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RECOVERY RECORD FOR SURFACE DRIFT CARDS RELEASED IN THE PUGET SOUND-STRAIT OF JUAN DE FUCA SYSTEM DURING CALENDAR YEARS 1976-1977

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The Puget Sound Drift Program released 5000 polypropylene drift cards in the Puget Sound and Strait of Juan de Fuca system between April 1976 and July 1977. By November 1977, 1,470 replies had been processed. These replies were analyzed statistically as well as descriptively. Winds with time scales varying from hours to weeks, as a function of system spatial constraints, have been found to be the dominant factor influencing the grounding of drifters. The migration of the drifters was consistent with a mean estuarine flow of 6 km per day with a superimposed dispersive component of 7 km per day. The average time a drifter was waterborne, likewise a function of system spatial constraints, ranged from less than 1 day in Puget Sound to greater than 3 days in the Strait of Juan de Fuca.

1. INTRODUCTION

An interdisciplinary study of the marine environment of the Strait of Juan de Fuca-Puget Sound estuarine system was initiated in October 1975 to provide additional information to assess the potential hazard to the environment from increased petroleum traffic. One such hazard is the increased probability of an accidental discharge of petroleum into the environment. Trajectory prediction of such discharges has been a subject of intense study in recent years; as yet a routinely operational system for prediction does not exist. In lieu of this, useful data on the potential grounding of material released at sea can be obtained by using Lagrangian drift techniques. Such drift information may be easily and inexpensively obtained through the use of surface drifting cards. This technique has seen wide-spread service in oceanographic research (Neumann, 1968). The drift-card program described here is an integral part of an oceanographic investigation of the Puget Sound-Strait of Juan de Fuca system.

Quantities of surface drifters were released at various sites throughout Puget Sound and the Strait of Juan de Fuca; the return information consisted of date and site of recovery for each device. The drifter selected for this program was a plastic plate embossed with instructions to the finder and a unique serial number. The cards are injection-molded polypropylene slabs that measure 660 x 870 x 2 mm (Fig. 1). International orange in color, each card has an embossed message requesting the finder to send notification of card number and time and location of recovery to the project office. The spe-

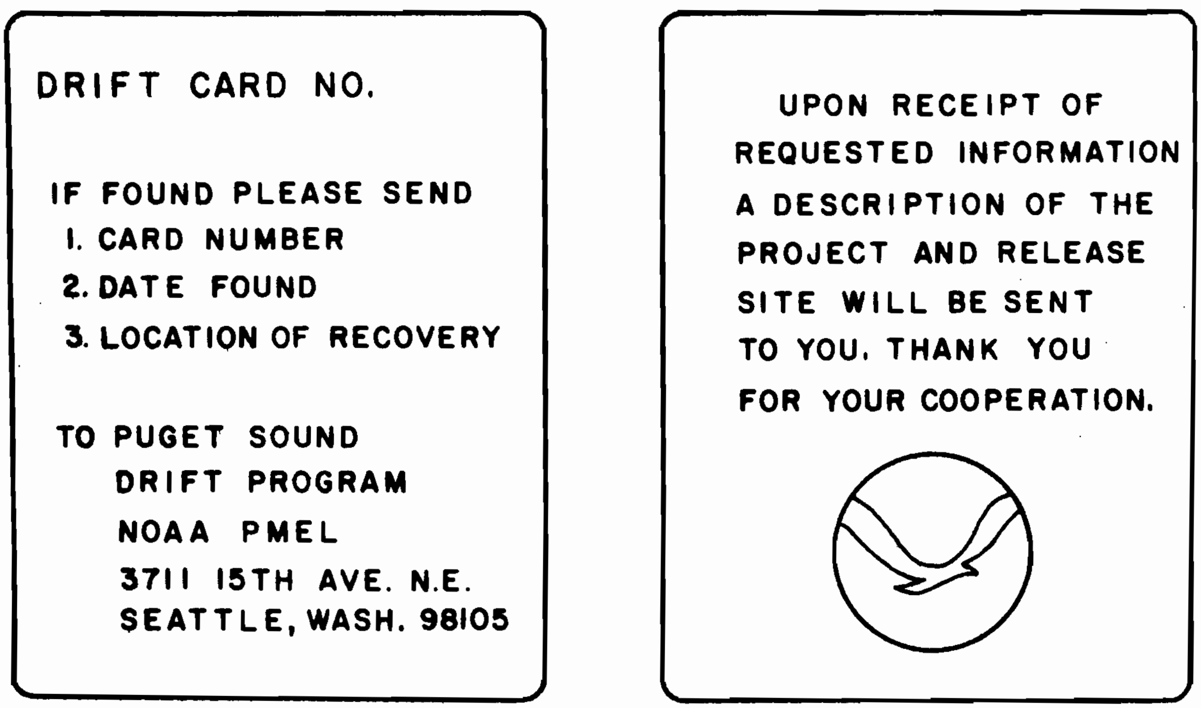

Figure 1. Drift card used for the program.

cific gravity of the polypropylene card is 0.9; the range of specific gravities for common crude oils is 0.84 to 0.98. Thus a drift card has a flotation characteristic similar to that of common crude oils.

A study of this nature relies on the public to return information for each drifter found. No reward was offered; an acknowledgment letter was sent, describing the program and indicating the launch and recovery sites.

Positive results are obtained only when the drifters move into areas accessible to the public. This is an important consideration for the Pacific Northwest where population density varies widely. Hence, interpretation of results must be made carefully, with emphasis on statistics rather than on single returns.

This report summarizes the results of the drift-card program conducted in the Strait of Juan de Fuca and Puget Sound during 1976-1977. The report contains release/recovery summaries and an analysis of implied drifter movement from the first 1470 cards recovered to November 1977. Data summary, analytical method, and data implications are presented.

2. RELEASES AND RECOVERIES

Drift cards were released throughout the Strait of Juan de Fuca and Puget Sound during cruises making conductivity-temperature-depth (CTD) casts and deploying or recovering current meter stations. Figure 2 shows locations of the release sites; the Appendix lists the release specifics and presents figures depicting the shortest possible paths for the movement of drifters from 54 of the release sites (no cards released at site 48 have been returned).

Of the 5,000 cards released at the 55 sites, 1,470 (29%) have been recovered. Information on the various releases are summarized in Table 1. Probable recovery clearly depends on the geographic location of release. For example, cards released at the western end of the Strait were lost to the study, presumably because they moved out to sea. This geographic factor partially accounts for the generally lower percentage recovered for releases in the Strait (23%), versus 52% recovered for releases in the Sound. The percentage recovered appears consistent with the seasonal wind patterns; this will be discussed in a following section. Future drift card releases are being scheduled to improve seasonal coverage.

It is possible that seasonal variations in recoveries are due to seasonal variations in public beach activities. For the study area, however, the consistent recovery rate suggests that beach walkers are a hardy lot and are out in sufficient numbers in winter to prevent seasonal bias on recoveries. Recoveries in spring and summer were higher on weekends, but overall mid-week returns were prevalent (Fig. 3).

There is a general tendency for cards released in the Puget Sound-Strait of Juan de Fuca system to migrate toward the ocean, due to transport resulting from the strong estuarine circulation (Cannon and Laird, 1978). Of the 5,000 cards released, approximately 38% of the recoveries were from locations

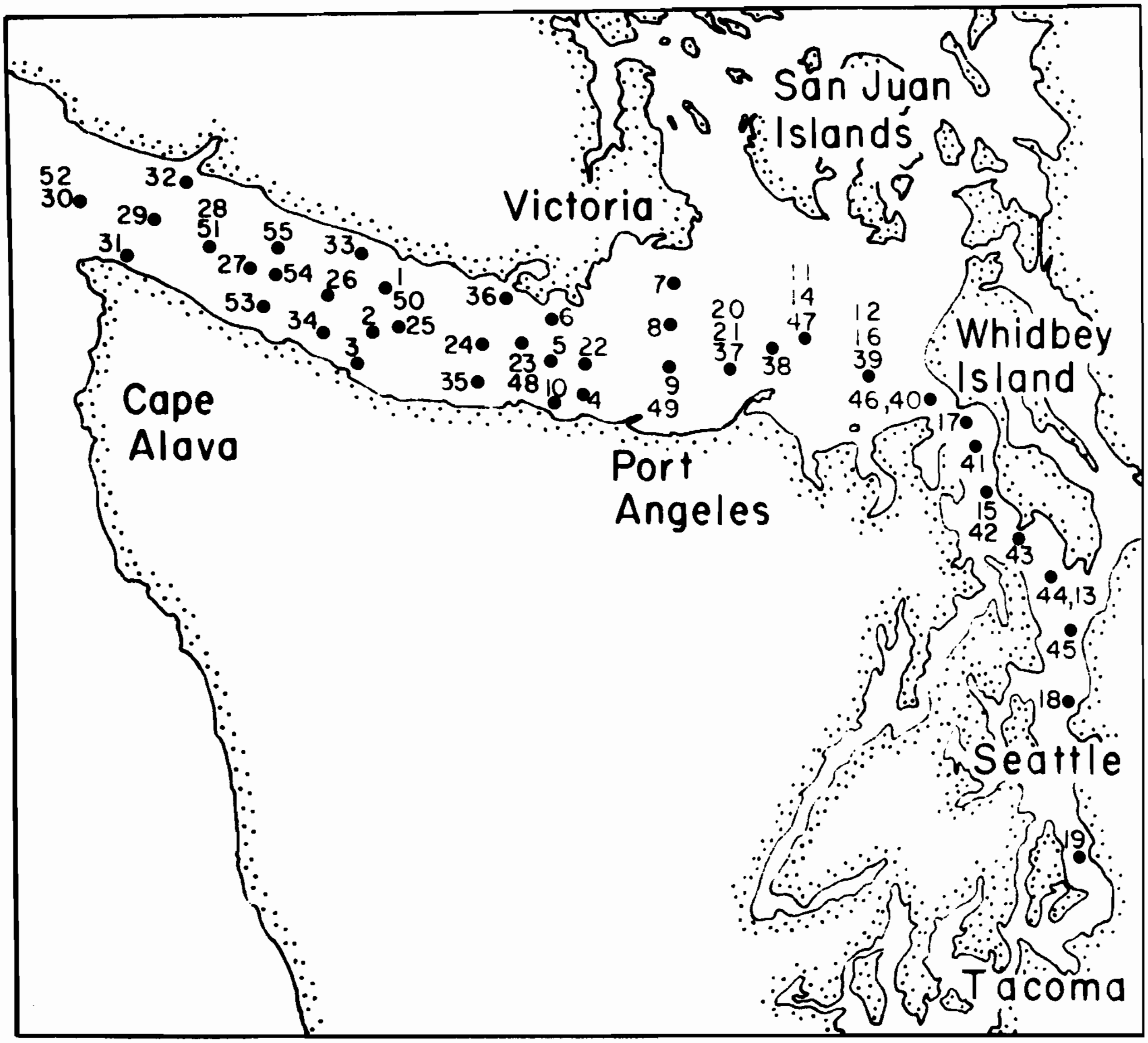

Figure 2. Chartlet of Release Sites.

Table 1

Drift Card Deployment Summary

Release	Dates	Area	Number Released	Number of Stations	Number Recovered	Percent Recovery
I	5-6 April 1976	Strait	500	10	178	36
II	14 Apr 1976	Puget Sound	500	3	278	56
III	22-23 Jul 1976	Puget Sound	400	6	202	51
IV	15-17 Feb 1977	Strait	1800	18	217	13
V	17 May 1977	Puget Sound	800	8	410	51
VI	20 Jul 1977	Strait	1000	10	185	21
		OVERALL	5000	55	1470	29

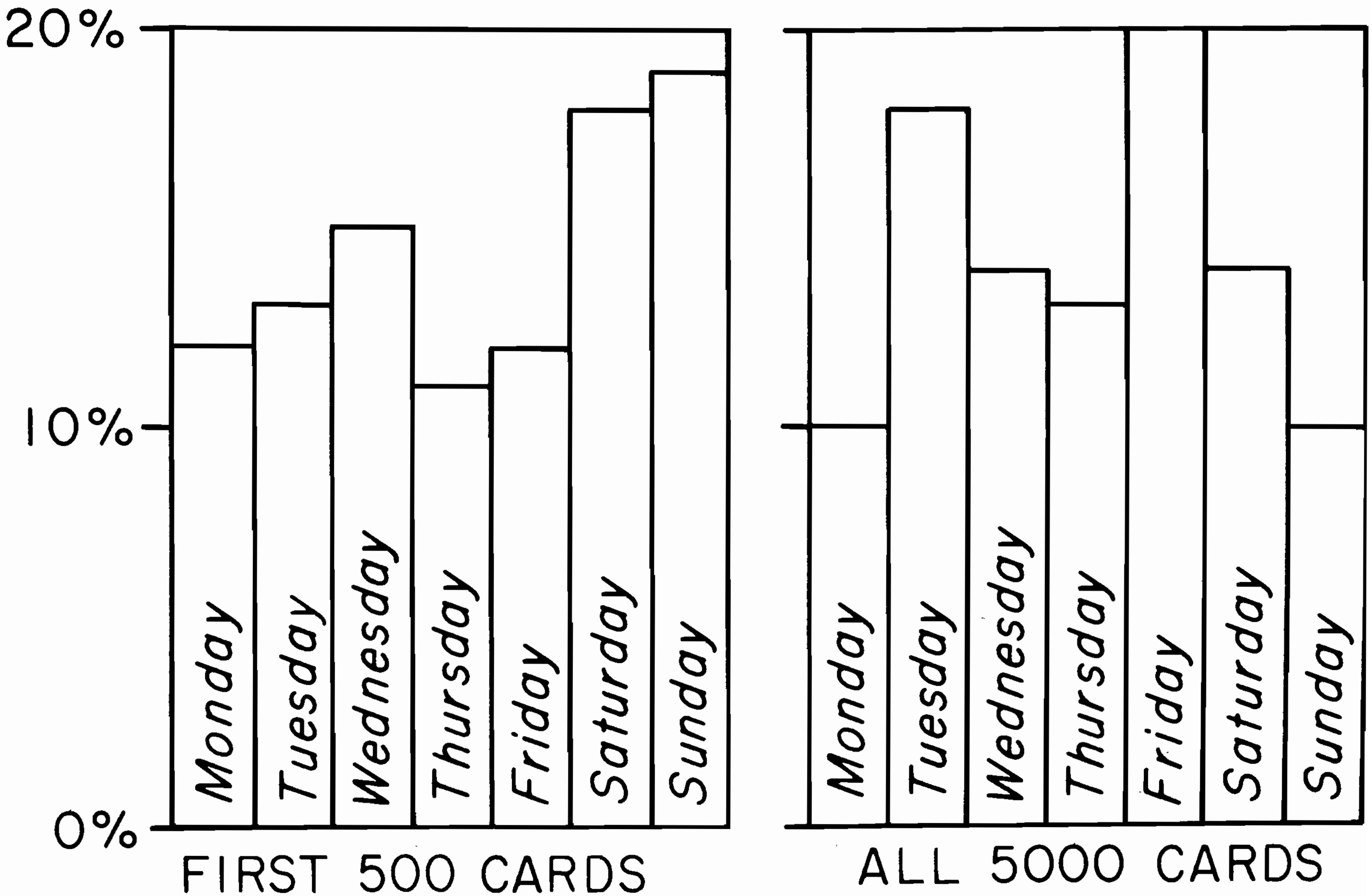

Figure 3. Daily return histories for the release of the first 500 cards and for all 5000 cards.

considered seaward from the release site; 7% were from areas considered upstream of the release site, and the balance were from locations considered in the general vicinity of the release site.

