Monitoring *Phragmites australis* increases from 1937 to 1976 in the Siyai Lagoon (Natal, South Africa) by means of air photo interpretation

P.J. WEISSER* and R.J. PARSONS*

**ABSTRACT**

The colonization of the Siyai Lagoon on the north coast of Natal by *Phragmites australis* was studied by means of air photo interpretation. It was possible to locate and estimate *P. australis* areas for 1957 (0.74 ha), 1965 (1.65 ha), 1969 (1.93 ha) and 1976 (2.94 ha). *Phragmites australis* first inhabited the shores of the middle section of the lagoon followed by rapid expansion in the lower section. The upper section was colonized only at its lower end by expansion from the middle section. It is suggested that *P. australis* was unsuccessful in this section because of competition by the *Hibiscus tiliaeus—Barringtonia racemosa* Lagoon Fringe Forest. This same community is shading out *P. australis* in some places. The notable increase in the rate of advance of land and littoral vegetation into the Siyai Lagoon was caused by sugar farming activities leading to erosion and sedimentation in the lagoon. A vegetation age gradient was observed from the upper section to the mouth region. The colonization of most of the Siyai Lagoon except the immediate mouth zone by *P. australis* Reedswamp and *Hibiscus tiliaeus—Barringtonia racemosa* Lagoon Fringe Forest, can be expected before the turn of the century. Dredging and mechanical control of vegetation will become necessary if major open water spaces are to be maintained.

**INTRODUCTION**

An increase of reeds was observed on air photos when studying the dune advancement at Mtunzini (Weisser et al., MS). The availability of air photo coverage for 1937–1979 offered the possibility to monitor the reed encroachment. Objectives of this work were to evaluate the adequacy of air photos in monitoring *P. australis* expansion; to provide baseline data on the Siyai Lagoon; to quantify the reed encroachment; to establish trends and extrapolate possible developments; and to offer possible management suggestions.

The Siyai drainage system is situated in Natal at latitude 28°58' South and longitude 31°45'45" East. The Lagoon is situated amidst a well-conserved, scenically beautiful, forested-dune landscape (Fig. 1). It has a surface of about 8 ha, an axial length of 2.5 km and a catchment of about 18 km² (Begg, 1978). Two streams are the main tributaries. In this work only the lagoon was studied and defined as extending from the confluence of the two tributaries to the Lagoon Mouth. Four sections were distinguished from south-west to north-east: upper section (from confluence to about 650 m north-east); middle section (inflexion area of watercourse); lower section (to watercourse constriction) and mouth section.

Between 1937 and 1977, the mouth of the Siyai Lagoon moved about 740 m north-eastwards, at an average rate of 17.4 m/year (Weisser et al., MS). The mouth is usually closed, being open for only very brief periods (of up to a week) after floods. The bar may be topped by high spring-tides and the mouth is not opened artificially (Begg, 1978).

Land encroachment into the Lagoon has increased markedly since sugar farming began in c. 1946. Changes in run-off and soil exposure caused extensive sedimentation reducing the depth to about 0.25 m in the upper zone of the Lagoon (Begg, 1978). Maximum depths of 1.5 and 2 m respectively were measured by the first author in June 1980 at the crossing of the nature trail (lower zone) and in the Lagoon mouth. Begg (pers. comm.) recorded a depth of 2.9 m in the middle section of the Lagoon.

**METHODS**

Information on the Siyai Lagoon and the reeds was obtained from air photos through direct inspection, enlargement and transference onto a base map using a Bausch & Lomb ZT-4 Zoom Transfer Scope (=ZTS). This instrument was also used to draw the 1:5 000 base map from the 1977 orthophoto maps.
MONITORING PHRAGMITES AUSTRALIS INCREASES FROM 1937 TO 1976 IN THE SIYAI LAGOON (NATAL, SOUTH AFRICA) BY MEANS OF AIR PHOTO INTERPRETATION

Fig. 1.—The middle section of the Siyai Lagoon covered with Phragmites australis (June 1980). A photograph taken in 1964 shows only a few patches of reeds. The foreground shows leaves of Hibiscus tiliacus; this plant and Barringtonia racemosa are the main components of the forest fringe. This community is encroaching into the P. australis stands.

RESULTS AND CONCLUSIONS

Field checking confirmed that the Siyai Lagoon was a good site for studying the colonization and expansion of P. australis Reedswamp. The period documented in the air photos was long enough to enable the reeds to cover all the available habitat in some sections of the river, whereas in others P. australis is still actively expanding. The observation time was also sufficient to allow succession to proceed, and in some areas P. australis Reedswamp is being displaced by other riverine vegetation (Fig. 1). The results deal first with the findings on P. australis, then with other aquatic or semi-aquatic vegetation, and finally with the Siyai Lagoon.

ALEQUACY OF AIR PHOTOS TO MONITOR P. AUSTRALIS COLONIZATION

It was possible to locate and estimate P. australis areas for 1957, 1965, 1969 and 1976 (Table 1 & Fig. 3). The resolution of the 1937 air photos is insufficient to give conclusive evidence. Difficulties were encountered in the interpretation of Job 291 (1977) and Job 329 (1979). Their scale (1:3 000) gives too few matching points in the optical field of the ZTS.

