

# Salish Sea Drift Card Study

## Preliminary Results

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## Highlights

1. The majority of recoveries from the two card drops in Burrard Inlet and Vancouver Harbour washed ashore very quickly (within 3 days) and continued to wash ashore on Vancouver beaches for a few weeks.
2. Cards from the two card drops in Burrard Inlet and Vancouver Harbour eventually circulated to the San Juans, Sunshine Coast and other locations.
3. Recoveries from the card drops outside Burrard Inlet (drops #3-9) showed wide spread and rapid dispersal, initially travelling very quickly (~ 1 kph in one verified case).
4. Cards were recovered at great distance from the initial drop locations within a few weeks (200-300 km).
5. It is likely that much of the south coast of Vancouver Island from Sidney to Tofino, the San Juans, the southern Gulf Islands, and the north coast of the Washington's Olympic Peninsula would be impacted by oil from a spill at any of these locations.

## Background

Drift card studies have been used for many years to help inform our understanding of how ocean currents and wind patterns might affect distribution and circulation of floating items. They have been undertaken in the context of underwater oil pipelines, sewage disposal facilities, marine park planning and invasive species colonization, amongst other reasons. This study was undertaken with two main objectives. Firstly, the Kinder Morgan pipeline expansion would see a vast increase in tanker traffic in the shipping routes between Vancouver and the Pacific Ocean, through the southern Strait of Georgia, the Gulf and San Juan Islands, and the Juan de Fuca Strait. By launching cards at select locations along the shipping route, we can help ascertain where oil from shipping incidents may be deposited, and to determine areas that may have a greater likelihood of having oil deposited on shorelines from one, or multiple incident locations. Secondly, drift cards present a unique and personal way to increase awareness about the Kinder Morgan proposal. Citizens finding the cards report the location, date, time and card number on a website, or by phone or email, and the locations are mapped on a website, [www.salishseaspillmap.org](http://www.salishseaspillmap.org).

## Preliminary Results

**Overall Statistics** – As of December 12, 2013, 458 cards (out of 1644 launched at 9 locations – Figure 1) have been recovered and reported. This represents a 28% recovery rate to date (Figure 2). This is within the range of the recoveries we would expect, given the results of other studies in the area. We expect additional cards to be recovered and reported. Also, the time of year (late fall/early winter) means that less people are out recreating or travelling where cards are likely washing up (for example the West Coast Trail is closed this time of year).

Figure 1: Drop locations

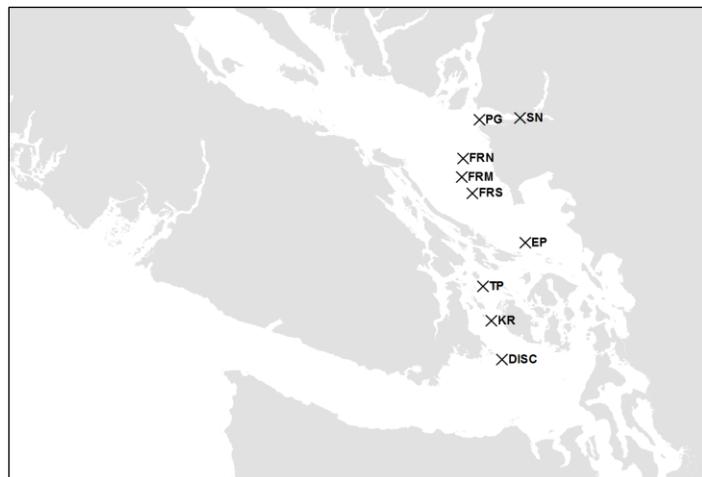
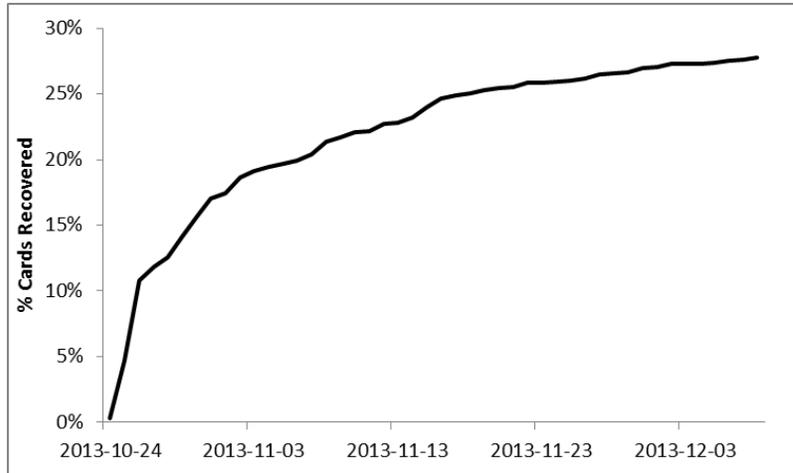


