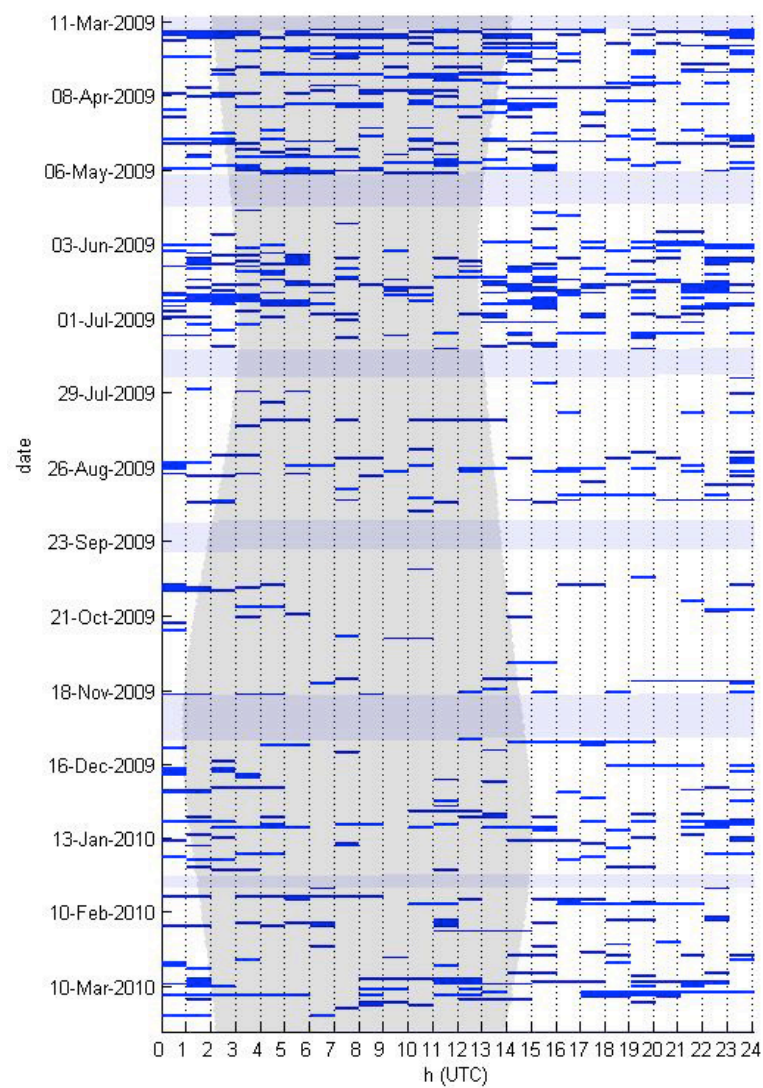
Blue Whale - "D" Call in Hourly Bins



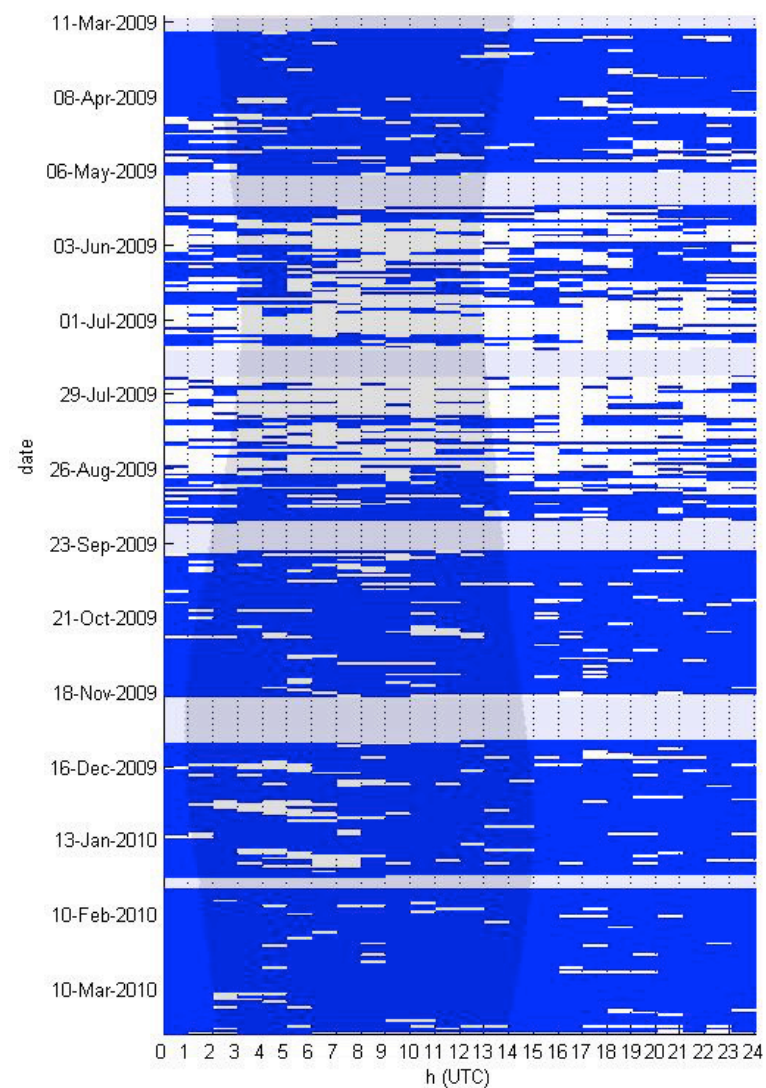
Blue Whale - Song in Hourly Bins



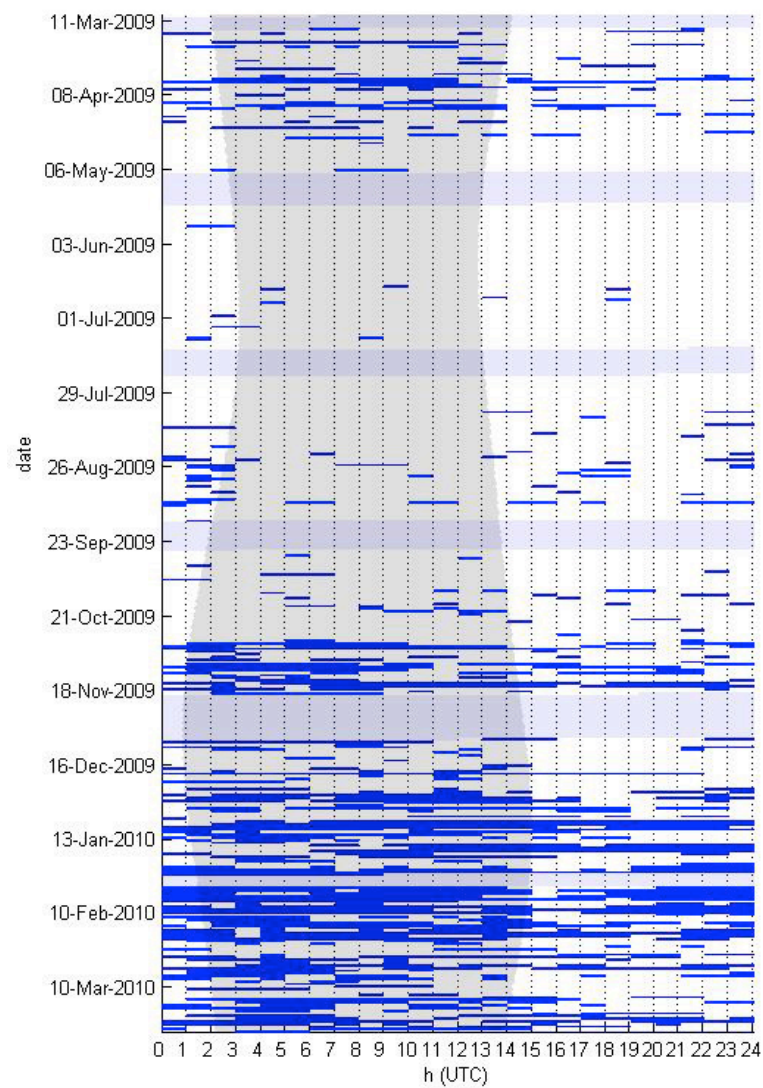
Bryde's Whale – All Call Types in Hourly Bins



