University of St Andrews

600 YEARS

Detection and Classification of blue and fin whale calls using the PAMGuard Whistle and Moan detector

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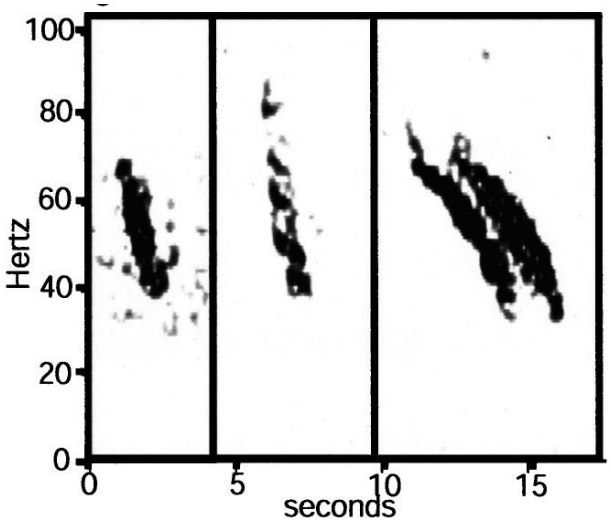
Outline

- The Challenge (You know this already)
- The Detector (You heard this in 2011)
- Classification (Pretty simple)
- Results (really bad !)
- Conclusions and Comment (Then I'll shut up)

The Challenge

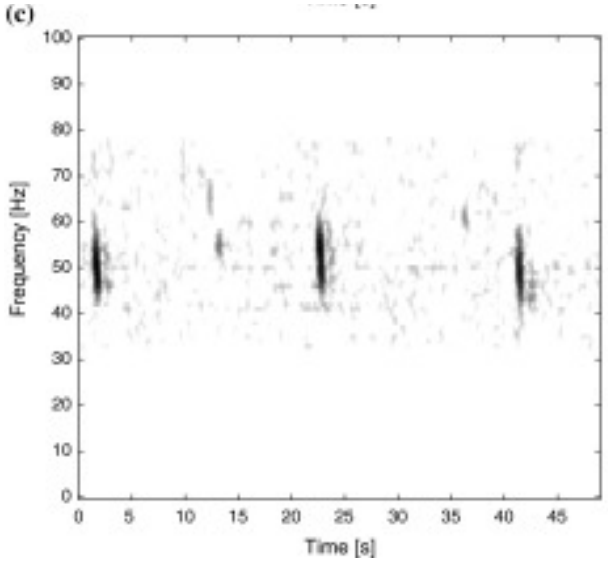
- Blue Whale D Calls-

  McDonald et al, J. Acoust. Soc. Am., Vol. 109, No. 4, April 2001



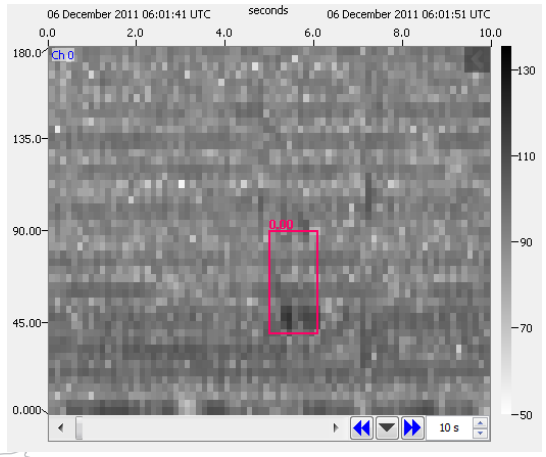
- Fin Whale 40Hz Calls -

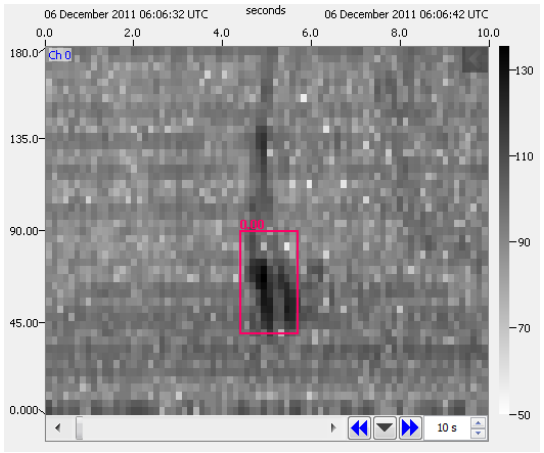
  Širović et al., Mar Biol. 2013; 160(1): 47–57.

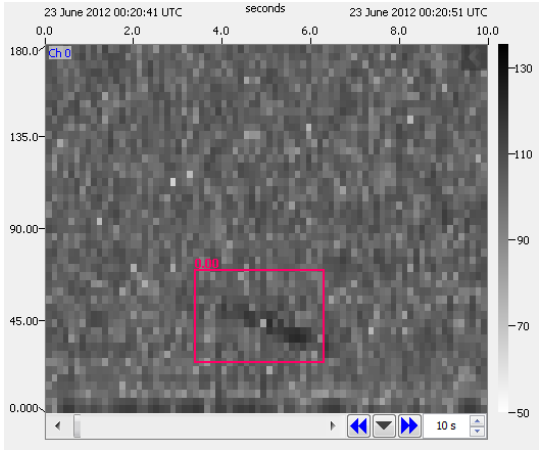


Training Data

- 66 days (1600 hours) training data
- 4506 blue whale D calls
- 320 fin whale 40Hz calls