Figure 2: Cumulative number of cards recovered from all drop locations.



Recovery rates have varied greatly between the drop locations, ranging from 6% (Kelp Reef) to over 60% (Pt. Grey in Burrard Inlet) (Figure 3). It is unclear why the drop at Kelp Reef produced the lowest recovery rates, when the Discovery Island and Turn Pt. drops nearby produced greater recovery rates.

Figure 3: Recovery rates for the 9 drop locations.

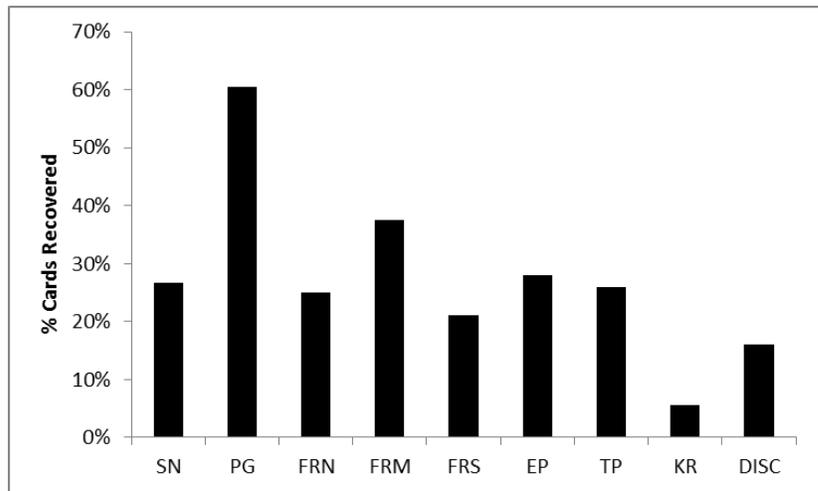


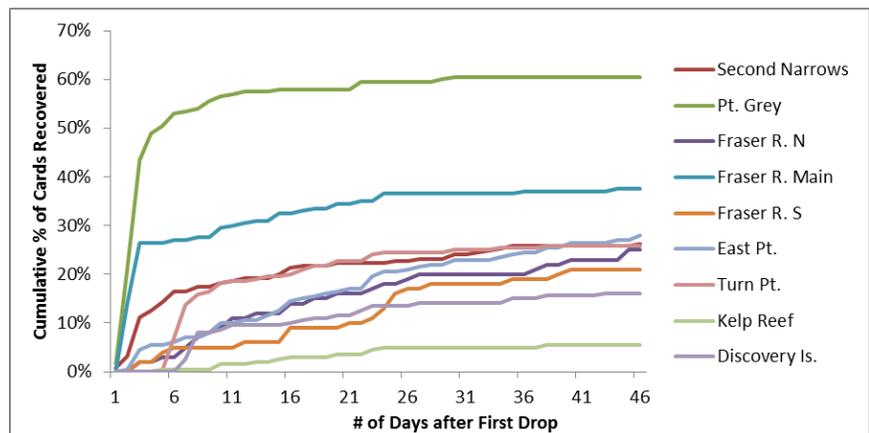
Table 1 shows the statistics for each of the drops.

