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Wilson Inlet
A Seasonally Closed Western Australian South Coast Estuary

BY

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WESTERN AUSTRALIA

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R E P O R T

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1974

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I INTRODUCTION

Considerable conflict has existed for many years between professional fishing, recreational usage and development in the west and south coast estuaries of Western Australia. One of the areas where intense conflict exists is Wilson Inlet.

The Government's task of advising the various interests concerned in these conflicts has been difficult, due to the lack of knowledge of estuarine fauna and environment in relation to usage and development.

The objective of this report is to present a preliminary description of the Wilson Inlet environment, to record the history of netting closures in the Inlet, and to discuss the history of the sand bar openings and their effect on the estuarine environment.

II LOCATION AND GENERAL DESCRIPTION

Wilson Inlet lies on the south coast of Western Australia between latitudes 34°56' and 35°06' south and longitudes 117°18' and 117°30' east (Figures 1 and 2). It is approximately 19.5 square miles in area. It is open to the ocean from 3 to 5 months of each year. During the remainder of the year its entrance to the ocean is blocked by a sand bar. Wilson Inlet is a shallow estuary fed by two main rivers, the Denmark River (dammed in 1961 for the town water supply) and the Hay River, and three small rivers, the Sleeman River, Cuppup Creek and Little River. A series of small fresh water lakes adjoin the south-east corner of the Inlet (Figure 2). The maximum central depth of the Inlet is approximately 18 to 20 feet in the winter months. The marginal sand banks are covered with water ranging in depth from 1 to 5 feet (Figure 2).

III GEOMORPHOLOGY

Wilson Inlet is similar to the Swan Estuary (Jennings and Bird, 1967) having been formed within a Pleistocene coastal plain. It transects an ancient inner weak quartsose dune system and cuts a channel through an outer resistant aeolian calcarenite dune system. Rivers entering Wilson Inlet (Figure 2) have a low discharge for most of the year. Most of the discharge is concentrated into floods for several months of late winter and spring (Rochford, 1954).

Dynamic factors, such as poor tides, together with the resistant rock of the coastal barrier, have contributed towards the smallness of the entrance of the estuary into the sea. High wave energy has caused the formation of an extensive barrier of recent calcareous sand dunes, (sand bar, Figure 2) partly cutting off the entrance of the estuary to the sea.

Pleistocene interglacial estuarine phases probably contributed to the morphology of the estuary. (Jennings and Bird, 1967).

IV CLIMATE

The climate is generally cool temperate.

Precipitation

The rainfall for the town of Denmark has been recorded daily each year since 1897. The total yearly average rainfall calculated over the 67 year period up until 1964, was 4508 points. Months of heaviest rainfall are from April to October inclusive (Table 1).

Winds

The nearest wind recording station to Wilson Inlet is situated at the town of Albany, 40 miles to the east. Wind strength and direction records have been summarised over the years 1950 to 1954 inclusive (Table 2). The morning wind direction was predominantly north-west, January to April being the calmest months. Afternoon wind was predominantly south-east to south-west, February to June being the calmest months (Table 2).

Air temperature

Air temperature records for the town of Denmark have been summarised over the years 1950-1954 inclusive (Table 3).

V TIDES AND CURRENTS

When Wilson Inlet is closed to the ocean, its waters experience no regular rise and fall of tide. Strong wind action can cause currents in the Inlet waters. Throughout the duration of a bout of strong easterly winds, water levels have been known to rise in the sand bar area, and fall in the area of the Hay and Sleeman Rivers.

The following sections on tides and currents refer to waters of the Southern Ocean outside of Wilson Inlet (Figure 1), and to the waters of Wilson Inlet when they are open to the ocean.

Tides

Hodgkin and Di Iollo (1958) have published the most detailed account of the tides in south-west Western Australia. Of the tides in the Albany region, they said:

> "Tides of daily type with high-water and low-water about 12 hours apart, occur near maximum declination, and tides of semi daily type occur near zero declination with two high-waters and two low-waters at about six hour intervals. Between maximum and zero declination, the tides change progressively and there are tides of mixed type, transitional in form between the typical daily and typical semi daily types".

Tide Range

Maximum Range 3.9 feet (December 18th)
Minimum Range 0.9 feet (June 14th)

Astronomical tides have a small range, and are often exceeded by tides due to prevailing weather conditions (i.e. barometric tides).

Currents

The southern ocean current flows continually eastward from the southern Indian Ocean to the southern Pacific Ocean. Its lower limit is 66° south latitude. It rarely exceeds 1 knot in speed and is greatly influenced by local wind conditions. Westerly currents are therefore not infrequent occurrences between the months of November and January. (Australia Pilot Vol.1).

VI WATER CONDITIONS

Water conditions in the Inlet are a function of the wind direction and strength. North-easterly and south-westerly winds, which blow down the long axis of the Inlet (Figure 2) cause the roughest water conditions in the Inlet. Waves generated by such winds can reach 3-4 feet in height.

VII HYDROLOGY

Historically, the only hydrological data available from Wilson Inlet and the rivers which enter the inlet, are some temperature and salinity recordings from the Denmark and Hay Rivers by Dr. E. Hodgkin of the Zoology Department, University of Western Australia.

In an attempt to achieve a better understanding of the hydrology of Wilson Inlet, whenever research staff were working in the area, hydrological samples were taken from nine stations in the Inlet (Figure 2). Temperature (°C), salinity (°/oo) and on one occasion, dissolved oxygen were measured. On a number of occasions, due to unfavourable weather conditions, recordings could not be made at Stations 7, 8 and 9.

Temperatures and salinities recorded over the period 1/7/1971 to 29/6/1972 from a P.W.D. Gauging Station, upstream from the Denmark Dam and five miles from the mouth of the Denmark River, are also available (Table 4). The relationship between the daily flow rate and salinity has been determined (Figure 3).

Salinity

The salinities recorded to date are summarised in Table 5 and Figure 4. A transect across the breadth of the Inlet in September 1972, consisting of twenty locations including Station 4, revealed only small variations of up to 0.5 $^{o}/_{oo}$ in both surface and bottom salinities.

Normally, heavy rainfall during the winter months (April to October) (Table 1), results in an increased amount of land water drainage entering the Inlet, causing a reduction in salinity of the Inlet water. The summer and winter levels in 1971/72 ranged between 17$^{o}/_{oo}$ and 21$^{o}/_{oo}$ and 13$^{o}/_{oo}$ and 17$^{o}/_{oo}$ respectively. Unseasonal heavy rainfall during early November, 1971 caused the salinities in the Inlet in late November and December to be lower than those which would have normally been expected. High bottom salinities recorded at a number of stations (Table 5 and Figure 4) during the times when the estuary was open to the ocean, indicated that oceanic water had entered the Inlet. The extent of these high salinity pockets of bottom water has not been investigated.

