Dolphins of the Kelp

Falkland Islands coastal aerial survey

Survey Plan and Observer Protocol 2017

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Background and aim

The Falkland Island coastal aerial survey is planned within the "Dolphins of the kelp: Data priorities for Falkland's inshore cetaceans" project funded by a Darwin Initiative grant in March 2016. The target species are the Commerson's (*Cephalorhynchus commersonii*) and Peale's dolphins (*Lagenorhynchus australis*).

The aim of the project is to establish baseline data on the abundance, distribution, natural history and genetic diversity of the Falklands inshore cetacean populations to provide a scientific basis for conservation and ecosystem-based marine management initiatives. In order to estimate abundance, a vessel-based survey using line-transect methods was planned within waters 10 kilometres from the coastline.

However, results from a pilot survey carried out in 2014, pointed out that dolphins were strongly attracted to the research vessel, which violates one of the key method assumptions, that animals do not respond to the survey platform before they are detected by the observers. If this assumption is not met density estimates will be positively biased, resulting in numbers up to six times higher than when the response movement is not taken into account (Cañadas et al., 2004).

To minimize dolphin attraction, the use of an airplane instead of a vessel was adopted in 2017. This observation platform also offers the flexibility to select and survey only good weatherdays, which minimises the number of days lost as a result of poor weather conditions and also improves the financial efficiency of the project.

Aerial-based surveys are considered more efficient than vessel surveys for wider areas ,and have been successfully carried out with several cetaceans including species similar to the target species of this project (MacKenzie & Clement 2014; Palka et al., 2016).

Small aeroplanes with bubble windows, double engines and experienced pilots were available in the Falklands where the Falkland Islands Government Aerial Service – FIGAS (www.fig.gov.fk/figas) is an essential part of the island transport infrastructure and way of life.

Survey area

The study area measures 19,314 km^2 and covers the waters within 10km from the main two islands (East Falkland and West Falkland) as well as the 778 smaller satellite islands with the exception of Beauchêne Island lying about 54 kilometres south the main Islands (**Figure 2**). The coastline of the Falkland Islands is complicated, containing many small inlets, bays and river estuaries.. it is also worth noting that Commerson's dolphin have been observed in the main rivers and lakes included within the study area. The majority of the Falkland Islands coast is rocky although sandy beaches are present. Kelp (mainly giant and tree kelp) forms extensive forests extending up to 1 km from the coast in several areas.

The study area falls within the continental shelf that extends from Patagonia. The Falkland Islands are in the southern coldtemperate zone of surface water with offshore sea surface temperatures ranging from around 6 °C in winter to 13 °C in summer. The Antarctic Convergence lies approximately 500 km to the south of the islands and 700 km to the east.

Aircraft

The survey platform is the BRAVO-OSCAR Britten-Norman BN-2B Islander with high-wing, double engine and two bubble windows on the rear allowing observation below the plane itself (**Figure 1 - Appendix 1**). The aircraft flies at **150 m** of altitude at the target speed of 90 knots (**~167 km/hour**). The maximum permitted cruise time is approximately six hours allowing for about 1,000 km to be flown per day. The aircraft is only able to be refueled at Stanley airport, the start and end point for each days surveying.

Figure 1 – The aircraft used for the survey was a Britten-Norman BN-2B Islander from FIGAS

Survey Design

The software Distance 6.2 (Thomas et al., 2010) is used to generate different survey designs for the study area (**Figure 2**). Distance 6.2 allows the comparison of several designs and therefore the selection of the most suitable for the characteristics of the area and the target species. Distance 6.2 is specifically designed for this kind of research activity and is widely used to obtain robust estimates of the abundance and density of several species in the marine and terrestrial environment. The software uses an automated survey design engine to examine the coverage properties of candidate survey designs prior to their implementation. For each given design, the software generates a map showing coverage probabilities estimated by simulation (**Table 1**) and allows researchers to determine whether a particular survey design is appropriate. Based on these considerations, the survey designed for the planned monitoring activities ensures a uniform coverage of the study area (i.e. each point within the study area has the same probability to be surveyed) and gives the maximum efficiency per unit effort, for instance, by minimising off effort time such as the time requested to travel to and from the airports and fly between successive transect lines.

The study area was divided in 12 strata accounting for possible differences in physical characteristics with respect to the prevailing winds and currents and the general physiography of the sea bottom.

A total of 217 transects spaced between 5 and 6 km and generally oriented perpendicular to the coast north-south were generated by the software Distance 6.2. Overall, the total length of the designed transects was 4317 km (**Table 1**). Accordingly, the estimated time to survey the planned transects, considering transfer time (to and from airports and from transect to another) is 52 hours.