It is difficult to unambiguously discern trends from releases at such diverse times and geographical locations. For displays in the Appendix, each trajectory may represent more than one recovered card; the display scale is too small to allow individual trajectories to be depicted in areas where many cards were recovered. In the following, recoveries will be discussed in terms of temporal groups of releases.

April 1976

Figures A1-A13 show trajectories for all recoveries of the 1000 cards released from 13 sites during April 1976. Throughout the April deployment, cards tended to migrate south upon exiting the Strait and had a high incidence of recovery along the Washington-Oregon coast. Very few cards were recovered north along Vancouver Island, outside of the Strait. For those released farther east in the Strait, a larger proportion were recovered within the Strait than for those released in the western Strait, indicating more dispersion of the card group before advection of the cards out of the system. Cards released at the easternmost station in the Strait (numbers 601-700) were blown due east by high winds; 93 of these 100 cards were found by one person along a short stretch of beach on Whidbey Island; one card was found outside the system along the coast of Oregon. For the remaining eastern Strait releases, returns seem balanced between north-shore and south-shore recoveries.

July 1976

Figures A14-A19 show trajectories for all recoveries from releases made during a 2-day period in July 1976. The 400 cards were released at 6 sites in the eastern Strait and upper Puget Sound; apparently because these sites were within the system, few reached the ocean. The incidence of recovery was high (51%) with most cards found within a few tens of kilometers from the release points. The Strait coastal distribution of recoveries was fairly uniform. There was a tendency for cards to beach on Whidbey Island, the San Juan Islands (eastward movement), and along the north coast of the Olympic Peninsula (southward migration). Cards recovered from releases within Puget Sound tended to make longer excursions than those released in the Strait. The tidal excursion in upper Puget Sound is larger than in the eastern Strait; thus, drifter groups were transported to the eastern Strait prior to dispersion and grounding within the upper Sound. An ebb-tide excursion from Bush Point is an average of 20 km, which is sufficient to allow surface material to exit Admiralty Inlet and enter the eastern Strait. These excursions in the eastern Strait are only half as large as those in the Admiralty Inlet.

February 1977

Figures A20-A37 show possible trajectories of recovered drift cards for releases made during February 1977. Primarily in the central Strait of Juan de Fuca, 1800 cards were released, the highest number deployed at any time during the study. The rate of return was the lowest, 13%. The majority of these groundings were along the west coast of Vancouver Island. Such low return may be due to low public access; this deployment was made in winter and return letters have indicated a migration of cards to an area of rugged, nearly inaccessible coastline. Most of the cards appear to have exited the entrance to the Strait; very few grounded on beaches along the south side of the Strait or along the Washington coast.

May 1977

Figures A38-A45 show trajectories of 410 recovered drift cards for releases on 17 May, 1977. This spring release of 800 cards occurred at a time when returns should be similar to the releases made the previous year (April 1976) due to similar weather. In May, release sites were primarily in the eastern Strait; recoveries were qualitatively similar to the returns from the April 1976 releases. There was a slightly greater tendency in 1977 for cards to migrate eastward from the same release sites and recoveries were more numerous along Whidbey Island. In fact, few Puget Sound cards moved westward. There appeared a rather diffuse flow northward into the San Juan Islands.

July 1977

Figures A46-A54 show trajectories for 185 recovered drift cards of the 1000 released on 20 July, 1977. Release sites were distributed uniformly along the entire axis of the Strait of Juan de Fuca. The general drift of cards was similar to that of cards from comparable release sites in July 1976. The cards of this July 1977 experiment released near the western end of the Strait migrated seaward, with a tendency for the cards to ground just south of the Strait on the North Washington coast.

3. DATA ANALYSIS

The high level of public participation in the program resulted in a phenomenal volume of return data. It was hoped that these data could be used both to estimate speeds and eventually to predict paths. The principal difficulty in performing an objective analysis stemmed from the requirement for known distance traveled in speed determinations. A technique was devised to allow objective computer estimation of distance and speed parameters.

The study region was divided into zones (Fig. 4) that reflect general environmental differences across the area. First the technique determined the zones of release and recovery, and subsequently computed the distance traveled by solution of "mid-latitude sailing" (Bowditch, 1962) using fixed-zone transition points. When release and recovery points fall within the same zone, the distance is computed directly. When release and recovery points fall in different zones, the distance computation is constrained to pass through mid-channel points. The zone boundaries are defined by 48°N, 123°, 124°, and 125° W.

Probabilities were assigned to the chance of cards grounding by considering each card released as a Bernoulli trial (Feller, 1968). The large number

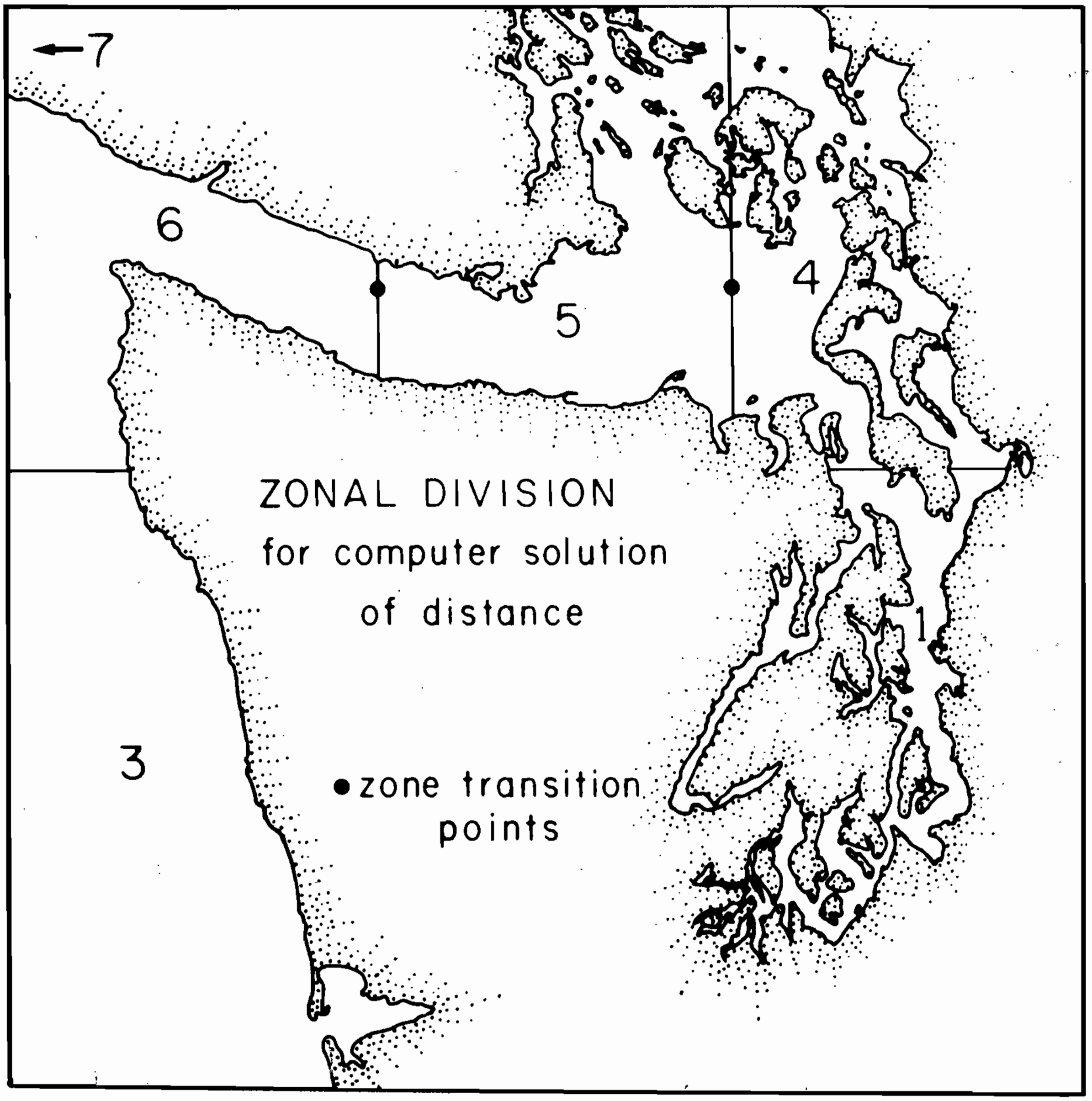

Figure 4. Zonal division of study area to facilitate automatic processing of the drift card information.

Table 2. Mean of recovery percentage for zonal combinations.

	Recovery Zones						
Release Zones	1	4	5	6	7	3	All
1	18.2	17.0	6.2	1.0	0.5	1.8	44.7
4	0.6	40.7	12.1	0.2	---	0.3	48.9
5	0.3	4.2	12.0	5.3	1.6	4.3	27.5
6	---	0.3	1.7	9.8	2.8	3.0	16.7

Variance of recovery percentage for zonal combinations.

	Recovery Zones						
Release Zones	1	4	5	6	7	3	All
1	18.2	277.9	36.1	2.8	1.5	13.0	13.8
4	1.3	538.2	176.9	0.2	---	0.5	76.0
5	1.7	66.4	185.0	19.3	3.2	36.1	256.0
6	---	0.4	36.5	210.2	15.2	39.3	269.9

of cards should lead to the approximation of the Poisson probability distribution. The mean percentage of returns and the variance in the percentages were tabulated for all combinations of release and recovery sites and all zone recoveries (Table 2). This analysis rejects a simple Poisson probability statement as representing the chance of surface-borne material grounding anywhere within the system or at specific locations. In future efforts, probabilities assigned to the grounding of surface-borne material will have to take the form of conditional probabilities and take into account the specific effects of external forcing by the wind, tide, and mean circulation.

4. DISCUSSION

The generalized drift-card recovery data presented here exhibit behavior that should be incorporated in models of trajectories of spilled oil.

4.1 Wind Responses

The release/recovery synopsis indicates a seasonal variability in the behavior of surficial water movement. Winds are an important agent in the redistribution of surface material. As an example, the movement of cards from the April 1976 release at site 12 (off Whidbey Island) was dominated by an observed 25-knot west wind. This forcing resulted in 93% of the cards grounding on a short stretch of beach. Recovery data in general, however, suggest that drift cards are waterborne for several days to weeks and therefore experience longer-term wind influence. Figure 5 shows the average wind data for the Washington coast on a monthly basis. These data, compiled by McGary (1971), cover a period from 1961-1963. A summary from a larger data base compiled by Nelson (1977) shows basically the same structure of seasonal variability. The important correlative feature, recognizing that surface water tends to move to the right of the forcing wind (Sverdrup, 1942), is the drift-card return response to regional wind.

The drift cards released in April 1976 exhibited little northward oceanic movement, as evidenced by the large number of returns from the Washington-Oregon coast. The average wind (Fig. 5) to the east-northeast for April was consistent with the recoveries. Winter data (February releases) show a strong tendency for grounding along the coast of Vancouver Island with little movement south to Washington and Oregon. This case is also consistent with dominant winds. For summer (July) releases, there was a tendency for drifters exiting the Strait to ground only on the North Washington coast. The wind pattern for July, in contrast, suggests that most drifters would be carried to the south-southwest and either ground at the southwestern tip of the Strait or be transported out of the area. Our drifter data showing response to the coastal climatic wind field is consistent with similar studies off the Oregon coast, as reported by Burt and Wyatt (1964).

