Surface circulation tracking drifter data for the Kitimat Fjord system in northern British Columbia and adjacent continental shelf for April, 2014 to July, 2016

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Canadian Data Report of Hydrography and Ocean Sciences 206

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Canadian Data Report of Hydrography and Ocean Sciences

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Regional and headquarters establishments of the former Ocean Science and Surveys sector ceased publication of their various report series in December 1981. A complete listing of these publications and the last number issued under each title are published in the *Canadian Journal of Fisheries and Aquatic Sciences*, Volume 38: Index to Publications 1981. The current series began with Report Number 1 in January 1982.

Rapport statistique canadien sur l'hydrographie et les sciences océaniques

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Les établissements de l’ancien secteur des Sciences et Levés océaniques dans les régions et à l'administration centrale ont cessé de publier leurs diverses séries de rapports en décembre 1981. Vous trouverez dans l'index des publications du volume 38 du *Journal canadien des sciences halieutiques et aquatiques*, la liste de ces publications ainsi que le dernier numéro paru dans chaque catégorie. La nouvelle série a commencé avec la publication du rapport numéro 1 en janvier 1982.

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As part of the Government of Canada's World Class Prevention, Preparedness and Response for Oil Spills from Ships Initiative, we developed a cost-effective low-impact satellite-tracked surface water drifter to aid in understanding surface drift for the coastal waters of British Columbia. These surface drifters provide positioning data in near real-time, offering high resolution temporal and spatial insights into circulation pathways. This dataset in turn aids in the calibration and validation of existing surface circulation models.

This report covers 265 Surface Circulation Trackers (SCTs) and 4 CODE/Davis style drifters deployed from April, 2014 to July, 2016. All of these SCTs were deployed in the Kitimat Fjord system in northern British Columbia and adjacent continental shelf.

Résumé

Page, S.J., Hannah, C., Juhasz, T., Spear, D. and Blanken, H. 2019. Surface circulation tracking drifter data for the Kitimat Fjord system in northern British Columbia and adjacent continental shelf for April, 2014 to July, 2016. Can. Data. Report. Hydrog. Ocean.Sci. 206: vi + 33 p.

Dans le cadre de l'initiative de calibre mondial du gouvernement du Canada pour la prévention, la préparation et la lutte contre les déversements de pétrole par les navires, nous avons mis au point une bouée dérivante peu coûteuse qui est suivie par satellite afin de mieux comprendre la circulation de surface des eaux côtières de la Colombie-Britannique. Ces bouées dérivantes de surface fournissent des données de positionnement en temps quasi réel, offrant des informations temporelles et spatiales à haute résolution sur les voies de circulation. Cet ensemble de données facilite à son tour l'étalonnage et la validation des modèles de circulation de surface existants.

Ce rapport documente le déploiement et les trajets de 265 bouées de suivi de la circulation de surface et de 4 bouées dérivantes de style CODE/Davis déployées d'avril 2014 à juillet 2016. Toutes ces bouées dérivantes ont été déployées dans le réseau de fjords de Kitimat, dans le nord de la Colombie-Britannique, et dans le secteur du plateau continental adjacent.

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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 which 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 the Government of Canada's World Class Prevention, Preparedness and Response for Oil Spills from Ships Initiative, we developed a cost-effective low-impact satellite-tracked surface water drifter to aid in understanding surface drift for the coastal waters of British Columbia. These surface drifters provide positioning data in near real-time updated every 5 minutes, offering high resolution temporal and spatial insights into circulation pathways. This dataset in turn aids in the calibration and validation of existing surface circulation models.

The low cost of each surface drifter ($300-$600) allows for multiple drifters to be launched at the same location at the same time. We have generally deployed 5 at a time. This allows for estimates drift and dispersion statistics, and predictions of the likelihood of a surface pollutant reaching a shoreline or other area of interest.

This report covers 265 Surface Circulation Trackers (SCTs) and 4 CODE/Davis style drifters deployed from April, 2014 to July, 2016. All of these SCTs were deployed in the Kitimat Fjord system in northern British Columbia and adjacent continental shelf.

2. Drifters

2.1. Surface Circulation Trackers

We set out to design a low-cost, low-impact, easily deployable drifter that would track the surface currents and report its location and timestamp via satellite communications. A number of versions of our initial concept were tested in a controlled environment before field testing Version 1 in the open ocean.

The physical makeup of the Surface Circulation Tracker (SCT) is comprised mainly of wood for the structural support and cellulose sponge for floatation. Four aluminum fins are mounted below the sponge to increase the surface area and a zinc weight is installed at the very bottom of the unit to act as ballast. There is also a thin aluminum disk installed above the cellulose sponge to facilitate labelling the SCT with drifter ID and contact information. Figure 1 shows the construction and dimension details for SCT version 1 and version 2, while Figure 2 shows the details for SCT version 3, the current model.

The location and timestamp of the SCT is provided by a SPOT Trace anti-theft device[1]. The SPOT Trace device is designed to track assets (e.g. containers, heavy equipment) and provide near real-time position information at configurable reporting intervals, ranging from every 2 ½ minutes up to hourly. All of the SCTs in this document were configured to report their position every 5 minutes,

[1] https://www.findmespot.ca/en/index.php?cid=128

except where noted. The SPOT Trace device is mounted directly to the aluminum deck for versions 1 and 2 (Figure 1), while on version 3 the SPOT trace device is mounted on top of the door spring that is fastened to the wood dowel that runs through the centre of the drifter (Figure 2).

The SPOT Trace devices were originally engineered to track assets as they move. As such, a vibration sensor to detect movement is incorporated into their architecture. If the tracking device does not detect any vibrations for more than 5 minutes, the internal logic triggers a power-saving suspended tracking mode and stops reporting its latitude and longitude. The unit does not resume reporting until the vibration sensor is agitated and thus senses movement. From our experience, the ocean and inlets are often calm enough that the vibration sensor does not vibrate adequately to operate at its set reporting interval, even with the increased sensitivity setting configured as in version 2.

SPOT released a tracking sensitivity firmware to allow the end user to modify the threshold for the internal vibration sensor. This sensor setting changes how the internal vibration sensor detected movement. SCTs version 2 and version 3 utilized this functionality. This change accounted for a 2.3 – 2.6 fold increase in data return.

The increased sensitivity setting used in version 2 was not sufficient to reliably achieve the goal of reporting every 5 minutes, as the units still went to sleep for periods of time. To overcome this hindrance, we added a standard door stopper spring between the tracking device and the drifter body for version 3 (Figure 2, Figure 3, Figure 4). The door stopper spring destabilizes the tracking device, and thus juddering the vibration sensor enough to keep the tracking device from entering the battery saving sleep mode and continuing to report its location.

2.2. CODE/ Davis Drifters

The use of the SPOT Trace device is not limited to SCTs and they can be used on a variety of drifters. Another common oceanographic drifter is the Davis or CODE drifter[2]. These ocean drifters have X-shaped sails and are designed to track the upper meter of the surface currents. We deployed four CODE/Davis style drifters in the study area for drifter comparison (see Table 2).

In keeping with our intentions to construct a low impact oceanographic tool, we built our CODE/Davis style drifters with cedar for the structural integrity and end floatation, and burlap fabric for the sails (Figure 5).

2.3. Drifter ID nomenclature

Each SPOT tracking device has an unique 9 character identifier with the format ‘0-########’, where # is an integer from 0 to 9 (eg 0-2542334). This electronic serial number ID is provided by the vendor, which is factory hardcoded into the device and cannot be modified. We refer to this ID as the Spot ID.

[2] CODE/DAVIS Drifter
https://www.metocean.com/product/codedavis-drifter/

Prior to deployment, we assign another ID to the tracking device. We refer to this ID as the IOS ID and it is in the form of an incremental integer. The IOS IDs in this report range from #6 to #531.

3. Drifter Missions and Data

From April, 2014 to August, 2016, we deployed 265 surface circulation trackers (SCTs) and 4 Davis/CODE style drifters over the course of 14 missions in the Kitimat Fjord System, the adjacent continental shelf and nearby areas. See Figure 6 and Figure 7 for a map of the study area. See Table 2 for deployment schedule and drifter IDs.

3.1. Mission 1 - April 2014 Drifter deployment (Douglas Channel Cruise)

From April 15-16, 2014, four deployments of five version-1 SCTs were launched in the Douglas Channel area. SCT IDs were #6-25. All SCTs were deployed from the CCGS John P. Tully during IOS sampling cruise number 2014-15. See Figure 8 for drift tracks and deployment locations.

Deployment locations were:
i) Douglas Channel (SCT#6-10, red).
ii) Principe Channel (SCT#11-15, blue)
iii) Squally Channel (SCT#16-20, black)
iv) Wright Sound (SCT#21-25, magenta)

This batch of twenty SCTs was our first operational set launched post testing in the Saanich Inlet. The data return for these 20 SCTs was lower than anticipated thus prompting the investigation of design improvements in tracking sensitivities and drifter configuration.

3.2. Mission 2 - July 2014 Drifter deployment (Mooring Cruise)

From June 30th to July 4th, 2014, five deployments of version-1 SCTs were launched in the Douglas Channel area. SCT IDs were #31-50. Drift tracks for this deployment are on Figure 9.

Deployment locations were

i) Camaano Sound (SCTs#31-35, blue)
ii) northern end of Squally Channel near Otter Channel (SCTs#36-40, red)
iii) Douglas Channel near the entrance to Devastation Channel (SCTs#41-43, green).
iv) southern end of Squally Channel (SCTs# 44-45, black)
v) Wright Sound (SCTs #46-50, magenta)

All SCTs were deployed from the CCGS John P. Tully during the annual DFO-IOS mooring cruise (cruise number 2014-20).

3.3. Mission 3 - October 2014 Drifter deployment:

From September 29th to October 4th, 2014 four deployments of five version-1 SCTs were launched in the Douglas Channel area. SCT IDs were #63-82. Drift tracks for mission 3 are on Figure 10.

Deployment locations were:
i) Squally Channel (SCT#63-67, blue)
ii) Ursula Channel at Verney Passage (SCT#68-72, red)
iii) Douglas Channel(SCT#73-77, green)
iv) Wright Sound (SCT#78-82, magenta)

All SCTs were deployed from the CCGS Vector.

3.4. Mission 4 - October 2014 Drifter deployment:

On October 9th, 2014, two SCTs (version 1) were deployed in Queen Charlotte Sound. SCT IDs deployed were SCT#83 and #84. See Figure 11 for drift tracks.

3.5. Mission 5 - March 2015 Drifter deployment:

From March 7th to 11th, 2015, seven deployments of five version-2 SCTs and one deployment of ten version-2 SCTs were launched in the Douglas Channel area. SCT IDs were #145-152, 154-173, 175-189, 191-194. See Figure 12 for SCT drift tracks and figure 13 for the Davis drifter tracks.

Deployment locations were:
i) offshore from Camaano Sound (#145-149)
ii) south end of Squally Channel near Caamano Sound (#150, 151, 152, 154)
iii) Wright Sound (#155-159, 185-189)
iv) north end of Squally Channel near Otter Channel (#160-164)
v) the junction of Verney Passage and Ursula Channel (#165-169).
vi) near the FOC mooring in Douglas Channel (#170-173)
vii) Gardner Canal (#175-179)
viii) Mackay Reach near Fraser Reach (#180-184)

In addition to the regular SCT drifters, four Davis style drifters were launched on this mission. Deployment locations were: one at i) near the HEC mooring, offshore from Camaano Sound (#191, red) ii) Wright Sound (#192 green) iii) near the FOC mooring in Douglas Channel (#193, blue) and iv) At the junction of Verney Passage and Ursula Channel (#194, yellow). All drifters were deployed from the CCGS Vector on cruise 2015-03.

3.6. Mission 6 - April 2015 Drifter deployment (Estevan Kelp)

On April 27th, 2015, five version-2 SCTs were deployed at single location in the Estevan Kelp beds in Caamano Sound. SCT IDs were 26i, 27i, 28i, 29i and 30i. Drift tracks are on Figure 14.

3.7. Mission 7 - August 2015 Drifter deployment (CHS Cruise)

The Canadian Hydrographic Service (CHS) deployed twenty-five SCTs between August 2nd and August 18th, 2015, as part of one of their cruises. The Pine Island area had two deployments: one set

of five on August 2nd, 2015 (SCT# 246-250, magenta) and another set of five on August 18th, 2015 (SCT# 236-240, red). See Figure 15 for mission #7 drift tracks.

The remaining fifteen SCTs were deployed in batches of five at:
i) west of Aristazabal Island (SCT# 241-245, green)
ii) west of Price Island (SCT# 251-255, blue)
iii) Caamano Sound (SCT# 256-260, gold)

3.8. Mission 8 - July 2015 Drifter deployment (Mooring Cruise)

From July 26th to 29th, 2015, six deployments of five version-2 SCTs were launched in the Douglas Channel area. IOS IDs deployed were #261-290. Drifter tracks for this deployment are shown on Figure 16.

Deployment locations were:
i) Wright Sound (SCT#261-265, red)
ii) Squally Channel (SCT#266-270, blue)
iii) offshore from Camaano Sound (SCT#271-275, black)
iv) Verney Passage (SCT#276-280, green)
v) Camaano Sound (SCT#281-285, gold/yellow)
vi) Douglas Channel (SCT#286-290, magenta)

All drifters were deployed from the CCGS John P. Tully during the DFO-IOS mooring cruise (cruise number 2015-46).