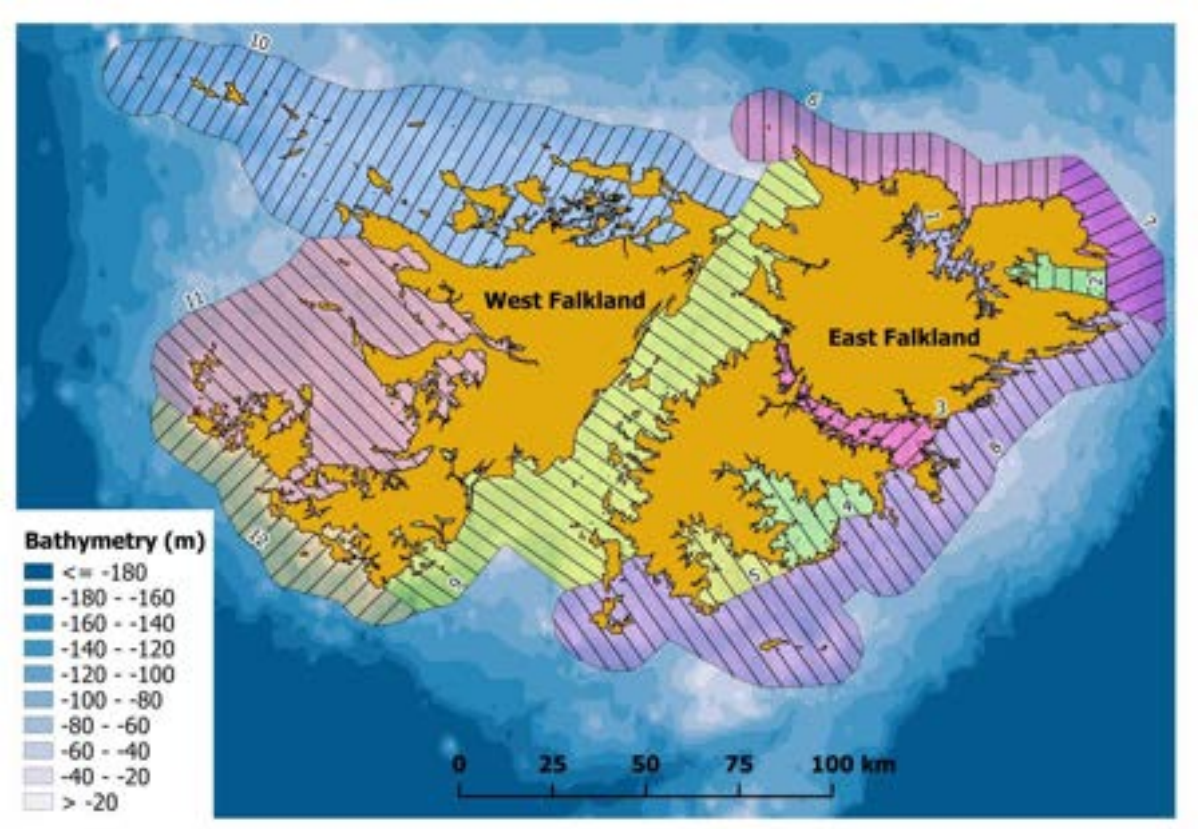

Figure 2 – Map of the Falkland Islands showing the study area within 10km from the coastline (divided in 12 strata) and the transects (parallel black lines) obtained with the software Distance 6.2.

Table 1 - Summary information on the planned aerial survey.

Stratum		Area (km^2)	Coverage probability (%)	Effort (km)	No. transect
Id	**Name**				
1	Port Salvador	174.5	0.57	46.4	8
2	Berkeley Sound	175.8	0.79	43.0	6
3	Choiseul Sound	349.9	0.68	76.3	11
4	Adventure Sound	447.1	0.69	88.0	7
5	Bay of Harbour	290.2	0.65	52.1	4
6	North East Falk.	,1162.6	0.86	254.4	20
7	East point East Falk.	590.1	0.80	126.6	11
8	West East Falk.	3,640.7	0.85	823.2	41
9	Falkland Sound	3,143.3	0.82	740.3	35
10	Northwest West Falk.	4,890.4	0.84	1,082.4	38
11	Middle West Falk.	3,335.4	0.81	751.1	17
12	South West Falk.	1,114.3	0.79	233.2	19
Total		**19,314.3**	**0.82**	**4,317.0**	**217**

Survey configuration and data collection

The research crew consists of a recorder and two observers. The recorder is positioned near to the pilot; the observers are seated at the rear of the plane, where the bubble windows are positioned. Researchers rotate positions in the plane according to the instructions of the recorder, ideally every hour, during off line effort.

Date, time, position, heading and speed of the plane are automatically recorded every second on a laptop running the software Logger with an MS Access customised database (Logger 2000, International Fund for Animal Welfare) interfaced via a GPS Garmin GPS 72H. The laptop battery has 5 hours autonomy; battery is replaced during passages between strata.

The recorder enters the flying mode the environmental variables, and the sighting data as reported by the observers (**Table 2**). Environmental and sea state conditions will be recorded at the start and end of each transect, and anytime the conditions change significantly during on line effort

The observation sector for each observer goes from the trackline to 90 degrees port or starboard (Figure **3**). An efficient means to achieve a good scan of the visual field is the "D-scan" procedure (**Figure 4** – as suggested by Daniel Pike). Observers initiate each sweep (scan) of their forward field of view by looking ahead of the aircraft, close to the trackline. Observer eyes slowly sweep along the water nearer to the aircraft until the beam position, then further out towards the horizon, then back (at a more rapid pace) towards the front. This ensures that more sighting effort is allocated close to the trackline.

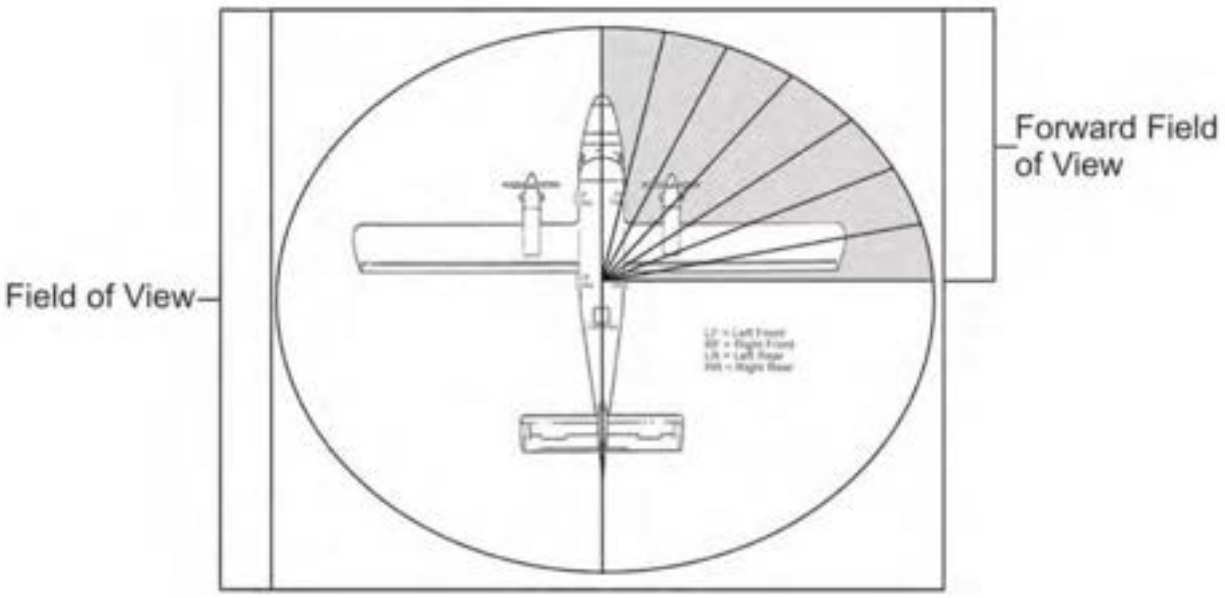

Figure 3 – Sector of view. In grey the Forward field of view searched by observers during the survey.

