Near-shore Australian waters tend to have only small concentrations of nutrients, and we have no major upwelling areas. We do not know why this is so, because the wind systems should favour upwelling in some areas. The only upwelling areas we know about are off the north coast of New South Wales, off Gippsland and at the western end of Bass Strait. In these areas upwelling is sporadic, intermittent and short-lived. Its influence on productivity is not known. The low level of nutrients and absence of major upwelling areas are factors contributing to the very low position of Australia as a fishing country.

ACKNOWLEDGMENT

Adapted from Chapter 1, which I wrote, in 'Australia's Underwater Wilderness' (Ed. Roland Hughes) 1985, 264 pp. with permission of the publishers (Weldons Pty Ltd: Sydney).

FURTHER READING

For more detail on the physics of the ocean, see:

Pickard, G. L. and Emery, W. J. (1982) 'Descriptive Physical Oceanography'. Fourth Edition, (Pergamon Press: Oxford.)

A local book, with some local examples and a different approach to the subject is:

Beer, T. (1983) 'Environmental Oceanography.' (Pergamon Press: Oxford.)

The Annual Reports and Research Reports of CSIRO Marine Laboratories, Hobart, (formerly CSIRO Division of Fisheries and Oceanography), and of Australian Institute of Marine Science (Townsville), contain semi-popular accounts of their work, and lists of their publications. For CSIRO, these reports cover at least 1974–77, 1977–79, 1979–81, 1981–84 and 1985–87.

CSIRO has also published the following, as one of its 'Research for Australia' series:

CSIRO (1987) 'Oceanography' (CSIRO: Canberra.)

Corella, 1990, 14(2): 62–63

PREDATION OF THE EGGS OF SILVER GULLS BY REPTILES

The protracted period of laying shown by Silver Gulls *Larus novaehollandiae* near Perth, Western Australia, may be due, in part, to sustained predation of eggs by King's Skinks *Egernia kingii* (Wooller and Dunlop 1979). These large lizards, which average 220 g in weight and have a head width of about 50 mm (Arena 1986), are common on both Penguin Island (32°18′S, 115°42′E) and Carnac Island (32°07′S, 115°39′E) which are the two largest breeding colonies of Silver Gulls on the west coast with about 3 000 and 4 000 breeding pairs respectively (Dunlop and Storr 1981; Dunlop *et al.* 1988). On Penguin Island, Arena (1986) estimated an average density of about 100 skinks per hectare over the whole 12 ha island, with densities up to 800 ha^{-1} in some areas; similar lizard densities probably occur on Carnac Island. The contribution of these lizards to egg losses was assessed on Carnac Island during 1980 by excluding them from part of the laying area.

METHODS

On Carnac Island, Silver Gulls lay in all months from March to November, often with peaks in April and August (Wooller and Dunlop 1979). In March, before laying started, a temporary fence was constructed around a 0.2 ha area containing about 150 nests. The 1 m high fence was of aluminium flywire mesh secured to wooden posts, with its lower section buried in the ground. Skinks within the fence were caught using box traps and by hand, and were relocated over 200 m away. Despite intensive trapping effort, at least one skink was known to have been inside the enclosure during the April laying period. Tiger snakes *Notechis scutatus* present on the island may also take eggs but none were believed to be present inside the enclosure. The fence was removed after the eggs laid in April/May had hatched and before the second major period of laying later in the year.

An unfenced control area was established on another part of the island. This plot was similar to the experimental area in size, shape, substrate, vegetation and the density of the gull nests and skinks. Laying started, ended and peaked simultaneously in both areas, which contained similar proportions of established breeding gulls. All nests in both study areas were marked individually and their contents recorded throughout the year.

RESULTS

During March and April, only 20 per cent of 93 clutches were lost in the area from which most skinks had been excluded, whereas 56 per cent of 73 clutches were lost from the unfenced area. Later in the year, after the fence was removed, losses in both areas were very similar and comparable to those in the unfenced area earlier in the year — 58 per cent of 50 clutches lost from the previously fenced area and 55 per cent of 100 clutches from the unfenced area. Some eggs were probably laid and lost between visits so that all values for clutch loss are likely to be underestimates.

After the loss of their first clutch, 42 per cent of pairs in the fenced area and 41 per cent of pairs in the unfenced area laid replacement clutches. Of those clutches not lost during the March–April period, at least one egg hatched in 64 per cent of clutches in the fenced area and 66 per cent in the unfenced area. The hatching success of clutches not lost during June–August was slightly, but not significantly lower than earlier in the year in both the fenced (52%) and unfenced (56%) areas (χ^2=0.85 and 0.79 respectively).

DISCUSSION

The exclusion of most skinks from one area of the gull breeding colony significantly reduced the number of clutches lost there during the first part of the season. Removal of the fence from this area resulted in clutch losses later in the season which were similar to values for an unfenced area both early and late in the season. Thus, skinks on Carnac Island appeared to take a substantial proportion of gull eggs laid at all times in the season, although many of these eggs were replaced. However, these high values may result, in part, from regular disturbances of gulls on their nests by researchers.

The 20 per cent clutch loss even in the fenced area may have been the result of predation by at least one skink not removed from this area or may have incorporated egg predation by gulls or by tiger snakes, although this was never observed. The hatching success of the eggs not eaten seemed unaffected by the presence of the lizards. The slightly lower hatching success of eggs laid later in the year may have been a natural phenomenon or an artefact of more frequent visits to the study areas in the earlier part of the year.

Reptiles are known to take a wide range of eggs and chicks of birds (Vestjens 1977; Kopan and Yom-Tov 1982). It is not known whether gull eggs form an important part of the diet of King's Skinks, which on Penguin Island appear to be mainly herbivorous. However, in some areas eggs may form a substantial part of their diet. Indeed, the high densities of these lizards may be maintained partially by the ability of the local gull population of keep producing eggs almost nine months of the year.

ACKNOWLEDGMENTS

We thank the Western Australian Department of Conservation and Land Management for permission to work on the island and Graeme Evans, Stuart Harris, Keith Brooker, David Montague and Michael Bamford for their help during the study, which was supported by the Australian Research Grants Scheme.

REFERENCES

Arena, P. C. (1986). Aspects of the biology of the King's Skink *Egernia kingii* (Gray), B.Sc. Honours Thesis, Murdoch University, Western Australia.

Dunlop, J. N. and Storr, G. M. (1981). Carnac Island, Western Australia. *Corella* **5**: 71–74.

Dunlop, J. N., Klomp, N. I. and Wooller, R. D. (1988). Penguin Island, Shoalwater Bay, Western Australia. *Corella* **12**: 93–98.

Kopan, R. and Yom-Tov, Y. (1982). *Agama stellio* (Reptilia: Sauria) feeding on avian eggs and chicks. *Israel J. Zool.* **31**: 159–160.

Vestjens, W. J. M. (1977). Reptilian predation on birds and eggs at Lake Cowal, NSW. *Emu* **77**: 36–37.

Wooller, R. D. and Dunlop, J. N. (1979). Multiple laying by the Silver Gull *Larus novaehollandiae* Stephens on Carnac Island, Western Australia. *Aust. Wildl. Res.* **6**: 325–335.

R. D. WOOLLER

Biological Sciences, Murdoch University, WA 6150

J. N. DUNLOP

School of Biology, Curtin University of Technology, GPO Box U1987, Perth, WA 6001

Received 26 May, 1988