WHERE DO THEY GO?

Predicting visitation intensity at focal tourist sites within protected areas

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SUSTAINABLE TOURISM CRC

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ABSTRACT

Growing visitor numbers at focal sites in protected areas have been shown to deleteriously influence ecological integrity across a wide range of ecosystems. In response to concerns over the influence of visitor activities on site ecosystem health, natural resource managers have expressed an interest in predictive models that might be able to identify affected sites before deleterious impacts have occurred. Hadwen, Arthington and Mosisch (2003) developed one such predictive model, known as the Tourist Pressure Index or TPI. Their TPI aimed to predict visitor numbers to significant sites (pristine lakes) on the World Heritage Listed Fraser Island (Queensland, Australia). In this study, we sought to apply the TPI model to sites on Fraser Island and developed thresholds for Early Warning and Management Action that can be used by natural resource managers to respond to site use before they become degraded from excessive visitor use.

In addition, we sought to further refine and develop the TPI model to facilitate its broader appeal and applicability to protected areas throughout Australia. We hoped both to add some additional relevant factors to the model and to collate data that improved the quantitative basis of model predictions. To achieve these goals, we applied a modified TPI model to a series of selected protected areas on mainland Australia and conducted two online surveys to collate data on the degree to which site features might influence visitor behaviour and visitation levels. Pulling both of these approaches together, we found that the original TPI model performed particularly well on mainland Australia sites. Modifications that increased the number of influencing factors and the degree of quantitative input improved model predictions, but rarely influenced the degree to which sites were likely to be influenced by visitor numbers. For example, sites at risk identified under all model simulations were the same.

Survey results were used to assess the need for quantitative terms in the revised TPI model. Specifically, we assessed the influence of a wide range of environmental and infrastructure factors on visitor decision-making processes, particularly with respect to visits to focal sites for tourism and recreation within protected areas. Survey output revealed some differences between male and female respondents, as well as some degree of varying perceptions and motivations with age class. These data can be used by protected area managers to refine TPI models used for particular sites, particularly those that appeal more strongly to certain demographic groups more than others. Future work will both field test the applicability of these model revisions and further examine the reasons for sex and age differences in visitor use of natural and built environments within protected areas.

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Modification of the original Tourist Pressure Index (TPI) was facilitated by comments and contributions from Christy Fellows and Kim Markwell at the Australian Rivers Institute (formerly the Centre for Riverine Landscapes), Griffith University. In addition, the online surveys produced as a major data collection component of this study were developed in coordination with and hosted by Kerry Rosenthal from the Queensland Department of Natural Resources and Mines and the Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management. Surveys were conducted in accordance with the Griffith University Human Research Ethics Guidelines, under Permit #AES/08/05/HREC.

SUMMARY

This study revolved around the development and application of a Tourist Pressure Index (TPI), a predictive model of visitor numbers at key sites within a protected area developed by Hadwen, Arthington and Mosisch (2003), in protected areas in Australia. This model was developed for use in protected areas where visitor data is not collected, as a means of identifying sites that are likely to receive high visitor numbers. Specifically, the model is designed to determine the relative importance of multiple sites within a single protected area as focal destinations for visitors and, to this end, resource managers can use the model output to determine how and where to invest in management activities that can aid in the sustainable management of sites in light of visitor pressure.

In this study, there were four key components to the continuing development of the TPI model, namely:

1. Developing TPI score thresholds for managers;
2. Redeveloping the TPI model to include additional factors that can influence visitor preference for particular sites;
3. Applying the revised TPI model to new protected areas; and
4. Collecting data on how the model might be further refined in the future, especially in relation to age and gender differences in visitor behaviour and perceptions.

Key Findings

The major findings from this study are:

1. TPI scores can be used to develop management trigger thresholds

Investigations of the condition and TPI scores of key visitor sites on Fraser Island facilitated the development of Early Warning and Management Action thresholds. These thresholds, whilst only applicable to the sites examined in this study, represent the best practice use of the TPI model to identify which sites require which types of management intervention to ameliorate the threats of visitor-mediated site degradation. We strongly suggest that TPI thresholds be determined and evaluated by protected area agency staff in collaboration with research scientists, but feel that the establishment of thresholds can be extremely beneficial in identifying management priorities. In addition, the TPI model can be re-run under various management intervention scenarios, with the view to providing an indication of visitor response to management options. To this end, the TPI model can be a planning tool used by protected area agency staff to optimise their monitoring and management strategies. This product has great potential in large, heavily visited protected areas as well as those with limited budgets and capacity to implement management strategies. It represents a defensible mechanism through which management and site hardening decisions can be made and is not subject to user bias the way that guesswork approaches of where visitors go within any given protected area tend to be.

2. Depending on the protected area, additional factors should be built into the TPI model

Whilst the original TPI model developed for Fraser Island dune lakes accurately predicted which lakes were most likely to be heavily visited, the general applicability of that model was limited. To address this shortcoming, we have identified several additional factors that can be easily incorporated into the TPI model to make it more generically applicable. Specifically, we have identified the inclusion of factors relating to aspects of site access (track grade) and accessibility to drinking water as two key factors that can play a strong role in influencing visitors' decision-making processes on which site to visit within a protected area.