3.9. Mission 9 -October 2015 Drifter deployment (Douglas Channel Cruise)

From October 17th to November 8thth, 2015, forty-four drifters were launched in the Douglas Channel area, consisting of seven deployments of five version-2 SCTs and one deployment of ten version-2 SCTs. SCT IDs deployed were #317-338 and #340-371. Mission #9 drifter tracks are on Figure 17.

Deployment locations were:
i) Wright Sound (10)
ii) Camaano Sound
iii) The north and south ends of Squally Channel
iv) Douglas Channel
v) Gardner Channel (dark green)
vi) Offshore from Camaano Sound (light green)
vii) Ursula Channel at Verney Passage

All drifters were deployed from the CCGS Vector on cruise number 2015-54.

3.10. Mission 10 - May 2016 Drifter deployment

SCT IDs deployed on this cruise were #398, 399, 400, 402 and #408-416 and 419-422. Figure 18 contains the drifter tracks for this mission. All SCTs were deployed from the CCGS John P. Tully.

Deployment locations for this mission were:
i) Douglas Channel (#398-402, 416, 420, red).
ii) Otter Channel at Squally Channel (#408-412, black)
iii) Squally Channel (#413-415, blue)
iv) Wright Sound (#419, 421, magenta)

3.11. Mission 11 - May 2016 Drifter Deployment (LaParouse Cruise)

Three version-3 SCTs were deployed from the CCGS John P. Tully just west of Pine Island on June 3rd, 2016. SCTs # were 401 (blue), 417 (red) and 418 (black).Drifter tracks are on Figure 19.

3.12. Mission 12 - July 2016 Drifter deployment (Mooring Cruise)

From July 6-11, 2016, twenty five version-3 SCTs were deployed on the annual IOS mooring cruise from aboard the CCGS John P. Tully (cruise number 2016-12). SCT IDs deployed on this cruise were SCTs #507-531. Figure 20 shows the southern Hecate Strait deployments while Figure 21 focuses on only the drifters launched the Kitimat Fjord System only.

Deployment locations were:
i) Squally Channel
ii) Devastation Channel
iii) Whale Channel
iv) Douglas Channel
v) Grenville Channel
vii) Otter Channel
viii) Pine Island (SCT#507-509, red)
ix) Scott Islands (SCT#527-531, various).

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3.13. Mission 13 - August 2016 Drifter deployment (Gwaii Haanas)

CHS deployed five version-3 SCTs on August 10th, 2016 at a single location in Hecate Strait just east of Gwaii Haanas National Park Reserve. SCTs deployed were #496, 497, 498,499, and 501. Deployment location and drifter tracks can be found on Figure 22.

3.14. Mission 14 - August 2016 Drifter deployment (Pine Island)

CHS deployed five version-3 SCTs on August 16th, just west of Pine Island, in Queen Charlotte Sound. SCTs deployed were #491, 492, 493,494, and 495. Deployment location and drifter tracks can be found on Figure 23.

3.15. SCT Data

All of the SCT data can be downloaded via the Institute of Ocean Sciences(IOS) data portal[3], or the Ocean Networks Canada Oceans (ONC) 2.0 Data Search portal[4]. For the IOS portal, select *Data, Search Holdings* and from the metadata panel select *Metadata Name = Data Description, Value = Drifting Buoy*. For the ONC portal on step 2 in the query process, select *Instruments by Category*, then select *Drifter Buoy*.

3.16. Recovered SCTs

Given the nature of the environment where the SCTS have been deployed, the majority of the drifters end up on a beach or shoreline at some point. Periodically they are found by citizens, and reported back to the drifter team. The drifters themselves are designed to degrade over time, so generally we have not been able to repurpose them, unless they were found shortly after deployment. Table 3 is a list of recovered SCTs. We are able to reuse the recovered Spot tracking devices after the batteries have been replaced and installed on a new drifter body. However for the time period covered by this report, no Spot tracking devices were redeployed on any mission.

4. References

Wright,C.A., Vagle, S., Hannah, C., and Johannessen, S.J. 2015. Physical, chemical and biological oceanographic data collected in Douglas Channel and the approaches to Kitimat, June 2013-July 2014. Can. Data. Report. Hydrog. Ocean.Sci. 196:viii+66pp.

Wright, C.A., Vagle, S., Hannah, C., Johannessen, S.J., Spear, D., Wan, D. 2016. Physical, chemical and biological oceanographic data collected in Douglas Channel and the approaches to Kitimat, October 2014-July 2015. Can. Data. Report. Hydrog. Ocean.Sci. 200:viii+74pp.

Wright, C.A., Vagle, S., Hannah, C., Johannessen, S.J. Spear, D.and Wan, D. 2017. Physical, chemical and biological oceanographic data collected in Douglas Channel and the approaches to Kitimat, October 2015-July 2016. Can. Data. Report. Hydrog. Ocean.Sci. 202: x+139pp

[3] Waterproperties.ca/data

[4] https://data.oceannetworks.ca/DataSearch

5. Acknowledgements

The authors would like to thank all who helped deploy the drifters, as well as the many individuals who found a beached drifter and reported it to us.

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

Table 1: SCT version-3 Buoy General Specifications

Height	0.5m
Beam	0.23m
Draft	0.38m
Dry Weight	1.1kg
Saturated Weight	3.0kg
Reserve Buoyancy	0.4-0.5kg
Area above water : Area Submerged	1:15
Operational life at 5min sampling interval	9-11 days
Operational life at 10min sampling interval	17-22 days
Near real-time data return	97-98%

Table 2: Deployment distribution

Mission #	Deployment Dates	Number deployed	IOS SCT IDs	Region	Style
1	15-16 April, 2014	20	6-25	KFS	SCT-1
2	30 June to 03-July, 2014	20	31-50	KFS	SCT-1
3	02-04 October, 2014	20	63-82	KFS	SCT-1
4	09-October, 2014	2	83,84	QCS	SCT-1
5	07-11 March, 2015	43	145-152,154-173,175-189	KFS	SCT-2
5	07-11 March, 2015	4	191-194	KFS	Davis
6	27 April, 2015	5	26i-30i	CS	SCT-2
7	August, 2015	25	236-260	KFS	SCT-3
8	28-29 July, 2015	30	261-290	KFS	SCT-3
9	October, 2015	45	317-336, 342-366	KFS	SCT-3
10	May, 2016	17	398-400,402,408-416, 419-422	KFS	SCT-3
11	May, 2016	3	401, 417, 418	PI	SCT-3
12	06-11 July, 2016	25	507-531	KFS	SCT-3
13	10 August, 2016	5	496-499, 501	GH	SCT-3
14	16 August, 2016	5	491-495	PI	SCT-3
	Total=	**269**			

Note: KFS = Kitimat Fjord System. QCS = Queen Charlotte Sound
CS = Caamano Sound GH = Gwaii Haanas National Park Reserve
PI = Pine Island Region

Table 3: Recovered SCTs

SCT ID	Recovered Location
8	Prince Rupert, BC
24	Long Island, Alaska (14-Aug/14)
44	Calamity Bay, BC (Banks Island) (05-Aug/14)
49	reported found but not returned
146	Cross Sound, Alaska (19-Mar/16)
151	Alaska (30-Jul/15)
178	Kitimat, BC (Mar/15)
250	Cape Scott, BC (22-Aug/16)
280	reported found but not returned
286	Kitimat, BC
398	reported found but not returned
418	reported found but not returned
426	Km 21 of West Coast Trail, BC

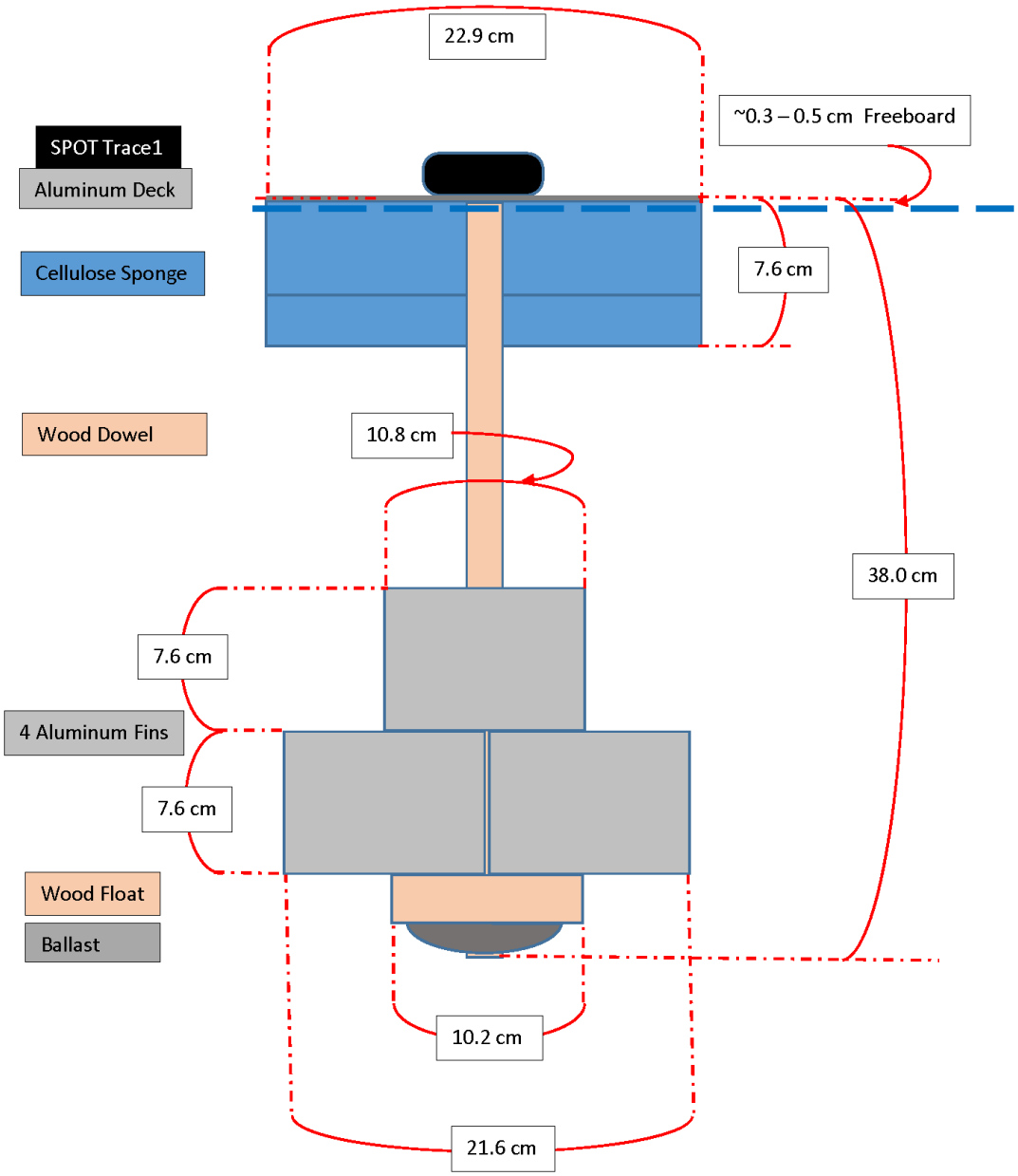

Figure 1: Schematic of the version 1 and version 2 surface circulation tracker (SCT)