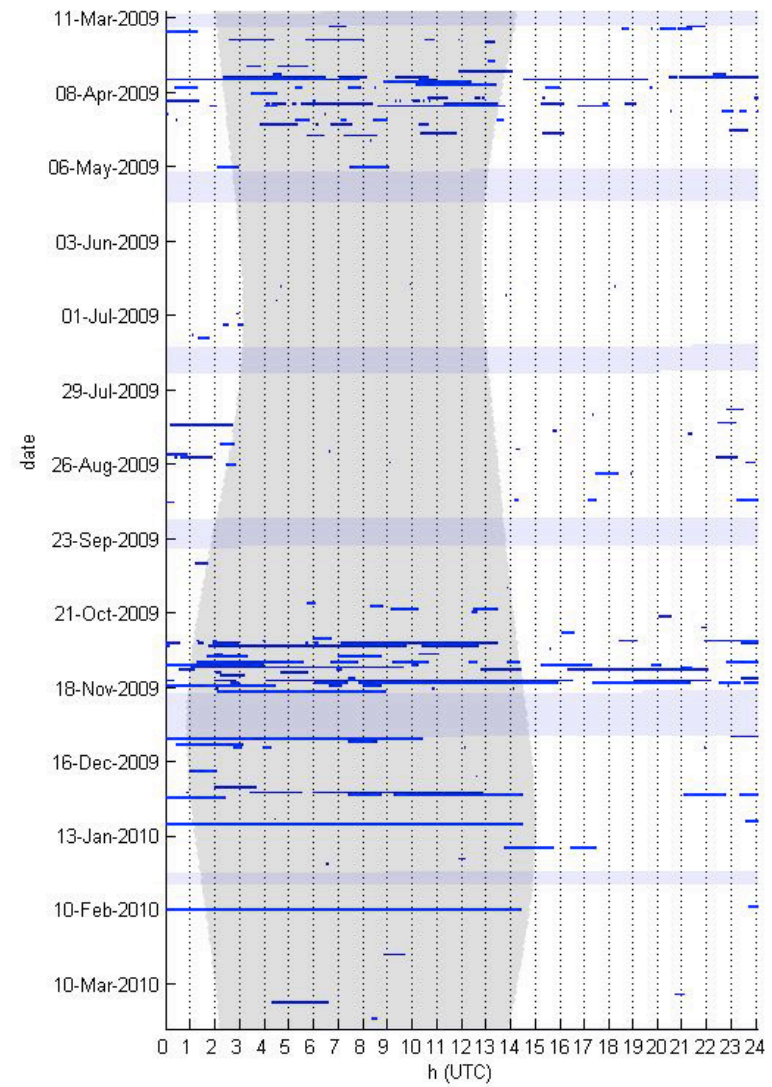
Unidentified Whale - 50 Hz Call in Hourly Bins



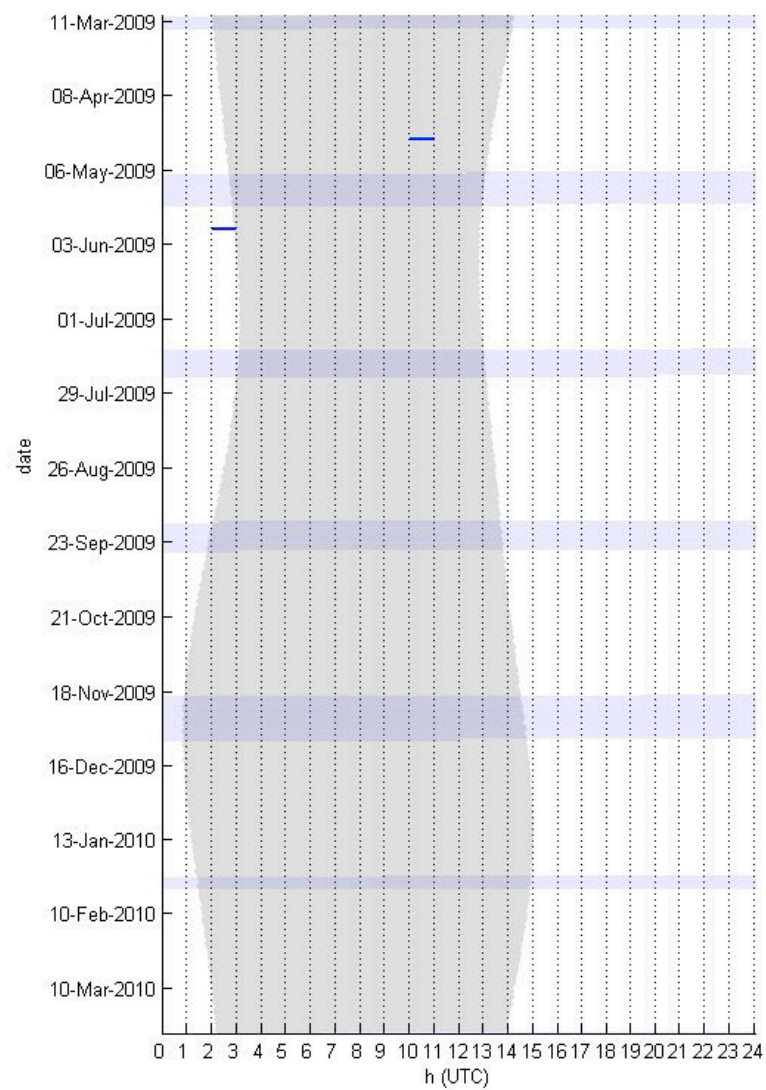
Fin Whale - All Call Types in Hourly Bins