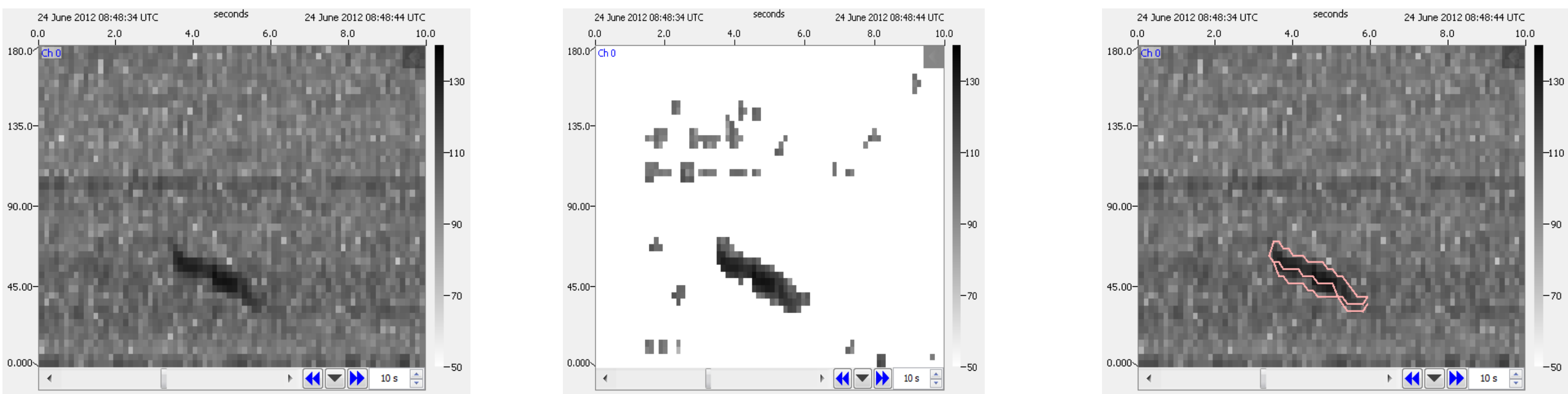






The Detector

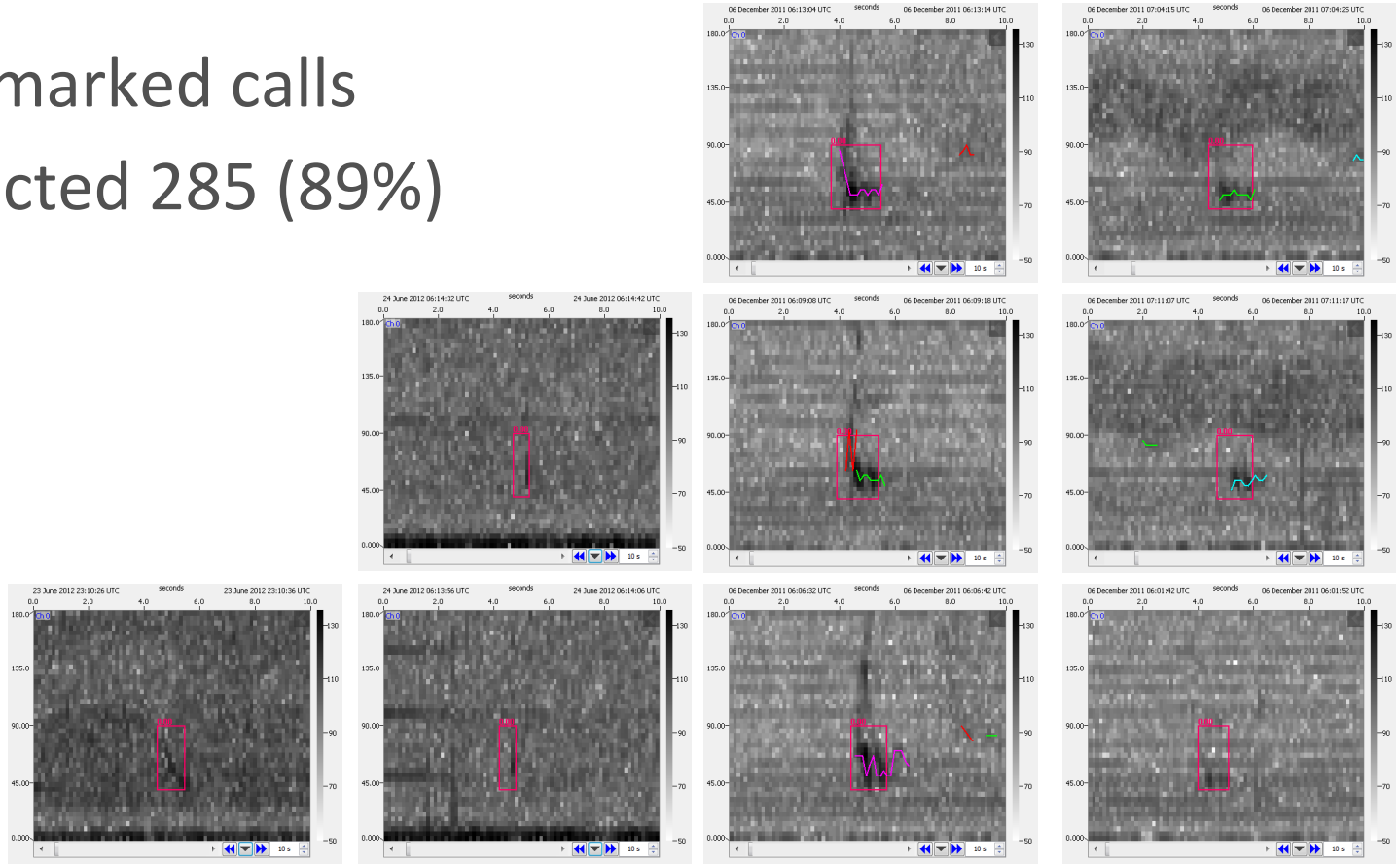
- PAMGuard Whistle and Moan Detector*
  - Data decimated to 1kHz sample rate
  - 256pt FFT with 50% overlap
  - 3.9Hz, 128ms advance
  - Five noise reduction / threshold stages
  - Connected region search
  - Output is outline of tonal calls.