The lowest salinities were generally those recorded at the stations closest to the entrances of the Denmark and Hay Rivers.

Temperature

Daily water temperatures recorded from Sations 1 to 9, ranged from a low of approximately 11^{o}C in the winter to a high of 24^{o}C in the summer months. Generally surface temperatures were higher than bottom temperatures (Table 6).

Monthly means of a series of 24 hour maximum and minimum recordings made in the shallow water on the western shore adjacent to Station 1, are presented in Table 7.

The daily winter temperature range, recorded in July 1971 was 12.0^{o}C to 13.0^{o}C (Table 6) and the means of minimum and maximum temperatures for July, were 12.0^{o}C and 13.0^{o}C respectively (Table 7). The greatest summer range was recorded in February, where the monthly means of minimum and maximum temperatures were 20^{o}C and 25^{o}C respectively (Table 7).

Dissolved Oxygen

Dissolved oxygen levels of surface and bottom waters at Station 1, 2, 4 and 6 were recorded during January 1973 (Table 8). Station 1 levels were noticeably the lowest, particularly on the estuary bottom where it was thought the dissolved oxygen was being utilised by large quantities of decaying algae.

VIII BIOTA

A preliminary check list has been prepared of fish and crustacea collected from a number of Western Australian estuaries, including Wilson Inlet (Lenanton), 1974). The paper includes a record of those species most commonly caught commercially from the Inlet.

The fishery operates all year round, but only in those areas open to netting (Appendix).

Plankton tows on September 1971 revealed specimens of copepods Acartia clausi, Oithona nana and Harpacticoid spp. At the time of sampling, the water temperature was 13.2°C and the salinity 17.8°/oo.

Several species of fixed algae collected from Wilson Inlet in July 1971 have been identified as Spyridia biannulata, Gracilaria venucosa (Class: Rhodophyta) and Nitella sp. (Class: Charales). The latter is basically a freshwater algae. The estuary salinity at the collection location was 23.0°/oo.

IX THE SAND BAR ACROSS THE ENTRANCE TO WILSON INLET

Brief History of the Opening of the Sand Bar

Originally, the sand bar across the entrance to Wilson Inlet was allowed to break naturally, relying on the accumulated winter freshwater runoff in the estuary to eventually flow over, and cut a considerable channel through the sand bar. This always occurred on the western side of the bar, near the calcarenite cliffs (Figure 2).

The Elleker-Nornalup railway line was constructed in June, 1929. Several years after its construction, it was realigned at a lower level closer to the shoreline of Wilson Inlet. From this time until the removal of the railway line in 1958, it became necessary to open the sand bar artifically each year, to ensure the water in the Inlet did not rise above a level which would flood the railway. Under the direction of the Railways Department, the water in the Inlet was not allowed to exceed a level of 5 ft. 4 ins. (Measured on a gauge at the town bridge) before the bar was artifically broken. The cost was shared by the Railways Department, the Denmark Road Board, and the Department of Fisheries and Fauna.

The latter contributed financially to the operation so that a slightly more costly channel could be cut through on the western side of the bar, where the natural opening had previously been. It was hoped this would create a deeper channel and so provide a more satisfactory passage for fish.

Later, potato growing developed as a large industry. Growers took up land on the shores of Wilson Inlet and the Denmark River. This was another reason for restricting the water level in the Inlet to 5'4" before cutting the channel through the bar.

In 1961, the Denmark River was dammed, and became the major source of water for Albany and surrounding areas. This further reduced the flow of water into the Inlet, and contributed towards the reduced scouring effect of the water flow through the channel in the sand bar.

The restriction placed on the estuary water level over recent years has resulted in a reduced scouring action in the channel, causing a substantial build-up and consolidation of sand banks in the bar area.

At various times over this period, when the level of water in the Inlet was being controlled, it was suggested that water should be allowed to rise to 6ft 4ins to generate a better scouring action. However, all these suggestions were disallowed, with one exception in 1961, when the water accidentally rose to a level of 5ft 7ins.

Opening dates, closing dates, duration and position of opening of the channel in the sand bar are shown in Table 9.

The position of the channel through the sand bar

Originally, the channel cut naturally through the western side of the sand bar. Since the realignment of the railway and prior to 1954, the opening was also made mainly through the western side of the bar. However, towards the end of 1954, it was arranged that the Public Works Department would, in the following winter, make a cut in the bar to ensure a good opening. In their initial years of control, they made the cut in the middle of the bar. Later, however, they changed the cut to the eastern end of the bar. Their objective in making the cut was to choose a place which was the shortest distance between the deep water in the Inlet and deep water in the ocean. This was usually the place which provided the steepest gradient between the Inlet and ocean water so generating a maximum scouring effect. The Public Works Department continued to make the cut in this fashion until

1971, when the Shire of Denmark resumed control for the first of a five year period. The Shire was not satisfied with the cut through the eastern side of the bar, claiming that the original natural location of the channel through the bar was likely to contribute towards a more favourable habitat for the biota of the Inlet. They therefore made the cut through the western side of the sand bar near the Cliffs. Plates 1 to 5 show the various stages of the 1971 opening.

The level of the water in the Inlet

As the railway no longer exists, recent disagreement over the allowable water level in the Inlet when the bar was closed concerned mainly the potato growers and the fishermen. To prevent their ground being flooded, the potato growers do not want the level of the water in the Inlet to rise above 5ft 4 ins. The fishermen however, would like the water in the Inlet to be allowed to rise to its natural maximum, so as to generate the maximum scouring action in the channel through the sand bar.

However, over past years, while the water has been limited to the 5ft. 4 ins level, much permanent road and home building has occurred round the shores of the Inlet. Any increase in the allowable level of the water in the Inlet would almost certainly flood this recent construction. With these points in mind, it is difficult to envisage the water in the Inlet ever being allowed to rise above the 5ft 4 ins level.

Discussion

The major factors which directly affect the hydrology and indirectly the composition and abundance of the species comprising the biota of Wilson Inlet are,

(i) rainfall and land runoff,

(ii) evaporation of estuary and runoff water,

(iii) oceanic water which enters the inlet as a result of tidal action.

It is generally agreed that, during the period when the Inlet is open to the ocean, the channel through the sand bar should allow for the maximum possible water exchange between the ocean and the estuary. This would enable accumulated freshwater, which prevents many potato crops from being planted and at times contains high nutrient agricultural runoff, to escape into the ocean, and provide a path for recruitment of fish into the Inlet.

There appear to be two main factors which govern the extent of the channel through the Wilson Inlet sand bar. These are:

(i) the position of the channel in the sand bar,

(ii) the extent of the head of water trapped in the Inlet.

From the previous section, it is clear that the head of water in the Inlet, prior to the sand bar opening, has in past years, been restricted to a level of 5'4" on the town bridge. This restriction is likely to be maintained in the future. The variable factor is the position of the channel through the sand bar.

