Supplement S1. VPS articles reference list

Includes all VPS articles identified using the search terms described in the manuscript. Numbers in superscript highlight cases where data are used by multiple articles, as reflected in subsequent summary statistics in the main manuscript. Note an article may still contain unique species datasets if multiple species were tagged. Ordinal number determined by timeline of search and is therefore non-alphabetical. Asterisk (*) indicates methods papers (n = 10) which either did not tag fish or tagged fish but did not position them (alive; non-cadaver) within a VPS array. Full dataset from review available on reasonable request.

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Supplement S2. Summary statistics for receivers and tags

On average, 28 receivers are used in a VPS study (cumulative value, *n* animal tracking studies excluding purely methodological studies = 83; range 4 – 151) and includes 22 sync tags (n studies that did mention sync tags = 18; n studies that did not detail how many sync tags were deployed = 8; range = 0 - 61) and 6 reference tags (n studies that did not mention reference tags = 45, n studies that did not detail how many reference tags were deployed = 3; range = 1 – 11). On average, 63 animal tags have been used in VPS studies to date (n studies with tag number not listed = 1; range = 1 - 198). To generate the average cost of these configurations a VEMCO quote was generated in December 2021.

Supplement S3. Range test reporting

To date, over a third of unique VPS tracking studies have not mentioned range testing (*n* = 31, 37%). Of the 52 studies that mentioned range testing, 19 (37%) did not conduct their study-specific range testing and often referenced studies conducted <100 km from the study site and/or over a different time frame. Of the 33 studies that utilised unique range test data, six (18%) did not report their results, and the remaining 26 studies explained their results using six unique reporting styles with poorly defined statistical parameters and language commonplace (Table S1). The period of range testing (pre-during-post) and duration (short or long term) has also been poorly defined by VPS studies to date (Table S2), with few studies reporting factors which may reduce performance (*n* = 7). This lack of consistent reporting echoes the call of Kessel et al. (2014) for non-VPS acoustic telemetry, that as a community consistent reporting is essential for robust hypothesis testing.

Table S1. Summary of in-test reporting style for the 33 (of 52) unique VPS tracking studies which mention range testing. 16 did not provide any information. Asterisk (*) indicates that one study reported results in a format that matches both D and G and is included in both rows.

Rule category	In-text reporting style	Defining characteristics	No. studies
A	"Estimated minimum"	Minimum % or distance given	1
B	"100% at.."	Maximum distance with 100% assumed	2
C	"< 99% at a specified distance"	User defines %, between 1-99%	12*
D	Range of values for a given percentage, "350-900m at 85%"	Range of values given	6
E	Two values for DE given at two distances: ">80% @ 330m; >50% @ 600m"	Two proportions given	2
F	"400m **detection range**" OR "**effective detection range** extends up to… " "400m detection **radius**" OR "detection **efficiency** higher at Xm" "**Average** receiver range" "Range was **optimal**…" "**optimal** spacing at.." "**range extended** up to…" "**operating range** of …"	Unclear language, or poorly defined statistical relationship	14*

Table S2. Range test reporting of period and duration. Durations include short-term testing (< 24 hours) and long-term testing (> 24 hours).

Information type	Duration	No. unique tracking studies
Range testing period	Pre-study	19
	During study	1
	Post-study	1
	Not described	12
Range test duration	Short term	5
	Long term	8
	Not described	20

Supplement S4. Using the VEMCO calculator

In this worked example (Table S3), the user aims to determine the delay programming for 69 kHz pulse per modulation (PPM) tags they plan to add to a study system which will enable >50% detection probability (ideal for Vemco Positioning System). This simple calculator is used to indicate the worst-case scenario, e.g., many tagged animals are detected on a small section of the array. In this scenario, a 3x3 array is initially deployed (therefore 9 sync tags are present to enable time synchronisation, one on each deployed receiver).