*Gillespie, D., Caillat, M., Gordon, J., and White, P. (**2013**). "Automatic detection and classification of odontocete whistles," J. Acoust. Soc. Am., **134**, 2427–2437.

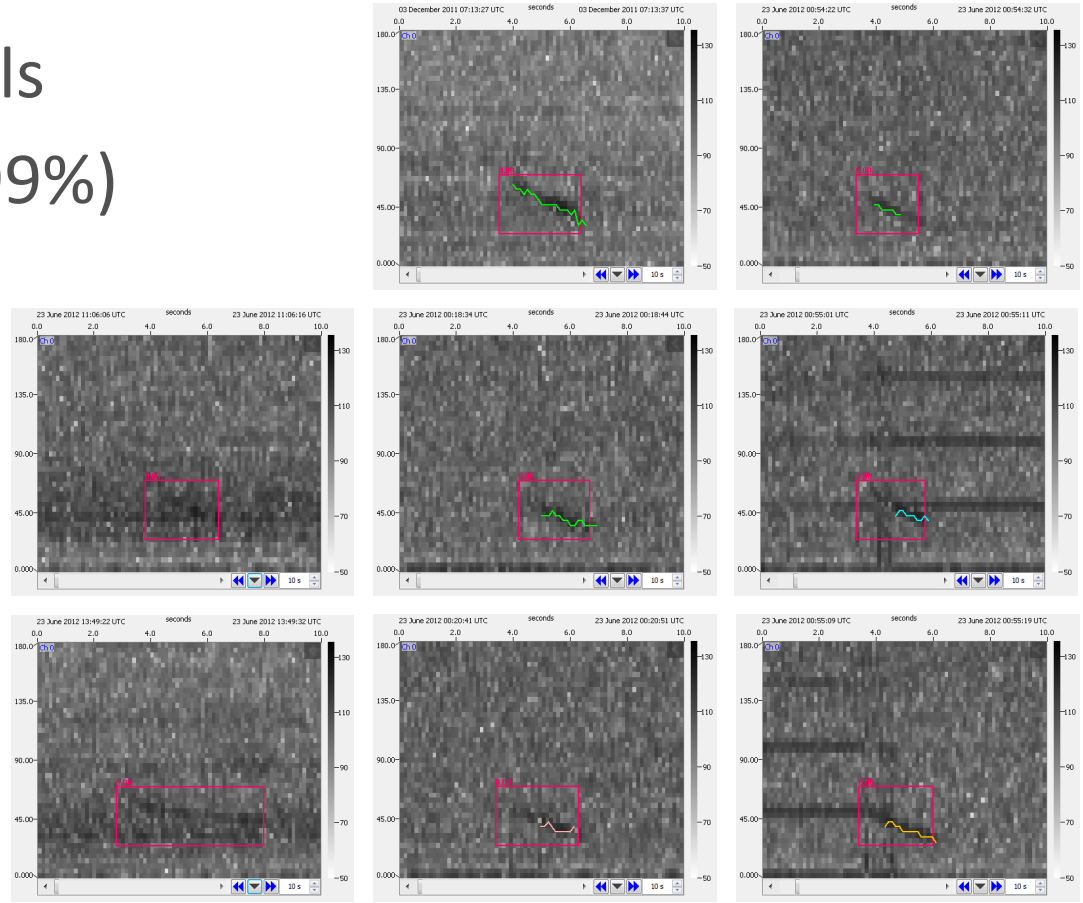
Fin Whale 40Hz calls

- 320 marked calls
- Detected 285 (89%)



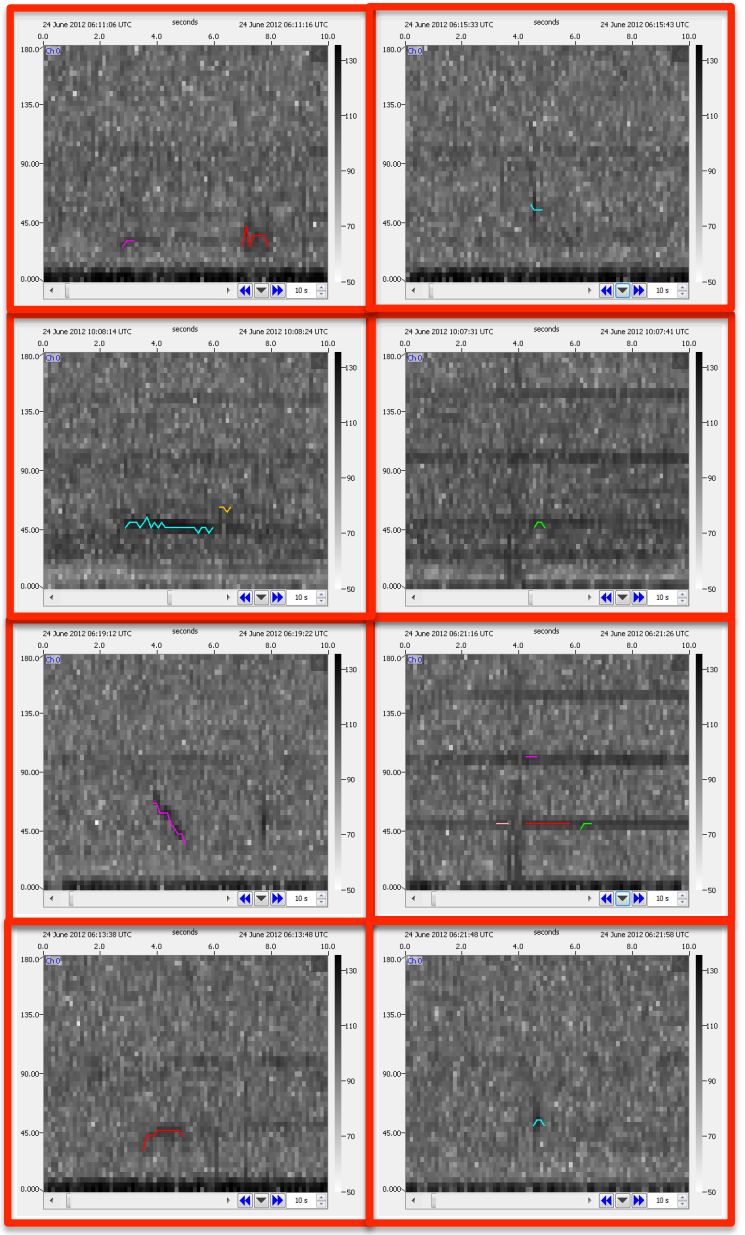
Blue Whale D Calls

- 4506 marked calls
- Detected 4455(99%)