Drop Number	Location	Short Form	Cards Launched	Cards	
				Recovered to Date	Recovery Rate
1	Second Narrows	SN	225	60	27%
2	Pt. Grey	PG	200	121	61%
3	Fraser R. N	FRN	100	25	25%
4	Fraser R. Main	FRM	200	75	38%
5	Fraser R. S	FRS	100	21	21%
6	East Pt.	EP	200	56	28%

7	Turn Pt.	TP	220	57	26%
8	Kelp Reef	KR	200	11	6%
9	Discovery Is.	DISC	199	16%	

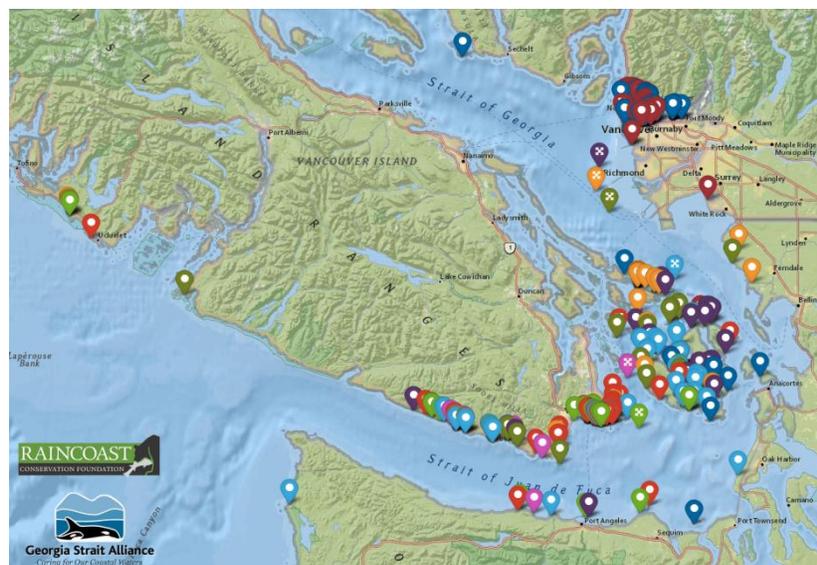
About half of the drop locations showed a fairly quick initial recovery of multiple cards (SN, PG, FRM and TP), with the others showing a more gradual reporting of recoveries. For the PG and SN drops, given their proximity to highly populated areas in Burrard Inlet with a large number of well-travelled public beaches, this is expected.

Figure 4: Card recoveries by drop location over time.



Overall Summary – After a month and a half, cards from all locations show a widespread distribution from their initial drop location (Figure 5). All cards (except one outlier) showed net movement south from Burrard Inlet and the mouth of the Fraser, through the Gulf and San Juan Islands and mainland Washington State (Boundary Bay and Birch Bays) and flushed out the Juan de Fuca Strait. Cards from all drops outside Burrard Inlet (FRN, FRM, FRS, EP, TP, KR and DISC) have been found on the southwest end of Vancouver Island and as far out as Pacific Rim National Park where cards from 3 drops (FRM, TP and DISC) have been recovered on Wickaninnish Beach. Cards from 6 drops (SN, FRN, EP, TP, KR and DISC) have been recovered from the Olympic Peninsula, with 1 card from the East Pt. drop recovered on the outer coast of Washington.

Figure 5: Initial drop locations and card recoveries to Dec. 12, 2013. Screenshot taken from [www.salishseaspillmap.org](http://www.salishseaspillmap.org), Dec 12, 2013 at 10:15 AM.



## Preliminary Analysis of Individual Drop Locations

### Drop 1 – Second Narrows, Burrard Inlet

225 cards were dropped just below the Second Narrows bridge in Vancouver Harbour on October 24<sup>th</sup>. In the first few days, cards remained in Burrard Inlet, English Bay and Vancouver Harbour and were recovered New Brighton Park nearby, inside the Second Narrows bridge, and along the shores of English Bay and North Vancouver. Cards continued to be recovered in Coal Harbour and Burrard Inlet over the next couple of weeks. Most of the recoveries occurred during this time period. After the first weeks, it appears that some of the cards moved out of Burrard Inlet and began to be deposited on shorelines ranging from north near Simson Island on the Sunshine Coast to near Vancouver airport on Iona Beach (around Nov. 9<sup>th</sup>). Late in November and in early December, cards from the Second Narrows drop continued to wash up in the Gulf and San Juan Islands and near Port Angeles (on Protection Island, WA). The farthest card from this drop was recovered on Protection Island near Port Angeles, on Nov. 26<sup>th</sup>, a distance of approximately 170 km 1 month after the initial drop.

