Acoustic and Visual Survey of Cetaceans at Palmyra Atoll

Intermediate report, August 29, 2007

Results from Palmyra long-term data
October 19, 2006-March 23, 2007

Simone Baumann

Scripps Institution of Oceanography
John Hildebrand Lab

Contact: sbaumann@ucsd.edu, jhildebrand@ucsd.edu

In the following I present preliminary results from the long-term dataset that was recorded during October 19, 2006 and March 23, 2007 by an autonomous bottom-moored high-frequency acoustic recording package (HARP). I compare this data with hydrophone array recordings that were taken while in the vicinity of groups of animals.

1. Daily cycle of acoustic activity

When looking at Long-term spectral averages (LTSAs) of one week of data (figure 1) there is a clear daily pattern visible that occurs on all days of the 6 months recorded. Ambient noise gets louder at sunset and seizes again around sunrise. Very regularly there is strong acoustic noise around 5 kHz between 8 and 10pm of each day. Figure 2 is a detailed view of two consecutive days showing this cycle.

Most delphinid signals on all days were from large delphinid groups. Dolphin echolocation signals are more dominant during the night with often a bimodal distribution of stronger activity shortly after dusk and in the early morning hours. There seem to be a lot of communication signals especially at dusk.

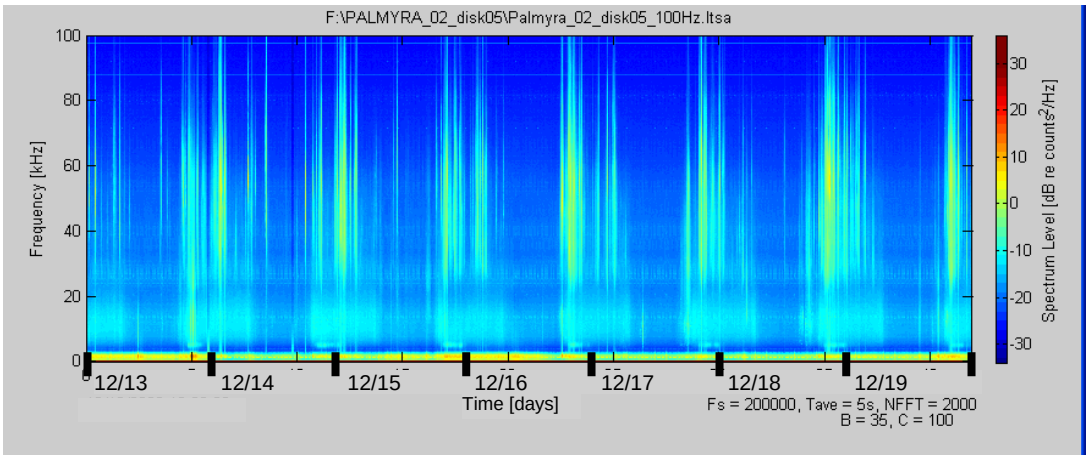

Figure 1: Weekly LTSA with daily acoustic cycle visible. December 13 - December 19, 2006, starts at midnight, local time.

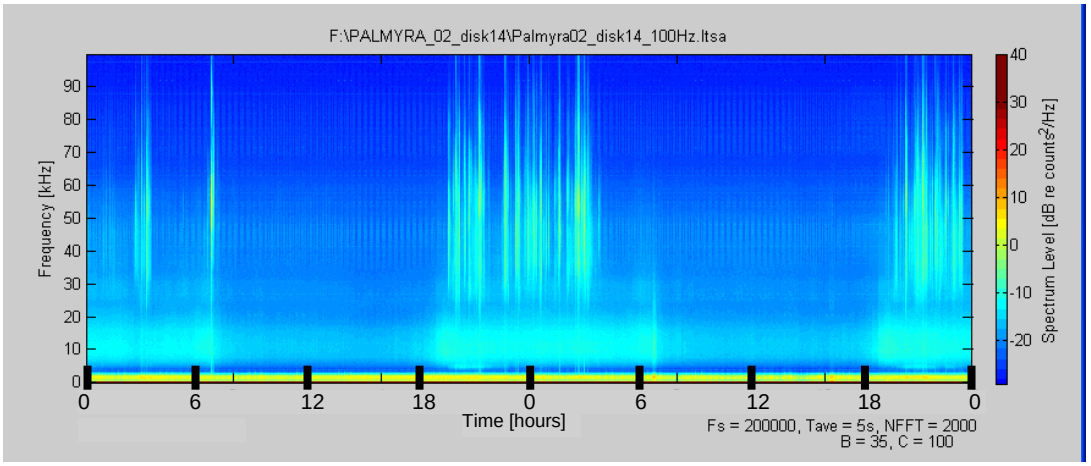

Figure 2: LTSA detail of 2 days showing the daily cycle. March 21 + 22, 2007, starts at midnight, local time.