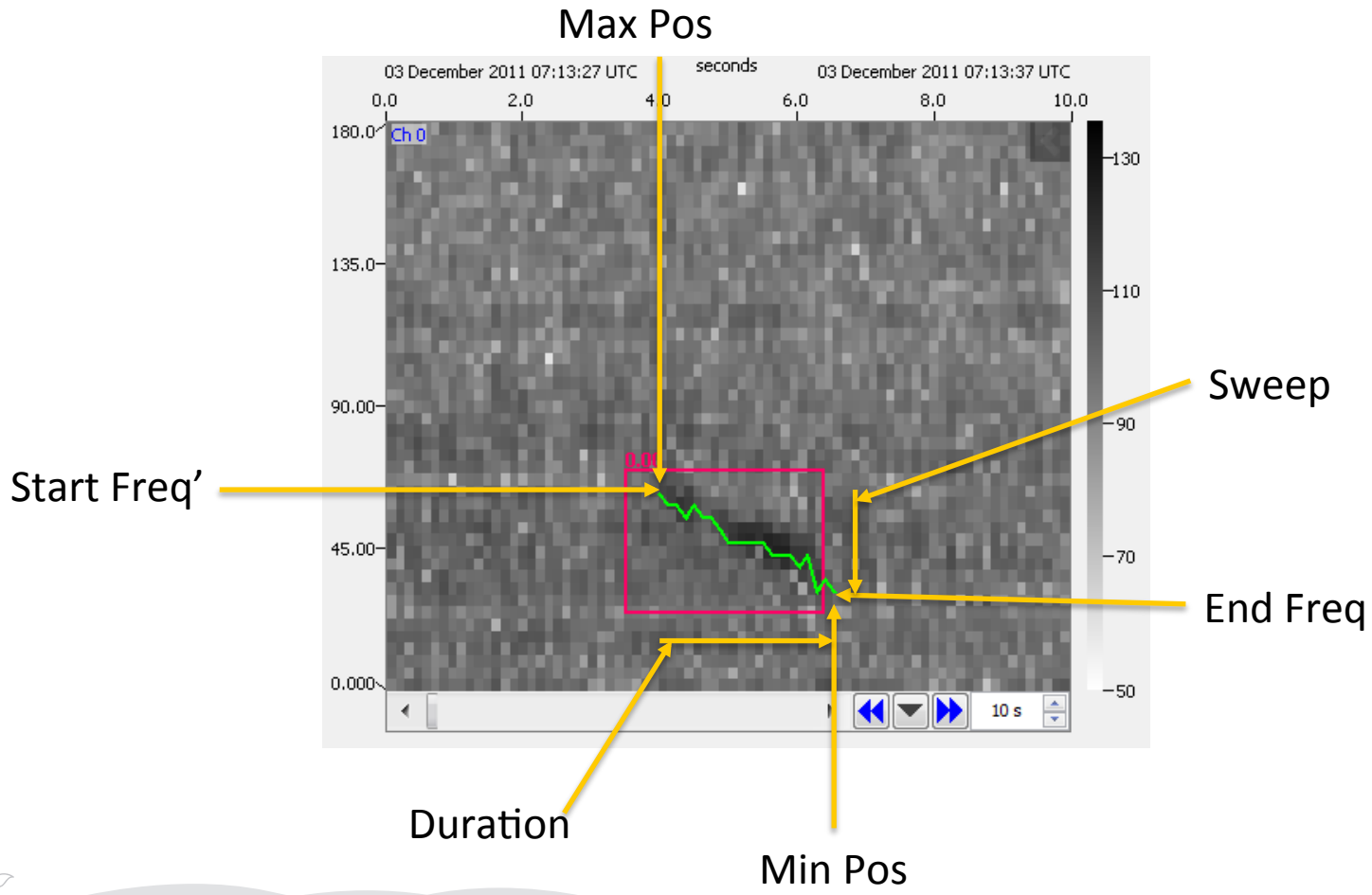


The tricky bit …

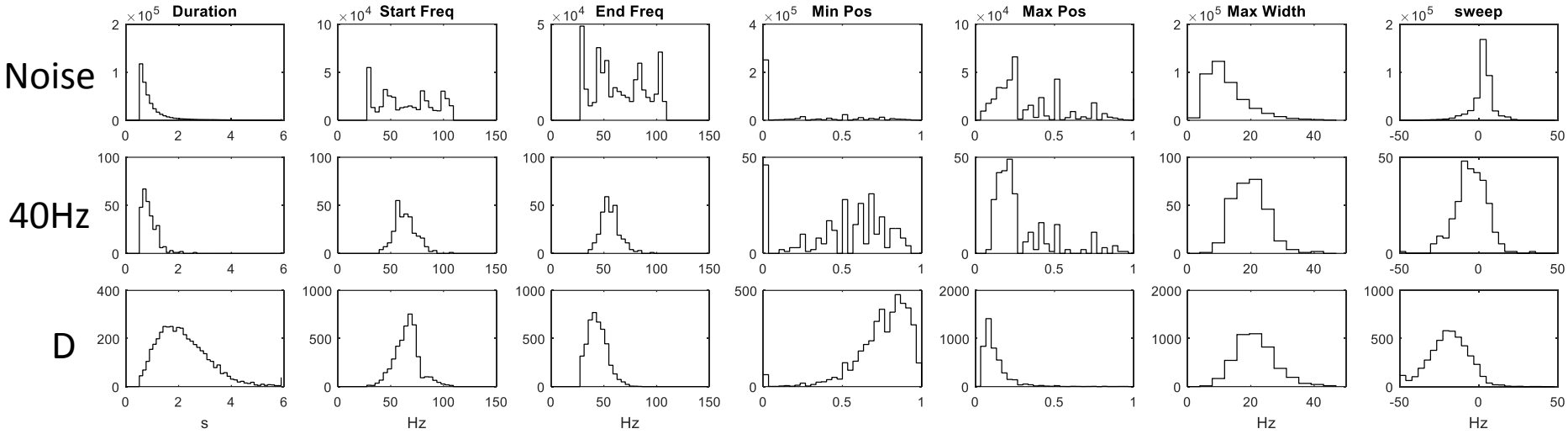
- 400,000 other detected sounds between 30 and 120 Hz.
  - Self noise
  - Other whale calls
  - Missed whale calls
  - Other



Classify based on contour shape



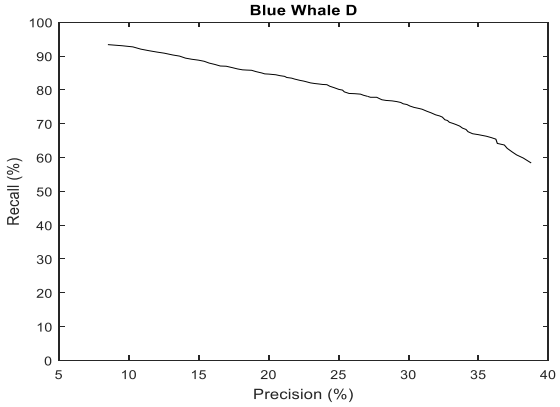
Contour Parameters

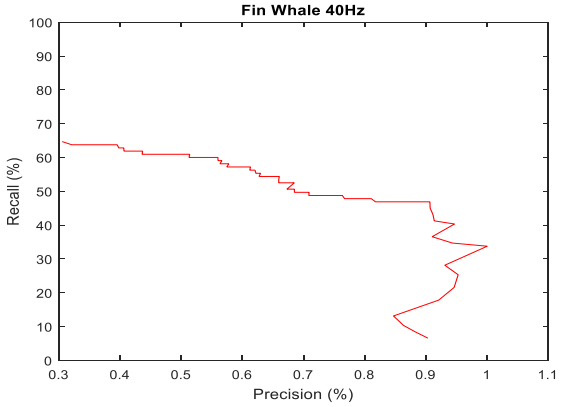


