Data analysis manual of A-tag for fixed monitoring

Ver.1.0

September 20, 2012

CONTENTS

- 1. Data you will get.
- 2. Noise reduction using Igor
- 3. Manual screening of data
- 4. Data analysis using Excel
- 5. Further analysis, up to your ideas



- 1. Diurnal or seasonal presence of dolphins and porpoises
- 2. <u>Maximum sensing distance by echolocation</u>
- 3. Number of phonated animals around A-tag
- 4. <u>Further analysis such as density, abundance, g(0) estimation,</u> <u>behavior, movement, species ID, etc.</u>

All these based on the time sequential statistical data of each click train provided as an Excel file. To get this Excel file, pre-processing is required by Igor procedure, which mainly reduce noise contamination.





Click A-tag Analysis Fixed.ipf



Type master 0 on the command line of Igor and press RETURN $\ensuremath{\mathsf{KEY}}$



Select initial setting of analysis. Normally <u>click **Continue** is OK.</u>

If you wish to examine raw data appearance without any noise reductions, choose 1.

If you wish to analyse very high noise contamined data, choose 3 If you wish to modify analysis parameters, choose 4 (only for experienced persons).

Detection threshold can be changed for all type of Initial settings. Normally, use default value 43, which is the minimum value of A-tag detection threshold (nearly equal to internal electronic noise level).



Select data file you wish to analyse and click **OPEN** The data file is created by Logger Tools>CSV file.



Wait for a while until dialog box below appears.

Click **Load** and wait for a while. It may take several minutes depending on the file size.

<u>DO NOT</u> change wave names

🔀 Igor Pro 6.12A
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Analysis finished.





Select Windows > New table

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Select train_data1 and Do it.

A-tag analysis manual for fixed monitoring



Put cursor on train_data1 table and right click on the mouse. Check **Digits** 13

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Select all of the data from 0 to 17 row

Edit > Copy

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Train_data1 contains statistics of each click rain. 0-4 will be used for further analysis. Raws 5-17 are not used in the analysis described in this manual.

Raw. Description

- 0. Np: number of pulses included in a click train
- 1. duration (ms) : duration of a click train between the first and last pulse.
- 2. Start : start time of the click train
- 3. End : end time of the click train
- 4. AvPi (ms) : average inter-pulse interval of the click train
- 5. SdPi : standard deviation of inter-pulse interval
- 6. MedPi (ms) : median of inter-pulse interval
- 7. MaxPi(ms) : maximum of inter-pulse interval
- 8. AvSPLR : averaged two band ratio in the click train. Two band ratio is the ratio of received intensity at primarily hydrophone (sensitive at 130kHz) and secondary hydrophone (sensitive at 70 kHz). Approximately ratio<0.8 suggests delphinidae click trains and ratio>0.8 suggests phocoenidae click trains.
- 9. SdSPLR : standard deviation of two band ratio.
- 10. MedSPLR : median of two band ratio.
- 11. self more 1 /other's more 0 : not used
- 12. # of self pulses : not used
- 13. # of other's pulses : not used
- 14. Linear regression of inter-pulse interval in the train
- 15. Standard deviation of regression
- 16. Minimum IPI within PIwin numbers of clicks in the beginning of the click train
- 17. Minimum IPI within PIwin numbers of clicks in the end the click train

Open **A-tag Analysis.xls** Paste data at D3 of From Igor TAB

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Drag last lines to the end of the data to calculate serial number of click trains.

Back to the Igor file and examine each click trains in Graph1 window. For this case, 44 and 45 are likely to be click trains.



If a train identified as real biosonar click train, mark 1 at the corresponding serial number on the 2^{nd} row of the excel sheet. This task takes time.

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47		44	2012/8/7 8:39	6	462.4	3427173562.884	3427	73563.346	92.48	34.6
48	1	45	2012/8/7 8:39	8	408.4001	3427173569.458	3427	73569.866	58.34286	23.6
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50		47	2012/8/7 8:40	6	32.49979	3427173606.748	3427	73606.781	6.5	2.06
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53		50	2012/8/7 8:52	7	332.5	3427174369.830	3427	74370.162	55.41667	14.0
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How to identify REAL click trains?

Cetacean biosonar clicks can be distinguished from random noise.

