MACQUARIE HARBOUR, TASMANIA — SEASONAL OCEANOGRAPHIC SURVEYS IN 1985

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(with three text-figures)

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Seasonal oceanographic surveys of Macquarie Harbour suggested the existence of a three-layer system: a surface layer responsive to seasonal heating and cooling and to river runoff, a slowly changing mid-level layer, and (in the deeper basins) a marine layer fed by tides flooding over the sill.

Key Words: oceanographic survey, Macquarie Harbour, Tasmania.

INTRODUCTION

Macquarie Harbour in western Tasmania is one of Australia's largest estuaries. It has inputs from both nature and the activities of mankind — the sea, rivers and rainfall (1.8 m annually at the coast and 2.6 m in the highlands); mine slurry discharged into the King River for over a century and cold water discharged from turbines deep in the Gordon Dam. A recent review of the state of knowledge of the hydrological and hydrodynamic system of Macquarie Harbour found this to be "totally inadequate for making any statement on the environmental effects of any development projects which will physically alter the rivers or the harbour" (Waterman and Matthews, 1979).

1985 SURVEYS

The present study was modest in both effort and expense; it was designed to get an initial feeling for the seasonal variations of standard oceanographic water properties in the harbour. Four oceanographic surveys of the harbour and the Gordon River were made in January, March, July and October 1985, using a powered catamaran chartered from the National Parks and Wildlife Service; the Gordon River was monitored because of its importance as a source of fresh water for the harbour. As shown in figure 1, four stations were sited along the harbour axis (named according to the nearest landmark) and three on the river — "down-river" at the mouth of the Gordon River, "mid-river" 8 km upstream, and "up-river" 35 km upstream at Warners Landing. (The undammed Franklin River flows into the Gordon River 5 km upstream from Warners Landing.)

Nansen bottles (with reversing thermometers) were spaced at 2.5, 5 or 10 m depth intervals. The lead weights on the Nansen bottle wires were used for sounding at the stations. Water samples were analysed for salinity, oxygen, nitrate, and silicate content (Major *et al.* 1972).

The January and October surveys were each completed in one day. Both the others required part of an extra day because of bad weather on the March survey and bad weather and short daylight hours on the July survey.

The authors' conclusions about seasonal variations take no account of high frequency variations due to tides, passing weather patterns, varying flow through the Gordon Power Station, etc. However, the harbour is expected to have a long time constant as compared to, say, a river, so that the coarse temporal sampling used will be suitable for identifying gross seasonal variability.

RESULTS

Macquarie Harbour

The sections (fig. 2) and the temperature, salinity, and oxygen profiles at the Sophia stations (fig. 3) enable three layers to be identified in the harbour: (1) A surface layer in the upper 10 m, dominated by seasonal heating and cooling and river runoff. The annual surface temperature range at the Sophia station is nearly 10°C. The runoffs from the Gordon

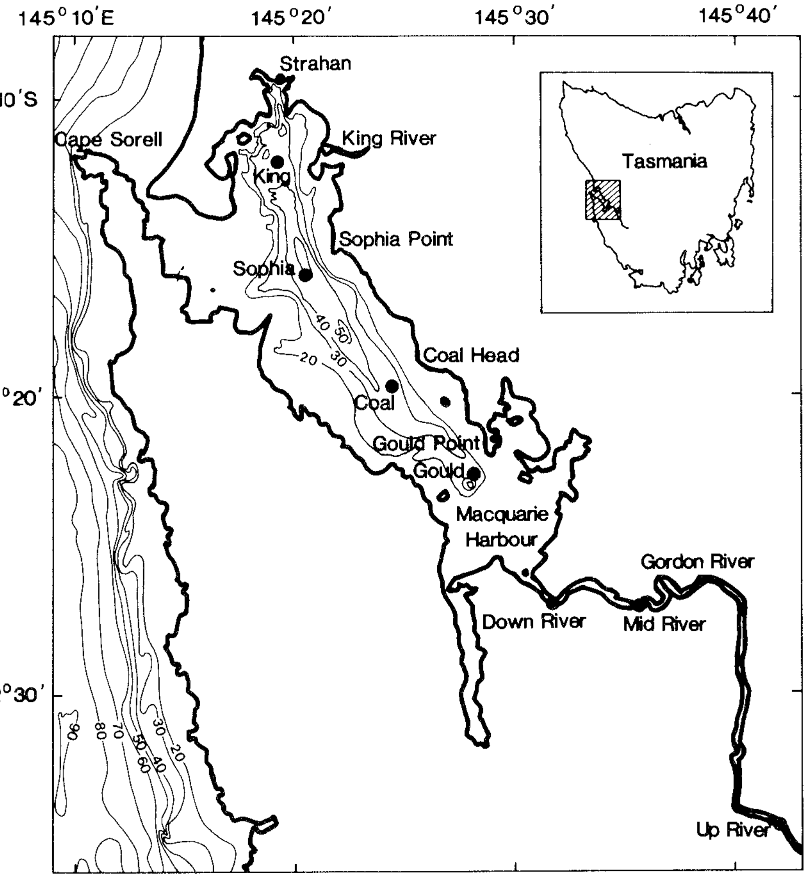


Fig. 1 — A chart of Macquarie Harbour and the Gordon River, showing the station positions.