This revised TPI model has been applied to three new protected areas, but still does need to be applied to more inland protected areas to prove its worth. Having said that, there is sufficient evidence to suggest that drinking water and track conditions strongly influence visitor behaviour in protected areas, so we feel this revised TPI model promises much in terms of more accurately representing how visitors are likely to be spatially distributed within protected areas throughout mainland Australia.

3. Demographic aspects may inform future TPI model developments, especially for protected areas with gender- and age-biased visitation

Our online survey results indicated that age- and gender-specific preferences might influence the spatial distribution of visitors within protected areas, especially in parks that have a skewed distribution towards either sex or certain age groups. These findings have implications for protected area planning and management, as management decision-making processes should take into consideration the type of visitors that visit their park. Interestingly, there were very few differences in survey responses between day trip and overnight stay respondents, suggesting that the type of visit does not have a strong influence on visitor decision-making.

Future protected area management and planning operations could utilise the TPI model to optimise their activities. This is likely to be an important cost-saving use of the TPI model, as scenarios run through the model can be evaluated in light of the limited budget and operational capacity of the agency staff in any given protected area, such that the best decisions relating to management and monitoring activities are made.

Future Action

The findings of this study reveal the broad applicability of the Tourist Pressure Index (TPI) model of Hadwen, Arthington and Mosisch (2003). In addition to modifications that have strengthened the model, future planned actions include rigorous field-testing, or ground-truthing, of the model in heavily visited protected areas. We suggest that one of the key limitations to effectively managing popular protected areas comes with the fact that the quantity and quality of visitor information is generally insufficient to guide managers (Hadwen, Hill & Pickering in press). Specifically, although total visitor numbers are known for some protected areas, there are no protected areas that routinely collect site visitation data (within their protected area). To some extent, the TPI model that forms the focus of this study can provide natural resource managers with information that may fill this gap, but ground-truthing of the model is likely to require some site-to-site comparisons of actual and predicted visitor numbers.

Key future actions, to be undertaken collaboratively between protected area management agencies (World Heritage authorities, state national parks and wildlife services, state forestry services etc) and research scientists are:

- The establishment and storage of visitor monitoring programs, both to collate total numbers of visitors within a protected area and also the number of visits, or visitors, at particular sites within a protected area.
- The establishment of routine data collection strategies to examine the motivations, perceptions and issues that influence visitor use and intensity at focal sites within popular protected areas.
- Studies examining the influence of site infrastructure (including hardening) and impacts (visual degradation) on visitor perception and visitation levels within heavily visited protected areas.
- Studies examining the seasonality of visitation to a wide range of protected areas, to elucidate climate-driven patterns in visitation and visitor activities (and their potential ecological impacts).
- Examination and development of relevant ecological indicators to provide information on visitor impacts in protected areas. This represents the necessary next step in determining the effects of activities (rather than visitor numbers) on natural ecosystems and species. This task is currently being undertaken in a series of STCRC-funded research projects that aim to develop terrestrial, aquatic, social and economic indicators of sustainable tourism and recreation for implementation in protected areas.

Chapter 1

WHY THE TOURIST PRESSURE INDEX? AN INTRODUCTION TO THE DEVELOPMENT AND APPLICATION OF THE MODEL

The Tourist Pressure Index (TPI) of Hadwen, Arthington and Mosisch (2003) was originally developed to provide a basis for analyses of the influence of visitors on key sites within protected areas (Hadwen 2003). Given the absence of visitor monitoring data at all of these sites, it was necessary to develop a standard semi-quantitative model to ascertain the relative tourist pressure (or anticipated tourist numbers) at each site. This approach facilitated cross-site comparisons of visitor pressure and ecological response. Whilst visitor data at key sites would be far superior to the use of the TPI model, the fact that such data is rarely if ever collected (Hadwen, Hill & Pickering in press) ensures that there is a place for the TPI model as a tool for use by protected area managers. Furthermore, whilst protected area staff may be able to guess which sites are heavily visited and which are not, the TPI has the added advantage of being: a) a standard model for application across all sites within a protected area; and b) a model that can be applied across multiple protected areas. As a result, the TPI approach can reduce bias and be used to indicate relative visitor pressure at larger spatial scales than protected area staff are likely to be able to do in isolation of such an approach.

The TPI Model

The TPI model of Hadwen, Arthington and Mosisch (2003) is a relatively straightforward and largely qualitative model to predict which sites are likely to receive high visitor numbers within a protected area. The model uses known features of the system relating to the accessibility, publicity and provision of facilities. As these features are known to influence visitation motivations, they can be used to assess the likelihood of visitation to an individual waterbody or a group of lakes, for example.