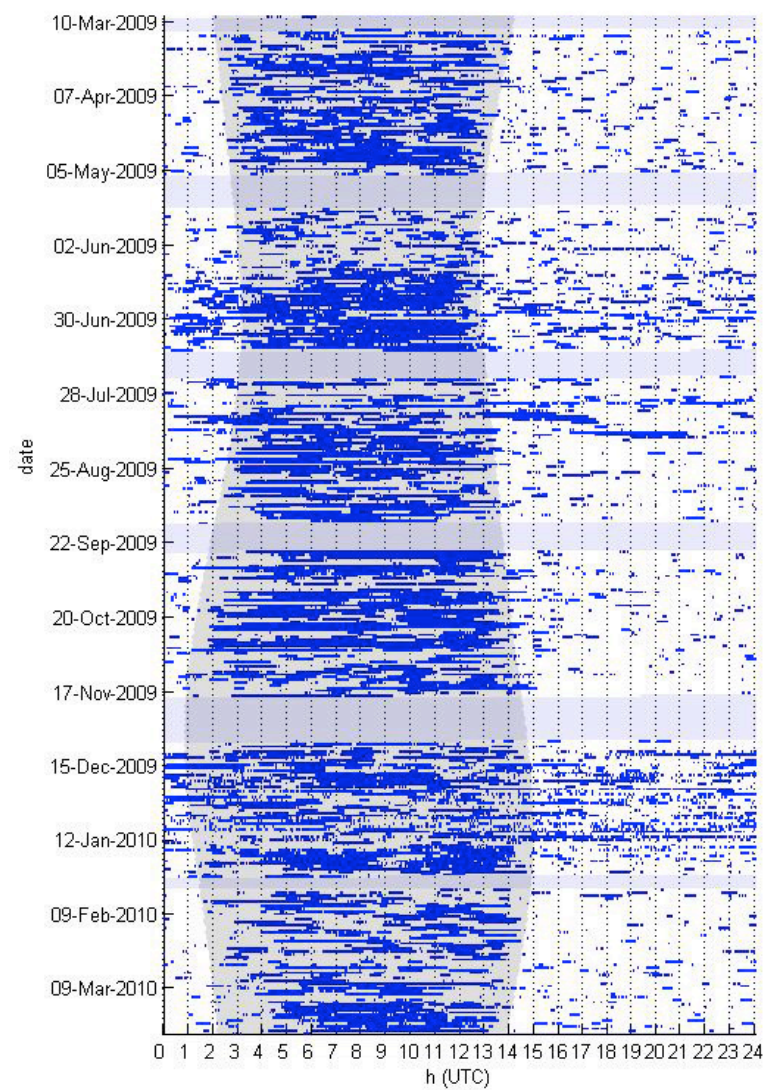
Humpback Whale - All Call Types in Hourly Bins



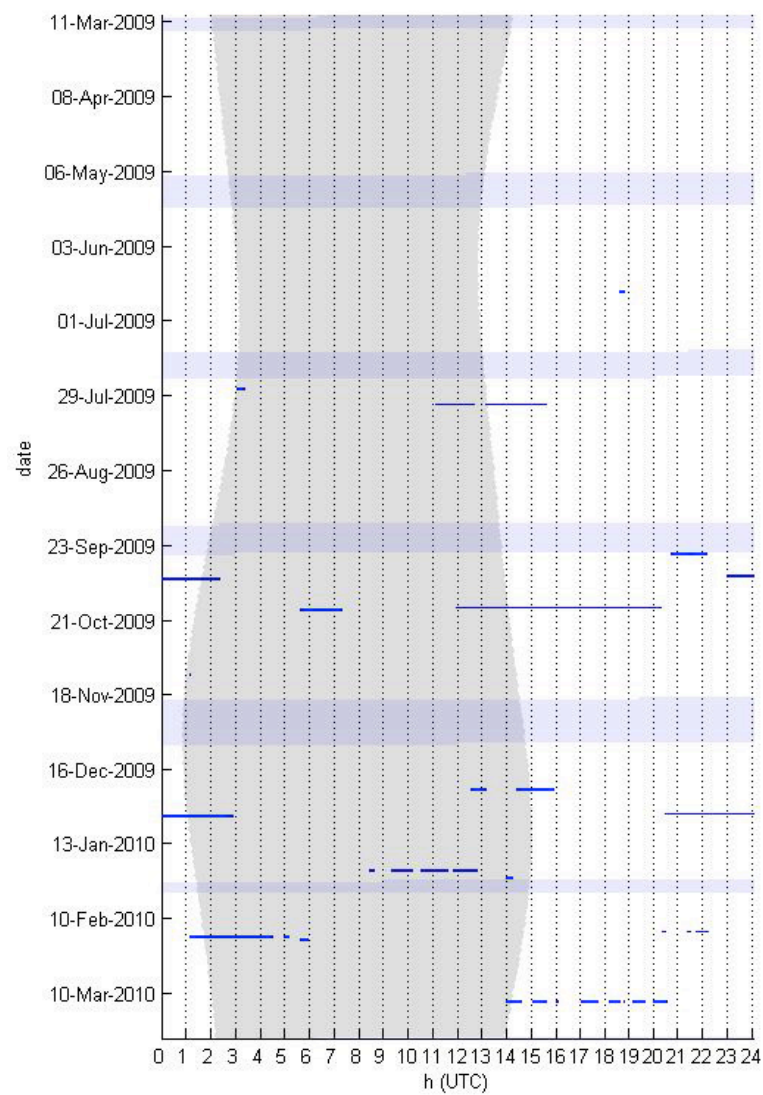
Humpback Whale - Song in One-Minute Bins



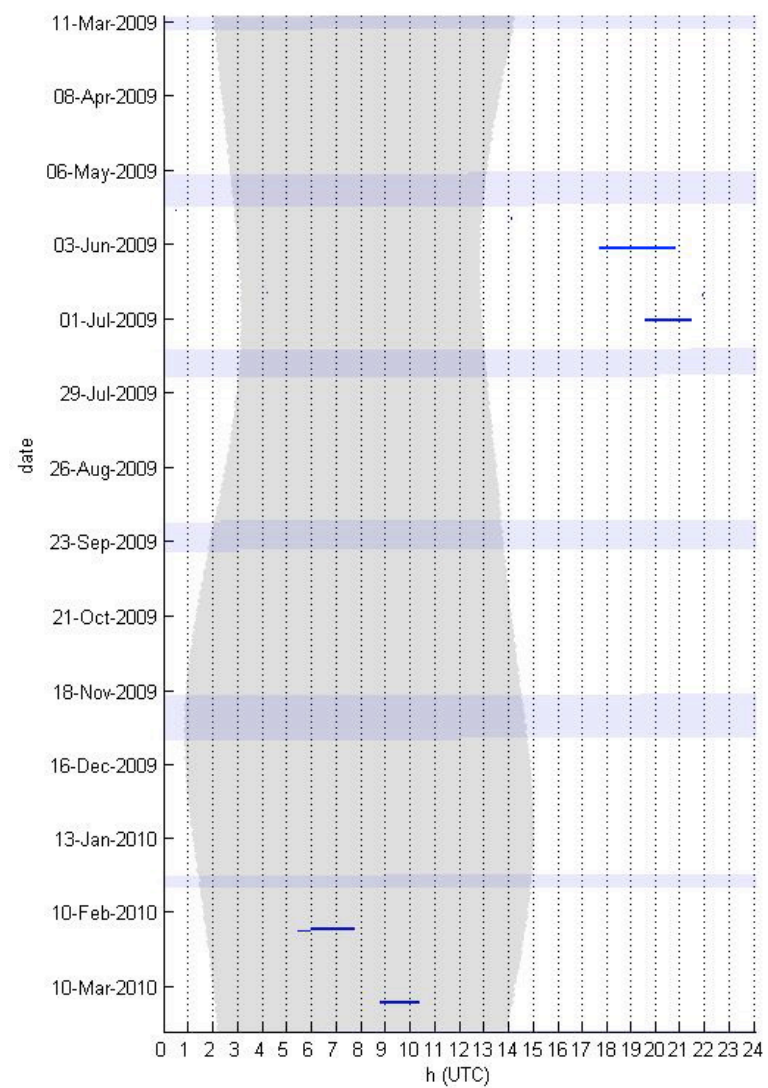
Minke Whale – All Call Types in Hourly Bins