River and, to a lesser extent, the King River brings waters low in salinity and high in oxygen and silicate into the harbour.

(2) A long-residence-time layer centred at about 20 m depth, having a small annual temperature range (0.8°C), low oxygen content and, in general, a peak in the nitrate content.

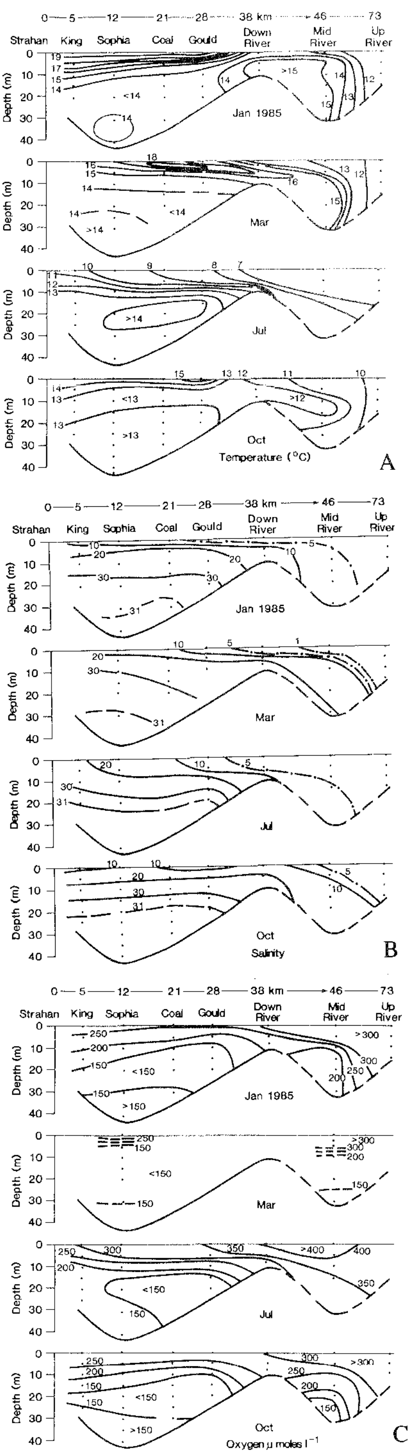
(3) A deep marine layer in which the salinity exceeds 31‰ and the oxygen content increases with depth. The annual variation of the temperature of this layer (1.5°C) has a phase similar to that of the ocean, being warmest in March and coldest in October. The layer is probably replenished by flood tides bringing in marine water, which is then modified by mixing across the harbour entrance before sinking to the deepest basins. The entrance to the harbour is about 7 m deep and the speed of the flood tide ranges from 2 to 6 knots (Waterman & Matthews 1979).

The Gordon River

The sections (fig. 2) revealed the Gordon River to be a source of fresh high-oxygen waters. The up-river station was mixed from top to bottom, with no sign of saline waters. The salt wedge always reached the mid-river station, where the maximum salinity was 20.8‰ in March.

DISCUSSION

A testable hypothesis arising from this work is that the water at about 20 m depth in the harbour has a long residence time and is low in oxygen. Above this, the water properties are controlled by runoff and seasonal heating and cooling, while below, in basins where depth exceeds 20 m, can be found marine water that has been modified by mixing.



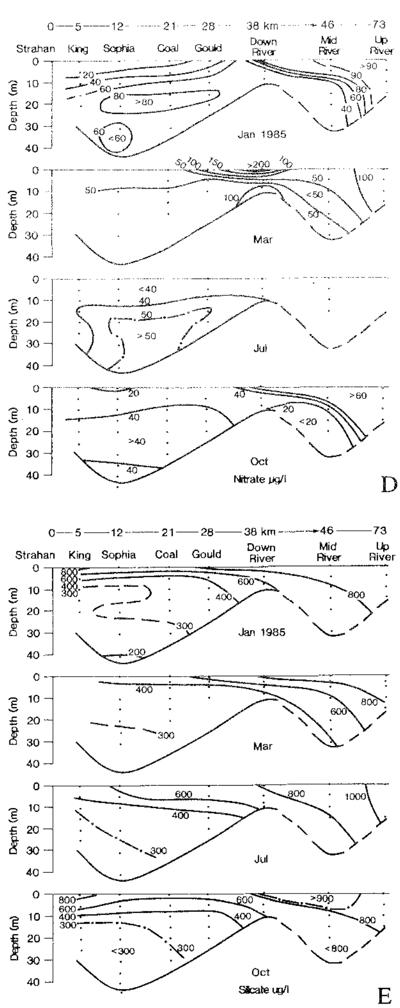


Fig. 2 — Sections along the axis of Macquarie Harbour and the Gordon River for the four surveys: (A) temperature, (B) salinity, (C) oxygen, (D) nitrate, (E) silicate.