Note this is an approximate estimate given the average transmission rate of an 8-ping tag (e.g. 1601/1602 code space tags) is 3.3s but in reality ranges from 2.34-4.26s (Colleen Burliuk, *pers. comm*), in addition a 10-ping tag (sensor tags, 9002-generation etc.) takes an average of 5s to transmit but ranges from 3.72-6.28s.

Table S3. Worked example using the VEMCO collision calculator. Decimals rounded to 3 d.p.

	Existing tags		New tags
	Sync tags	Animal and/or reference tags	Animal and/or reference tags
No. Tags	6	2	5
Burst rate (s)	3.3	5	5
Delay (s)	600	120	65
	0.033	0.080	0.387†

†Users should not aim to reach high saturation rates (negative values) given the delay associated with tag transmissions, reaching negative values will likely result in data loss due to ping saturation which can lead to signal collisions. Experimental work is required to resolve at what saturation rate is likely deleterious.

The following steps were taken to calculate the above example (Table S3):

1. The estimated ping-time saturation (time taken up by existing tag pings in the system) of the existing sync tags in the system (purple highlight) is calculated as:

Equation 1.

$$\frac{(\text{Number existing sync tags in the system } * \text{ Burst rate of the existing sync tags})}{(Burst\ rate\ of\ the\ existing\ sync\ tags + Existing\ sync\ tag\ delay)}$$

2. Equation 1 is also used to solve the ping-time saturation of animal and/or reference tags in the system (gray highlight). The sum of two components equates to the total ping saturation.

3. The estimated time available to fill with pings (yellow highlight) is calculated with a desired detection probability of 50% (0.5) using the following:

Equation 2.

$$(1-0.5) - Ping\ time\ saturation\ of\ existing\ sync\ tags \\ - Ping\ time\ saturation\ of\ existing\ animal\ and\ reference\ tags$$

4. The minimum advisable nominal delay (blue highlight) for the new tag types is calculated as:

Equation 3.

$$((Number\ of\ new\ animal\ pinger\ tags\ added * Burst\ rate\ of\ pinger\ tag) + \\ (Number\ of\ new\ animal\ sensor\ tags\ added * Burst\ rate\ of sensor\ tag)) / \\ Output\ of\ Equation\ 2$$

Supplement S5. Ascension case study range tests

Preliminary assessment: estimating detection range using range tests

To evaluate detection efficiency across the two predominant substrate types, range tests were conducted across rock and sand habitats. A single acoustic receiver (VEMCO VR2W) was affixed to a 14 mm polypropylene line attached 3 m below an 8” trawl float (850 g lift) terminating in a 30 kg anchor. An inflatable surface marker buoy was attached to the float to enable quick visual assessments of the receiver’s position. All range tests were conducted using a range test tag (VEMCO V16-6x, fixed 7 s transmission rate, 158 dB) >500 m from English Bay. The detection range of the range test tag was assessed at distances of 0 – 250 m (using benthic SCUBA trials) and 0 – 500 m (using surface kayak trials, 250 m max during rock range testing) at 50 m intervals. During benthic testing the range test tag was affixed to a 14 mm polypropylene line which terminated in an 8” trawl float (850 g lift) which was held to one side by a SCUBA diver for 4 - 5 minutes at each fixed distance. During surface testing, the range test tag was affixed to 4 mm nylon kernmantle rope which terminated in a 2 kg dive weight and lowered 3 m from the base of a two-person kayak. The position of the boat was marked using a handheld GPS (Garmin eTrex 30x) to ensure the boats position was maintained. Both sand range tests were conducted on the 15th of May 2019, and rock range test were conducted on the 17th of May 2019. Observed conditions were markedly similar (e. swell 0.5 – 1 m, sunny and clear skies). Across both substrates benthic range testing outperformed surface range test results; we theorise this is due to winds impacting surface water stability and increasing ambient noise (by reducing signal reception). Detection range was slightly higher for sand (Fig. S1A) habitat versus rock (Fig. S1B) which is likely due to signal scatter.