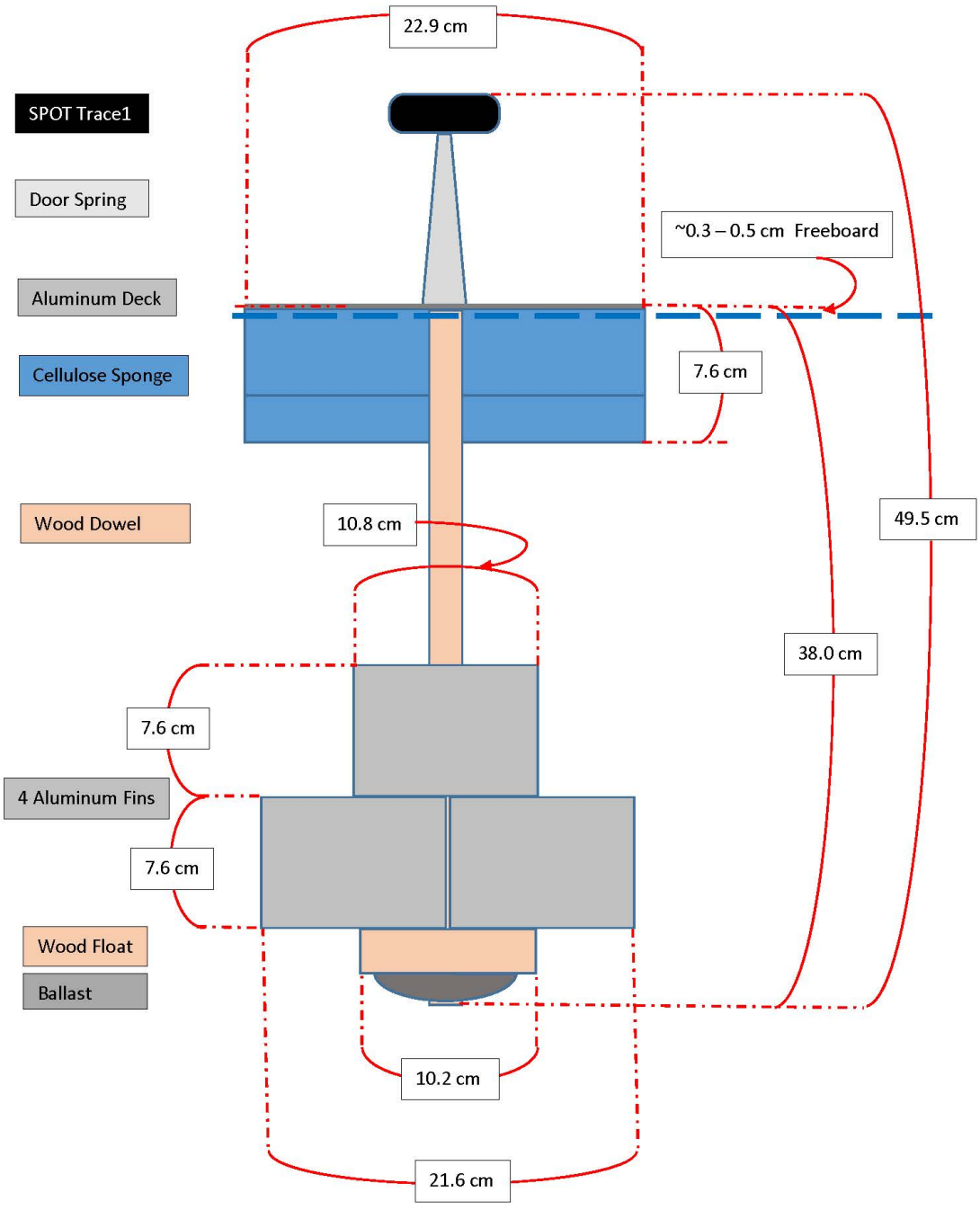

Figure 2: Schematic of the version-3 surface circulation tracker (SCT)

Figure 3: Surface Circulation Tracker evolution

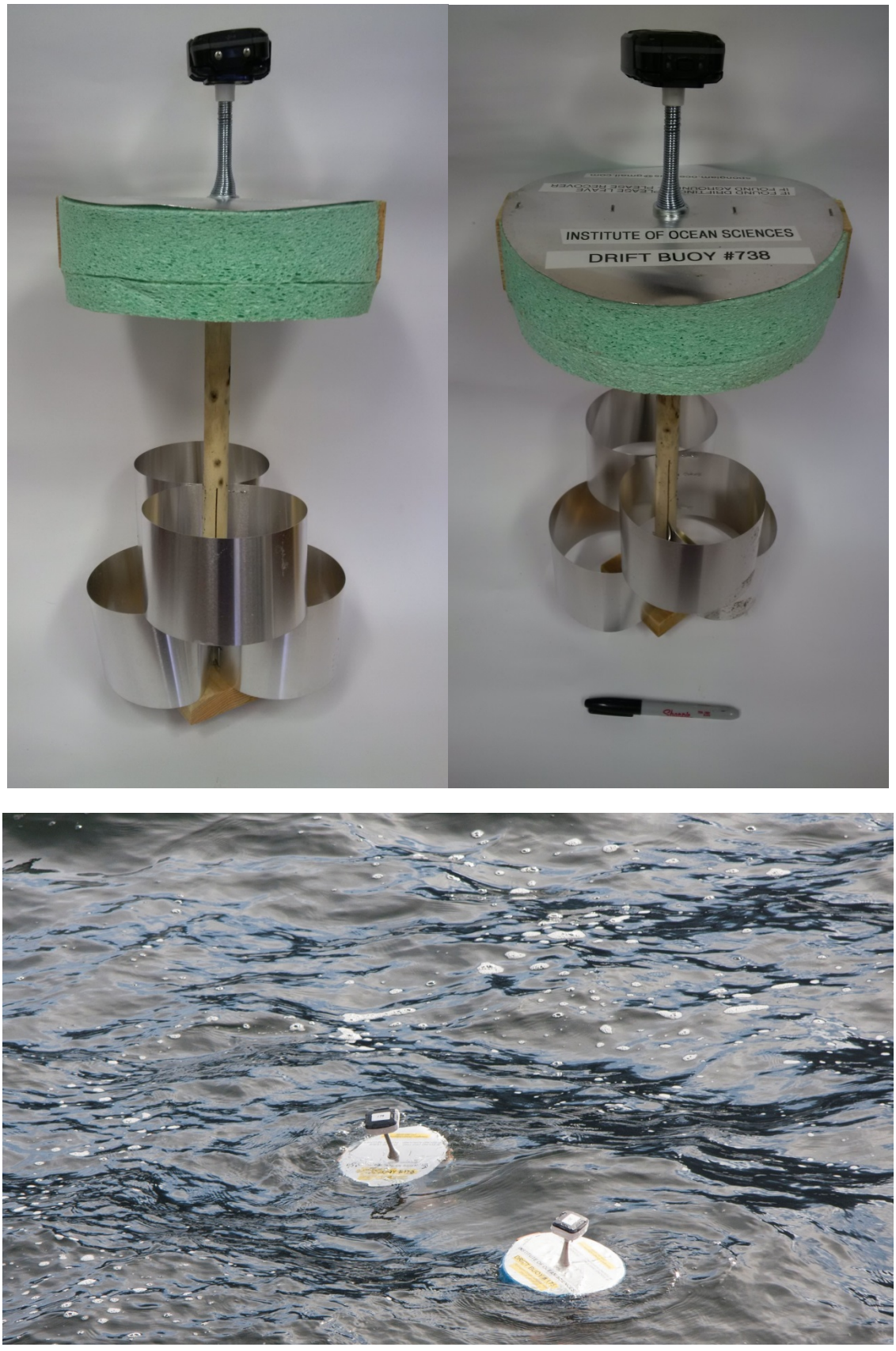

Figure 4: SCT version 3 pre-deployment (upper) and post-deployment (lower)

