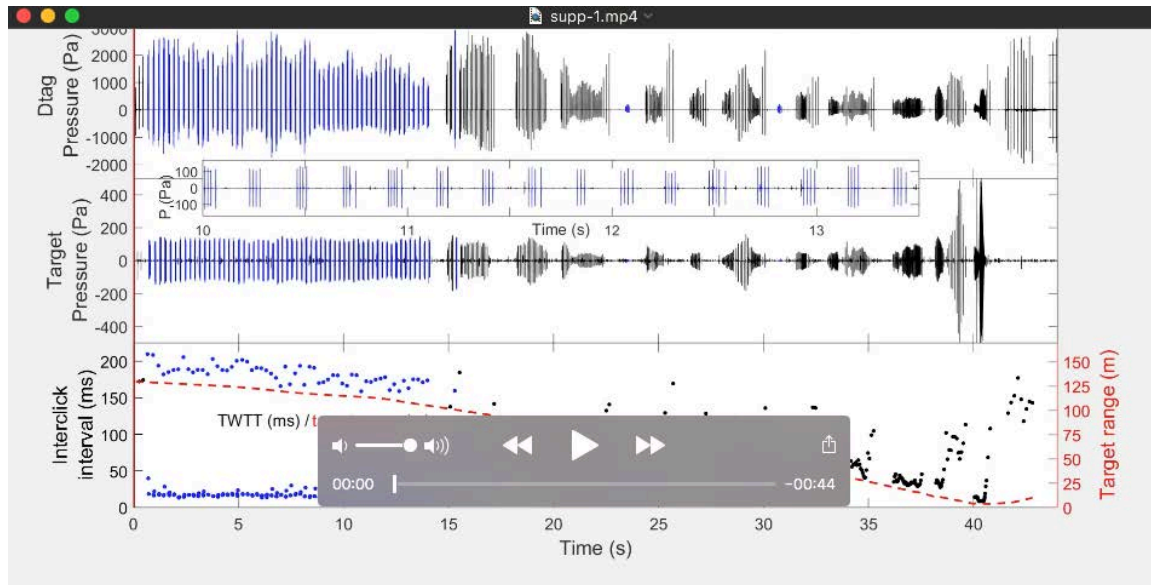# Supplementary material

Movie 1. SAY approach example. Top panel shows received level measured on the Dtag (~5 cm behind the blowhole). Middle panel shows received level measured by the SoundTrap on the target. The insert between the top and middle panels shows a short section of the received levels on the target to better illustrate the echolocation pattern during click packet emission. Lower panel shows ICI (black dots) along with TWTT (left y-axis) and target range (right y-axis) with the latter two depicted as the same red dashed line. In all three panels, the click packets detected using the automated routine are shown in blue. Note that all IPIs are kept above the TWTT, but that ICIs for regular clicks only consistently exceed the TWTT for target ranges below 33 m. Also, note that the automatic packet detector is not perfect as it fails to detect two packets around 15 s and erroneously detects two short low-amplitude click trains at 23.5 and 30.8 s that do not resemble usual packet ICI patterns.
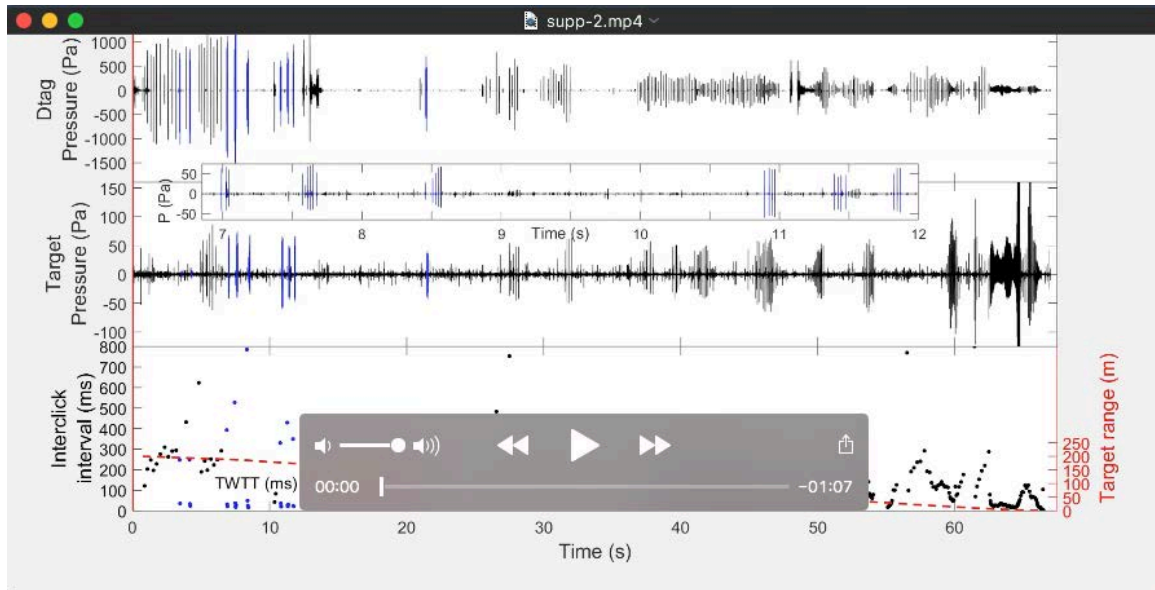
Movie 2. TRO approach example. For explanation of layout, see caption for Movie 1. The dolphin surfaces about 13 seconds into the trial with another surfacing at about 48 seconds.

