ENVIRONMENTAL EDUCATION AND ITS ROLE IN RESTORING NATIVE ECOSYSTEMS AT SAINT NARSAI ASSYRIAN CHRISTIAN COLLEGE, HORSLEY PARK

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ABSTRACT

Increasingly, environmental educators are incorporating visits to natural areas into their environmental learning programs. Learning in natural environments is attractive to students and has an important impact on their attitudes towards the environment, their desire to look after the environment and their behaviour in natural areas which in turn influences their household environmental practices (Ballantyne and Packer, 2002). Combining observation with instruction is a powerful teaching strategy, allowing students to understand the impact of human action on wildlife and natural habitats.

The recent construction of Saint Narsai Assyrian Christian College, located in Horsley Park, western Sydney has presented a unique opportunity to incorporate environmental sustainability into the curriculum. Situated on former agricultural land (and formerly Cumberland Plain Woodland), the school site features a stretch of Reedy Creek, a degraded waterway that drains much of the Horsley Park area. Approval for the College included re-instating Reedy Creek to mimic the natural creekline and re-establishing Cumberland Plain Woodland in long-term conservation areas on the site. As part of the conservation works, baseline data was recorded for water quality, insect diversity, fauna species (including frogs and aquatic fauna) and seeded/planted vegetation. This presents a unique opportunity for school students to be actively involved in experiments, and biodiversity and environmental monitoring of the restoration of the onsite conservation areas.

By using the school grounds for sampling and population studies on the species present, possible trophic interactions and patterns of distribution of the plants and animals can be studied. Students will relate this to the short-term and long-term consequences on the ecosystem of species competing for resources and possible impacts of humans in the ecosystem. The implementation of the different aspects of environmental sustainability will result in the school having effective environmental education integrated into appropriate sections of the curriculum; ensuring students are active in maintaining and improving their surroundings.

KEYWORDS

Environmental Monitoring; Ecology; Restoration; Education; Ecosystem

1. INTRODUCTION

Environmental sustainability has been increasingly incorporated into planning legislation since the 1970s, with legislation enacted such as the *National Parks and Wildlife Act 1974*, and the *NSW Environmental Planning and Assessment Act 1979* obliging applicants and consent authorities to consider their impacts on the environment. In the last 20 years, there has been a strong sense of urgency to halt and reverse damage to native ecosystems, develop sustainable land management practices, and introduce environmental education into school programs.

The environmental learning programs for school students generally incorporate observations of natural areas to educate students on the impact of human actions on wildlife and natural habitats (Ballantyne and Packer, 2002). Hands-on activities such as measuring pollutants in creeks or observing effects of litter on

local wildlife have powerful influences on Grade 5-12 students' interest in and awareness of environmental problems, often resulting in increased environmental awareness of parents (Ballantyne *et al.* 2001A and 2001B). Teachers have reported that students involved in the sustainable schools program have an increased awareness of their impact on the environment, and their ability to achieve positive environmental outcomes (Kennelly *et al.* 2008).

The planned learning experiences at Saint Narsai Assyrian Christian College are a positive application of environmental legislation. The activities relate to the conservation, enhancement and re-establishment of native ecosystems, as part of the environmentally sustainable development on formerly cleared agricultural land in western Sydney. The sustainability challenges of this school project are being met through clear identification of existing environmental risks, application of scientific research, integrated team management and involvement of stakeholders including the school staff and students.

The planning approval for the College included re-instating Reedy Creek to mimic the natural creekline and re-establishing Cumberland Plain Woodland in long-term Conservation Areas on the site. Cumberland Plain Woodland is one of the major vegetation types in the Sydney region and is listed as critically endangered (DECC, 2010). This presents a unique opportunity for school students to be actively involved in experiments and biodiversity and environmental monitoring of the restoration of the onsite Conservation Areas. This will provide practical education in conjunction with classes, creating a richer educational experience. It is also hoped that this will help build individual and community interests in the environment, encouraging student inquiry into nature and helping to steer interested students into career paths incorporating research, ecology and the environment.

