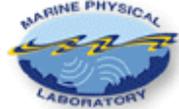


**Marine Physical
Laboratory**



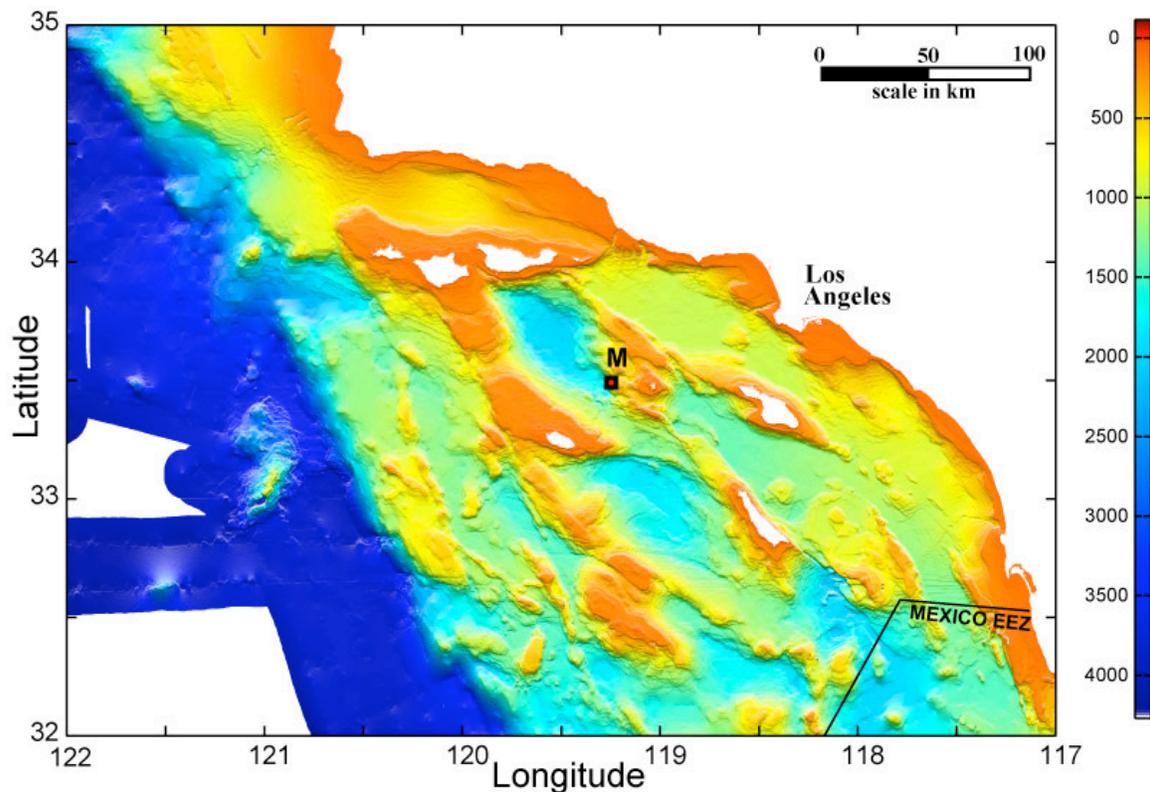
of the Scripps Institution
of Oceanography
University of California,
San Diego

SCRIPPS



Whale Acoustics

High Frequency Acoustic Recording Package Data Summary Report May 17, 2009 – July 8, 2009 SOCAL 33, Site M



**John Hildebrand, Hannah Bassett, Simone Baumann, Greg Campbell,
Amanda Cummins, Sara Kerosky, Karlina Merkens, Lisa Munger,
Marie Roch and Sean Wiggins**

Marine Physical Laboratory, Scripps Institution of Oceanography
University of California San Diego, LA Jolla, CA 92037-0205

Contract Number: FISC N00244-08-1-0028

Project Title: Southern California Marine Mammal Studies

Location: Site M, Latitude 33-30.580 N, Longitude 119-15.253 W, Depth 1120 m

Deployment Cruise: SOCAL 33, R/V Sproul

Recording Period: May 17, 2009 – July 8, 2009

Sample Rate: 200kHz Recording Interval: Continuous

Summary

This report summarizes data analysis for deployment 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.

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 1 gives a summary, by species or anthropogenic sound source, of the number of hours and days sounds were detected, as well as the percentage of hours or days they were detected.

Site M is located to the west of Santa Barbara Island, and north of the primary area of naval training activity near San Clemente Island. The HARP at site M was deployed by the R/V Sproul during cruise SOCAL 33, on May 16, 2009 and recovered on the R/V Sproul during cruise SOCAL 34 on July 27, 2009. It recorded acoustic data continuously at a 200 kHz sample rate between 00:00 May 17 and 14:56 July 8, a total of 53 days (1263 hours) of recording.

Detected marine mammals include: blue whale, fin whale, humpback whale, sperm whale, beaked whale, Risso's dolphin, unidentified dolphin, and California sea lion. Anthropogenic sounds include mid-frequency active sonar (3.5 kHz) and broadband (10 Hz – 10 kHz) ship noise. Blue whale D calls, associated with feeding, were present from the beginning of the recording window, whereas blue whale A+B song calls began on about June 10. Fin whales at 20-Hz are present throughout the data, as were Fin whales at 50-Hz, although the latter were more prominent in late June. Humpback whale song only was recorded on a single day in late May. Sperm whales were recorded intermittently throughout the data set. Beaked whales (primarily Cuvier's beaked whales) were recorded throughout the data set, on 40% of the recording days. Risso's dolphins were detected on 57% of recording days, primarily during nighttime hours. Unidentified dolphin whistles and echolocation clicks were recorded throughout the data, but at the highest rates during the beginning and ending sections of the data set. The most probable dolphin species represented by these data are common dolphins (both long and short beaked) as well as bottlenose dolphins. California sea lions were recorded nearly

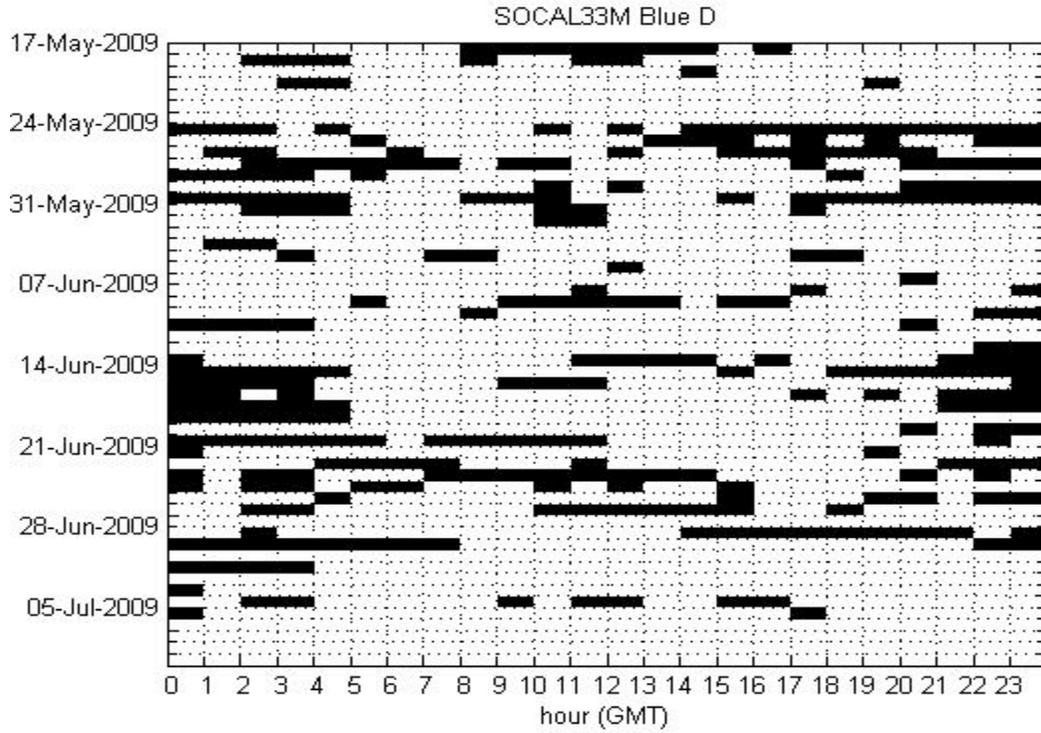
continuously during the later half of the data set, but were absent during the first half of the data set.

Anthropogenic sound sources include mid-frequency active (MFA) sonar (3 – 5 kHz) and broadband (10 Hz – 10 kHz) ship noise. The MFA sonar was recorded primarily in mid-to-late May, and again in late June and early July. Broadband ship noise from nearby vessels was recorded intermittently, primarily in the later half of the data set.

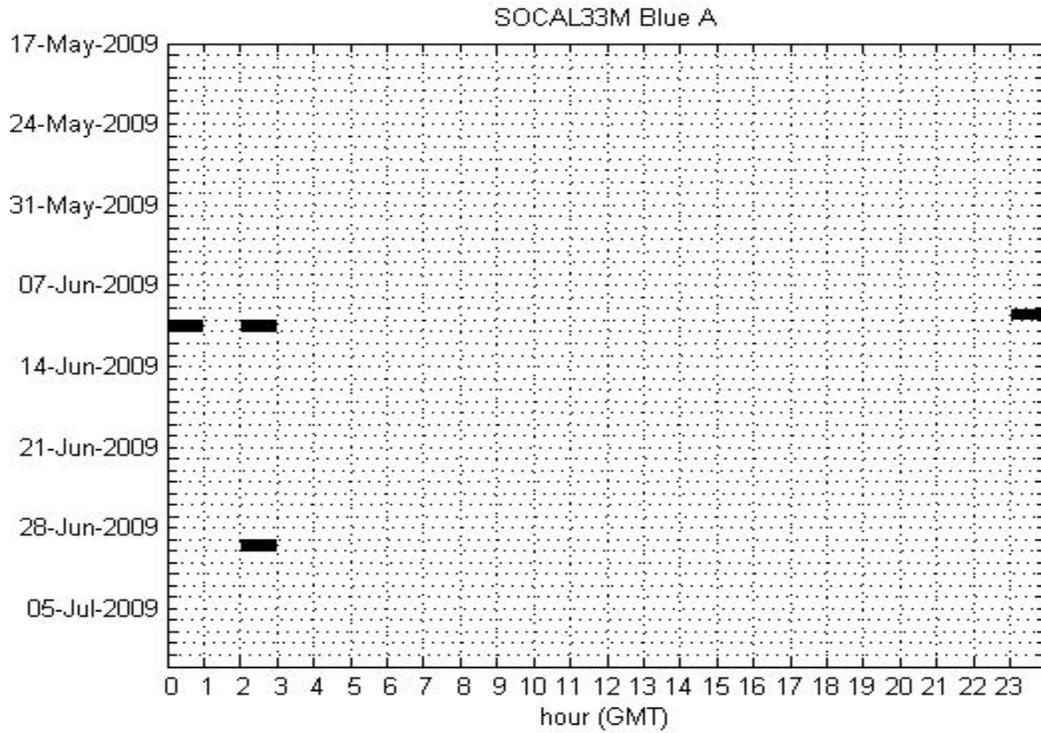
Species/Source	Call Type	# Hour Bins	Percent	# Daily Bins	Percent
Blue Whale	D	276	22	42	79
Blue Whale	A	4	0.3	3	5.7
Blue Whale	B	34	2.7	14	26
Fin Whale	20 Hz	659	52	53	100
Fin Whale	50 Hz	396	31	51	96
Humpback Whale	Song	3	0.2	1	1.9
Sperm Whale	Echolocation	46	3.6	16	30
Beaked Whale	Echolocation	41	3.3	21	40
Risso's Dolphin	Whistles/ Echolocation	132	10	30	57
Un ID Dolphin	Whistles/ Echolocation	403	32	50	94
CA Sea Lion	Bark/Whine/ Buzz	481	38	26	49
MFA Sonar	Ping	134	11	15	29
Ship	Broadband Noise	34	2.7	17	33

Table 1. Detections of Marine Mammal Species and Anthropogenic Sound Sources.