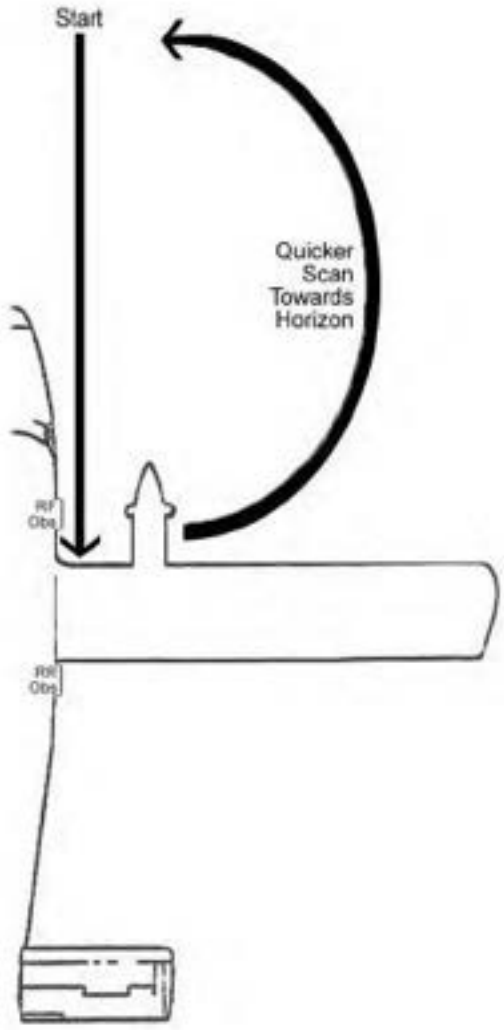

Figure 4 – The figure shows the "D-scan" procedure to achieve a good scan of the visual field.

The survey is conducted in passing mode, without leaving the route at the time of a sighting. If large groups of dolphins are observed, transect might be temporally abandoned to circle the group, possibly lowering altitude, to count animals and/or to facilitate species identification. The route is then resumed at the exact point where it was left to start circling. Sightings occurring during the circling over the animals will not be taken into account for the abundance and density estimates.

The survey plan by day is displayed in **Appendix 4**. The waypoints latitude and longitude are in the excel file "Parameters_for_distance".

Data collection by the recorder

At the beginning of the survey the Aircraft **name/model**, the **pilot** name, and the **researcher** positions in the aircraft (**Observer left** and **right** and **Data Recorder**) are recorded. Researcher positions are recorded again when/if researchers rotate.

The following data are recorded at the beginning of the survey, at the beginning/end of each transect and anytime conditions change (**Table 2**):

- Event
- Stratum number
- Transect IDs
- Beaufort sea state
- Cloud cover
- Precipitation
- Fog
- Turbidity
- Glare intensity
- Glare right and left sector (start and end, clock face 1-12)
- Sightability for each side

Other data, if needed, obtained by the pilot:

- Altitude (if not the target altitude of 150m) and drift angle. Due to wind conditions etc., aircraft often 'crab' along the trackline i.e. the nose does not point straight ahead. This can sometimes be a large angle and it is important to collect this information so that the positional data can be corrected

Data collection at sighting by observers

The survey technique used is the cue-counting. When a cue (cetacean) is spotted, observers recoded the following categories (**Table 2**):

1. Time of the cue – by saying "sighting, sighting" to the recorder
2. Angle abeam
3. Species
4. Group size (best compulsory and if needed low and high)

If there is time:

- Cue
- ID confidence – recorded only when is not "Certain" (by default)
- If any, presence of young, young number and age
- Observer (spotter) name – recorder should be able to recognise the observer voice
- Swim direction (clock face from 1 to 12) – only for whales
- Reaction to the airplane – only if evident ("none", by default)
- Picture – only if taken

The following table summarize the field in the database.

Table 2 - List of data collected during the aerial survey, divided by environmental and sighting data.

ENVIRONMENTAL FIELD CODES		
Event	Beg - Begin line	
	End - End line	
	Eva – Environmental variable change	
	Abl - Abandon line	
	Lan - Land. When over land or no fly-zone (e.g. an island!)	
	Cir - Circle. When leaving the track line to circle over the dolphin group to identify the species, take pictures/video, or count the animals. PRESS Cic AS SOON AS LEAVING THE TRACKLINE AND MAKE SURE TO RESUME EFFORT RIGHT WHERE THE TRACKLINE WAS ABANDONED!	
	Hig - High density. When entering in area of high density meaning that data might be uncompleted	
	Ehi - End high density	
	Oth - Other (specify)	
NOTE: the data recorder needs to change the conditions when the observer is back on effort or when the land was passed		
Beaufort scale	0 - Calm	Sea like a mirror
	1 - Very light breeze	Ripples with appearance of scales, no foam crests
	2 - Light breeze	Wavelets, small but pronounced. Crests with glassy appearance, but do not break
	3 - Gentle breeze	Large wavelets, crests begin to break. Glassy looking foam, occasional white horses
	4 - Moderate breeze	Small waves becoming longer, frequent white horses
	5 - Fresh breeze	Moderate waves of pronounced long form. Many white horses, some spray
Cloud cover	Coverage in %	
Glare: from/to	Use the clock face 1-12 system with glare from xx to xx measured clockwise - e.g. 12 to 3 means the right side of the plane is covered in glare whereas 12 to 9 means the left side of the plane is covered in glare	
Glare intensity	1 – no glare	
	2 – Mild. Glare affects sightings within that sector very little	
	3 – Moderate. Glare affects may ability to detect sightings within that sector	
	4 – Severe. Glare severely affect ability to detect sightings within that sector	
Precipitation/Fog	1 - None	
	2 - Mild	