2. ENVIRONMENTAL EDUCATION PROGRAM AT SAINT NARSAI ASSYRIAN CHRISTIAN COLLEGE

2.1 Education program

The New South Wales environmental education policy allows for the development and enhancement of the local school environment. In order to equip students with the understandings and skills required for an active and informed participation in managing the environment, environmental education is incorporated into various sections of the science school curriculum. At Saint Narsai Assyrian Christian College, a whole school approach will be instigated to maintain the school environment. In particular, the focus will be on the year 7 students new to the school environment and indifferent to their surroundings. From the unit of 'classifications and habitats', year 7 is introduced to their environment, the nature and function of the ecosystem, the impact of people on environments and their role in maintaining and protecting the environment. Activities include water-sampling, introduction to local and introduced species, ecosystem services and re-using resources provided by the environment. The Year 7s will be responsible for monitoring in their first year at the site, along with the year 11 students that will aid them.

The year 11 introductory module for preliminary biology explores local ecosystems. Year 11 students are to investigate the impact the environment has on all organisms and the relationships among these organisms. The approach is more comprehensive and analytical; students will use the school grounds for sampling and population studies on the species present, possible trophic interactions, and patterns of distribution of the plants and animals. Students will relate this to the short-term and long-term consequences on the ecosystem of species competing for resources and possible impacts of humans in the ecosystem.

Following data analysis, students are to explore the human and industrial impacts on the environment, particularly the school and surrounding areas, identifying past and present impacts. This can include investigating the new school currently being situated in the rural area of Horsley Park, Western Sydney, NSW. [Western Sydney was once covered with the vegetation community called Cumberland Plain Woodland (Figure 1, Benson and Howell, 1990); however, it has been reduced to 9% of its original distribution as Sydney's population has grown (OEH 2017). The site has a tributary of Reedy Creek running through the site, which has been extensively rehabilitated with local provenance native plants during the construction of the school]. In turn, students can evaluate methods of maintenance and how their local ecosystem can be supported, regardless of urbanisation. Following their studies, students work to address the

management of the school environment, as a whole school approach. This is linked to the year 7s' study of the environment and includes reduction in litter and waste and the re-use of resources. The activities will integrate observation, data collection and interpretational skills, as students work in groups over the course of the first term. This includes familiarisation with their environment (based on observation), data collection of abiotic and biotic factors, interpretation of results based on acceptable limits and evaluation of human impacts and monitoring from all students, as led by the environmental committee.

The implementation of the different aspects of environmental sustainability relies on the school having effective environmental education integrated into appropriate sections of the curriculum – ensuring students are active in maintaining and improving their surroundings. The school intends to incorporate the significance of the natural environment of the creek and its context within western Sydney biodiversity into the school curriculum. The goal is to engage the students in understanding the context of the school site in relation to the Cumberland Plain region, and develop a connection with the site to ensure its condition is maintained through people power.