Table S1. Echolocation click source parameters estimated from the SoundTrap recordings for clicks where SNR >6 dB, target range >1 m, and ICI >10 ms. Packet clicks have been divided into a group containing only the first click in each packet and a second group containing the remaining packet clicks in order to evaluate the potential effects on SL for long (>150 ms) versus short (10-50 ms) delays before click emission. The source parameters for presumed on-axis clicks are also shown for each dolphin.

SAY	All clicks	All regular clicks	First packet click	Last packet clicks	Units
SL_{pp}	192.5±14.7 [125-225]	188.4±12.2 [125-223]	208.9±10.6 [157-222]	210.2±12.0 [156-225]	dB re µPa
ICI	114.0±488.0 [10-22822]	108.6±476.3 [10-22822]	508.3±1005.6 [152-12984]	19.7±7.2 [10-50]	ms
F_c	82.3±21.5 [13-160]	81.6±22.2 [13-160]	82.8±17.9 [26-117]	86.4±18.2 [19-116]	kHz
F_P	83.5±38.8 [8-206]	81.1±39.8 [8-206]	83.9±33.1 [13-148]	91.0±33.4 [13-145]	kHz
BW_{RMS}	33.3±6.3 [4-92]	33.8±6.6 [4-92]	31.0±4.7 [11-48]	31.8±4.8 [13-53]	kHz
SNR	22.4±6.7 [6-36]	22.1±6.8 [6-36]	24.2±5.9 [6-33]	23.4±6.0 [6-34]	dB
Range	89.7±82.1 [1-444]	69.3±71.1 [1-444]	174.0±63.9 [16-438]	179.3±67.4 [15-438]	m
N	14383	11687	648	2048	

SAY	All clicks (on-axis)	Regular clicks (on-axis)	First packet click (on-axis)	Last packet clicks (on-axis)	Units
SL_{pp}	205.2±10.3 [161-225]	200.9±9.4 [161-221]	213.6±5.5 [206-221]	214.3±4.7 [201-225]	dB re µPa
ICI	108.8±267.8 [11-3446]	145.2±317.2 [11-3008]	263.9±92.1 [171-442]	19.4±6.0 [11-44]	ms
F_c	93.7-13.7 [16-160]	94.0±14.7 [16-160]	84.4±16.4 [58-109]	93.6±10.8 [60-116]	kHz
F_P	102.0±27.5 [11-205]	103.0±28.1 [11-205]	81.1±34.8 [45-128]	100.9±25.3 [40-143]	kHz
BW_{RMS}	32.2±4.0 [11-79]	32.3±4.4 [11-79]	30.5±4.3 [24-37]	32.0±2.7 [23-40]	kHz
SNR	25.5±5.9 [6-36]	26.2±5.9 [6-36]	20.6±5.7 [12-26]	24.4±5.5 [7-33]	dB
Range	114.6±91.6 [4-437]	81.3±80.9 [4-437]	263.2±97.3 [124-349]	178.8±67.7 [82-430]	m
N	433	292	8	133	