In the past, the channel cut through the eastern side of the bar has been located at a point which is the shortest distance between the deep estuary water and the ocean, with a negative gradient from the estuary to the ocean.

When the bar was broken in this position, the trapped estuary water running into the ocean eroded a deep straight channel in the bar allowing rapid passage into the ocean. After several days, the estuary becomes tidal, and experiences a good water exchange with the ocean.

On most occasions, the point where the channel opened into the ocean was in line with an offshore "rip" over what is known locally as the "Dunsky Reef". This "rip" helps relocate the suspended material from the channel area into deeper water further offshore.

The deep channel allows for better recruitment of fish into, and quick release of accumulated fresh water from, the estuary.

In 1971 and 1972, the channel was cut through the western side of the bar, next to the cliffs. At this location, the distance between the deep estuary water and the ocean was greater, and the negative gradient between the estuary and the ocean less, than for the channel cut through the eastern side of the bar.

When the bar was broken, the trapped estuary water flowed into the ocean more slowly, forming a shallow meandering channel in the bar (Plate 6). Once the estuary became tidal, there was a poor water exchange between the ocean and the estuary. Suspended material from the channel area was relocated immediately offshore from the channel entrance forming a shallow bank where heavy ocean swells broke, causing the water at the entrance to the channel to become very turbulent.

The turbulent nature of this channel water could well adversely affect recruitment of fish into the Inlet. The shallow meandering

nature of the channel could restrict water exchange between the Inlet and the ocean, so preventing the quick release of accumulated fresh water trapped in the estuary.

A review of the situation which has existed in Wilson Inlet in the past two years, further illustrates the above points.

The sand bar was opened by the Denmark Shire Council in July 1971 after what appeared to be a normal winter's rainfall. It remained open for 231 days, to close naturally in March 1972. Normally over these summer months, the rainfall is minimal. However, during early November 1971 there were some very heavy falls of unseasonal rainfall with the inevitable result that the amount of freshwater runoff entering the Inlet was much greater than usual. This was reflected in the salinities, which fell from approximately 17°/oo in September 1971 to approximately 11°/oo in late November (Table 5).

During the period the bar was open, there was at times an influx of oceanic water, as evidenced by pockets of high salinity bottom water (Table 5).

Throughout the 1972 winter, rainfall was particularly light. The sand bar was re-opened by the Shire in August 1972. It remained open for 122 days, to close naturally in December 1972. Salinities taken during September 1972 when the bar was open, indicated that there had been very little penetration of oceanic water into the Inlet.

The salinities were lower than at the corresponding time during 1971. (Table 5).

In both the 1971 and 1972 openings, the channel through the sand bar was shallow and meandering. This had the effect of restricting the water exchange between the estuary and the ocean so preventing estuarine water from escaping into the ocean.

Unseasonal rainfall in November, 1971 caused lowered salinities in Wilson Inlet and maintained a continuous freshwater input to the Inlet, which had the effect of keeping the channel to the ocean open for a longer period than normal.

The fact that in 1972 the channel through the sand bar remained open for only 122 days and that during this period there was no evidence of a significant influx of oceanic water further supports the view that the shallow meandering nature of the channel restricted the water exchange between the estuary and the ocean.

Conclusion

From the above discussion it is apparent that rainfall and land run-off, and the water exchange between the ocean and the estuary, are the two factors which most affect directly the hydrology, and indirectly the biota, of Wilson Inlet.

Of these two factors, the one over which man has the most control is the water exchange between the estuary and the ocean.

It would appear from the short period of studying the Inlet, that the ideal situation would be one which allows the maximum amount of exchange between ocean and estuary during the period the estuary is open to the ocean.

This can best be achieved if the channel connecting the estuary and the ocean is deep, straight, and located at a point which is the shortest distance between the deep water of the estuary and the ocean, so generating the maximum negative gradient between the estuary and the ocean.

REFERENCES

Australia Pilot Vol. I. 5th Edition 1960. (Hydrographic Dept. Admiralty, London)

Dept. of Fisheries and Fauna. File 142/51. (Government of Western Australia, Perth)

Details of Western Australian Dams.(Public Works Dept. Water Resources Section. Govt. of Western Australia, Perth)

Hodgkin E.P. and Di Lollo, V. (1958) The Tides of South Western Australia. J. Proc. R. Soc. West. Aust. 41 (2), 42-54.

Jennings J.N. and Bird E.C.F. (1967). Regional geomorphological characteristics of some Australian estuaries. In "Estuaries" (Ed. G.H. Lauff), p. 121-129. (American Association for the Advancement of Science, Washington).

Lenanton, R.C. (1974) The fish and crustacea of the Western Australian south coast rivers and estuaries. Fish. Bull. West. Aust. 13 , 1-17.

Rochford D.J. (1959) Classification of Australian estuarine systems. Estr. Arch. Oceanog. Limnol., 11, 171-177

Plates 1 – 6

Plate 1—The first step in the opening of the estuary. A channel has been bulldozed from the estuary to the centre of the sand bar, a week or so prior to the opening date.

Plate 2—The second half of the channel is bulldozed early on the opening day. A small section of the sand bar, midway along the channel is left unbroken.

Plate 3—The final section of the bar is broken, late on the opening day.

Plate 4—The channel the day after the opening.

Plate 5—The channel the second day after the opening.

Plate 6—The shallow meandering channel through the bar several weeks after the initial opening.

APPENDIX

History of netting closures in Wilson Inlet

The following are the schedules which cover the closed waters in Wilson Inlet.

The Minister of Fisheries and Fauna prohibits all persons from taking any fish whatsoever by means of fishing nets in any of the Western Australian waters specified in the schedules below.

Schedules

1. The whole of the waters of the Denmark River and its tributaries and that portion of the waters of Wilson Inlet within a radius of half-a-mile from the mouth of said Denmark River. (Extract from Government Gazette (No.52) of the 30th May, 1969). See Figure 2 in text.

2. The whole of the waters of the Hay River and its tributaries, and that portion of the waters of Wilson Inlet east and south east of a line drawn from the north-east corner of Plantagenet Location 1500 to the south-west corner of Plantagenet Location 3502. (Extract from the Government Gazette (No.50) of the 23rd May, 1969). See Figure 2 in text.

3. All waters of Wilson Inlet situated between the low water mark of Ratcliffe Bay (Southern Ocean) and a line joining the southernmost extremity of reserve 12344 and the north-eastern corner of Plantagenet Location 1828. (Extract from the Government Gazette (No.7) of 2nd February 1968). See Figure 2 in text.

The Denmark and Hay Rivers (Schedule 1 and 2) were originally closed to protect the juvenile fish which were thought to be living in the rivers. The closure specified in Schedule 3 (above) has been the subject of some controversy in past years. The following is a brief account of the controversy.