The time scales for "climatic wind response" are a function of spatial constraints. There are three major spatial constraints through the system: narrow passages in the Sound, the breadth of the Strait, and the expanse of open ocean. The time scales for "climatic winds" under the above constraints are hours, days, and weeks respectively. Examples of each scale of wind re-

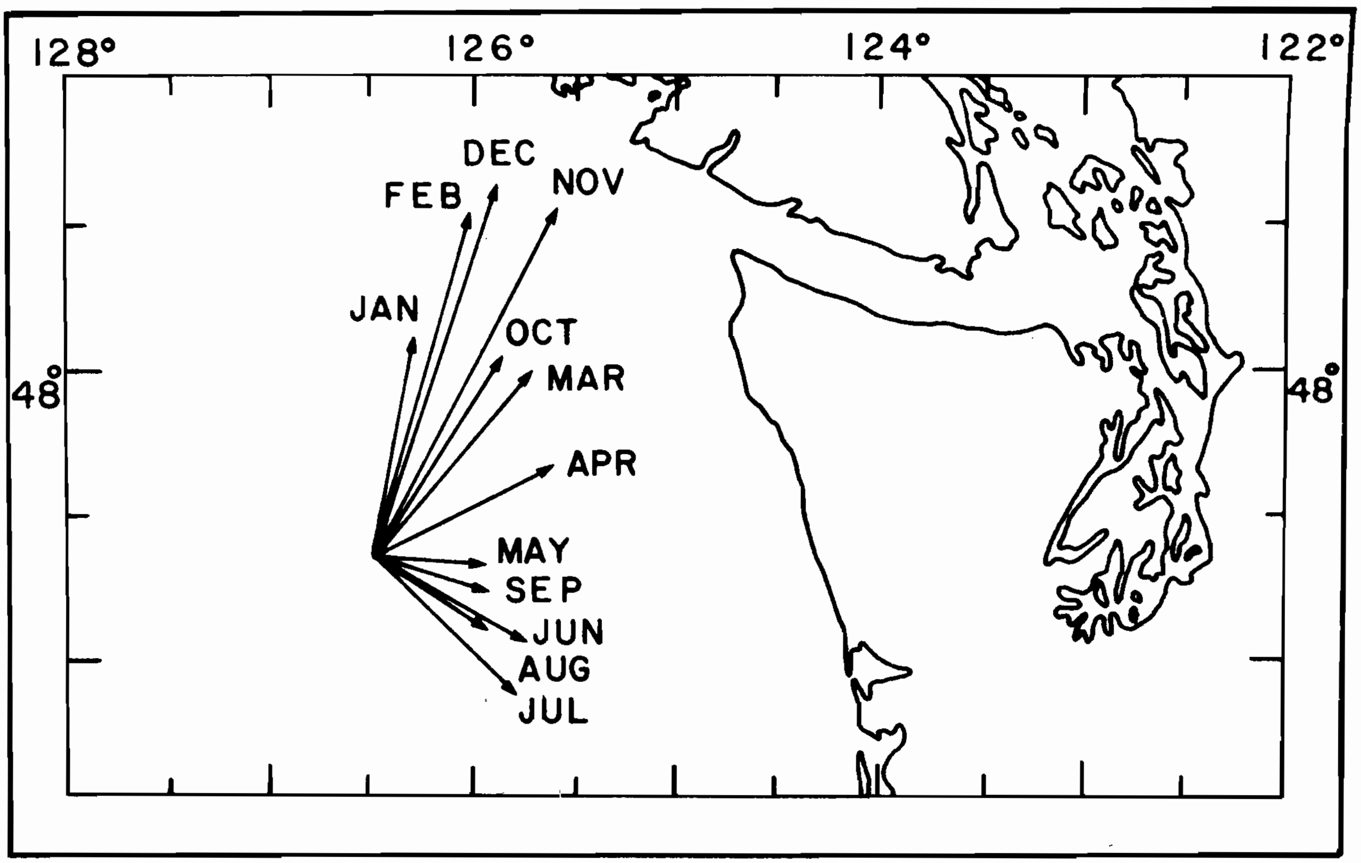

Figure 5. Average direction and velocity of monthly winds for 1961-1963, after McGary (1971).

sponse are seen in the return data.

At site 12, close to Whidbey Island, almost the entire group of cards responded to a short-term (6-h) west wind by grounding on a short stretch of beach on the island. One card is known to have exited the system, since it was recovered on the Oregon coast. The card may have been resuspended from the beach on Whidbey Island. The releases in July 1977 were concurrent with a tracked drifter study in the central Strait (Ebbesmeyer, 1977). The tracked drifters were followed throughout a 5-day period of westerly winds; they exhibited a definite cross-channel flow to the south during flood tidal currents, and ill-defined cross-channel flow on ebbing tides. A similar wind influence is seen in drift-card returns from July 1977, which were predominantly from the south shore of the Strait. Returns from the open coast are clearly responding to the monthly wind patterns with durations of weeks. Thus, in all the returns, examples of wind influence are seen for time scales of hours, days, and weeks as a function of the spatial constraints of the Puget Sound-Strait of Juan de Fuca system.

4.2 Speed through the System

As a major result of the extensive drift-card study, flow rates in the area can be estimated. The Puget Sound-Strait of Juan de Fuca system is estuarine in nature with predominant flow seaward in the surface layers and shoreward in the deeper layers (Cannon and Laird, 1978). The drift-card returns follow this basic circulation; 38% of the returns were obtained from zones laying seaward of the release zone. Additionally, 55% were obtained within the zone of release, and 7% were obtained from zones upstream of the release zones. Drift-card returns may continue for a very long time after release. The cumulative percentages of returns, a function of elapsed time were developed for four groupings of cards to November 1977 (Fig. 6) in order to determine elapsed time limits for use in statistical evaluation. Each of the four groups approaches its eventual "percent recovered" at different rates, reflecting the varying conditions at the time of release. Within 100 days of release, all releases had attained better than 70% of their eventual return; thus, for the purpose of data processing, returns with an elapsed time in excess of 100 days were not considered in speed determination.

For all considered releases mean time to recovery was 29 days; mean distance traveled was 65 km; mean speed was 9.7 km per day. These statistics reflect the histories of returns without regard to direction of motion.

To study the flow of drift cards through the system, only those recoveries seaward of the release zone were considered. The distribution of cards from a release is determined by the advection of the centroid of the card cluster by the mean circulation, and the dispersion of the cluster of cards by wind and tide. Every speed determination contains a component directed seaward with the estuarine circulation and dispersive component relatively independent of direction. With the large number of returns in this study, the mean of the seaward speeds should approach the mean speed of the centroid of cards and thus reflect the mean speed through the system. The histogram of seaward speeds is displayed in Figure 7. The mean of these speeds is 6.2 km per day, which is the mean speed through the system.

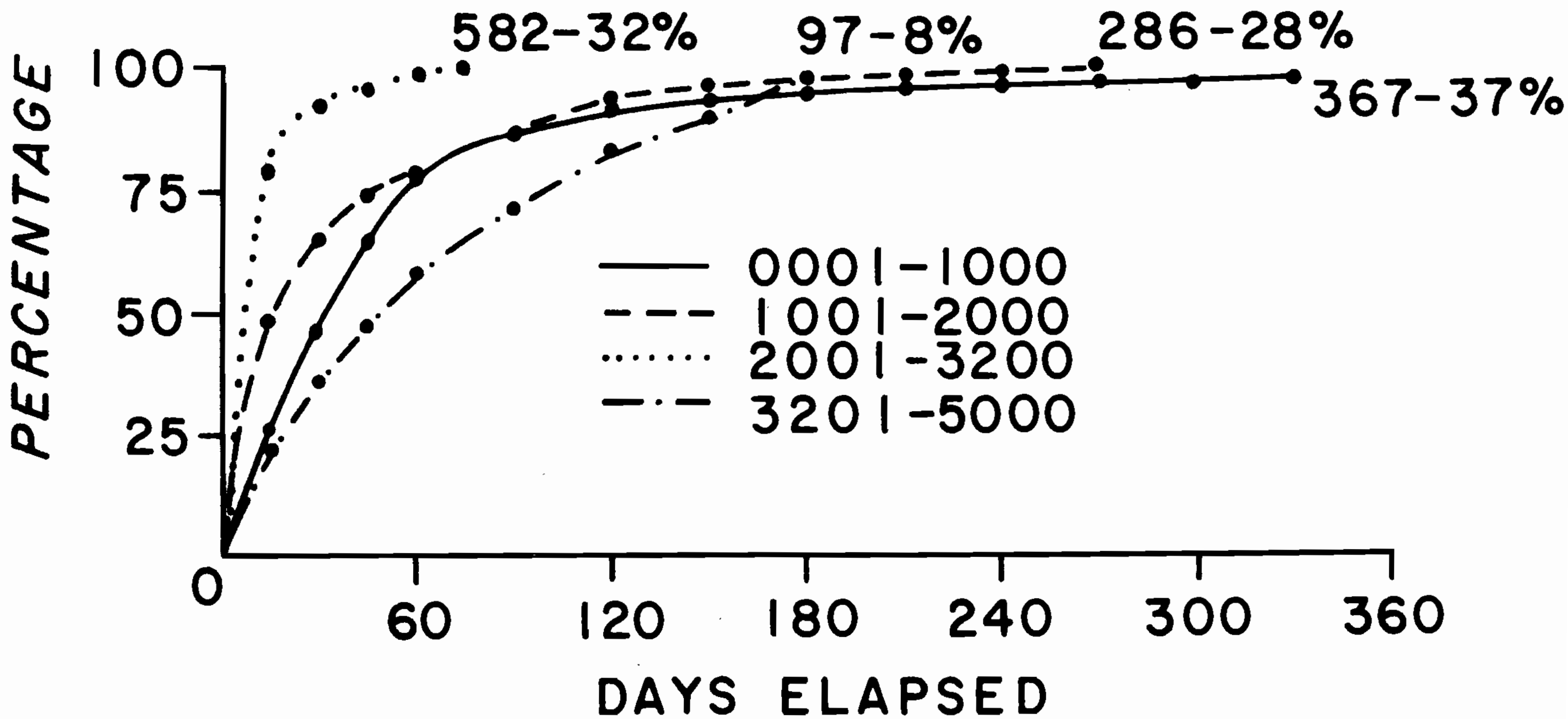

Figure 6. Temporal history of return occurrence.

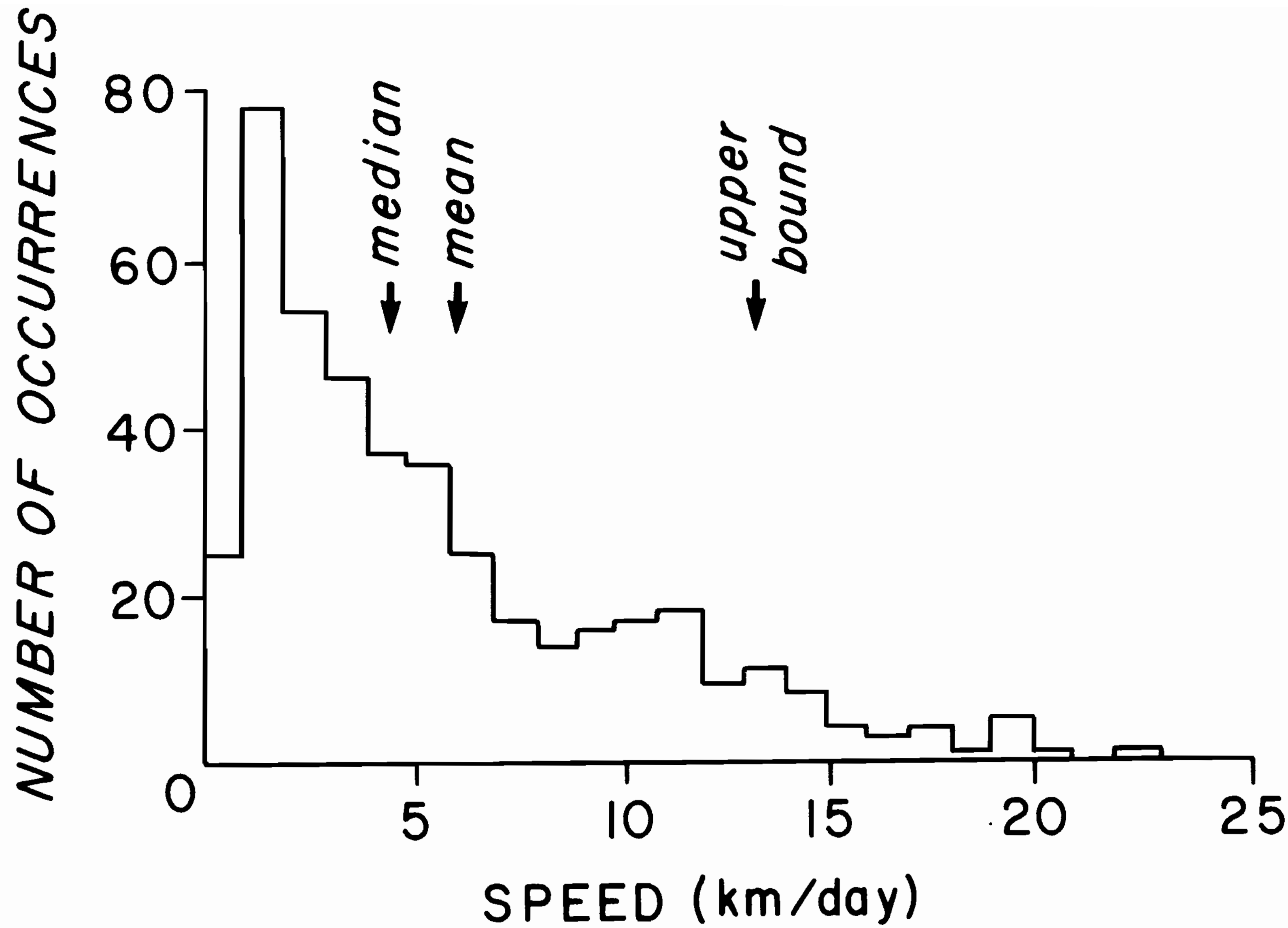

Figure 7. Histogram of observed seaward speeds.

