Activity-specific guidelines: tools to maximise Environmental Impact Assessment outcomes: a case study of coral transplantation from the Great Barrier Reef Marine Park, Australia.

Key Words: net environmental benefit, environmental impact assessment, management guidelines, coral transplantation, tourism impacts, marine protected area, rehabilitation.

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ABSTRACT
Maximising environmental outcomes is critical for managing high use and high value areas. Regulators in balancing use and conservation regularly apply the generic EIA process. However by developing guidelines that interpret and apply EIA principals to specific activities significant additional benefits can be achieved. This paper aims to demonstrate the stated benefits of activity-specific EIA guidelines using the example of the transplantation of coral at tourism sites in the Great Barrier Reef. The results of a pilot study confirm the original net benefit analysis and demonstrate the application of activity-specific EIA guidelines.

INTRODUCTION
Maximising environmental outcomes is critical for management of high use and high value areas. The process of delivering practical, clear and effective EIA outcomes across geographically vast, ecologically diverse areas for a multitude of uses and users requires a significant combination of resources, skills, tools and culture. The EIA process is generically well defined (for example IAIA, 1999) and regularly applied by regulators in balancing use and conservation. However significant additional benefits can be achieved over generic EIA by developing guidelines that interpret and apply EIA principals to specific activities. This is a strategic approach that requires initial additional resources, but by ensuring critical EIA elements are not overlooked and by providing clear interpretation it achieves a range of additional benefits over generic EIA including:

- further minimises environmental impacts;
- clarifies minimum information requirements for proponent, regulator and stakeholders;
- provides transparent, consistent and contemporary approaches;
- provides evidence of appropriate management actions;
- incorporates lessons learned through scientific literature,
- builds relationship with stakeholder group
- reduces ongoing administrative workloads – time and cost savings;
- increases acceptance of process and decisions; and
- provides the opportunity for feedback and continual improvement.

As a consequence of these additional benefits, task-specific guidelines have been developed for a range of high frequency or high impact (real or perceived) activities within the Great Barrier Reef (GBR).

Case Study: Development and implementation of Guidelines for transplantation of coral.
This paper aims to demonstrate the stated benefits of activity-specific EIA guidelines applied to the transplantation of coral at tourism sites. This activity was selected as it represents a rare, potentially significantly impacting process with high public interest, proposed by a significant commercial user of the GBR.

Identification of need
The GBR is the worlds largest, most complex and diverse coral reef system, it is listed as a World Heritage Area and protected by the Great Barrier Reef Marine Park (GBRMP). The Great Barrier Reef Marine Park Authority (GBRMPA) manages the park through a multiple use philosophy, which aims to balance the values of conservation with the reasonable use of the park.

Tourism spending across the Great Barrier Reef catchment in 2003 was estimated at $AU 4.3 billion (Australian Productivity Commission, 2003). Tourism pontoons are one of the most intensive site-based uses of the GBRMP with some pontoons accommodating 400 persons per day. There are currently approximately 14 large tourist pontoons permitted in the GBRMP (Smith *et al.*, 2005). Some pontoons have operated at the same sites for over 20 years.

The principal component of the tourism operation is to display the natural values of the GBRMP to the customer. That is to provide access to the viewing of a dynamic, colourful and healthy coral reef system. Most tourism pontoon sites are initially installed at sites of total hard coral cover of greater than 35 % (Richards and Associates, 1992; C&B Group, 2003; Maunsell Australia, 2003). Minimisation of impacts to adjacent coral reefs is vital to the sustainability of the site. Early post-installation coral monitoring programs typically found that the impact to coral cover from pontoon operations was minor (Breen and Breen, 1994).

Coral cover on healthy reefs fluctuates under a range of natural and human induced forces, including decreased water quality (Linton *et al.*, 2002), fin damage from snorkellers and divers (Barker and Roberts, 2004), coral eating fish and crown of thorns (Sweatman *et al.*, 2002), algal blooms, coral bleaching (Wilkinson *et al.*, 2000, Marshall and Baird, 2000), disease (Chin, 2003), ship groundings (Marshall *et al.*, 2002) and storms (Done *et al.*, 1992). Consequently, levels of coral cover at a tourism site on an otherwise healthy reef can vary from year to year. Following decreases in coral cover a site may take over five years to visually recover.