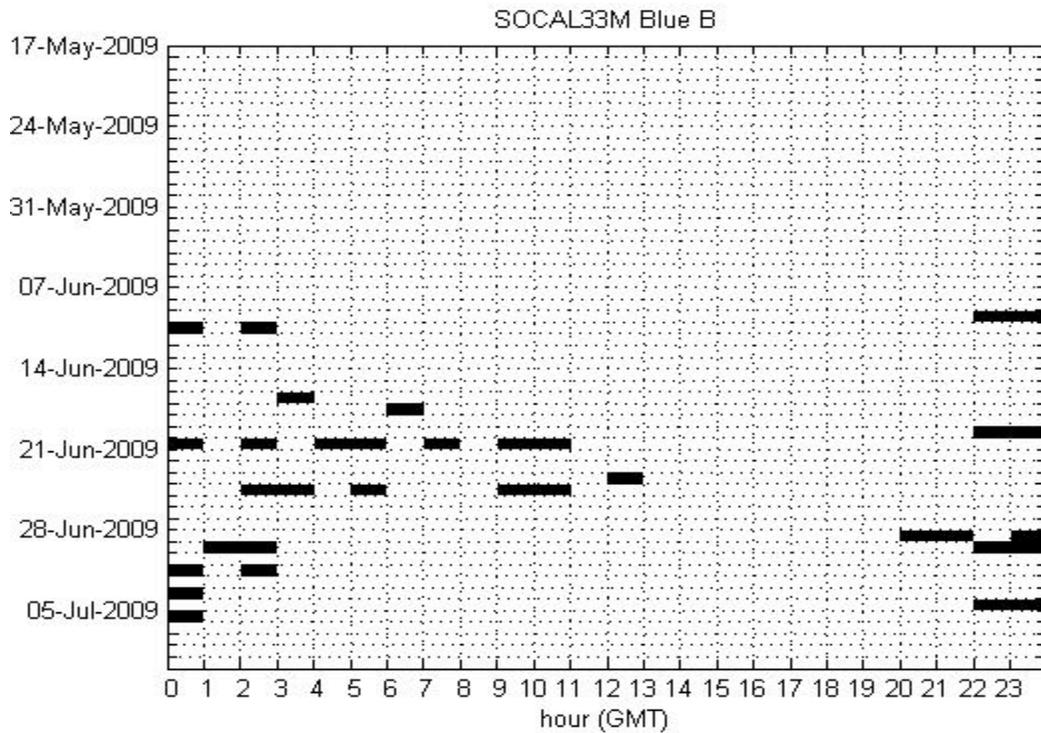
MARINE MAMMAL DETECTIONS BY SPECIES AND CALL TYPE AND ANTHROPOGENIC SOUND BY SOURCE TYPE