	3 - Moderate
	4 - Severe
Turbidity	1 - Clear water: objects/animals visible several meters under the surface
	2 - Moderately clear water: objects/animals visible under the surface
	3 - Turbid water (e.g. algae, mud): objects/animals only visible very close (<50cm) to the surface
	4 - Unknown turbidity
Sightability	This represents each observer's subjective view of the likelihood that, given all of the conditions, they would see a dolphin/whale within the primary search area should one be present
	1 - Excellent. Beaufort is 0, there is no glare and turbidity of less than 2
	2 - Good. Observer believes that the likelihood is good. Normally will require at least a sea state of two or less and a turbidity of less than 2
	3 - Moderate. Observer believes that the likelihood while not good is not poor
	4 - Poor. When the observer believes that they are unlikely to see a dolphin/whale unless for example it is showing exuberant behaviour and/or is very close to the track line
SIGHTING FIELD CODES	
Species	Enter the species code here. The list includes non-cetacean sightings (other marine fauna, such as seal and birds) and any other "particular" sighting (specify in the comment). See the list in the appendix.
AngleAbeam	This is the declination angle (to the nearest degree – do not round to the nearest 5°) to the animal (or centre of a school) when the sighting is abeam (or estimated to come abeam if it has dived). Use the left hand scale of the inclinometer (the horizon=0 and directly below the plane=90). Keep the inclinometer in your hand so that you are quickly ready to record the angle. Where more than one animal is involved measure the angle to the centre of the group
Group size	Enter the total group size including calves. If you are unsure of the exact number enter your best low and high estimate and put the range in the comments field. A group is defined as containing individuals not more than 5 animal lengths from each other, and exhibiting the same swimming pattern and/or general behaviour
	When populations are distributed in loose aggregations it is better to identify smaller, homogeneous groups within the aggregation. Note in a comment that the groups belong to the same aggregation
IDConfidence	1 - High / Definite
	2 - Med / Probable
	3 - Low / Uncertain
Cue	1 - Body seen at surface
	2 - Body seen underwater
	3 - Blow
	4 - Breach/Jump/Splash

	5 – Slick/Footprint/Ring
	6 - Birds
	7 - Other associated wildlife (e.g. fish)
Observer	Enter the code for the spotter
PresYoung	Record the number of young in the group, using the size of the animal and behaviour to determine the age. If there are no young enter 0 or leave blank. In mixed species group, enter the number of young for each species
	1 - Yes
	2 - No
Young	Enter the number of the young
SpecifyAge	1 - Newborn. Less than half of the mother body length
	2 - Calf. Half of the mother body length
	3 - Juvenile. Three quarter of the mother body length
	4 - Undetermined. Smaller than adult
SwimDirection	Enter the swimming direction (heading) of the animal(s) relative to the plane using clock face, 1 to 12
Reaction	Enter Y or N (yes or no) if you think the animal either did or did not react to the plane
Picture	1 - Yes
	2 - No
Comments	Enter any additional information you feel helps to explain the sighting or the quality of the data. NB The program is limited in how many characters the comment holds. Try to make it short or add another sighting (e.g. C for centre) and continue the comment

Beaufort	Glare	Rain	Fog	Sightability
0	1	1	1	1
			3	3
		2	1	1
		3	1	2
	2	1	1	1
			3	3
			4	4
	3	1	1	2
	4	1	1	2
1	1	1	1	2
			2	2
		2	1	2
		3	1	3
	2	1	1	2
			2	3
	3	1	1	3
			2	3
	4	1	1	3
2	1	1	1	2
			2	2
			3	3
			4	4
		2	1	2
		3	1	3
	2	1	1	2
			3	3
			4	4
	3	1	1	2
			2	3
			3	3
	4	1	1	3 (2 with noglare)
			3	4 (3 with noglare)
3	1	1	1	3
			2	3
		2	1	3
		3	1	4
	2	1	1	3
			2	3
	3	1	1	4 (3 with noglare)
			2	4 (3 with noglare)
			3	4
			4	4
	4	1	1	4 (3 with noglare)
			3	4
4-5	any	any	any	4

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Cañadas A., Desportes G., and Borchers D. (2004). The estimation of the detection function and g (0) for short-beaked common dolphins (*Delphinus delphis*), using double-platform data collected during the NASS-95 Faroese survey. Journal of Cetacean Research and Management 6.2. P 191-198.

MacKenzie D. L., and Clement D. M. (2014). Abundance and distribution of ECSI Hector's dolphin. Report for Ministry for Primary Industries, Wellington, New Zealand. P 1-83.

Palka D. L., Cañadas A., Donovan G., Fortuna C., Scheidat M. and Zerbini A. (2016). Report of the Intersessional Expert Group to Review Hector Dolphin Abundance Estimates, IWC – SMWP8. P 1-20.

APPENDIX

Appendix 1 - Aerial survey plane specifications

- Capacity: 10
- Length: 10.9m
- Wingspan: 14.92m
- Height: 4m approx
- Wing area: 30.2 m²
- Empty weight: 2127
- Max. takeoff weight: 2994
- Powerplant: Lycoming 0540
- Maximum speed: 184kts
- Cruise speed: 120kts
- Stall speed: 50kts (max weight, clean), 40kts (max weight, full flap)
- Range: 900nm
- Service ceiling: 10000 feet limit as no oxygen.
- Rate of climb: Depends on many factors. At sea level, max weight: 1000'/minute is normally achievable

Appendix 2 – List of equipment

- Laptop HP ProBook 450 with 2 extra batteries
- GPS Garmin 72H with batteries and two packages of extra batteries (AA)
- GSP data cable with COM port and USB-COM adaptor
- Inclinometers Suunto PM-5-360 (x2)
- Small notepads and pencils
- Digital watch with hh:mm:ss (x2)
- Digital Dictaphones (x2)
- DIGITAL SLR Cameras and video recorders
- Binoculars
- Ducktape
- Windscreen cleaners
- Pillows from sofa