2. Interesting species on long-term dataset

By manually looking through the dataset a few interesting species have been identified and will be discussed in this paragraph.

2.1 **Sperm whales**

Sperm whale clicks have been found on the long-term dataset. Sperm whales must have been vocal in the vicinity of Palmyra Atoll between 3-8 pm on January 15 (figure 3) and between 6-8 am on January 16, 2007. These clicks are very distinct and an automatic detection routine will be developed to get possible other occurrences.

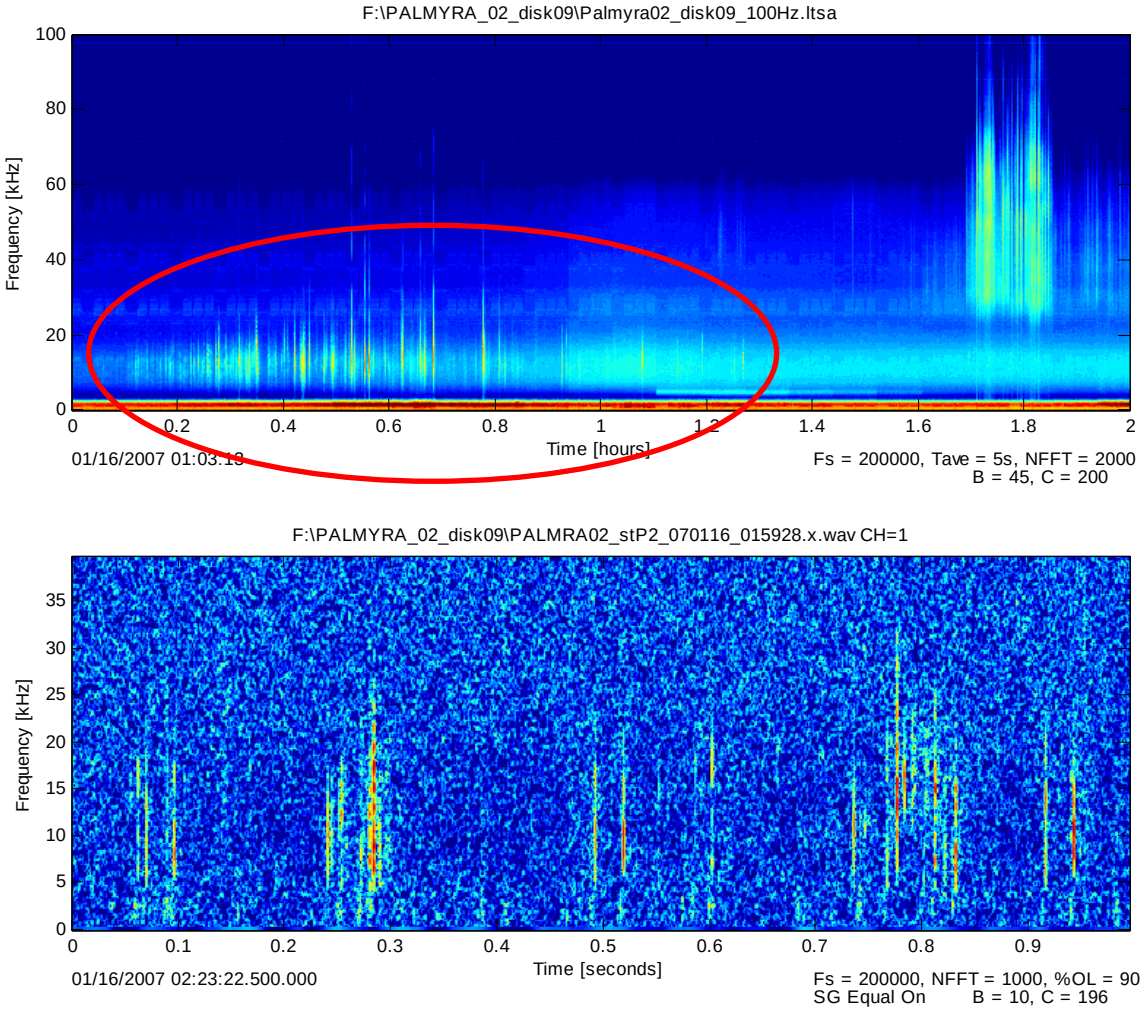

Figure 3: Sperm whale clicks on long-term data set. Top: LTSA – detection starts on January 15, 3pm local time; they were about 5 hours audible (time axis: 8 hours real time, duty cycle ¼, 2 hours actual recording time). Bottom: 1 second recording, typical sperm whale clicks with major frequency content at around 10-15 kHz.

2.2 **Beaked whales**

On the long-term recordings I found so far two incidents where I can be certain that the recordings are from beaked whales. Below you can find a description of the recorded calls and a comparison of the two detections.

2.2.1 **Detection 1 – January 24, 2007 at 1pm local time**

On January 24, 2007 at 1pm local time there was at least one beaked whale audible during the 5 minutes recording time. It used mostly regular beaked whale clicks which have a sweep-like character. Intermittently there appeared a different kind of clicks which have been described as buzz clicks in literature (figure 4)