The large volume of data allows estimation of the dispersive component of speed, particularly in the seaward direction. The leading edge of the cluster of cards travels with a speed that equals the sum of the mean flow plus the downstream dispersive component of speed. Thus the speed derived from first arrivals as the cards move seaward will be representative of the sum of the mean and dispersive components. To obtain this estimate, a histogram of occurrence of returns as a function of distance and elapsed time was compiled (Fig. 8). The edge of the field defined by first arrivals represents the total seaward speed as the distance increases from the release point. Visually fitting a linear estimate of the field edge provides an approximation of the total speed: 13 km per day.

The speed through the system is the vector sum of mean flow directed seaward at 6.2 km per day and dispersive flow of approximately 7 km per day. Thus if a surface contaminant can be approximated by a collection of packets, the leading edge of the contamination will arrive at a point seaward of the source with a speed of about 13 km per day, while the bulk of the contamination will arrive later, based on a speed of 6 km per day. After the center of the contamination passes, the contamination concentration will decrease until it is negligible.

4.3 Waterborne Residence Times

The concept of a waterborne residence time for surface material within the Strait of Juan de Fuca-Puget Sound system is complicated by spatial and forcing constraints. Figure 9, the histogram of elapsed times between release and recovery, shows a maximum number of cards recovered within the first day after release, though the mean is 29 days and the median is 6 days. The mean and the median reflect the influence of cards that have either been waterborne for a number of days or have lain on a beach for a number of days before recovery. In an attempt to reduce the uncertainty imposed by beach residence, returns with speeds in excess of 9 km per day were tabulated. These returns should reflect the recovery of cards on the down-stream edge of the cluster and so represent first arrivals on the beach. Viewed in this form, 69% of the returns occur within the first day after release. These views do not indicate the total picture, however, without taking into account geographic differences.

The dominance of first arrivals in the distributions displayed in Figure 9 is associated with Puget Sound releases. Of the returns from these releases, 21% were recovered within the first day after release and 49% within 3 days; of the returns from the Strait of Juan de Fuca releases, only 14% were recovered in the first day and 29% in the first 3 days. This, of course, is tempered by the fact that 46% of the Puget Sound releases were recovered and only 19% of the Strait of Juan de Fuca releases were recovered.

The differences in residence times between the Strait of Juan de Fuca and Puget Sound reflect the effects of forcing under two different spatial constraints. Because of the spatial limits within Puget Sound, coupled with external forcing, residence time was 3 days or less for more than half of the cards released. However, in the broader reaches of the Strait, the majority of cards were waterborne for more than 3 days.

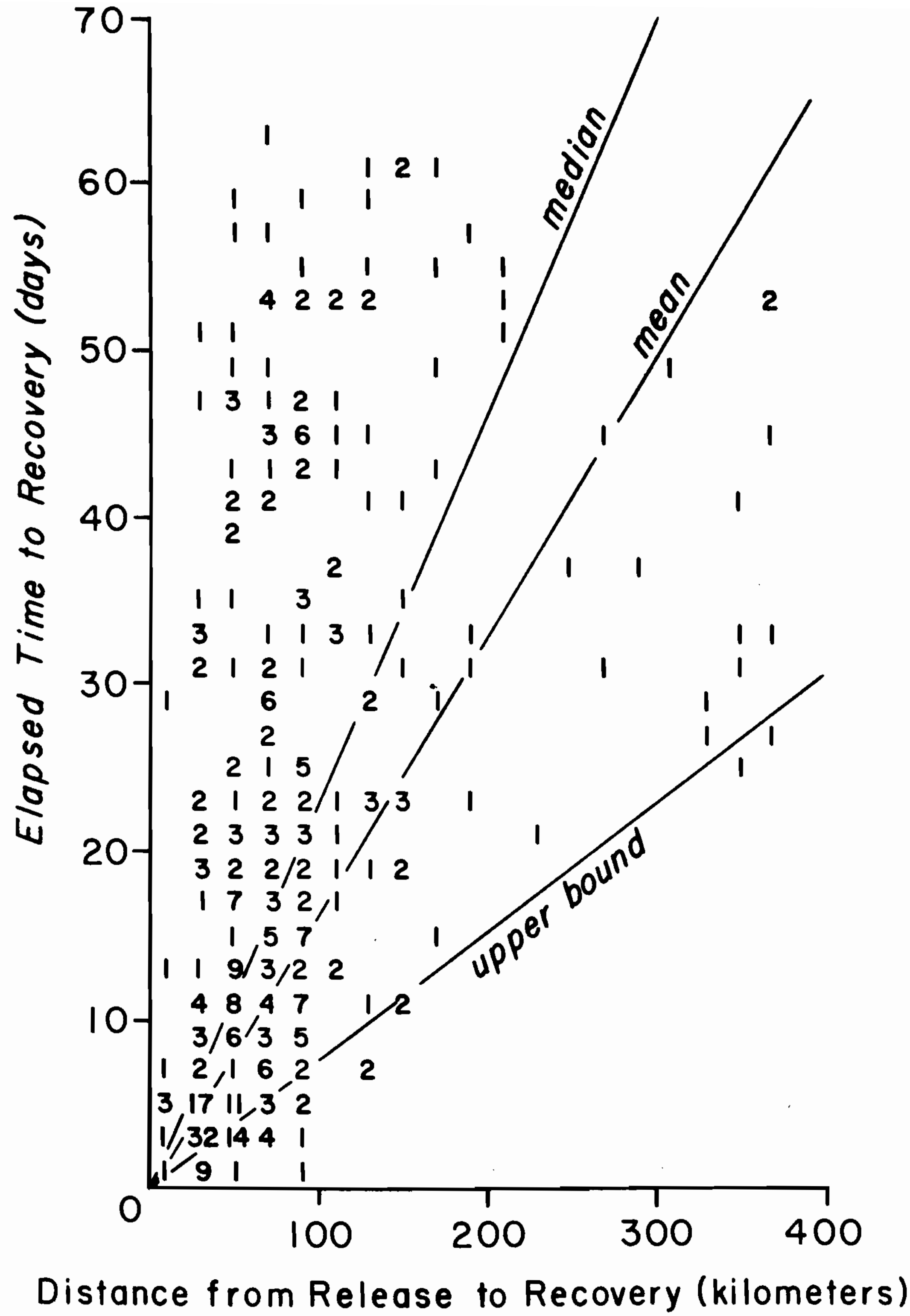

Figure 8. Histogram of observed speeds with respect to elapsed time and distance from the release point.

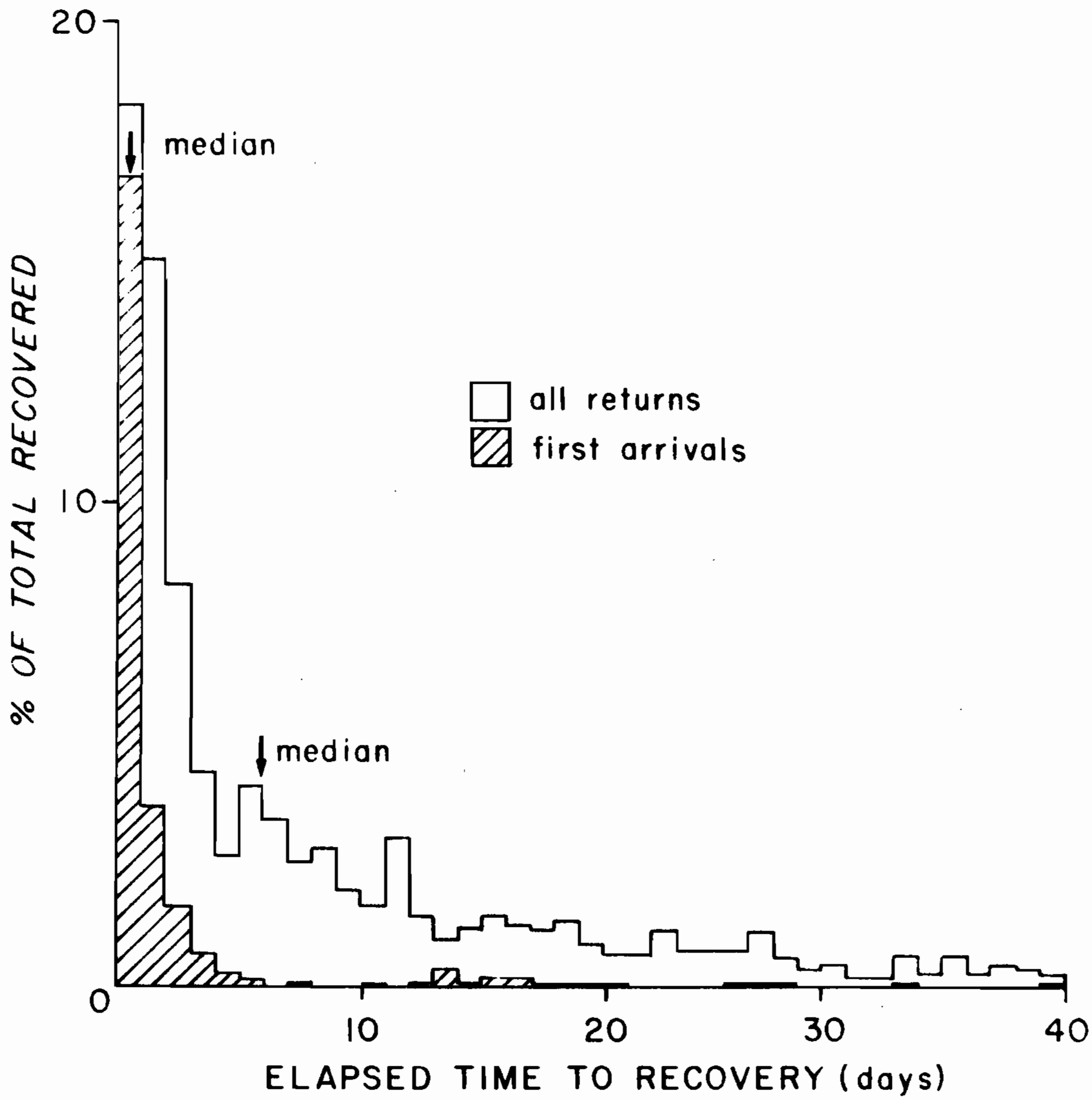

Figure 9. Histogram of elapsed times to recovery for all returns and for first arrivals.

These results are consistent with the aspects of forcing discussed earlier. Surface cards are more likely to experience more than one tidal cycle in the course of their drift, in the environment of the Strait than within Puget Sound. This indicates that prediction models for the Strait of Juan de Fuca should require nearly the same input conditions as the Puget Sound models, despite the larger scale of the Strait.

5. SUMMARY

For the Puget Sound-Strait of Juan de Fuca Drift Program, we released 5,000 polypropylene drift cards at various locations throughout 1976 and 1977. Of these, 29% were recovered; 52% of the Puget Sound releases and 23% of the Strait releases were recovered. In spite of seasonal public participation there was little seasonal variability in the recovery of cards. Many of the returned cards were covered with oil or tar-like substances.

Analysis of the data indicates that winds are the dominant factor influencing the distribution of returns. The time scales for wind influence range from weeks on the open coast to days in the confined areas of the system. In specific instances, short-duration wind events resulted in extensive returns. A knowledge of winds on these time scales is required to investigate the potential distribution of surface materials along the shoreline.

Recovery of a large number of cards responding to the dominant seaward flow, composed of mean circulation and dispersion, allowed a reasonable estimate of drift through the Strait portion of the system. Analysis led to an estimate of 6 km per day for the mean speed through the system with a dispersive component of 7 km per day superimposed on the mean.

The data indicate that many of the cards were waterborne for a few days. Conditions within the Sound resulted in grounding of about half of the cards within 3 days, whereas recoveries in the Strait indicated less than one-third of the cards grounded within 3 days. The actual residence time for a card in the waterborne state was event-controlled. Thus, for effective prediction, the forcing must be known in near-real time for both the Sound and the Strait.

6. ACKNOWLEDGMENTS

We gratefully acknowledge the contribution to categorizing and data manipulation made by Cathy Wright, Darby Fuerst, and Carolyn Elmhirst. This work was supported in part by the Environmental Protection Agency through a program administered by the Puget Sound Project Office of NOAA's Marine Ecosystems Analysis Program. Success of this program is due to the cooperation of an interested public.

