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Representative Lighthouse Reports for Marine Coastal Regions

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INTRODUCTION

In the near future, a marine verification will be implemented in order to check the forecasting of gale to storm force winds. The purpose of this report was to find the most representative lighthouses for each B.C. marine coastal region.

The best procedure for determining the most representative lighthouse would be to compare the reports with the actual winds (over the open waters) reported by ships. However, this procedure was not possible due to the lack of ship reports.

The problem had to be faced differently. It was assumed that the best light station would have the best exposure, and therefore it should have gale and storm force winds more frequently over a long period of time. However, some caution should be taken as local effects could overestimate winds.

Records from many of the lighthouse anemometers have been sent to the climate centre (Toronto) during the past years. Hourly mean winds are available for a certain number of years (depending on the station) up to generally 1980. A program, MODELB, was written to handle this data. The program calculates the frequencies (in percentage) of occurrence of winds for different speed classes, but only winds that were greater than 63 km/hr (34 knots) were considered in this application.

The station with the highest frequency of gales and storms was chosen to be the most representative.

However, in the case of Juan de Fuca Strait and of Johnstone and Queen Charlotte Straits, the MODELB program couldn't be used. Too many stations were missing in the climatological data bank. Instead, the strongest winds blowing each day for each station were used (from the SXCN3). The data comprised of a period of three (3) months last winter when gale and storm warnings were frequent (Dec. '81 to Feb. '82). The fact that a station was reporting generally stronger winds relative to the others in the area was an indication that it might be the best one.

To avoid any short term anomaly, this study would have required at least 30 years of data. This was impossible since many light stations have only recently begun a weather program or have been relocated. Additional information was also provided by the meteorological inspectors Jack Buchanan

and John Lozanski who gave indications about lighthouse exposures. Their comments were generally in accordance with the statistical analysis. The tabulated results for all the regions are given in Appendices A and B. Reference maps are also included for the northern and southern portions of B.C. coastal waters.

WEST COAST CHARLOTTES

Only two (2) stations report winds on the West Coast Charlottes: Langara and Kindakun Point. Cape St. James is also fairly close to this marine region. A statistical analysis was available for Langara and Cape St. James but not for Kindakun which is a new station. Up to now, the latter doesn't seem to have a good exposure (according to the inspectors) and will not be considered.

Langara has reported in total almost as many storms and gales as Cape St. James. But differences were noted in each direction (due to the differences in their location). Both should be considered in the verification, even if Cape St. James seems to be slightly better. Over the next few years this region should be re-examined when more data from Kindakun will be available.

DIXON ENTRANCE

Four lighthouses report winds over Dixon Entrance; Lucy, Rosespit, Triple, and Green. No statistical analysis is done for the latter since Green does not have a recorder.

The statistical analysis (from 1974 to 1980) shows that Lucy, Rosespit, and Triple report more gales from the southeast quadrant than any other direction. The best station seems to be Rosespit but it should be noted that Lucy and Triple are also very good. According to the inspectors, Green also has an excellent exposure. However, the winds reported from Green are usually less than those over the "open waters" since Green is closer to the coast and is surrounded by islands. On the other hand the flow at Rosespit is sheltered only from the southwest by the Queen Charlotte Islands. Thus Rosespit seems to be the most representative except in the case of outflow winds where Green would be the best.

HECATE STRAIT

A statistical analysis has been made from the year 1970 to 1980 (except from 1979 to 1980 for Boat Bluff and Dryad). Ivory was not available where winds are estimated instead of measured by an anemometer. Bonilla is undoubtedly the best station. McInnes is also fairly good in catching the southeasterlies (which predominate in Hecate Strait) but to a lesser extent than Bonilla.

The inspectors have confirmed that Bonilla would be the best station. The lighthouse is on a high hill with the anemometer on its top (the anemometer is about 40 meters above sea level). The only possibility of obstruction would be from the east.

QUEEN CHARLOTTE SOUND

Cape St. James has registered more gale force winds (from any direction) than any other station (between 1972 and 1980). Egg was the second best but with far fewer gales reported.