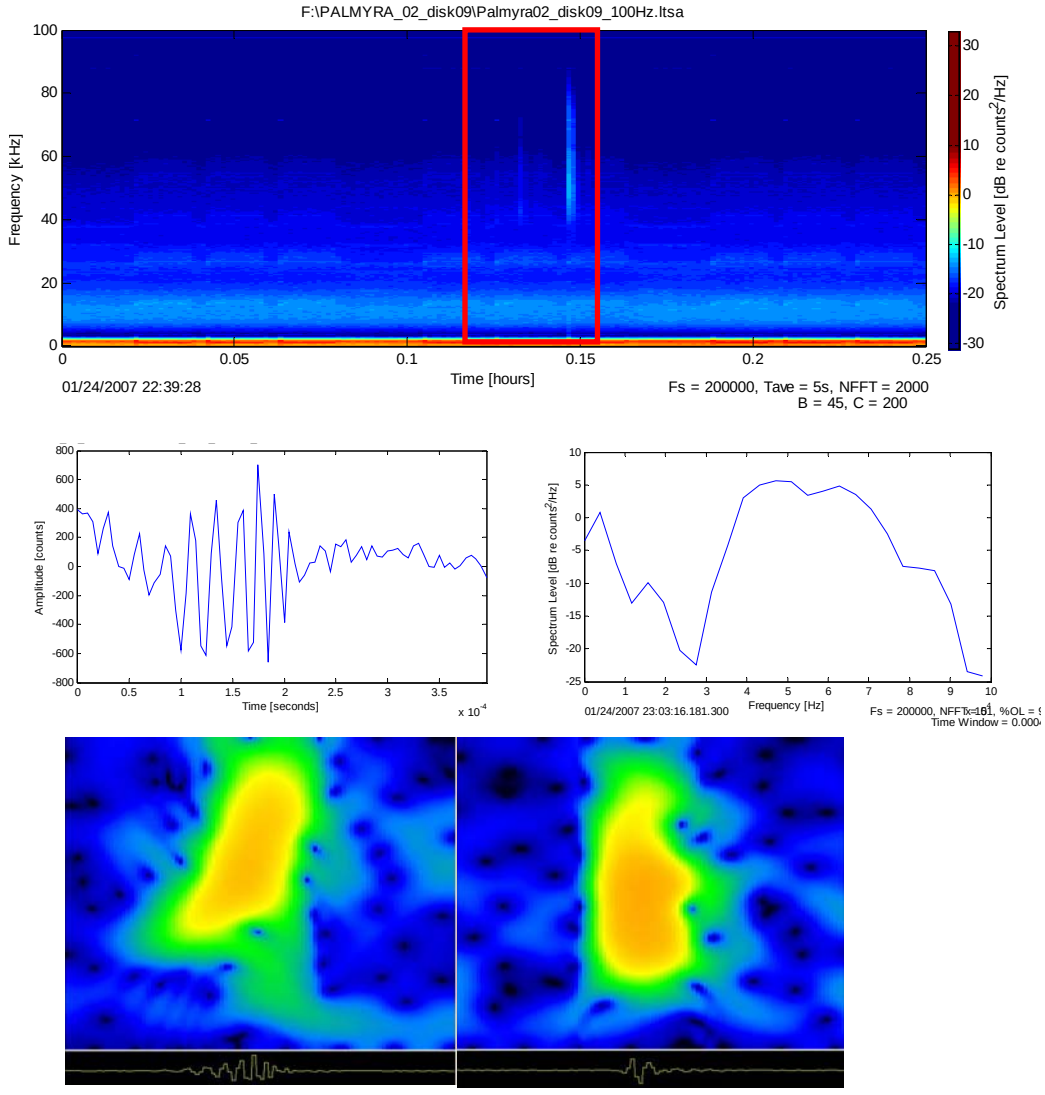

Figure 4: Beaked whale clicks on long-term data set, example 1. Top: LTSA – detection on January 24, 1pm local time; 5 minutes audible (time axis: 1 hour real time, duty cycle ¼, 0.25 hour actual recording time). Middle: typical waveform (left) and spectra (right) of a beaked whale regular click. Bottom: spectrogram and waveform of a regular click (left); spectrogram and waveform of probably a buzz click (right).

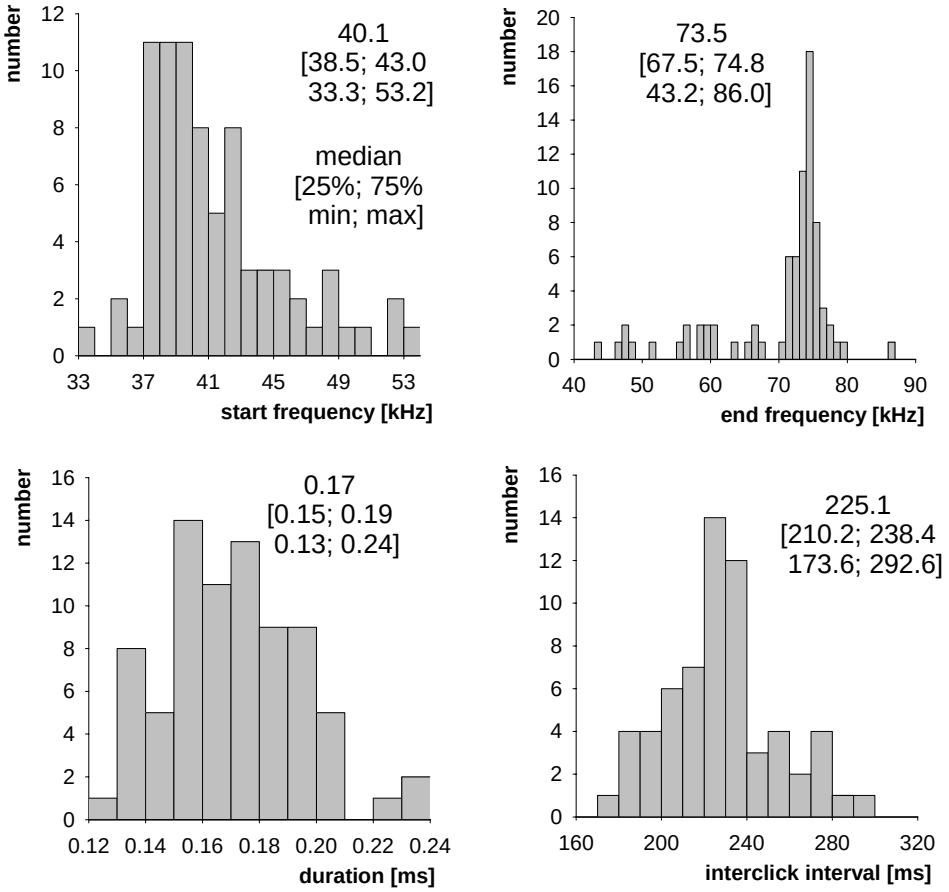

Figure 5: Histogram of click parameters start frequency, end frequency, duration and interclick interval with median, 25 and 75% quartiles, minimum and maximum value of beaked whale regular clicks, example 1.

The spectral measurements (FFT 32, overlap 99.5%) gave a median starting frequency of 40 kHz, an end frequency of 73 kHz, duration of 0.17ms and an inter-click interval of 225 ms (figure 5).

2.2.2 **Detection 2**

On February 10, 2007 at 11am local time there were at least two beaked whales audible during the 5 minutes recording time. The animals mostly used regular beaked whale clicks which have a sweep-like character (figure 6). Intermittently there appeared a different kind of clicks which have been described as buzz clicks in literature.