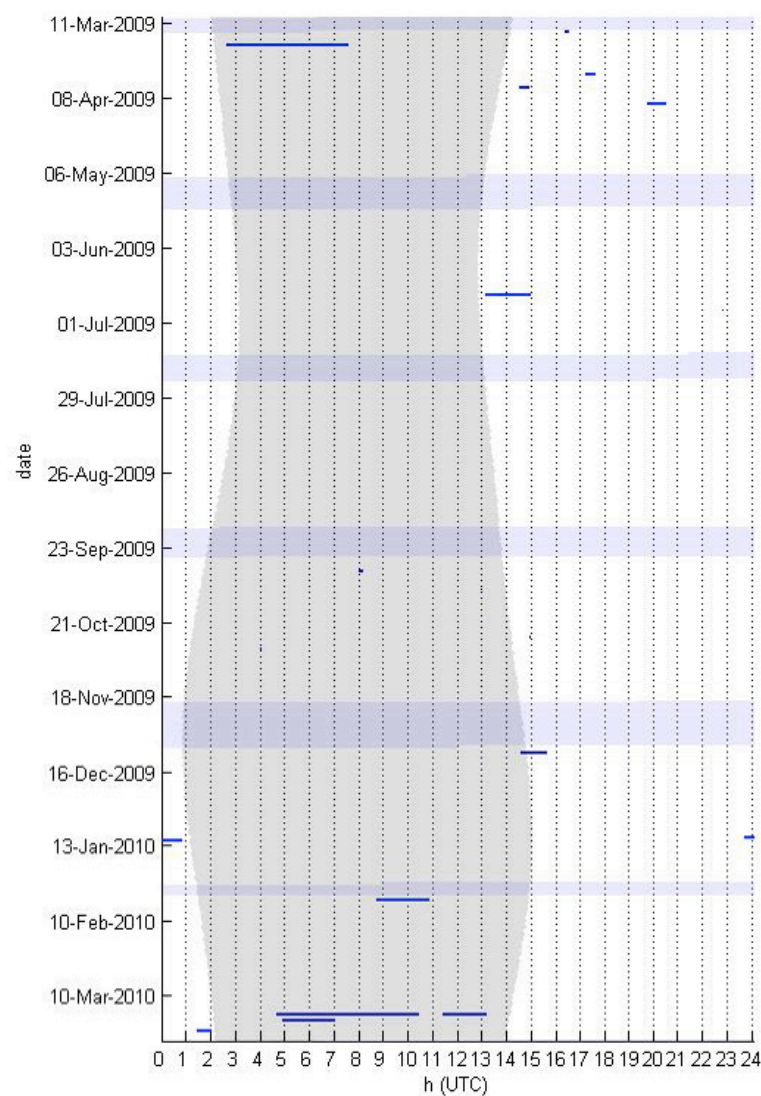
Odontocete - Echolocation Clicks in One-Minute Bins



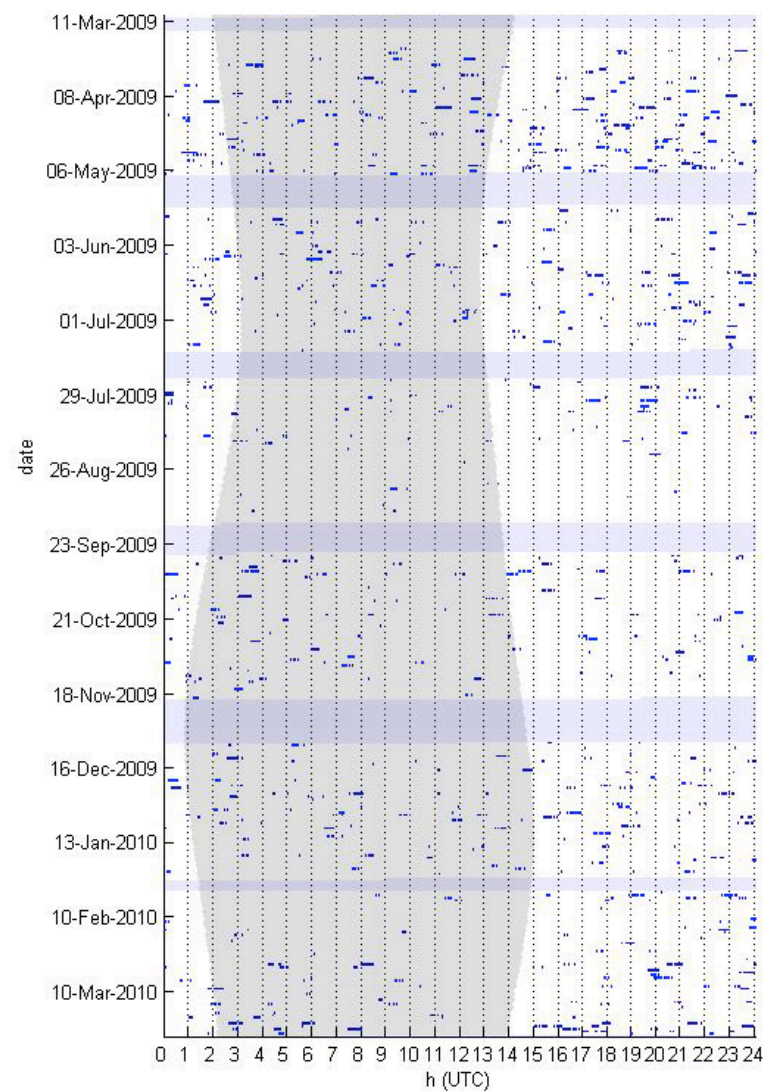
Sperm Whale - Echolocation Clicks in One-Minute Bins



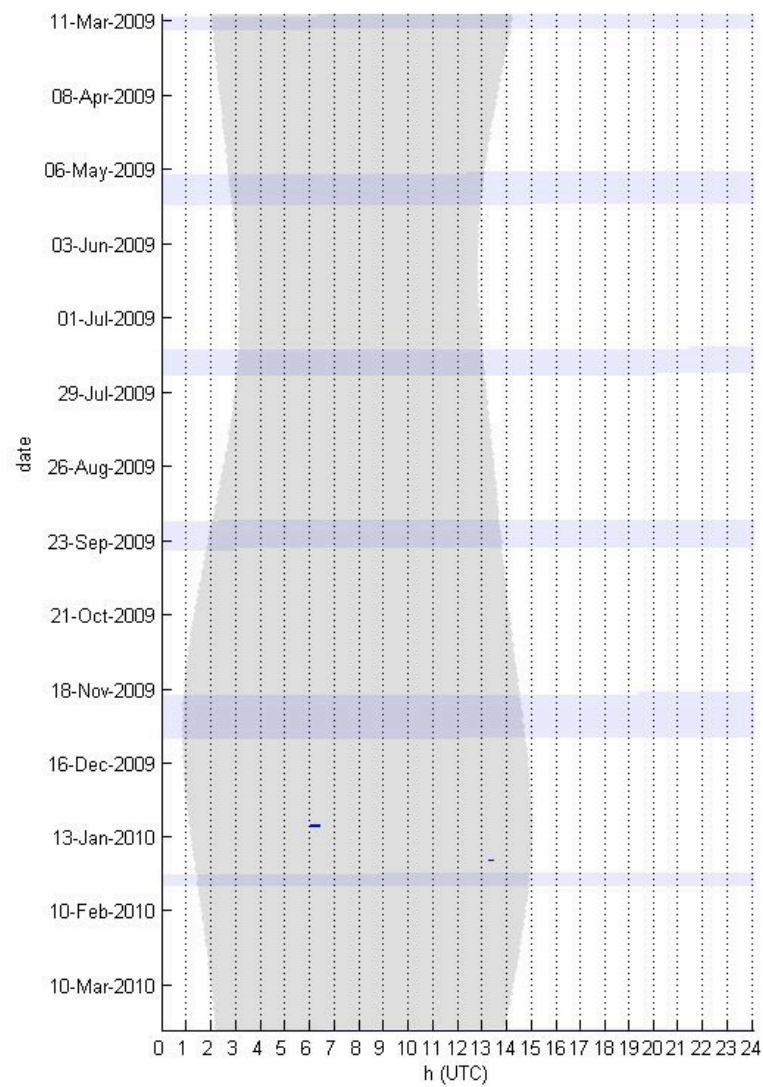
Killer Whale – Whistles and Echolocation Clicks in One-Minute Bins



