Surface ocean circulation tracking drifter data from the Northeastern Pacific and Western Arctic Oceans, 2014-2020

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ABSTRACT

Hourston, R.A.S., Martens, P.S., Juhász, T., Page, S.J. and Blanken, H. 2021. Surface ocean circulation tracking drifter data from the Northeastern Pacific and Western Arctic Oceans, 2014-2020. Can. Data Rep. Hydrogr. Ocean Sci. 215: vi + 36 p.

Several Government of Canada ocean monitoring programs have deployed ocean surface drifting buoys off the coasts of British Columbia in the Pacific Ocean and Canada's northern territories in the Arctic Ocean. This report covers a total of 1397 drifter tracks from 13 different types of ocean surface drifting buoys deployed both near and offshore of Canada's Pacific and Arctic coasts over 2014-2020. The surface drifters provide position data from GPS satellites in near real-time as they float along the ocean surface while being driven by ocean currents, waves, and the wind. The resultant data offers high resolution temporal and spatial insights into circulation pathways and aids further understanding of surface drift in both nearshore coastal and offshore waters. The data can be applied to the calibration and verification of simple and complex ocean surface circulation models, which can in turn help answer questions related to pollution monitoring and abatement, search and rescue, and why a particular beach may or may not be seeded by free-floating animal eggs such as clam larvae.

RÉSUMÉ

Hourston, R.A.S., Martens, P.S., Juhász, T., Page, S.J. and Blanken, H. 2021. Surface ocean circulation tracking drifter data from the Northeastern Pacific and Western Arctic Oceans, 2014-2020. Can. Data Rep. Hydrogr. Ocean Sci. 215: vi + 36 p.

Plusieurs programmes de surveillance des océans du gouvernement du Canada ont déployé des bouées dérivantes (drifters) à la surface des océans au large des côtes de la Colombie-Britannique dans l'océan Pacifique et des territoires du nord du Canada dans l'océan Arctique. Ce rapport couvre un total de 1397 trajectoires de dériveurs provenant de 13 types différents de bouées dérivantes de surface océaniques déployées à proximité et au large des côtes canadiennes des océans Pacifique Arctique au cours de la période 2014-2020. Les dériveurs de surface fournissent des données de position des satellites GPS en temps quasi réel alors qu'ils flottent le long de la surface de l'océan tout en étant entraînés par les courants océaniques, les vagues et le vent. Les données obtenues offrent des informations temporelles et spatiales à haute résolution sur les voies de circulation et aident à mieux comprendre la dérive de surface dans les eaux côtières et extracôtières. Les données peuvent être appliquées à l'étalonnage et à la vérification de modèles simples et complexes de circulation de surface des océans, qui peuvent à leur tour aider à répondre aux questions liées à la surveillance et à la réduction de la pollution, aux activités de recherche et sauvetage, et identifier les plages favorables à l'ensemencement avec larves flottantes tel que c'est le cas pour les palourdes.

1. Introduction

Ocean circulation patterns are generally complex with substantial variability in space and time. One tool for describing and understanding ocean currents is the deployment of ocean drifters that provide direct evidence of where the water goes – the drift trajectory. Traditional oceanographic drifters are often engineered for tracking sub-surface currents, whereas, drifters for emergency response, such as search and rescue and oil spills, generally focus on the surface currents.

As part of various Government of Canada ocean monitoring programs, different types of satellite-tracked surface and near-surface drifters were deployed off the British Columbia and Western Arctic coasts to aid in understanding surface drift in these oceans. These drifters provide positioning data in near real-time and were configured to be updated over various intervals from 5 to 60 minutes. The resulting dataset offers high resolution temporal and spatial insights into circulation pathways that in turn can aid in the calibration and validation of existing surface circulation models.

This report follows on an earlier report by Page et al. (2019) which described drifters deployed in the Kitimat Fjord system in northern British Columbia over 2014-2016. This report covers drifter deployments over 2014-2016 in additional regions such as the Salish Sea, Johnstone Strait, Station Papa (50N 145W), and the Western Arctic. It also includes all deployments over 2017-2020 off the west coast of British Columbia and north coast of the northern territories in the Western Arctic. Institute of Oceans Sciences staff also contributed drifters to various drifter studies on the East Coast of Canada and internationally, those data are available as described in Section 4 but not included in this summary report. In some cases drifters were deployed one at a time, in other instances they were deployed in multiples of the same or different drifter types. The latter approach allows estimating drift and dispersion statistics, which in turn can be used in applications related to navigation, pollution monitoring and abatement, search and rescue, and plankton and clam larvae drift.

This report summarizes a total of 1397 surface current drifter tracks from 1214 different drifters deployed between April, 2014, and October, 2020. The drifter track total is comprised of tracks from 1163 Surface Circulation Trackers (SCTs), 164 OSKERS, 19 CODE/Davis and 51 from drifters of other types. The drifter types are described in detail in Section 2. The drifter tracks are grouped into six different deployment areas in this report. The drifters deployed along the BC Coast and adjacent continental shelf are grouped into five different areas (Table 1; Figure 1). Other drifters were deployed in the Arctic and make up the last area.

Table 1: Number of drifter tracks per deployment area

No.	Deployment Area	Total
1	Salish Sea	575
2	West Coast Vancouver Island	61
3	North Coast Vancouver Island	384
4	Douglas Channel	220
5	Station P/Open Ocean	67
6	Arctic	90
	Total	**1397**

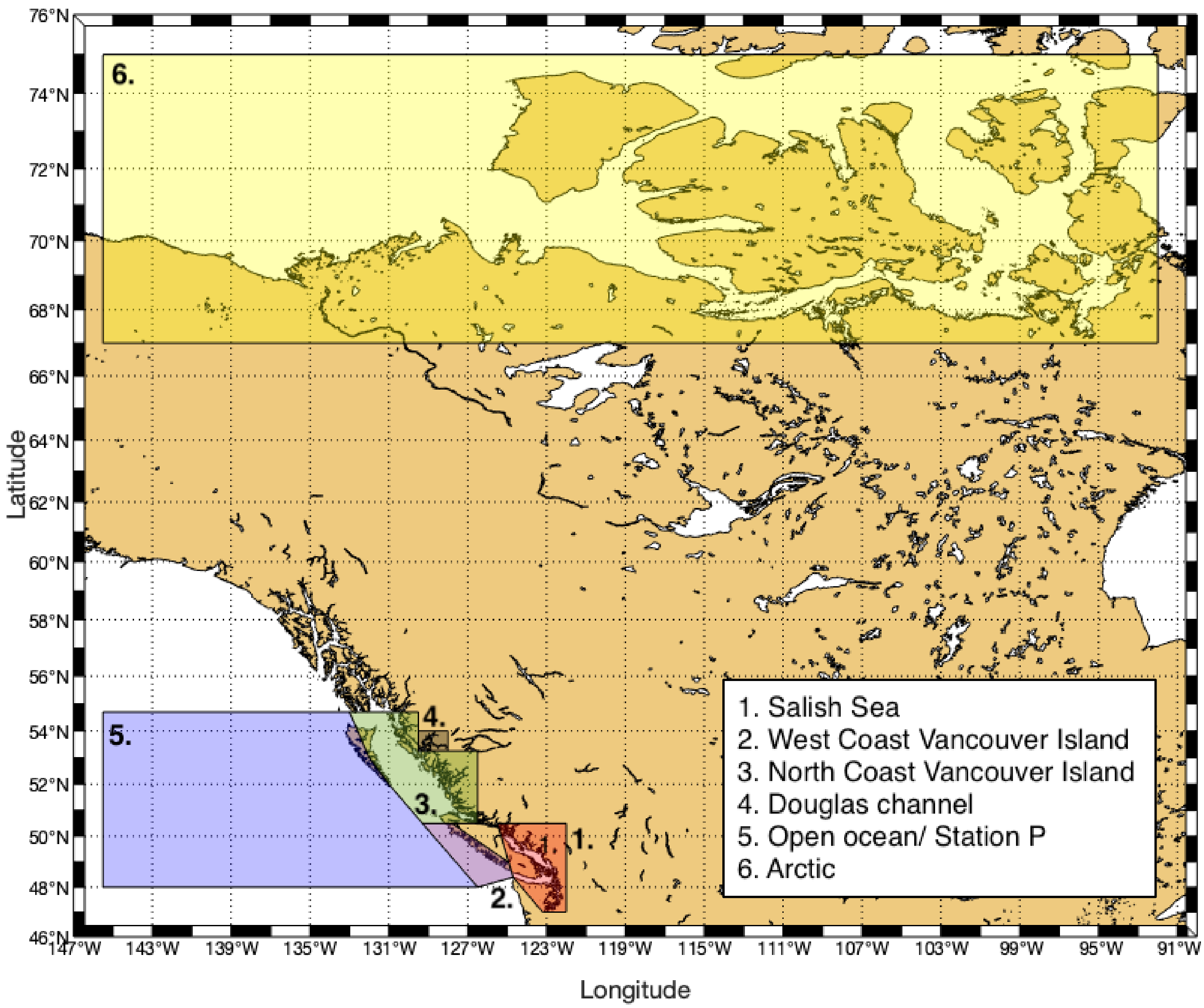


Figure 1: Drifter deployment areas.

2. Drifter Types

The variety of near-surface ocean drifters deployed have different dimensions both above and below the waterline, thus they possess and display different drift characteristics. These differences are typically quantified by their drag area ratio: the cross-sectional area below the waterline over the cross-sectional area above the waterline, with each area multiplied by the corresponding drag coefficient. The drifters are listed by names that designate both their manufacturer/development origin and design type. The different drifter types are described in the following sections.

2.1. IOS Surface Circulation Tracker (SCT)

The IOS (Institute of Ocean Sciences) Surface Circulation Tracker has a draft (extends to a depth) of 39 cm below the water line. They are constructed of wood, cellulose sponge, aluminum, zinc, a metal door spring, and a SPOT Trace GPS on top. A schematic is shown in Figure 2. See Page et al. (2019) and Oceanetic Measurement (http://www.oceanetic.com/oceanetic-surface-circulation-tracker.html, where they are now manufactured) for detailed descriptions and pictures.

The SPOT Trace GPS (https://www.findmespot.com/en-ca/support/spot-trace/get-help) is typically used to track assets in near real-time at a pre-set time interval of 2.5, 5, 10, 30, or 60 minutes. Here – and for other drifting buoys as noted – SPOTs are used to report the drifting buoy location. For various buoys in this report they have been configured to any one of those different reporting intervals, although for most buoys it has been set to 5 or 10 minutes.

Another SPOT Trace setting that is configurable is the Time Zone it reports with the location data. By default this is usually set to local time. But that can lead to problems if local time shifts between standard and daylight time and the drifter deployment spans those time shifts. Since UTC is not an option, we typically set the time zone to GMT0 Atlantic/Reykjavik – which is the same as UTC – and does not switch between standard and daylight time (unlike GMT0 London which does switch times).

The SPOT Trace transmits location information only when it is moving as determined by its built-in vibration sensor. Calm seas can sometimes fool the vibration sensor, so two factors enhance the sensor's sensitivity to movement and mitigate the potential loss of data. One factor is the door spring that the SPOT Trace is mounted on which makes the SPOT more sensitive to movement. Additionally, the device's movement sensitivity can be increased above the default setting by using the SPOT Trace Sensitivity software obtained from SPOT (https://www.findmespot.com/en-ca/).

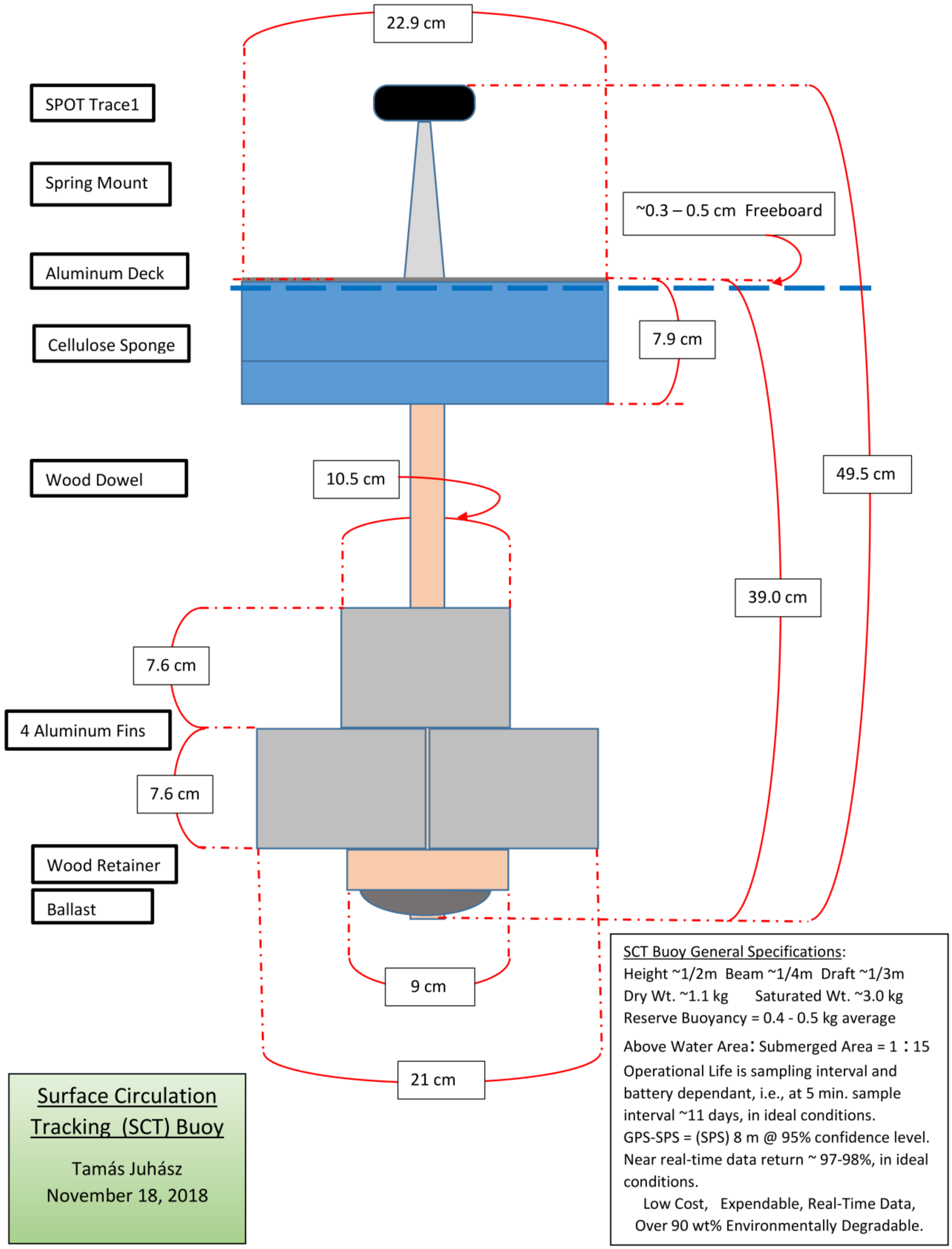


Figure 2: IOS Surface Circulation Tracker.