The spectral measurements (FFT 32, overlap 99.5%) of these clicks gave a median starting frequency of 38 kHz, an end frequency of 54 kHz, duration of 0.16ms and an inter-click interval of 222 ms (figure 7).

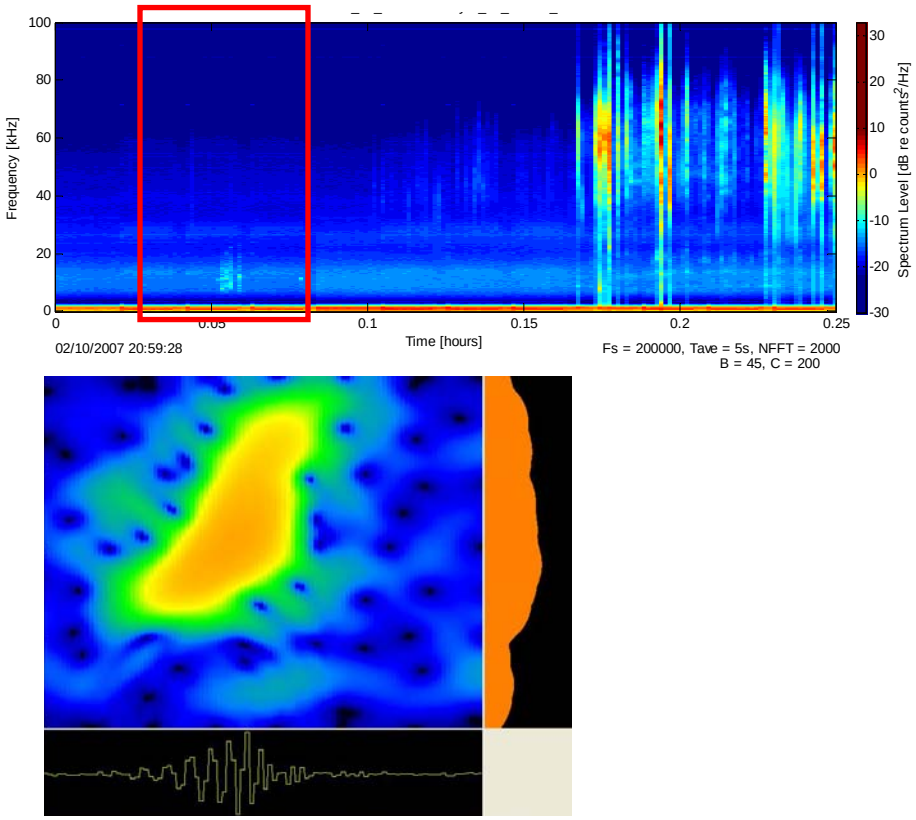

Figure 6: Beaked whale clicks on long-term data set, example 2. Top: LTSA – detection on February 10, 11am local time; 5 minutes audible (time axis: 1 hour real time, duty cycle ¼, 0.25 hour actual recording time). Bottom: spectrogram (top left), waveform (bottom left) and spectra (top right) of a regular click.