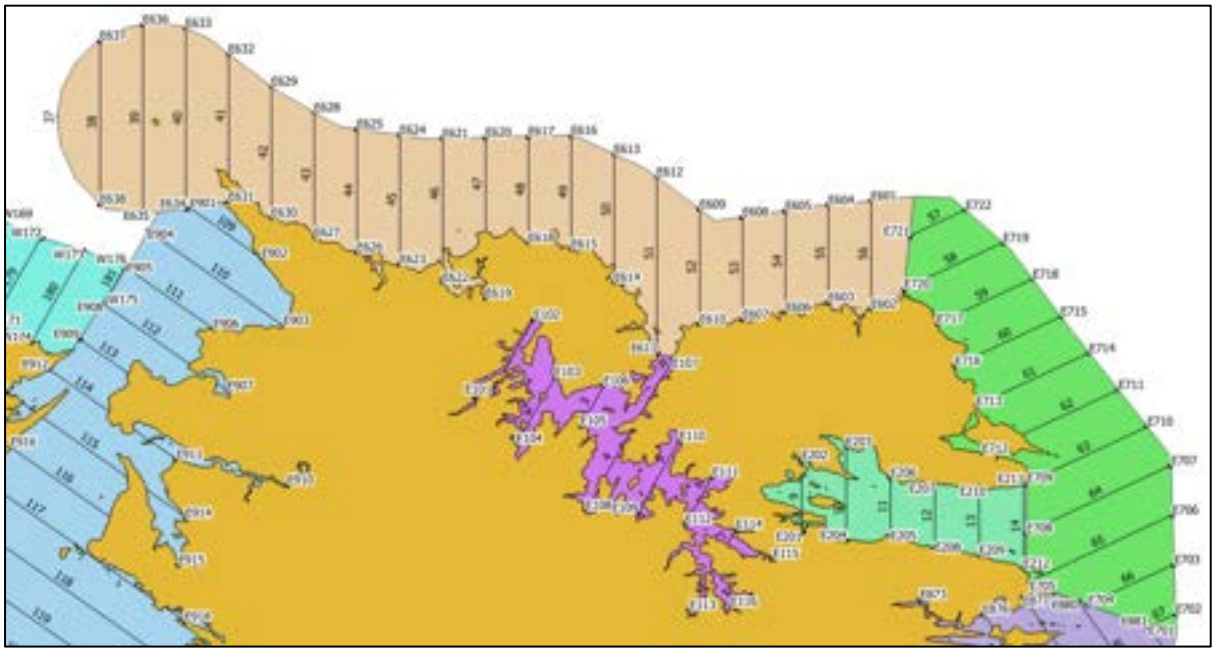
Appendix 3 – Species list

Id	Code	Species (English)	Species (scientific name)
1	Cco	Commerson's dolphin	*Cephalorhynchus commersonii*
2	Lau	Peale's dolphin	*Lagenorhynchus australis*
3	Bbo	Sei whale	*Balaenoptera borealis*
4	Oor	Killer whale	*Orcinus orca*
5	Bph	Fin whale	*Balaenoptera physalus*
6	Lcr	Hourglass dolphin	*Lagenorhynchus cruciger*
7	Eau	Southern right whale	*Eubalaena australis*
8	Lob	Dusky dolphin	*Lagenorhynchus obscurus*
9	Ba	Minke whale	*Balaenoptera acutorostrata*
10	Gme	Long-finned pilot whale	*Globicephala melas*
11	Bmu	Blue whale	*Balaenoptera musculus*
12	Pma	Sperm whale	*Physeter macrocephalus*
13	Mno	Humpback whale	*Megaptera novaeangliae*
14	Hpl	Southern bottlenose whale	*Hyperoodon planifrons*
15	UNW	Unidentified whale	
16	UNB	Unidentified baleen whale	
17	UND	Unidentified dolphin	
18	UKM	Unidentified marine mammal	
19	UNO	Unidentified otariidae	
20	UNP	Unidentified phocidae	
21	UNPI	Unidentified piniped	
22	Aa	Falkland Fur seal	*Arctocephalus australis australis*
23	Ofl	Southern sea lion	*Otaria flavescens*
24	Hl	Leopard seal	*Hydrurga leptonyx*
25	Mle	Southern elephant seal	*Mirounga leonina*
26	Bir	Birds (specify)	
27	OTH	Other	

Appendix 4 – Survey plan day by day

Day 1 – Strata 1, 2, 6 and 7 completed; stratum 9 partial.

- E701 – E022 (11 transects from 57 to 67)
- E601 – E638 (19 transects from 38 to 56 – transect 37 was not performed because it was only few meters long)
- E901 – E916 (8 transects from 109 to 116)
- E101 – E116 (8 transects from 1 to 8)
- E201 – E212 (6 transects from 9 to 14)

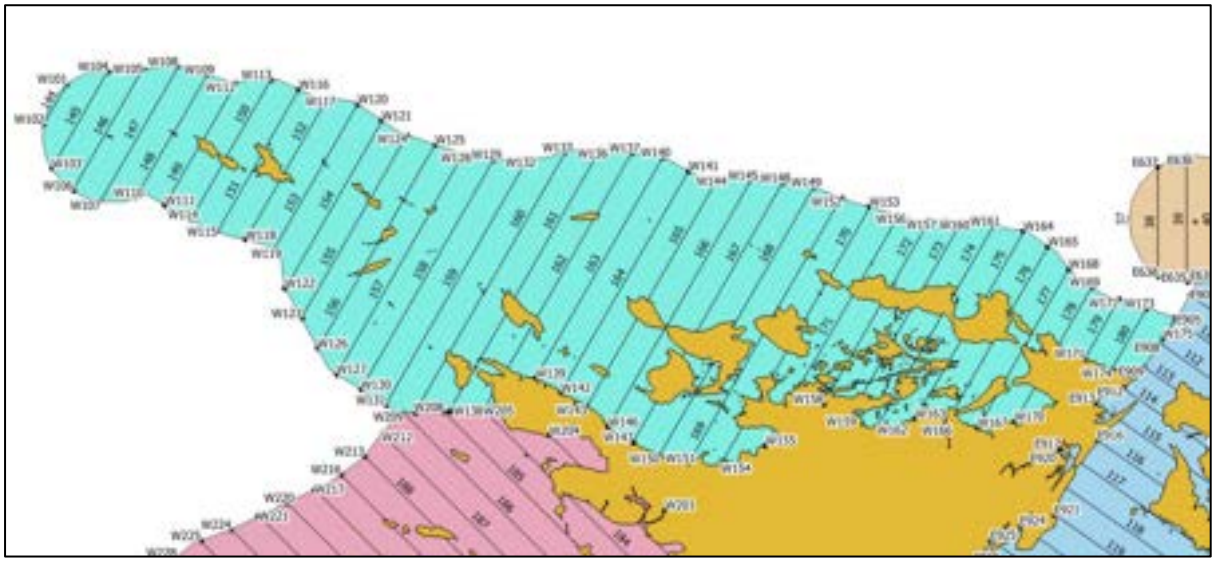


Day 2 – Stratum 10 part 1

- W101 – W136 (18 transects from 144 to 161)