- Classify with multivariate classifier and with regression trees.
  - Results broadly similar for both

Results

Confusion Matrix		Output (%)		
		Noise	40Hz	D
Input	Noise	90	7	3
	40Hz	26	65	9
	D	8	11	81





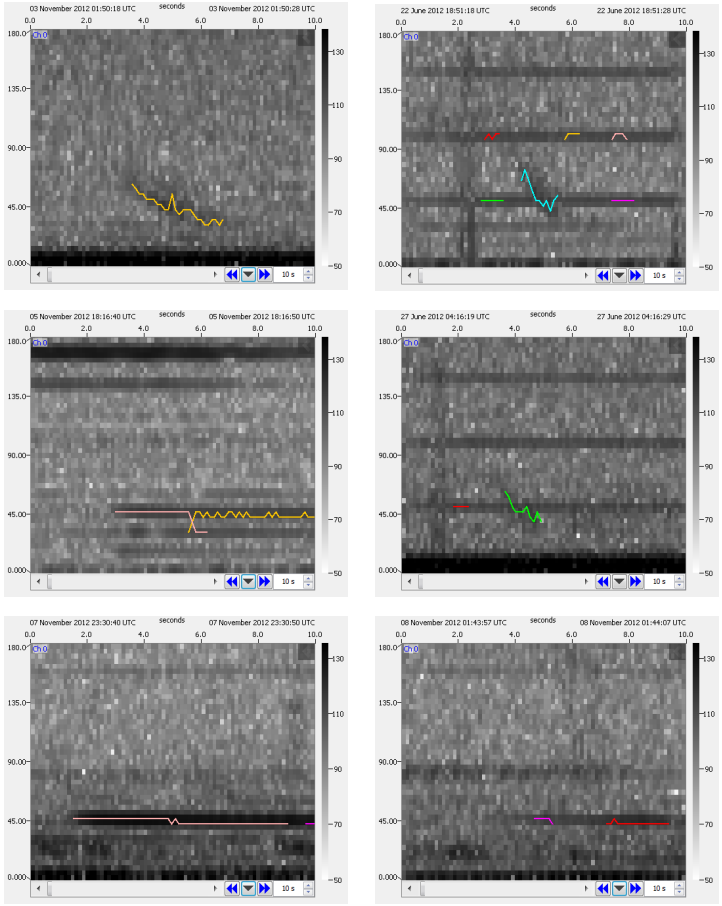
1. Why are these results so poor ?
2. Would such a detector / classifier still be useful ?

Is it useful ?