2.2. IOS Biodegradable CODE/Davis Drifter

The IOS Biodegradable CODE/Davis drifter has a draft of 134 cm. It was briefly described in Page et al. (2019) but there is a more detailed schematic in **Figure** 3 and the specifications are as follows:

- Materials: cedar wood structure, burlap bags, and minimal steel construction fittings, fasteners, and steel bar ballast.
- Dry Weight: 15 kg.
- Designed for low cost and simple assembly in the field.

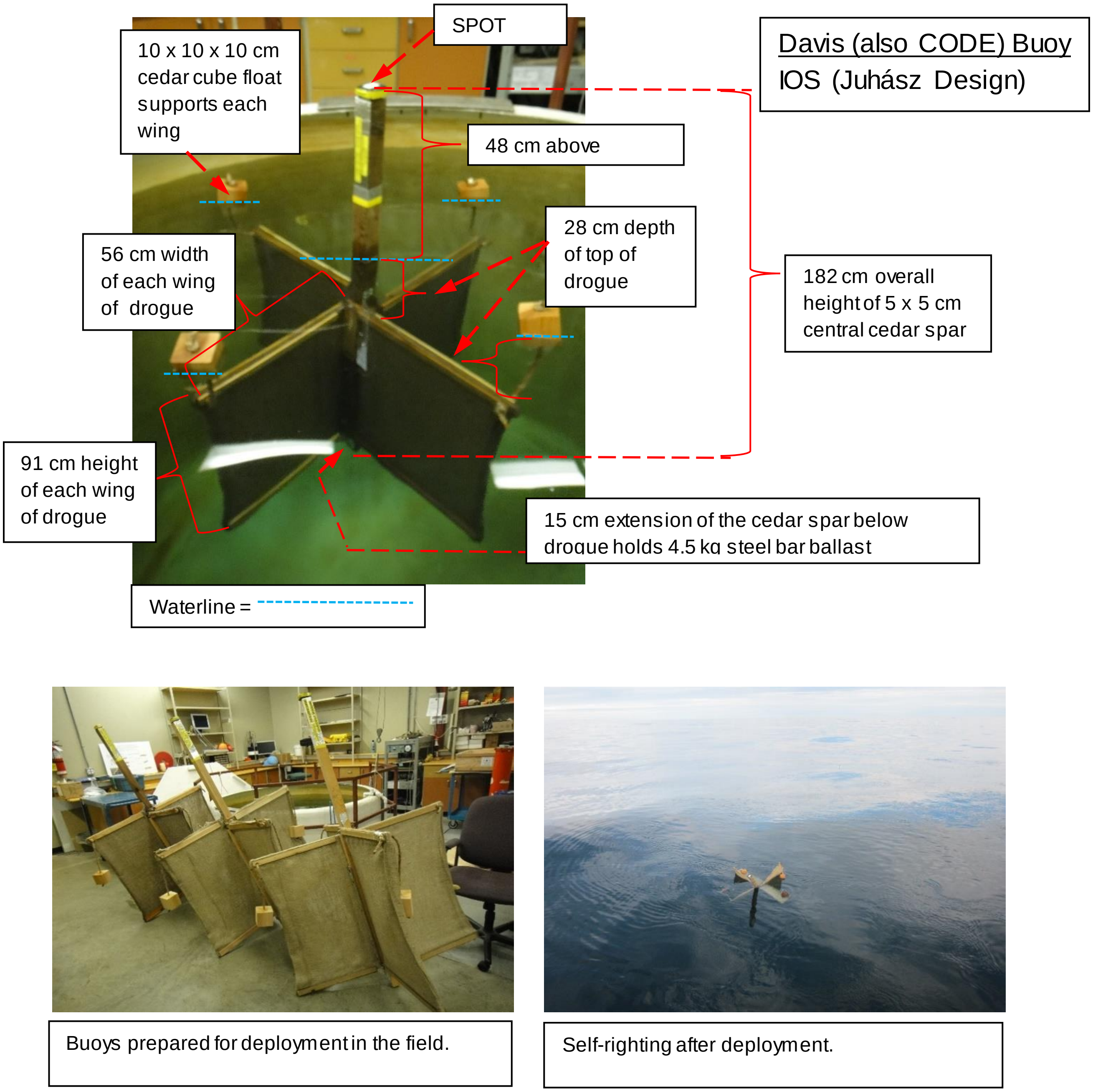


Figure 3: IOS Biodegradable CODE/Davis Drifter.

2.3. IOS Recycled CODE/Davis Drifter

The IOS Recycled CODE/Davis drifter has a draft of 161 cm. It is mostly plastic and recycled from earlier buoys and is shown in Figure 4.

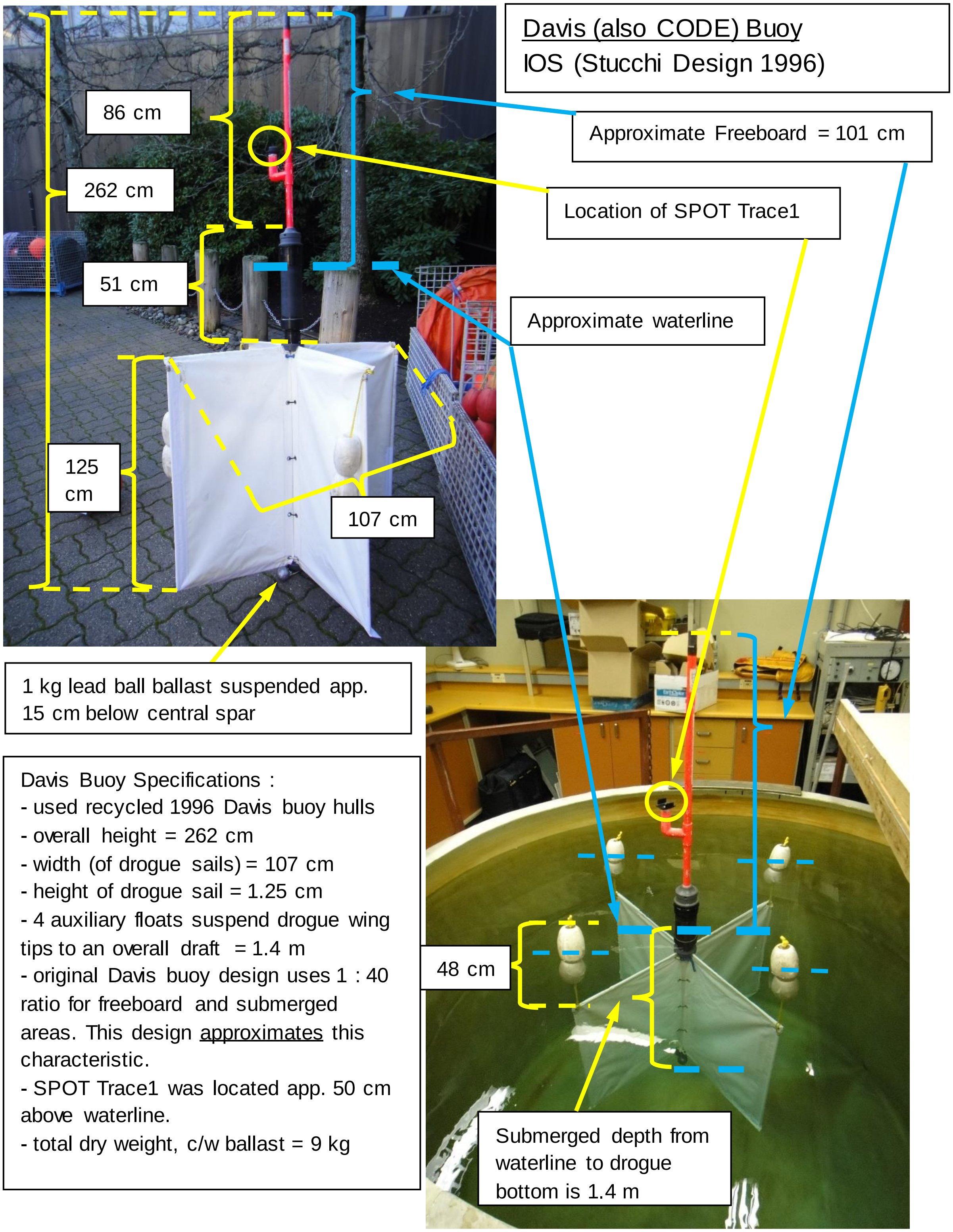


Figure 4: IOS Recycled CODE/Davis Drifter.

2.4. MetOcean CODE/Davis Drifter

Like other CODE/Davis drifters, this drifter by MetOcean has X-shaped sails and a 1 m draft. It is designed to track the upper meter of the surface currents. For specifications and pictures see the MetOcean website: https://www.metocean.com/product/codedavis-drifter/.

2.5. XEOS OSKER Drifter with and without a Drogue

The Xeos OSKER drifter has a shallow draft of 1 cm and therefore tracks currents right at the surface. For specifications and pictures of the OSKER without a drogue see the Xeos website: https://xeostech.com/osker. The drogued drifter is the same but with a drogue with these specifications:

- Rigid holey sock drogue + line length: 71 cm.
- Drogue length: 18 cm.
- Drogue diameter: 9.5 cm.
- Drogue weight: 85 g.

2.6. Pacific Gyre CARTHE Drifter

The Pacific Gyre CARTHE drifter has a draft of 40 cm. For specifications and pictures see the Pacific Gyre website: https://www.pacificgyre.com/carthe-drifter.aspx.

2.7. IOS WIND Drifter

The WIND following drifter has a draft of about 9 cm and with two thirds of the buoy above the waterline is designed to track the wind and not the surface current. Figure 5 shows the WIND drifter and the specifications are as follows:

- 800 m rated plastic trawl float by Gael Force was used.
- Weight in air: 3 kg.
- Calculated displacement: 11.7 kg.
- Net positive buoyancy: 8.4 kg.
- 28 cm diameter sphere.
- 2.54 cm diameter central hole/tube.
- 2.22 cm wood dowel was inserted in central hole to mount SPOT Trace1 complete with plastic cradle on top, and one half of a 5/16” wire zinc plate for ballast at the bottom.
- SPOT Trace1 + cradle + wood dowel + ballast comprised the payload of 500 g.
- Freeboard was approximately 2/3 above water.

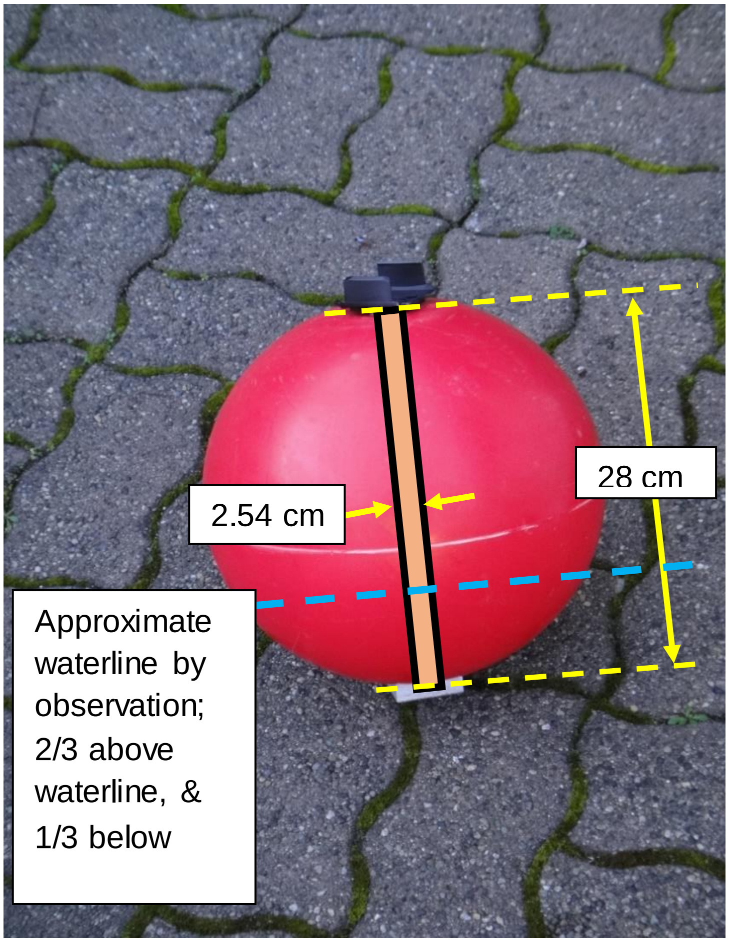


Figure 5: IOS Wind drifter.

2.8. IOS Surface Velocity Program (SVP) Drifter, 8 and 18 m Versions

The 8 and 18 m versions of the Surface Velocity Program drifters have total drafts of 13 and 23 m, respectively. Figure 6 shows the SVP drifter and the specifications are as follows:

- SVP buoys from previous programs were recycled.
- Two versions were used, 8M and 18M, the 8 and 18 refer to the depth of the top of the drogue. Thus the overall draft of an 8M buoy was 5 m + 3 m + 4.9 m = approximately 13 m depth at the ballast weight. Similarly, the draft of the 18M buoy was 5 m + 13 m + 4.9 m = approximately 23 m at the ballast weight.
- The weight in air of an 8M buoy assembly = 32 kg, and the 18M assembly would be slightly heavier.
- The A2 float has a gross buoyancy of 31 kg. The system below the surface buoy is near neutral.