TRO	All clicks	All regular clicks	First packet click	Last packet clicks	Units
SL_{pp}	183.0±17.8 [132-225]	179.4±16.0 [132-225]	203.8±10.6 [156-223]	206.2±9.7 [166-224]	dB re µPa
ICI	182.9±631.5 [10-17948]	181.1±651.0 [10-17948]	621.6±790.4 [162-5865]	28.4±9.4 [11-50]	ms
F_c	58.3±22.4 [14-197]	55.9±21.9 [14-197]	71.2±19.3 [25-110]	73.8±19.4 [22-116]	kHz
F_P	48.9±29.7 [8-203]	46.0±28.8 [8-203]	64.4±28.3 [14-133]	67.4±30.8 [13-134]	kHz
BW_{RMS}	28.6±9.1 [6-86]	28.5±9.5 [6-86]	28.8±6.8 [12-44]	29.2±6.5 [11-49]	kHz
SNR	19.3±6.2 [6-35]	19.2±6.3 [6-35]	19.7±6.0 [6-30]	20.0±5.6 [6-30]	dB
Range	94.2±101.7 [1-401]	72.6±89.6 [1-401]	220.6±65.8 [14-400]	229.4±62.1 [19-366]	m
N	7681	6604	301	776	

TRO	All clicks (on-axis)	Regular clicks (on-axis)	First packet click (on-axis)	Last packet clicks (on-axis)	Units
SL_{pp}	202.3±12.3 [155-225]	199.8±12.2 [155-224]	213.2±4.0 [205-218]	212.9±3.7 [205-224]	dB re µPa
ICI	144.8±126.4 [12-763]	164.8±125.2 [14-763]	292.5±82.1 [207-463]	27.2±9.1 [12-50]	ms
F_c	84.0±15.1 [18-111]	82.9±16.0 [18-111]	88.7±11.1 [63-98]	88.5±9.6 [68-108]	kHz
F_P	83.9±31.0 [10-136]	82.1±31.1 [10-136]	95.3±22.2 [65-123]	91.3±30.0 [40-134]	kHz
BW_{RMS}	32.1±4.7 [11-54]	32.1±5.0 [11-54]	30.6±2.6 [26-33]	32.1±3.4 [24-39]	kHz
SNR	24.1±5.4 [6-34]	24.5±5.3 [6-34]	25.7±3.8 [19-30]	22.1±5.3 [11-29]	dB
Range	129.6±102.7 [1-386]	110.9±102.8 [1-386]	198.6±86.9 [113-342]	211.7±43.8 [135-310]	m
N	355	288	8	59	

Table S2. Linear mixed-effects model analysis of the relationship between ICI and target range for the 16 trials in which SAY produced more than 100 clicks at ICI<TWTT at ranges<100 m.

Model: ICI ~ 1 + **range** + (1 + range | trial)

Fixed effects coefficients (95% CIs):

Name	Estimate	SE	t-statistic	df	p-value	Lower	Upper
Intercept	10.7	1.96	5.47	2593	$5.0*10^{-8}$	6.87	14.6
range	0.59	0.035	16.9	2593	$1.4*10^{-60}$	0.52	0.66

Random effects covariance parameters (95% CIs):

Name1	Name2	Type	Estimate	Lower	Upper
Intercept	Intercept	std	7.15	4.62	11.1
range	Intercept	corr	-0.82	-0.94	-0.53
range	range	std	0.13	0.084	0.20

Residual errors

Name	Estimate	Lower	Upper
Residual std	9.62	9.36	9.89

	Model comparison	df	ΔAIC	ΔBIC	χ^2	p-value
Model 1	ICI ~ 1 + **range** + (1 + range | trial)	6	0	0	46	$1.1*10^{-11}$
Null model	ICI ~ 1 + (1 + range | trial)	5	44	38	-	-

Table S3. Generalised linear mixed-effects model analysis of the relationship between number of clicks per packet and target range for two bottlenose dolphins SAY and TRO. Trial was not included as a random effect, because several trials contained very few click packets.