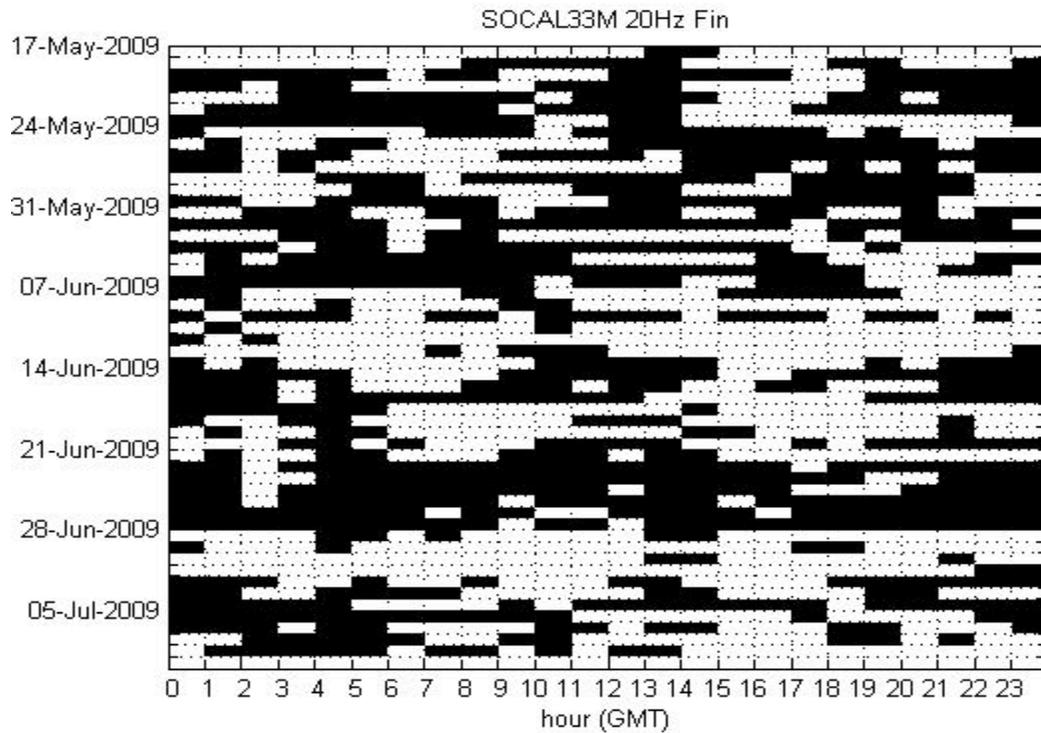
Blue Whale – “D” Call in Hourly Bins



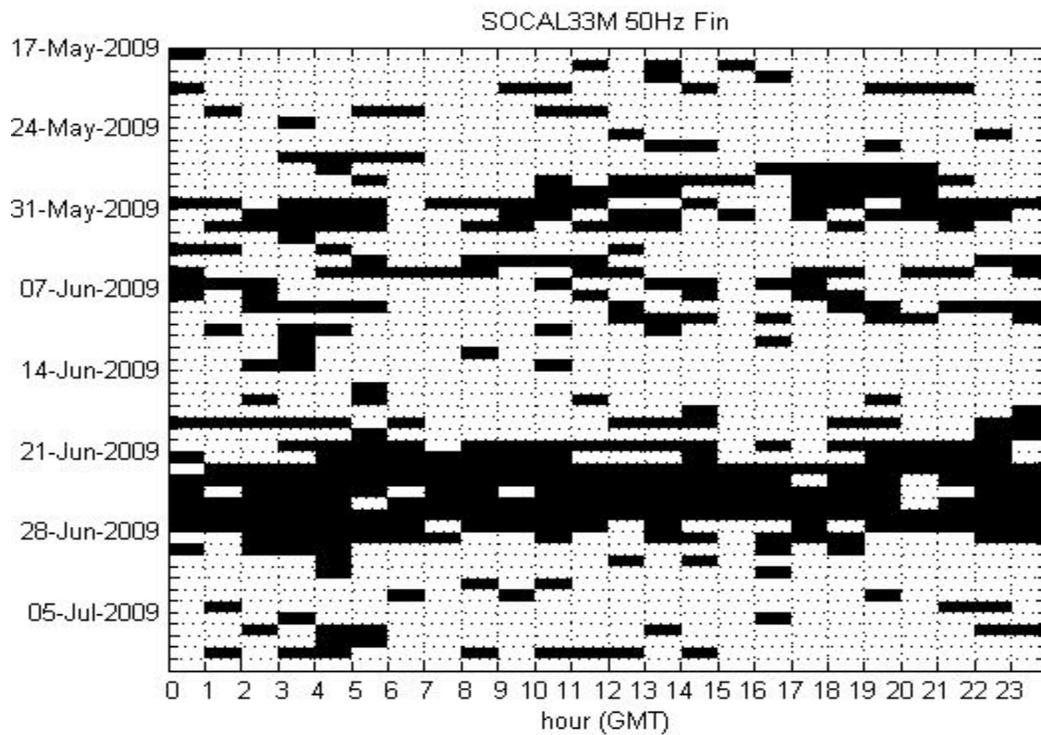
Blue Whale – “A” Call in Hourly Bins



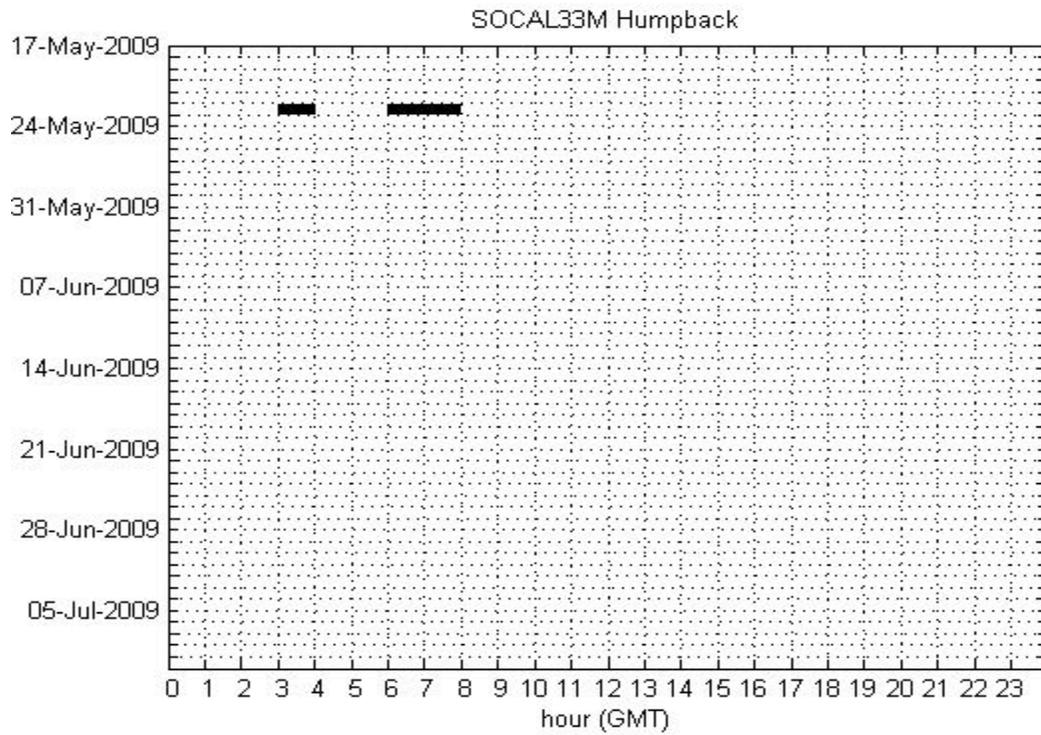
Blue Whale – “B” Call in Hourly Bins



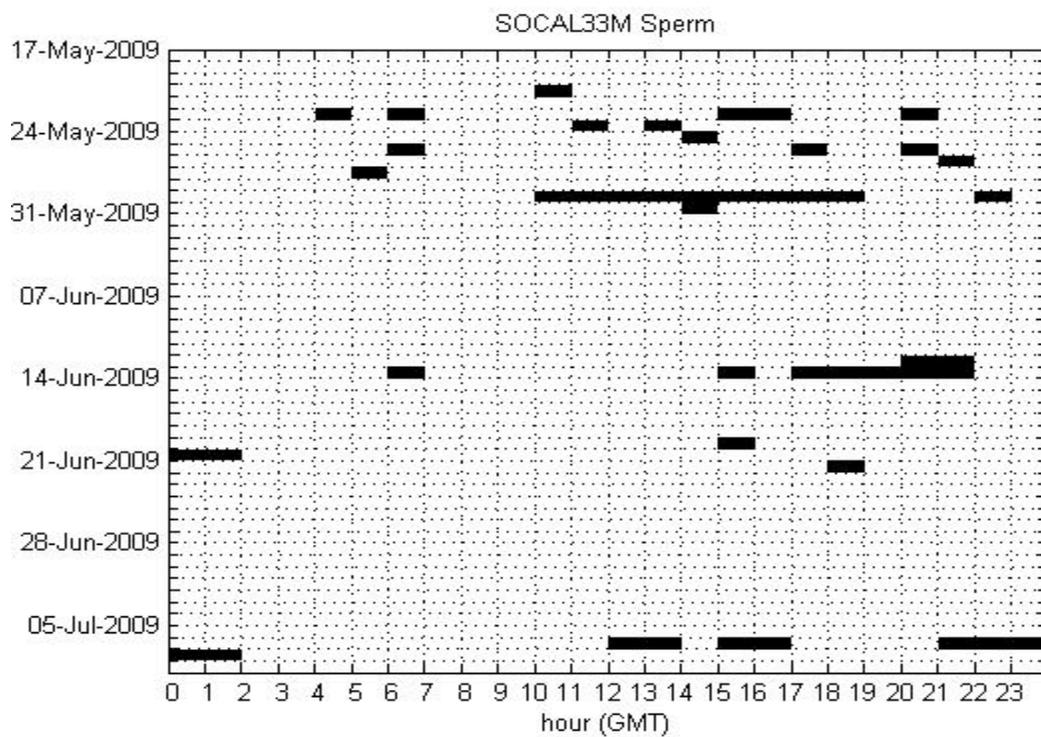
Fin Whale – “20-Hz” Call in Hourly Bins



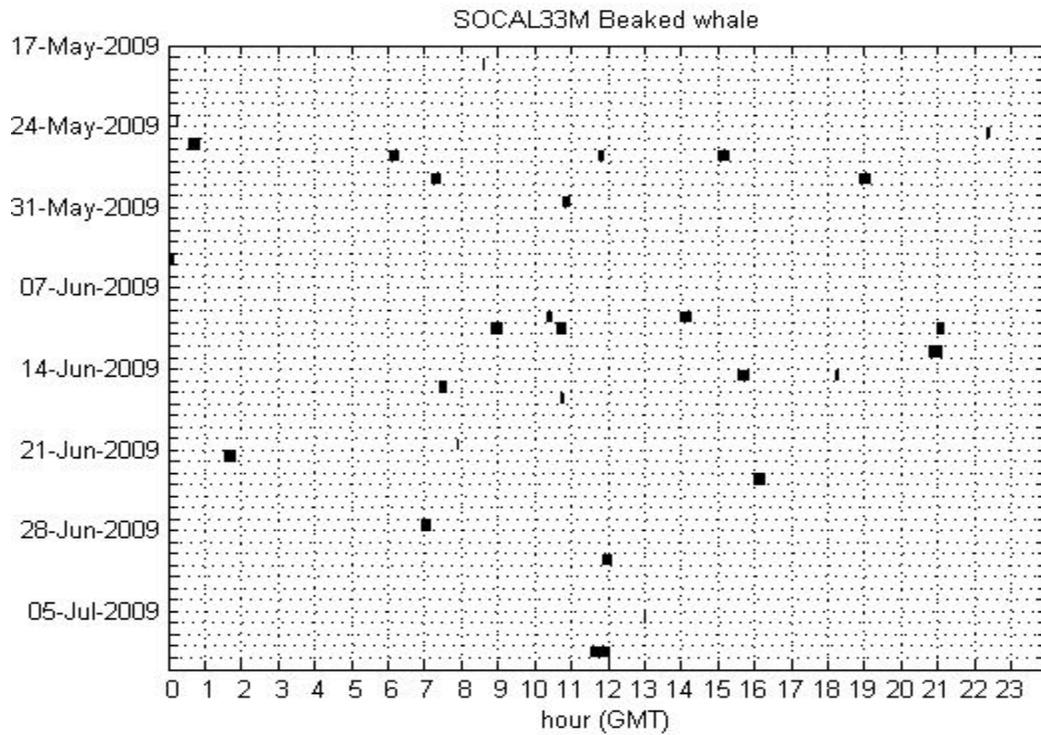
Fin Whale – “50 Hz” Call in Hourly Bins



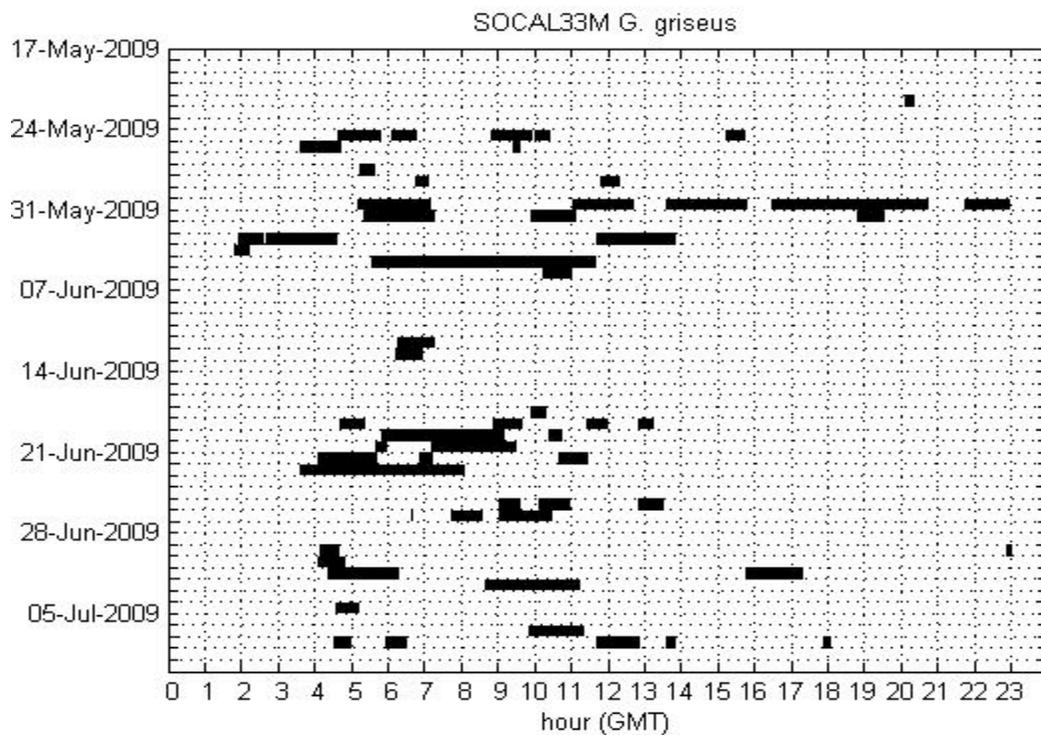
Humpback Whale – Song in Hourly Bins



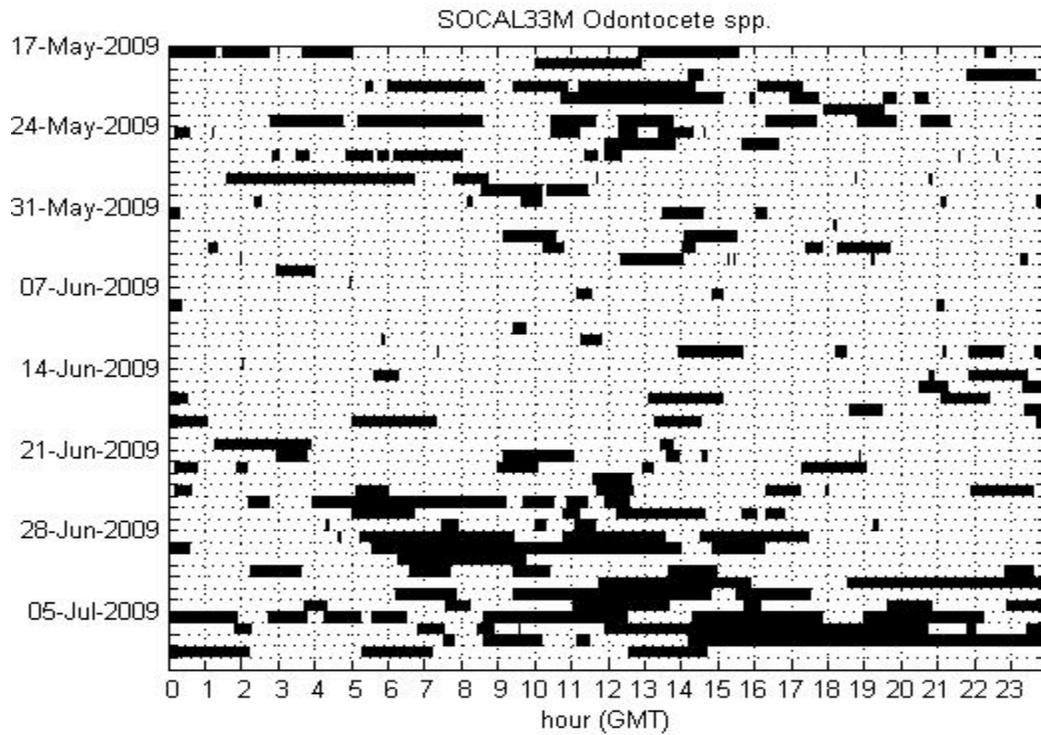
Sperm whales – Echolocation Clicks in Hourly Bin