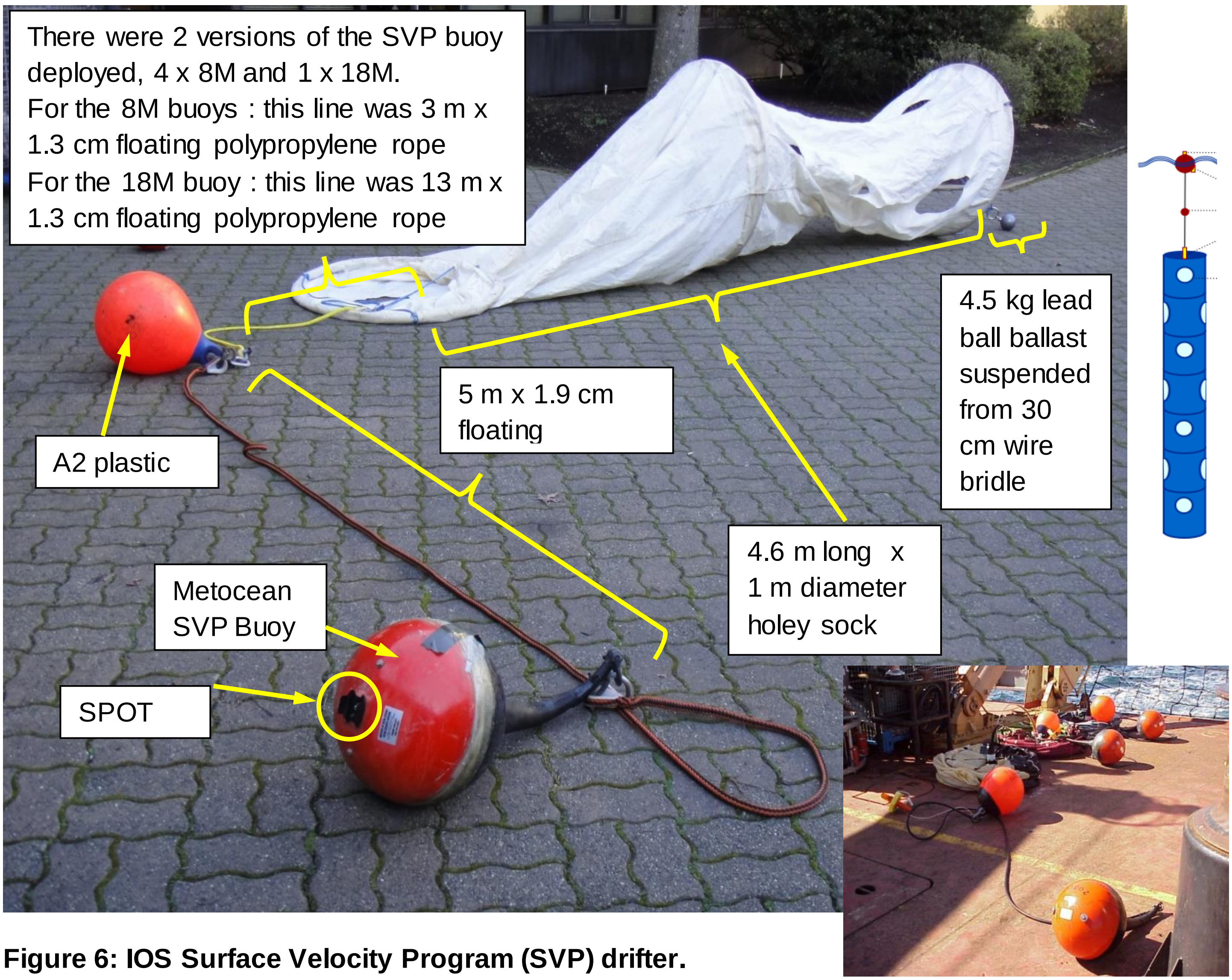


Figure 6: IOS Surface Velocity Program (SVP) drifter.

2.9. IOS Marine Emergency Response (MER) Sponge Drifter, 10 and 12 inch Versions

The 10 and 12 inch versions of the Marine Emergency Response drifters have drafts of about 25 and 30 cm, respectively. Figure 7 shows the MER drifters and the specifications for the 10 and 12 inch versions as follows:

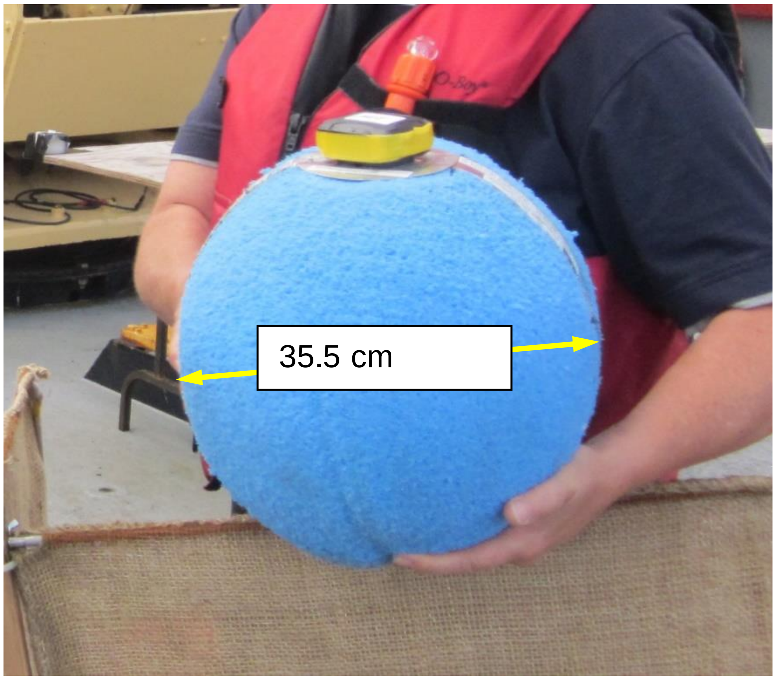
- Nominal 10 inch/25.4 cm and 12 inch/30.5 cm dry diameters swell to ~ 31.5 cm and 35.5 cm when water saturated.
- Wood cellulose sponge spherical body.
- Internal wood structural member.
- Internal ballasting.
- Dry weight 4.3 kg (5.5 kg).
- Wet cross-section ~ 0.0075 m sq (0.1 m sq).
- Drag ratio ~ 1: 10 (~ 1: 10).

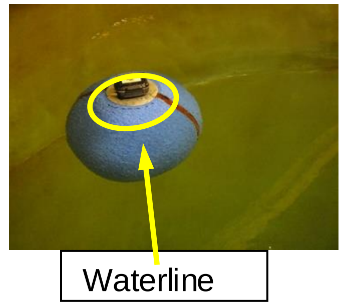
2.10. IOS Marine Emergency Response (MER) Concrete Drifter with and without a Drogue

The Marine Emergency Response Cellular Foam Concrete (CFC) drifter prototypes P1-P7 were constructed of cement with various additives including sealants and strength enhancers to reduce density, water absorption and increase strength. They included versions using a standard SPOT Trace GPS as well as an extended battery pack. Figure 8 shows both versions and the specifications are as follows:

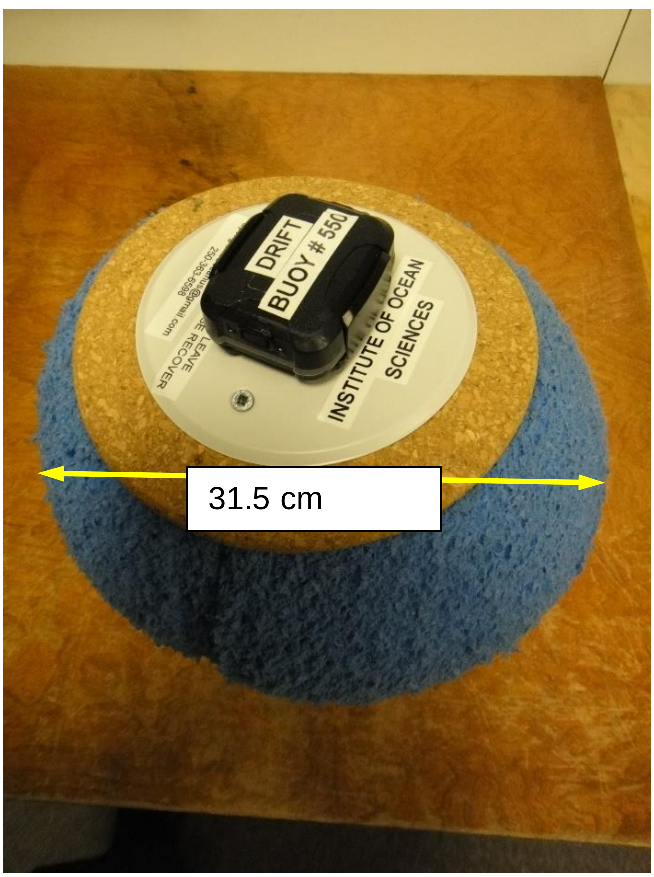
- Hull diameter = 21-22 cm.
- Draft from waterline to drogue bottom = 1 m.
- Draft without drogue = 15-17 cm.
- Drag ratio of hull without drogue ~ 1:8 to ~ 1:10.
- Drag ratio of hull with drogue ~ 1:23 to ~ 1:25.
- Dry (cured) weight in air = 3.2 kg to 3.35 kg depending on battery pack size and hull material density.

MER - 12





MER – 10



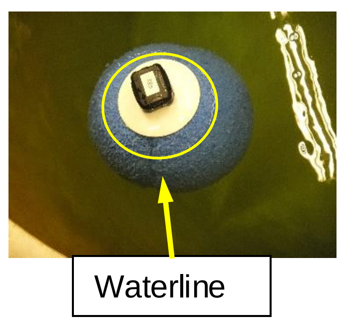
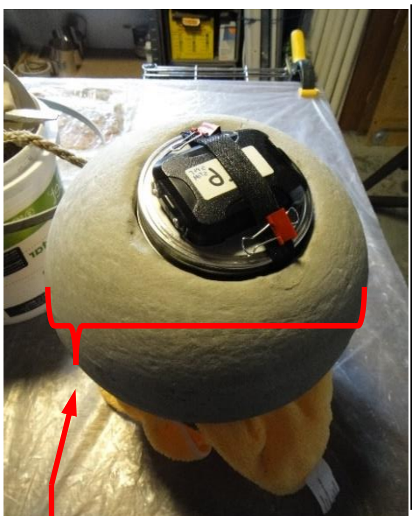


Figure 7: IOS Marine Emergency Response (MER) sponge drifter.

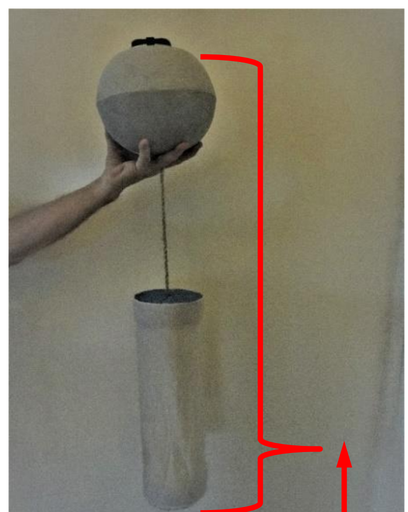
CFC (Cellular Foam Concrete) MER Prototypes P1-P7

These buoys are under development resulting in versions being modified in response to observed performance of design changes. The following specifications are very general.

Standard SPOT Trace1 spring mounted down the central well of the hull. Tested both with and without a drogue.



SPOT Trace1 mounted on, and in another version in, a custom pressure case housing a quadruple battery pack, The combined unit was then inserted and secured into central well of the hull. Tested both with and without a drogue.



Various hull materials were tested but basically consisted of cement with additives, i.e., fillers, sealants and strength enhancers to reduce density, water absorption and increase strength.

Hull diameter = 21-22 cm   Draft from waterline to drogue bottom = 1 m
Draft without drogue = 15-17 cm
Drag ratio of hull without drogue variously ~ 1:8 through ~ 1:10
Drag ration of Hull with drogue variously ~ 1:23 through ~ 1:25
Dry (cured) weight in air = 3.2 kg to 3.35 kg depending on battery pack size and hull material density.

Figure 8: IOS Marine Emergency Response (MER) concrete drifter.

3. Drifter Deployments by Drifter Type

From April 2014 to October 2020, 1214 ocean circulation drifters were deployed, and sometimes re-deployed, yielding 1397 drift tracks. The majority of drifters were Surface Circulation Trackers (SCTs) and OSKERs. In addition, there were eleven other drifters types deployed in much smaller numbers (Table 2). These drifters were deployed along the BC Coast and continental shelf as well as the Arctic, and are divided into six different deployment areas (Figure 1).

The main difference between the drifters is their draft, or depth over which their surface drift is integrated, and this ranges from 1 cm to 23 m (Table 2). This different draft – and the variable geometry of the drifters below the waterline – results in different drift characteristics for different drifters. The surface drift in turn reflects a combination of current, wind, and wave-induced circulation components.

Table 2: Drifter Types, draft depths, drag-area ratios, and the number of drifter tracks by year.

Drifter Type	Draft depth (cm)	Drag-Area Ratio (decimal)	Drag-Area Ratio (fraction)	2014	2015	2016	2017	2018	2019	2020	Total
IOS SCT	39	0.084	1/11.9	83	237	214	218	186	149	72	**1159**
Xeos OSKER	1	1.000	1/1				97	41	21	5	**164**
Xeos OSKER with Drogue	72	0.181	1/5.5					6			**6**
IOS Biodegrad CODE/Davis	134	0.029	1/34.0		13						**13**
IOS Recycled CODE/Davis	161	0.024	1/42.3		3						**3**
MetOcean CODE/Davis	100	0.011	1/87.1					3	5	11	**19**
IOS WIND	9	2.459	1/0.4		8						**8**
Pacific Gyre CARTHE	40	0.041	1/24.3					8			**8**
IOS MER 10 inch	25	0.1	1/10			3	2				**5**
IOS MER 12 inch	30	0.1	1/10		1						**1**
IOS MER Concrete	15-17	0.1	1/10					2	3		**5**
IOS MER Concrete with Drogue	100	0.04	1/25							1	**1**
IOS SVP 8 M	1300	0.006	1/157.3		4						**4**
IOS SVP 18 M	2300	0.006	1/159.8		1						**1**
Total				**83**	**267**	**217**	**317**	**246**	**178**	**89**	**1397**

Most of the drifters deployed were Surface Circulation Trackers (SCT) with a draft of 39 cm. The OSKER drifters on the other hand have a very shallow draft of 1 cm. The IOS Surface Velocity Program drifters have the largest draft measuring 23 and 13 m. Other drifters that are deployed less regularly have drafts ranging from 9 to 161 cm.