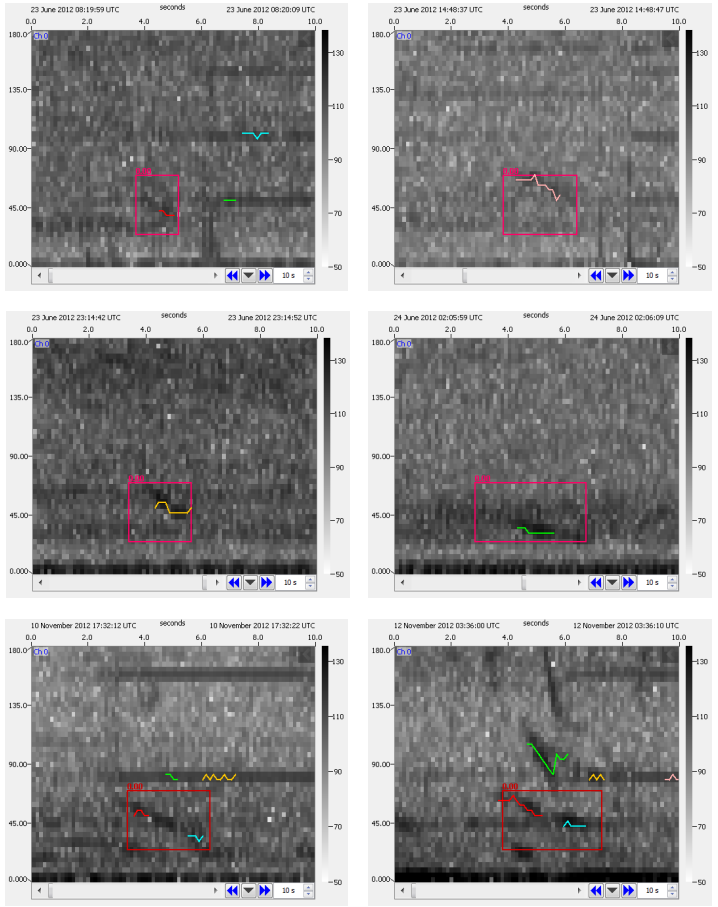
- 1600 hours data (96k minutes, 576k 10s clips)
- Blue whale D calls
  - 25% precision, 4506 calls
  - Approx. 18,000 candidate detections
- Fin whale 40Hz calls
  - 1% precision, 360 calls
  - Approx. 36,000 candidate detections
- Would you rather …
  - View 96k 1 minute spectrogram ?
  - View 576k 10 second spectrograms ?
  - View 54k (36k+18k) 10 second spectrograms ?
- Even a poorly performing detector has the potential to drastically reduce the amount of data a human must analyse.

Why is it performing poorly ?
Examples of Errors (D calls)