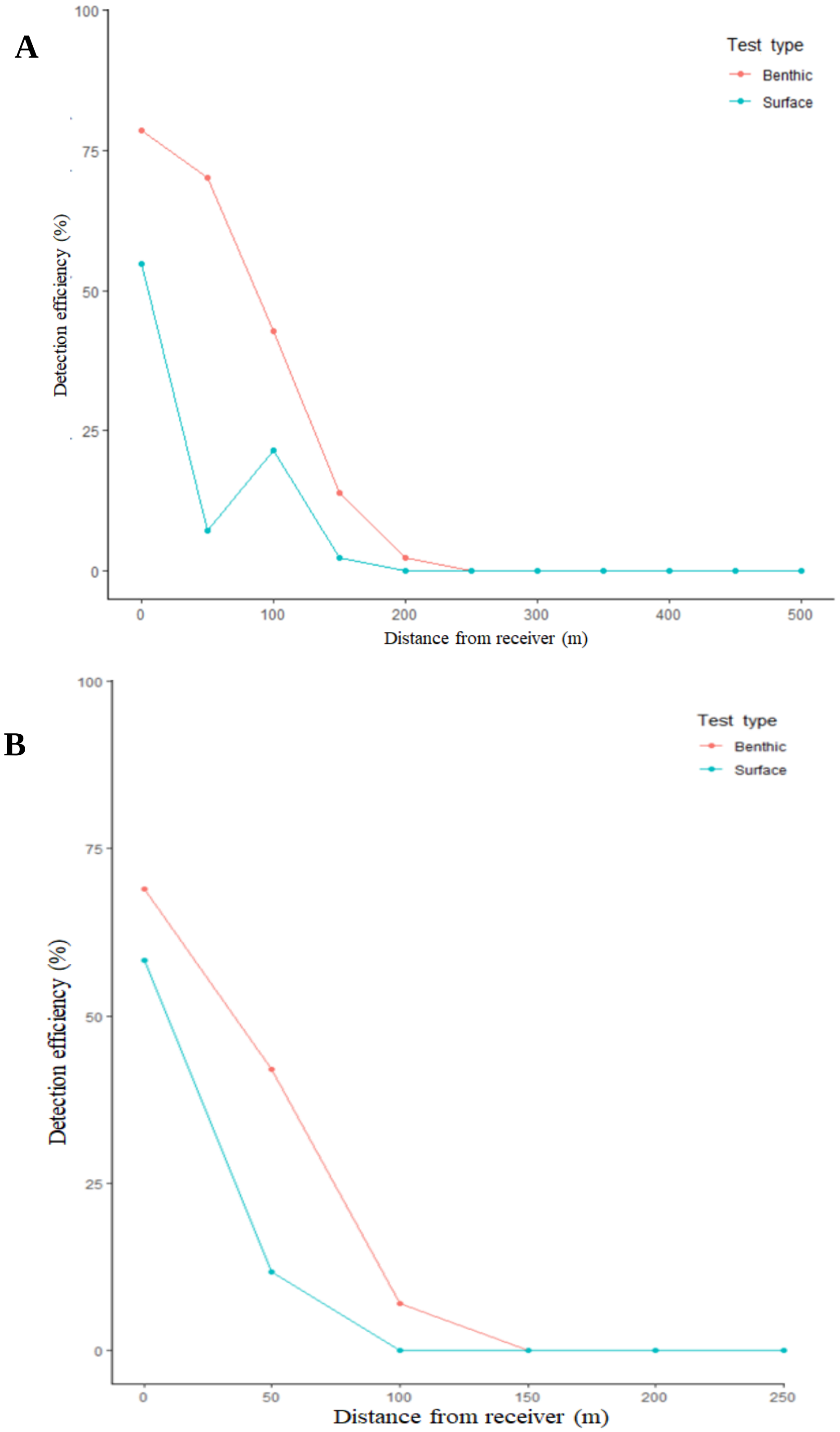

Figure S1. Range tests conducted in English Bay, northwest of Ascension Island. Surface tests (blue line) were conducted from a kayak, and benthic tests using SCUBA (red line) using a VEMCO V16 range test tag (7 s nominal transmission rate, 158 dB) power. A. Trials conducted across sand environments, with the range test tag held at fixed distances of 0 – 250 m during benthic trials, and 0 – 500 m during surface trials. B. Trials conducted across rock environments, with the tag held at distances of 0 – 250 m for both surface and benthic trials.