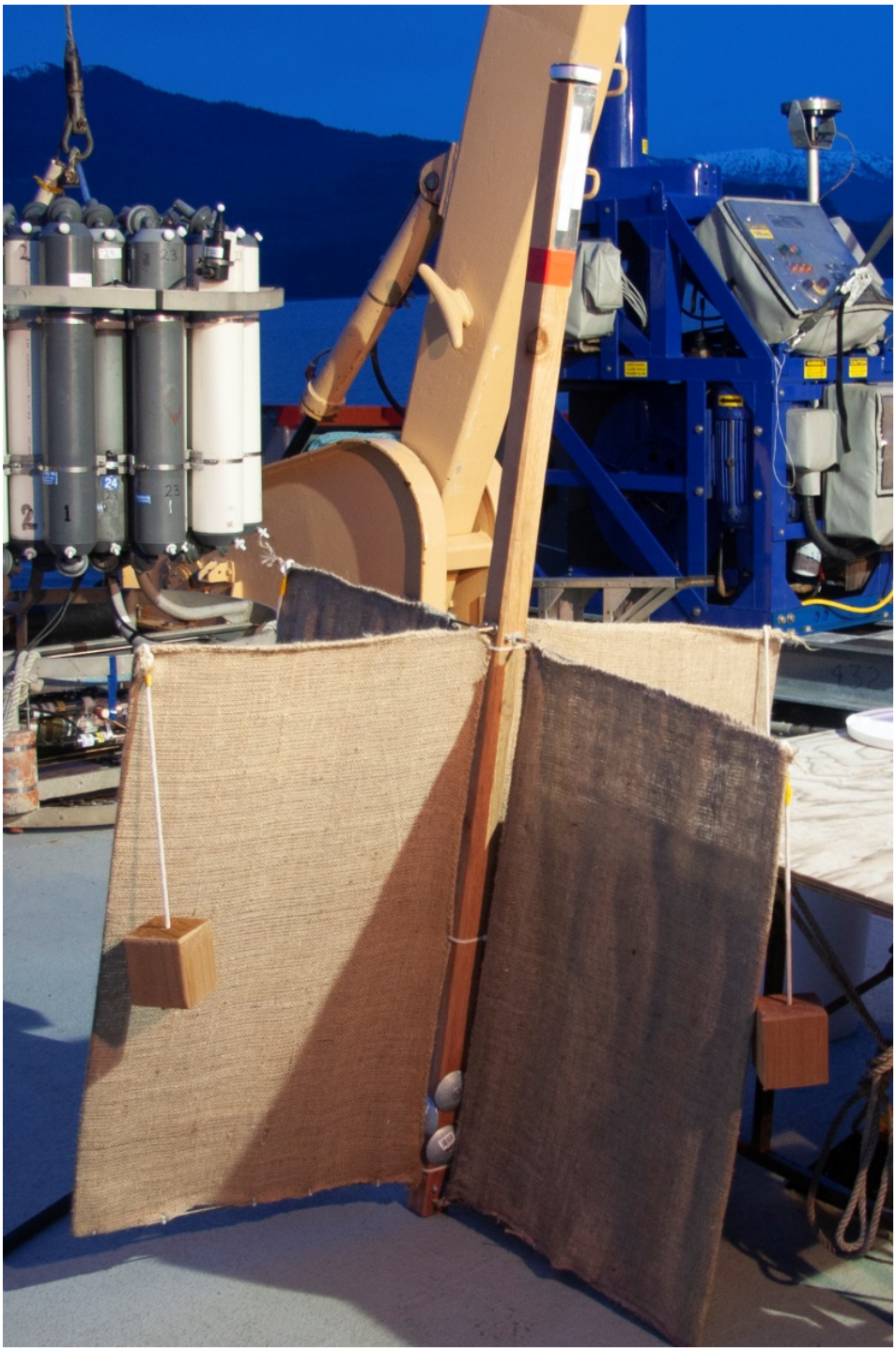

Figure 5: CODE/Davis style drifter

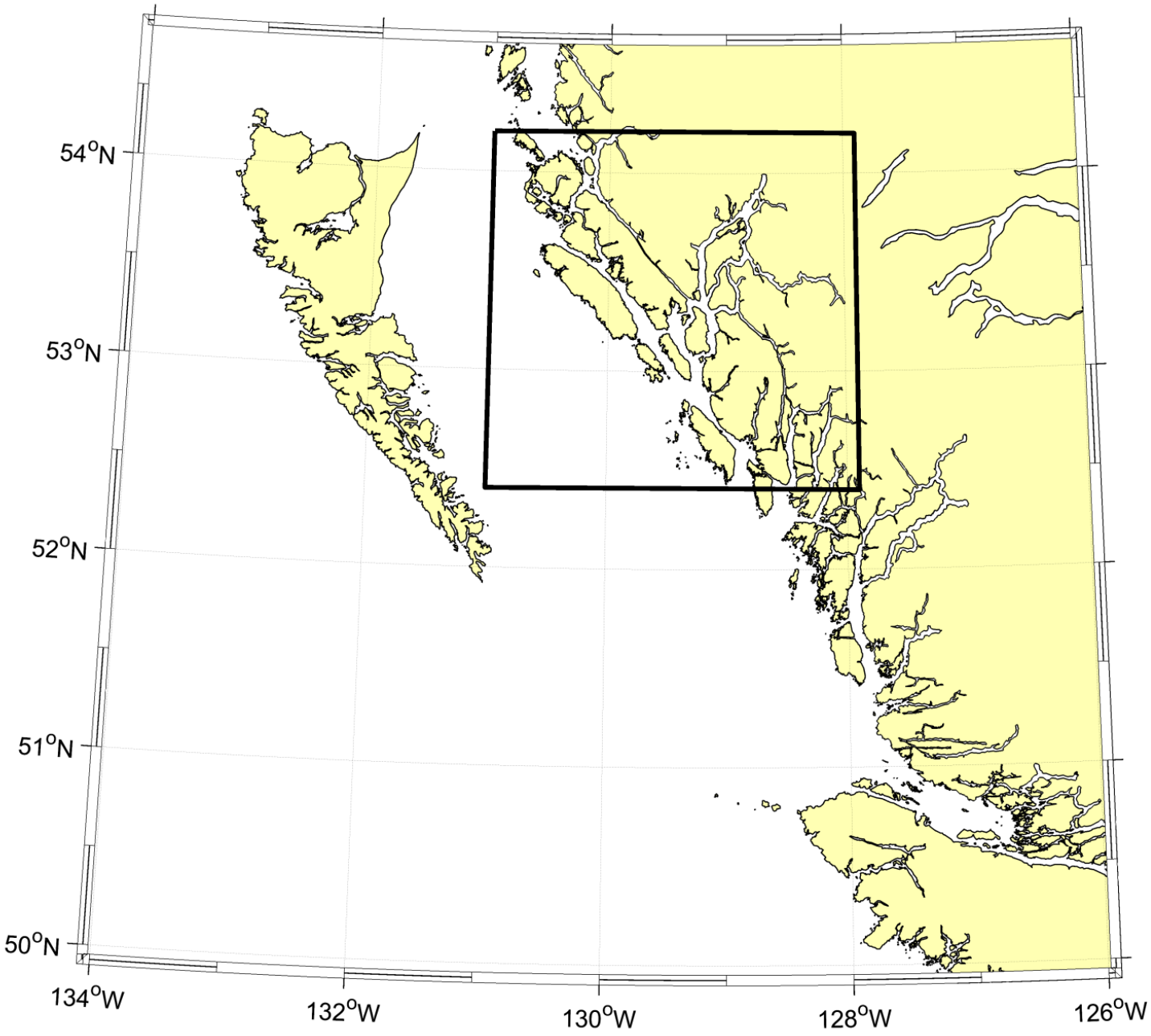

Figure 6: Principle region of study: the approaches to the Kitimat Fjord System

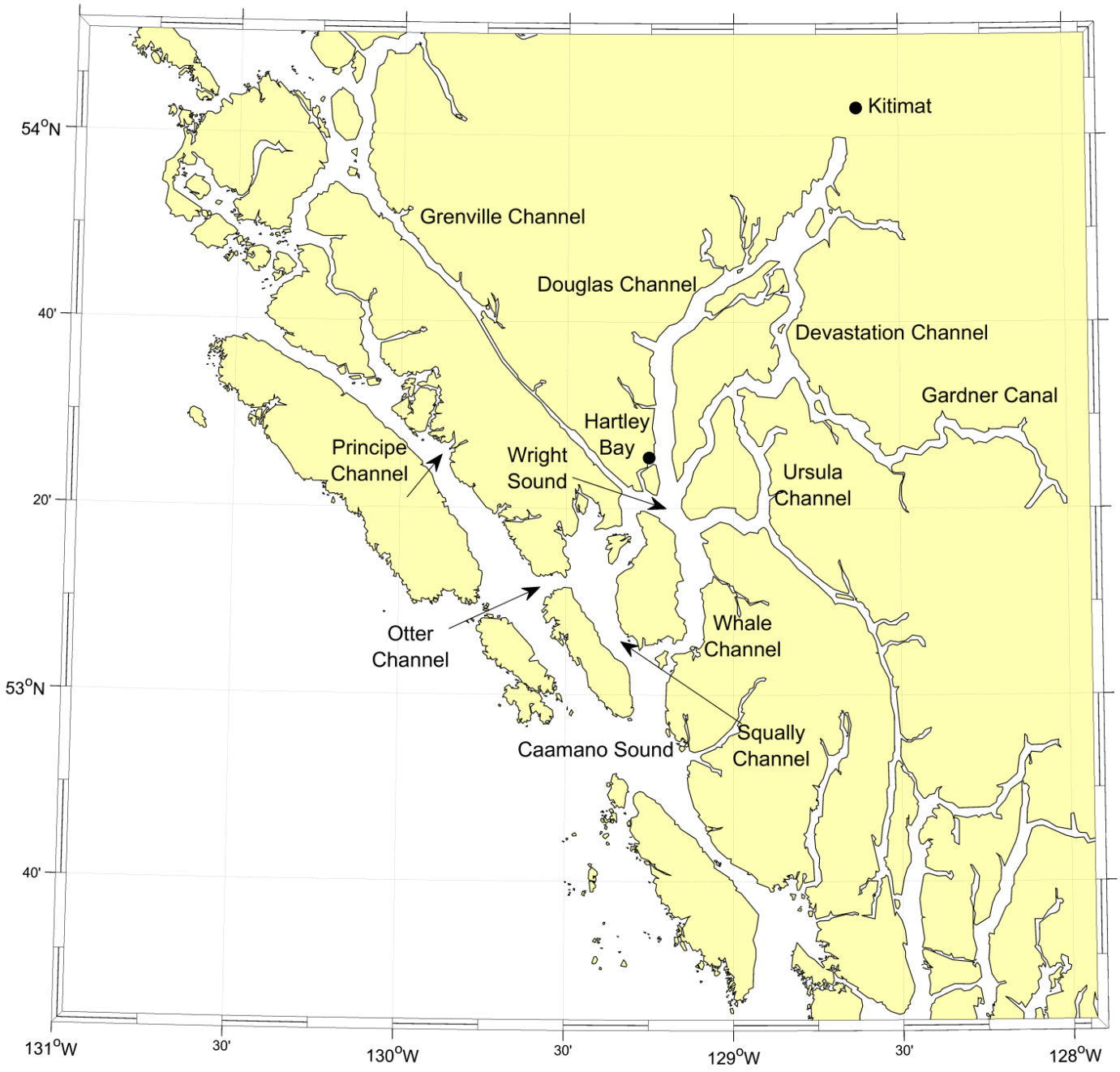

Figure 7: Principle region of study: Kitimat Fjord System

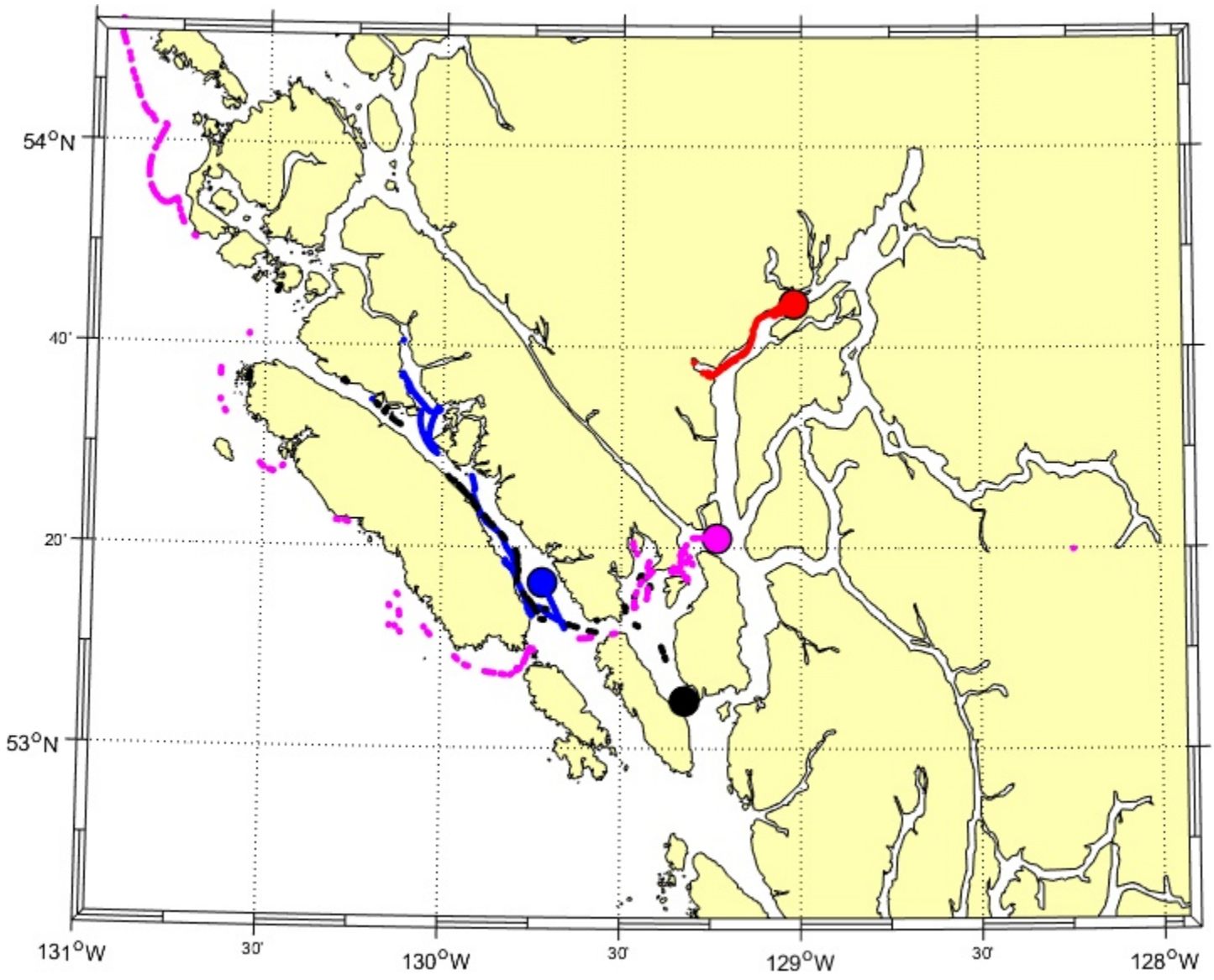

Figure 8: Mission #1 SCT tracks (April, 2014).

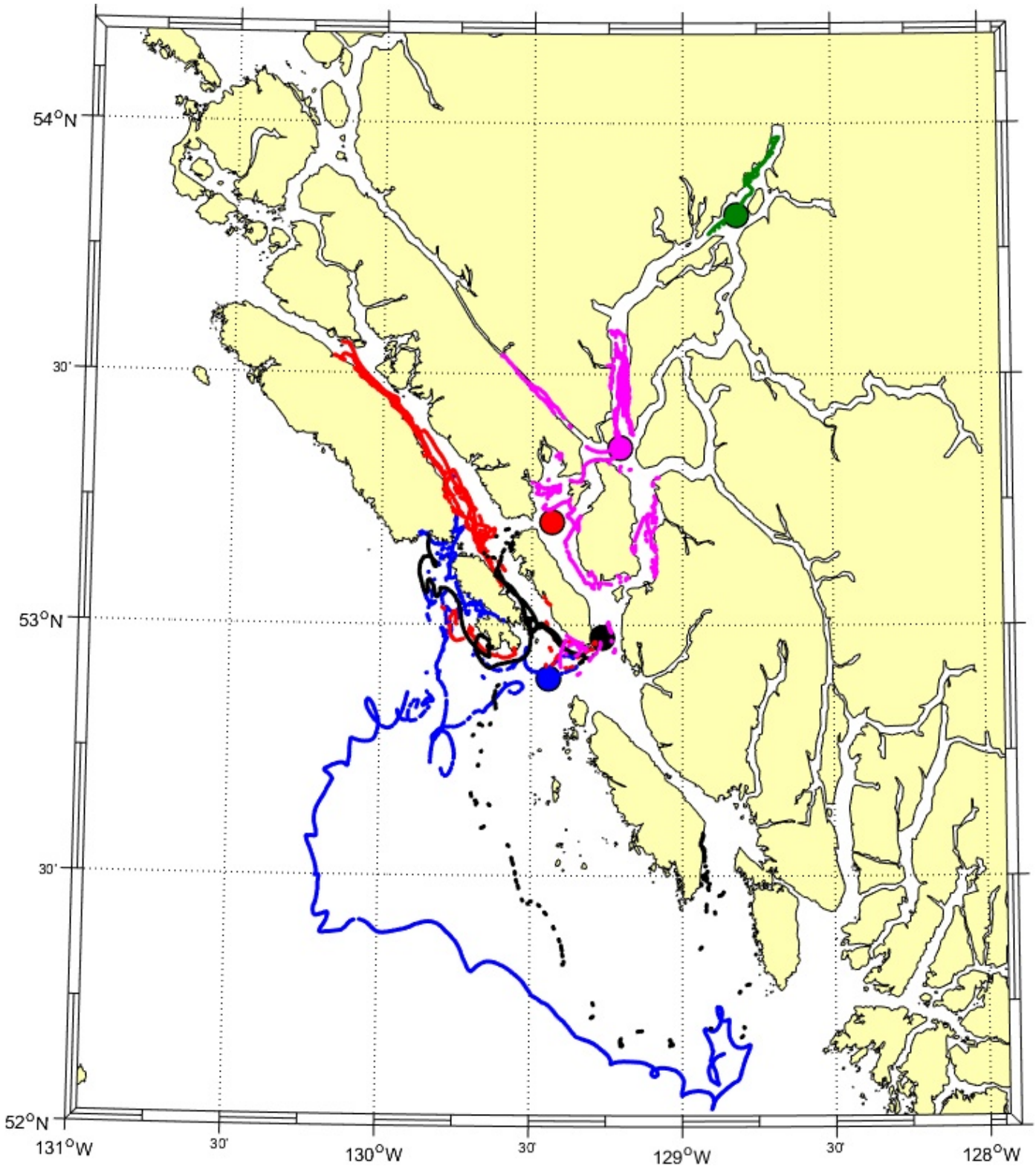

Figure 9: Mission #2 SCT tracks (July, 2014)