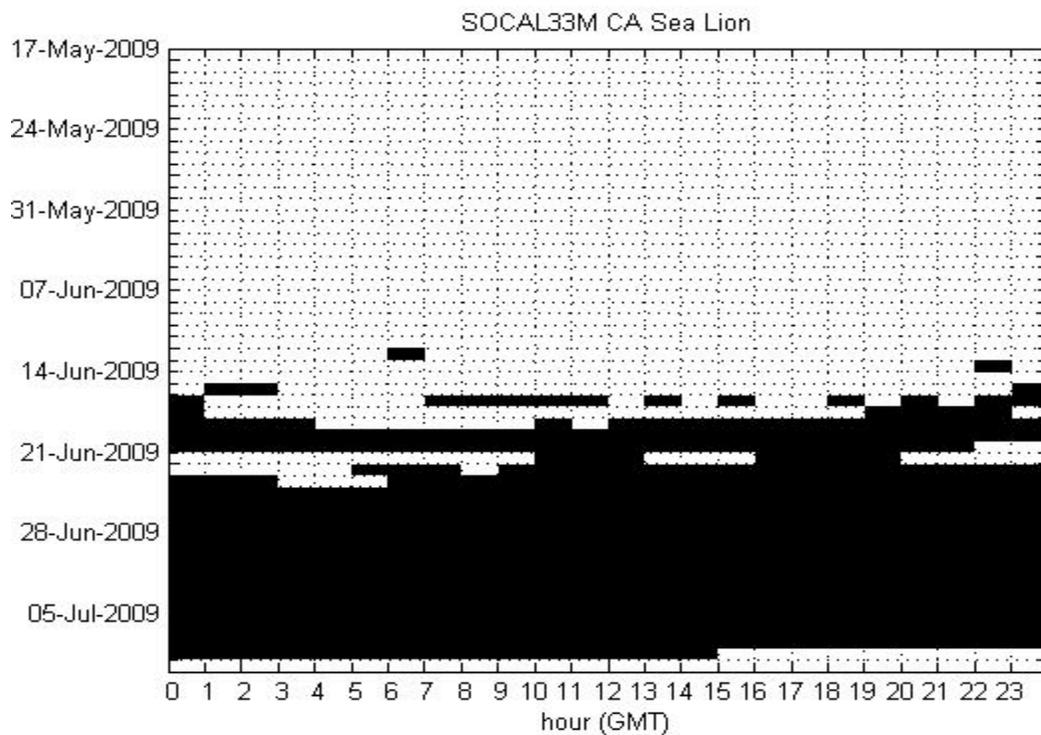
Beaked whales – Echolocation Pulses in One-Minute Bins



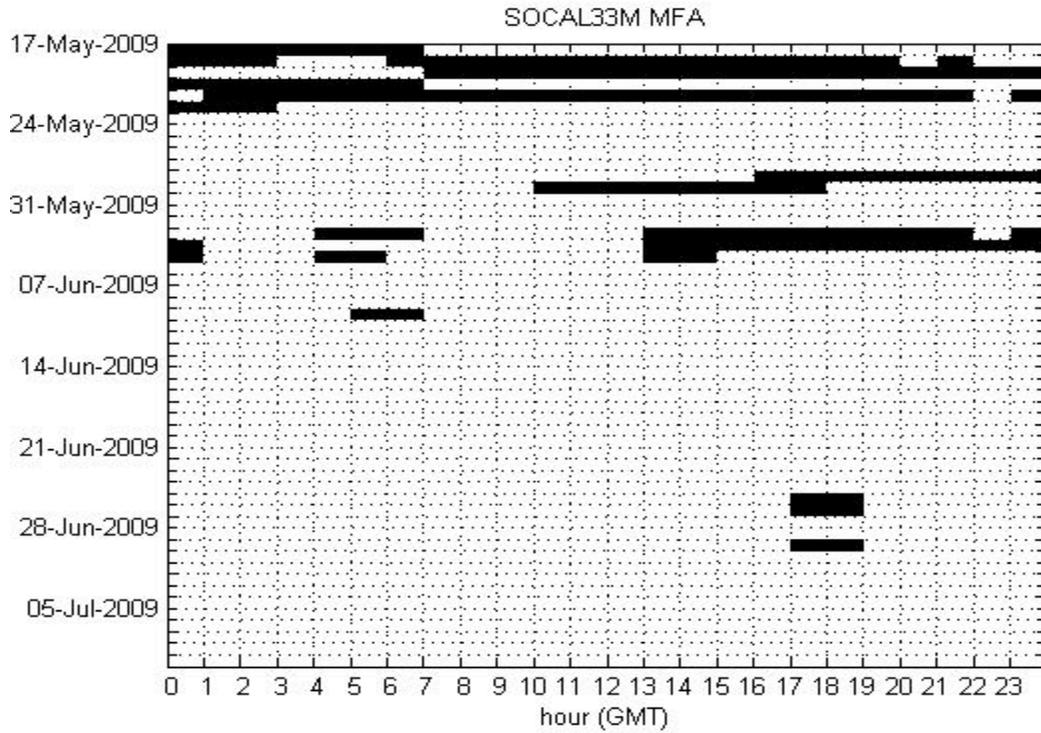
Risso's Dolphin – Echolocation Clicks in One-Minute Bins



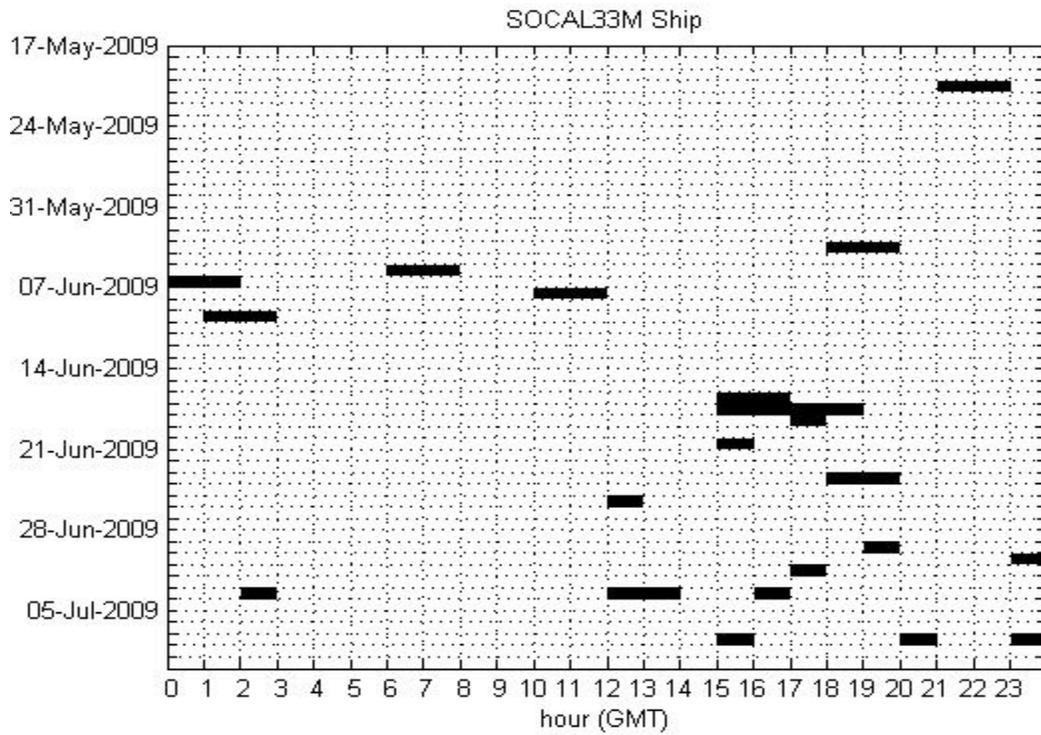
Unidentified Dolphin – Echolocation Clicks and Whistles in One-Minute Bins



California Sea Lion – Calls in Hourly Bins



Mid-Frequency Active Sonar (3 – 5 kHz) in Hourly Bins



Broadband Ship Noise in Hourly Bins

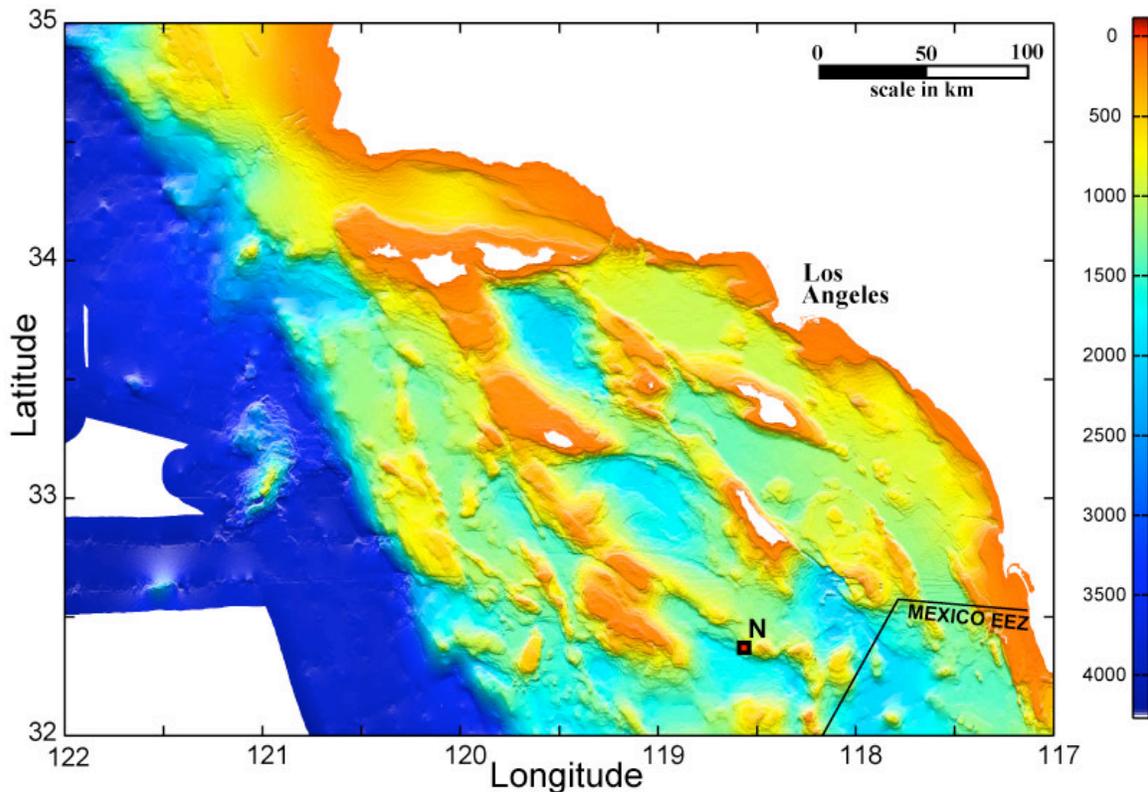
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of the Scripps Institution
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University of California,
San Diego



High Frequency Acoustic Recording Package Data Summary Report May 19, 2009 – July 12, 2009 SOCAL 33, Site N



**John Hildebrand, Hannah Bassett, Simone Baumann, Greg Campbell,
Amanda Cummins, Sara Kerosky, Karlina Merkens, Lisa Munger,
Marie Roch and Sean Wiggins**

Marine Physical Laboratory, Scripps Institution of Oceanography
University of California San Diego, LA Jolla, CA 92037-0205

Contract Number: FISC N00244-08-1-0028
Project Title: Southern California Marine Mammal Studies
Location: Site N, Latitude 32-22.205 N, Longitude 118-33.905 W, Depth 1295 m
Deployment Cruise: SOCAL 33, R/V Sproul
Recording Period: May 19, 2009 – July 12, 2009
Sample Rate: 200kHz Recording Interval: Continuous

Summary

This report summarizes data analysis for deployment 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.