No trees are found on Egg Island. The hill itself is fairly high (about 83 meters above sea level) which at times causes a "cliff problem". When strong winds hit the cliff, they are deflected upward and form an angle with the anemometer. Thus strong winds in most cases are underestimated.

The inspectors have mentioned that the Cape (about 100 meters above sea level) reports winds fairly close to reality. The "cliff problem" is also likely to occur and winds are usually underestimated. Fishermen and other users of the sea complain that winds at Cape St. James are usually lower than the actual winds by about 10 knots.

Cape St. James is the most representative lighthouse for the "open waters" of the Queen Charlotte Sound but Egg represents the winds fairly well along the coast which are usually less than those at the Cape.

WEST COAST VANCOUVER ISLAND

Most of the west coast stations are quite protected. They are usually on a cliff with tall trees surrounding them. The "cliff problem" mentioned for Egg Island (see Queen Charlotte Sound) occurs at many stations. Estevan is the only station which was said to have a fairly good exposure from all directions (except from the east).

A statistical analysis was made with data collected from 1969 to 1975 for Estevan, from 1972 to 1976 for Cape Scott, and from 1979 to 1980 for the others (Cape Beale, Lennard, Nootka, Quatsino). No data was available for Amphitrite, Carmanah, and Pachena. It should be noted that the latter estimate winds.

The statistical analysis has confirmed that Estevan has the best exposure in spite of the discrepancies in the length of the records. These discrepancies would have modified the results, but not enough to influence the choice.

Another point of interest concerning Estevan is that gale force northwesterlies occur as often as the southeasterlies.

GEORGIA STRAIT

Southeasterly gales are predominant and are reported mostly by Merry, Saturna, and Sisters. These three stations have an excellent exposure with the exception of Saturna for the southwest quadrant and Merry for the northwest quadrant.

Northwest gales do not occur frequently in Georgia Strait and are reported more often by Sandheads which is said to have an excellent exposure.

However, in terms of total gales Sandheads and Entrance report them much less frequently than Merry, Sisters, and Saturna. This could be explained by their location in the extreme southern section where the channel broadens. These results are subject to be revised if ever a statistical analysis (or other more exhaustive information) becomes available.

In the case of Georgia Strait, the choice of a representative station is not evident. Sandheads would be the "best" for northwesterly gales; Sisters would be slightly preferred over Merry and Saturna for southeasterly gales (with data and inspector's information).

JUAN DE FUCA STRAIT

With the MODELB program, only Race Rocks and Sooke were available. Thus another method was followed (see the Introduction). The number of gale and storm force easterlies and westerlies have been reported from Dec. 81 to Feb. 82 for each station.

Only two (2) stations reported easterly gales during these three (3) months: Discovery and Trial. The former had only one more gale occurrence. Because Discovery estimates winds, Trial should be used to verify the easterlies, even though Discovery's (according to the inspectors) estimates are close to reality.

In the case of gale or storm force westerlies, Race was the "best" one. Trial was the second best with about half those registered at Race. Race has an excellent exposure and should be chosen to verify westerlies.

QUEEN CHARLOTTE STRAIT AND JOHNSTONE STRAIT

As in the case of Juan de Fuca Strait, no statistical analysis was available for Scarlett and Pulteney, and the alternate method of analysis was used to select the most representative station. Pine was included in the study for southeasterlies, but not for northwesterlies, since it is in a different regime.

In Johnstone and Queen Charlotte Straits, Scarlett, and Pulteney are the stations which report stronger southeasterlies most frequently. Both are similar in reporting southeasterlies below 35 knots, but not in the case of gales and storms, where Scarlett seems better. However, Pine is actually the best station for southeasterlies and should be considered if two stations are used in the verification.

There was only one northwesterly gale reported from December 1981 to February 1982 which was by Chatham Point. However, Pulteney was doing slightly better in general (for any wind speed class). Thus if Pine is chosen to verify southeasterlies, Pulteney should be chosen for northwesterlies. On the other hand, if Scarlett is used to check the southeasterlies, it could also check the northwesterlies.