Model: Clicks per packet ~ 1 + **range** + (1 + range | dolphin)

Fixed effects coefficients (95% CIs):

Name	Estimate	SE	t-statistic	df	p-value	Lower	Upper
Intercept	1.07	0.13	8.16	206	$3.3*10^{-14}$	0.81	1.33
range	0.0017	0.00056	2.98	206	0.003	0.00056	0.0028

Random effects covariance parameters (95% CIs):

Name1	Name2	Type	Estimate
Intercept	Intercept	std	0.097
range	Intercept	corr	-1
range	range	std	0.00029

	Model comparison	df	ΔAIC	ΔBIC	χ^2	p-value
Model 1	Clicks per packet ~ 1 + **range** + (1 + range | dolphin)	5	0	0	4	0.047
Null model	Clicks per packet ~ 1 + (1 + range | dolphin)	4	2	1	-	-

Table S4. Linear mixed-effects model analysis of the relationship between SL and $\log_{10}(R)$, where R is target range.

Model: SL ~ 1 + **$\log_{10}(R)$** + **packet click** + **dolphin** + (1 + $\log_{10}(R)$| trial)

Fixed effects coefficients (95% CIs):

Name	Estimate	SE	t-statistic	df	p-value	Lower	Upper
Intercept	172.6	1.42	121.8	784	$<2.2*10^{-308}$	169.8	175.4
dolphin_TRO	-2.13	0.72	-2.95	784	0.0032	-3.54	-0.71
$\log_{10}(R)$	16.6	0.79	21.0	784	$5.3*10^{-78}$	15.0	18.1
packet click_1	5.86	0.60	9.79	784	$1.9*10^{-21}$	4.68	7.03

Random effects covariance parameters (95% CIs):

Name1	Name2	Type	Estimate	Lower	Upper
Intercept	Intercept	std	7.07	4.86	10.3
$\log_{10}(R)$	Intercept	corr	-0.96	-0.99	-0.89
$\log_{10}(R)$	$\log_{10}(R)$	std	4.05	2.76	5.96

Residual errors

Name	Estimate	Lower	Upper
Residual std	5.92	5.61	6.24

Model comparison		df	ΔAIC	ΔBIC	χ^2	p-value
Model 4	SL ~ 1 + **$\log_{10}(R)$** + **packet click** + **dolphin** + **$\log_{10}(R)$** *dolphin + (1 + log(R) | trial)	9	0	0	1	0.31
Model 3	SL ~ 1 + **$\log_{10}(R)$** + **packet click** + **dolphin** + (1 + $\log_{10}(R)$ | trial)	8	1	6	8	0.0050
Model 2	SL ~ 1 + **$\log_{10}(R)$** + **packet click** + (1 + $\log_{10}(R)$ | trial)	7	6	1	91	$<2.2*10^{-308}$
Model 1	SL ~ 1 + **$\log_{10}(R)$** + (1 + $\log_{10}(R)$ | trial)	6	89	84	145	$<2.2*10^{-308}$
Null model	SL ~ 1 + (1 + $\log_{10}(R)$ | trial)	5	143	138	-	-

Table S5. Linear mixed-effects model analysis of the relationship between SL and ICI.

Model: SL ~ 1 + **ICI** + **packet click** + **dolphin** + (1 \| trial)

Fixed effects coefficients (95% CIs):

Name	Estimate	SE	t-statistic	df	p-value	Lower	Upper
Intercept	189.0	1.77	107	317	$2.2*10^{-250}$	185.5	192.5
dolphin_TRO	-4.89	1.12	-4.4	317	$1.8*10^{-5}$	-7.09	-2.68
ICI	0.133	0.050	2.7	317	0.0079	0.0351	0.231
packet click_1	23.1	1.05	22	317	$9.0*10^{-66}$	21.0	25.2

Random effects covariance parameters (95% CIs):