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 analyst 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 1 gives a summary by species or anthropogenic sound source of the number of hours and days they were detected, as well as the percentage of hours or days detected.

Site N is located south of San Clemente Island, an area of naval training activity. The HARP at site N was deployed by the R/V Sproul during cruise SOCAL 33, on May 19, 2009 and recovered on the R/V Sproul during cruise SOCAL 34 on July 22, 2009. It recorded acoustic data continuously at a 200 kHz sample rate between 15:00 May 19 and 21:19 July 12, a total of 54 days (1302 hours) of recording.

Detected species include: blue whale, fin whale, humpback whale, Minke whale, sperm whale, killer whale, beaked whales, Risso's dolphin, Pacific white-sided dolphin, unidentified dolphin, and California sea lions. Anthropogenic sounds include mid-frequency active sonar (3.5 kHz) and broadband (10 Hz – 10 kHz) ship noise. Blue whale D calls, associated with feeding and A+B song calls began at this site on about June 1, 2009. Fin whales at 20-Hz are present throughout the data. Fin whales at 50-Hz are predominantly present after June 1, 2009. Humpback whale song was recorded sporadically, primarily in the later part of June. A single bout of Minke whale song was recorded in late May, and a single encounter with sperm whales was recorded in mid-June. Two encounters with killer whales were recorded, in early June and late June. Beaked whales (primarily Cuvier's beaked whales) were recorded throughout the data set, on 87% of the recording days. Risso's dolphins were recorded on 9% of recording

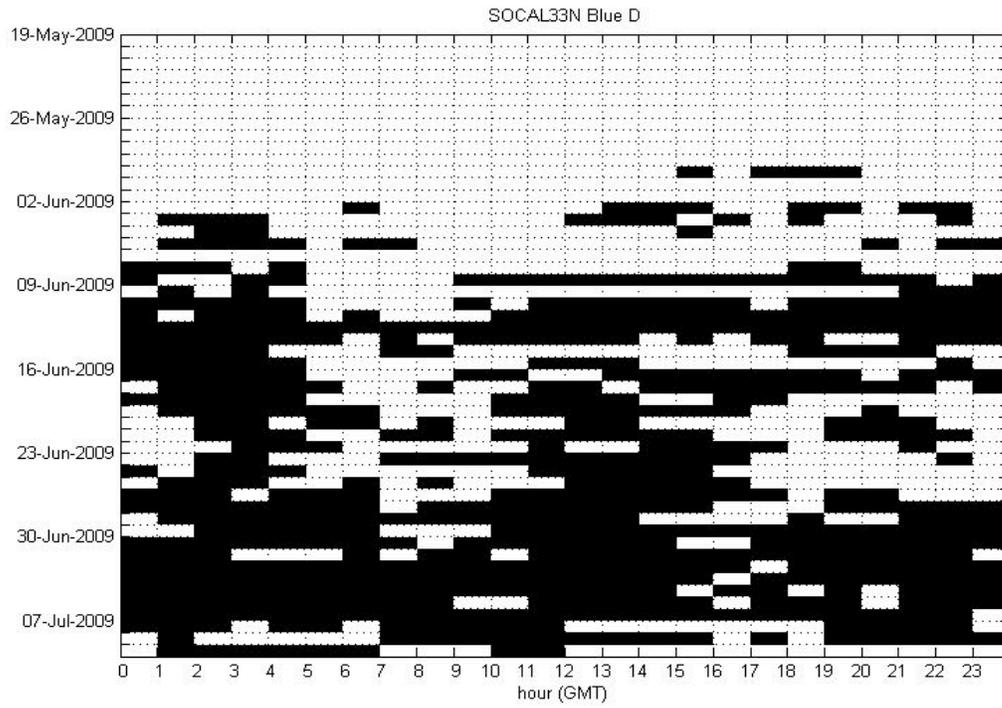
days, and Pacific white-sided dolphins were recorded only during a single encounter. Unidentified dolphin whistles and echolocation clicks were recorded throughout the data, but at the highest rates during the later portion of the data set. The most probable dolphin species represented by these data are common dolphins (both long and short beaked) as well as bottlenose dolphins. California sea lions were recorded during a few encounters in late June and early July.

Anthropogenic sound sources include mid-frequency active (MFA) sonar (3 – 5 kHz) and broadband (10 Hz – 10 kHz) ship noise. The MFA sonar was recorded primarily in mid-to-late May, and again in late June and early July. Broadband ship noise, tabulated from the mid-frequency data set to indicate close approaches, was recorded throughout the data set.

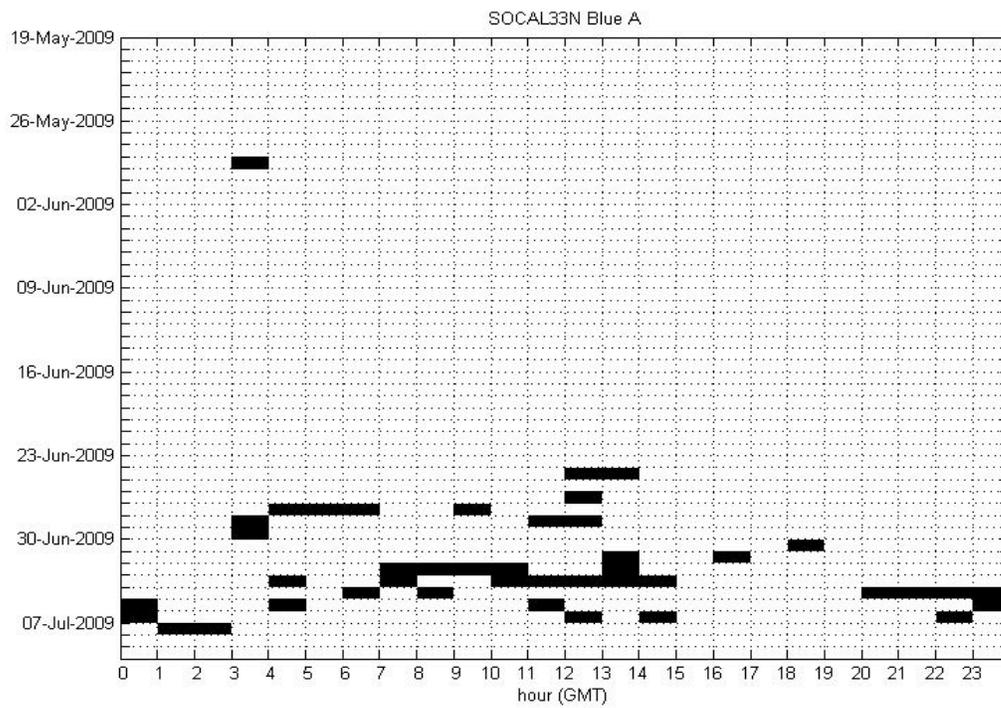
Species/Source	Call Type	# Hour Bins	Percent	# Daily Bins	Percent
Blue Whale	D	543	42	38	70
Blue Whale	A	43	3	14	26
Blue Whale	B	223	17	36	67
Fin Whale	20 Hz	558	43	47	87
Fin Whale	50 Hz	209	16	43	80
Humpback Whale	Song	17	1.3	10	19
Minke Whale	Song	1	0.1	1	2
Sperm Whale	Echolocation	1	0.1	1	2
Killer Whale	Whistles/ Echolocation	11	0.8	6	11
Beaked Whale	Echolocation	213	16	48	88
Risso's Dolphin	Whistles/ Echolocation	15	1.1	5	9
Pacific WS Dolphin	Whistles/ Echolocation	1	0.1	1	2
Un ID Dolphin	Whistles/ Echolocation	781	60	52	96
CA Sea Lion	Bark/Whine/ Buzz	14	1.1	6	11
MFA Sonar	Ping	133	10	21	39
Ship	Broadband Noise	220	17	45	83

Table 1. Detections of Marine Mammal Species and Anthropogenic Sound Sources.

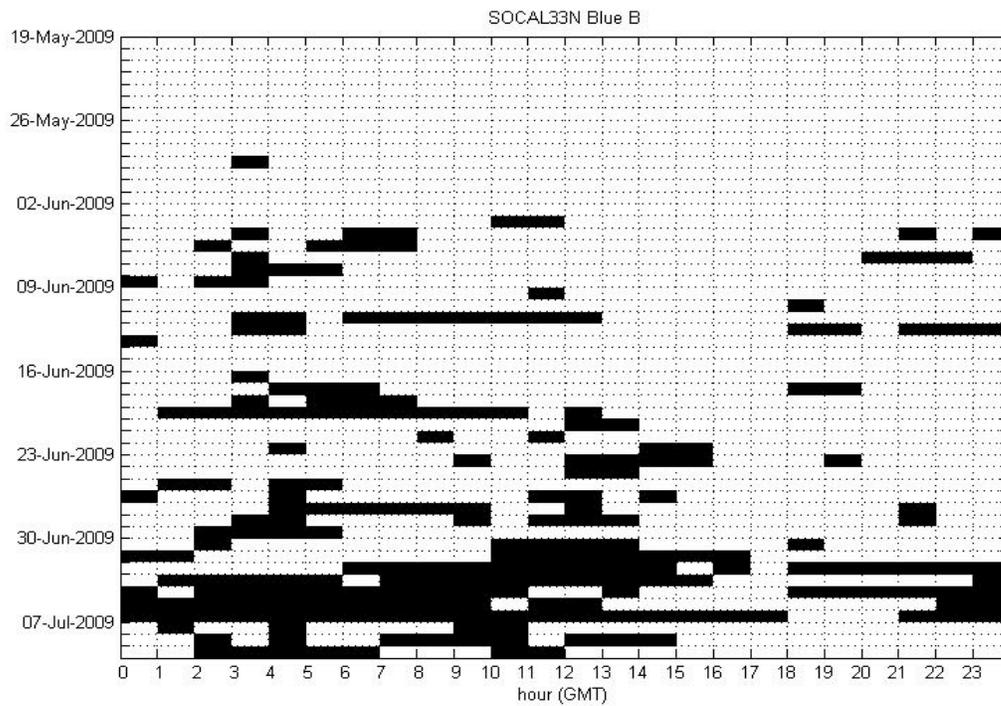
MARINE MAMMAL DETECTIONS BY SPECIES AND CALL TYPE AND ANTHROPOGENIC SOUND BY SOURCE TYPE