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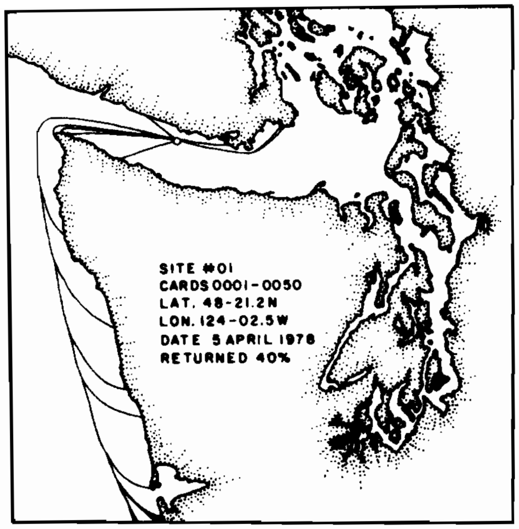
APPENDIX: Release Site Specifics and Recovery Displays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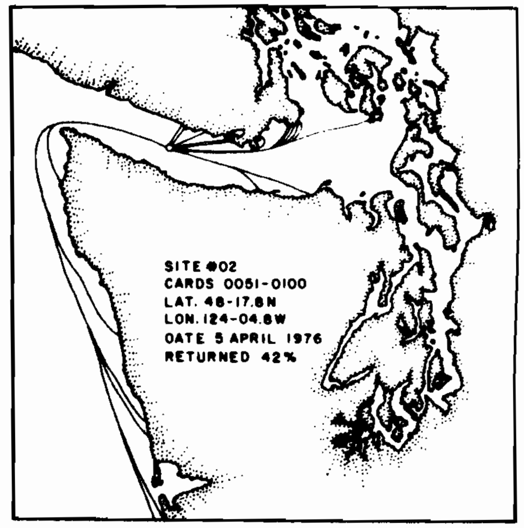
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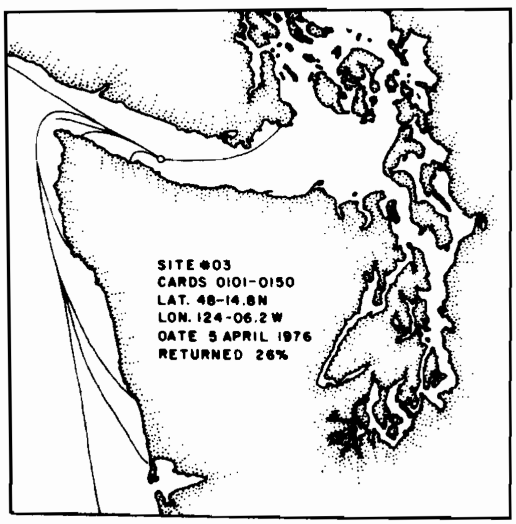
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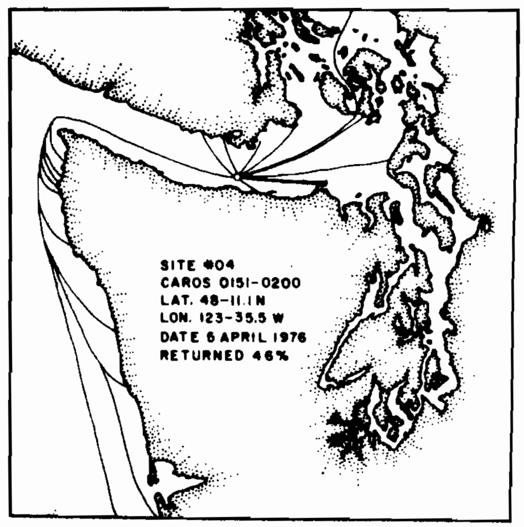
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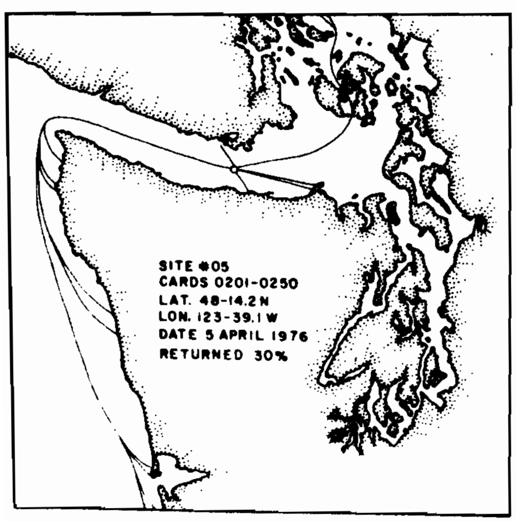
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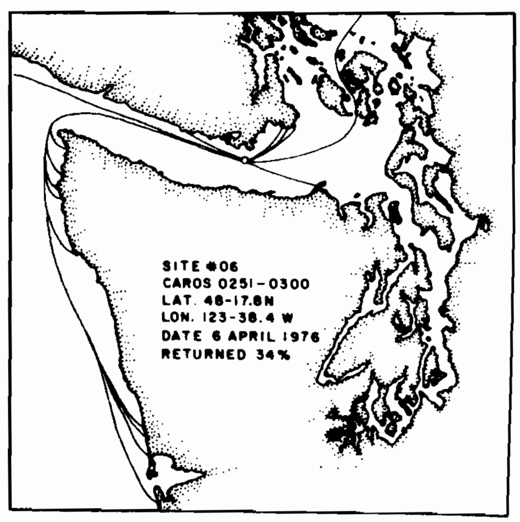
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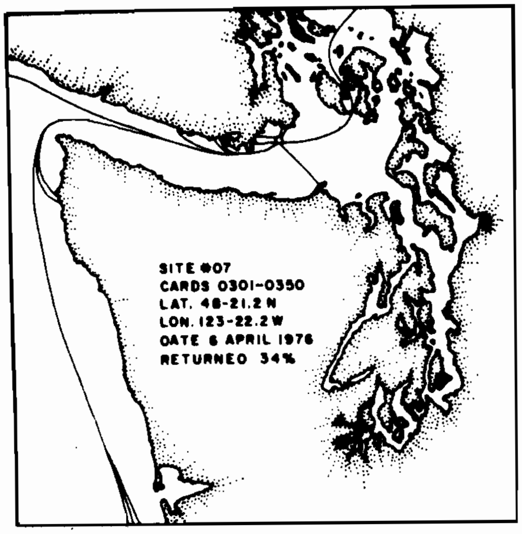
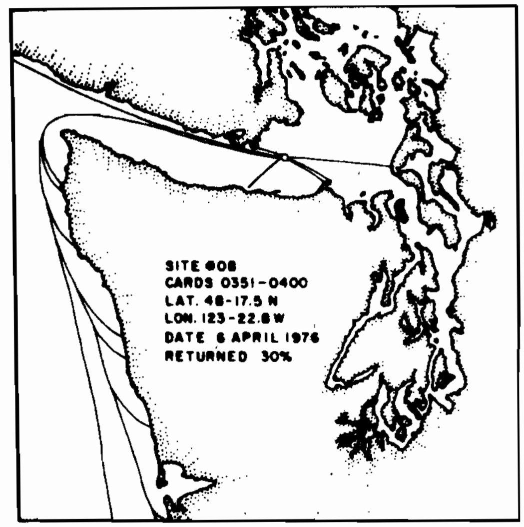
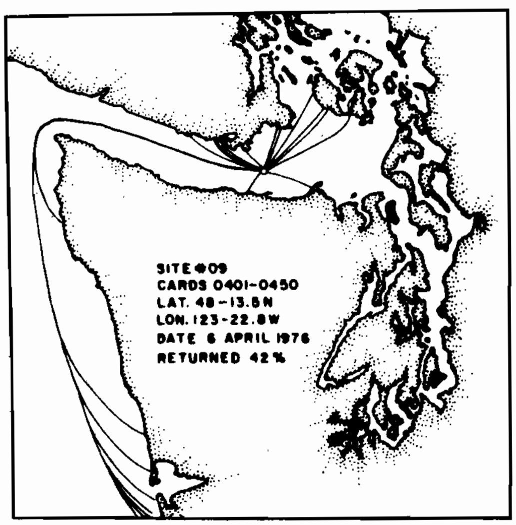
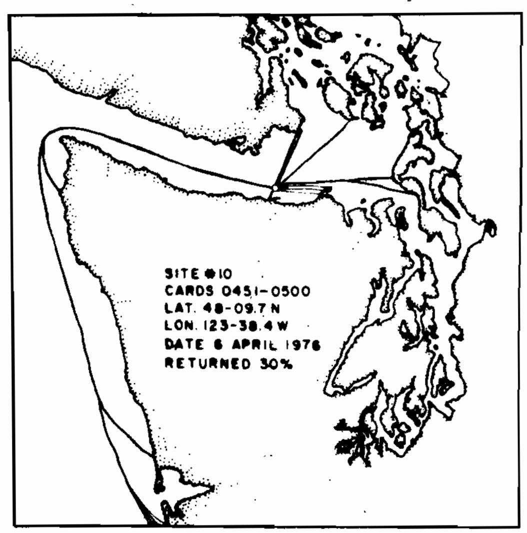
LON. 123-38.4 W
DATE 6 APRIL 1976
RETURNED 34%


SITE #07
CARDS 0301-0350
LAT. 48-21.2 N
LON. 123-22.2 W
DATE 6 APRIL 1976
RETURNED 34%


SITE #08
CARDS 0351-0400
LAT. 48-17.5 N
LON. 123-22.8 W
DATE 6 APRIL 1976
RETURNED 30%


SITE #09
CARDS 0401-0450
LAT. 48-13.5N
LON. 123-22.8W
DATE 6 APRIL 1976
RETURNED 42%


SITE #10
CARDS 0451-0500
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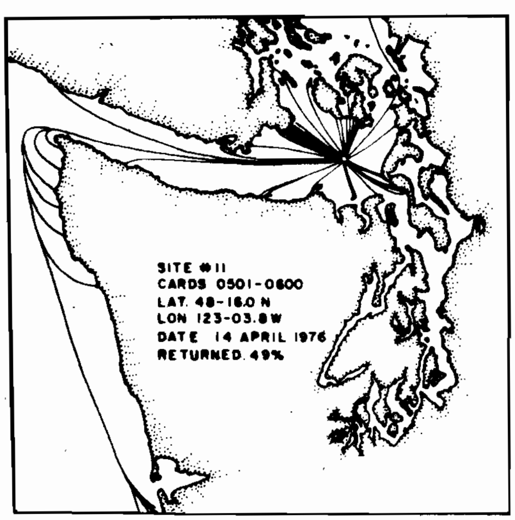
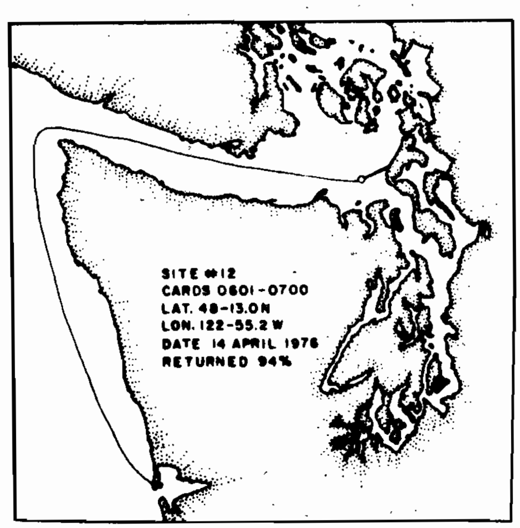
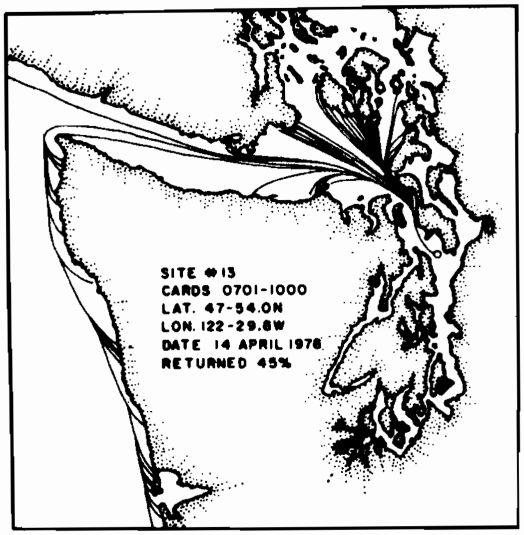
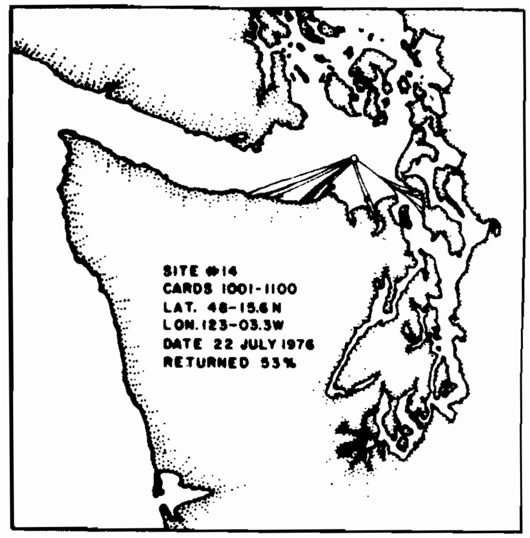
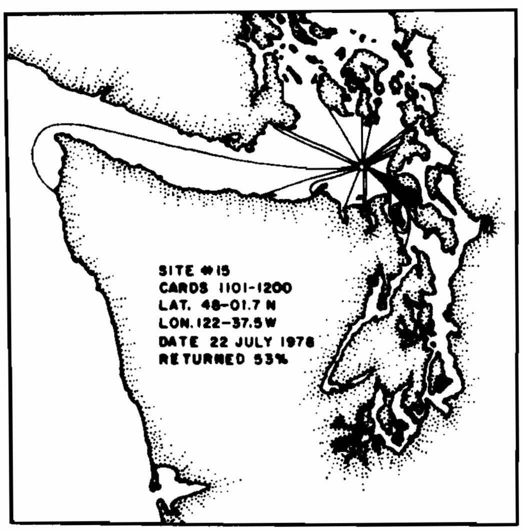
LON. 123-38.4 W
DATE 6 APRIL 1976
RETURNED 30%