The closure of the waters inside the sand bar at the entrance of Wilson Inlet was originally designed to protect schools of potential spawning fish which congregated in the Inlet in the shallow water near the sand bar.

Prior to 1951, the closure included water further upstream than the waters indicated in the present schedule. (Schedule 3 above). It included water up to 20 feet in depth, and only applied to the

period when the estuary was open to the sea. This was most unsatisfactory, because when the Inlet was closed, potential spawning fish which ventured into the shallow water near the bar were able to be caught. After 1951, the upstream boundary of the closed water was reduced by $\frac{3}{4}$ mile, the closure operating all the year round. This offered year round protection to the potential spawners waiting to go to sea, and those living in the shallow water over the sand bar. The new boundary still included parts of the Inlet with water ranging from 12 to 16 feet in depth. In 1966, the closure was again extended upstream to include the waters generally south of Honeymoon Island.

In 1967, the General Fisheries Advisory Committee considered the problem of the closed water boundary and recommended the following from a meeting on May 1st, 1967.

> "It was said that the restrictions on nets in Wilson Inlet should be lifted during part of the winter months. Professional fishermen claimed that when the bar was cut and the Inlet opened to the sea, large quantities of fish escaped which did not return to the Inlet. The main reason the Denmark Shire Council want the area permanently closed is because it claimed that fish leave the Inlet to spawn when the bar breaks through. However, Mr. R. Slack-Smith, Research Officer with the Department of Fisheries and Fauna, stated that these fish, which were considered part of the whole oceanic stock, would have little ill effect on the re-stocking of the Inlet".

As a result, the following resolution was passed.

> "The Committee resolved that a recommendation be made to the Minister, that the Waters of Wilson Inlet be opened to net fishing from July 1st to July 31st or when the bar opens, whichever comes first".

The proclamation was issued on the 4th August, 1967 and subsequently withdrawn in February 1968. The present proclamation (see Schedule 3 above) is identical to the one issued in 1956.

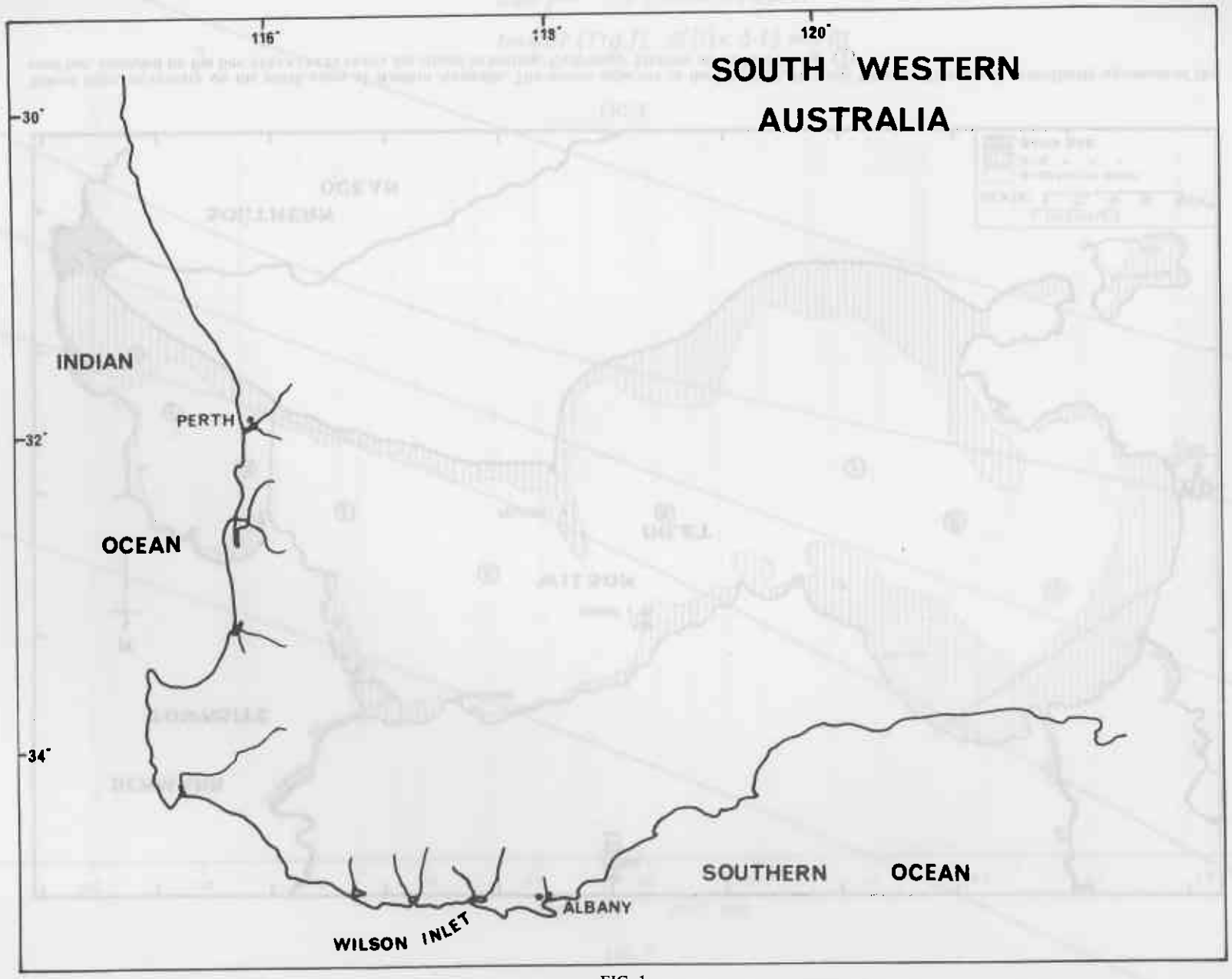

FIG. 1

The location of Wilson Inlet in south Western Australia.