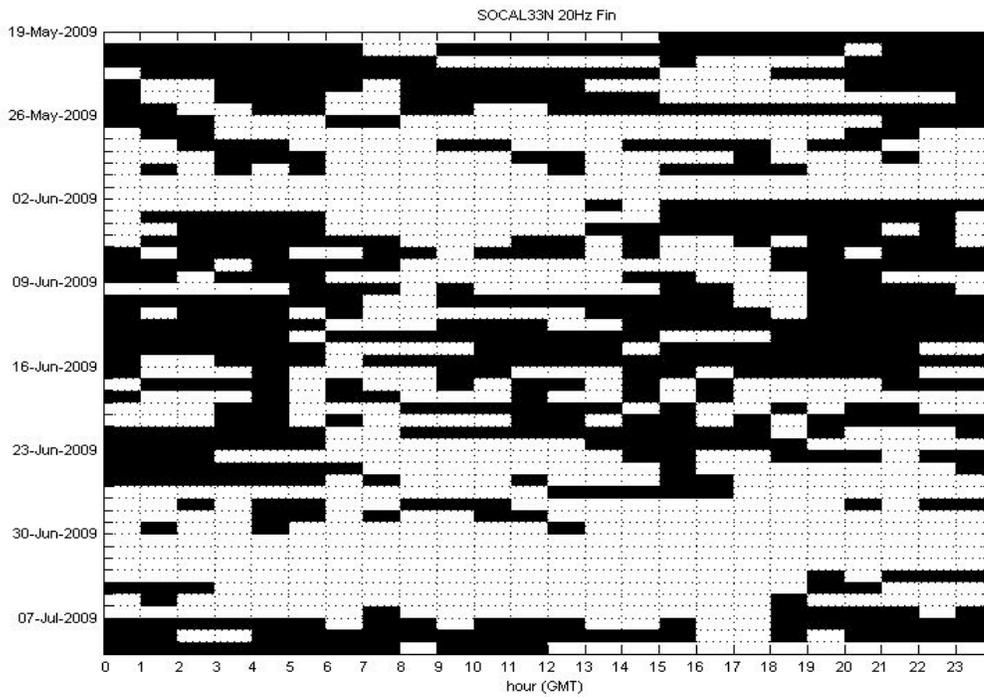
Blue Whale – “D” Call in Hourly Bins



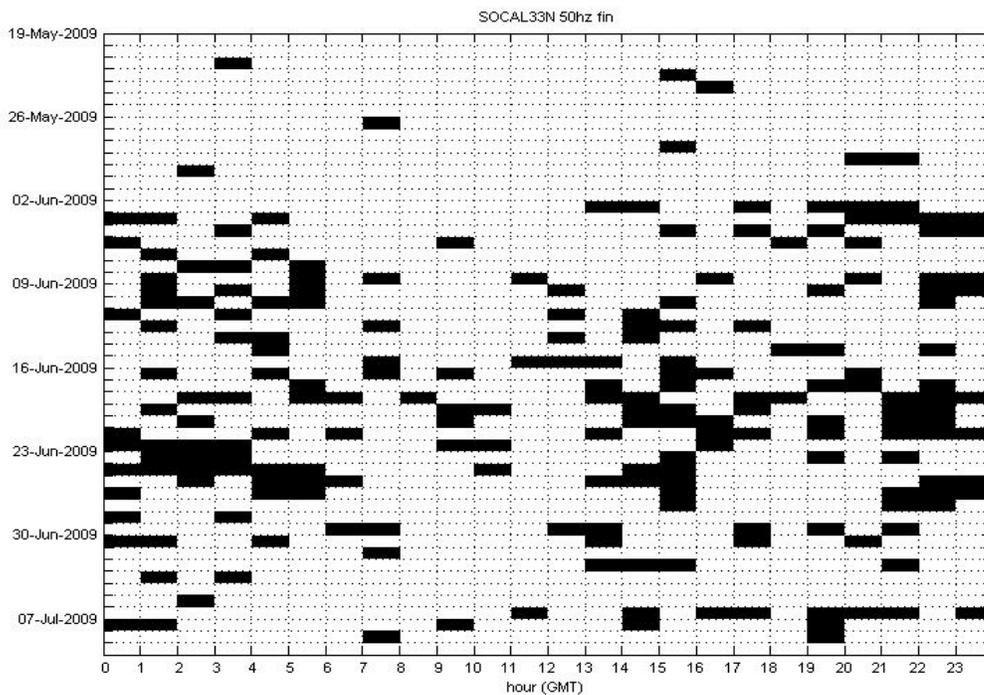
Blue Whale – “A” Call in Hourly Bins



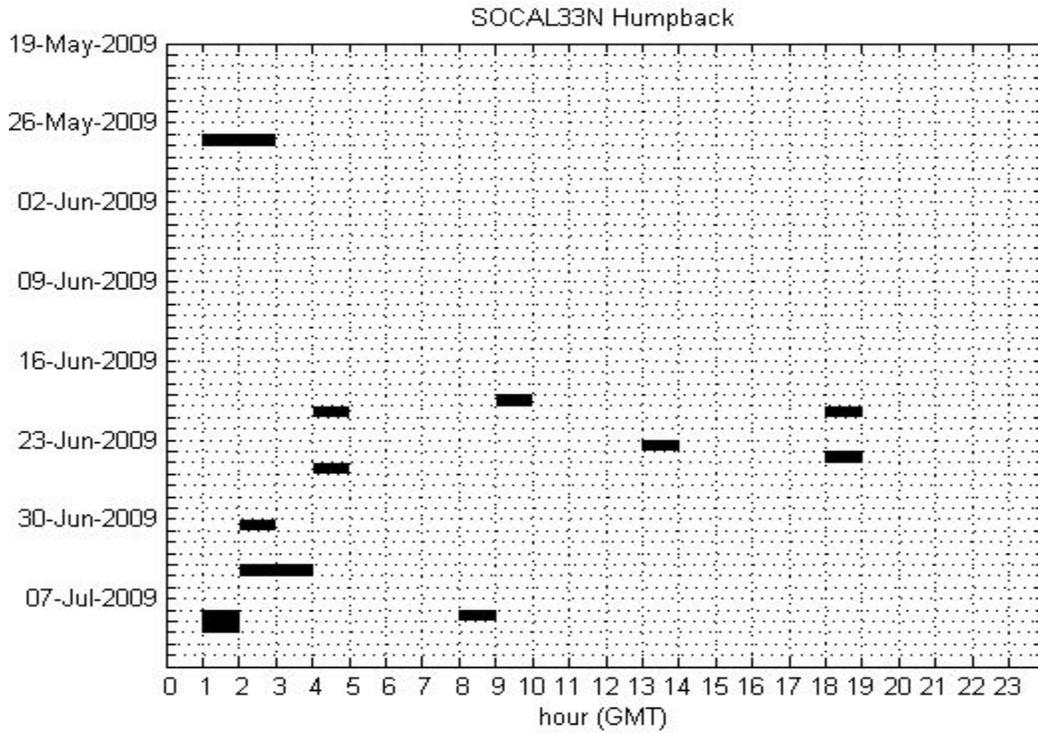
Blue Whale – “B” Call in Hourly Bins



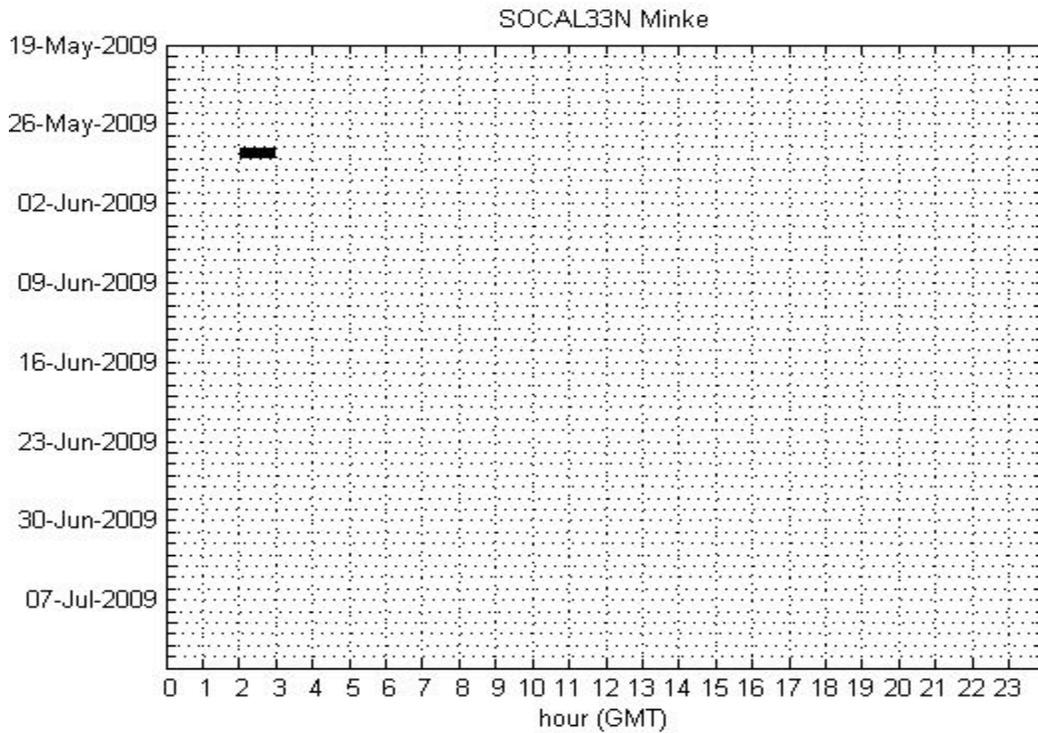
Fin Whale – “20-Hz” Call in Hourly Bins



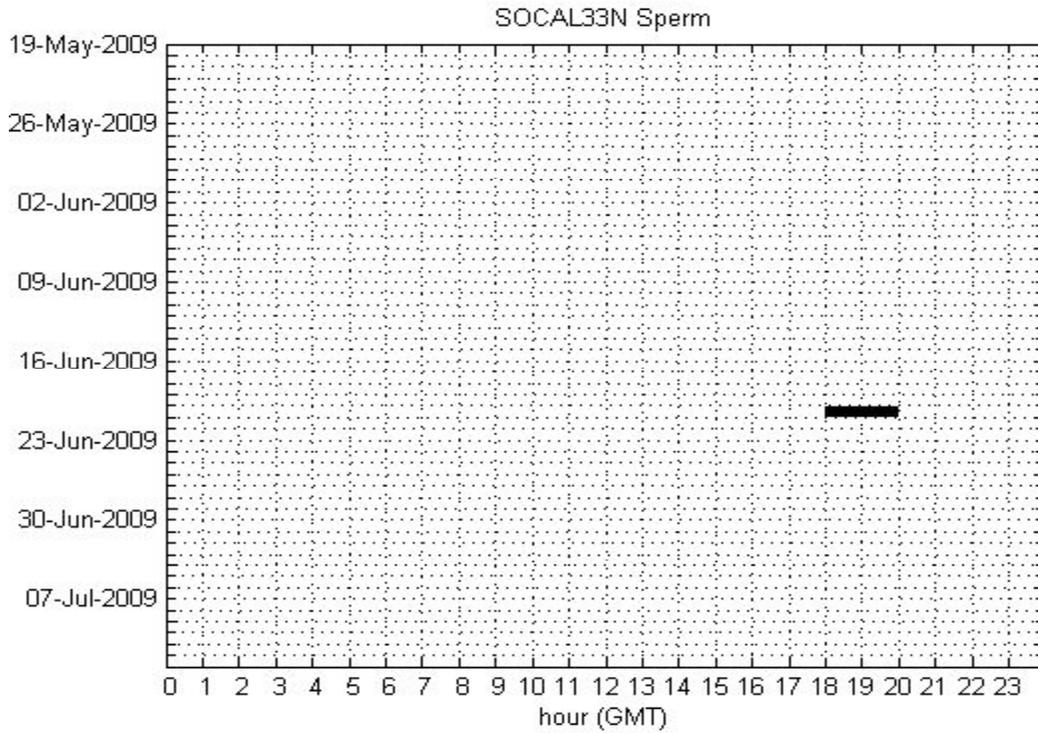