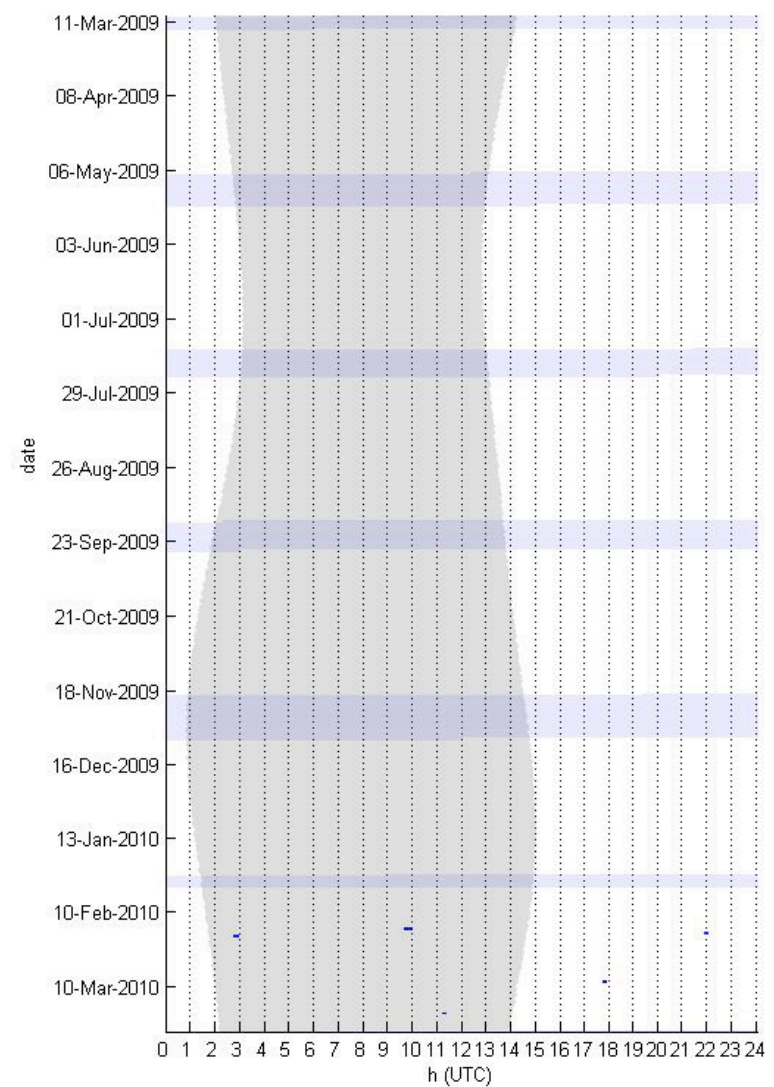
Unidentified Odontocete – Low-Frequency Whistles and Echolocation Clicks in One-Minute Bins



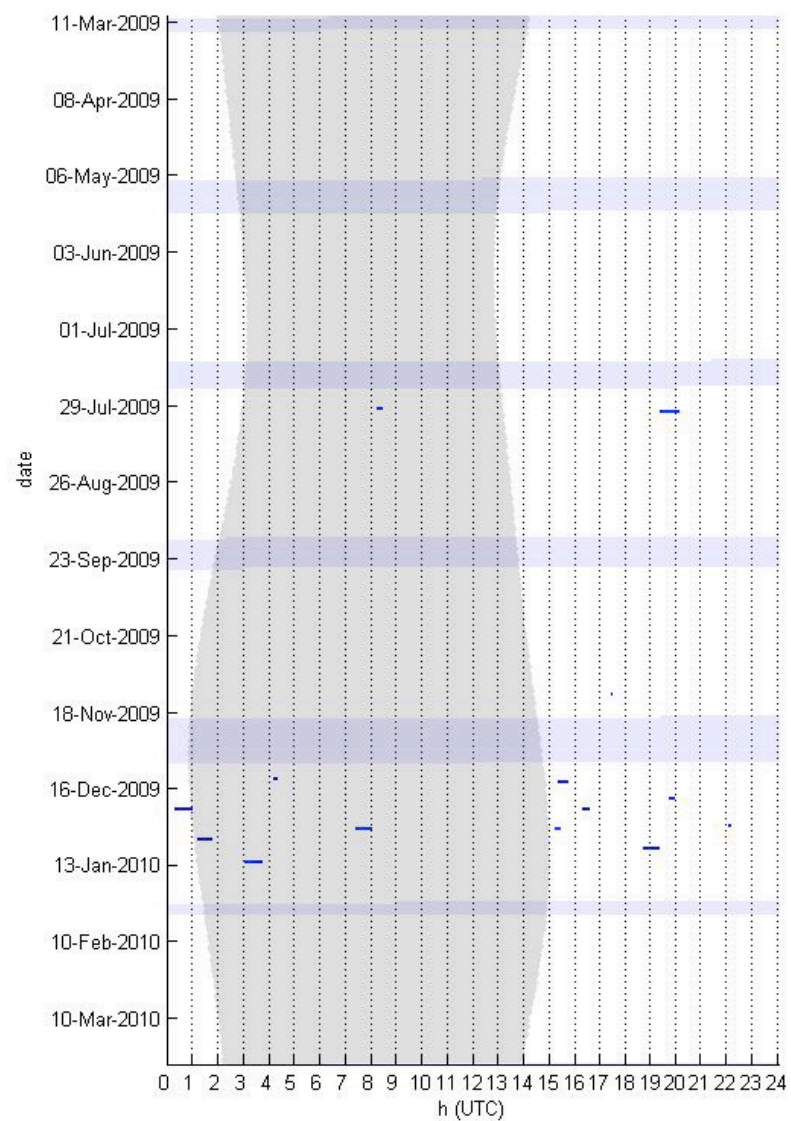
Beaked Whale - Frequency-Modulated Clicks ($20 \text{ kHz} < \text{Peak Frequency} < 55 \text{ kHz}$) in One-Minute Bins