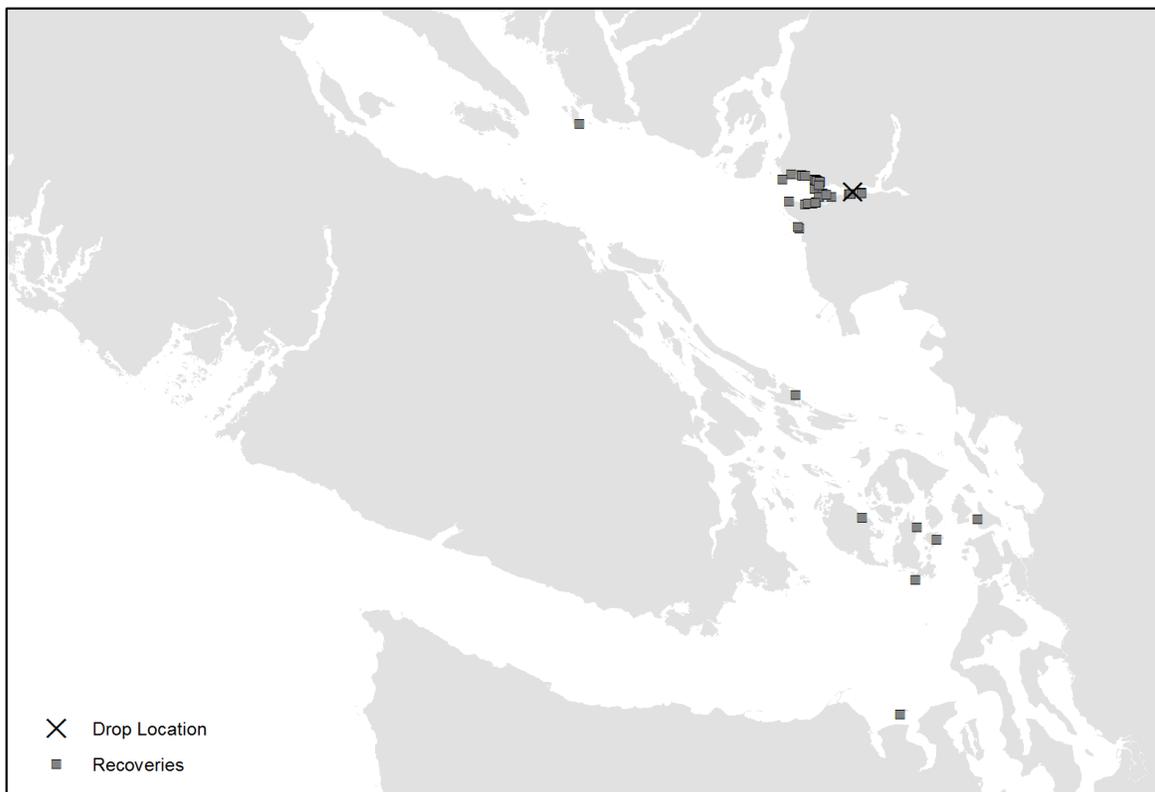


Figure 6: Drop location and recoveries up to Dec. 12, 2013 for the Second Narrows drop.

## Drop 2 – Pt. Grey, Burrard Inlet

200 cards were dropped near Pt. Grey in Burrard Inlet on Oct. 24<sup>th</sup>. Within the first few days, 50% of the cards had already been recovered from beaches in English Bay and North Vancouver. After the first few days, cards recoveries continued along beaches in Kitsilano and North Vancouver, indicating that the cards were still circulating within Burrard Inlet. Three weeks later, one card was recovered near Vancouver airport, and Nov. 22<sup>nd</sup> and 23<sup>rd</sup> saw recoveries in Boundary Bay and on Orcas Island, indicating that the remaining cards had likely moved out of Burrard Inlet and into the Gulf/San Juan Islands. The furthest card recovered from this drop was on Orcas Island, about one month after the initial drop, a net distance of approximately 80 km.