Table 2 also shows for each drifter type the drag-area ratio (DAR) which is a primary measure of its water-following characteristics. Drifters with drag-area ratios below 1:40 are generally considered to be ‘good’ water followers in that they experience slippage less than 1 cm/s in a 10 m/s wind (Niiler et al., 1995). The trade-off is that a small DAR requires a relatively large subsurface area, which reduces the drifters’ ability to track currents near the ocean surface. Drifters with a DAR greater than 1:40 will be increasingly affected by direct wind drag, and this must be accounted for when interpreting the data collected by these drifters.

The drag-area ratio is determined by the following formula:

$$DAR = \frac{A_a C_a}{A_w C_w} = \frac{\int_0^{Z_{max}} w(z)C(z)dz}{\int_{Zmin}^{0} w(z)C(z)dz}$$

Here $A_{a/w}$ is the cross-sectional area of the drifter above (subscript a) and below (subscript w) the water line and $C_{a/w}$ are the drag coefficients corresponding to these areas. Some common drag coefficients are included in Table 3, and these were used in combination to compute the DAR. Practically, DAR is calculated by considering the integrals of the product of the drifters cross-sectional width w(z) and drag coefficient C(z). The DAR is the ratio of the integral from the water surface to the highest point of the drifter (Z_{max}) and the integral from the deepest point of the drifter (Z_{min}) to the water surface. For example, considering the dowel connecting the float of an SCT drifter to the drogue, one would set w(z) to the diameter of the dowel and C(z) to 0.47 (cylinder) for the length of the dowel.

Table 3: Drag Coefficients for Common Shapes, used in the calculation of the drag-area ratio (DAR)

Geometry	Drag Coefficient, C
Sphere	0.47
Cylinder	0.47
Half Sphere	0.42
Cone	0.5
Cube	1.05
Angled Cube	0.8
Long Cube	0.82
Short Cube	1.15
Double Cylinder	0.87
Flat Plate	1.15

4. Drifter Data

All of the drifter data can be downloaded via the Institute of Ocean Sciences(IOS) data portal at https://www.waterproperties.ca/data/ by selecting *Data, Search Holdings* and from the metadata panel selecting *Metadata Name = Data Description, Value = Drifting Buoy*.

5. Recovered Drifters

Given the nature of the environment where drifters have been deployed, the majority end up on a beach or shoreline at some point. Periodically they are found by citizens, and reported back to the drifter team. The SCT drifters are designed to degrade over time, so generally they have not been able to be repurposed, unless they were found shortly after deployment. OSKER drifters that were found and returned have been able to be refurbished and redeployed. For all drifters that use SPOT tracking devices (GPS's), the recovered tracking devices can be reused after the batteries have been replaced and it is installed on a new drifter body, and that was done many times. To date, 216 drifters have been found and a list of when and where they have been found is given in Appendix 1.

6. Ocean Drifter Data Processing

The drifter tracks are processed using software developed by R. Pawlowicz at the University of British Columbia. This software allows categorizing transmitted locations in terms of different quality, and greatly simplifies quantifying drifter lifetimes and recovery rates. Drifter locations are classified into four categories (Pawlowicz et al., 2019). Category 1 includes all points in which the drifter was moving freely at sea ("valid"). Category 4 includes points at sea that were not valid, for instance when the drifter was on a ship or in a car and when a bad position fix was reported. Bad fixes can be identified by unrealistic speeds either to a far-away position followed by its almost immediate return, or two data points at different locations with identical time stamps. Categories 2 and 3 are used for interactions with land, when the drifter was in the intertidal zone or grounded on land, respectively. In addition to this, the last recorded endpoint of the drifter is flagged as either as being "grounded/on land" or "died at sea".

7. Ocean Drifter Statistics

The processed data are used to calculate the lifetime, total distance, grounding rate and recovery rate to assess these variables for different deployment areas, field missions, drifter types and type of endpoint (at sea or on land). In the next sections statistics are described for each of the 6 deployment areas as shown in Figure 1 and for the total of all drifters deployed.

For each area the distance and lifetime are calculated for two categories; at sea and deployed. The statistics at sea are based on valid data points at sea only, describing the time and distance over which data was gathered on surface ocean currents. The lifetime and distance deployed take into account the period the drifter is grounded and in the intertidal zone. This gives an indication of the drifter capabilities, meaning the duration of time it is reporting its location and the maximum distance it has travelled. The difference between these two categories is largest for drifters deployed close to the coast. In the case of a high lifetime (>30 days) the drifter signal is intermittent. Care was taken to ensure none of these drifter tracks showed multiple deployments, where the drifter was recovered and redeployed at a different location at a later point in time.

In addition to this, the grounding rate (share of drifters ending on land) and the recovery rate (share of drifters found on land) can be calculated using the processed data. These rates are dependent on the deployment area and influenced strongly by the proximity of the drifter to the coast and the population density at the location of grounding. Drifters can be recovered one of two ways: the drifter ends on land and is found or the drifter ends at sea and is found on land at a later time.

7.1. Overall Drifter Statistics

The total of 1397 drifters had a lifetime at sea of 10 days on average with a median of 8 days (Table 4). They last a total of 16 (mean) and 11 (median) days if the time is included that the drifter was not drifting freely, either in the intertidal zone or grounded. The lifetime is highly variable – the standard deviation is greater than the average in both cases of at sea and total time deployed. The maximum lifetime at sea is 87 days, and almost double (172 days) when looking at the deployed lifetime. The minimum lifetimes (and distances) at sea and over total time deployed are zero. This indicates there is only one valid location in a drift track. For more context the minimum greater than zero is also shown, this is the case where there are at least two valid locations in the drift track. The distance travelled at sea is also subject to extreme values ranging from 0 to 2819 km, such that the median (153 days) is more representative of the population than the mean (244 days), and is the metric compared between deployment areas in subsequent sections. In those extreme long lifetime cases the drifter signal is always intermittent, particularly when it is grounded. The occurrence of a spring tide or other high tide is often enough for the drifter to start floating again and transmitting a signal.

In total, 47% of the drifters end grounded and 13% of the drifters are found on land. Most of the found drifters were returned (or the GPS unit was returned) and were redeployed during a later mission.

Table 4: Statistics for all deployed drifters.

Total deployed	1397	100%
Grounding rate	655	47%
Recovery rate	183	13%

	Mean	Median	Std. Dev.	Min.	Min. > 0	Max.
Lifetime at sea (days)	9.7	7.6	10.2	0	0.003	87.1
Lifetime deployed (days)	15.9	11.4	18.0	0	0.003	171.7
Distance at sea (km)	243.5	152.8	328.4	0	0.019	2818.5
Distance deployed (km)	245.9	155.8	327.9	0	0.102	2818.5

7.2. Salish Sea

In total 575 drifters were deployed in the Salish Sea (Figure 9), this was the most of any region. Many of them were deployed in Burrard Inlet and Vancouver Harbour (Figure 10), and although many ended grounded in the inlet or harbour, many more made it out into the Straight of Georgia. Grounding typically happened in two to four days (Pawlowicz et al., 2019). Drifters that reached or were deployed in the southeast section of the Strait of Georgia and northern Puget Sound tended to float towards the Pacific Ocean through Juan de Fuca Strait. Of those drifters that reached the Pacific Ocean, most floated southward along the U.S. Coast.

Fewer drifters deployed in the Salish Sea drifted northward in the Strait of Georgia and into Johnstone Strait, but all of those drifter tracks end before reaching the Pacific Ocean. Most of these drifters end grounded on land along the relatively narrow Johnstone Strait.

The grounding rate of 51% in the Salish Sea (Table 5) is relatively similar to the overall rate, even though this region is constricted by a lot of coastline. The recovery rate of 25% on the other hand is double the overall rate – due to the high population density in this region the drifters are more likely to be found. The median lifetime at sea of 4 days is the shortest of all the deployment areas, and 4 days shorter than the overall median lifetime at sea. It is strongly affected by the very short lifetimes in Vancouver Harbour. It naturally follows that the median distance at sea of 91 km was also lower than the overall 153 km, and the shortest of all deployment areas.

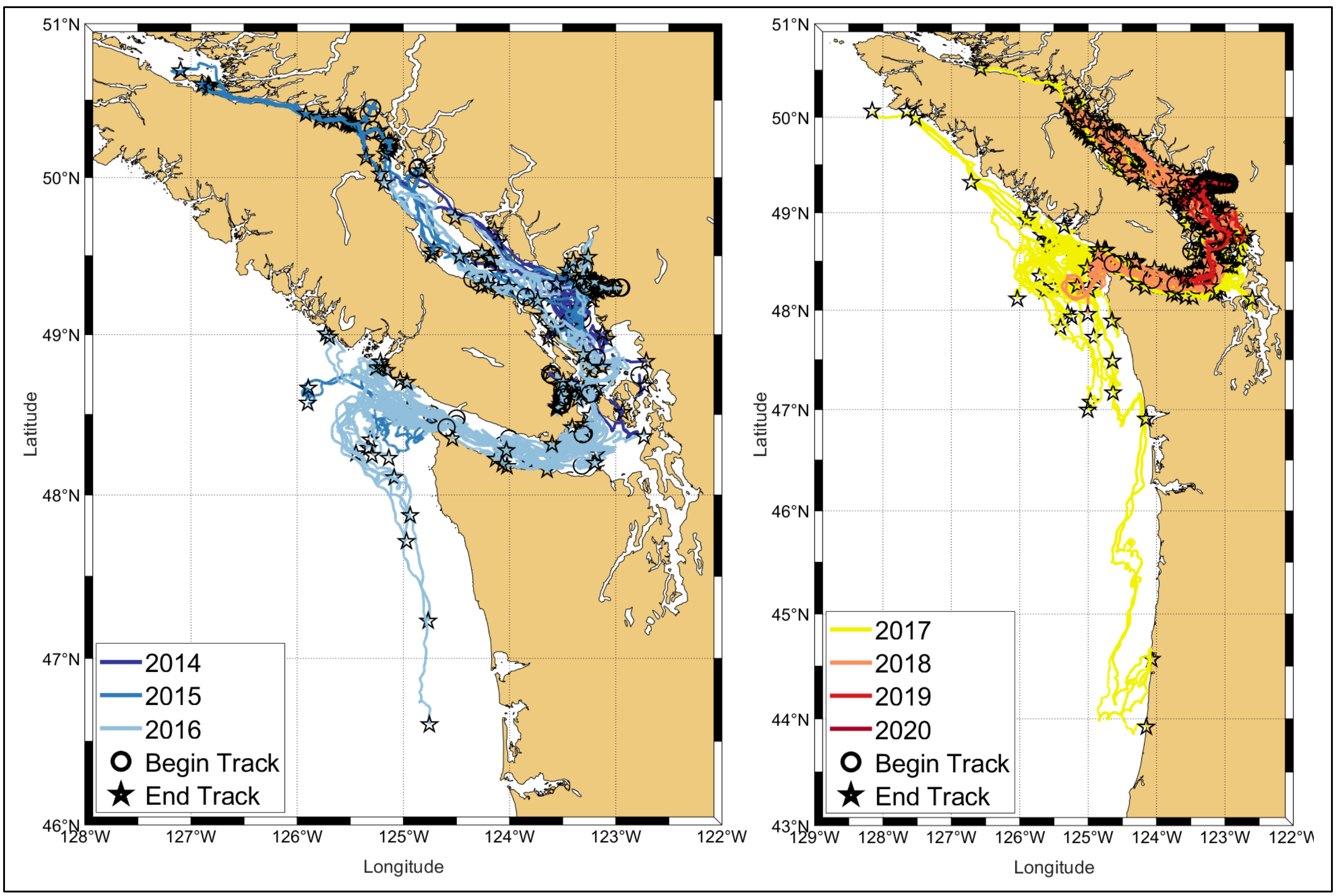


Figure 9: Drifter tracks of drifters deployed in the Salish Sea between (A) 2014 – 2016 and (B) 2017 – 2020.

Table 5: Statistics for drifters deployed in the Salish Sea.

Total deployed	575	100%
Grounding rate	294	51%
Recovery rate	142	25%

	Mean	Median	Std. Dev.	Min.	Min. > 0	Max.
Lifetime at sea (days)	6.3	4.1	7.7	0	0.010	78.8
Lifetime deployed (days)	10.5	6.8	14.5	0	0.010	148.2
Distance at sea (km)	153.1	90.7	173.7	0	0.054	1246.2
Distance deployed (km)	155.1	93.4	173.7	0	0.162	1247.9

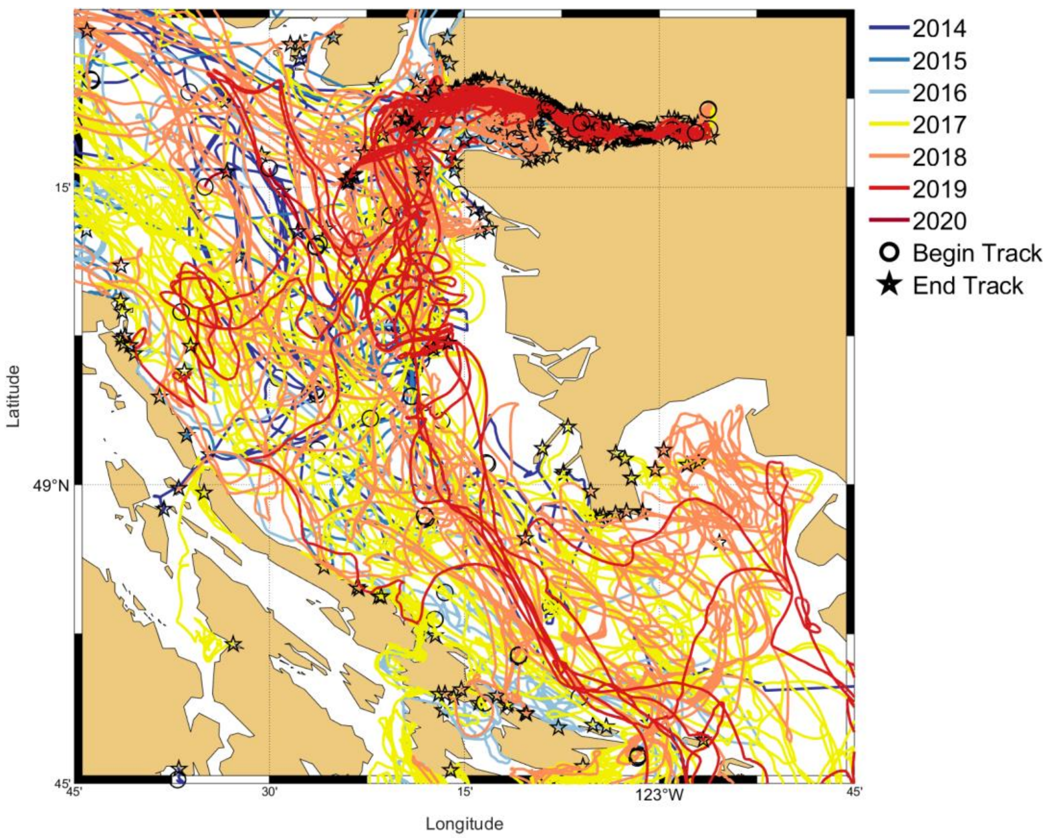


Figure 10: Drifter tracks in the Strait of Georgia, Burrard Inlet and Vancouver Harbour.