- 1. Regular inter-pulse interval
- 2. Coming from same direction
- 3. Smooth change of sound pressure level. A click train looks like a mountain shape.
- 4. Once a click train detected, several click trains tend to be recorded. Because odontocetes produce click trains frequently, namely every 10 seconds.
- 5. Artificial noise source such as echosounder, depth meter, ADCP etc resemble to biosonar click trains except for constant inter-pulse interval. They produce sound exactly regularly, which can be a key to remove artificial ultrasonic contaminations.
- 6. Ship noise is commonly detected. It shows random inter-pulse interval because the noise source is cavitation behind the screw. In addition, ship noise is continuous, but click trains are intermittent. Time difference appeared in the Igor figure shows dotted line for click trains and continuous line for ship noise.
- 7. Snapping shrimp noise is common in warm coastal water. It shows random inter-pulse interval and time difference is also random because numbers of shrimps produce loud but single pulse at various locations.
- 8. <u>Do not try to extract doubtful sounds.</u> A faint pulse trains from shrimp, ship or artificial echosounder could be quite similar to a faint click train. If you wish to detect biosonar click trains as much as possible, you will take risk to include noise as signals*.

*This is called false alarm rate. Ideally, 100% correct detection and 0% false alarm is best situation. In reality, this never happens. Second best is to maximize correct detection and minimize false alarm. For example, if you try to detect all possible click trains, false alarm rate also increased. This means data reliability is getting worse. On the other hand, if you are conservative and wish to extract extremely reliable click trains, it suppress false alarm nearly equal to zero, but need to accept small correct detection. This is OK as long as sufficient correct detection is obtained. Decide acceptable level of false alarm rate and maximize detection effort until false alarm reaches the level.



Kimura et al. (2010) Density estimation of Yangtze finless porpoises using passive acoustic sensors and automated click train detection, J. Acoust. Soc. Am. 128, 1435-1445.

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Now you've got qualified data of biosonar click trains.

Save this Igor file for your record.



Diurnal detection pattern

Copy D row (time and date) of identified TAB of A-tag Analysis.xls to A row of diurnal TAB, number of detection in each 1 hour time bin in a day will be shown.

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	4	2012/8/7 8:40	0.36143	2:00	0.000							
	5	2012/8/7 8:40	0.36145	3:00	0.000							
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Maximum sensing distance (m)

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Counting individual by fixed system 1

Apply filter for A row of identified TAB and select 3 (minutes) or over. Copy Sorted data shows the minimum number of presented individuals. Definition of the number is that number of silence >=3 minutes. This means the minimum number of presented individuals. Even two or more animals presented during 180 seconds, this analysis count minimum one animal was there. If one animal passed by the monitoring site then back again after 180 seconds or longer, this calculation counts two animals presented. Note that any static observation such as visual point transect has same issue. This is the limitation of platform, not the limitation of acoustics.

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Counting individual by fixed system 2

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1	6	2012/5/21 23:12	0.96679	318.51090	14:00	2	2					
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5. Further analysis, up to your ideas

For example;

1. General overview

Li, S., Akamatsu, T., Dong, L., Wang, K., Wang, D., and Kimura, S. (2010) Widespread passive acoustic detection of Yangtze finless porpoise using miniature stereo acoustic data-loggers: A review, J. Acoust. Soc. Am. 128, 1476-1482.

2. Towed survey

2-1 Strip transect and detection probability

Akamatsu, T., Wang, D., Wang, K., Li, S., Dong, S., Zhao, X., Barlow, J., Stewart, B.S., Richlen, M., (2008), Estimation of the detection probability for Yangtze finless porpoises (*Neophocaena phocaenoides asiaeorientalis*) with a passive acoustic method, J. Acoust. Soc. Am. 123(6), 4403-4411.

2-2 Localization of animals

Li, S., Akamatsu, T., Wang, D., and Wang, K. (2009), Localization and tracking of phonating finless porpoises using towed stereo acoustic data-loggers, J. Acoust. Soc. Am. 126, 468-475.

2-3 Local distribution

Kimura, S., Akamatsu, T., Li, S., Dong, L., Wang, K., Wang, D., and Arai, N. (2012), Seasonal changes in the local distribution of Yangtze finless porpoises related to fish presence, Marine Mammal Science, 28(2), 308-324.