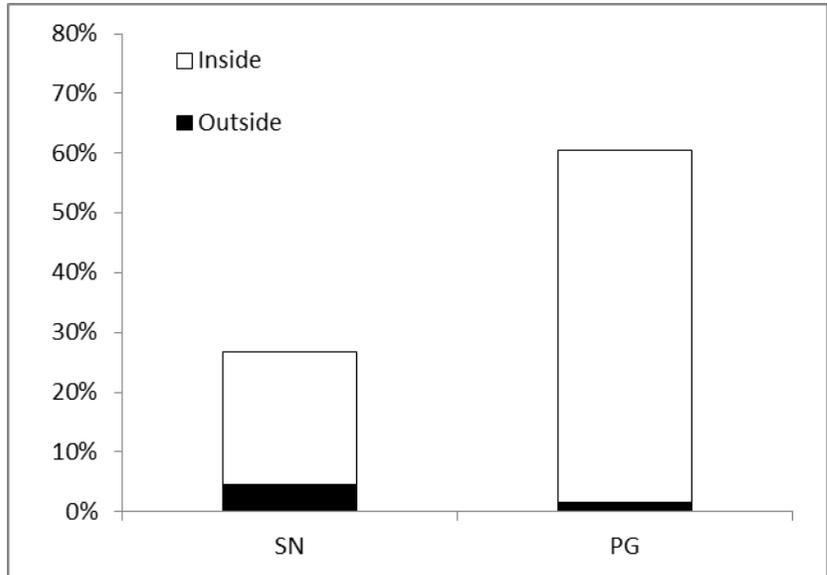


Figure 7: Drop location and recoveries up to Dec. 12, 2013 for the Pt. Grey, Burrard Inlet drop.

## Vancouver Harbour/Burrard Inlet Drop Summary

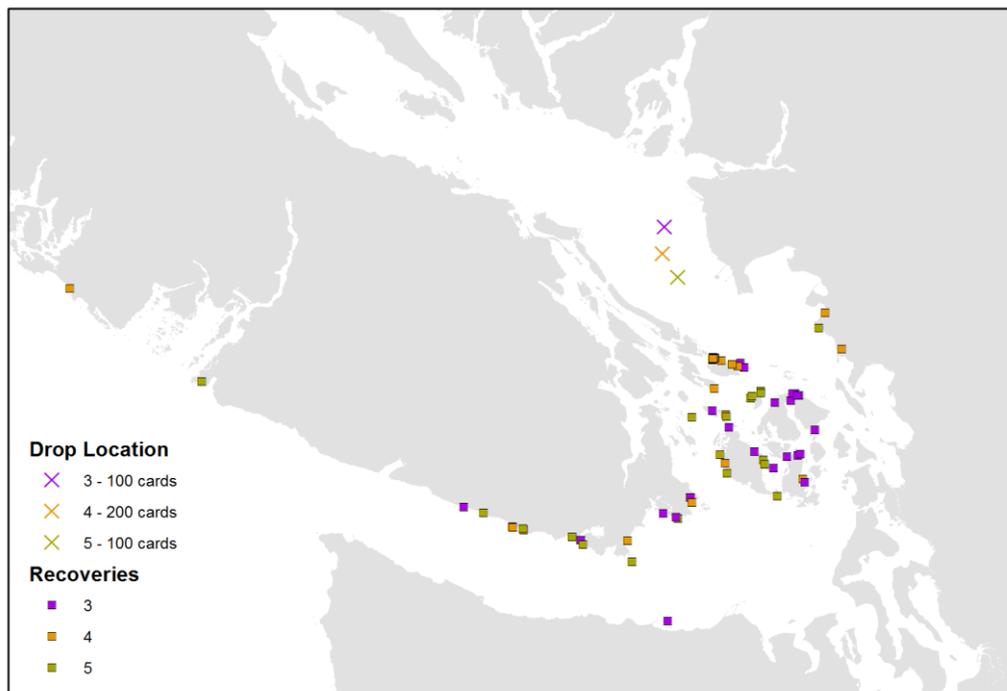
Cards dropped near Pt. Grey and at Second Narrows remained in the vicinity of the drop locations for the first weeks. Winds in this time period tended to remain light. After the first couple of weeks, the cards appear to have moved out of Burrard Inlet and into circulation through the Gulf/San Juan Islands and south Strait of Georgia. Figure 8 shows the proportion of cards recovered inside and outside Burrard Inlet from these drops.