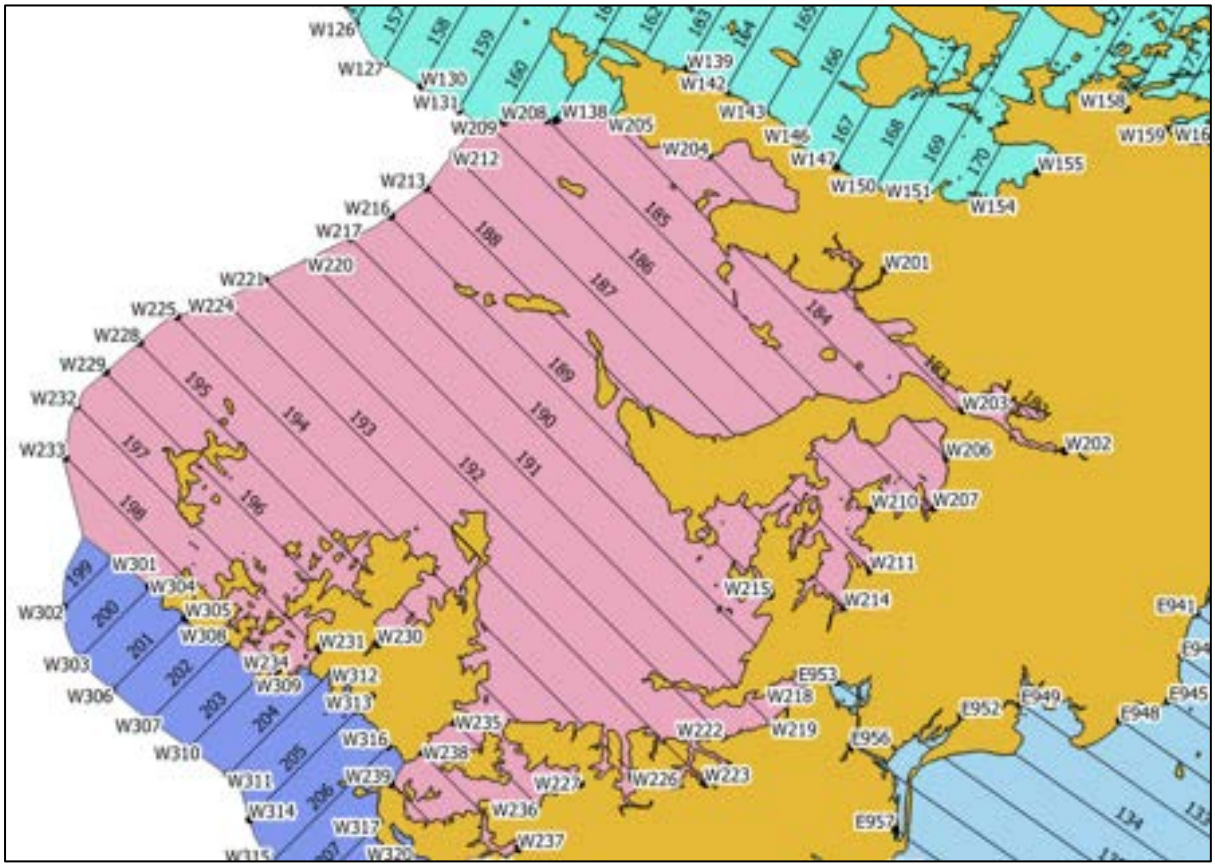
Day 3 – Stratum 10 part 2

- W137 – W176 (20 transects from 162 to 181)