No information was available about the anemometers at Scarlett or Pulteney. It seems that their winds are either estimated or measured with a "homemade" anemometer. Therefore, these results should be treated with some caution.

CONCLUSION

Lighthouses to be used for marine verification.

| | |
|--|---|
| West Coast Charlottes | Langara Cape St. James |
| Dixon Entrance | Rosespit Green (for outflow winds) |
| Hecate Strait | Bonilla |
| Queen Charlotte Sound | Cape St. James Egg (for winds just along the coast) |
| Georgia Strait | Sisters (for southeasterly winds) Sandheads (for northwesterly winds) |
| West Coast Vancouver Island | Estevan |
| Juan de Fuca Strait | Race (for westerly winds) Trial (for easterly winds) |
| Queen Charlotte Strait and Johnstone Strait | Pine (for southeasterly winds) Pulteney (for northwesterly winds) or Scarlett (for both wind directions) |

ACKNOWLEDGMENTS

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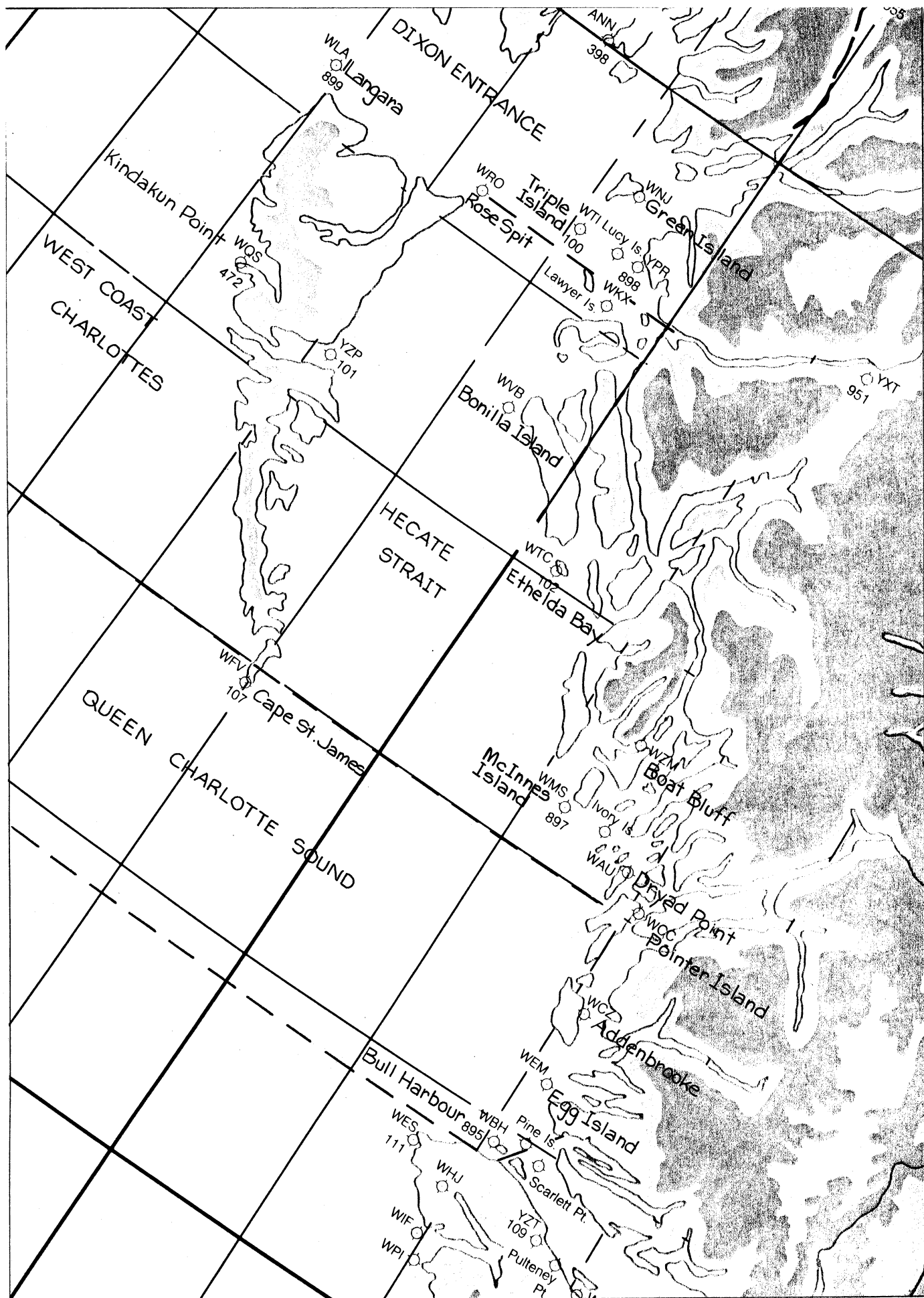