Figure 8: Proportion of cards recovered inside and outside Burrard Inlet.



### Fraser River (Sand Heads) Card Drops Summary

Drops 3,4 and 5 - Cards were dropped in 3 locations near the mouth of the Fraser River on Oct, 25<sup>th</sup>. Figure 9 shows the drop locations and the recoveries colour coded by drop location.



The cards appeared to move very quickly from the main Fraser River drop, as we have eyewitness reports (and recovery of 48 cards) washing ashore on the north end of Saturna island on Oct. 26<sup>th</sup> between 4 and 6 pm, and again in the morning of Oct. 27<sup>th</sup>, only 30 hours after the cards were launched. This is a straight line distance of about 32 km, indicating that the cards moved a net average of ~1 kph.

After 1 and a half months, cards from these drop locations show a widespread distribution throughout the southern Gulf Islands, on mainland Washington near Birch Bay and on the Olympic Peninsula, along the southeast and southwest coasts of Vancouver Island, and as far as Bamfield and Wickaninnish Beach in Pacific Rim National Park. Notably, the card from the Fraser River main drop (#3), travelled a net distance of almost 300km) in about 3 weeks, and was recovered on Wickaninnish Beach on Nov. 11<sup>th</sup>. It is likely that this card was recovered very soon after it washed ashore, as that beach is highly popular even in the offseason.

Cards from these drops appear to have many trajectories, as recoveries continue in the San Juans and near Birch Bay even as some of the cards have reached the west coast of Vancouver Island. This indicates a large dispersal of these cards occurred sometime after they passed Saturna Island. With recovery rates ranging from 20—38%, we expect to continue getting card recoveries.

#### **Drop 6 - East Point, Saturna Island**

Much like the drops near the mouth of the Fraser River, cards from this drop were quickly dispersed throughout the San Juans, and along the south coast of Vancouver Island in Saanich and Victoria. Cards were recovered in early November near Point No Point beach, a distance of over 100 km in 9 days. Recoveries of these cards continue, with notable ones coming from the outer coast of Washington and the north side of the Juan de Fuca (found in mid-November), near Port Angeles (late November) and on Whidbey Island in early December. This counter-intuitive pattern indicates that cards from this drop are still in circulation throughout the Juan de Fuca Strait and that there was likely an early dispersal causing widespread distribution.