2-4 Cargoship platform

Dong, L., Wang, D., Wang, K., Li, S., Dong, S., Zhao, Z., Akamatsu, T., Kimura, S. (2011), Passive acoustic survey of Yangtze finless porpoises using a cargo ship as a moving platform, J. Acoust. Soc. Am. 130, 2285-2292.

2-5 Boat avoidance

Li, S. Akamatsu, T., Wang, D., Wang, K., Dong, S., Zhao, X., Wei, Z., Zhang, Z., Taylor, B., Barrett, L.A., Turvey, S.T., Reeves, R.R., Stewart, B.S., Richlen, M., and Brandon, J.R. (2008), Indirect Evidence of boat avoidance behavior of Yangtze finless porpoises, Bioacoustics The International Journal of Animal Sound and its Recording, 17, 174-176.

3. Fixed survey

3-1 Diurnal and seasonal presence pattern

Akamatsu, T., Nakazawa, I., Tsuchiyama, T., Kimura, N., (2008), Evidence of nighttime movement of finless porpoises through Kanmon Strait monitored using a stationary acoustic recording device, Fisheries Science 74, 970-976.

Akamatsu T., Nakamura K., Kawabe R., Furukawa S., Murata H., Kawakubo A. Komaba M., (2010), Seasonal and diurnal presence of finless porpoises at a corridor to the ocean from their habitat, Marine Biology 157, 1879-1887.

3-2 Relative density comparison

Kimura, S., Akamatsu, T., Wang, K., Wang, D., Li, S., Dong, S., and Arai, N. (2009), Comparison of stationary acoustic monitoring and visual observation of finless porpoises, J. Acoust. Soc. Am., 125, 547-553.

3-3 Absolute density estimation

Kimura, S., Akamatsu, T., Li, S., Dong, S., Dong, L., Wang, K., Wang, D., and Arai, N. (2010) Density estimation of Yangtze finless porpoises using passive acoustic sensors and automated click train detection, J. Acoust. Soc. Am. 128, 1435-1445.

3-4 Underwater movements

Sasaki-Yamamoto, Y., Akamatsu, T., Ura, T., Sugimatsu, H., Kojima, J., Bahl, R., Behera, S., Kohshima, S. (2012), Diel changes in the movement patterns of Ganges River dolphins monitored using stationed stereo acoustic data loggers, Marine Mammal Science, in press

4. Tagged survey

4-1 Biosonar behavior

Rasmussen, M.H., Akamatsu. T., Teilmann. J., Vikingsson, G., and Miller, L.A. (2012) Biosonar, diving and movements of two tagged white-beaked dolphin in Icelandic waters, Deep-Sea Research II in press

Linnenschmidt, M., Teilmann, J., Akamatsu, T., Dietz, R., Miller, L. (2012), Biosonar, dive and foraging activity of satellite tracked harbor porpoises (*Phocoena phocoena*), Marine Mammal Science, in press.

4-2 Conspecific association

Sakai, M., Wang, D., Wang, K., Li, S., Akamatsu, T. (2011), Do porpoises choose their associates? a new method for analyzing social relationships among cetaceans, PLoS ONE, 6(12), 1-8.

4-3 Feeding behavior

Akamatsu, T. Wang, D. Wang, K, Li, S., Dong, S. (2010), Scanning sonar of rolling porpoises during prey capture dives. J. Exp. Biol. 213, 146-152.

4-4 Sensing distance

Akamatsu, T., Teilmann, J., Miller, L.A., Tougaard, J., Dietz, R., Wang, D., Wang, K., Siebert, U., and Naito, Y. (2007), Comparison of echolocation behaviour between coastal and riverine porpoises, Deep-Sea Research II 54(3-4), 290-297.

Akamatsu, T. Wang, D. Wang, K. and Naito, Y. (2005), Biosonar behaviour of free-ranging porpoises, Proc. R. Soc. Lond. B 272, 797-801.

4-5 Beam pattern

Akamatsu, T. Wang, D. and Wang, K. (2005), Off-axis sonar beam pattern of free-ranging finless porpoises measured by a stereo pulse event data logger, J. Acoust. Soc. Am. 117(5), 3325-3330.