7.3. West Coast Vancouver Island

Only 61 drifters were deployed along the West Coast of Vancouver Island, a small number relative to other areas. More than half of them were deployed on the shelf near the mouth of Juan de Fuca Strait where it enters the Pacific Ocean (Figure 11). Many of these drifted westward initially, and almost all of these drifters floated southward along the U.S. Coast.

Most of the rest of the drifters were deployed in the coastal inlets on the West Coast of Vancouver Island in 2019. These drifters remained close to the coast for their entire lifetime. Overall, the grounding rate for drifters deployed on the West Coast of Vancouver Island at 28% is low compared to overall, as is the recovery rate of 10% (Table 6). The median lifetime and distance at sea were 11 days and 206 km, respectively, both higher than overall.

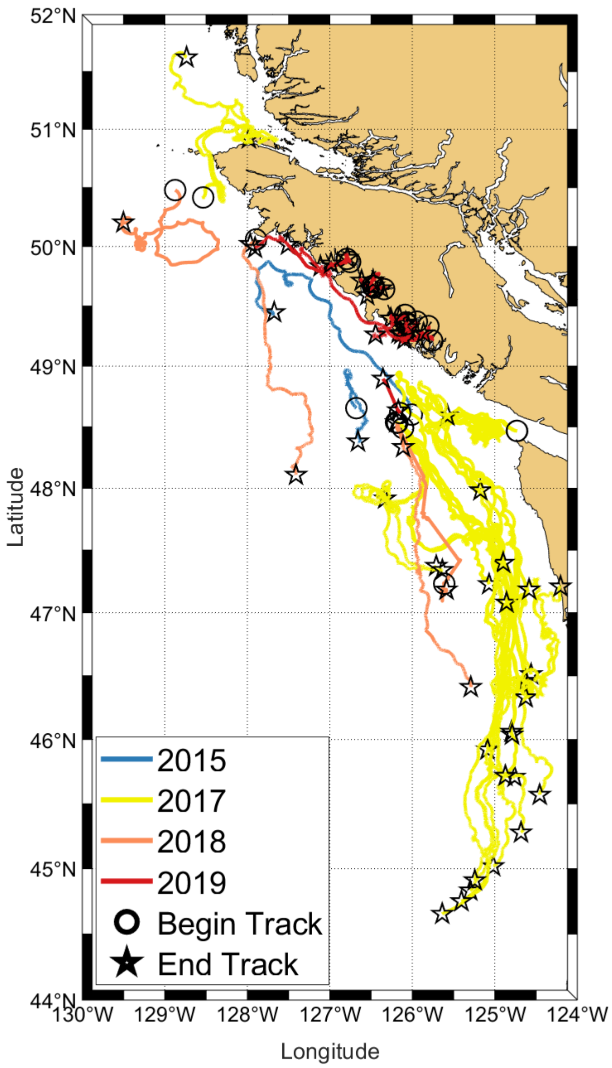


Figure 11: Drifter tracks of drifters deployed on the West Coast of Vancouver Island.

Table 6: Statistics for drifters deployed on the West Coast of Vancouver Island.

Total deployed	61	100%
Grounding rate	17	28%
Recovery rate	6	10%

	Mean	**Median**	**Std. Dev.**	**Min.**	**Min. > 0**	**Max.**
Lifetime at sea (days)	12.1	11.2	9.8	0.020	0.020	52.5
Lifetime deployed (days)	16.4	13.0	17.5	0.020	0.020	92.8
Distance at sea (km)	267.8	206.4	246.8	0.133	0.133	880.5
Distance deployed (km)	269.0	206.4	245.9	0.133	0.133	881.1

7.4. North Coast Vancouver Island

The second largest number of drifters (384) were deployed between the North Coast of Vancouver Island and Haida Gwaii in Queen Charlotte Sound and Hecate Strait. Between 2014 to 2016 drifters were generally deployed closer to the mainland coast than over 2017 to 2020 (Figure 12).

Drifters that were deployed, or floated near the northwest coast of Vancouver Island tended to drift southeastward, while drifters deployed further north tended to not float out to the open ocean. The latter drifters generally remained in Hecate Strait. Drifters deployed close to the coast at times drifted inland, along one of the channels of the Douglas Channel system.

Relative to the other deployment areas the recovery rate in this area is low at 7%, but the grounding rate of 41% (Table 7) is similar to the overall rate. This is likely the result of the drifter's tendency to remain close to the coast, relatively few of the drifters are transported to the open ocean by the surface currents. The median lifetime and distance at sea were 11 days and 236 km, respectively, both higher than overall.

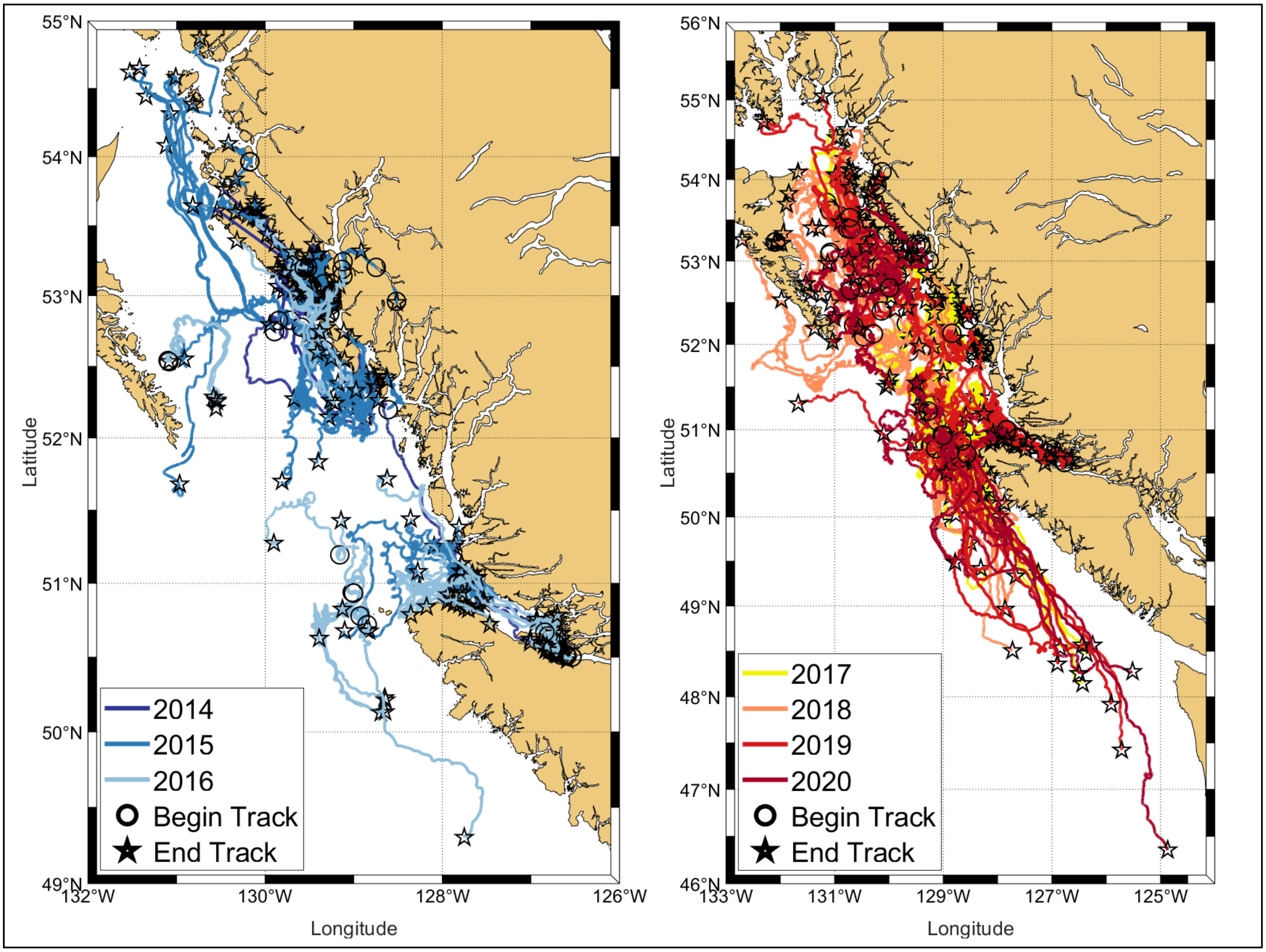


Figure 12: Drifter Drifter tracks of drifters deployed on the North Coast of Vancouver Island and Haida Gwaii between (A) 2014 – 2016 and (B) 2017 – 2019.

Table 7: Statistics for drifters deployed on the North Coast of Vancouver Island.

Total deployed	384	100%
Grounding rate	156	41%
Recovery rate	27	7%

	Mean	Median	Std. Dev.	Min.	Min. > 0	Max.
Lifetime at sea (days)	12.0	10.8	10.8	0	0.003	87.1
Lifetime deployed (days)	17.4	13.2	17.0	0	0.003	145.6
Distance at sea (km)	276.3	236.2	262.5	0	0.019	1935.9
Distance deployed (km)	278.5	236.2	261.5	0	0.102	1935.9

7.5. Douglas Channel

In the Douglas Channel system 220 drifters were deployed (Figure 13) and they had the highest grounding rate out of any of the deployment areas: 69% (Table 8). This can likely be explained by the narrowness of the channels, resulting in a high likelihood for the drifters to float close to the coastline. Over 2014-2016 they reached close proximity to the shoreline within 12-15 hours of being released (Blanken et al., 2020). Often the drifters refloat during a high tide, after having been grounded for a number of tidal cycles. They had a median lifetime at sea of 7 days which is very close to the overall mean and is 3 days longer than in the Salish Sea. Their median distance at sea of 106 km is 15 km more than the Salish Sea. Drifters in this region had a very low recovery rate of 3%.

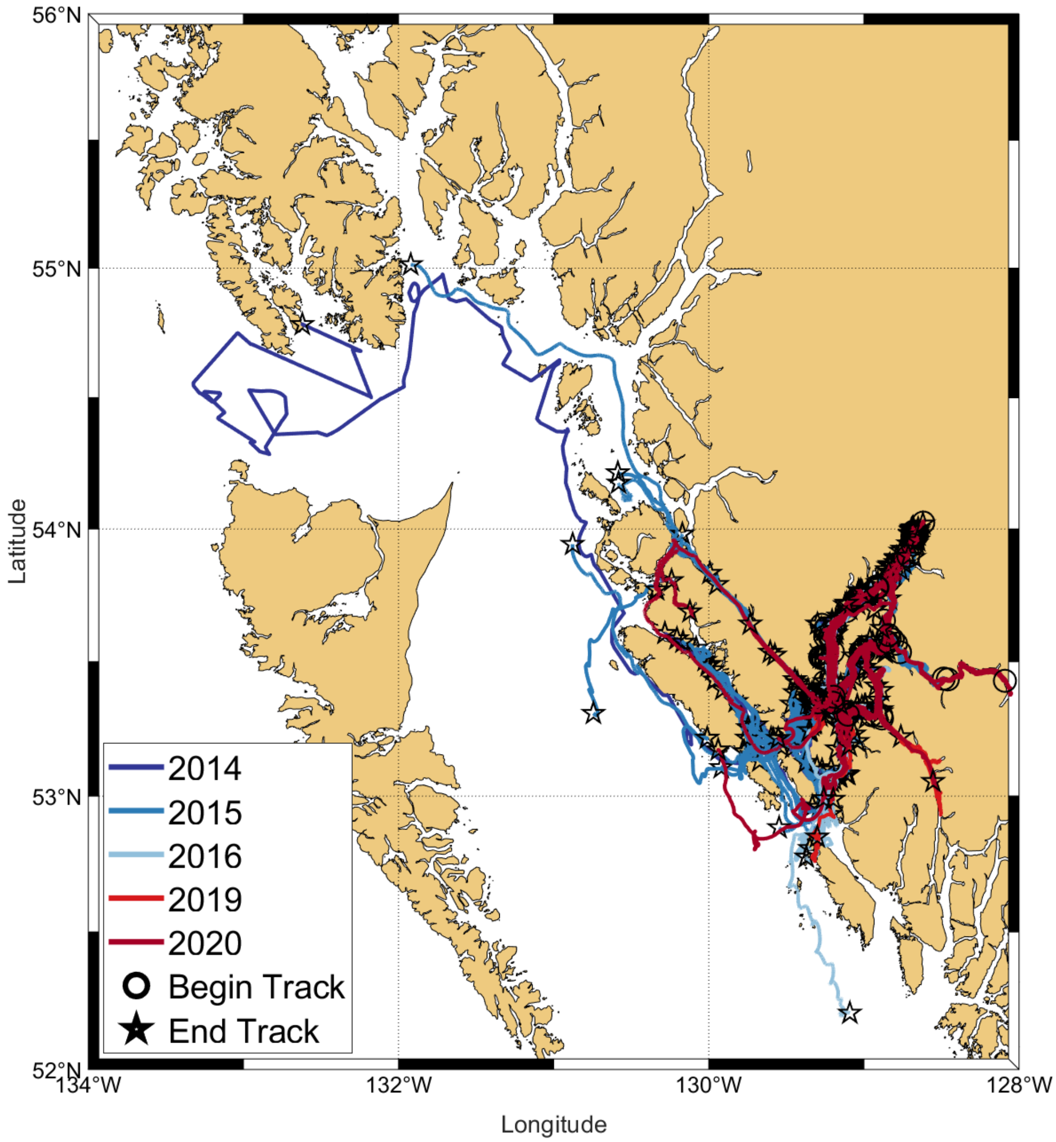


Figure 13: Drifter tracks of drifters deployed in the Douglas Channel System

Table 8: Statistics for drifters deployed in the Douglas Channel System.