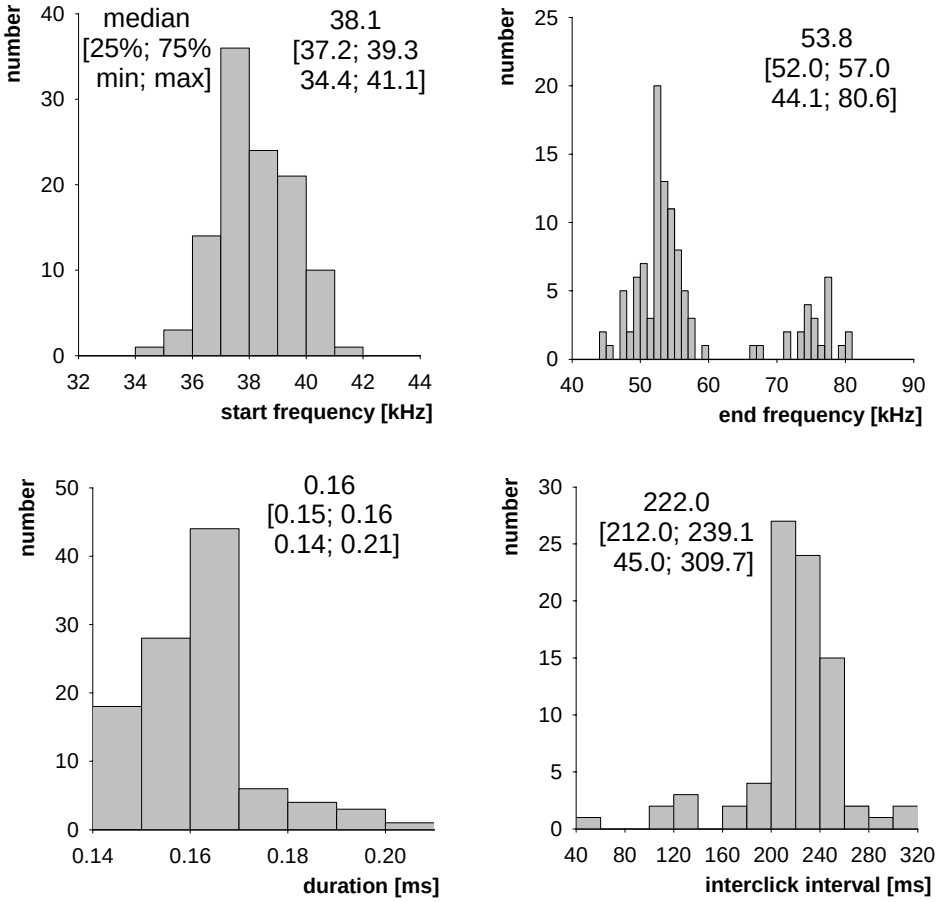

Figure 7: Histogram of click parameters start frequency, end frequency, duration and interclick interval with median, 25 and 75% quartiles, minimum and maximum value of beaked whale regular clicks, example 2.

2.2.3 **Comparison of detection 1 and 2**

The whales in example 2 had fainter clicks than those in example 1 and were probably farther away from the HARP. They had a lower starting and especially a lower end frequency, slightly shorter durations and inter-click intervals. The signals of the animals recorded in example 2 seemed to be more curved than those recorded in example 1.

Higher frequencies are attenuated stronger than lower frequencies over distance. One would expect that therefore the end frequency is more vulnerable to the effect of attenuation. It is with this in mind difficult to say according to the described parameters whether the animals of the two examples were of the same species or not.

The described parameters will allow implementing a detection algorithm to automatically count beaked whale occurrences on the long-term dataset.

2.3 **Melon headed whales**

On December 5, 2006, as an example of many, there were most probably melon-headed whales present at the HARP location (figure 8). As you can see on the LTSA there is a strong whistle activity visible in the region of 5-20 kHz, time axis 0-0.25 hour (real time 0-1 hour). The whistles of melon-headed whales are very characteristic (figure 9) and they will be useful for species discrimination. Unfortunately especially during night time hours, presumably while hunting there is very little whistle activity. Therefore it is necessary to discriminate also clicks on a species-specific level. Presently I am working on this.