FIGURE 1.
LIGHTHOUSE STATIONS FOR
NORTHERN B.C. COASTAL WATERS

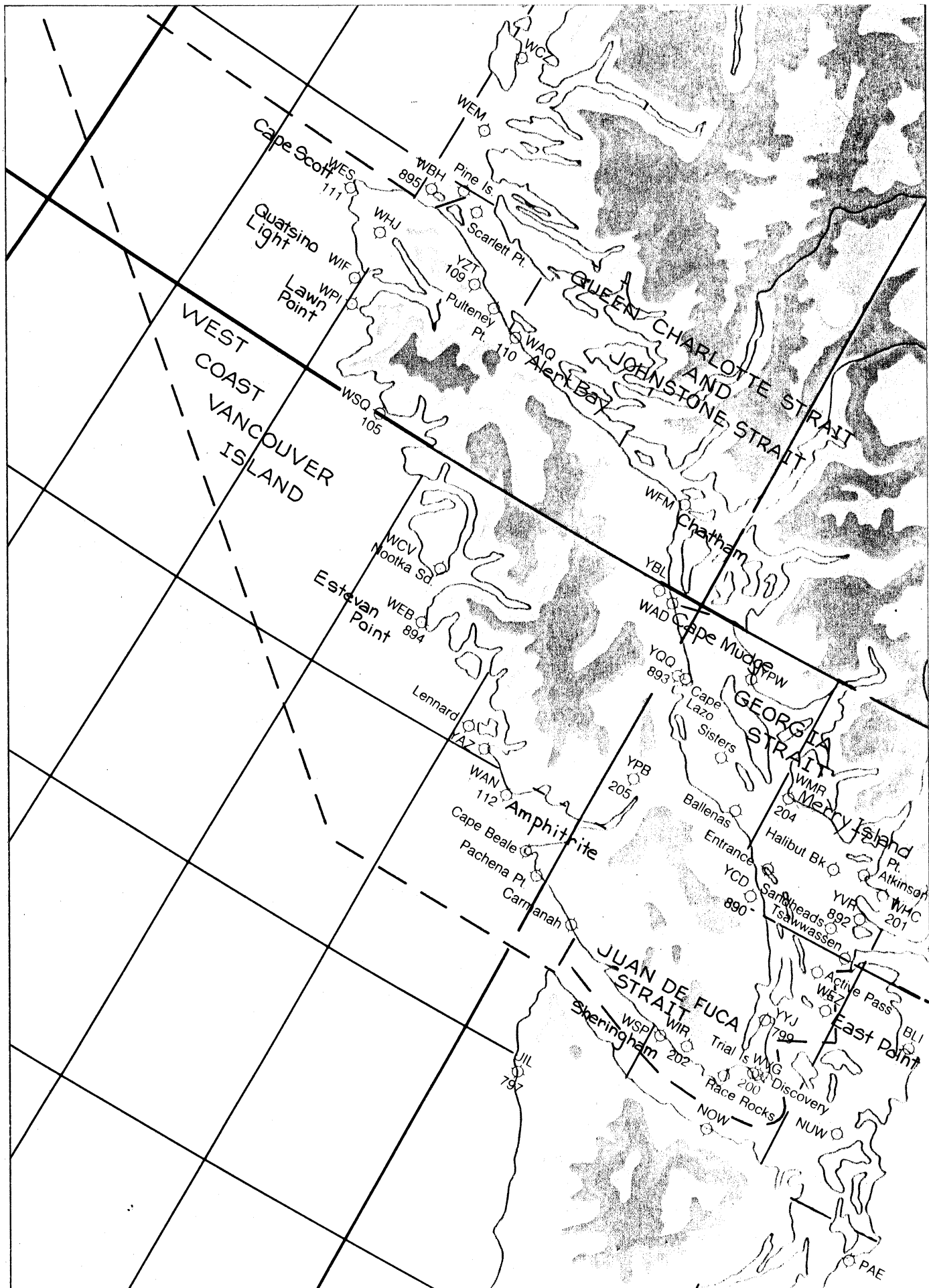


FIGURE 2.
LIGHTHOUSE STATIONS FOR
SOUTHERN B.C. COASTAL WATERS

APPENDIX A

Tabulated results for West Coast Charlottes, Dixon Entrance, Hecate Strait, Queen Charlotte Sound, West Coast Vancouver Island, and Georgia Strait.

West Coast Charlottes Percentage of winds higher than 34 knots

| | Langara (1954-80) | Cape St. James (1972-80) |
|----|----------------------|-----------------------------|
| NE | .67 | .43 |
| E | .77 | .28 |
| SE | .47 | 2.14 |
| S | .99 | 1.62 |
| SW | 1.36 | .59 |
| W | .78 | .96 |
| NW | .30 | 1.11 |
| N | .22 | .02 |
| | <u>5.54</u> | <u>7.15</u> |

Dixon Entrance Percentage of winds higher than 34 knots

| | Lucy (1974-80) | Rosespit (1974-80) | Triple (1974-80) |
|----|-------------------|-----------------------|---------------------|
| NE | --- | .29 | .04 |
| E | --- | .36 | .01 |
| SE | 1.90 | 2.10 | 1.67 |
| S | .30 | .81 | .58 |
| SW | --- | .01 | .02 |
| W | --- | .10 | .05 |
| NW | --- | .01 | .01 |
| N | --- | .04 | .08 |
| | <u>2.20</u> | <u>3.72</u> | <u>2.46</u> |

Hecate Strait Percentage of winds higher than 34 knots