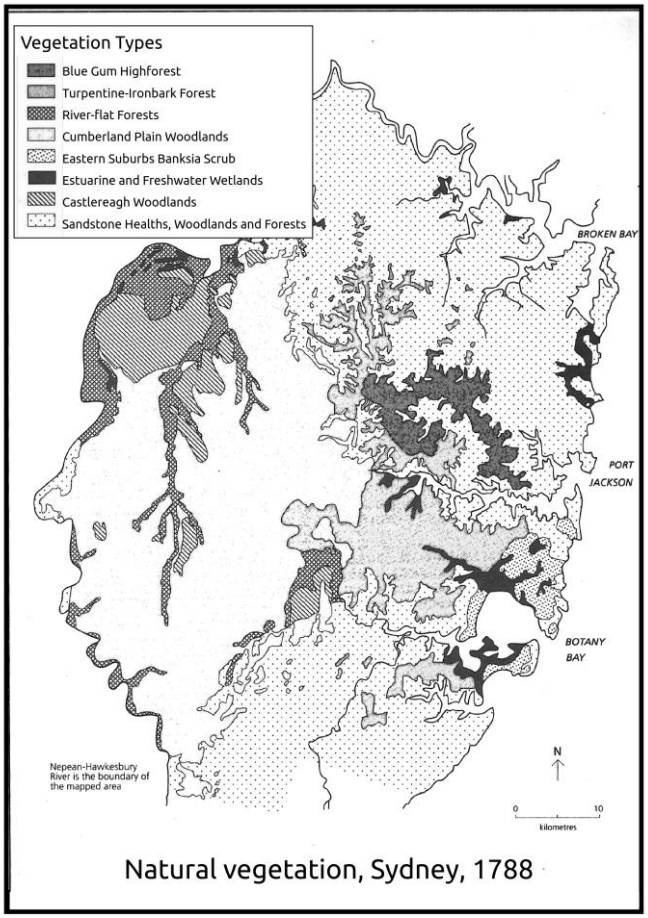

Figure 1. Location of the original extent of Cumberland Plain Woodland in western Sydney

2.2 Onsite opportunities to achieve environmental sustainability

The new school site is situated on a former agricultural paddock in western Sydney with the original native vegetation reduced to that surrounding a dam, narrow drainage channel and scattered trees along the roadside reserve. The original vegetation is likely to have been Cumberland Plain Woodland (CPW), now a critically endangered ecological community. The existing threats to the section of Reedy Creek corridor are

weed invasion, fragmentation, and increased nutrients associated with former agricultural land uses and soil disturbance.

In line with NSW Office of Water's requirements and development consent conditions for the new school, a Vegetation Management Plan (VMP) was written for the school site (Clements *et al.* 2010). The VMP prescribes the establishment of a long-term ecologically viable riparian corridor section of Reedy Creek by conserving and enhancing the existing local native vegetation. This is designed to effectively restore CPW to the Conservation Areas on the school grounds (Figure 2).