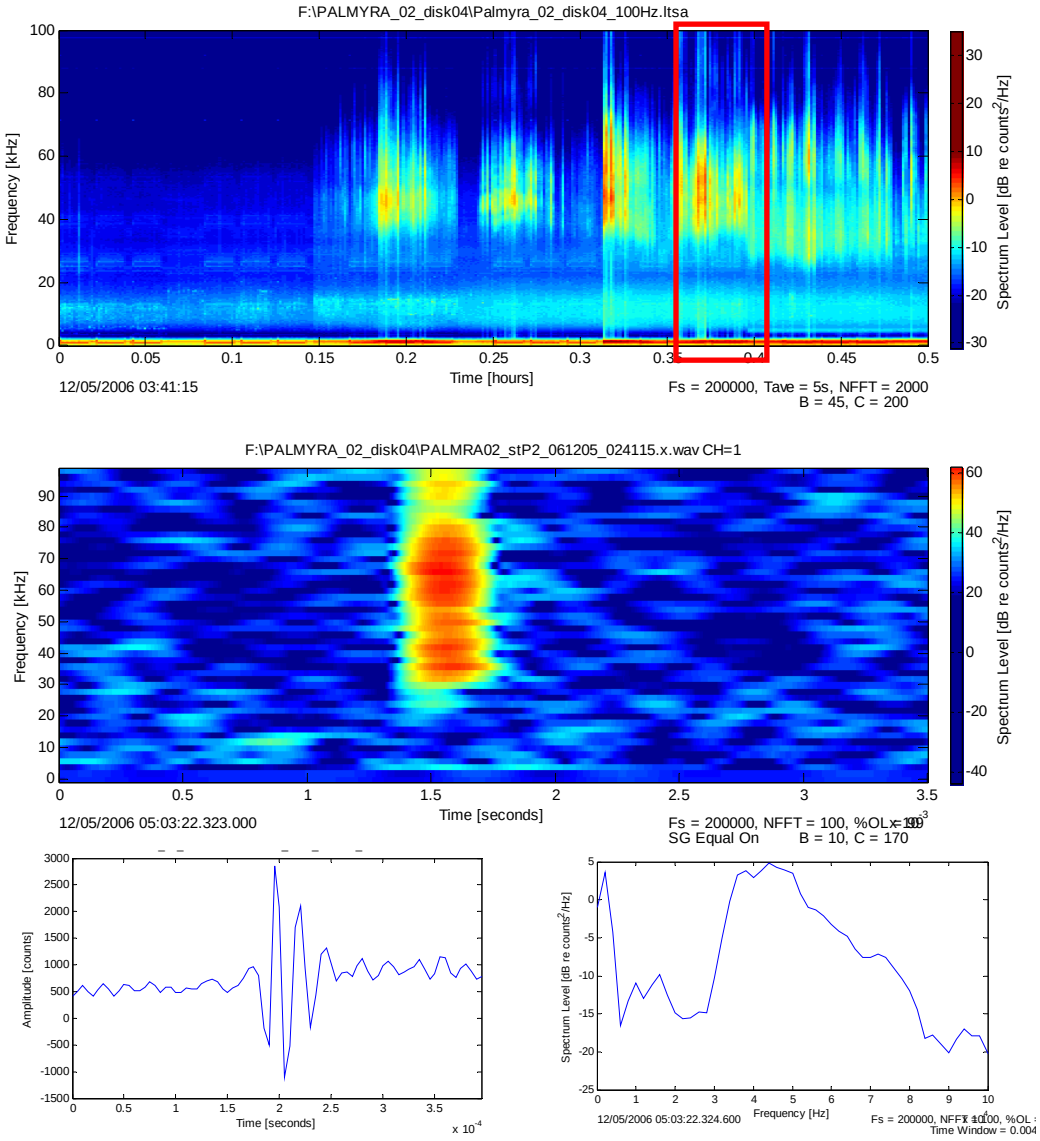

Figure 8: Recording of melon-headed whales on long-term data. Top: LTSA – December 5, 2006, display 6.30pm-8.30pm local time; about 4 hours audible (time axis: 2 hours real time, duty cycle ¼, 0.5 hours actual recording time). Center: on click enlarged. Bottom: waveform (left) and spectra of enlarged click.

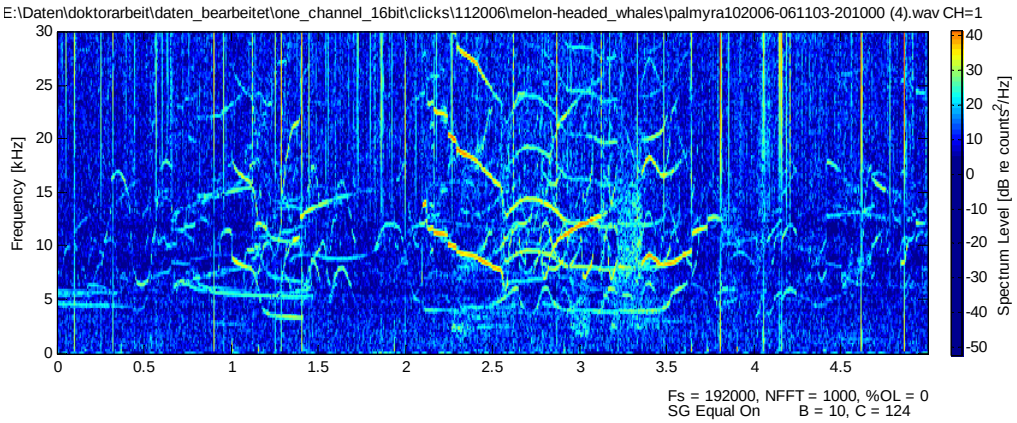

Figure 9: Whistles of melon-headed whales on acoustic-array data. 5s detail on November 3, 2006, 10:10 am local time.