Total deployed	220	100%
Grounding rate	151	69%
Recovery rate	6	3%

	Mean	Median	Std. Dev.	Min.	Min. > 0	Max.
Lifetime at sea (days)	10.4	7.4	11.5	0	0.008	68.0
Lifetime deployed (days)	22.7	15.2	21.1	0.010	0.010	90.8
Distance at sea (km)	140.3	105.9	142.0	0	0.411	1113.8
Distance deployed (km)	145.3	109.3	143.9	1.441	1.441	1138.1

7.6. Open Ocean/Station Papa

Most of the 67 drifters deployed in the open ocean were deployed at Station Papa (50N 145W) (Figure 14). Drifters deployed at Station Papa tend to follow a very similar trajectory, and most of the drifters deployed in this area have the median lifetime of 11 days. This results in a low relative standard deviation of the lifetime compared to the other deployment areas. Due to the lack of coastal interaction the drifters flow freely, resulting in continuous data, and the second longest median distance at sea of all regions at 307 days (Table 9). Understandably they have a low recovery rate of 4%.

All drifters end at sea, which means that there are no differences of time and distance between the at sea and total deployed statistics.

All WIND, SVP18M and SVP8M drifters were deployed in the open ocean at the same location and during the same deployment mission. Due to this the lifetime and distance of these different drifter types are very similar as can be seen in Figure 16 and Figure 17.

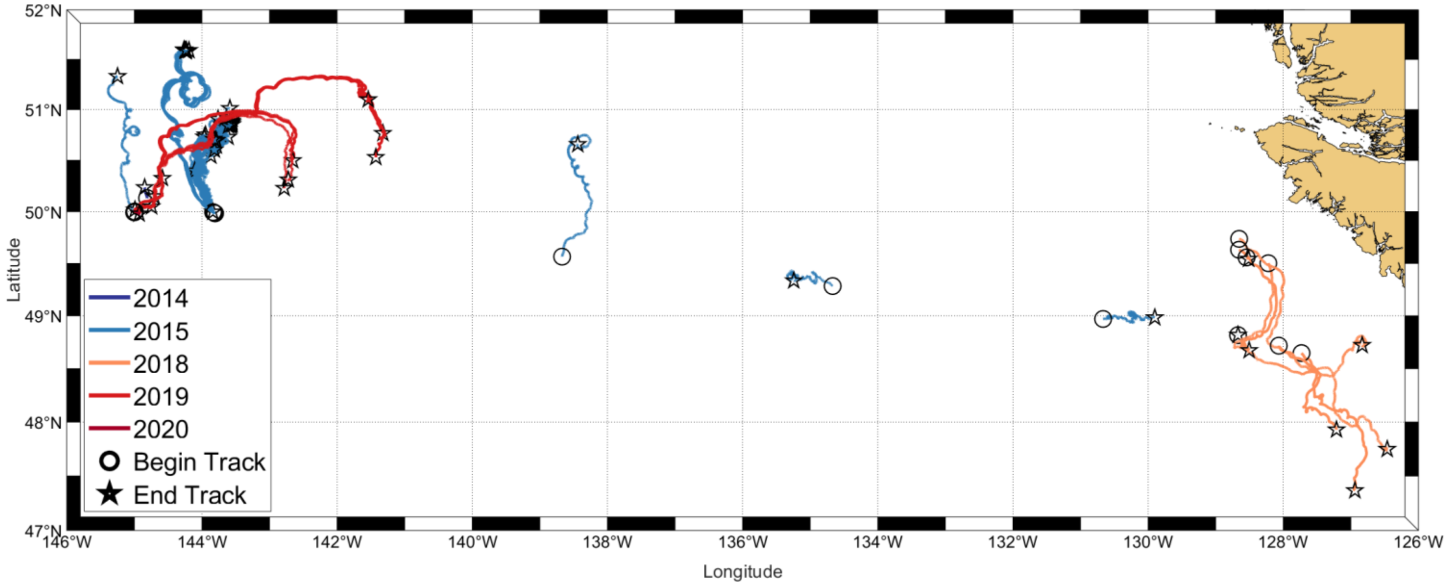


Figure 14: Drifter tracks of drifters deployed in the Open Ocean/ at Station Papa

Table 9: Statistics for drifters deployed in the Open Ocean/ at Station Papa.

Total deployed	67	100%
Grounding rate	0	0%
Recovery rate	3	4%

	Mean	Median	Std. Dev.	Min.	Min. > 0	Max.
Lifetime at sea (days)	10.2	11.4	4.5	0.008	0.008	21.0
Lifetime deployed (days)	10.2	11.4	4.5	0.008	0.008	21.0
Distance at sea (km)	278.7	307.0	139.6	0.119	0.119	630.9
Distance deployed (km)	278.7	307.0	139.6	0.119	0.119	630.9

7.7. Arctic

In total 90 drifters were deployed in the Arctic (Figure 15). These drifters had a lower measurement interval than other areas, reporting locations every 60 minutes compared to the typical 10. This likely resulted in the longest median lifetime at sea of drifters (18 days; Table 10) compared to other regions. The drifters also covered long distances and have the highest median (704 km) and maximum (2819 km) distance at sea out of all the different deployment areas.

The grounding rate of 41% for drifters deployed in the Arctic is similar to the rate over all the deployment areas. Drifters initially float close to the coast, and many are grounded at some point along this path. Most of the drifters that did not end on land make their way towards the Beaufort Sea. None of the drifters deployed were recovered.

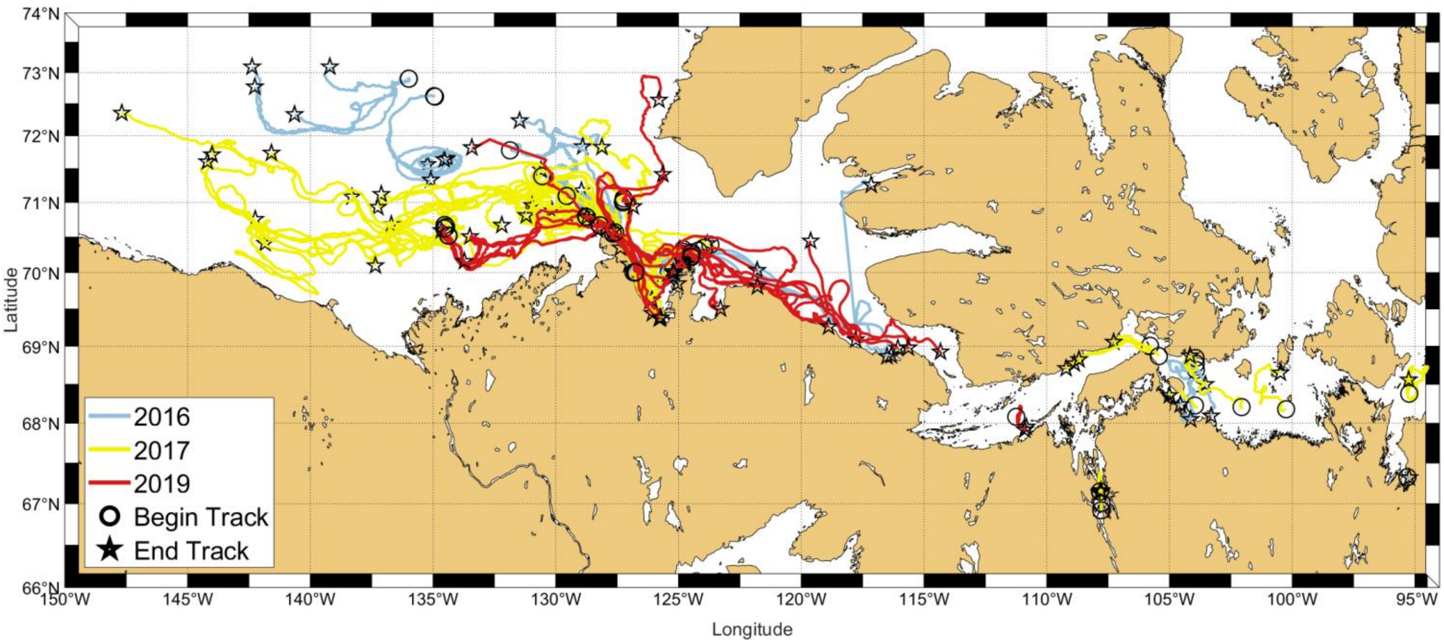


Figure 15: Drifter tracks of drifters deployed in the Arctic.

Table 10: Statistics for drifters deployed in the Arctic

Total deployed	90	100%
Grounding rate	37	41%
Recovery rate	0	0%

	Mean	**Median**	**Std. Dev.**	**Min.**	**Min. > 0**	**Max.**
Lifetime at sea (days)	17.7	18.1	13.4	0.028	0.028	48.6
Lifetime deployed (days)	31.3	28.4	23.8	0.028	0.028	171.7
Distance at sea (km)	891.3	703.7	765.4	1.942	1.942	2818.5
Distance deployed (km)	892.3	703.7	764.9	2.718	2.718	2818.5

8. Drifter Statistics By Area, End Location, and Type

Figure 16 and Figure 17 show comparative statistics for both drifter lifetime at sea and distance at sea between deployment areas, end location, and drifter type. The lifetime and distance of any given drifter is highly variable – many of the drifter groupings show a large spread in values of lifetime and distance at sea. The median is considered a more representative statistic for groupings with a large spread, since extremes strongly affect the mean.

In terms of the different regions, the Salish Sea had the shortest and the Arctic had the longest median lifetimes and distances at sea. Drifters in the Arctic travelled much further distances than drifters deployed in the Station Papa/Open Ocean region, despite both regions being open ocean. This is likely due to the Arctic drifters reporting locations less frequently than Station Papa/Open Ocean, thus battery lifetimes and therefore distances were longer. Another reason might be the type of drifter – only SCTs were deployed in the Arctic while eight different drifter types were deployed within the Station Papa/Open Ocean region.

On average, drifters ending at sea had longer lifetimes and travelled further than those ending on land. This is related to the area that the drifter is deployed. Drifters deployed in the open ocean are more likely to freely travel a great distance and only end once their battery runs out, while drifters deployed closer to the coast are often restricted in their movement due to the coastline and often get grounded on land (e.g., due to getting stuck in a kelp bed or washing up on land with the tide).

The different drifter types appear to have systematic different lifetime and distance characteristics, although the number of each different type deployed varied greatly (Table 2). OSKERs with drogues had the longest median lifetimes (23 days) and distance travelled (639 km), but only 6 of these were deployed (Table 11 and Table 12). Except for their drogues, they are identical to OSKERs without drogues, which had much lower median lifetimes (11 days) and distances (270 km). These values are greater still than those of SCTs which make up 83% of deployments, their median lifetimes and distances at sea are 7 days and 138 km, respectively. SCTs also had the largest maximum lifetime (87 days) and distance (2819 km) of all the drifter types. MetOcean CODE/Davis drifters had the second greatest range in lifetime and distance after SCTs but with many fewer deployed – only 19. Their median lifetime of 15 days ranked second (behind OSKERs with drogues) and median distance of 324 km ranked third behind OSKERs with drogues and IOS WIND drifters (436 km).

Table 11: Lifetime at sea (days) by drifter design.

Design	N	Mean	Median	Std. Dev.	Min.	Max.
IOS_SCT	1159	9.2	6.8	9.9	0	87.1
Xeos_OSKER	164	11.6	10.7	9.3	0.2	57.1
Xeos_OSKER_with_Drogue	6	21.8	22.8	7.7	10.5	29.8
IOS_Davis Biodegradable	13	8.6	7.9	5.6	0.9	18.7
IOS_Davis Recycled	3	11.4	11.4	0.0	11.4	11.4
MetOcean_CODE_Davis	19	25.5	15.3	24.1	0.0	62.8
IOS_Wind	8	11.4	11.4	0.0	11.4	11.4
Pacific_Gyre_CARTHE	8	10.3	11.7	6.7	0.2	17.7
IOS_MER10IN	5	6.7	4.0	3.9	3.9	12.4
IOS_MER12IN	1	0.0	0.0	0.0	0.0	0.0
IOS_MER_Concrete	5	5.3	1.3	6.7	0.1	15.3
IOS_MER_Concrete_with_Drogue	1	0.3	0.3	0.0	0.3	0.3
IOS_SVP8M	4	11.4	11.4	0.0	11.4	11.4
IOS_SVP18M	1	11.4	11.4	0.0	11.4	11.4

Table 12: Distance at sea (km) by drifter design.