The GBRMPA received enquiries from tourism operators about the options available to manage coral cover at their sites. They were considering either site management or relocation to new sites with higher coral cover.

Net Environmental Benefit Assessment

Site management

On investigation the changes in coral cover at the sites were similar to those that had been recorded across wider areas of the GBR and considered to be a combination of impacts from tourism, coral bleaching, cyclones and crown of thorns. Operators demonstrated that they applied best environmental practices required by the GBRMPA (GBRMPA, 2003), and that they appropriately managed those impacts within their control. GBRMPA acknowledged that there may be a need for shorter than natural periods of coral recovery in discrete areas to support well-managed site-based tourism.

Relocation

EIA studies and site supervision of works conducted at new or refitted pontoons across the GBR indicated that the estimated scale of coral loss relocating a pontoon to a new site was approximately 500 coral colonies (Lady Musgrave, Agincourt 2D, Knuckle Reef and Moore Reef) even when significant effort was undertaken to reduce impacts.

Coral transplantation

A review of scientific literature relating to coral transplantation and its impacts and efficacy was undertaken. A very brief synopsis of the matters considered in the comparative EIA process follows here: Coral transplantation has been conducted or proposed to improve the aesthetics of tourist sites (Clark, 2002) and for a range of reasons including; constructing artificial reefs (Bouchon *et al.*, 1981); mitigating construction impacts (GBRMPA, 2001); preserving rare corals (Plucer-Rosario and Randall, 1987); improving reef resilience in the face of climate change (Grimsditch 2006); regenerating damage (Abelson, 2006; Clark and Edwards, 1995; Harriott and Fisk, 1987; Kaly, 1995); and to test experimental effects (Berkelmans and van Oppen, 2006).

Success of those transplantation activities varied from poor to 100% survivorship. Variability in survivorship was attributed to *inter alia*, the selection of donor species, size of transplant, intactness of colony, method and time of transport, site and method of attachment, increased predation and storms. There is evidence that some transplanted colonies experience increased mortalities compared to non transplanted colonies (Yap *et al.*, 1992) and the reproductive fecundity of transplanted corals may be reduced compared to natural corals (Smith and Hughes, 1999; Okubo *et al.*, 2005). Based on the reviewed literature, transplant induced mortality was likely to be highest in the seven months following transplantation. Some coral colonies achieved normal growth (cf. controls) within approximately 12 months and colonies self accreted to the substrate within two to 13 months (for example Okubo *et al.*, 2005).

Assessment of impacts included of the donor area from loss of the transplanted coral, reduced fecundity and partial mortality impacts. For example impacts from fragmentation of donor coral have been reported to take greater than two years to recover (Lindahl, 1998).

Net environmental benefit
The conclusion was that there is strong evidence that a well managed transplantation exercise will result in successful attachment, survivorship and growth of transplanted corals, with high survival (80-100%). A net environmental benefit test balancing the impacts of transplantation with the impacts of relocation to a green-field site, indicated transplantation projects would be ecologically beneficial if they were small-scale (<500 colonies) as this represented the approximate maximum scale of impact from a well managed installation of a new pontoon.

Activity-Specific Guidelines
Specific guidelines were developed to gain the additional benefits indicated above. They were designed to inform applicants of a range of key EIA processes including: planning; alternatives; information requirements; baseline data; impact assessment; methodology; skills and qualifications; monitoring; and feedback; all applied specifically to the activity of coral transplantation. The guidelines were posted on the web (GBRMPA, 2008).

Implementation: Pilot Study - Agincourt Reef 2d
Agincourt 2D Reef is a planar reef of approximately 310 ha situated close to the southern extent of the Agincourt group, approximately 29 Nautical miles NE of Port Douglas, Queensland, Australia (**Figure 1**). A tourism pontoon has been in operation at Agincourt 2D Reef since 1984.

Figure 1. Location of Pilot Study area

Using the transplantation guidelines a pilot program was conducted by the operator over 20 September 2003 to 22 October 2003. 99 live coral colonies and fragments were transplanted to three discrete sites totalling approximately 80 m2 (Laycock, 2004). The transplanted corals included the taxonomic groups: Staghorn *Acropora* (n=51); Bottle Brush *Acropora* (n=19); Corymbose *Acropora* (n=21); *Pocillopora spp*. (n=2); and *Sinularia spp*. (n=6).