In March 2017, range tests were conducted off the northwest coast of Ascension Island in English Bay by the Ascension Island Government Conservation and Fisheries Directorate (*unpublished data*). Three trials were conducted to test the detection range of three acoustic transmitter types (VEMCO V13-1x, V16-4x, V9-2x) to identify which would be best suited for tracking studies conducted in the nearshore environment. During each trial a single tag was suspended off the back of a kayak, several metres below the water's surface, at 50 m intervals (0 - 450 m) from a listening VR2W acoustic receiver. Detection efficiency was calculated by dividing the number of observed detections (number recorded during the 5-minute waiting interval at each fixed distance from the receiver) by the number of expected detections (burst rate * transmission rate). Detection range was calculated as c. 90% for all tag types at 50 m from the listening receiver, however, dropped to 30-70% at 100 m (Fig. S2).

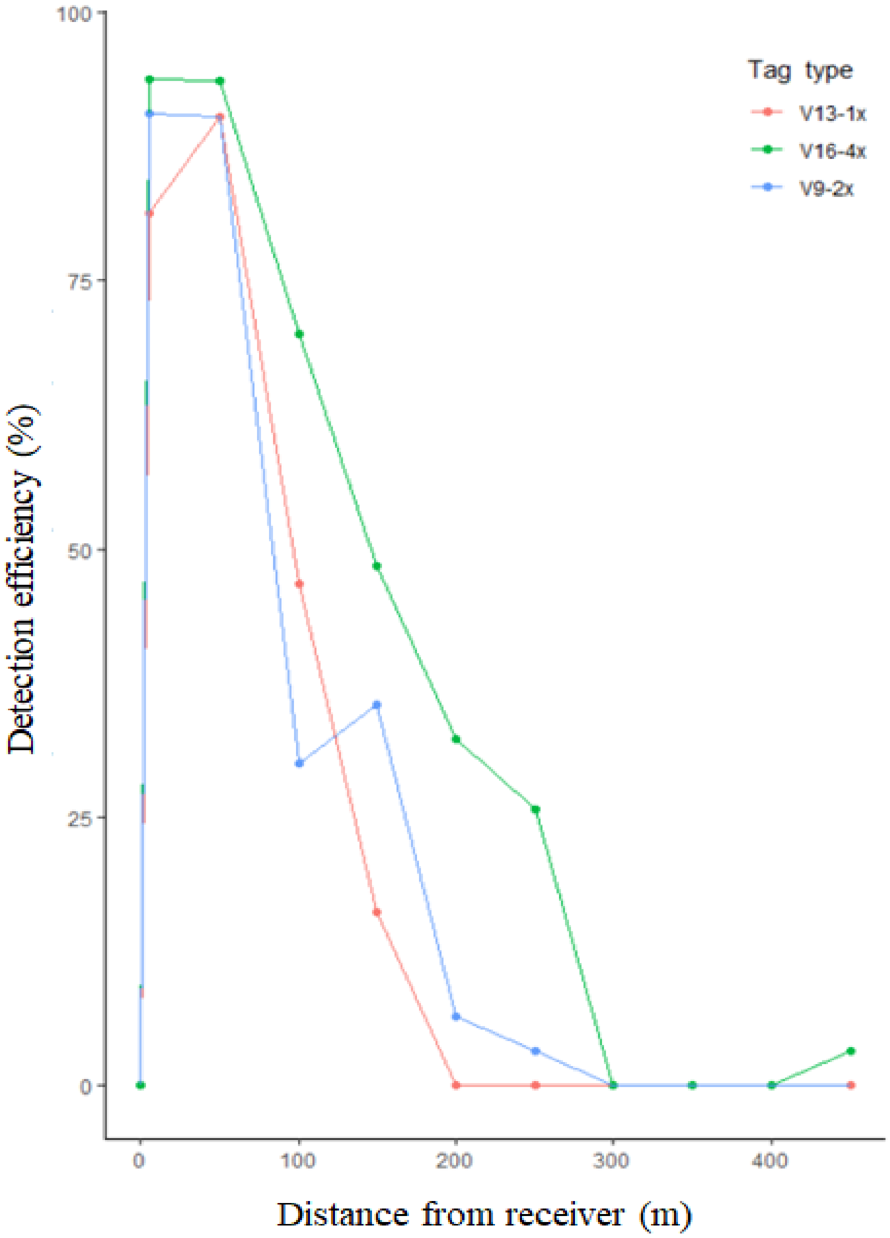

Figure S2. Range test output for tests conducted in English Bay, northwest of Ascension Island in March 2017 using three tag types (red = V13-1; green = V16-4x; blue = V9-2x) using fixed-distance surface tests from a kayak (0 - 450 m at 50 m intervals)