Design	N	Mean	Median	Std. Dev.	Min.	Max.
IOS_SCT	1159	227.3	138.5	326.9	0.1	2818.5
Xeos_OSKER	164	336.7	269.9	287.5	4.1	1247.9
Xeos_OSKER_with_Drogue	6	666.8	639.2	280.0	317.1	1072.1
IOS_Davis Biodegradable	13	199.3	153.2	169.2	12.0	496.7
IOS_Davis Recycled	3	242.4	238.4	7.2	238.0	250.7
MetOcean_CODE_Davis	19	546.9	324.7	613.2	10.3	1935.9
IOS_Wind	8	437.4	436.4	3.5	435.2	445.8
Pacific_Gyre_CARTHE	8	267.1	283.8	174.4	8.3	480.6
IOS_MER10IN	5	68.3	47.6	38.4	27.5	110.9
IOS_MER12IN	1	0.0	0.0	0.0	0.0	0.0
IOS_MER_Concrete	5	96.1	29.9	106.3	2.8	217.6
IOS_MER_Concrete_with_Drogue	1	7.6	7.6	0.0	7.6	7.6
IOS_SVP8M	4	233.4	233.4	3.9	229.8	237.0
IOS_SVP18M	1	222.3	222.3	0.0	222.3	222.3

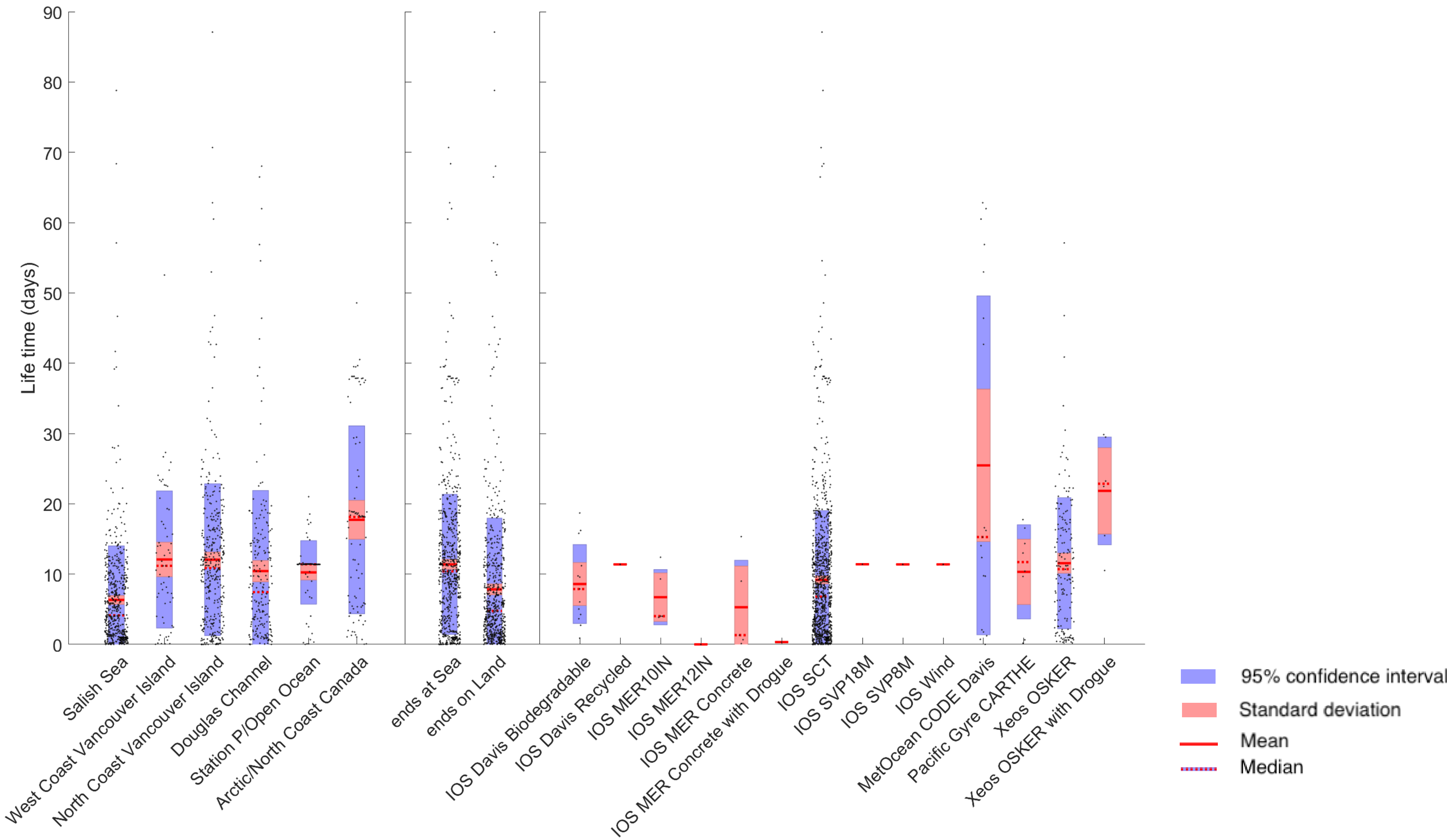


Figure 16: Lifetime at sea statistics for drifters over 2014-2020 by deployment area, end location, and drifter type.

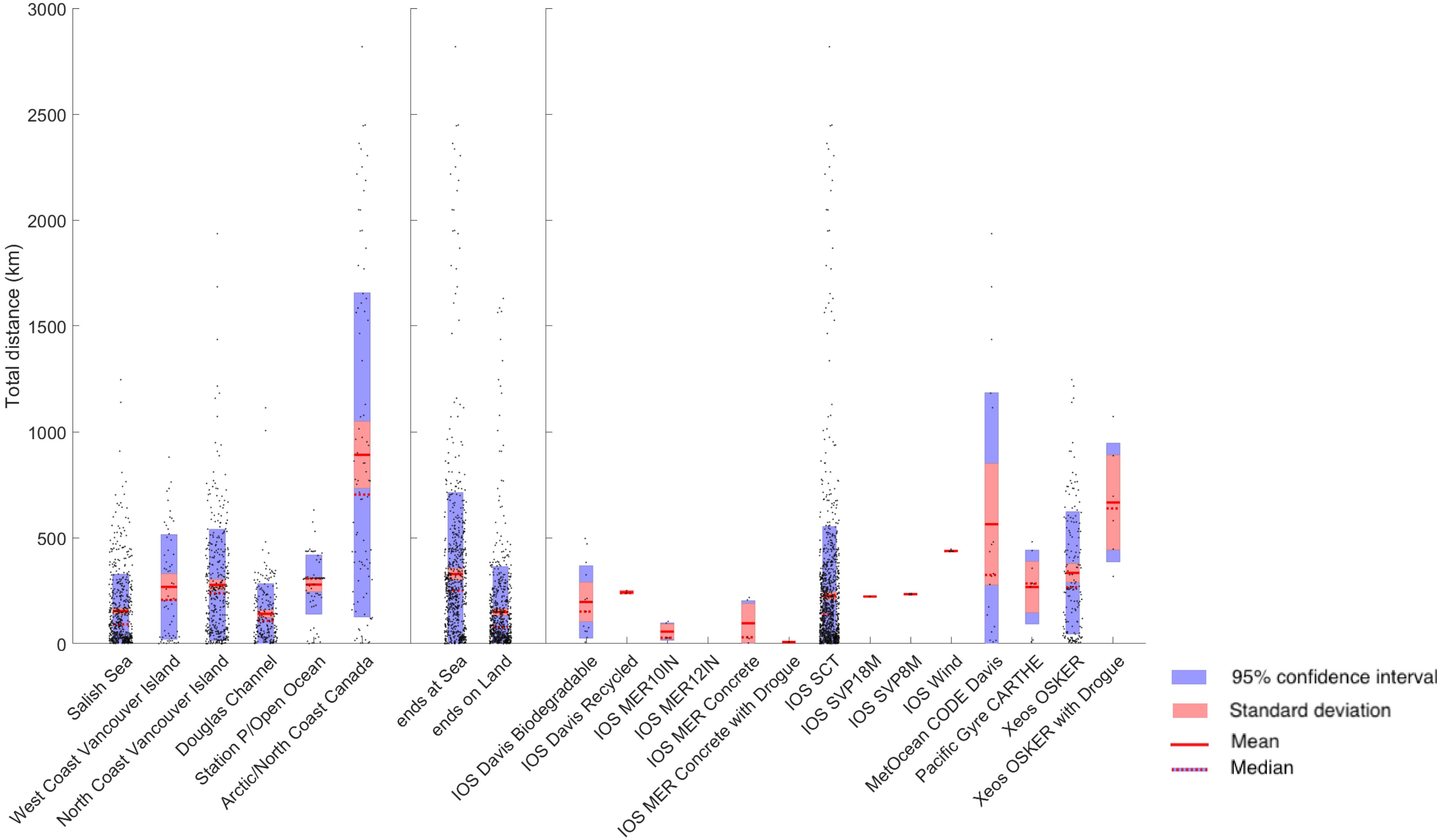


Figure 17: Distance at sea statistics for drifters over 2014-2020 by deployment area, end location, and drifter type.

9. Summary

This report describes a total of 1397 drifter tracks from 14 different types of ocean surface drifting buoys deployed both near and offshore of Canada's Pacific and Arctic coasts over 2014-2020. Depending on the deployment area, median lifetimes and distances at sea ranged from minimums of 4 days and 91 km in the Salish Sea to maximums of 18 days and 704 km in the Arctic. Absolute lifetimes and distances at sea for an individual drifter ranged from minimums of 0 days and 0 km (in all areas, where the drifter failed upon deployment), to maximums of 87 days (North Coast of Vancouver Island) and 2819 km (Arctic).

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11. Acknowledgements

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We would also like to thank the officers and crew of the *CCGS* John P. Tully and the *CCGS* Vector for their assistance.

Appendix A. List of Found Drifters.

In the following list of found drifters the day is as reported by the finder, or if not available, when the find was reported. It is in Pacific Standard Time. Since the data themselves are stored in UTC, the found dates included with the drifter data are incremented by one day to “convert” them to UTC. This was necessary since some drifters were found immediately after they grounded and were transmitting time and location data. In these cases if the found day was not incremented by one, it would have appeared the drifter was found before it grounded. Incrementing the found day by one for all drifters eliminated that problem. It should also be noted that where the Drifter Type and/or Location is given by N/A and/or the ID, Latitude, and/or Longitude have values of zero, that information was not provided by the finder.

Count	Date	Drifter Type	Drifter ID	Latitude	Longitude	Location
1	2015-08-22	SCT	250	50.859307	-128.000395	Cape Scott
2	2015-10-19	SCT	334	53.410792	-129.236223	Promise Island
3	2015-11-24	SCT	52	49.139201	-123.200452	Richmond
4	2016-03-23	SCT	146	58.125350	-136.426178	Cross Sound, AK
5	2016-06-22	SCT	378	48.072452	-124.697473	Yellow Banks, WA
6	2016-06-23	SCT	426	48.702634	-124.980302	West Coast trail
7	2016-06-30	SCT	449	49.324014	-123.150667	West Vancouver
8	2016-07-02	SCT	313	49.435278	-123.358333	Gambier Island
9	2016-07-03	SCT	433	48.160511	-123.711528	Crescent Bay
10	2016-07-03	SCT	437	48.182536	-124.709413	Ozette River
11	2016-07-04	SCT	490	49.485390	-124.178731	Rabbit island
12	2016-07-07	SCT	431	48.114145	-122.598810	Whidbey Island
13	2016-07-12	SCT	424	0.000000	0.000000	Olympic Peninsula
14	2016-07-14	N/A	0	60.027313	-147.367669	Montague Island, AK
15	2016-07-14	SCT	423	45.608858	-123.947276	Rockaway Beach, OR
16	2016-07-25	SCT	394	49.357815	-123.425202	Bowen Island
17	2016-08-03	SCT	391	48.134312	-122.833423	Port Townsend
18	2016-08-03	SCT	392	0.000000	0.000000	N/A
19	2016-08-08	SCT	418	50.867433	-128.091223	North Vancouver Island
20	2016-08-26	SCT	550	48.647279	-123.551100	Mill Bay
21	2016-08-31	SCT	444	48.170910	-124.730643	Cape Alava
22	2016-09-15	SCT	489	49.511533	-124.305068	Jelina Island
23	2016-09-19	SCT	341	0.000000	0.000000	Vancouver
24	2016-10-13	SCT	448	0.000000	0.000000	N/A
25	2016-10-20	SCT	549	0.000000	0.000000	Saanich Inlet
26	2016-11-04	SCT	390	48.433993	-123.303234	Oak Bay
27	2016-11-06	SCT	573	49.312479	-124.261825	Parksville
28	2016-11-06	SCT	574	49.312479	-124.261825	Parksville
29	2016-11-17	SCT	574	49.354041	-124.367310	Columbia Beach
30	2016-11-25	SCT	550	48.713613	-123.486817	Saltspring Island

Count	Date	Drifter Type	Drifter ID	Latitude	Longitude	Location
31	2017-01-01	WIND	94	58.195446	-152.353892	Kitoi Bay, Alaska
32	2017-01-17	SCT	500	48.434286	-123.258296	Chatham Island
33	2017-01-23	SCT	572	49.276422	-124.104184	Southey Island
34	2017-03-28	SCT	452	48.651100	-123.552402	Mill Bay
35	2017-04-14	SCT	622	49.125298	-123.698084	Valdes Island
36	2017-04-15	SCT	610	48.911632	-123.380523	Galiano Island
37	2017-04-15	SCT	611	48.817604	-123.232377	Mayne Island
38	2017-04-16	SCT	613	49.833914	-125.057150	Courtenay
39	2017-04-16	SCT	616	49.516697	-124.603605	Hornby Island
40	2017-04-17	SCT	625	48.887569	-123.312969	Gossip Island
41	2017-04-20	SCT	626	49.015779	-123.039665	Vancouver
42	2017-04-23	SCT	604	49.008427	-123.035969	Tsawwassen
43	2017-05-02	SCT	592	50.390203	-125.098976	Stuart Island
44	2017-05-03	SCT	596	48.826822	-123.291898	Mayne Island
45	2017-07-15	SCT	670	50.689399	-128.351582	Cape Scott
46	2017-07-19	SCT	662	48.161656	-123.708107	Crescent Bay
47	2017-07-22	SCT	588	48.549440	-122.913604	Lopez Island
48	2017-07-27	OSKER	0	48.119760	-122.600130	Whidbey Island
49	2017-07-31	OSKER	0	0.000000	0.000000	N Vancouver Island
50	2017-08-01	SCT	629	50.237529	-125.304318	Granite Bay, Quadra island
51	2017-08-03	SCT	671	50.546344	-128.210122	Topknot/Hecht Bay
52	2017-08-10	OSKER	410	50.795000	-128.597000	Cox Island
53	2017-08-12	SCT	586	49.291940	-122.924515	Burnaby
54	2017-08-16	OSKER	442	48.140733	-123.574665	Port Angeles
55	2017-08-20	OSKER	0	0.000000	0.000000	N/A
56	2017-08-25	SCT	611	47.798244	-122.493719	Kingston, WA
57	2017-08-30	SCT	563	49.338303	-123.200479	North Vancouver
58	2017-09-05	SCT	749	48.184290	-123.103665	Dungeness Spit
59	2017-09-13	OSKER	0	49.691335	-124.869778	Courtney
60	2017-09-14	OSKER	0	50.012769	-125.232946	Campbell River
61	2017-09-14	OSKER	498	49.921312	-125.184472	Campbell River
62	2017-09-15	SCT	730	49.920454	-125.184705	Campbell River
63	2017-09-16	OSKER	427	48.794713	-123.062363	Tumbo Island
64	2017-09-21	OSKER	420	44.569828	-124.069891	South Beach, OR
65	2017-09-21	OSKER	500	50.697979	-128.364443	Cape Scott
66	2017-09-21	SCT	748	49.789239	-124.995413	Courtenay
67	2017-09-21	SCT	755	48.707279	-122.868647	Orcas Island
68	2017-10-01	OSKER	477	46.350286	-124.065792	Long Beach, WA
69	2017-10-01	OSKER	492	46.271420	-124.076356	Illwaco,WA
70	2017-10-01	SCT	670	45.359823	-123.971551	Tillamook, OR
71	2017-10-08	OSKER	416	48.484585	-123.086528	Kanaka Bay
72	2017-10-10	OSKER	427	48.561589	-122.947445	Shaw Island