Name1	Name2	Type	Estimate	Lower	Upper
Intercept	Intercept	std	1.84	0.333	10.1

Residual errors

Name	Estimate	Lower	Upper
Residual std	7.61	6.87	8.43

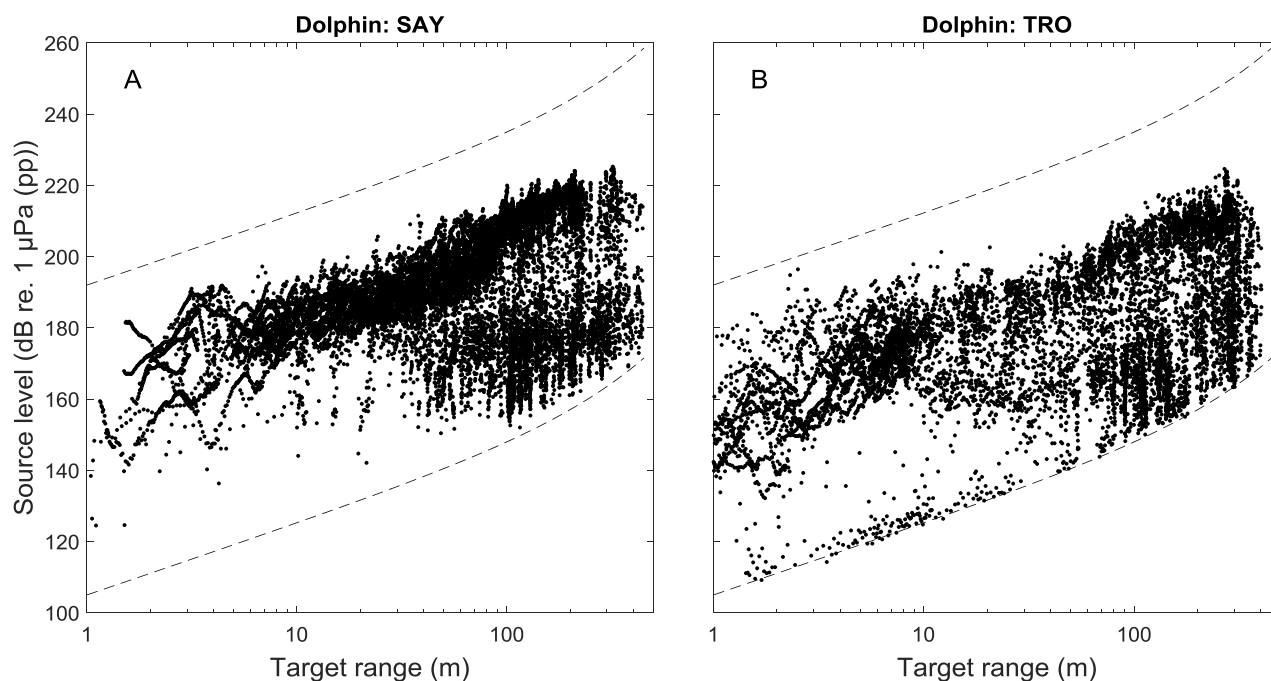| Model comparison		df	ΔAIC	ΔBIC	χ^2	p-value
Model 5	SL ~ 1 + **ICI** + **packet click** + **dolphin** + ICI*dolphin + (1 + ICI | trial)	9	0	0	0.1	0.73
Model 4	SL ~ 1 + **ICI** + **packet click** + **dolphin** + (1 + ICI | trial)	8	2	6	0.5	0.78
Model 3	SL ~ 1 + **ICI** + **packet click** + **dolphin** + (1 | trial)	6	4	11	13	$2.6*10^{-4}$
Model 2	SL ~ 1 + **ICI** + **packet click** + (1 | trial)	5	11	8	271	$<2.2*10^{-308}$
Model 1	SL ~ 1 + **ICI** + (1 | trial)	4	267	265	37	$1.0*10^{-9}$
Null model	SL ~ 1 + (1 | trial)	3	143	138	-	-