False Detections

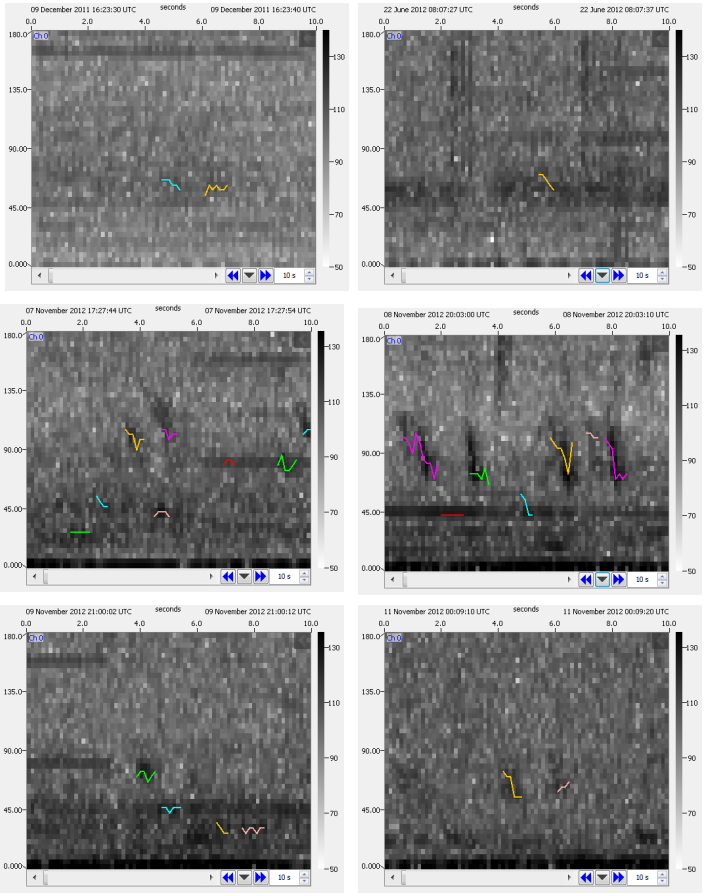


Missed Detections

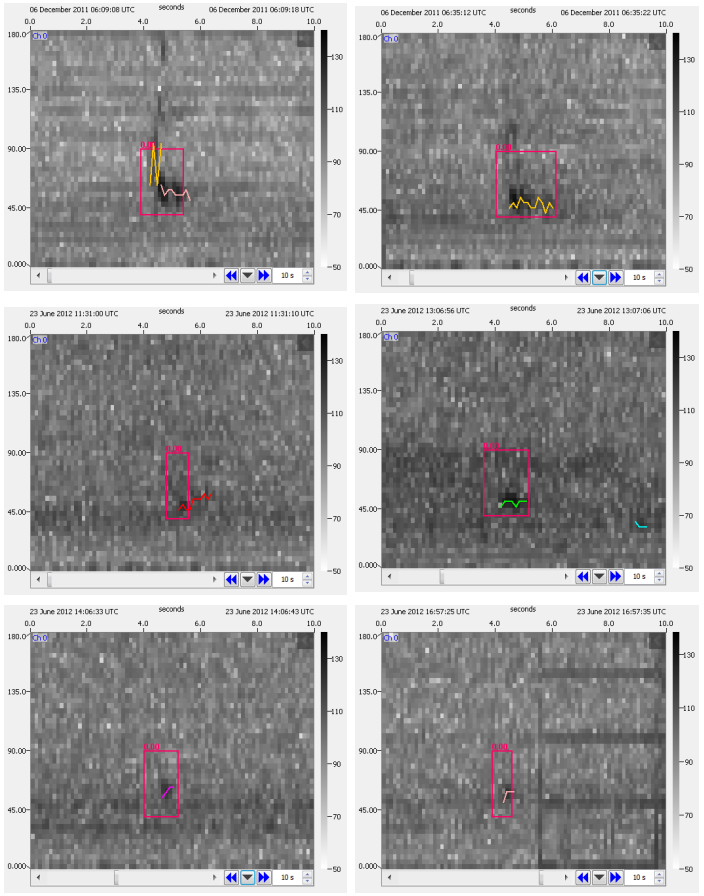


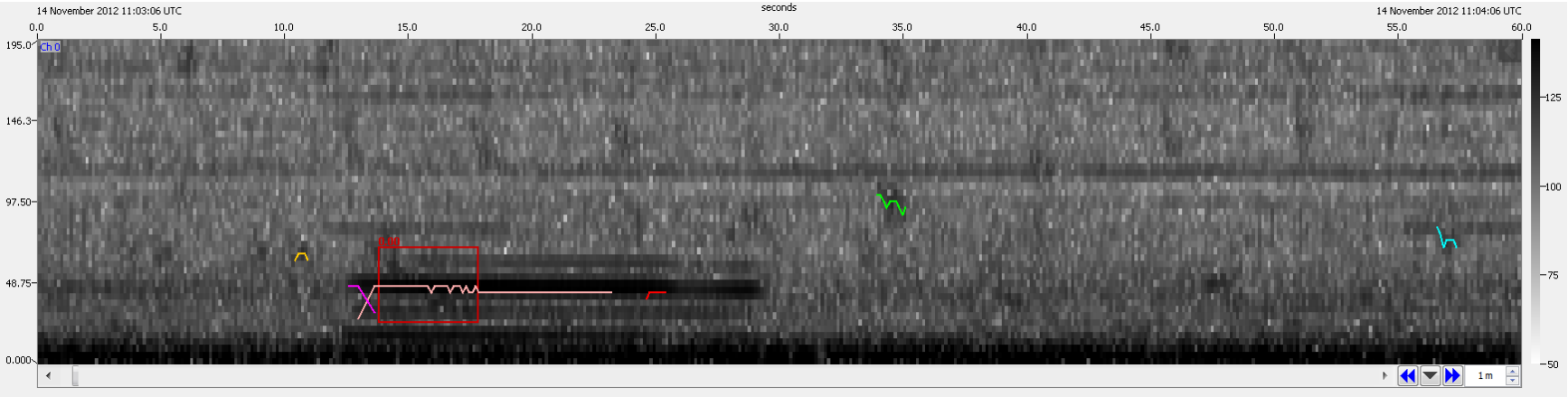
Examples of Errors (40Hz)

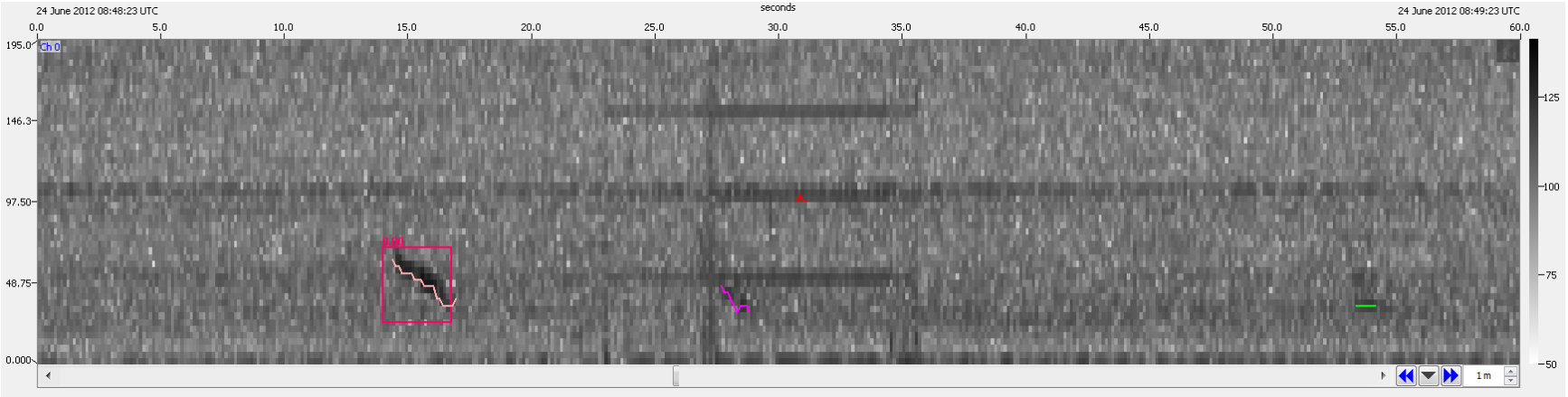
False Detections



Missed Detections




14 November 2012 11:03:06 UTC
seconds
14 November 2012 11:04:06 UTC
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
195.0
146.3
97.50
48.75
0.000
Ch 0
125
100
75
50
1 m