Fin Whale – “50 Hz” Call in Hourly Bins



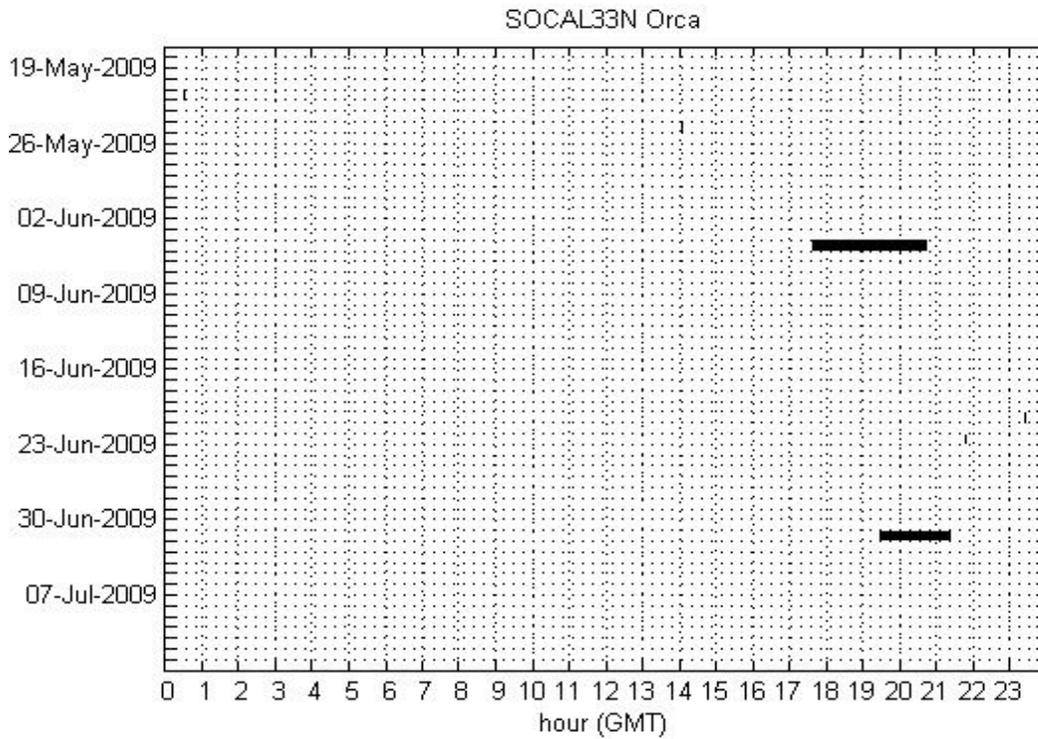
Humpback Whale – Song in Hourly Bins



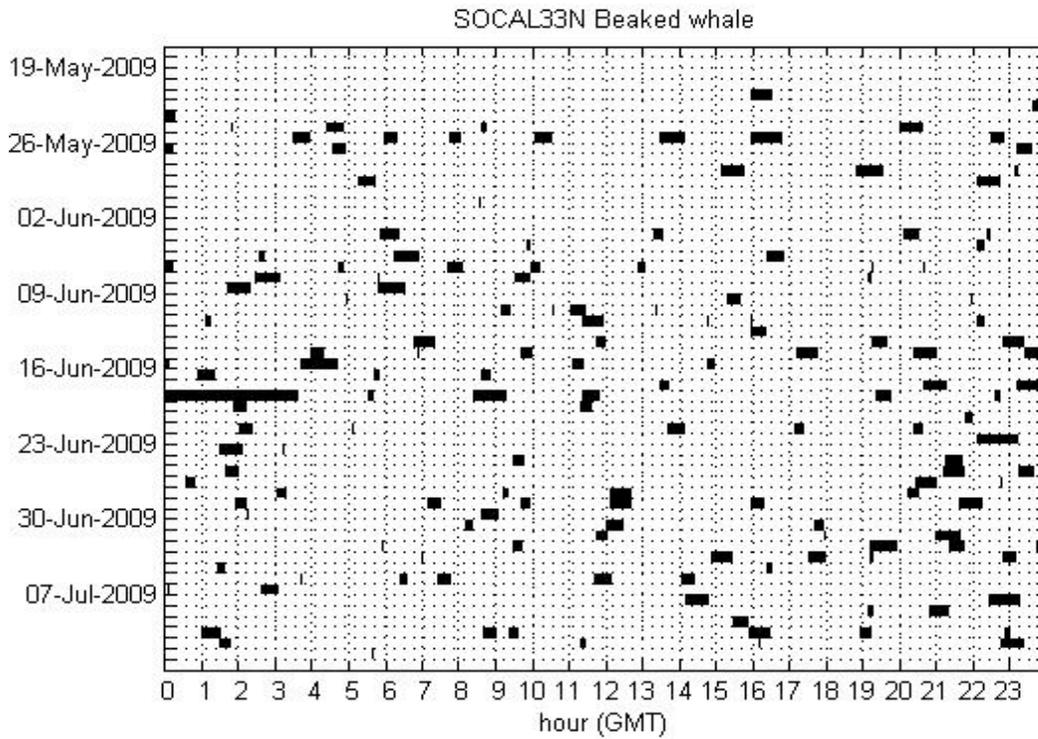
Minke Whale – Song in Hourly Bins



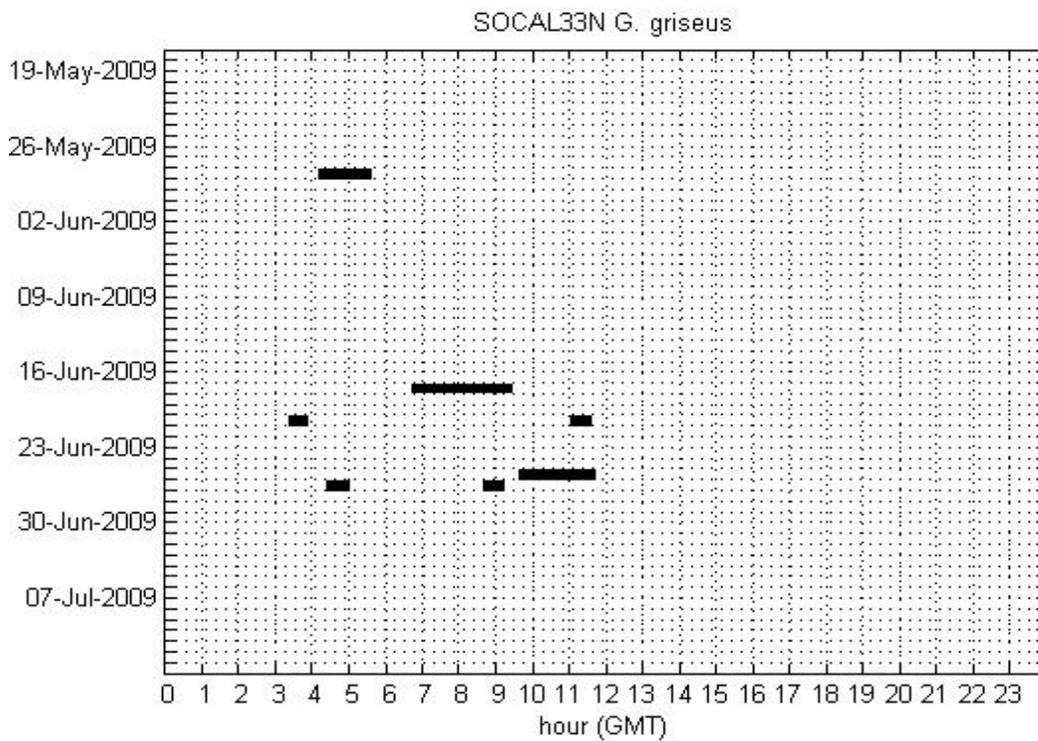
Sperm whales – Echolocation Clicks in Hourly Bin



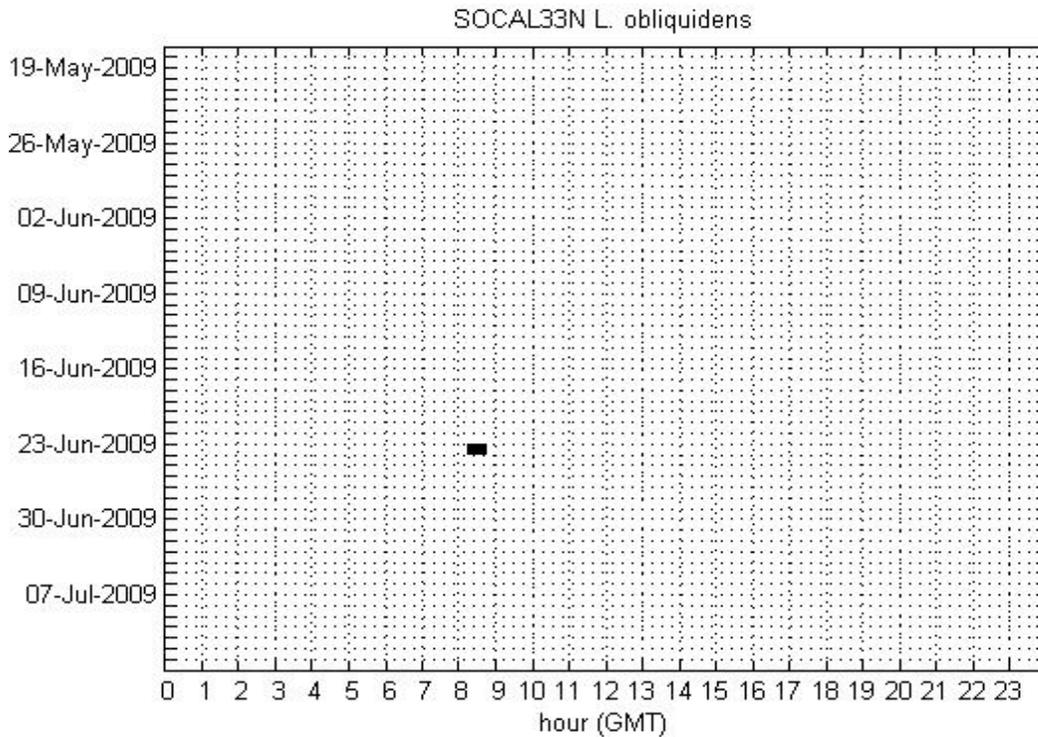
Killer whales – Echolocation Clicks and Whistles in One-Minute Bin