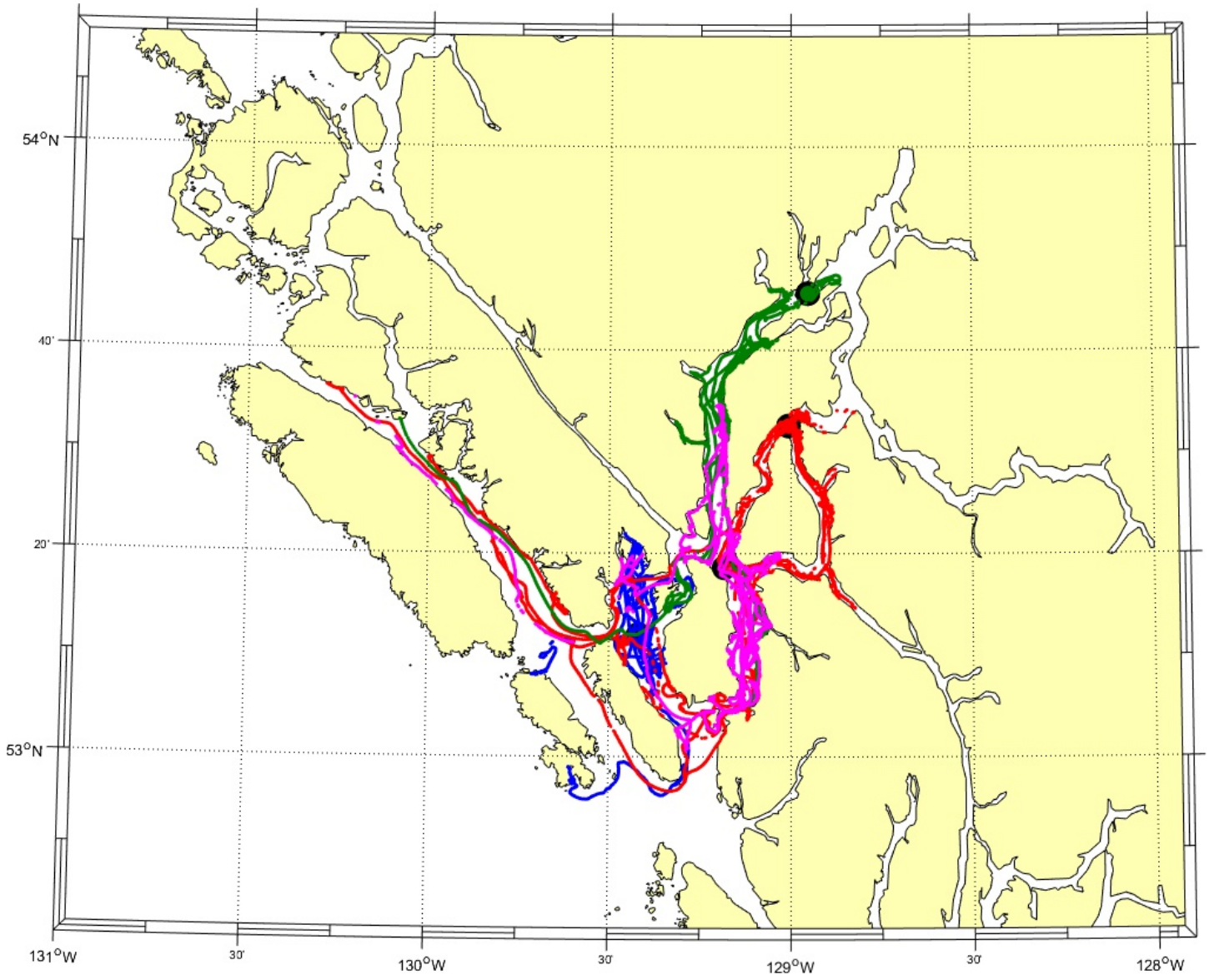

Figure 10: Mission #3 SCT tracks (October, 2014)

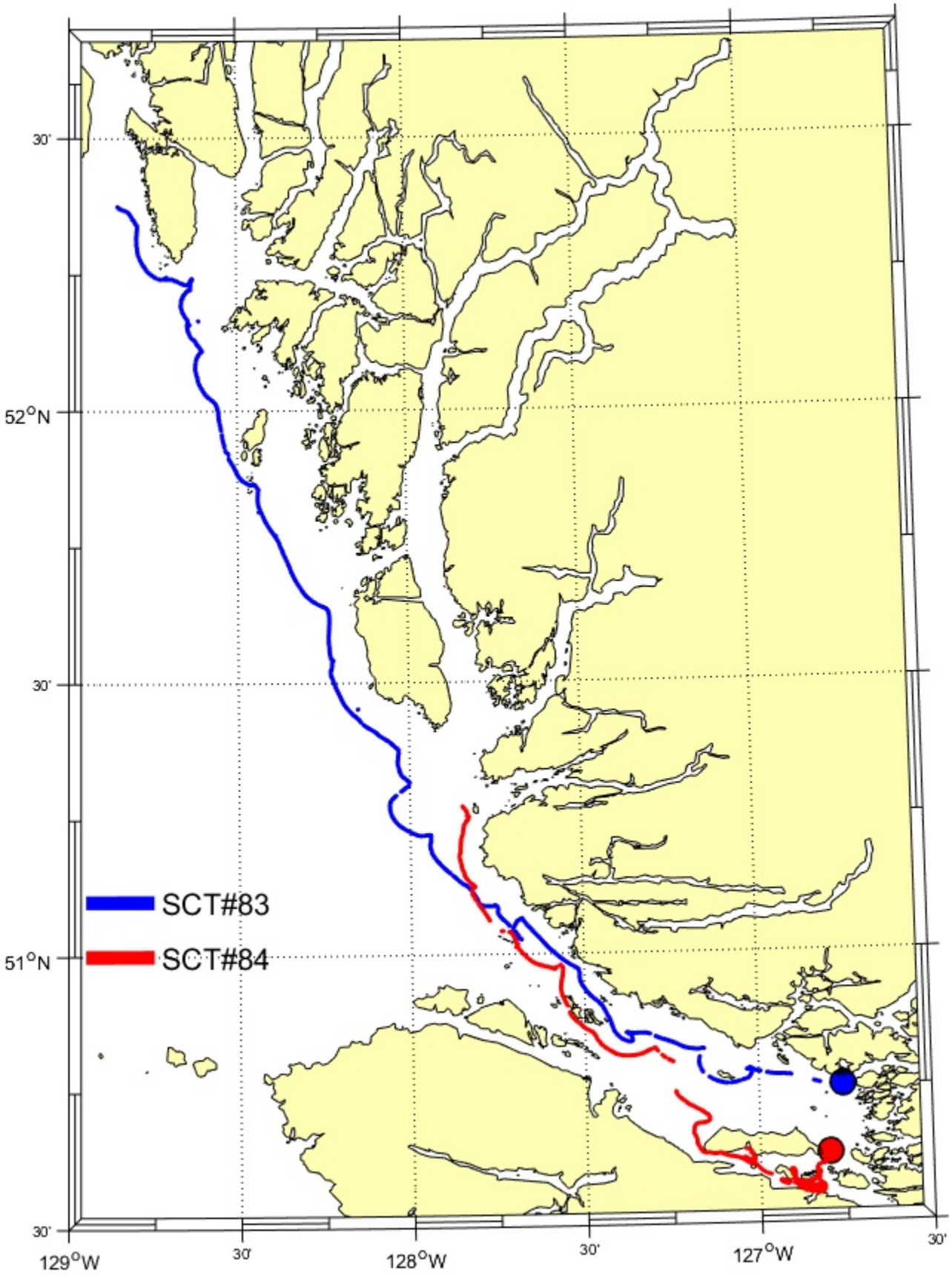

Figure 11: Mission #4 SCT tracks (deployed 09-October, 2014)

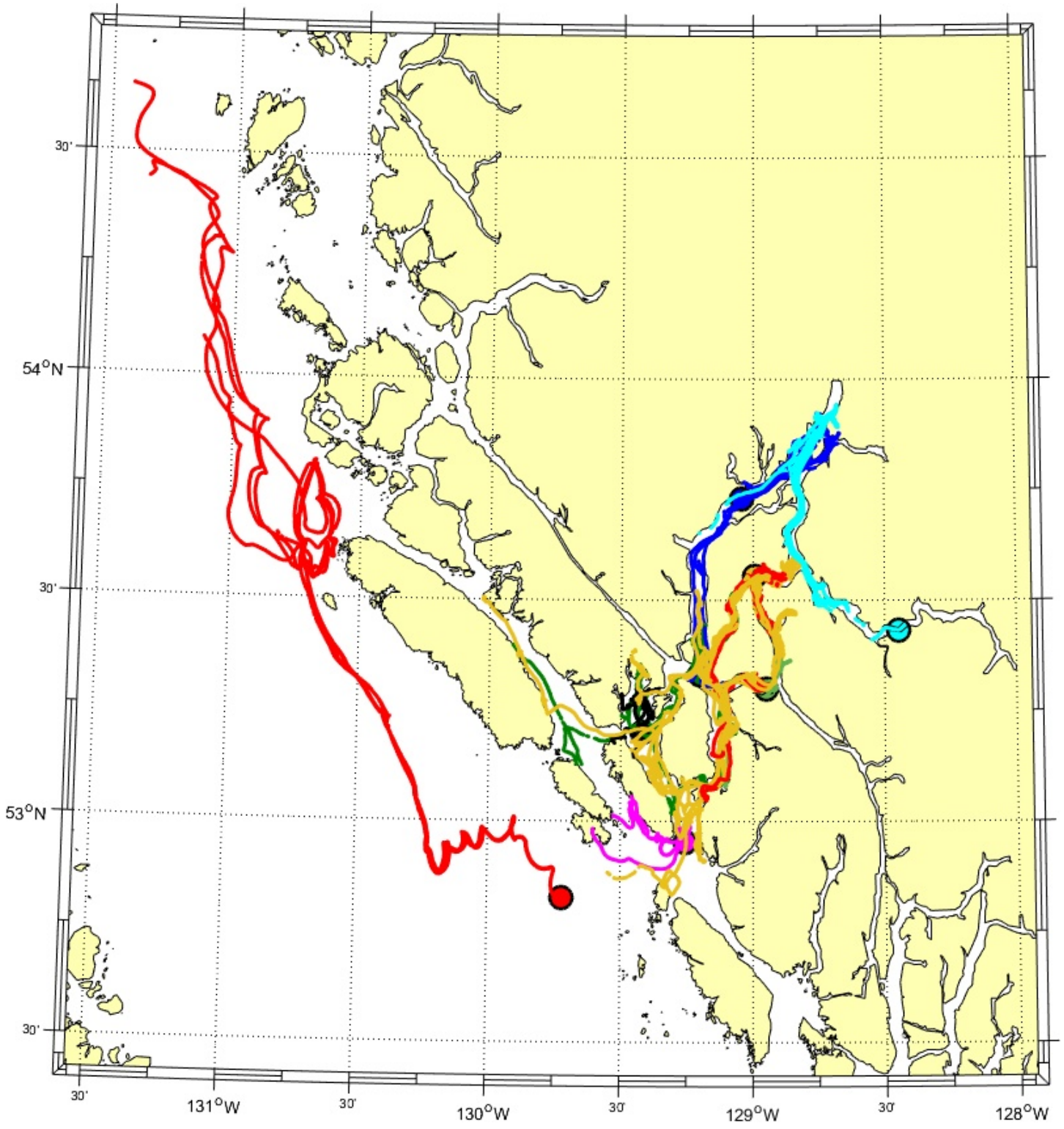

Figure 12: Mission #5 SCT tracks (March, 2015)

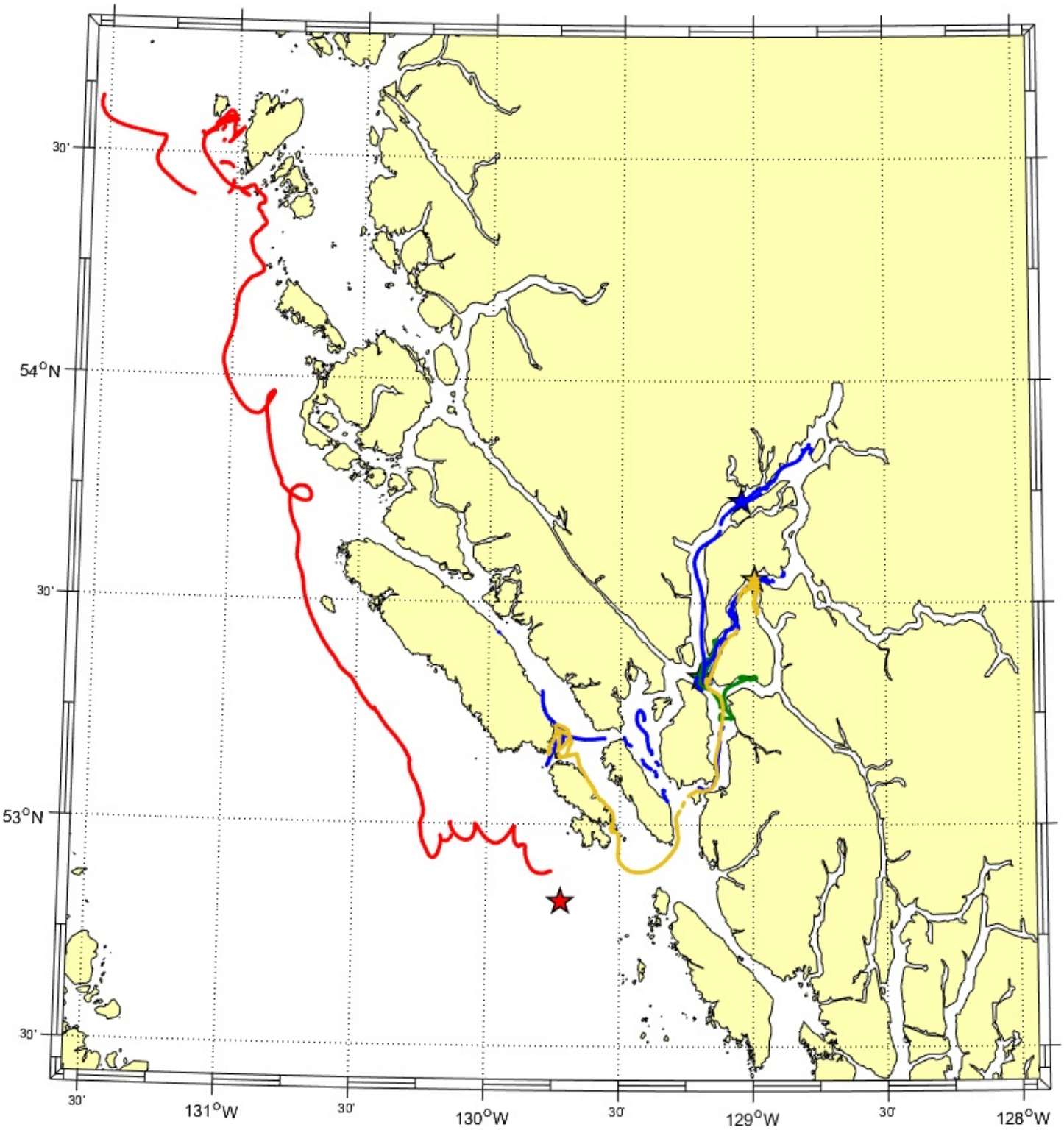

Figure 13: Mission #5 CODE/Davis Tracks (March, 2015)