| | Boat Bluff (1979-80) | Bonilla (1970-80) | Dryad (1979-80) | Ethelda (1979-80) |
|----|-------------------------|----------------------|--------------------|----------------------|
| NE | --- | --- | --- | --- |
| E | --- | .01 | --- | --- |
| SE | .02 | 2.36 | --- | --- |
| S | --- | .83 | --- | --- |
| SW | --- | .02 | --- | --- |
| W | --- | .02 | --- | --- |
| NW | --- | .03 | --- | --- |
| N | --- | --- | --- | --- |
| | <u>.02</u> | <u>3.27</u> | <u>.00</u> | <u>.00</u> |

Queen Charlotte Sound
Percentage of winds higher than 34 knots

| | Addenbroke (1972-80) | Bull Harbour (1972-80) | Cape St.James (1972-80) | Egg (1972-80) | Pine (1972-80) |
|----|-------------------------|---------------------------|----------------------------|------------------|-------------------|
| NE | --- | --- | .43 | --- | --- |
| E | --- | --- | .28 | --- | --- |
| SE | .02 | --- | 2.14 | .58 | .04 |
| S | .06 | --- | 1.62 | --- | --- |
| SW | --- | --- | .59 | .01 | --- |
| W | --- | --- | .96 | .03 | --- |
| NW | --- | --- | 1.11 | .02 | .03 |
| N | --- | --- | .02 | --- | --- |
| | <u>.08</u> | <u>.00</u> | <u>7.15</u> | <u>.64</u> | <u>.07</u> |