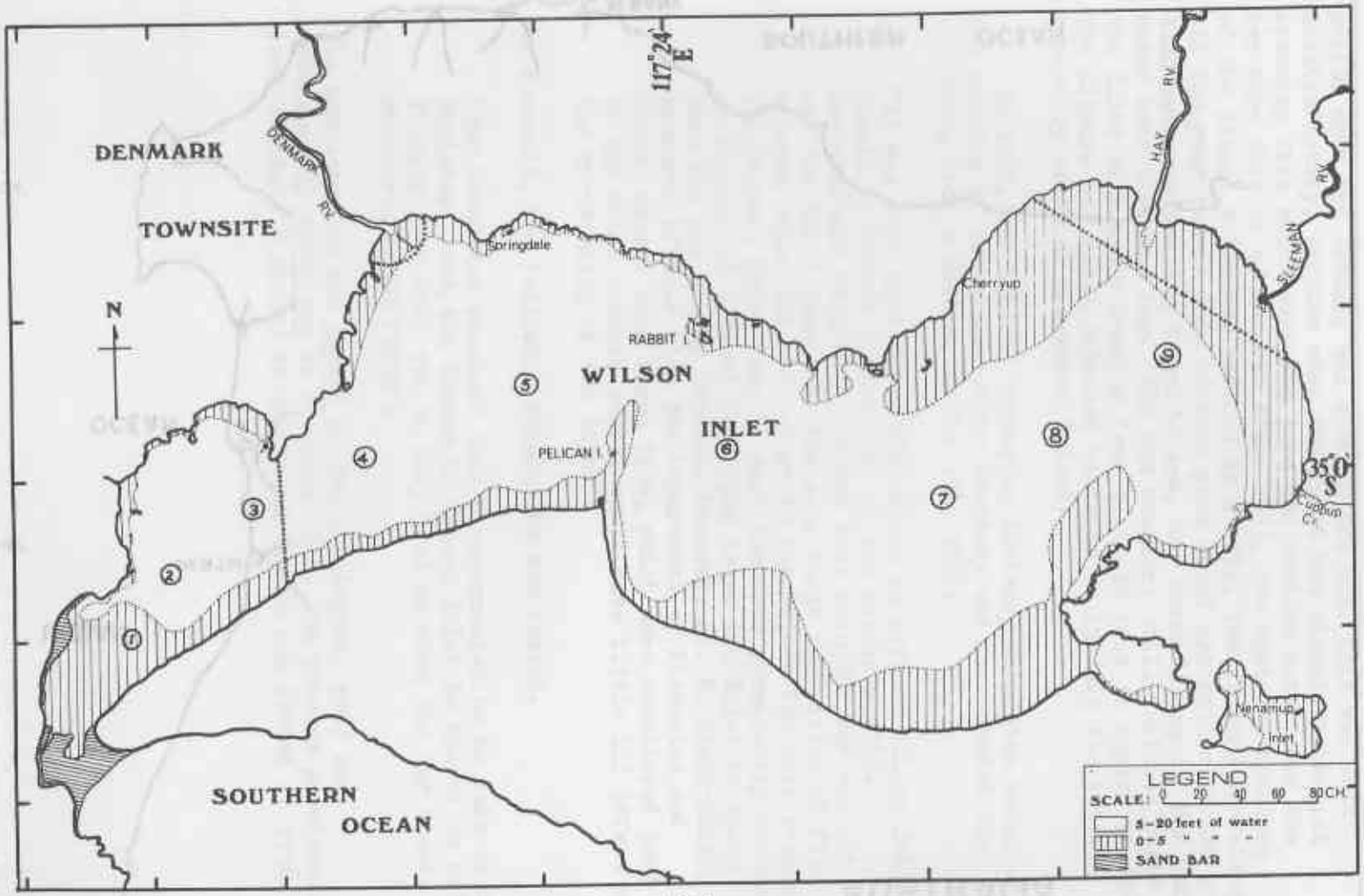

FIG. 2

Wilson Inlet, an estuary on the south coast of Western Australia. The waters adjacent to the Denmark, Hay and Sleeman Rivers, and immediately upstream of the sand bar, bounded by the line xxxxxxxxxxxxxxx are closed to netting. Hydrology Stations are indicated, e.g. (1)

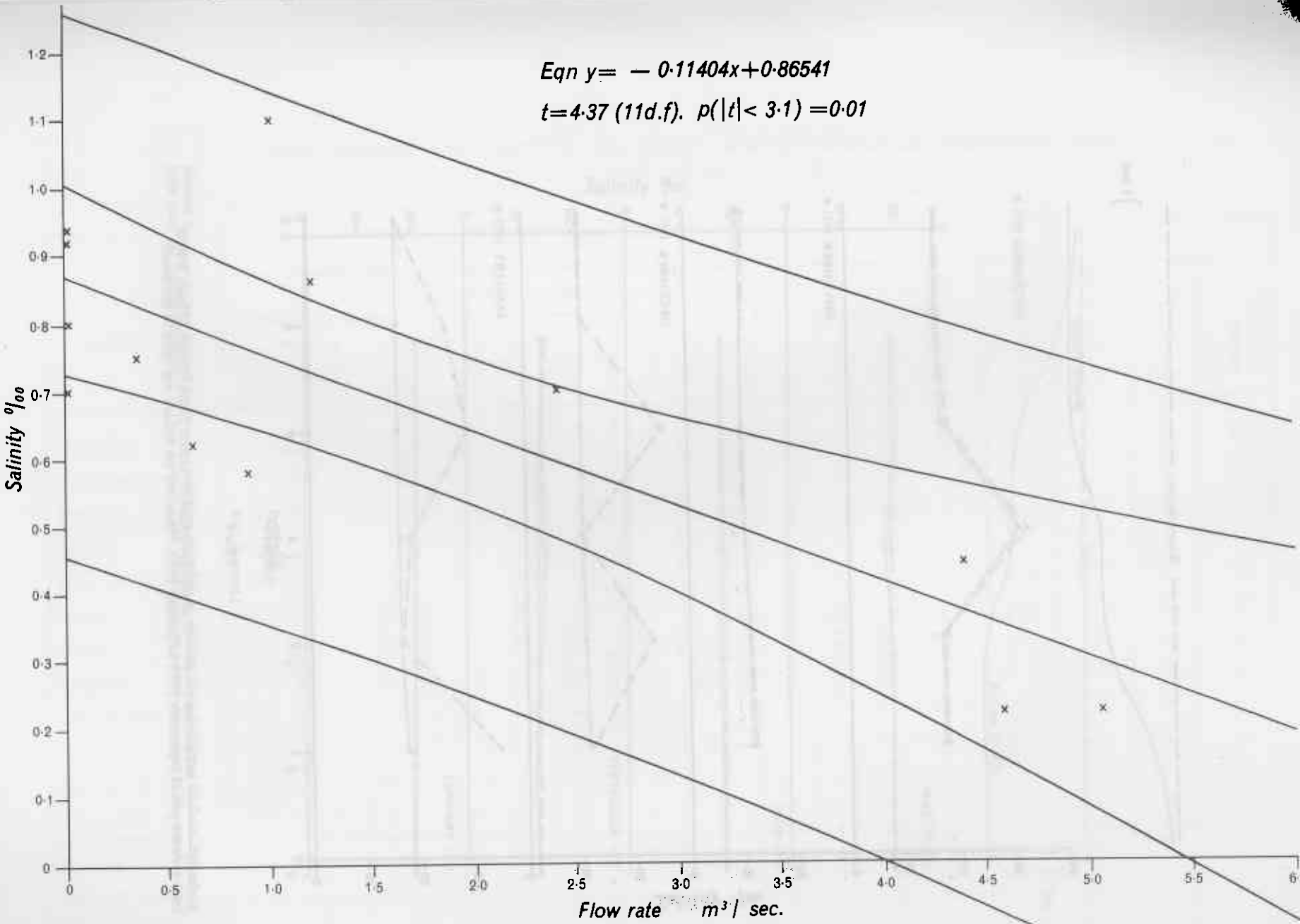

FIG. 3

The relationship between salinity and flow rate at a point 5 miles up the Denmark River, calculated from data recorded over the period July 1971 to June 1972.