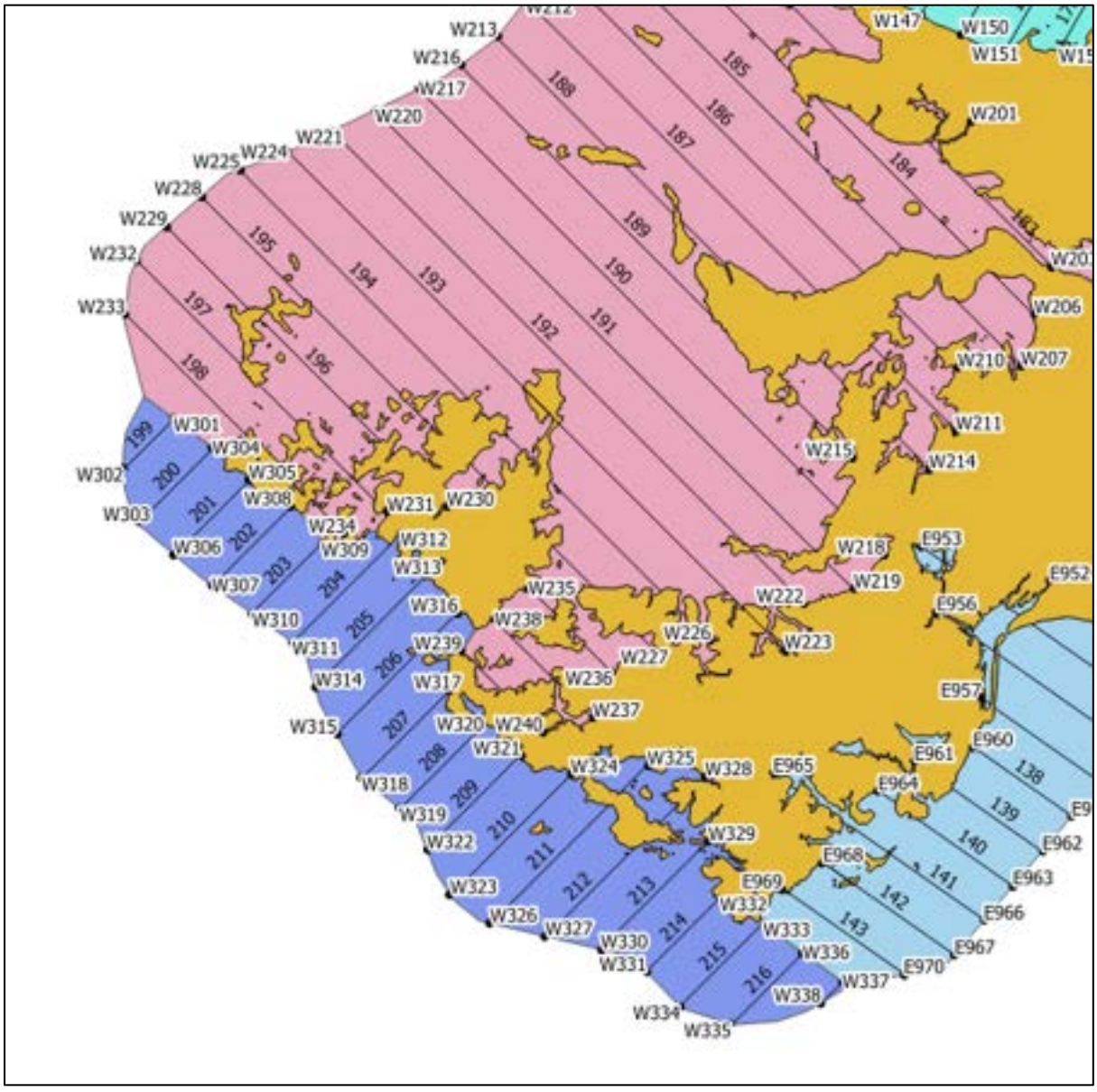
Day 4 – Stratum 11 part 1

- W201 – W222 (11 transects from 182 to 192)



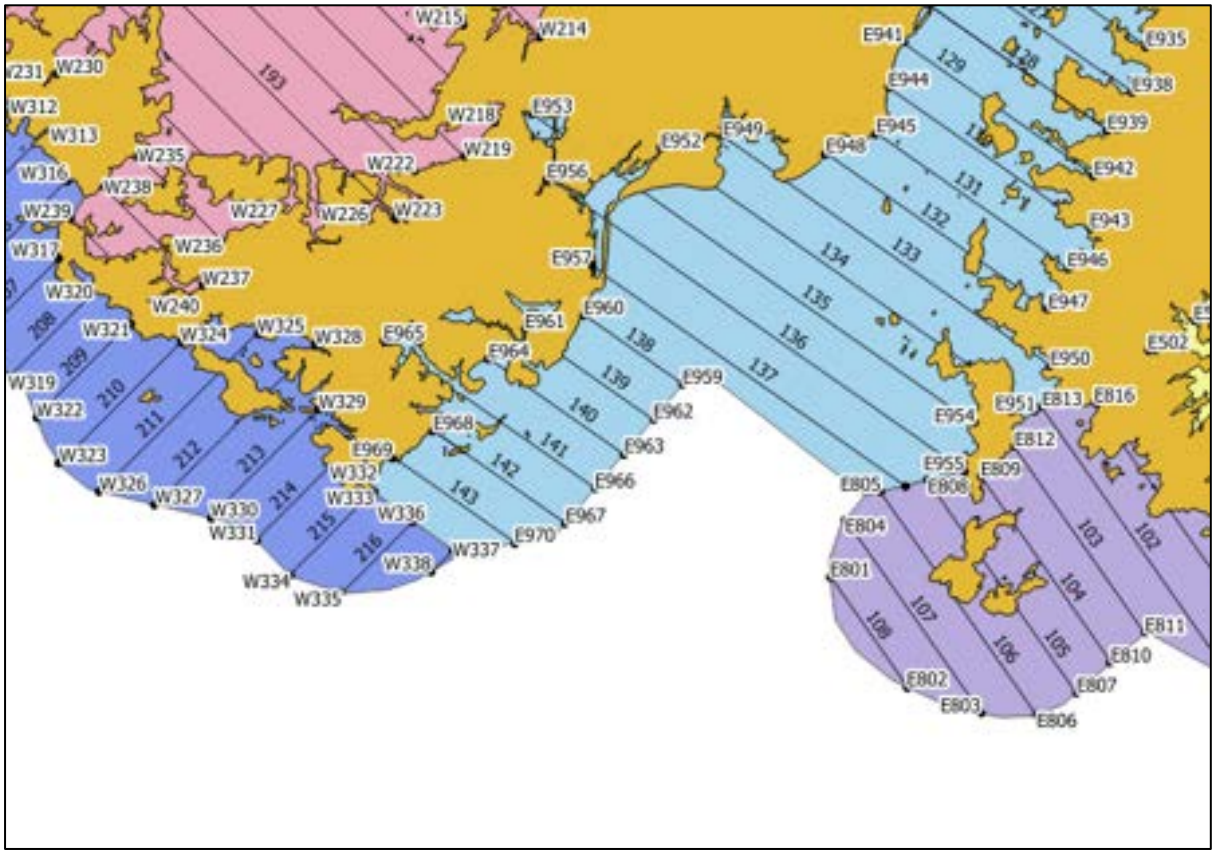
Day 5 – Stratum 11 part 2 and stratum 12 part 1

- W223 – W234 (6 transects from 193 to 198 – transects 196-198 partial 1)
- W301 – W316 (8 transects from 199 to 206)
- W235 – W240 (3 transects 196-198 partial 2)
- W317 – W320 (2 transects, 207 and 208)