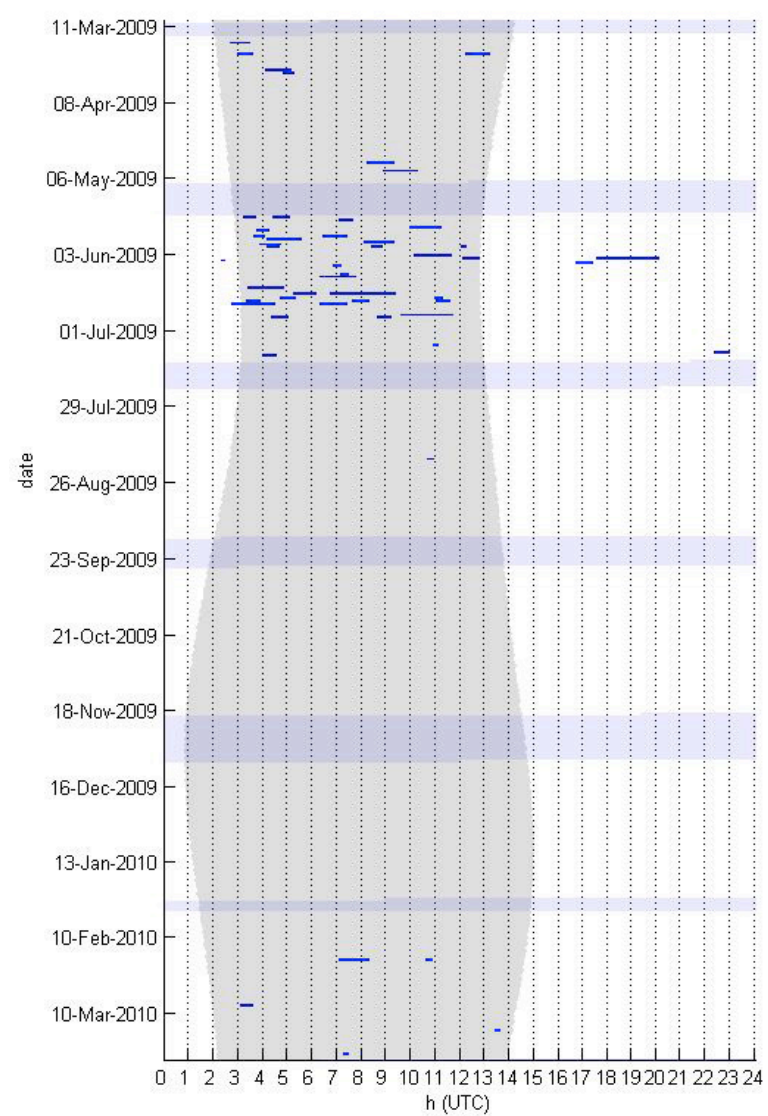
43 kHz Beaked Whale - Echolocation Clicks in One-Minute Bins



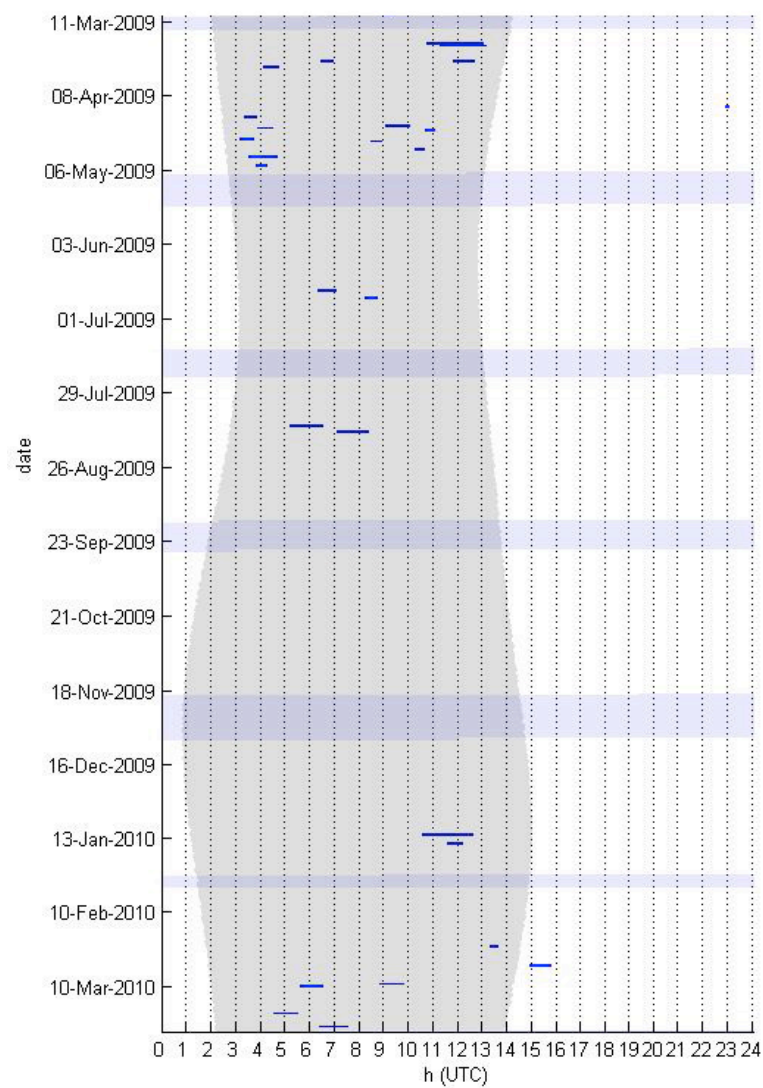
50 kHz Beaked Whale - Echolocation Clicks in One-Minute Bins



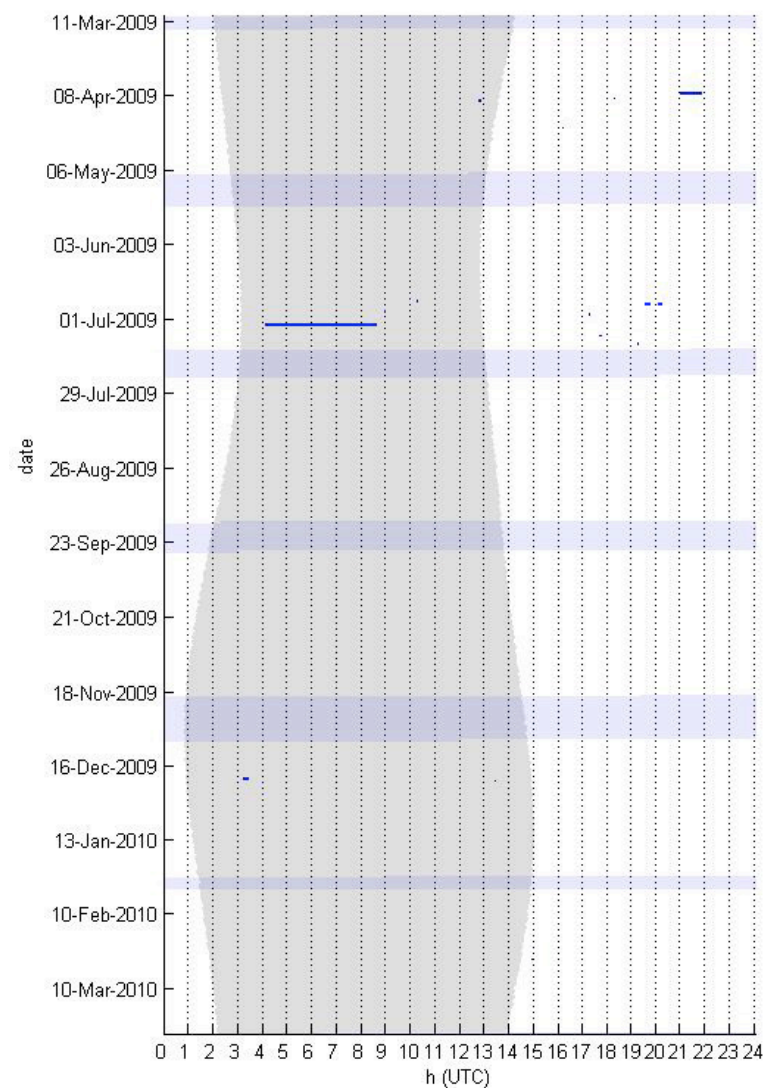
Baird's Beaked Whale - Echolocation Clicks in One-Minute Bins