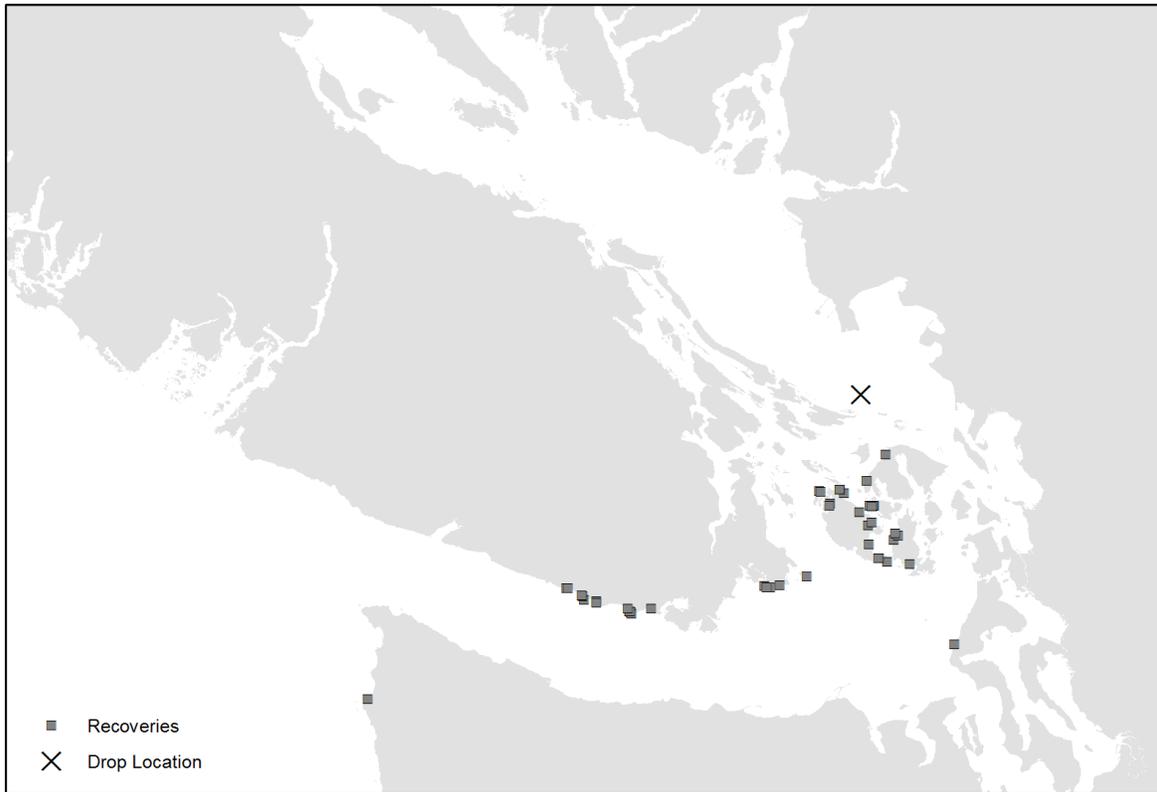


Figure 10: Drop location and recoveries up to Dec. 12, 2013 for the East Pt, near Saturna Island card drop.

### **Drops 7 and 8: Turn Point and Kelp Reef (Haro Strait)**

Cards from these drops again show widespread distribution, mostly to the south and west of the initial drop locations. It is presently unclear why there has been such a low recovery rate (6%) from the cards dropped at location 8 (Kelp Reef). Either many of them were deposited on a remote beach that has not been accessed recently, or they transited out the Juan de Fuca without intercepting land. The later is likely since the cards from the Turn Pt. drop to the north generally moved to the south and west, coming ashore all along the coast of Vancouver Island between Sidney and Victoria within a few days. Cards from the Turn Pt. drop again appear to have widespread dispersal with cards being recovered both on the Olympic Peninsula, Wickaninnish Beach and the San Juans in mid- to late- November. The cards recovered on Wickaninnish Beach travelled a net distance of about 250 km in 16 days.