Figure S1. SL as a function of target range for the 16,284 and 9,739 total click detections in the SoundTrap recordings for the two bottlenose dolphins SAY (A) and TRO (B). The clipping level (pp, i.e. 186+6 dB re. 1 µPa) plus estimated transmission loss ($20\log_{10}(R)+0.03R+192$ dB re. 1 µPa (pp)) is shown as the upper dashed line. Because click detection in the SoundTrap recordings involved manual inspection, the plotted detection threshold (lower dashed line, $20\log_{10}(R)+0.03R+105$ dB re. 1 µPa (pp)) is only an approximation based on the lower boundary of the two SL distributions. The absorption loss coefficient of 0.03 dB/m is estimated using a frequency of 80 kHz, 15°C water temperature, 0 km depth, 35 ppm salinity, and a pH of 8 following Ainslie and McColm (1998). This figure shows that clicks were likely to be detected in the SoundTrap recordings if SLs exceeded 169 dB re. 1 µPa (pp) at 400 m target range.
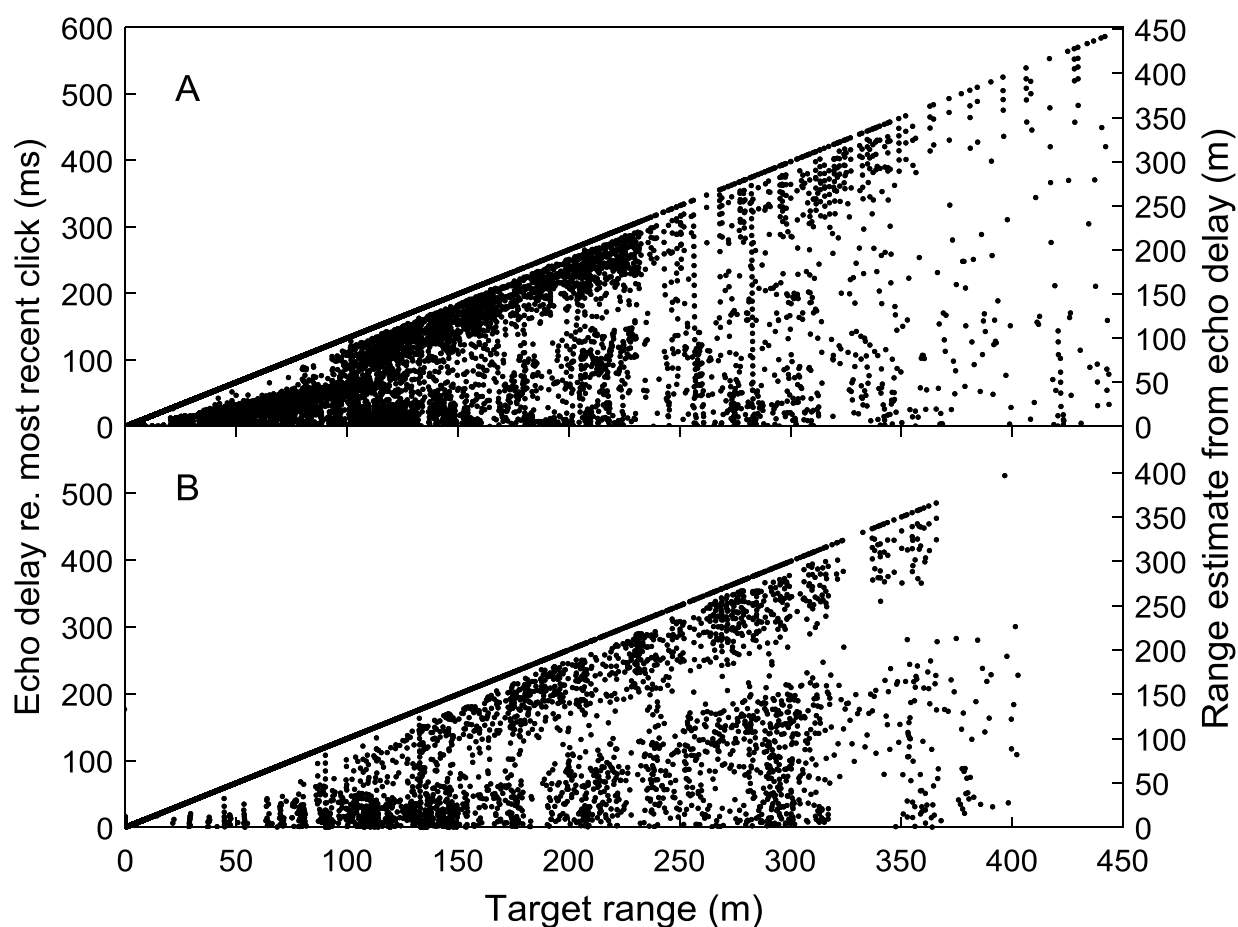
Figure S2. Echo delays measured between estimated target echo return times and the most recent click event as a function of target range for all click detections made on the target-mounted SoundTrap for the two bottlenose dolphins SAY (A, 16,284 clicks) and TRO (B, 9739 clicks). When ICIs are longer than the TWTT to the target and back, the target range is estimated correctly, whereas ICIs shorter than the TWTT result in underestimated target ranges. The number of correct target range estimates using this method is 8,311 for SAY and 3,146 for TRO. Note that the correct estimates separate out above the underestimates by a gap of ~10 m or more due to the dolphins generally clicking at ICIs longer than ~13 ms.