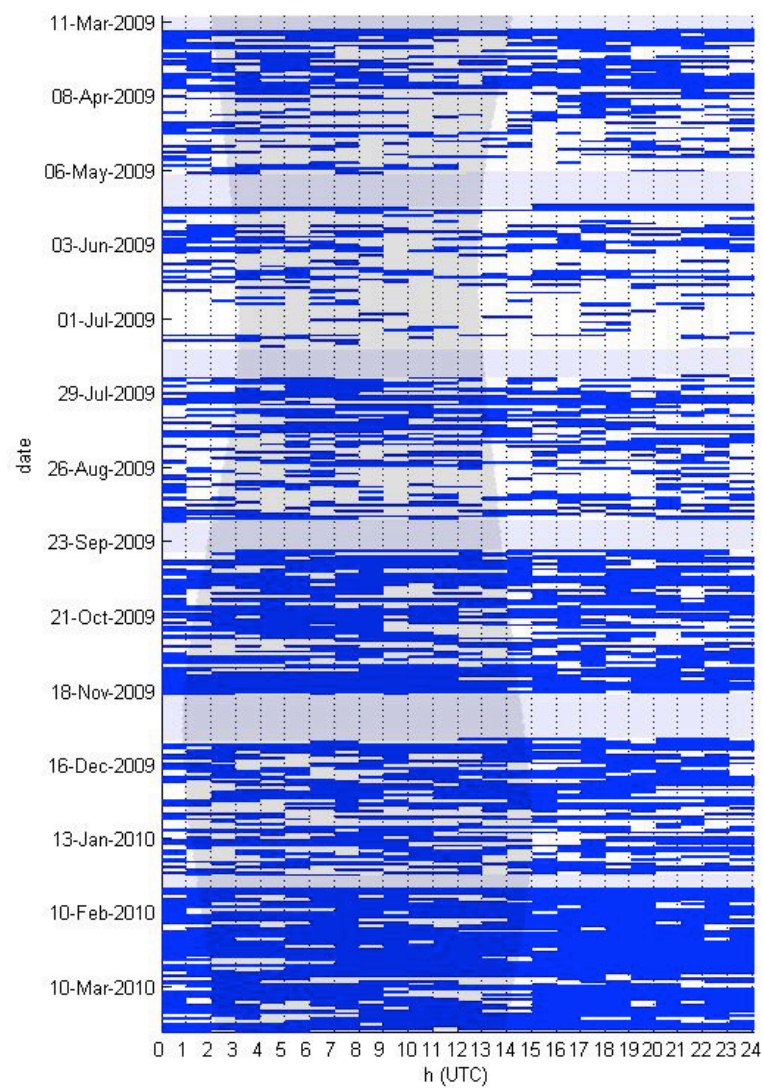
Risso's Dolphin - Echolocation clicks in One-Minute Bins



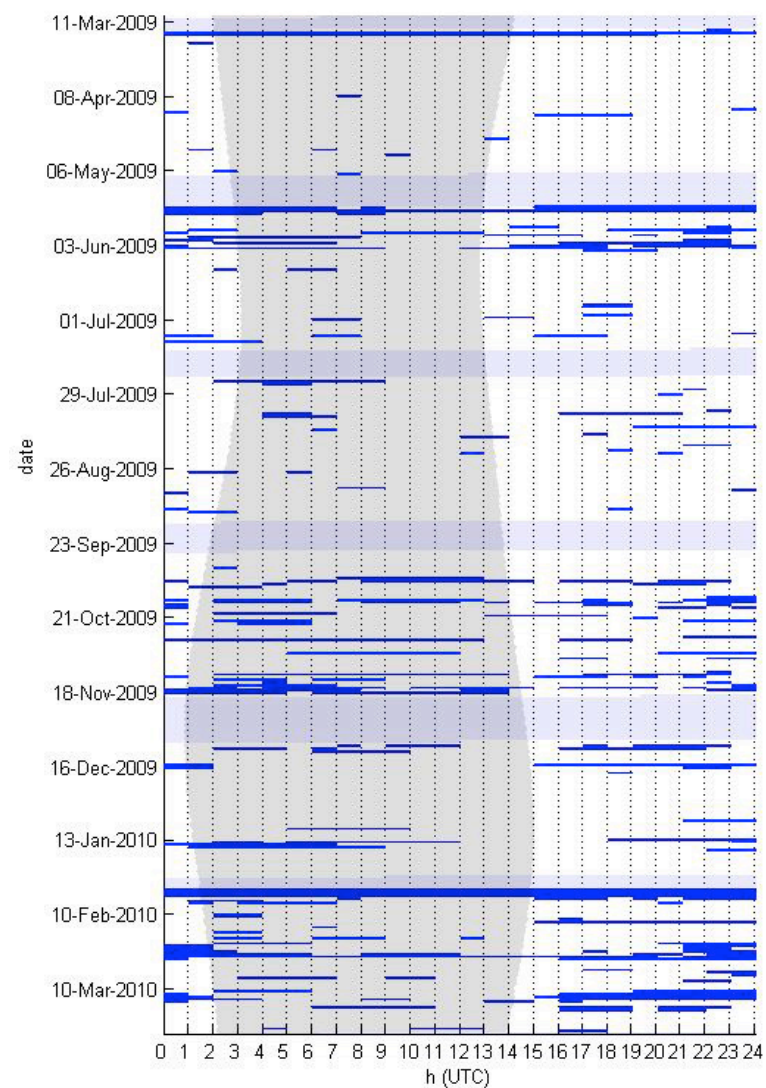
Pacific White-sided Dolphin – All Echolocation Clicks in One-Minute Bins