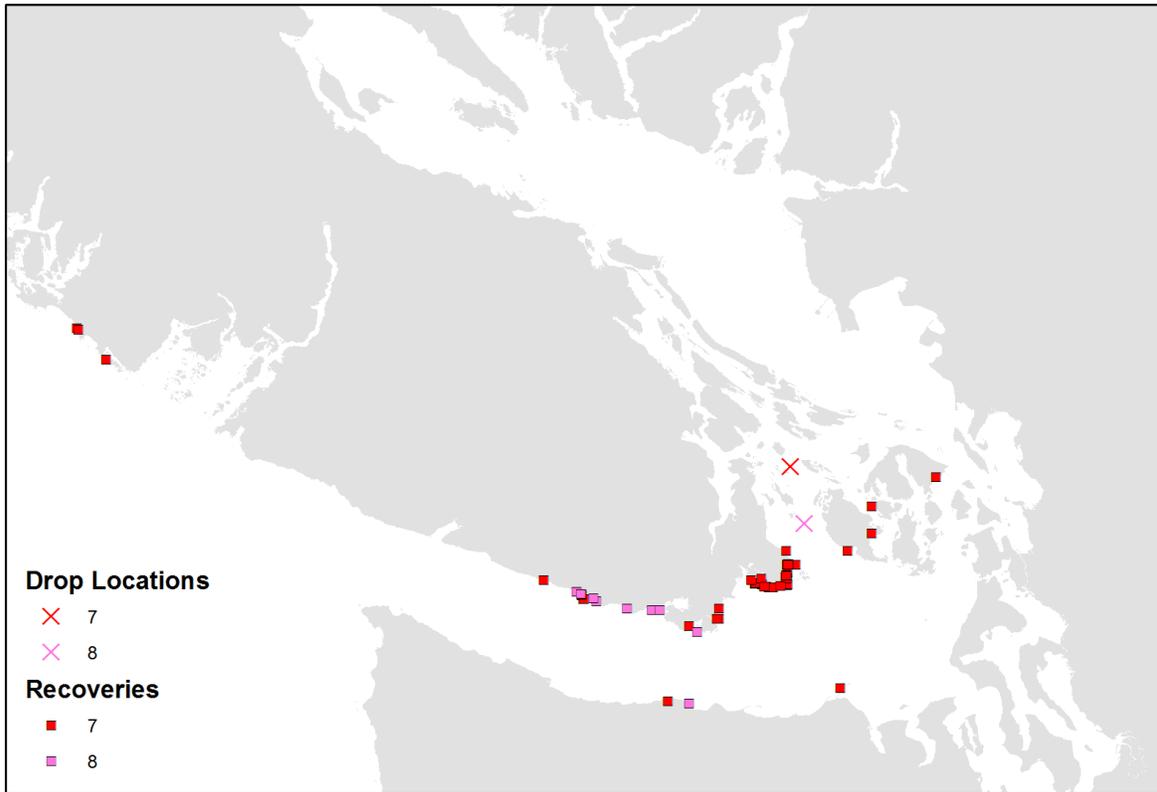


Figure 11: Drop location and recoveries up to Dec. 12, 2013 for the Turn Pt. and Kelp Reef card drops on Oct. 28<sup>th</sup>, 2013.

### Drop 9 – Off Discovery Island

Cards from drop 9 initially were recovered from beaches in Victoria and Esquimalt, and continued to be recovered along the south coast of Vancouver Island, Olympic Peninsula and Wickaninnish Beach over the next few weeks, indicating a dispersal out the Juan de Fuca Strait. Notably, one card was recovered on San Juan Island at the end of November, however it is uncertain how long it had been on that beach. The cards recovered in Pacific Rim National Park were recovered 14 days after the initial drop, a net distance travelled of about 215 km.



Figure 12: Drop location and recoveries up to Dec. 12, 2013 for the Discovery Island card drop on Oct. 30<sup>th</sup>, 2013.

### Conclusions:

6. Cards from the majority of drops showed recovery rates within the expected range (although on the low end in some cases).
7. The majority of recoveries from the two card drops in Burrard Inlet and Vancouver Harbour washed ashore very quickly (within 3 days) and continued to wash ashore on Vancouver beaches for a few weeks.
8. Cards from the two card drops in Burrard Inlet and Vancouver Harbour eventually circulated to the San Juans, sunshine coast and other locations.
9. Recoveries from the card drops outside Burrard Inlet (drops #3-9) showed wide spread and rapid dispersal, initially travelling very quickly (~ 1 kph in one verified case).
10. Cards were recovered at great distance from the initial drop locations within a few weeks (200-300 km).
11. Well known areas of deposition (eg. Wickaninnish Beach) would likely be impacted by an oil spill from many locations along the shipping route.

12. It is likely that much of the south coast of Vancouver Island from Sidney to Tofino, the San Juans, the southern Gulf Islands, and the north coast of the Washington's Olympic Peninsula would be impacted by oil from a spill at any of these locations given the following caveats:
- a. The cards are somewhat representative of oil.
  - b. Weather conditions are similar.
  - c. Cards likely represent a very conservative estimate of the distribution of a major oil spill.
  - d. This was one study, during one season, with one set of weather conditions.