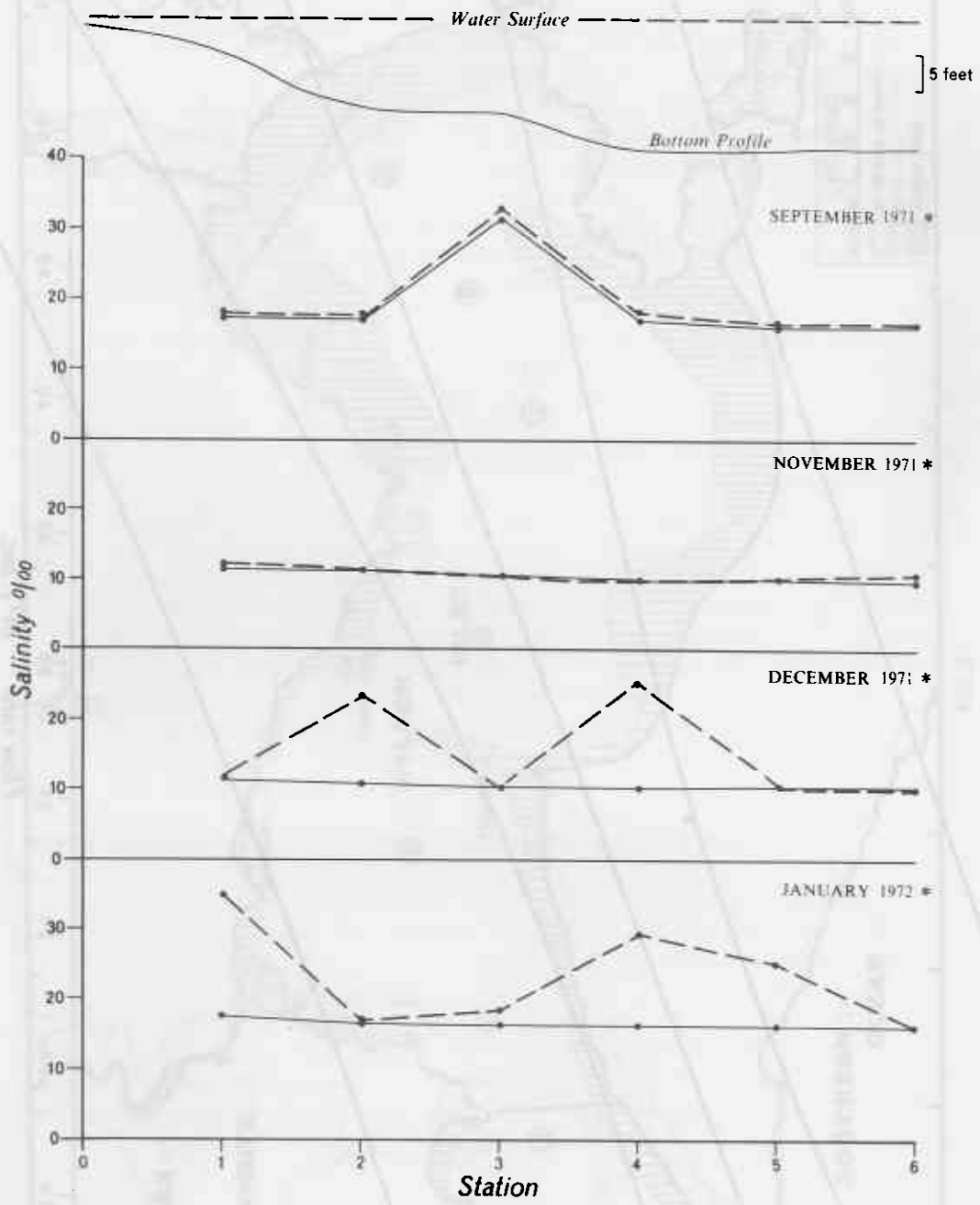

FIG. 4

Surface (•———•) and bottom (•— — —•) salinities recorded at stations 1 to 6 (Figure 2) from Wilson Inlet over the period September 1971 to January 1973. *Indicates the estuary was open to the ocean.