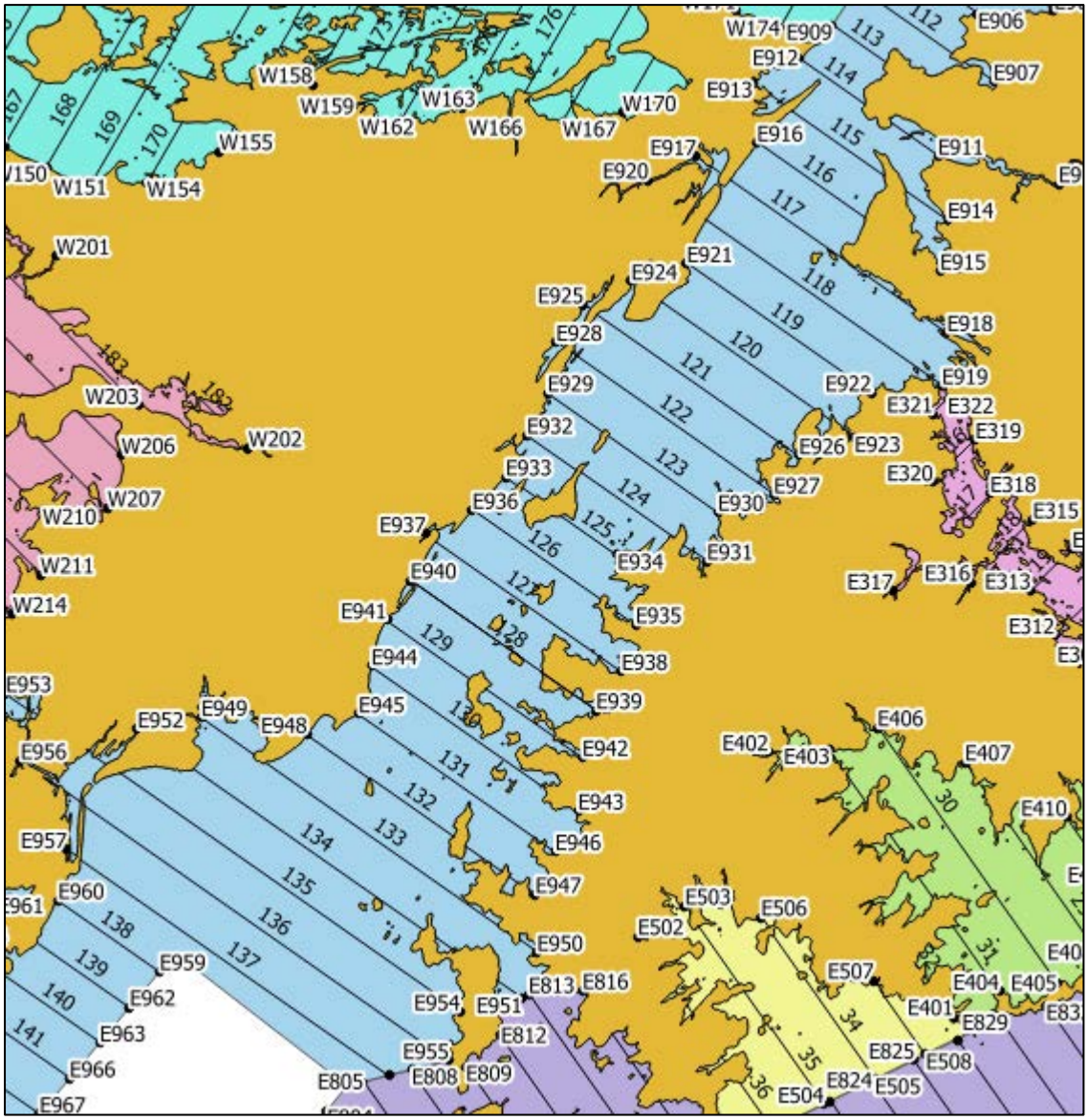
Day 6 – Stratum 12 part 2, stratum 9 part 3 and stratum 8 part 3

- W321 – W336 (9 transects from 209 to 217)
- E970 – E958 (7 transects from 143 to 137)



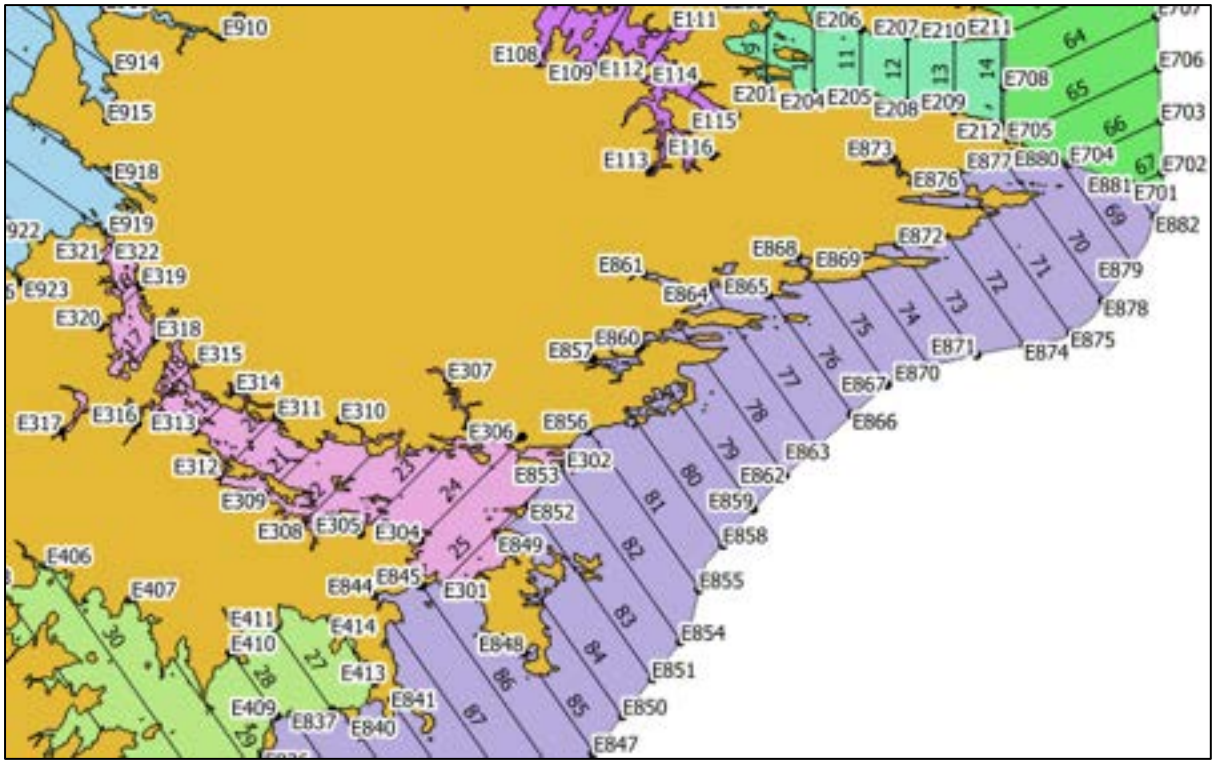
Day 7 – Stratum 9 part 2

- E918 – E955 (20 transects from 117 to 136)



Day 8 – Stratum 9 part 1, and stratum 3 completed

- E881 – E849 (17 transects from 68 to 84)
- E301 – E322 (11 transects from 15 to 25)



Day 9 – Strata: 8 part

- E847 – E811 (19 transects from 85 to 103)
- E401 – E414 (7 transects from 26 to 32)
- E501 – E508 (4 transects from 33 to 36)