Since 20 m is not an uncommon depth in the harbour, a large part of the harbour floor will be covered by water low in oxygen. The chemistry and biota may reflect this.

Waterman & Matthews (1979) took temperature and salinity profiles around the harbour on four days in early September 1979. Their temperature section along the harbour axis was very similar to that for July 1985, except that it was restricted to 26 m depth by the length of their instrument cable. The salinities measured at these depths were lower

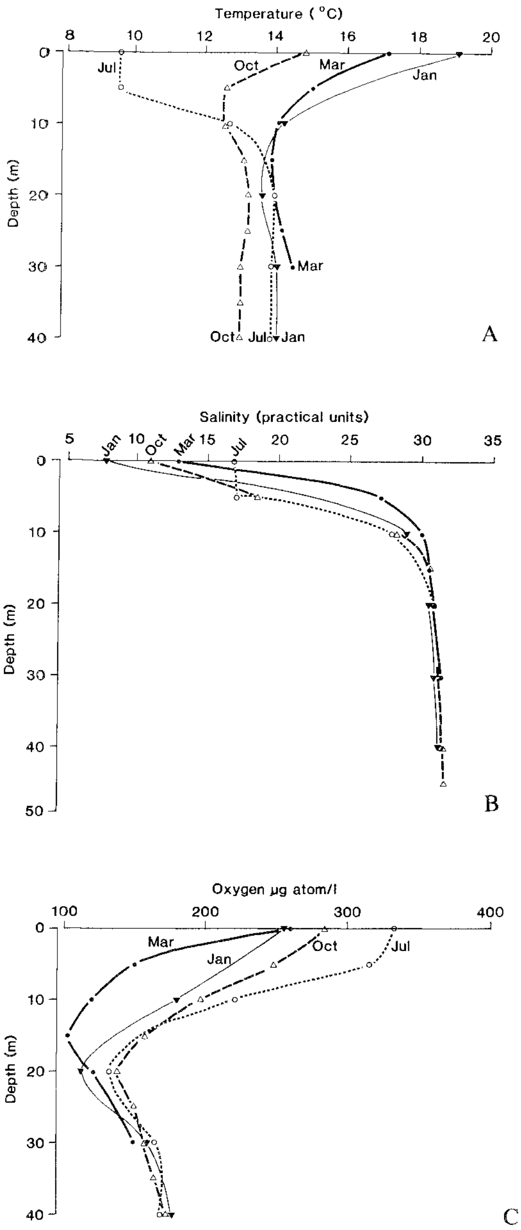


Fig. 3 — Profiles for the four surveys at the Sophia station for (A) temperature, (B) salinity, and (C) oxygen.

(27‰) than the value of 31‰ measured on all four of these 1985 surveys.

In the Gordon River, the salt wedge was always present at the mid-river station. Kearsley (1978) found that the length and depth of the wedge depended almost entirely on the flow in the river and concluded that in high flows the salt wedge would be almost entirely flushed out of the river. King & Tyler (1981) have expressed a concern that the controlled flow from the Gordon River Power Station prevents the natural upstream excursions of the salt wedge, which are probably essential to provide salt water to the meromictic lakes along the river. Certainly, the salinities at the mid-river station 8 km from the mouth were much less (20‰ versus 30+‰) than the pre-dam values reported by Kearsley (1978).

CONCLUSIONS

The series of surveys along the harbour axis has proven useful in identifying gross seasonal variations. The biological implications of the apparent long-residence-time, low-oxygen layer at mid-levels could be a fruitful subject for future study.

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REFERENCES

KEARSLEY, B.V., 1978. *THE PHYSICAL BEHAVIOUR OF SALINE WATER IN THE GORDON RIVER ESTUARY.* Lower Gordon River Scientific Survey, Hydro-Electric Commission, Hobart.

KING, R.D. & TYLER, P.A., 1981. Meromictic lakes of South-west Tasmania. *Aust. J. Mar. Fresh. Res.* 32: 741–756.

MAJOR, G.A., DAL POINT, G., KLYE, J. & NEWELL, B., 1972. Laboratory techniques in marine chemistry. A manual. *CSIRO Aust. Div. Fish Oceanogr. Rep.* No. 51.

WATERMAN, P. & MATTHEWS, J.H., 1979. A Review of Information on the Macquarie Harbour Environment. *SWTRS Discussion Paper* No. 20, NPWS, Hobart.

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