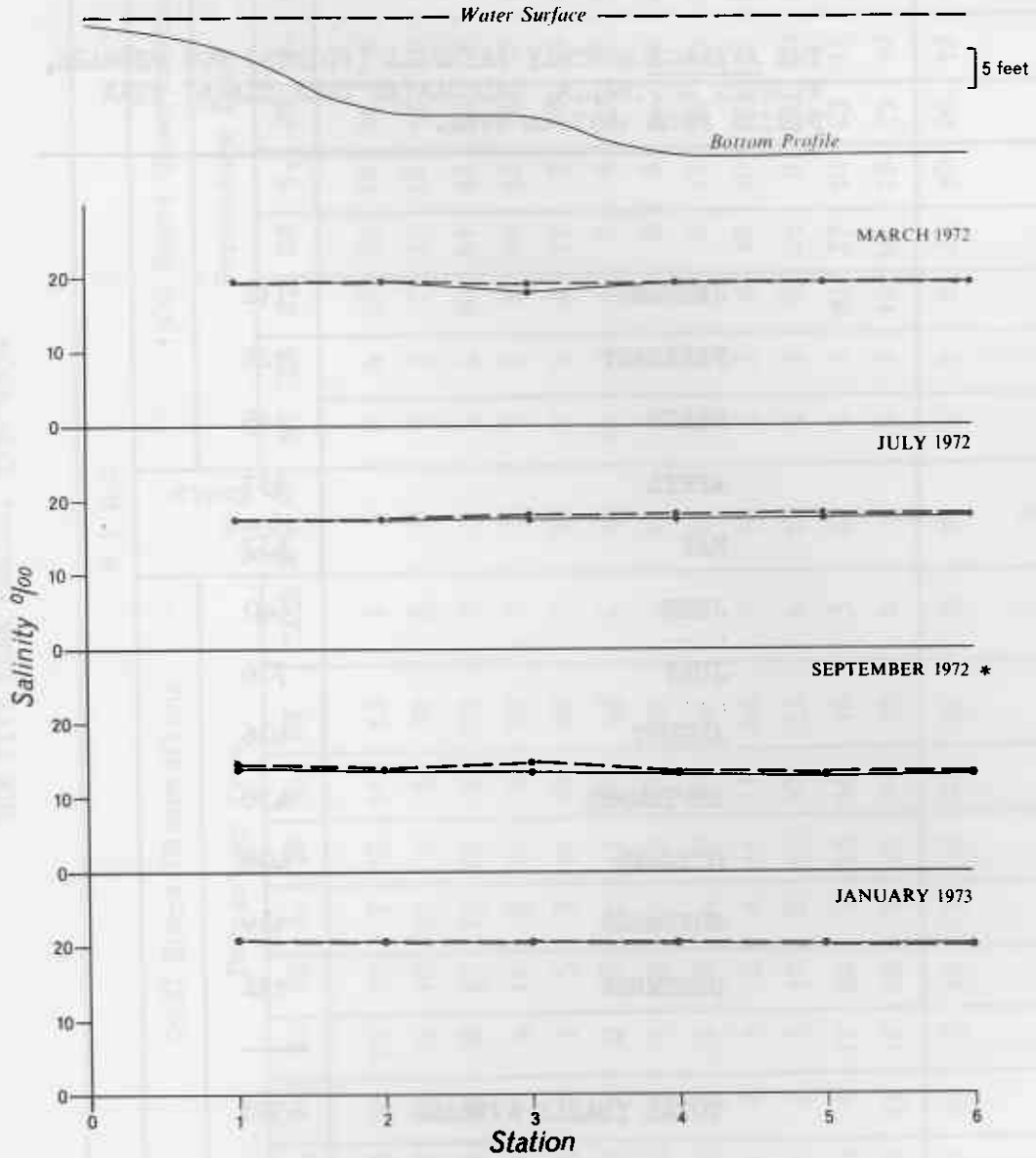

FIG. 4 (cont.)

Surface (•———•) and bottom (•– – –•) salinities recorded at stations 1 to 6 (Figure 2) from Wilson Inlet over the period September 1971 to Janaury 1973. *Indicates the estuary was open to the ocean.

TABLE 1

THE AVERAGE MONTHLY RAINFALL (POINTS) FOR DENMARK, WESTERN AUSTRALIA, CALCULATED OVER THE 67 YEAR PERIOD FROM 1897 to 1964.

JANUARY	112
FEBRUARY	126
MARCH	215
APRIL	337
MAY	537
JUNE	640
JULY	706
AUGUST	606
SEPTEMBER	478
OCTOBER	408
NOVEMBER	189
DECEMBER	152
TOTAL YEARLY AVERAGE	4508

TABLE 2

WIND STRENGTH AND DIRECTION FOR ALBANY, WESTERN AUSTRALIA, CALCULATED OVER THE FIVE YEAR PERIOD, 1950-1954

MONTH	WIND																			
	0900 Hours Observations										1500 Hours Observations									
	Percentage from									Mean Speed In Knots	Percentage from									Mean Speed In Knots
	N.	NE	E.	SE	S.	SW	W.	NW	CALM		N.	NE	E.	SE	S.	SW	W.	NW	CALM	
January	3	16	15	19	7	13	11	13	3	9	0	4	12	39	12	24	6	3	0	14
February	7	16	15	18	10	6	5	20	3	9	1	7	17	35	12	13	12	3	0	13
March	7	18	8	17	13	14	6	12	5	9	1	4	10	41	12	22	6	4	0	13
April	11	11	4	11	9	11	5	29	9	8	3	8	9	29	12	16	12	10	1	12
May	15	6	1	5	5	11	10	40	7	10	9	9	4	11	7	18	13	28	1	12
June	17	6	0	3	5	11	10	45	2	12	14	5	1	9	6	17	12	36	0	13
July	14	3	1	5	5	10	13	45	4	12	7	4	1	6	6	14	20	41	1	14
August	11	8	2	6	4	8	15	40	6	12	8	6	8	8	12	12	23	25	0	15
September	11	8	1	4	6	11	11	41	7	10	5	3	6	10	10	25	18	22	1	15
October	10	6	5	12	8	12	10	33	4	10	1	3	8	25	9	24	20	10	0	15
November	5	9	11	20	7	13	16	16	3	12	1	1	10	37	10	29	11	1	0	15
December	3	12	12	26	9	11	10	13	4	9	0	2	12	40	13	19	10	4	0	13
Means	10	10	6	12	7	11	10	29	5	10	4	5	8	24	10	20	13	16	1	14
No. of years of observation										5										

TABLE 3

THE AVERAGE MONTHLY AIR TEMPERATURE (^{o}F) FOR DENMARK, WESTERN AUSTRALIA, CALCULATED OVER THE 5 YEAR PERIOD FROM 1950 TO 1954.

	MAXIMUM	MINIMUM
JANUARY	78.5	55.7
FEBRUARY	77.5	55.8
MARCH	75.9	52.9
APRIL	70.2	49.0
MAY	65.1	46.8
JUNE	61.7	44.0
JULY	60.7	42.0
AUGUST	61.4	43.7
SEPTEMBER	64.1	44.6
OCTOBER	65.9	47.4
NOVEMBER	68.7	48.9
DECEMBER	72.5	51.9
YEARLY AVERAGE	68.5	48.6

TABLE 4

SALINITY AND TEMPERATURE OBSERVATIONS AT GAUGING STATION 603136 ON THE DENMARK RIVER AT MOUNT LINDSAY.

DATE	SALINITY °/oo	TEMPERATURE °C	DAILY FLOW RATE m^3 /sec.
1/ 7/71	0.746	11.1	0.34546
21/ 7/71	0.580	11.1	0.89481
3/ 8/71	0.860	11.7	1.25727
11/ 8/71	1.140	11.1	1.01091
30/ 8/71	0.700	11.1	2.49189
5/10/71	0.225	13.9	4.58735
28/10/71	0.440	13.3	4.38913
27/11/71	0.220	16.7	5.04042
24/1 /72	0.700	21.1	0.02265
27/ 3/72	0.800	20.0	0.00028
9/ 5/72	0.920	13.3	0.02293
30/ 5/72	0.940	11.1	0.02038
39/ 6/72	0.620	9.4	0.60598

TABLE 5

SALINITIES (°/oo) RECORDED FROM WILSON INLET

I Prior to the hydrological stations being established.