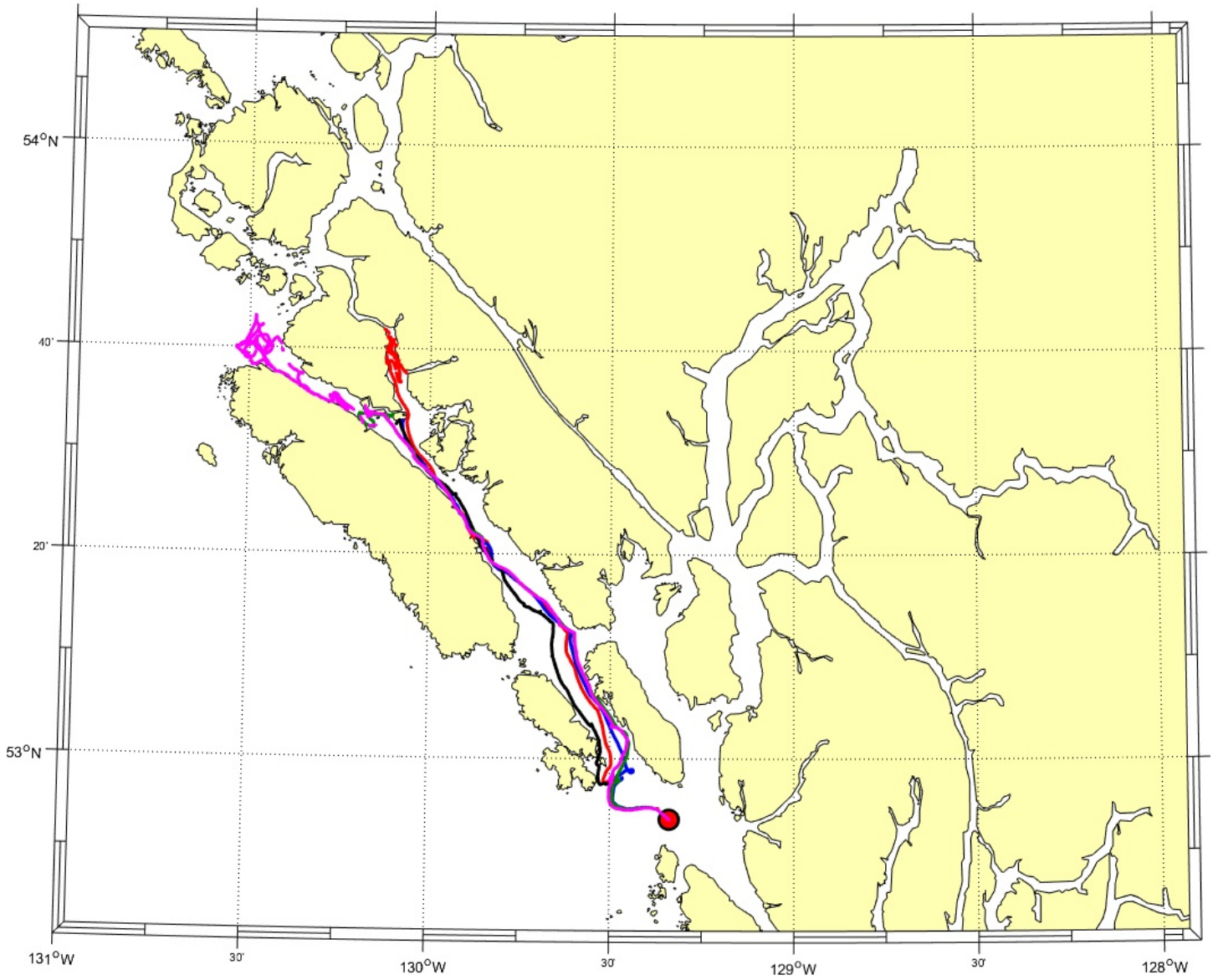

Figure 14: Mission #6 SCT Tracks (April, 2015)

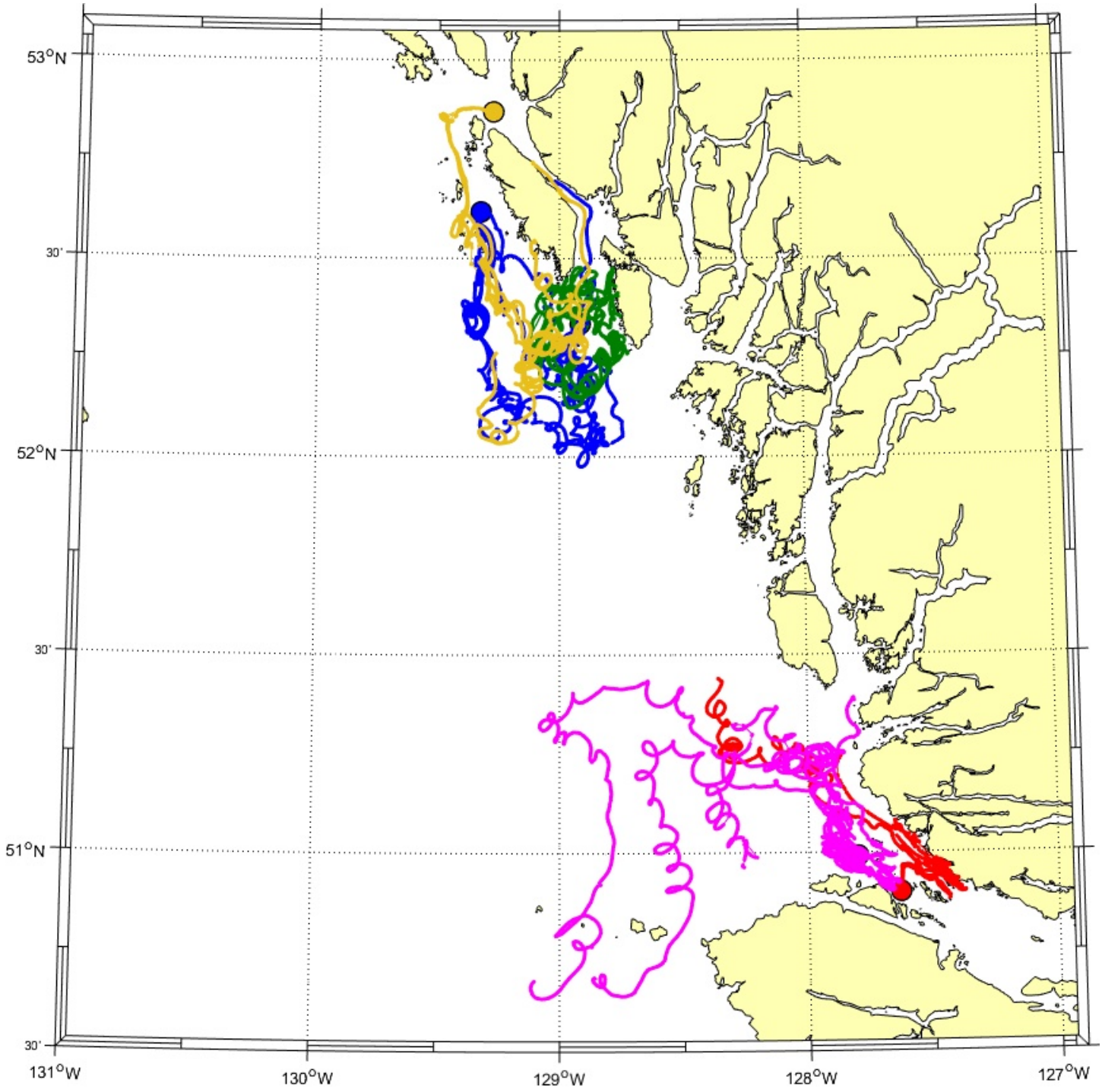

Figure 15: Mission #7 SCT Tracks (August, 2015)

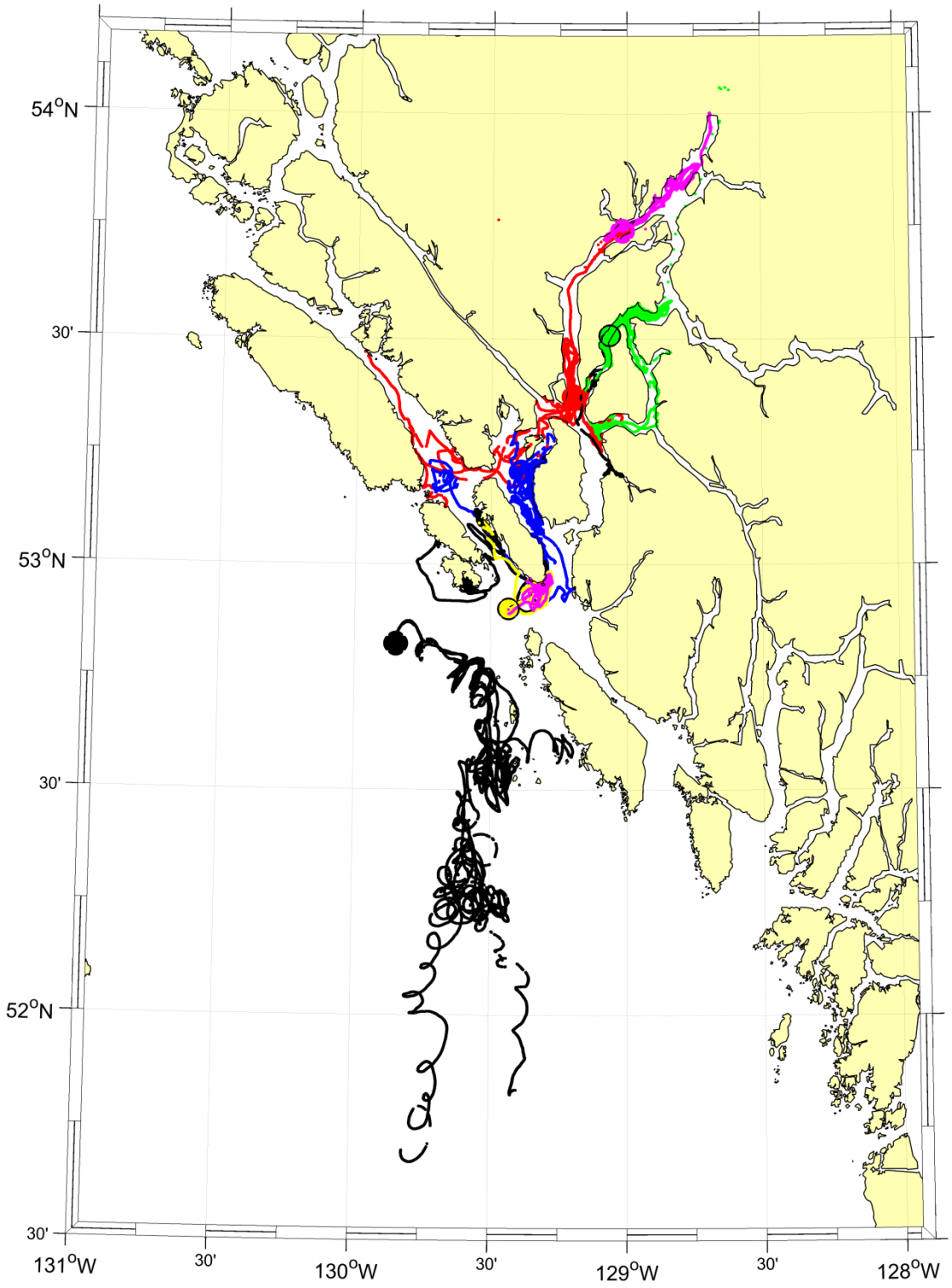

Figure 16: Mission #8 SCT Tracks (July, 2015)