Supplement S6. Diurnal sync tag variability across the English Bay VPS array

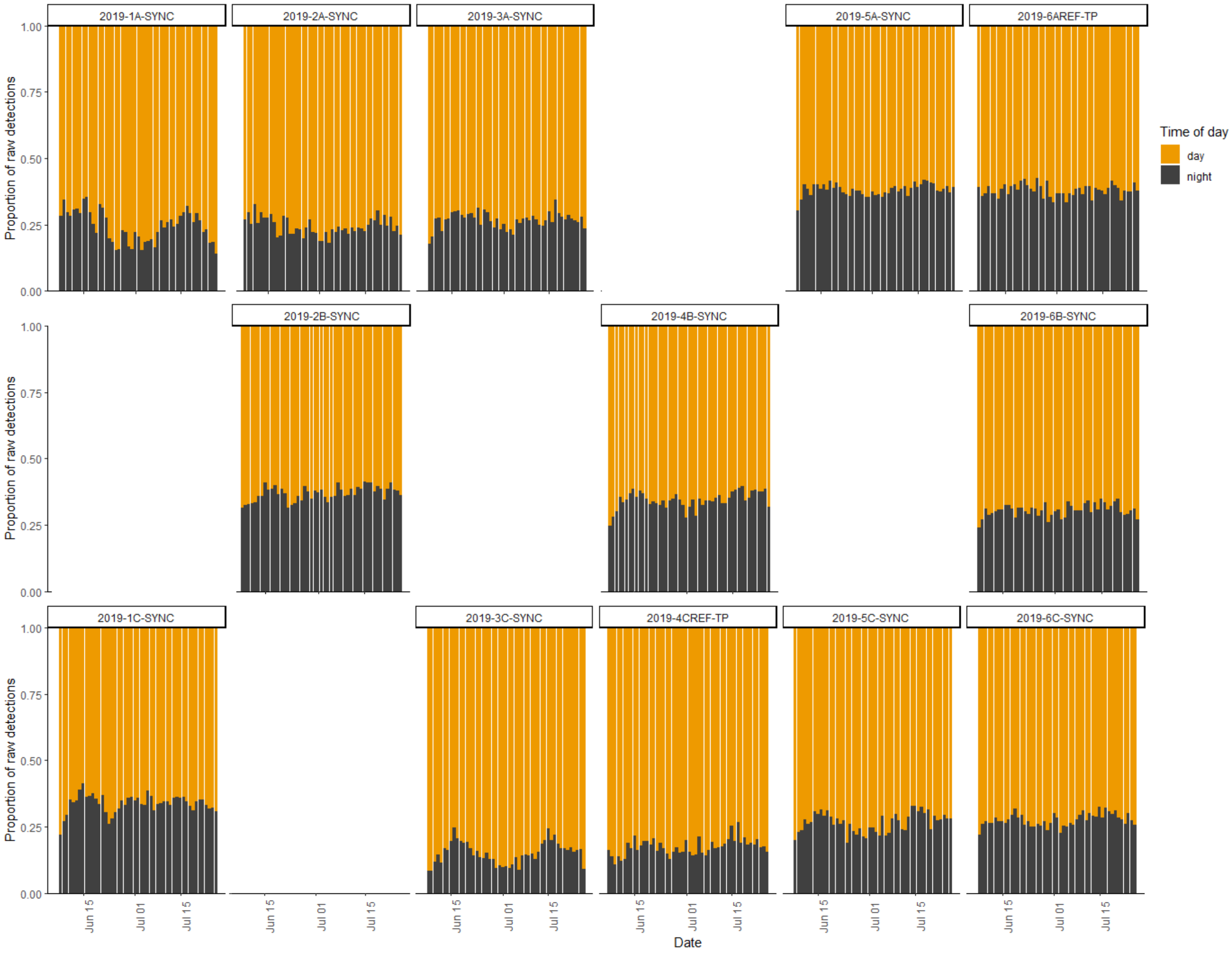

Figure S3. Sync tag performance within the Ascension Island acoustic array: number of detections of fixed co-located acoustic synchronisation ("sync", $n = 12$) and reference ("REF-TP, $n = 2$) tags (VEMCO V16-H, 152 dB, 240-300 s delay; deployed during the six-week study period. Total detections are expressed as a proportion of diurnal detections (day, orange; night, black). Graph grid arrangement matches position (and presence) of fixed tags within 6x3 Vemco Positioning System array of VEMCO VR2W acoustic receivers.

Table S4. Summary of recorded detections and triangulated positions of collocated sync (VEMCO V16-6x, *n* = 12; 69 kHz, 540-660 s transmission rate, 162 dB power) and reference tags (denoted by asterisk *; VEMCO V16-TP, 69 kHz, transmission rate = 540 – 660s, nominal transmission rate = 600 s, 162 dB power) deployed within a VPS northwest of Ascension Island. The time frame was trimmed from June 6 to July 27, 2019, so that only data from equal timeframes (day and night) are presented.