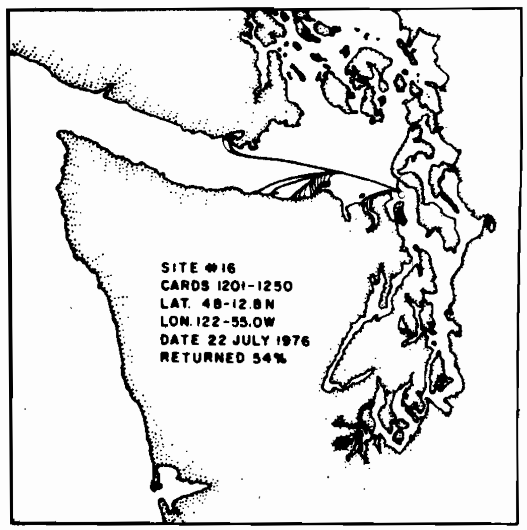

SITE #11
CARDS 0501-0600
LAT. 48-16.0 N
LON 123-03.8W
DATE 14 APRIL 1976
RETURNED 49%

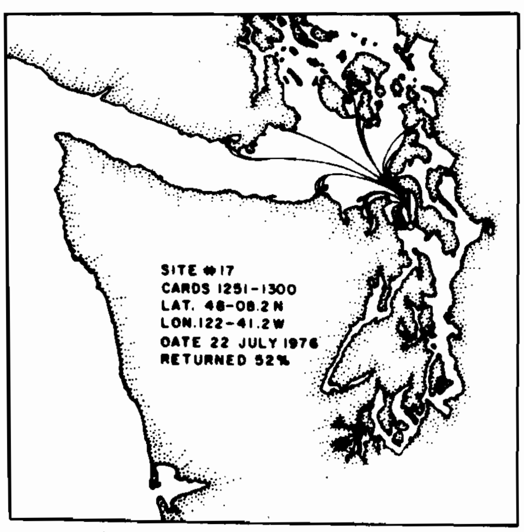

SITE #12
CARDS 0601-0700
LAT. 48-13.0N
LON. 122-55.2 W
DATE 14 APRIL 1976
RETURNED 94%

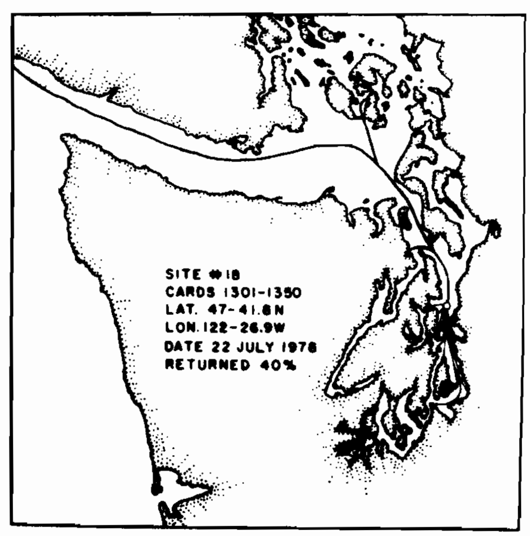

SITE #13
CARDS 0701-1000
LAT. 47-54.0N
LON. 122-29.8W
DATE 14 APRIL 1976
RETURNED 45%

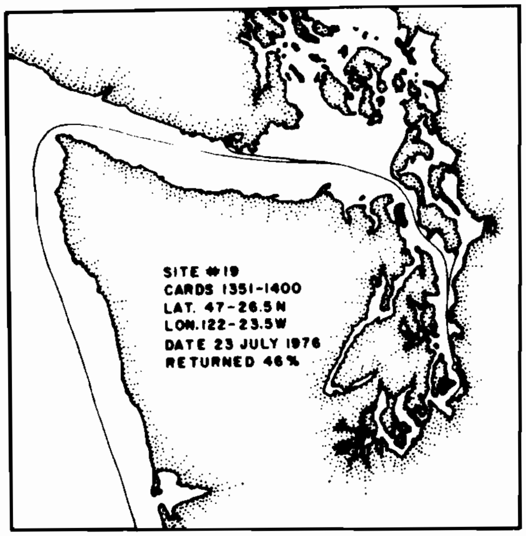

SITE #14
CARDS 1001-1100
LAT. 48-15.6N
LON. 123-03.3W
DATE 22 JULY 1976
RETURNED 53%

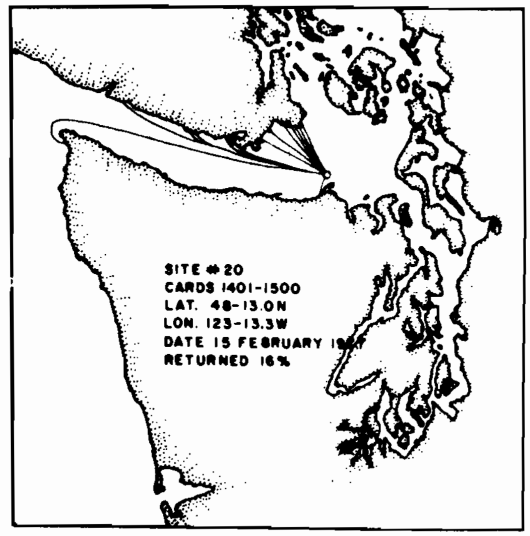

SITE #15
CARDS 1101-1200
LAT. 48-01.7N
LON. 122-37.5W
DATE 22 JULY 1976
RETURNED 53%

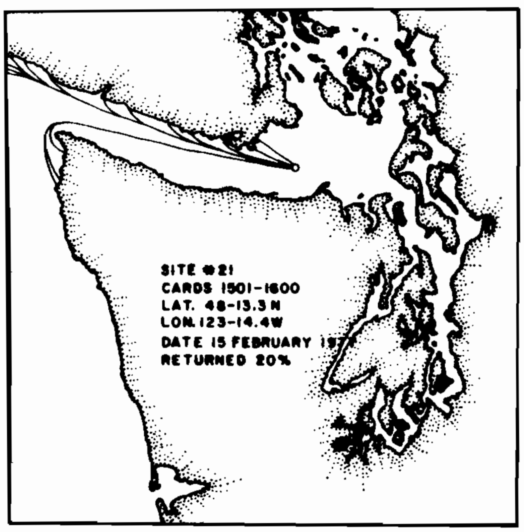

SITE #16
CARDS 1201-1250
LAT. 48-12.8N
LON. 122-55.0W
DATE 22 JULY 1976
RETURNED 54%

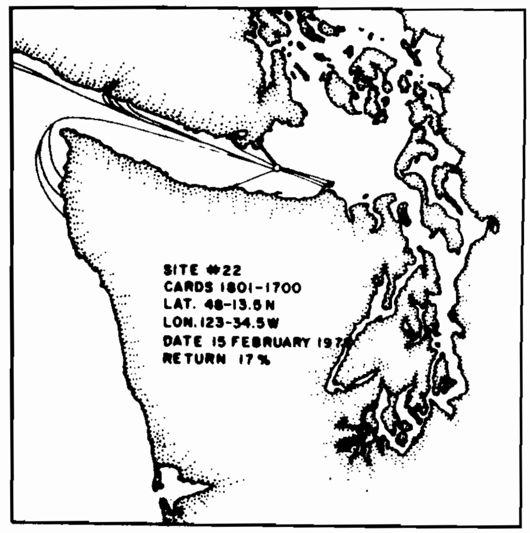

SITE #17
CARDS 1251-1300
LAT. 48-08.2N
LON. 122-41.2W
DATE 22 JULY 1976
RETURNED 52%

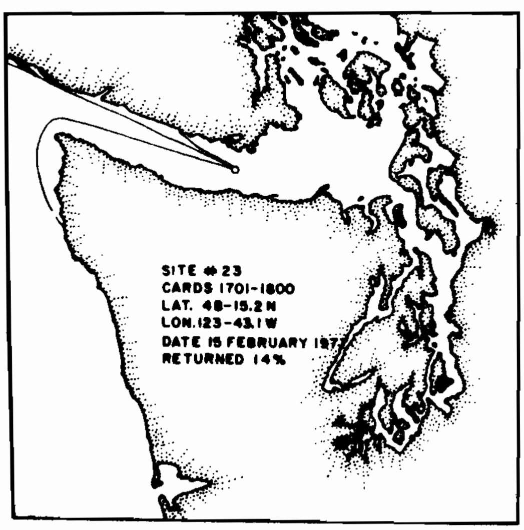

SITE #18
CARDS 1301-1350
LAT. 47-41.8N
LON. 122-26.9W
DATE 22 JULY 1976
RETURNED 40%

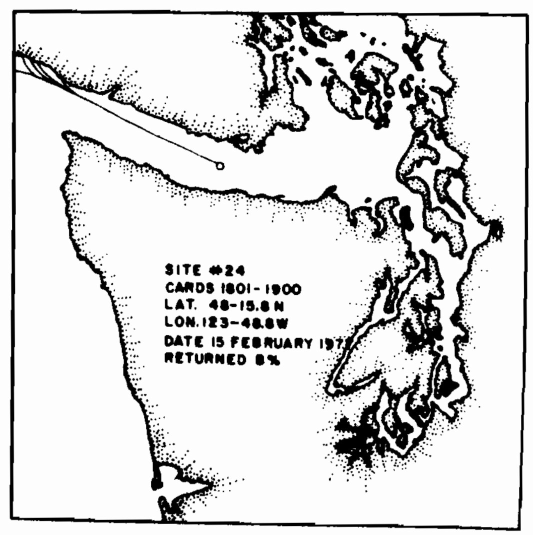

SITE #19
CARDS 1351-1400
LAT. 47-26.5 N
LON.122-23.5W
DATE 23 JULY 1976
RETURNED 46%

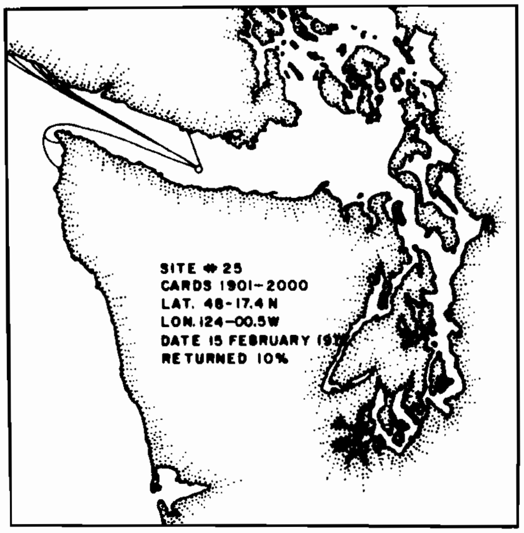

SITE # 20
CARDS 1401-1500
LAT. 48-13.0 N
LON. 123-13.3W
DATE 15 FEBRUARY 19
RETURNED 16%

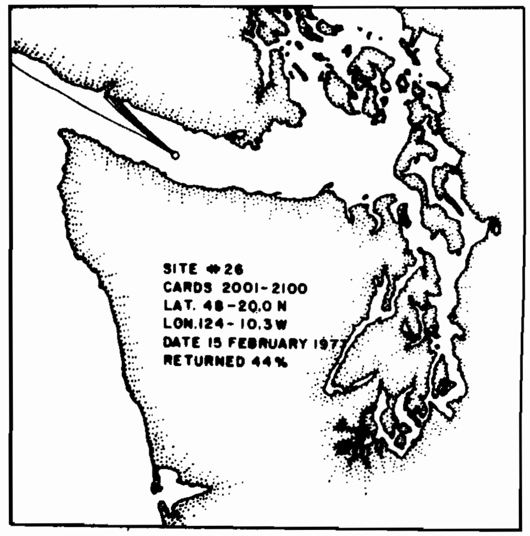

SITE #21
CARDS 1501-1600
LAT. 48-13.3 N
LON.123-14.4W
DATE 15 FEBRUARY 19
RETURNED 20%

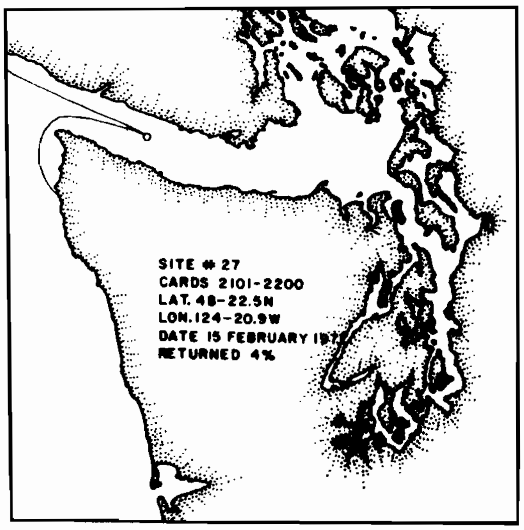

SITE #22
CARDS 1801-1700
LAT. 48-13.5 N
LON.123-34.5W
DATE 15 FEBRUARY 197
RETURN 17%

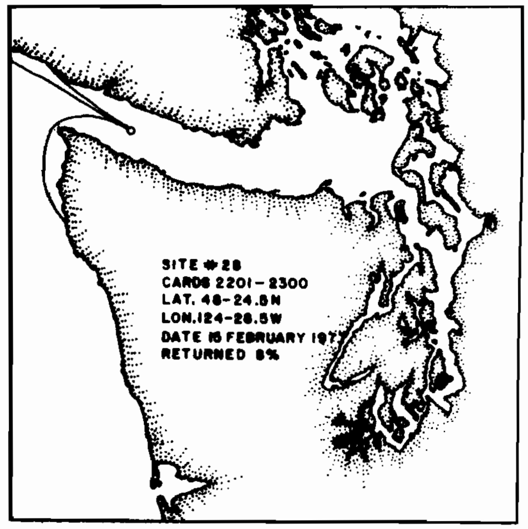

SITE # 23
CARDS 1701-1800
LAT. 48-15.2 N
LON.123-43.1W
DATE 15 FEBRUARY 197
RETURNED 14%

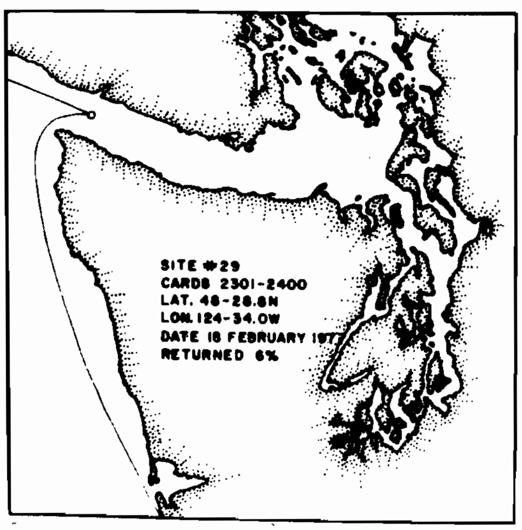

SITE #24
CARDS 1801-1900
LAT. 48-15.8 N
LON.123-48.8W
DATE 15 FEBRUARY 197
RETURNED 8%

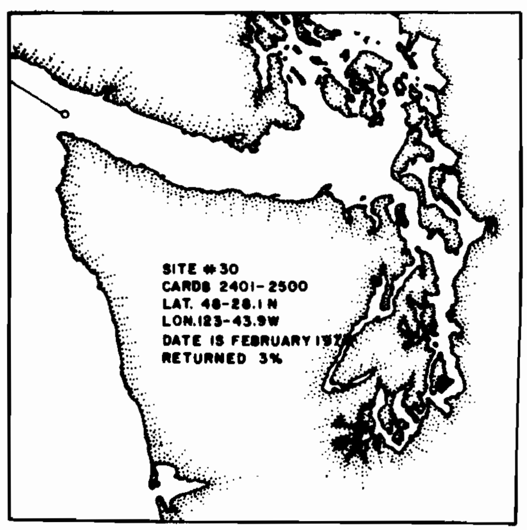