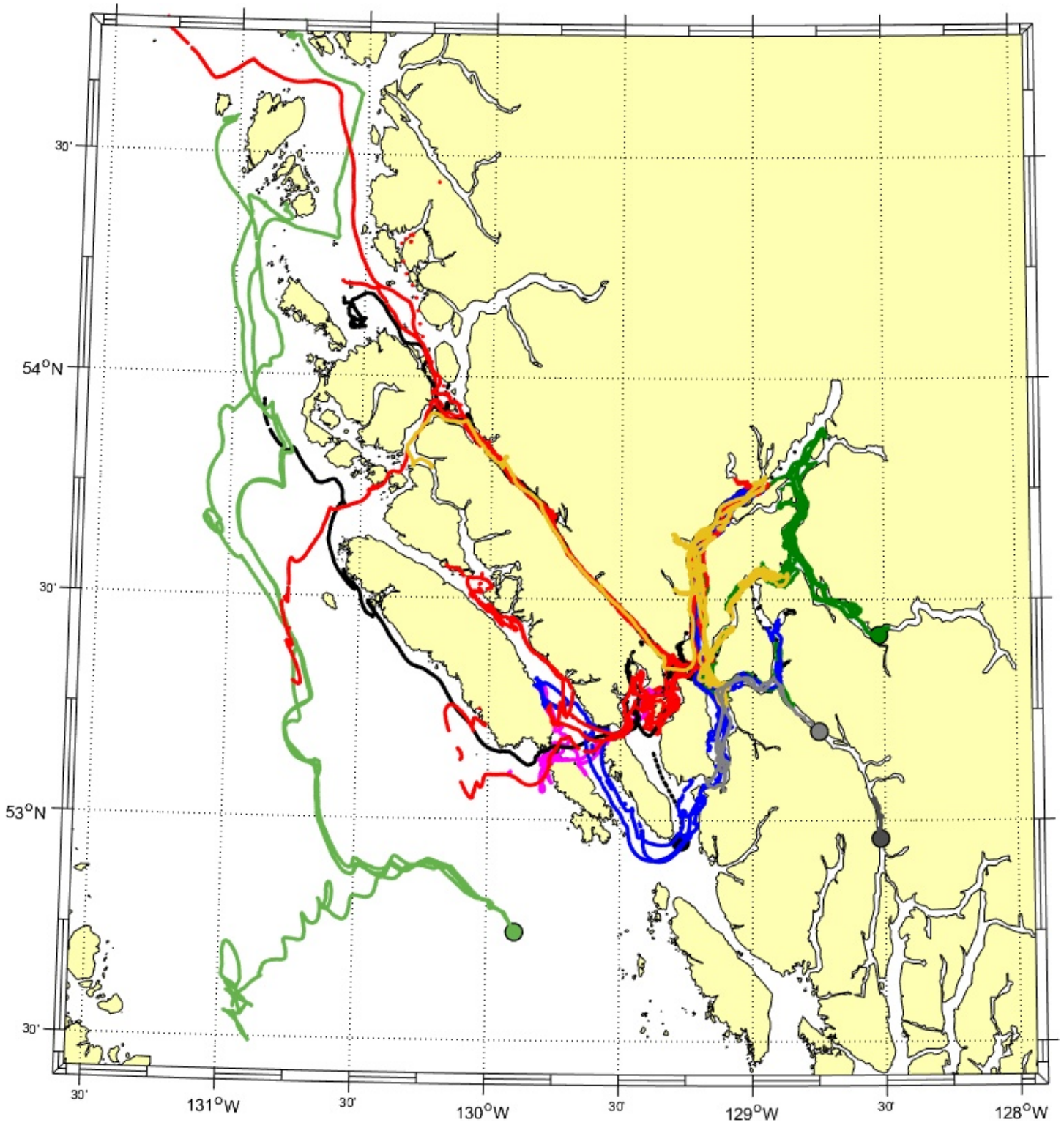

Figure 17: Mission #9 SCT Tracks (October, 2015)

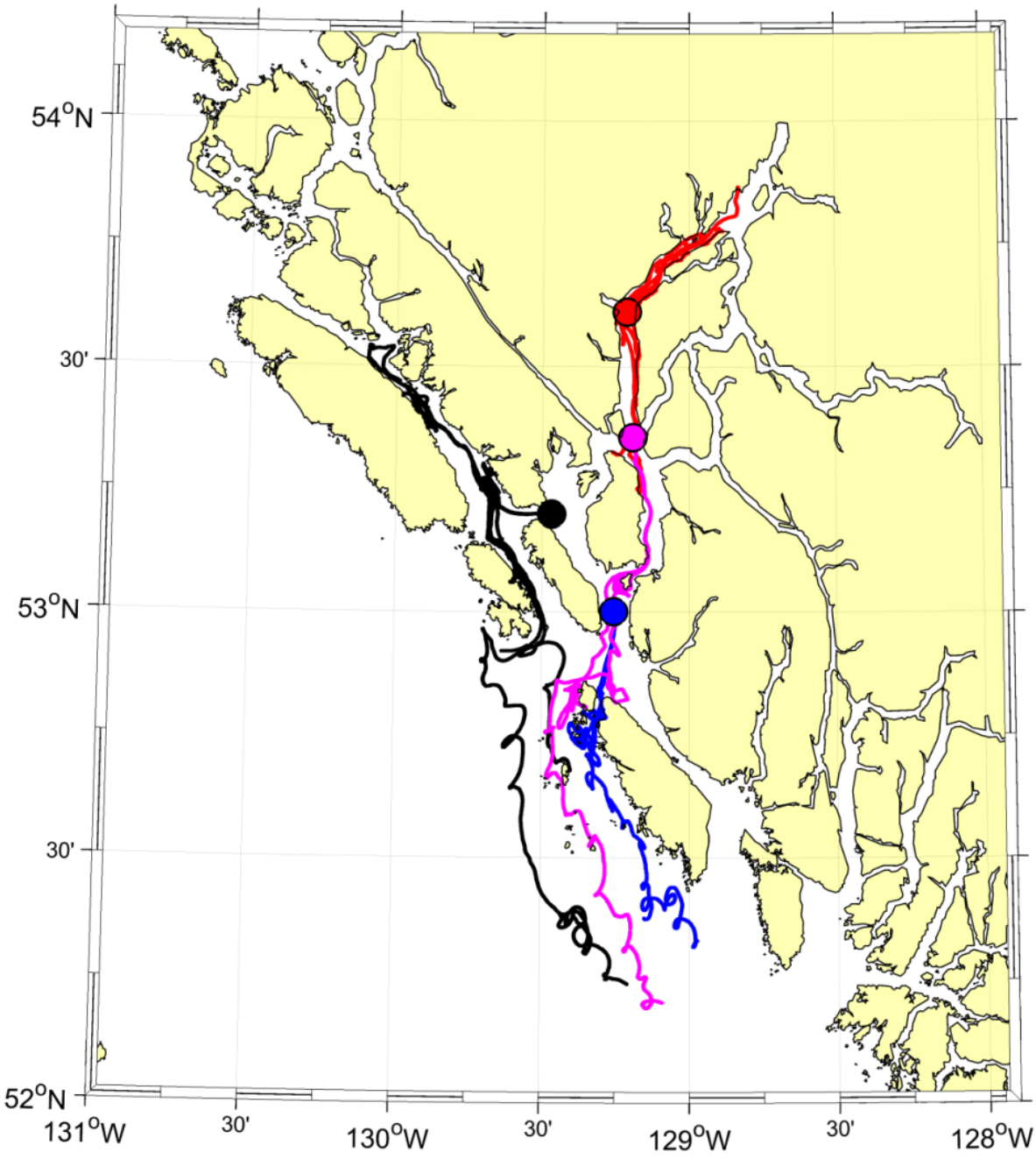

Figure 18: Mission #10 SCT Tracks (May, 2016)

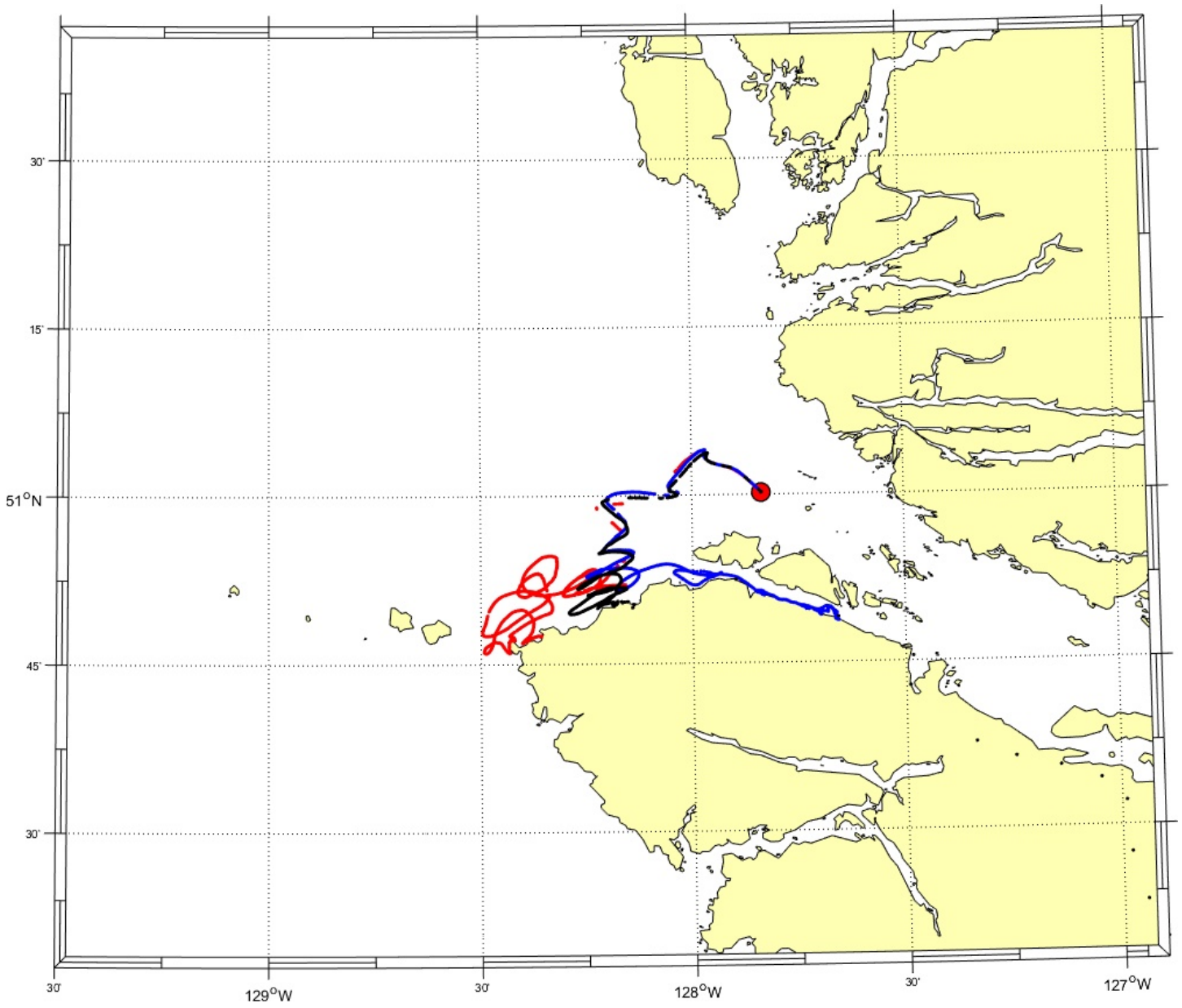

Figure 19: Mission #11 SCT Tracks (June, 2016)

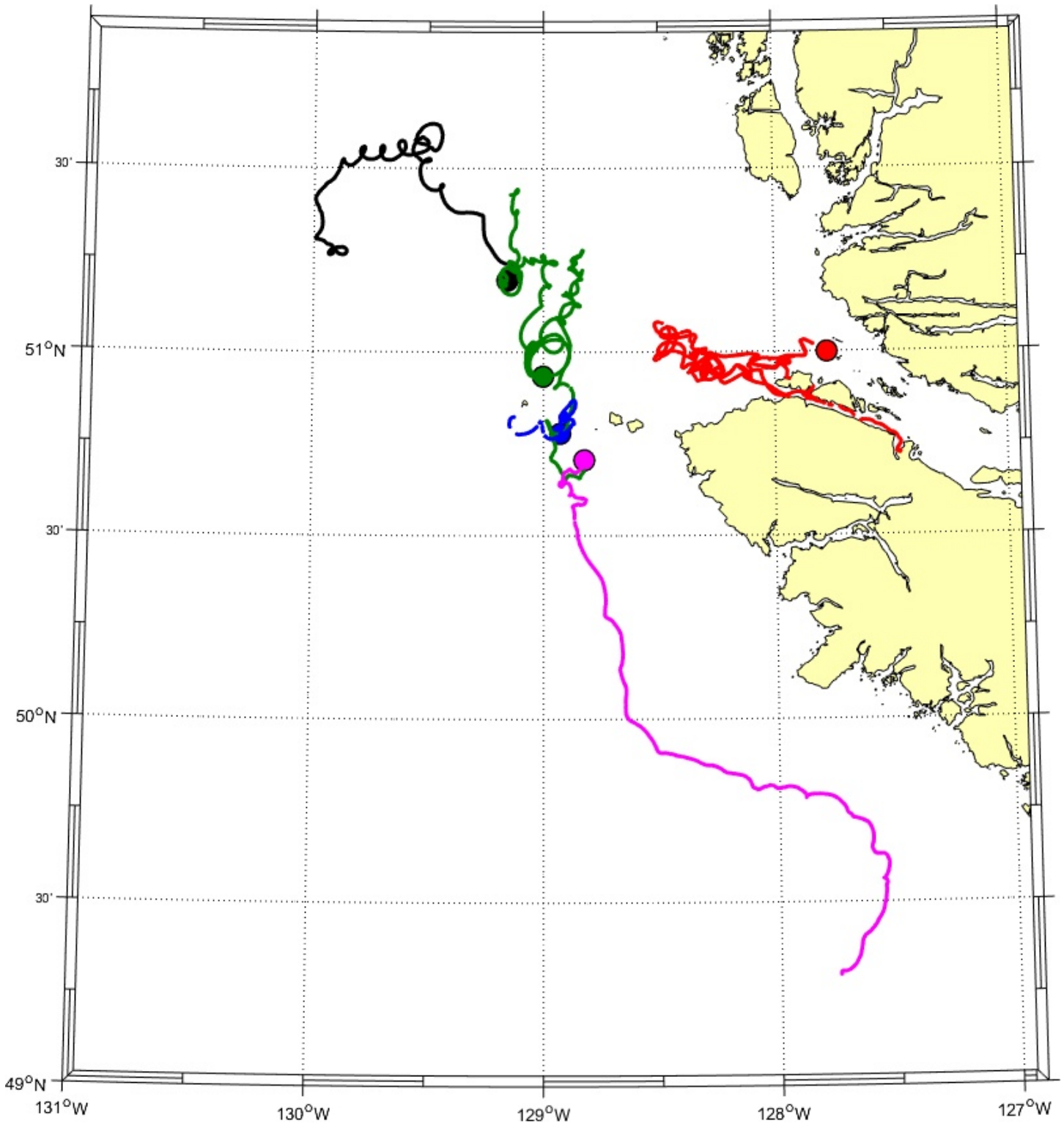

Figure 20: Mission #12 SCT Tracks for southern Hecate Strait only (July, 2016)