Count	Date	Drifter Type	Drifter ID	Latitude	Longitude	Location
73	2017-10-11	OSKER	470	48.461505	-123.032518	San Juan Island
74	2017-10-11	SCT	760	49.270817	-123.262087	UBC Vancouver
75	2017-10-11	SCT	777	48.971624	-123.083553	N/A
76	2017-10-12	SCT	761	48.407426	-123.365236	Patricia bay
77	2017-10-12	SCT	782	49.876720	-125.115365	Oyster Rive
78	2017-10-13	OSKER	425	43.925240	-124.100774	Florence, OR
79	2017-10-13	SCT	785	48.974593	-123.064119	Point Roberts
80	2017-10-14	SCT	789	48.972105	-123.078385	Point Roberts
81	2017-10-16	OSKER	0	48.530099	-122.918551	Lopez Island
82	2017-10-20	OSKER	0	49.488695	-124.357730	Lasqueti Island
83	2017-10-20	OSKER	0	49.488695	-124.357730	Lasqueti Island
84	2017-10-29	OSKER	415	48.548652	-123.161951	Friday Harbor
85	2017-10-30	OSKER	467	44.833141	-124.058141	Boiler Bay
86	2017-11-01	OSKER	0	48.510854	-123.020572	Friday Harbor
87	2017-11-01	OSKER	0	44.623481	-124.068108	Newport, OR
88	2017-11-11	OSKER	0	48.507090	-122.791164	Decatur Island, East shore
89	2017-11-23	SCT	776	49.801274	-124.516996	Powell River
90	2017-12-03	SCT	764	49.021744	-123.100724	tsawwassen
91	2017-12-09	SCT	499	46.280799	-124.059008	Waikiki Beach, WA
92	2017-12-13	OSKER	455	48.184709	-123.100870	New Dungeness LS
93	2017-12-14	SCT	284	53.054316	-129.452233	Campania Island
94	2017-12-15	SCT	769	49.529013	-124.211588	Texada Island
95	2017-12-24	OSKER	0	48.642000	-124.758000	Carmanah Point LS
96	2018-01-06	SCT	396	49.469360	-124.243686	Lasqueti Island
97	2018-01-08	OSKER	450	48.408486	-123.330163	Gonzales Beach
98	2018-01-15	N/A	0	49.314408	-123.129565	Burrard Inlet
99	2018-01-20	OSKER	0	46.945182	-124.126546	Damon Point
100	2018-01-23	SCT	622	49.309685	-124.189264	Nanoose Bay
101	2018-01-28	SCT	747	48.772747	-122.661823	Lummi Bay
102	2018-02-04	SCT	814	48.599577	-123.150037	San Juan Island
103	2018-02-10	N/A	0	48.973897	-123.028434	Lily Point
104	2018-02-10	SCT	802	48.974636	-123.065072	Point Roberts
105	2018-02-10	SCT	821	49.008935	-123.035830	Point Roberts
106	2018-02-11	SCT	108	48.982410	-123.083920	Point Roberts
107	2018-02-12	SCT	821	48.973930	-123.028589	Lily Point
108	2018-02-16	SCT	803	48.807644	-123.167791	Saturna Island
109	2018-02-21	SCT	829	48.488863	-123.301321	Gordon Head
110	2018-02-24	SCT	827	48.379111	-123.869027	Muir Creek
111	2018-02-26	SCT	826	48.272230	-124.681998	Shi shi Beach
112	2018-03-01	SCT	824	48.359777	-123.753985	Ella Beach
113	2018-03-17	SCT	818	48.614753	-123.160344	Pearl Island
114	2018-04-06	OSKER	0	54.138056	-131.663321	Rose Spit

Count	Date	Drifter Type	Drifter ID	Latitude	Longitude	Location
115	2018-04-09	OSKER	0	54.104820	-131.671277	Cape Fife
116	2018-04-09	SCT	842	49.413274	-123.616319	Roberts Creek
117	2018-04-09	SCT	847	49.413274	-123.616319	Roberts Creek
118	2018-04-11	SCT	855	49.937647	-124.860681	Savary Island
119	2018-04-14	SCT	857	49.371024	-123.472692	Hermit Island
120	2018-04-15	OSKER	407	55.865883	-132.578635	Little Ratz Harbor, AK
121	2018-04-15	SCT	849	48.355751	-123.742808	Sooke
122	2018-04-19	SCT	841	49.843600	-124.671900	Harwood Island
123	2018-04-21	SCT	862	48.497770	-124.296890	Sombrio Beach
124	2018-04-22	SCT	866	48.423766	-123.236918	Discovery Island
125	2018-04-23	SCT	838	49.468941	-123.860009	Halfmoon Bay
126	2018-04-23	SCT	845	50.132350	-125.330317	Heriot Bay
127	2018-04-23	SCT	865	49.936728	-124.791818	Savary Island
128	2018-04-25	SCT	861	49.941390	-124.775007	Savary Island
129	2018-04-28	SCT	860	50.148156	-125.146429	Read Island
130	2018-05-10	SCT	621	48.621600	-123.150434	San Juan Island
131	2018-06-01	OSKER	487	49.030483	-123.149907	Southeast beach of Roberts Bank, Delta, BC
132	2018-06-09	OSKER	481	55.472500	-133.742800	Notes Island
133	2018-06-10	SCT	797	48.804700	-123.157500	Saturna Island
134	2018-06-18	OSKER	628	49.835800	-124.529400	Powell River
135	2018-06-18	SCT	926	49.278071	-123.148658	Vancouver
136	2018-09-12	SCT	902	49.301334	-122.958461	Cates Park North Vancouver
137	2018-09-12	SCT	902	49.301134	-122.957720	North Vancouver
138	2018-09-12	SCT	914	49.300495	-122.956057	West Vancouver
139	2018-09-12	SCT	919	49.274161	-123.163027	Vancouver
140	2018-09-13	SCT	911	49.293472	-123.016002	Vancouver
141	2018-09-13	SCT	931	49.340025	-123.249574	West Vancouver
142	2018-09-14	SCT	290	52.961283	-129.604917	Estevan Island Group
143	2018-09-14	OSKER	380	49.310415	-123.111099	West Vancouver
144	2018-09-14	OSKER	455	49.326517	-123.160575	West Vancouver
145	2018-09-14	SCT	909	49.310415	-123.111099	West Vancouver
146	2018-09-14	SCT	920	49.301931	-123.157344	Vancouver
147	2018-09-14	SCT	924	49.286854	-123.143588	Vancouver
148	2018-09-14	SCT	937	49.291244	-123.039550	Vancouver
149	2018-09-15	OSKER	425	49.338246	-123.240860	West Vancouver
150	2018-09-15	OSKER	470	49.313221	-123.140424	Vancouver
151	2018-09-15	OSKER	500	49.291179	-123.039396	Vancouver
152	2018-09-15	SCT	907	49.328639	-123.171731	West Vancouver
153	2018-09-15	SCT	937	49.291179	-123.039396	Vancouver
154	2018-09-16	OSKER	471	49.289889	-123.119052	Vancouver
155	2018-09-17	SCT	916	49.330454	-123.263083	West Vancouver

Count	Date	Drifter Type	Drifter ID	Latitude	Longitude	Location
156	2018-09-17	SCT	922	0.000000	0.000000	N/A
157	2018-09-18	SCT	909	49.303622	-123.130918	Vancouver
158	2018-09-19	SCT	897	49.279853	-123.242242	Vancouver
159	2018-09-19	SCT	908	49.312069	-123.151314	Vancouver
160	2018-09-23	OSKER	414	49.330720	-123.262496	West Vancouver
161	2018-09-23	SCT	921	49.285278	-123.102497	Vancouver
162	2018-09-24	OSKER	439	53.399597	-131.925775	Queen Charlotte, B.C
163	2018-09-24	OSKER	624	53.399597	-131.925775	Queen Charlotte, B.C
164	2018-09-24	SCT	921	49.285312	-123.102603	Vancouver
165	2018-09-26	SCT	913	49.340840	-123.211548	West Vancouver
166	2018-09-28	OSKER	491	18.932267	-155.646087	Hawaii
167	2018-09-28	SCT	900	48.976501	-123.022078	Lily Point
168	2018-10-05	SCT	911	49.329675	-122.918904	Indian Arm, BC
169	2018-10-08	SCT	901	49.321976	-123.147918	West Vancouver
170	2018-10-11	SCT	901	49.338795	-123.255156	West Vancouver
171	2018-10-14	OSKER	499	48.421414	-123.419117	Saxe Point, Esquimalt
172	2018-10-18	OSKER	471	49.289473	-123.110225	Vancouver
173	2018-10-20	SCT	903	49.289898	-123.118980	Vancouver
174	2018-10-27	SCT	929	0.000000	0.000000	Surrey, BC
175	2018-11-12	SCT	904	49.338712	-123.254714	West Vancouver
176	2018-12-02	SCT	910	48.786600	-122.704067	Sandy Point, WA
177	2018-12-06	SCT	927	49.294776	-122.987529	Vancouver
178	2018-12-10	OSKER	631	48.494615	-123.022494	San Juan Island
179	2018-12-28	SCT	793	48.974071	-123.029102	Point Roberts
180	2019-01-07	OSKER	410	49.415177	-123.485507	Gibsons, BC
181	2019-02-02	OSKER	414	48.767944	-123.179139	Saturna Island
182	2019-02-20	OSKER	471	48.184240	-123.100007	northern beach of Dungeness Spit, northern Olympic Peninsula
183	2019-02-21	SCT	903	48.755100	-122.903400	Sucia Island, San Juan Islands, WA, USA
184	2019-04-12	SCT	980	50.127617	-127.574283	Battle Bay, near Kyuquot
185	2019-06-07	SCT	992	50.659529	-127.031949	Malcolm Island, Queen Charlotte Strait
186	2019-06-08	SCT	994	50.722267	-127.668417	Malcolm Island, Queen Charlotte Strait
187	2019-08-01	SCT	436	48.257773	-124.282092	Sekiu
188	2019-08-02	SCT	995	50.629027	-127.219626	Cluxewe Beach near Port Hardy
189	2019-08-07	OSKER	628	49.591733	-126.645697	Nootka Island
190	2019-08-10	SCT	955	46.172179	-123.979567	North Oregon Coast
191	2019-08-18	OSKER	438	52.997252	-129.561545	West of Dewdney Island
192	2019-08-28	SCT	388	0.000000	0.000000	N/A
193	2019-09-03	SCT	451	48.642766	-123.330384	Sidney Spit
194	2019-09-11	SCT	442	48.829111	-125.216306	Edward King Island, Deer Group

Count	Date	Drifter Type	Drifter ID	Latitude	Longitude	Location
						Islands, Bamfield
195	2019-09-14	SCT	1040	53.988333	-130.663883	Porcher Island
196	2019-10-08	OSKER	779	47.194491	-124.202046	Seabrook Beach, WA
197	2019-10-17	SCT	895	49.212830	-123.229640	Iona Beach Jetty
198	2019-11-21	OSKER	478	21.211154	-156.966195	Moloka'i, Hawaii
199	2020-02-09	SCT	943	52.529836	-128.824507	Swindle Island
200	2020-02-21	WIND	98	59.279775	-154.129482	Amakdedori Beach
201	2020-04-02	SCT	1092	49.191765	-122.726187	Barnston Island Ferry
202	2020-05-10	SCT	1100	54.001136	-128.688242	Kitimat River Estuary
203	2020-05-28	OSKER	457	49.154309	-123.690574	Silva Bay, Gabriola Island
204	2020-05-31	SCT	1083	50.678312	-128.348290	Sea Otter Cove, BC
205	2020-06-06	SCT	1115	53.996528	-128.695083	Kitimat Rio Tinto pier
206	2020-06-25	OSKER	500	48.539761	-123.018771	Friday Harbor
207	2020-07-04	OSKER	426	51.971970	-128.449600	Goose Islands, west coast
208	2020-08-14	SCT	1003	50.839170	-128.128010	Shuttleworth Bight
209	2020-08-24	OSKER	510	51.826662	-128.197489	Spider Island, Queen Charlotte Sound
210	2020-09-02	SCT	1116	53.999900	-128.651500	Kitimat
211	2020-09-03	SCT	1148	50.875700	-128.058800	Northern Vancouver Island
212	2020-09-11	SCT	414	52.452100	-128.765600	Price Island south of Higgins Passage
213	2020-09-23	OSKER	402	54.708000	-132.171500	Prince of Wales Island, Alaska
214	2020-09-30	SCT	1163	49.821614	-64.439641	Anticosti Island
215	2020-10-01	SCT	982	49.747276	-126.983554	Nootka Island
216	2020-12-09	SCT	1102	53.981980	-128.699220	Kitimat