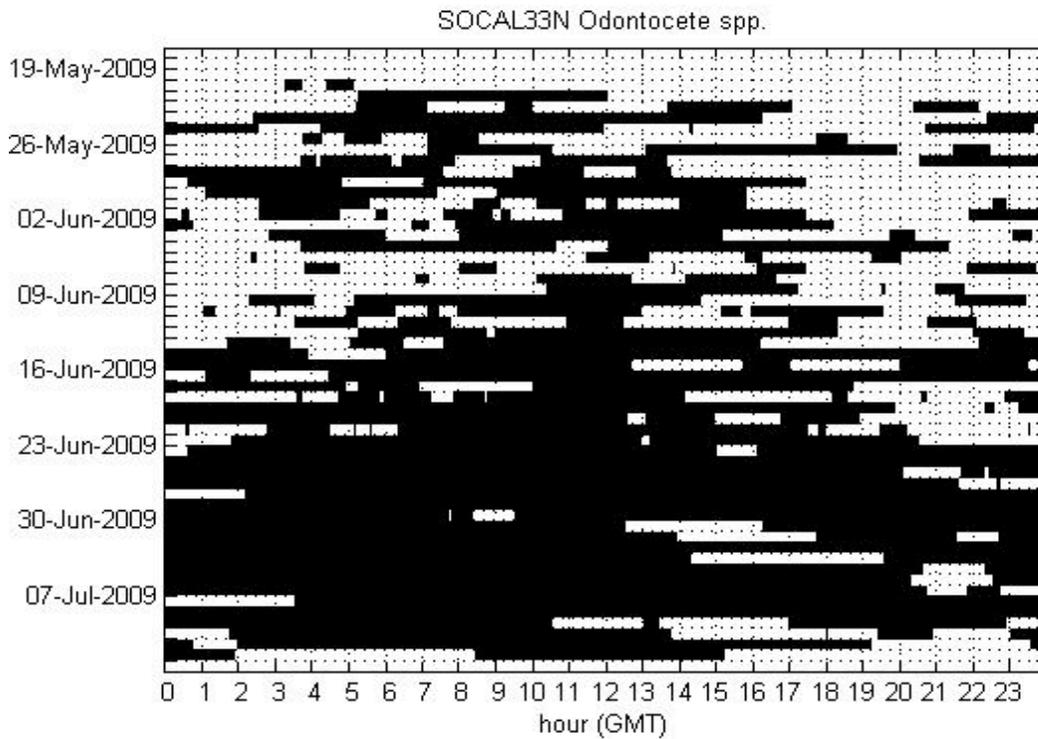
Beaked whales – Echolocation Pulses in One-Minute Bins



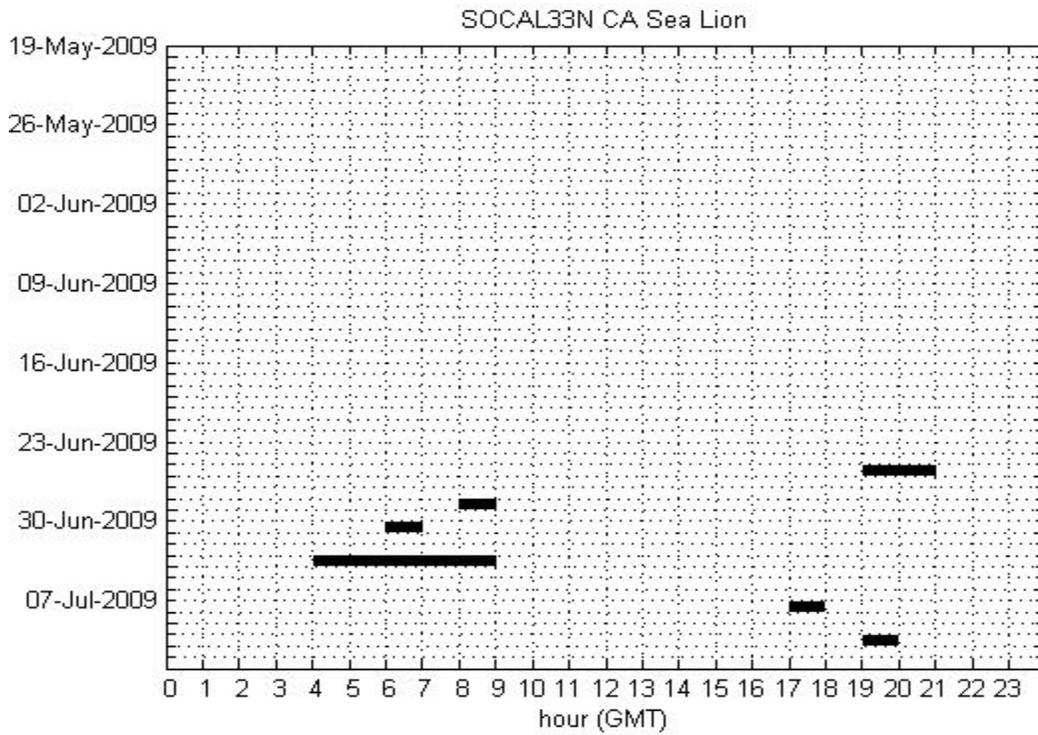
Risso's Dolphin – Echolocation Clicks in One-Minute Bins



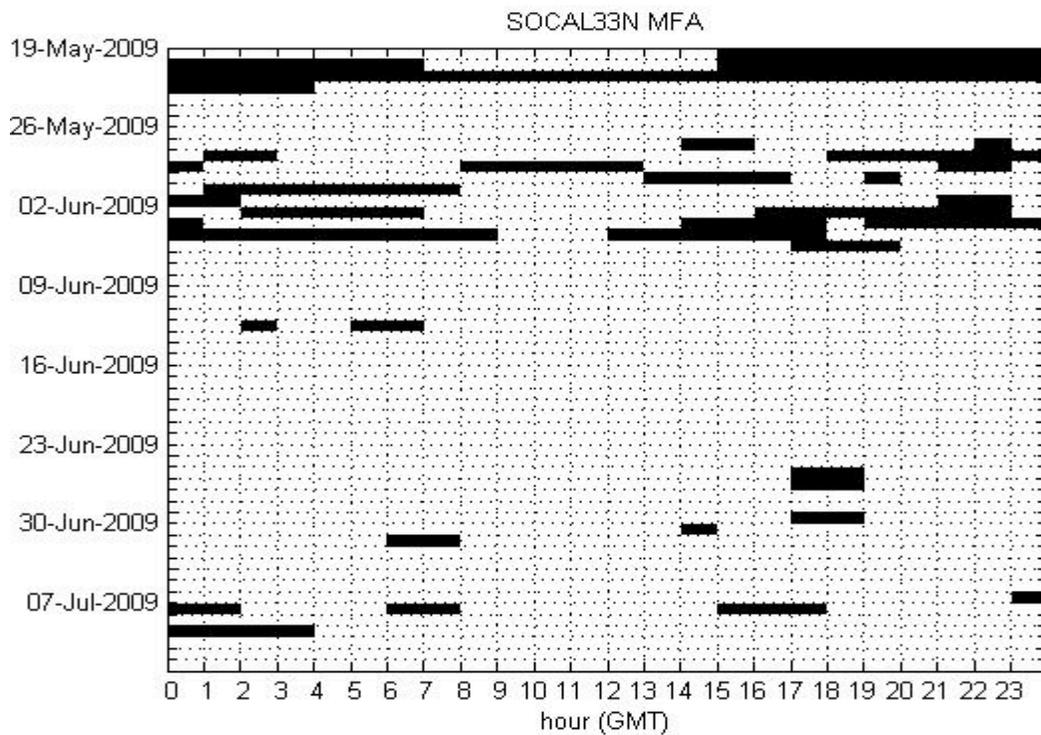
Pacific White-sided Dolphin – Echolocation Clicks in One-Minute Bins



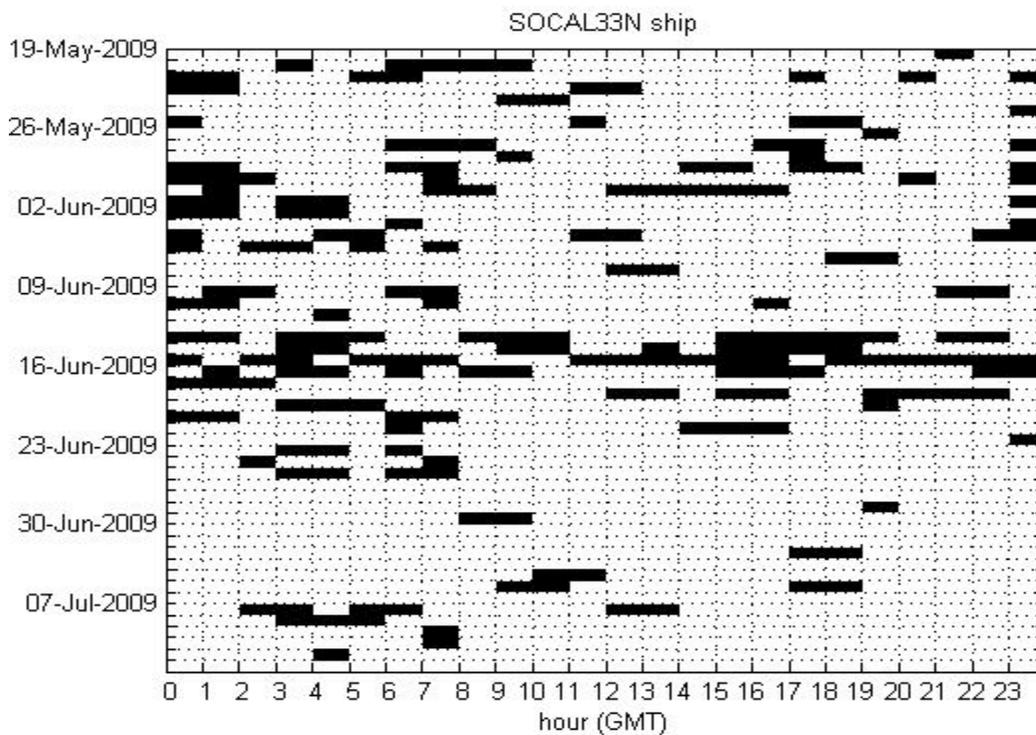
Unidentified Dolphin – Echolocation Clicks and Whistles in One-Minute Bins



California Sea Lion – Calls in Hourly Bins



Mid-Frequency Active Sonar (3 – 5 kHz) in Hourly Bins



Broadband Ship Noise in Hourly Bins