Effects of Nutrient Additions on Dune Lakes on Fraser Island, Australia.

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Abstract

Given the rapidly increasing visitation levels to Fraser Island, there is increasing concern that tourist activities may threaten the long-term ecological health of the region's unique dune lakes. This project aimed to investigate the consequences of tourist use of Fraser Island's dune lakes and to develop appropriate monitoring tools and management objectives in light of the projected increases in visitation levels in the foreseeable future.

The initial phase of this research aimed to identify the relative importance of some of the most popular dune lakes on the island as key destinations for tourists. Tourist surveys, in conjunction with the development of a Tourist Pressure Index (TPI), which quantifies logistic, social and natural variables, identified Lakes McKenzie, Allom and Birrabeen as the lakes most at risk from excessive tourist use.
In addition, analyses of water quality in 15 lakes on Fraser Island aimed to determine the current trophic status of dune lakes on Fraser Island and the ecological implications of tourist use of these systems. Detailed comparisons of nutrient and chlorophyll *a* concentrations in five popular dune lakes in February 1990 (data from Arthington *et al*. 1990) and February 1999 suggested that productivity has increased significantly in the past decade.

More detailed examinations of nutrient and algal variables in five popular perched dune lakes revealed that while ambient nutrient and phytoplankton chlorophyll *a* concentrations remained relatively stable, periphyton chlorophyll *a* concentrations increased over the course of the 1999-2000 summer in most lakes. Significantly, these increases were found only in heavily visited (disturbed) sites in the clear lakes examined (McKenzie and Birrabeen). In these lakes, where algal growth is likely to be only limited by nutrient availability, tourist nutrient additions may stimulate excessive periphyton production. Experimental algal bioassays identified that phytoplankton and to a lesser degree periphyton growth was stimulated by nutrient additions in all five perched dune lakes. However, the degree to which growth was stimulated was both lake and nutrient (nitrogen versus phosphorus versus nitrogen +

phosphorus) dependent, highlighting the variable nature of systems within a relatively small geographic range.

Since periphyton biomass was higher in heavily visited areas of lakes and was likely to be stimulated by nutrient additions by tourists, stable isotope analyses of littoral zone food webs were conducted to quantify the percent contribution of periphyton to consumer diets. There was a trend towards higher periphyton contributions in systems identified as key tourist locations (on the basis of their TPI scores) and this indicates that increasing visitation may increase the contribution of periphyton to littoral zone food webs, both via increases in the quantity and quality of periphyton as a food resource.

To further explore the contribution of periphyton in littoral zone food webs of heavily visited lakes, a ^{15}N-tracer addition experiment was conducted to establish the fate of nutrient additions within the littoral zone. Nutrients were added in quantities that mimicked those likely from tourists, to enable a realistic appraisal of the fate of tourist additions. As expected, periphyton rapidly assimilated the added ^{15}N-tracer and was found to be the first and most significant sink for nutrients entering the littoral zone.

Finally, the results from this research were used to develop a conceptual model of nutrient enrichment for perched dune lakes on Fraser Island. The model indicates that although nutrient additions from tourists may lead to undesirable increases in periphyton biomass, the degree to which this is deemed to be a detrimental ecological outcome is likely to be mediated by water level fluctuations and the consumptive capacity of grazers. Given that excessive periphyton growth is likely to be seen as negative impact of tourism, regular periphyton monitoring (biomass and percent contribution to littoral zone food webs) should be built into an updated monitoring program for this series of dune lakes. Whilst the implementation of periphyton monitoring is likely to enable the early detection of deleterious impacts of excessive tourist use, it is likely that the long-term conservation of the region will, in the future, require the implementation of strict visitation level guidelines, to ensure that the irreversible consequences of long term additions of nutrients are ameliorated.

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Declaration

This work has not previously been submitted for a degree or diploma in any university. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

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