Colonization pattern

Phragmites australis first colonized the middle and lower sections of the Lagoon. It failed to establish itself in the immediate mouth zone and in the upper region with the exception of a 0.5 m, patch in the confluence (June, 1980). Both zones are at present

TABLE 1.—Area changes (in ha) in the Siyai Lagoon (1937–1976) as shown in the air photos

| Year | P. australis area | Open water surface | Open water without new mouth regions | Total area of lagoon |
|------|-------------------|--------------------|--------------------------------------|----------------------|
| 1937 | 0.27 (?)          | 5.79               | 5.79                                 | 6.06                 |
| 1957 | 0.74              | 5.58               | 5.41                                 | 6.33                 |
| 1965 | 1.65              | 5.17               | 5.00                                 | 6.82                 |
| 1969 | 1.93              | 5.04               | 4.69                                 | 6.97                 |
| 1976 | 2.94              | 4.94               | 3.54                                 | 7.87                 |
shallow. It seems that when silting increased drastically in the upper section, the already present woody fringe vegetation rapidly invaded the new habitat and ousted *P. australis*. In the lower section of the Lagoon, *P. australis* was able to establish itself and to expand in the direction of the Lagoon mouth.

**Phragmites australis Reedswamp area changes: 1937–1976**

The *P. australis* surface increases at the Siyai Lagoon are summarized in Table 1 and represented graphically in Fig. 3. Whereas from 1937 to 1957 there was an increase of only 0.47 (?) ha in the area covered by *P. australis*, the area increased by 2.20 ha between 1957 and 1976. Therefore expansion of *P. australis* in the Lagoon accelerated after 1957 (Fig. 3). The curve will flatten out as the available habitat diminishes. However, with the north-eastward advancement of the mouth, new areas suitable for *P. australis* colonization are being created (Fig. 2).

**Probable causes of reedswamp increase**

Reedswamp expansion is often a natural process in some lagoons. Conspicuous increases of reeds have been reported in lakes after lowering of water levels (e.g. Kopf, 1964, in Weisser 1970; Björk, 1974) or when siltation increases (Weisser, 1978). Begg (1980) states that reed encroachment is due to the Lagoon becoming shallower and less saline. We agree that sedimentation and consequent reduction in depth are the chief causes of the remarkable increase in *P. australis*. No records are available for assessing the influence of the salinity factor.

The sedimentation of the Siyai Lagoon has increased strikingly, becoming critical with the advent of sugar farming in the catchment area (c. 1946 fide Begg, 1978). This must be considered as the main reason for the deterioration of the Siyai Lagoon. Garland (pers. comm.) considers the clearing and cultivation of Swamp Forest and *Cyperus papyrus* Swamp (c. 1955) as being especially detrimental, because of the consequent elimination of the "sponge" function of the vegetation.

**Succession**

In some areas of the middle section of the Lagoon, a replacement of *P. australis* Reedswamp by the *Hibiscus tiliaeucus–Barringtonia racemosa* Lagoon Fringe Forest was observed, probably by shading. This community seems to be the following phase in the land reclamation process in this Lagoon. This corresponds with successional schemes proposed (Edwards, 1967; see also Ward, 1980).

**Reduction of open water by increase of woody shore vegetation**

An expansion of the Lagoon Fringe Forest formed mainly by *Hibiscus tiliaeucus* and *Barringtonia*...
The sedimentation has been heaviest in the upper section of the Lagoon, mainly owing to the reedswamp encroachment and the expansion of the Lagoon fringe vegetation. However, the advancement of the Lagoon mouth has produced new open-water areas, compensating partially for the loss to the reed beds and the Hibiscus tilicinus—Barringtonia racemosa Lagoon Fringe Forest. If the values are corrected by subtracting the new open-water areas of the mouth section, the real loss of open-water surface becomes evident (Table 1 & Fig. 3).

**Sedimentation**

The sedimentation has been heaviest in the upper zone of the Lagoon. The dense \textit{P. australis} stand in the middle zone probably acts as a sediment trap partly protecting the lower section of the Lagoon from sedimentation.

If sedimentation is not controlled, the accelerated filling up of the bed will continue. This could eventually lead to the water breaking through and forming another bed.

**Prognosis**

Because of sedimentation, the colonization by \textit{P. australis} Reedsowamp and \textit{Hibiscus tilicinus}—\textit{Barringtonia racemosa} Lagoon Fringe Forest of most of the Siyai Lagoon, except the immediate mouth zone, can be expected probably before the turn of the century. Any management action tending to diminish sedimentation, e.g. erosion control upstream, should be encouraged. Reeds could be controlled locally by repeated underwater cutting. The opening of a new river course may occur in the long term owing to filling up of the existing Lagoon bed. Dredging and mechanical control of vegetation will probably become necessary if major open-water spaces are to be maintained at the Siyai Lagoon.