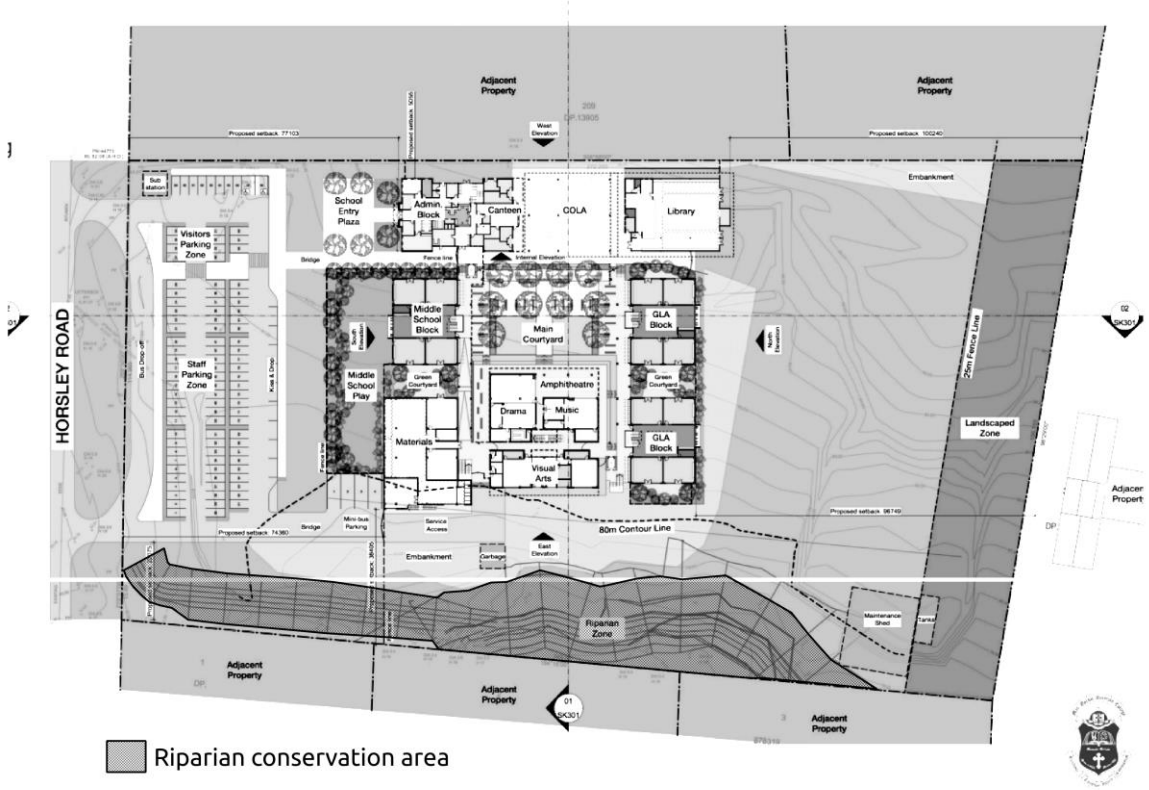

Figure 2: Conservation Areas at Saint Narsai Assyrian Christian College, supplied by PMDL.

As part of the conservation works, the opportunity existed for the students to further study the local ecosystem including local flora, fauna and insect species. The existing data collected contribute to the resources for the school students studying water quality and natural ecosystems with baseline data collected. Water quality was assessed from the onsite section of Reedy Creek using AUSRIVAS (Australian River Assessment System) to measure aquatic insect abundance and diversity. Terrestrial insect diversity was measured by collections from pitfall traps. These water quality and insect data will be monitored by students over time, along with monitoring of progress in the re-establishment of the Cumberland Plain Woodland, documenting changes in diversity and abundance of plant species. This is designed to increase students' awareness of their local environment, the importance of creekline and native ecosystems for sustainable land use. Weed occurrence is monitored and observed by students and provides opportunities for understanding the effects of agriculture on the native ecosystems.

Fortunately, Saint Narsai Assyrian Christian College is located in Fairfield Local Government Area which has a local provenance native plant nursery, and capable and committed nursery and bush regeneration staff.

2.2.1 Collection, propagation and direct sowing of local native species

Local provenance seed was collected from the School site and other nearby Cumberland Plain Woodland areas, including Eastern Creek and Kemps Creek. Species propagated included canopy species such as

Eucalyptus fibrosa, E. moluccana, E. tereticornis, and *Melaleuca decora, M. linariifolia* and *M. styphelioides,* and shrub species such as pioneering *Acacia* species, *Indigofera australis, Bursaria spinosa, Hardenbergia violacea,* and *Ozothamnus diosmifolius.* The groundcovers include the local native grasses as well as local species suited to riparian environments such as *Carex appressa* and *Alternanthera denticulata.* The local provenance seed collected was pre-treated and hand-broadcasted in the Conservation Areas onto the wet soil in March 2017; followed unfortunately by periods of low rainfall resulting in low rates of germination. The seed is now likely to be surviving in the soil seed bank and may germinate in the future.

2.2.2 Planting of local native species and habitat re-construction

Initial planting of the Conservation Areas was completed by early August 2017. The plantings consisted mainly of tubestock, growtubes and Hikos^{TM} with some larger 100 mm, 140 mm and 200 mm pots. A 1.5 m wide 'green' pathway was planted with the native grass, *Microlaena stipoides* in the outer 50% of the Riparian Zone, designed to provide access for the students and teachers for Science and Geography classes, as well as pathways installed in Conservation Areas to facilitate access between the playing fields. These frequently used pathways through the Conservation Areas are planted with the cosmopolitan grass *Cynodon dactylon* (Couch) over a reinforced mesh.