	Date	Position	Hay River	Denmark River	Wilson Inlet
*	11/1/71	Surface	25.4	24.0	-
		Bottom	26.9	27.7	-
	30/3/71	Surface	28.7	15.6	-
		Bottom	29.0	28.0	-
	29/6/71	Surface	16.1	11.2	23.3
		Bottom	-	26.0	23.3

II At Hydrological Stations

	Date	Position	Stations 1	2	3	4	5	6	7	8	9
*	22/9/71	Surface	17.7	17.7	31.8	17.2	16.3	16.4			
		Bottom	17.8	17.7	33.0	17.5	16.7	16.5			
*	20/11/71	Surface	11.7	11.4	10.9	10.3	10.5	10.0			
		Bottom	12.0	11.4	10.9	10.1	10.4	10.4			
*	11/12/71	Surface	11.5	11.0	10.8	10.7	10.6	10.7			
		Bottom	11.8	23.3	10.9	25.5	10.8	10.5			
*	29/1/72	Surface	17.9	16.7	16.5	16.3	16.0	16.1			
		Bottom	35.0	17.1	18.4	29.2	25.2	16.1			
	7/3/72	Surface	19.6	19.5	18.0	19.2	19.1	19.1			
		Bottom	19.5	19.5	19.1	19.1	19.1	19.1			
	6/3/72	Surface	17.3	17.3	17.5	17.4	17.5	17.6	17.6	17.7	17.8
		Bottom	17.3	17.3	17.6	17.6	17.9	17.8	17.8	17.9	17.8
*	27/9/72	Surface	13.9	13.7	13.5	13.3	13.0	13.1			
		Bottom	14.1	13.8	14.9	13.5	13.3	13.4			
	11/1/73	Surface	20.3	20.4	-	20.1	20.0	20.1			
		Bottom	20.3	20.4	-	20.1	20.0	20.0			
Station Depth (ft) (Depth varies with tides and prevailing weather conditions)			4-5	12-15	12-15	18-20	18-20	18-20	16-17	10-11	8-9

* Indicates the estuary was open to the ocean.

N.B. Ocean salinity measured on the 7the July, 1971 was 35.653°/oo.

TABLE 6

WATER TEMPERATURES (°C) RECORDED FROM WILSON INLET

I Prior to the hydrological stations being established

	Date	Position	One mile east of the Denmark River mouth	Springdale
*	20/7/71	Surface	12.5	12.3
	20/7/71	Observed daily range		12.0 - 13.0

II At hydrological stations

	Date	Position	Stations 1	2	3	4	5	6	7	8	9
*	22/9/71	Surface	14.0	13.7	13.8	13.3	13.3	13.5			
		Bottom	14.2	13.7	13.4	12.8	12.7	12.7			
*	20/11/71	Surface	16.9	16.3	16.5	15.7	15.8	16.3			
		Bottom	16.6	16.1	16.5	14.8	14.4	15.3			
*	11/12/71	Surface	19.8	19.4	19.2	19.0	19.1	18.9			
		Bottom	19.5	18.5	19.1	18.2	19.2	18.7			
*	29/1/72	Surface	23.4	22.5	22.3	22.2	22.3	22.5			
		Bottom	21.2	22.3	22.7	22.3	21.7	22.4			
	7/3/72	Surface	21.9	22.6	22.4	21.9	22.0	22.0			
		Bottom	21.9	22.5	22.2	21.8	21.8	21.9			
	6/7/72	Surface	11.4	11.0	11.1	11.2	11.0	11.1	11.3	11.4	11.6
		Bottom	11.3	11.0	11.0	10.9	10.8	10.7	11.0	11.1	11.6
*	27/9/72	Surface	16.7	15.7	15.5	15.4	15.9	15.9			
		Bottom	16.5	15.4	14.4	14.8	14.9	14.8			
	11/1/73	Surface	23.4	23.5	-	23.3	23.3	23.3			
		Bottom	23.2	23.5	-	23.3	23.3	23.3			
Station Depth (ft) (Station depth varies with tides and prevailing weather conditions)			4-5	12-15	12-15	18-20	18-20	18-20	16-17	10-11	8-9

* Indicates the estuary was open to the ocean.

TABLE 7

MONTHLY MEANS OF DAILY MAXIMUM AND MINIMUM SURFACE WATER TEMPERATURES RECORDED FROM A JETTY ON THE WESTERN BANK OF WILSON INLET ADJACENT TO THE NUMBER 1 HYDROLOGICAL STATION, OVER THE PERIOD JULY 1971 TO MAY 1972

Month	Mean Temperature °C		Number of Observations
	Maximum	Minimum	
July	13	12	6
August	12	11	20
September	13	12	24
October	15	14	10
November	18	14	21
December	22	17	31
January	24	19	31
February	25	20	29
March	22	18	31
April	18	14	30
May	16	14	20
June	-	-	-

TABLE 8

DISSOLVED OXYGEN RECORDED FROM THE WATERS OF WILSON INLET ON 11/1/1973

Station	Position	Temperature °C	Salinity °/oo	O_2 % saturation
1	Surface	23.4	20.3	87.44
	Bottom	23.2	20.3	72.13
2	Surface	23.5	20.4	95.00
	Bottom	23.5	20.4	105.84
4	Surface	23.3	20.1	98.92
	Bottom	23.3	20.1	98.88
6	Surface	23.3	20.1	99.50
	Bottom	23.3	20.0	101.55

TABLE 9

OPENING AND CLOSING DATES, DURATION AND POSITION OF OPENING OF THE CHANNEL, THROUGH THE WILSON INLET SAND BAR.

Year	Opening Date	Closing Date	Period Open(Days)	Position of Opening
1954	N.A.	N.A.	-	West Side
1955	15 June '55	N.A.	-	" "
1956	10 June '56	N.A.	-	" "
1957	8 August '57	N.A.	-	" "
1958	7 August '58	28 December '58	147	" "
1959	Bar Not Open	-	-	" "
1960	12 July '60	5 January '61	177	" "
1961	4 July '61	24 December '61	173	" "
1962	17 August '62	24 January '63	160	Middle to East Side
1963	4 July '63	19 January '64	199	" "
1964	22 July '64	N.A.	-	" "
1965	24 August '65	N.A.	-	" "
1966	27 July '66	N.A.	-	" "
1967	18 July '67	April '68	277 ± 15	" "
1968	1 August '68	14 February '69	198	" "
1969	1 September '69	22 December '69	113	" "
1970	2 August '70	22 February '71	204	" "
1971	16 July '71	4 March '72	231	West Side
1972	10 August '72	10 December '72	122	" "

N.A. = Not Available.

Source of Information:

(i) Public Works
Harbours and Rivers Section
Albany District Office

(ii) Dept. Fisheries and Fauna File 142/51

38679/6/74-600-3888

CORRIGENDUM

DEPARTMENT OF FISHERIES AND FAUNA
REPORT NO. 14

"Wilson Inlet a Seasonally Closed Western Australian South Coast Estuary"

by R.C.J. Lenanton
June 1974

Page 8 VII HYDROLOGY
para 1 should read:

"Historically, the only hydrological data available from Wilson Inlet, besides the CSIRO data collected during 1944-50 (Spencer, 1952), are some temperature and salinity data from the Denmark and Hay Rivers recorded by Dr E. Hodgkin of the Zoology Department, University of Western Australia."

Page 16 Add

"Spencer, R.S. (1952), Hydrological investigations in South-Western Australia, 1944-50. CSIRO Oceanographical Station List 8, 96-101, 136-137, 151"