SITE # 25
CARDS 1901-2000
LAT. 48-17.4 N
LON. 124-00.5W
DATE 15 FEBRUARY 19
RETURNED 10%

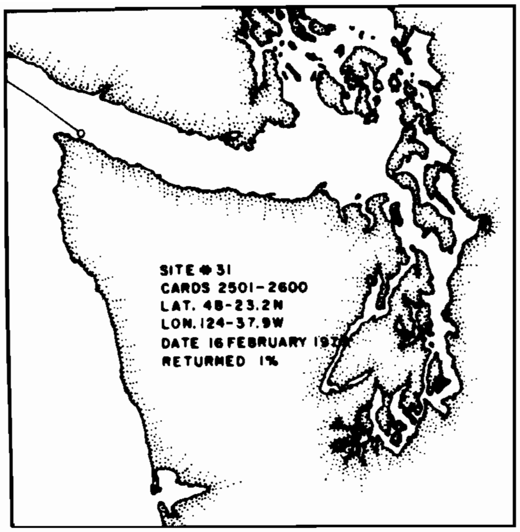

SITE # 26
CARDS 2001-2100
LAT. 48-20.0 N
LON.124-10.3W
DATE 15 FEBRUARY 197
RETURNED 44%

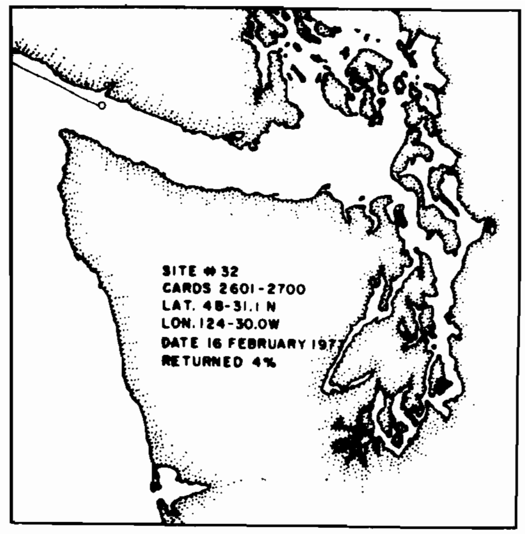

SITE # 27
CARDS 2101-2200
LAT. 48-22.5N
LON.124-20.9W
DATE 15 FEBRUARY 197
RETURNED 4%

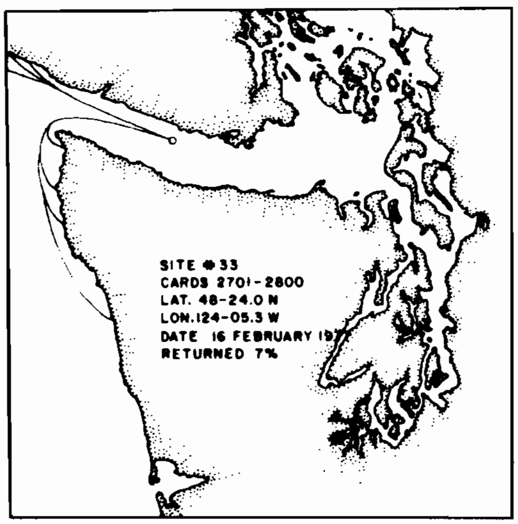

SITE # 28
CARDS 2201-2300
LAT. 48-24.8N
LON.124-28.5W
DATE 15 FEBRUARY 197
RETURNED 8%

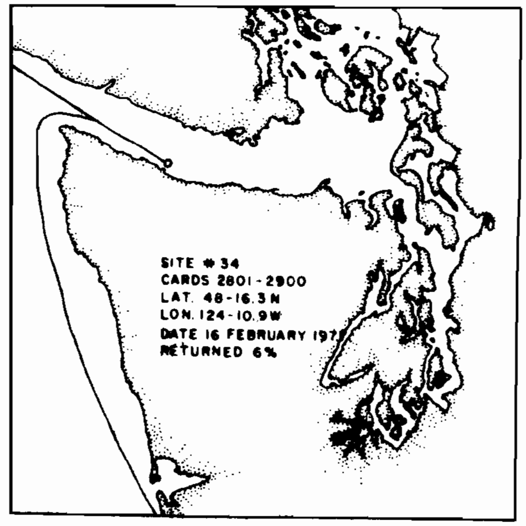

SITE # 29
CARDS 2301-2400
LAT. 48-28.8N
LON. 124-34.0W
DATE 16 FEBRUARY 197
RETURNED 6%

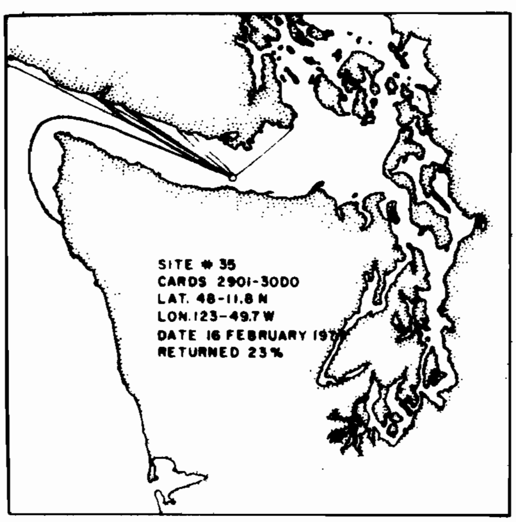

SITE # 30
CARDS 2401-2500
LAT. 48-26.1 N
LON.123-43.9W
DATE 15 FEBRUARY 197
RETURNED 3%

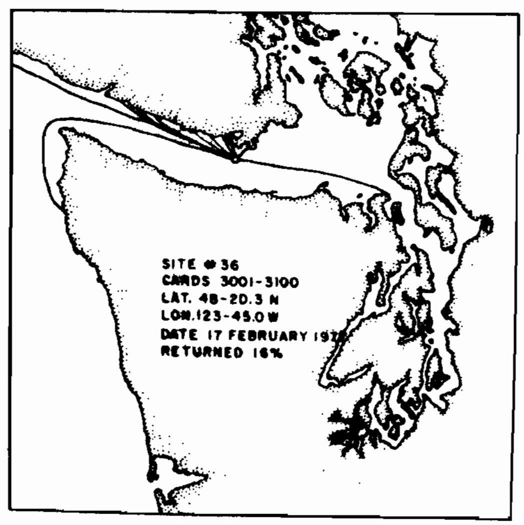

SITE # 31
CARDS 2501-2600
LAT. 48-23.2 N
LON. 124-37.9 W
DATE 16 FEBRUARY 197
RETURNED 1%

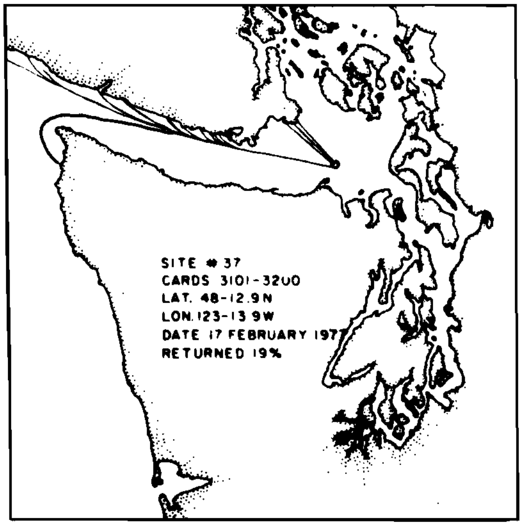

SITE # 32
CARDS 2601-2700
LAT. 48-31.1 N
LON. 124-30.0 W
DATE 16 FEBRUARY 197
RETURNED 4%

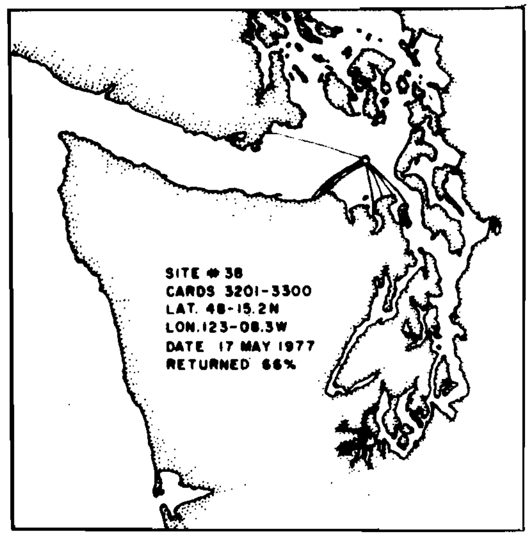

SITE # 33
CARDS 2701-2800
LAT. 48-24.0 N
LON. 124-05.3 W
DATE 16 FEBRUARY 197
RETURNED 7%

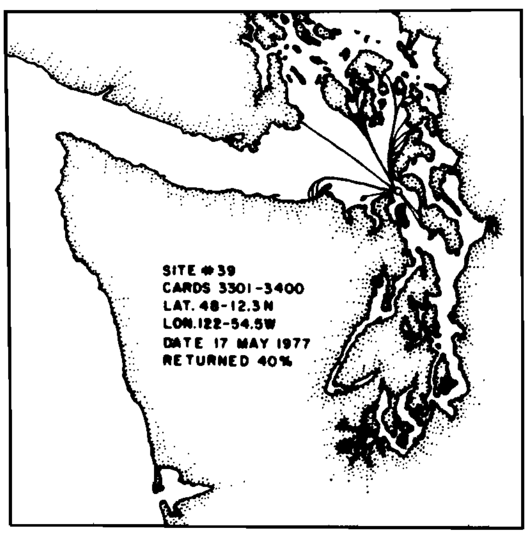

SITE # 34
CARDS 2801-2900
LAT. 48-16.3 N
LON. 124-10.9 W
DATE 16 FEBRUARY 197
RETURNED 6%

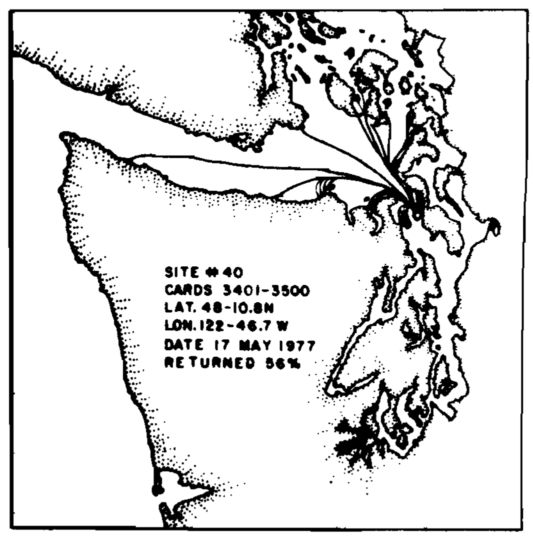

SITE # 35
CARDS 2901-3000
LAT. 48-11.8 N
LON. 123-49.7 W
DATE 16 FEBRUARY 197
RETURNED 23%

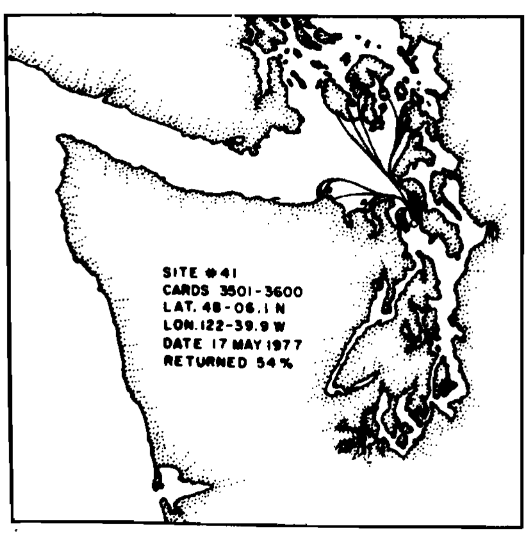

SITE # 36
CARDS 3001-3100
LAT. 48-20.3 N
LON. 123-45.0 W
DATE 17 FEBRUARY 197
RETURNED 16%

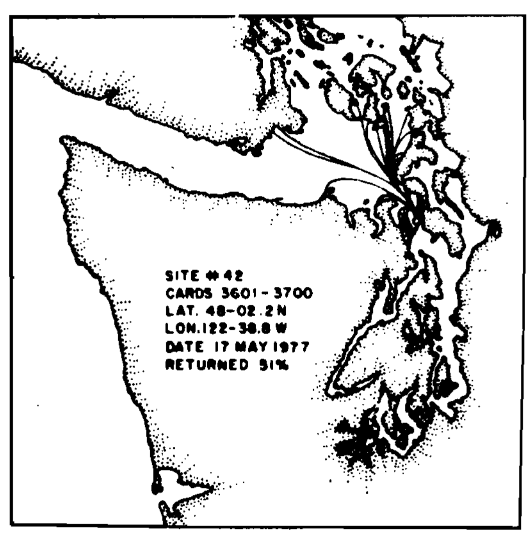

SITE # 37
CARDS 3101-3200
LAT. 48-12.9N
LON.123-13.9W
DATE 17 FEBRUARY 1977
RETURNED 19%

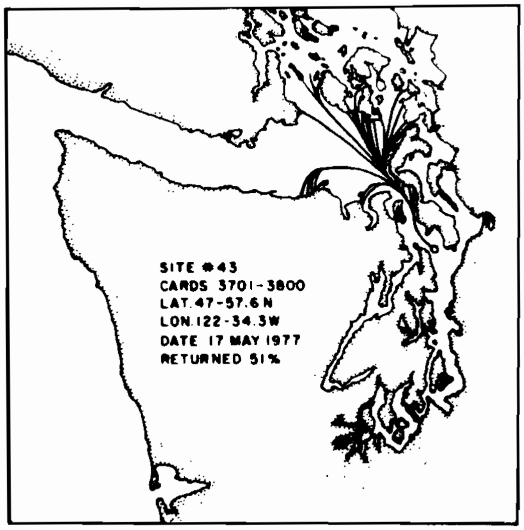

SITE # 38
CARDS 3201-3300
LAT. 48-15.2N
LON.123-08.3W
DATE 17 MAY 1977
RETURNED 66%