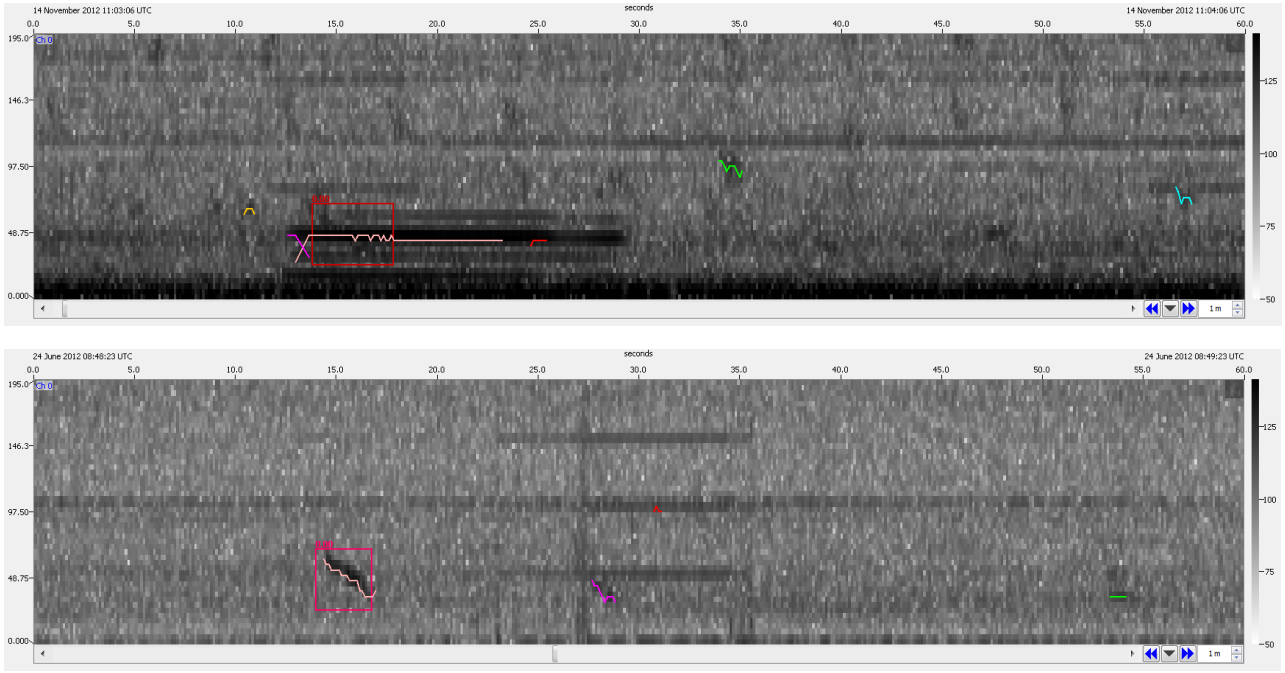

24 June 2012 08:48:23 UTC
seconds
24 June 2012 08:49:23 UTC
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
195.0
146.3
97.50
48.75
0.000
Ch 0
125
100
75
50
1 m

“False” Detections

- Hard drive noise
- Real whale sounds not marked by the operator
- Noise

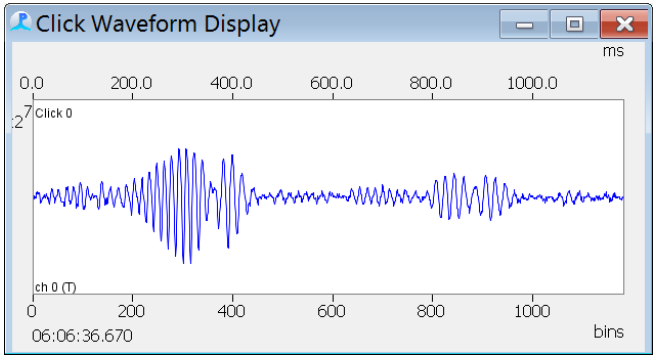
“Missed” Detections

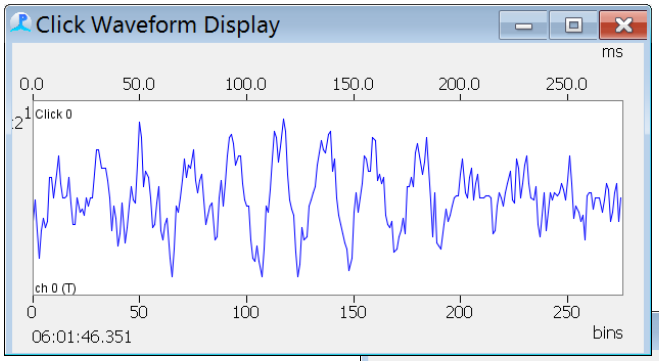
- Low SNR
- Broken calls
- Poor contour tracking
- Marking noise as calls

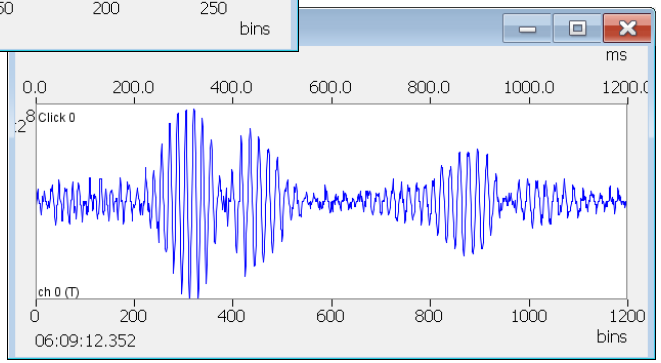


Future Plans

- Spectrogram based detector / classifier not well suited to very short pulses.
- Consider treating them as clicks and running a time domain based click detector as we would for odontocete clicks.







Summary / Concluding remarks

- Very challenging dataset, particularly the 40Hz calls
- Detecting is relatively easy – it's not detecting all the other c*** that's difficult
- While performance is poor, checking a few thousand short clips may still be of more use than browsing an entire dataset (user effort reduction)
- Any results from these detectors / classifiers are very specific to this hardware since the dominant source of noise is from the hardware.
  - Don't use equipment with noise at 40Hz if you want to detect 40Hz signals.
- I'd like to know a lot more about how the dataset were annotated.
- Good null datasets are needed since there seemed to be a lot of missed calls and general inconsistency in the annotation process – we're trying to train detectors to match a flawed human rather than actual truth.
- This leads into Fridays discussions on how to make better training sets.

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Thanks to

Sound and Marine Life JIP for continued PAMGuard funding support

UCSD for their work in providing the data set

Sea Mammal Research Unit