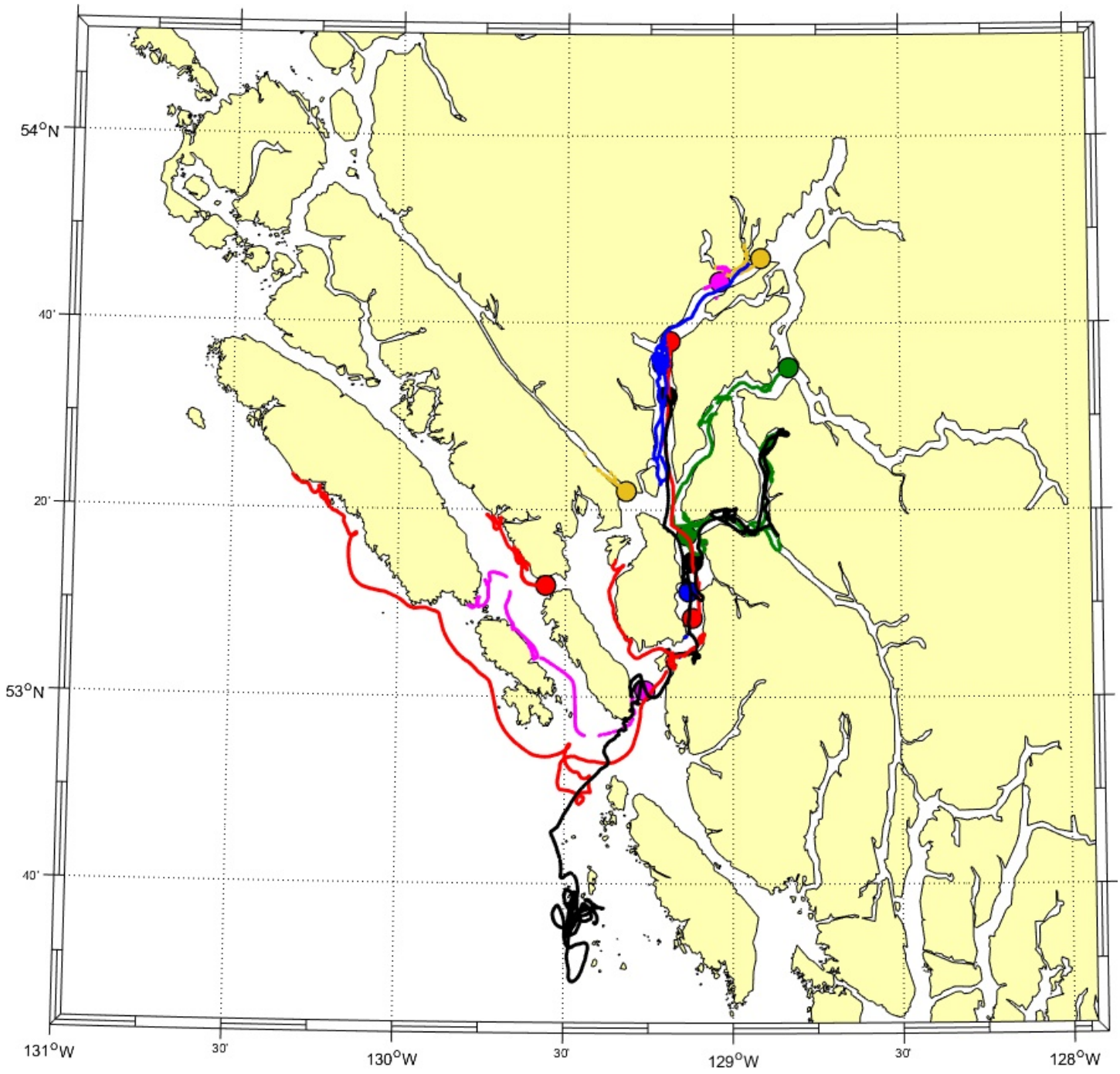

Figure 21: Mission #12 SCT Tracks for Kitimat Fjord system only (July, 2016)

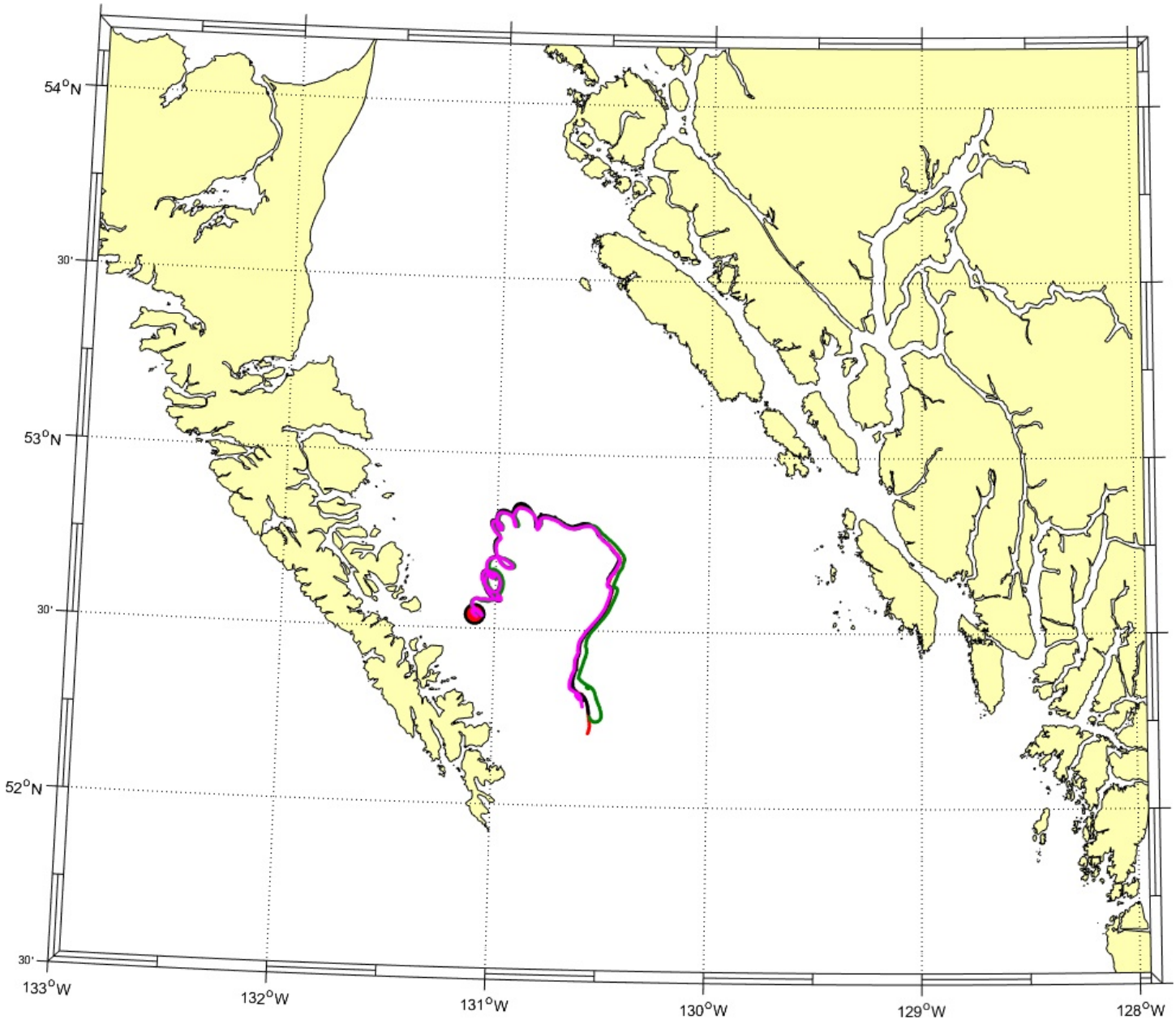

Figure 22: Mission #13 SCT Tracks (August, 2016)

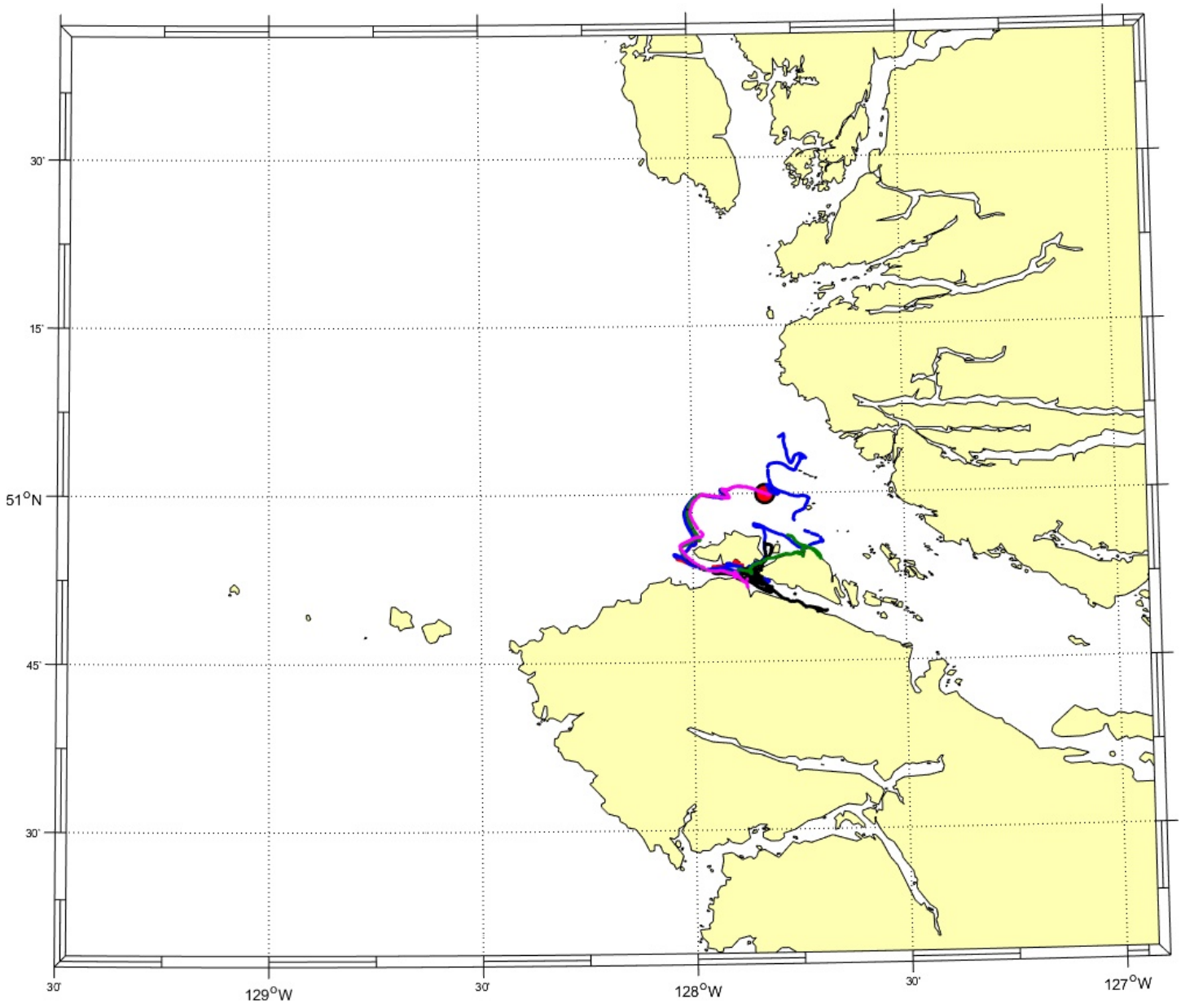

Figure 23: Mission #14 SCT Tracks (August, 2016)