West Coast Vancouver Island
Percentage of winds higher than 34 knots

| | Cape Beale (1979-80) | Lennard (1979-80) | Nootka (1979-80) | Quatsino (1979-80) | Cape Scott (1979-80) | Estevan (1979-80) |
|----|-------------------------|----------------------|---------------------|-----------------------|-------------------------|----------------------|
| NE | --- | --- | --- | --- | --- | --- |
| E | --- | --- | --- | --- | --- | .03 |
| SE | .25 | .01 | .02 | .11 | .09 | .48 |
| S | .01 | .05 | --- | .01 | --- | .12 |
| SW | .02 | --- | --- | --- | --- | .01 |
| W | .03 | --- | --- | .01 | --- | .24 |
| NW | .02 | --- | --- | --- | --- | .41 |
| N | --- | --- | --- | --- | --- | --- |
| | <u>.33</u> | <u>.06</u> | <u>.02</u> | <u>.13</u> | <u>.09</u> | <u>1.29</u> |

Georgia Strait
Percentage of winds higher than 34 knots

| | Ballenas (1969-79) | Entrance (1970-79) | Merry (1969-79) | Sandheads (1969-79) | Saturna (1969-78) | Sisters (1976-79) |
|----|-----------------------|-----------------------|--------------------|------------------------|----------------------|----------------------|
| NE | --- | --- | --- | --- | .05 | --- |
| E | .21 | .05 | .43 | --- | --- | .28 |
| SE | .10 | .02 | .15 | .09 | .37 | .37 |
| S | --- | --- | --- | .01 | .12 | --- |
| SW | --- | --- | --- | --- | .01 | --- |
| W | .01 | --- | --- | .04 | --- | --- |
| NW | .04 | .05 | .01 | .10 | --- | --- |
| N | --- | --- | --- | --- | --- | --- |
| | <u>.36</u> | <u>.12</u> | <u>.59</u> | <u>.24</u> | <u>.54</u> | <u>.65</u> |

APPENDIX B

Tabulated results for Queen Charlotte Sound, Johnstone Strait, and Juan de Fuca Strait.

Queen Charlotte Sound and Johnstone Strait

Number of events (per month and per direction) when gale-storm force winds have occurred (from December 1981 to February 1982).

| | | Mudge | Chatham | Alert Bay | Pulteney | Scarlett | Pine |
|----------------|------|----------|----------|-----------|-----------|-----------|-----------|
| South-easterly | Dec. | 2 | 1 | 8 | 11 | 13 | 14 |
| | Jan. | 1 | 0 | 3 | 6 | 7 | 9 |
| | Feb. | 2 | 1 | 4 | 5 | 7 | 8 |
| | | <u>5</u> | <u>2</u> | <u>15</u> | <u>22</u> | <u>27</u> | <u>31</u> |
| North-westerly | Dec. | 0 | 1 | 0 | 0 | 0 | 0 |
| | Jan. | 0 | 0 | 0 | 0 | 0 | 0 |
| | Feb. | 0 | 0 | 0 | 0 | 0 | 0 |
| | | <u>0</u> | <u>1</u> | <u>0</u> | <u>0</u> | <u>0</u> | <u>0</u> |

Number of events when winds at a lighthouse were equal or greater than those reported by the other lighthouses (for December 1981).

| | | Mudge | Chatham | Alert Bay | Pulteney | Scarlett | Pine |
|----------------|------|-------|---------|-----------|----------|----------|------|
| South-easterly | Dec. | 0 | 1 | 5 | 19 | 15 | 14 |
| North-westerly | Dec. | 3 | 3 | 3 | 7 | 2 | 0 |

Juan de Fuca Strait

Number of events (per month and per direction) when gale-storm force winds have occurred (from December 1981 to February 1982).

| | | Discovery | Trial | Race | Sheringham |
|----------|------|-----------|----------|----------|------------|
| Easterly | Dec. | 5 | 4 | 0 | 0 |
| | Jan. | 0 | 0 | 0 | 0 |
| | Feb. | 2 | 2 | 0 | 0 |
| | | <u>7</u> | <u>6</u> | <u>0</u> | <u>0</u> |
| Westerly | Dec. | 1 | 1 | 4 | 0 |
| | Jan. | 0 | 2 | 3 | 2 |
| | Feb. | 0 | 0 | 0 | 0 |
| | | <u>1</u> | <u>3</u> | <u>7</u> | <u>2</u> |