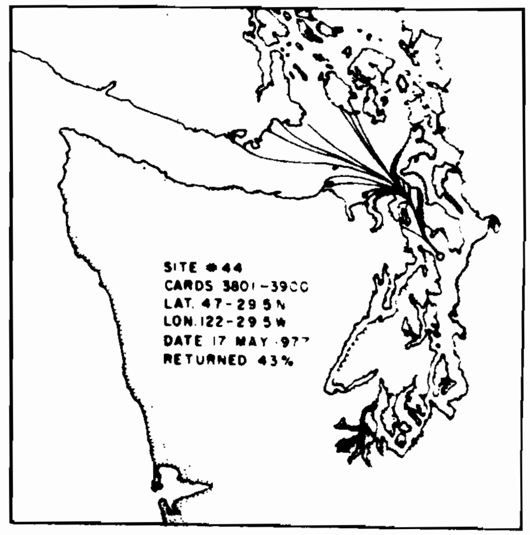

SITE # 39
CARDS 3301-3400
LAT. 48-12.3N
LON.122-54.5W
DATE 17 MAY 1977
RETURNED 40%

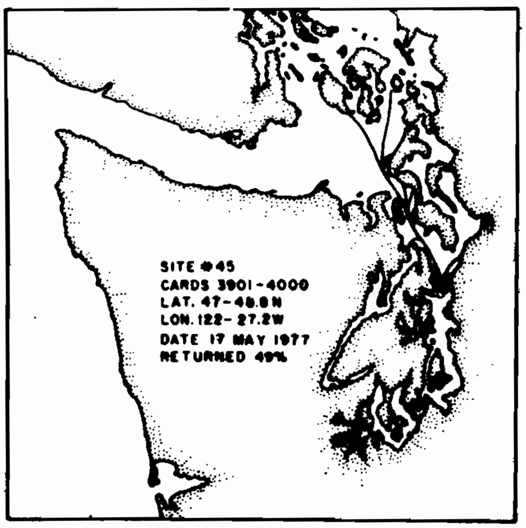

SITE # 40
CARDS 3401-3500
LAT. 48-10.8N
LON.122-46.7 W
DATE 17 MAY 1977
RETURNED 56%

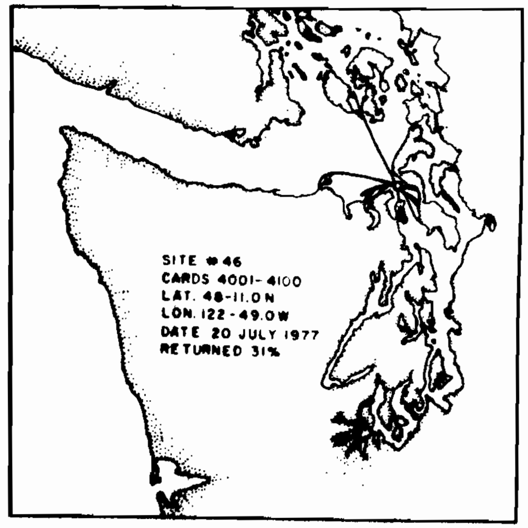

SITE # 41
CARDS 3501-3600
LAT. 48-06.1 N
LON.122-39.9 W
DATE 17 MAY 1977
RETURNED 54%

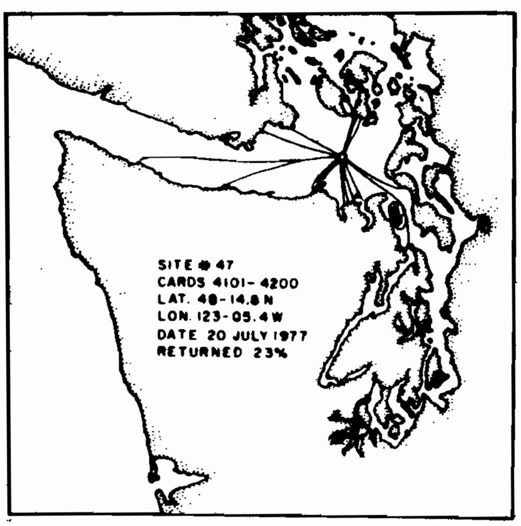

SITE # 42
CARDS 3601-3700
LAT. 48-02.2 N
LON.122-38.8 W
DATE 17 MAY 1977
RETURNED 51%

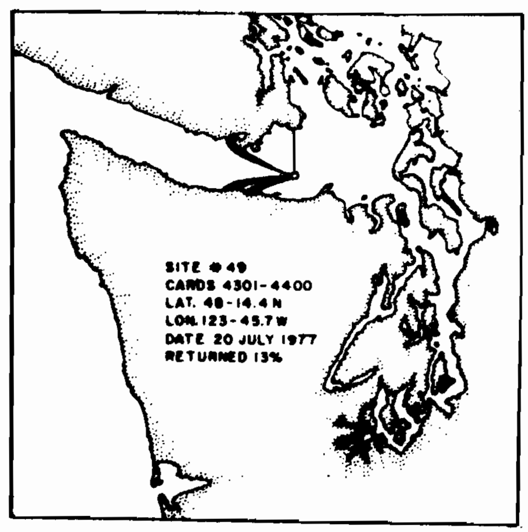

SITE #43
CARDS 3701-3800
LAT. 47-57.6 N
LON. 122-34.3 W
DATE 17 MAY 1977
RETURNED 51%

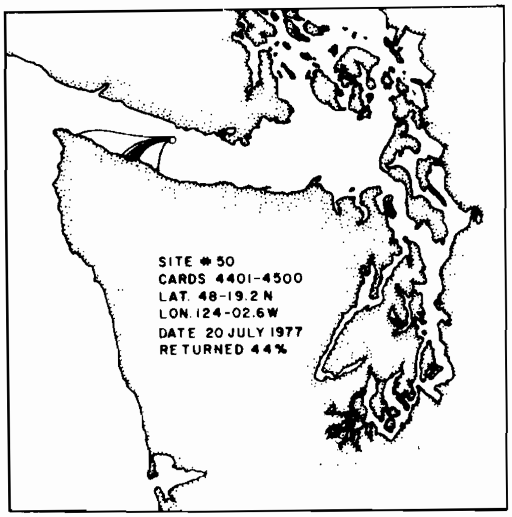

SITE #44
CARDS 3801-3900
LAT. 47-29.5 N
LON. 122-29.5 W
DATE 17 MAY 1977
RETURNED 43%

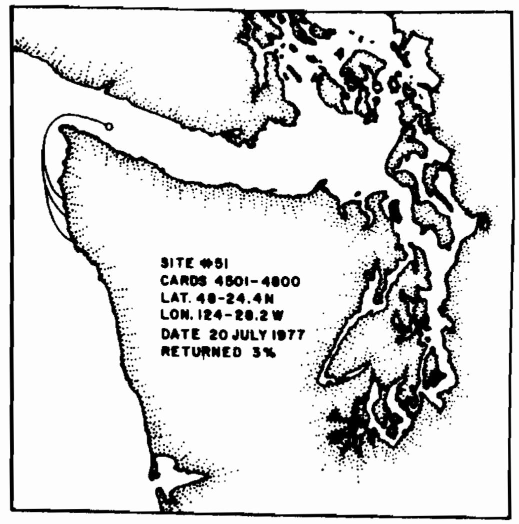

SITE #45
CARDS 3901-4000
LAT. 47-48.8 N
LON. 122-27.2 W
DATE 17 MAY 1977
RETURNED 49%

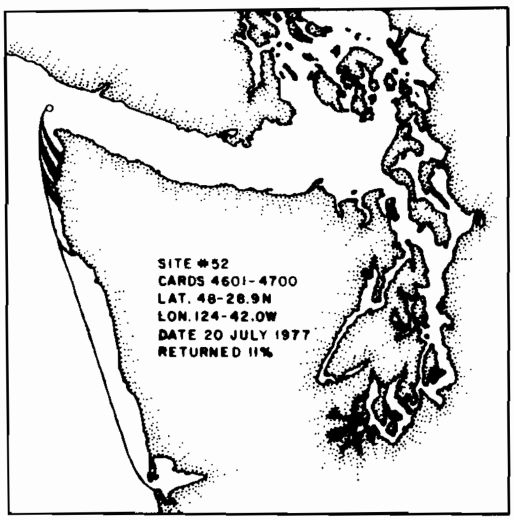

SITE #46
CARDS 4001-4100
LAT. 48-11.0 N
LON. 122-49.0 W
DATE 20 JULY 1977
RETURNED 31%

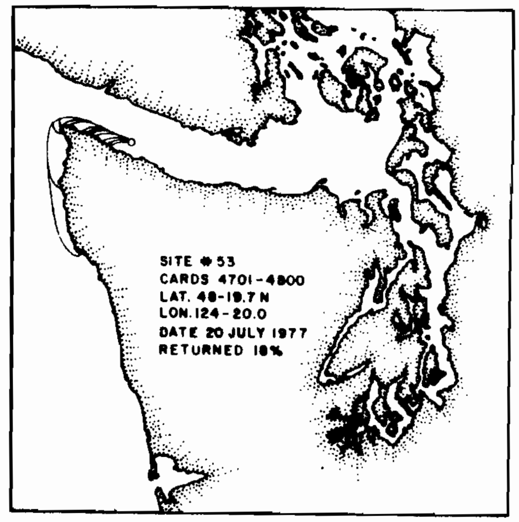

SITE #47
CARDS 4101-4200
LAT. 48-14.8 N
LON. 123-05.4 W
DATE 20 JULY 1977
RETURNED 23%

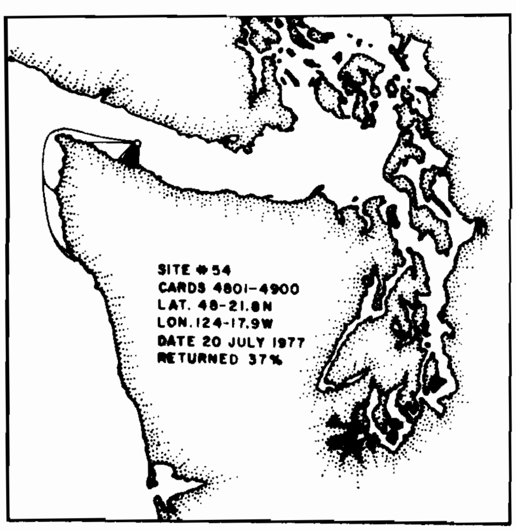

SITE #49
CARDS 4301-4400
LAT. 48-14.4 N
LON. 123-45.7 W
DATE 20 JULY 1977
RETURNED 13%

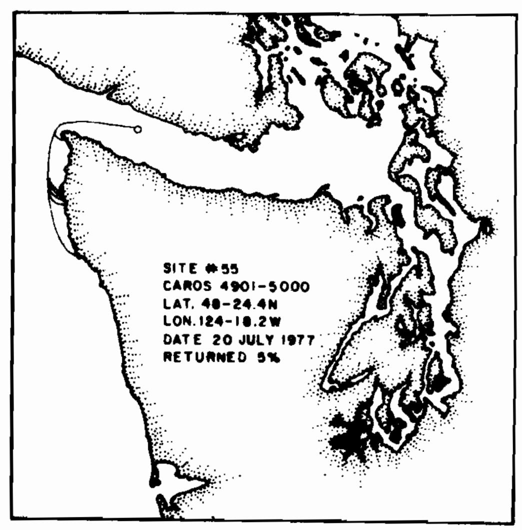

SITE # 50
CARDS 4401-4500
LAT. 48-19.2 N
LON. 124-02.6 W
DATE 20 JULY 1977
RETURNED 44%


SITE #51
CARDS 4501-4600
LAT. 48-24.4 N
LON. 124-28.2 W
DATE 20 JULY 1977
RETURNED 3%


SITE #52
CARDS 4601-4700
LAT. 48-28.9N
LON. 124-42.0W
DATE 20 JULY 1977
RETURNED 11%


SITE # 53
CARDS 4701-4800
LAT. 48-19.7 N
LON. 124-20.0
DATE 20 JULY 1977
RETURNED 18%


SITE # 54
CARDS 4801-4900
LAT. 48-21.8N
LON. 124-17.9W
DATE 20 JULY 1977
RETURNED 37%


SITE #55
CAROS 4901-5000
LAT. 48-24.4N
LON. 124-18.2W
DATE 20 JULY 1977
RETURNED 5%