Tag Station ID	Number of recorded detections		Number of triangulated positions	
	Day	Night	Day	Night
1A	14,734	4,846	1,778	27
2A	20,432	6,628	2,908	329
3A	21,736	7,913	2,972	134
5A	22,144	13,681	3,440	2,624
6A*	17,325	10,575	2,658	163
2B	19,244	11,233	3,111	1,396
4B	24,550	12,920	3,461	1,850
6B	22,340	9,812	3,375	674
1C	13,356	6,793	1,406	5
3C	15,828	2,847	2,648	10
4C*	16,520	3,493	2,208	11
5C	19,884	7,337	3,116	388
6C	19,736	7,517	2,974	93
Total	**247,829**	**105,595**	**36,055**	**7,704**

Table S5. Summary of detections and positions for fixed transmitters (reference and sync) deployed alongside (sync) or within (reference) the VPS array. The study dataset spanned from when the array was completed on June 6 2019 (all receivers nin-water), to the first receiver removal on July 27 2019.

Tag type	No. tags	No. recorded detections			No. triangulated positions		
		Day	Night	**Total**	Day	Night	**Total**
Reference	3	39,7	16,713	**56,413**	5,798	508	**6,306**
Sync	11	213,984	91,527	**305,511**	31,189	7,53	**38,719**
Total	**14**	**253,684**	**107,24**	**361,924**	**36,987**	**8,038**	**45,025**