In October 2017, the future year 7 students are to plant tubestock of the local provenance eucalypts as part of their belonging to the Saint Narsai Assyrian Christian College community.

Leaf litter and small branches were spread over the riparian area to provide habitat for insects and small fauna.

2.2.3 Monitoring fauna associated with Reedy Creek

Prior to recontouring the creek, the area was surveyed for frogs in October 2016. The section of Reedy Creek is suitable for the Green and Golden Bell Frog (*Ranoidea aurea*), an endangered species which inhabits reedy, slow flowing creeks and dams, and historically has been found throughout much of Western Sydney. Consequently, creek works were supervised to detect and re-locate fauna affected by the works. Creek works occurred between 31 October 2016 and 8 November 2016. Over that time fauna species detected onsite were recorded, including fauna directly impacted by creek works and fauna that was incidentally observed.

Frogs and other stream dependent fauna are good indicators of water quality and habitat suitability. Frogs and particularly tadpoles are sensitive to pollutants in the water and highly polluted waterbodies support fewer individuals and a reduced species diversity than similar habitats with better water quality (Romansic *et al.* 2006). Students monitoring riparian fauna will be able to correlate changes as the conditions improve and draw inferences and conclusions about the association between habitat suitability, ecosystem function and species diversity. It is expected that there will be changes in species composition over the years, both in the long term and short term in response to varying environmental conditions.

2.2.4 Water quality testing and macroinvertebrate sampling

Aquatic macroinvertebrates are well established indicators of water quality and ecosystem health (Barbosa *et al*. 2001). Macroinvertebrates are to be collected using a 0.25 mm mesh kick net for 40 minutes and live-picked in the field and placed into a labelled container of 70% ethanol. Sample pickings are to be undertaken as per the AUSRIVAS guidelines.

The onsite section of Reedy Creek was assessed for water quality using the AUSRIVAS (Australian River Assessment System) sampling and processing manual. Two water samples were collected in November 2016 at two separate locations for pH, conductivity, turbidity, alkalinity, total nitrogen and total phosphorus, and compared to the ANZECC (2000) trigger values for 'slightly disturbed' ecosystems for South-East Australia and in particular for lowland rivers (Freshwaters).

Water quality and macroinvertebrates are to be monitored as part of the school curriculum and base line data used along with other resources such as Streamwatch information provided by Sydney Water, Water NSW and Australian Museum.

2.2.5 Insects

Insects contribute to approximately 80% of the biodiversity in the animal kingdom with over a million documented species (Engel, 2015). Despite the astonishing diversity they are often overlooked and their ecosystem function taken for granted. Insects provide indispensable natural services such as pollination, nutrient cycling, and are an essential part of the food web. The abundance and diversity of insect species can provide an indication of the relative health of an ecosystem, so it is important to monitor the succession of local insect communities. Insect abundance and diversity is being monitored in the Conservation Areas with pitfall traps installed at 2 m intervals along six monitoring transects on 8 August 2017. The pitfall traps are 50 ml centrifuge tubes sunk into the ground so that the mouth is level with the soil surface allowing ground-dwelling insects to fall into the trap. The installed tubes are half-filled with 70% ethanol and one drop of glycerol and left out for 48 hours. The collected tubes are sealed and stored for later insect identification.

2.3 Results to date

2.3.1 Establishment of the Conservation Areas

The success of germination of directly sown seed has so far been low due to lack of rain and possible overspray onto batters from herbicides used in adjacent landscape areas. Depending on germination rates in spring, additional seed is available to be applied. The plantings are currently in the early stages of establishing. With regular watering and/or rain, plant growth is expected to increase with warmer spring temperatures.

2.3.2 Water quality and macroinvertebrate sampling

For both of the two water samples taken, the initial water quality results showed all analyses were elevated compared with ANZECC guidelines (Table 1).