Donor corals were collected from sites within 200 m of the pontoon, at the same depth and aspect as the intended transplant site. Only whole colonies were collected and when fragments were generated, a colony provided numerous fragments. Colonies were 15- 30 cm diameter for all species other than staghorn *Acropora* for which 30 – 50 cm and a select group of 50 - 100 cm fragments were used. Attachment was through a mixture of 3:1 cement:plaster after preparation of the natural reef surface including scrubbing and chiselling. The transplanted corals were monitored weekly for 3 weeks, then at 4-6 week intervals for 7 months. Monitoring included attachment state, estimates of % live tissue area (%LTA), counts of growing tips, measurement of colony height and width, and a statement of general condition.

The following is a summary of results draw from Laycock (2004). After approximately seven months, 96 of the 99 corals were alive (96% survival) (refer **Table 1**). Stable or positive increments in %LTA were recorded for 68 % of corals. Approximately 83 % of colonies had increased in size and 62 % of corals had both a combined increase in %LTA and increase in colony dimension (**Figure 2**). All mortality was attributed to attachment failure. There were 27 attachment failures due to wave action during two cyclones (14 cases), dislodgment by falling rubble and by foraging fish.

Taxonomic Group	Colony (n)	Initial Size Range (cm)	Increasing in Size (n)	Change in estimated percent live tissue.(n)			Survivorship (%)
				Decrease	No Change	Increase	
Staghorn *Acropora*	51	15-47	44	15	15	21	98
Bottle Brush *Acropora*	11	12-35	5	5	3	3	91
Corymbose *Acropora*	29	11-26	27	5	8	16	97
Pocillopora damicornis	2	18-20	1	1	0	1	100
Sinularia spp.	6	15-32	0	0	6	0	100

Table 1. Summarised performance of transplanted corals seven months post transplantation (after Laycock 2004).

Benefits of guidelines

Review of the pilot project concluded that there were impacts from the transplantation, including to donor areas and reduced growth, and mortality of transplants. Results clearly confirmed the net environmental benefit assessment and the benefit of the coral transplantation guidelines.

The activity-specific guidelines delivered additional valuable benefits including:

- resolution of significant issues raised by tourism, fishing and coral collection stakeholders;
- conveyed information from the scientific community to the general public in an accessible form;
- provided a publicly available demonstration of effective management;
- provided an ongoing streamlined processes providing consistent outcomes with reduced resources for subsequent applications; and
- monitoring programs established under the guidelines continue to provide data to support the efficacy of the approach and to provide feedback to improve future decisions.

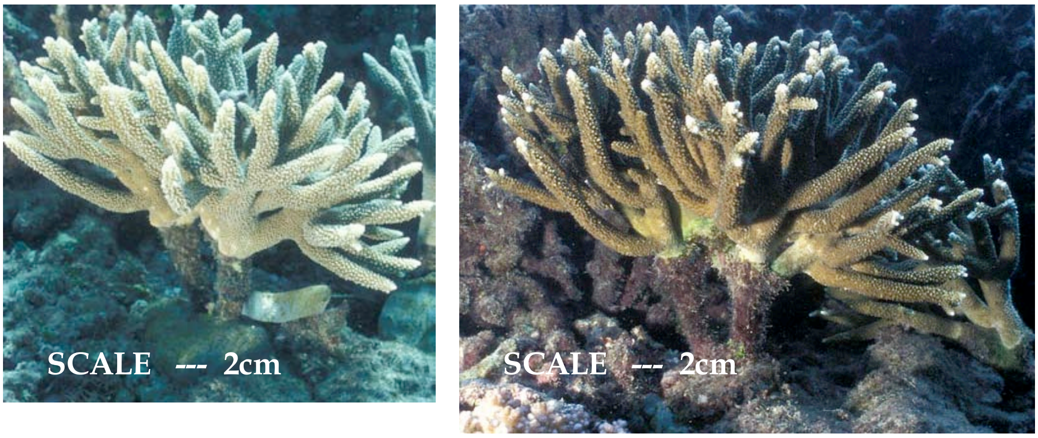

Figure 2: Indicative transplant growth, an *Acropora* Staghorn colony at initial transplant and after 7 months. Note colony extension, basal die back and increased number of growing tips.

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