Supplement S7. Bathymetric complexity of the English Bay VPS array site

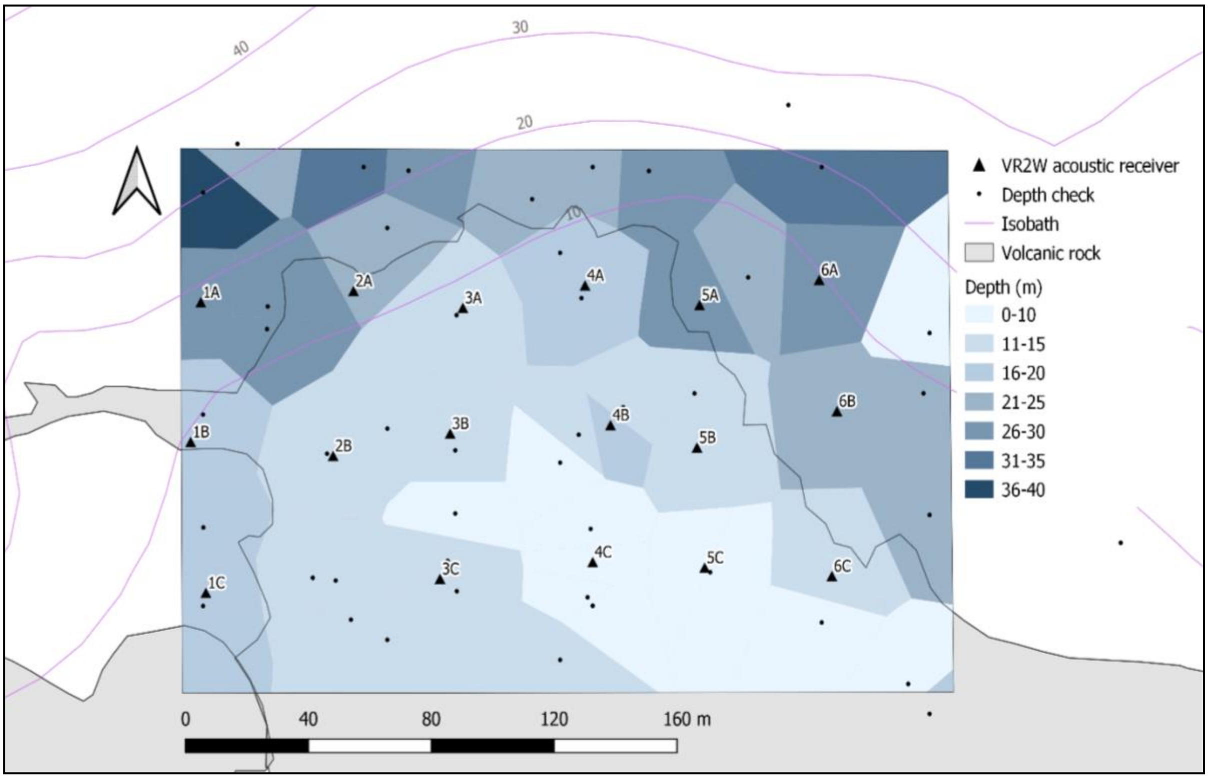

Figure S4. Bathymetric complexity across the study site where the array was deployed off northwest Ascension Island. A comparison of the inferred bathymetry from the 1691 British Admiralty Nautical Chart to Voronoi polygons (5% buffer) generated from opportunistic depth point data (*n* = 78) collected using a handheld GPS (Garmin eTrex 30x) during the study period.

Supplement S8. Ping conversion ratios from the English Bay VPS

Table S6. The total number of detections and pings recorded by VEMCO VR2W acoustic receivers (*N* = 17) deployed northwest of Ascension Island from June 6 2019 to July 27 2019. The ping conversion (PCR) was calculated as: (No. recorded detections in 24 hours * the number of pings per detection) / No. observed pings in 24 hours) * 100. The PCR was rounded to 2 d.p.

Station	Total detections	Total pings	PCR (%)
1A	16,870	1,794,700	0.94
1B	49,758	614,865	8.09
1C	34,897	322,615	10.82
2A	54,587	1,796,069	3.04
2B	20,838	1,338,882	1.56
3A	29,414	1,660,953	1.77
3B	43,848	804,293	5.45
3C	20,574	1,163,630	1.77
4A	46,606	920,355	5.06
4B	17,509	587,183	2.98
4C	43,905	450,316	9.75
5A	19,311	698,545	2.76
5B	42,305	1,003,989	4.21
5C	37,083	364,453	10.17
6A	41,076	795,802	5.16
6B	36,354	748,598	4.86
6C	26,215	314,510	8.34