Table 1. Baseline water quality test results for the onsite section of Reedy Creek

Test	Results for 2 samples	Possible reason for elevated levels
pH	8.09, 8.20	Algal growth, breakdown of concrete pipes, possible lime use on agricultural land.
Conductivity	2930, 2610 µS/cm	Leaks in onsite sewer systems or pipes, saline soils.
Turbidity	35.6, 30.4 NTU	Indicates how much silt, algae and other material is suspended in the water column. Some streams are naturally turbid due to the clay soils in their catchment. The creek was clay-lined, but nearby excavation works were probably the main reason for the elevated results.
Total nitrogen	3.5, 2.3 mg/L	Agricultural runoff and sewage discharges. Other sources include decaying vegetation, leachate from landfill, animal faeces, industrial wastewater and fertilisers.
Total phosphorus	0.28, 0.10 mg/L	Agricultural runoff, fertilisers, leaking sewer pipes or systems.
Alkalinity	436, 416 mg/l	Alkalinity does not have an ANZECC guideline level.

At the time of the water quality sampling on 2 November 2016, few insects were observed.

2.3.3 Fauna species detected

Common frog species detected included *Crinia signifera* (Common Froglet), *Limnodynastes peronii* (Striped Marsh Frog) and *Litoria fallax* (Dwarf Tree Frog). Additionally, two more common species: *Litoria*

peronii (Peron's Tree Frog) and *Litoria verreauxii* (Whistling Tree Frog) were heard calling from the dam on the adjacent property which feeds into Reedy Creek. While Green and Golden Bell Frogs were not detected, this survey was not sufficient to rule out their presence at the site.

Only a small number of native fauna species were impacted directly by the creek works. Over the seven days of creek works, two Eastern Long-necked Turtles (*Chelodina longicollis*), one Striped Marsh Frog (*Limnodynastes peronii*), one Eastern Water Skink (*Eulamprus quoyii*) and one native eel (*Anguilla* sp.) were disturbed and re-located during the works. Animals were relocated about 100 m further downstream.

The species detected during the initial survey (both frogs and other riparian associated fauna) are generally regarded as hardy and tolerant species which are able to survive in semi-polluted environments. As environmental conditions and water quality are expected to improve along Reedy Creek with the revegetation of the riparian zone there should be corresponding changes in riparian fauna. So far, 56 fauna species have been detected on the school site, many from the riparian zone. This includes five exotic species, and one species listed as Vulnerable (Dusky Woodswallow). Fauna species that were directly associated with Reedy Creek included the 5 frog species, Eastern Long-necked Turtle, Eastern Water Skink, the eel species, and several species of birds including the Clamorous Reed Warbler, Superb Fairy Wren, Pacific Black Duck, Chestnut Teal, White-faced Heron, Australasian Swamphen and Great Egret.

3. MONITORING SUCCESS

The monitoring report at the completion of the initial planting in August 2017 provides the Guidelines for ongoing monitoring, with required information to include monthly rainfall records, works done, any fauna sighted, water quality testing, photographic record of works, photographs from the fixed monitoring points, vegetation structure, species composition from fixed monitoring points at end of each year, further works required and any issuing requests for corrective action.

Increases in native flora and fauna (especially insect) species diversity and decreases in exotic flora species diversity over time are indicative of success of the restoration works. Results of the monitoring are to be discussed with the class group and form the basis of the student reports. Any issues that arise through the monitoring process are to be addressed and corrective actions implemented, following discussion with students and staff.

4. CONCLUSIONS

The restoration and re-establishment of local native vegetation in the Conservation Areas at the Saint Narsai Assyrian Christian College presents an exciting opportunity for both education of students and sustainable enhancement of the local environment. Through careful revegetation, Cumberland Plain Woodland is being restored to its natural habitat following historic clearing for farmland. Ongoing monitoring of this vegetation, water quality and associated fauna not only helps to develop individual and community interest in the environment, but measures the success of the conservation works. In turn, the School's Conservation Areas are a valuable asset for future seed collection of local provenance seed for the school and the staff of Fairfield Council.

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