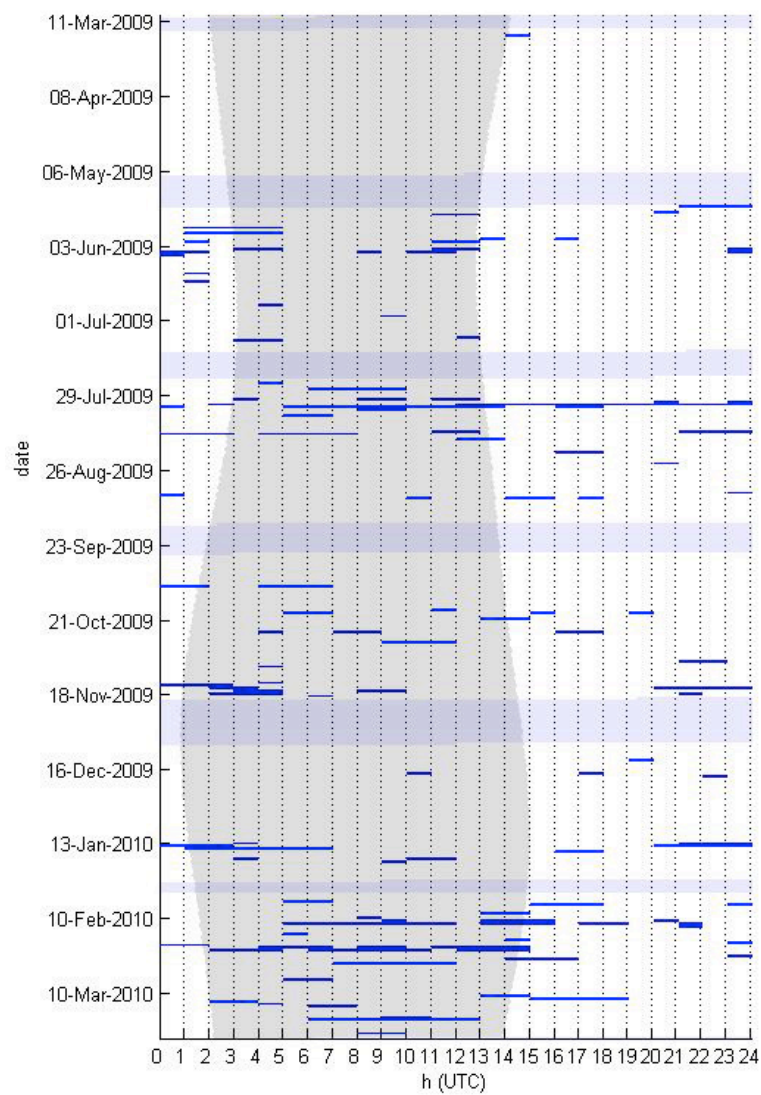
Pinniped - All Call Types in One-Minute Bins



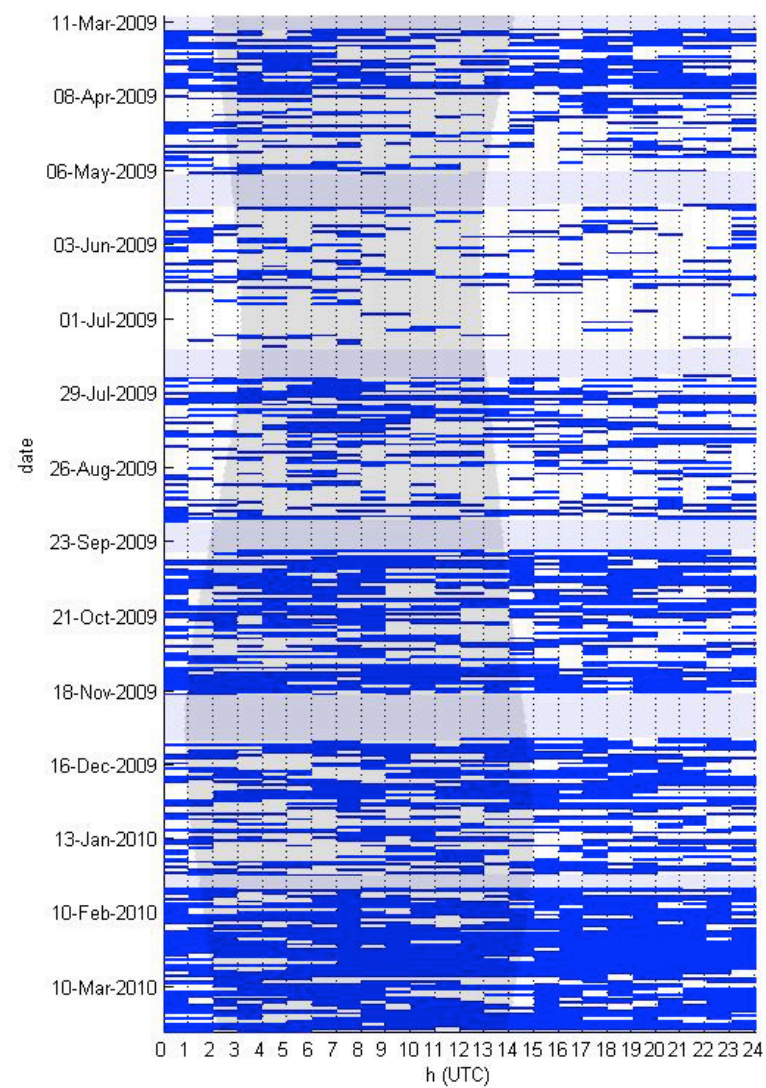
Anthropogenic - All Sound Sources in Hourly Bins



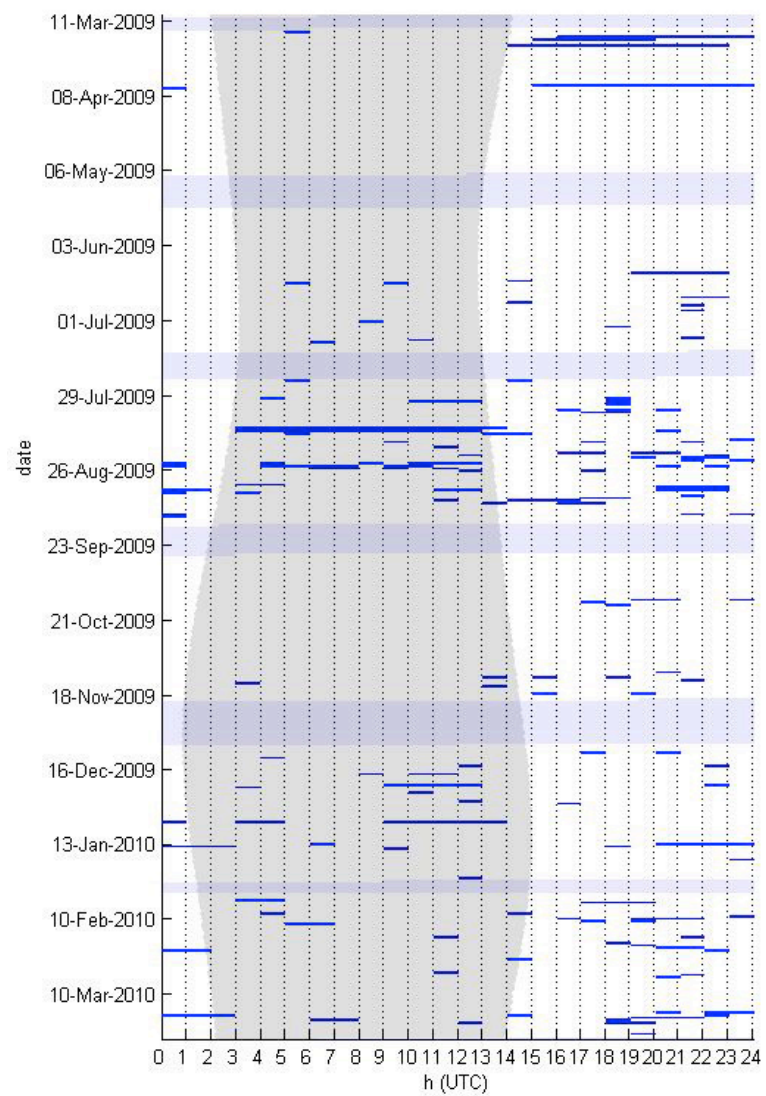
Anthropogenic –Mid-Frequency Active Sonar in Hourly Bins



Anthropogenic - Echosounder, Various Frequencies, in Hourly Bins



Anthropogenic - Ship Engine in Hourly Bins



Anthropogenic - Explosion in Hourly Bin