From Hadwen, Arthington and Mosisch (2003), the equation used to calculate a Tourist Pressure Index (TPI) for lakes on Fraser Island is as follows:

$$\mathbf{TPI = \{(P + R + A) / [(lowest\ of\ B\ or\ S) + C + T)]\} \times 100}$$

Where: **P** = publicity surrounding site (0=unknown, 1=on postcards, QNPWS flyers etc, 2=extremely well known)
R = road quality – relates to ease of travel (0=closed road, 1=used road, 2=scenic drive)
A = accessibility of lake to parking facilities (0=no track, 0.5=long track, 1=medium length track, 2=short track)
B = distance to nearest barge landing (kms)
S = distance to nearest settlement (kms)
C = distance to nearest camping area (kms)
T = distance to nearest toilet facilities (kms)

Since day visits to lakes by tourists are strongly influenced by the ease of access from the mainland (access via barge only) or from settlements on the island (4WD vehicular access only), the lower of **B** or **S** was used to calculate the TPI score for each lake. **S** was primarily used for the lakes in the northern part of the island, where long distances to the nearest barge landings tend to prohibit day-trips.

High TPI scores relate to higher potential pressure from tourism. Low values for **B** (or **S**), **C** and **T** are likely to attract tourists to a lake, as they represent the accessibility and comfort afforded to tourists whilst at the lake. In contrast, low values for **P**, **R** and **A** have a negative effect on potential impacts, as each has the potential to reduce tourist motivation to visit any given lake.

Applying the TPI Model

The application of the TPI model as a reliable indicator of visitation levels in protected areas, has already been highlighted in several studies on Fraser Island, Australia. Specifically, Hadwen, Arthington and Mosisch (2003) found that the lakes most at risk from visitor-mediated impacts (especially nutrient inputs) were also those with the highest TPI scores. In addition, Hadwen and Bunn (2004) applied the TPI to their investigation of food web function in five lakes on Fraser Island and found it to be a better predictor of autochthonous carbon contributions to consumer diets than all of the available physical and chemical factors. To this end, the TPI developed for Fraser Island not only identifies sites at risk, but also reveals how sites have already responded to visitor numbers and activities.

Project Aims and Outcomes

The main aim of this project is to develop and provide a product (TPI Model and User Guidelines) that will enhance the capacity of protected area managers to sustainably manage visitor numbers and activities within their area. The model will facilitate the identification of sites most likely to be threatened by excessive visitation and the establishment of threshold levels for management response will engender a proactive approach to managing visitors within protected areas.

In order to meet these aims, there are five anticipated research activities and outcomes from this project:

1. Use existing scores for Fraser Island lakes to determine thresholds for Early Warning and Management Action.

Modification of the existing TPI model will enable the development of threshold scores for a) Early Warning, and b) Management Action for Fraser Island sites. Early Warning scores are intended to highlight sites with high visitation, ensuring that the protected area managers can implement monitoring programs to assess whether or not existing pressures are adversely influencing the environmental values of the site. Management Action scores are intended to highlight sites with extremely high visitation pressures. Protected area managers should respond to Management Action scores through a range of actions, possibly including changes in site access and infrastructure (including hardening), but also in the form of the implementation of visitation level regulations and ongoing monitoring programs.

2. Calculate TPI scores for other sites on Fraser Island to develop the adaptability of the TPI for non-lake sites.

Non-lake sites of interest on Fraser Island will be included in analyses to examine the capacity of the model to generate predictions of visitor pressure across a broader suite of sites and systems.

3. Modify the TPI model to become more generally applicable to the wide range of protected areas throughout Australia.

The original TPI model of Hadwen, Arthington and Mosisch (2003) only seriously considered parameters that were likely to be relevant to activities of specific interest to that study, namely swimming and relaxation pursuits in and around dune lakes. In this study, we recognise that additional uses of protected areas like camping, hiking, recreational fishing, kayaking/canoeing and power boating require the inclusion of additional parameters that relate to access, facilities and site restrictions.

4. Refine the TPI model to include separate modules for tourists (i.e. visitors to a region) and local residents.

With respect to protected areas, it has been proven that values, perceptions and activities often differ between tourists (visitors from at least 50km away) and local residents. Since many protected areas (especially those in coastal regions) have adjoining urban communities, issues of accessibility differ markedly between visitor groups (i.e. local residents versus visitors from greater than 50km away). The development of separate modules for tourists and local residents is a necessary modification of the existing TPI, particularly given that some protected areas are more heavily used by local residents than visitors, and vice versa. Fundamental differences between these user groups will require modification of the TPI model. Key components to be taken into consideration include infrastructure, developments and proximity of other recreational areas. Development of modules specific to tourists (visitors to a region) and local residents will aid in the management of these different user groups within protected areas.

5. Development and production of the revised TPI model and TPI User Guidelines.

The revised TPI model represents a significant addition to visitor management tools available to protected area managers. The model promises to empower protected area managers with information regarding the appeal of sites within their area. The TPI User Guidelines will enable protected area managers, local councils and interested stakeholders to assess the predicted spatial distribution and associated threats of tourist activities within their region. Sites with consistent and/or seasonally high TPI scores may exceed Early Warning or Management Action thresholds, prompting action from managers either through the development of specific monitoring programs or the regulation of tourist activities and/or visitation levels. The development of these thresholds for TPI scores will greatly enhance the usability and appeal of the TPI model.

Finally, ongoing ground-truthing of the TPI model and its predictive capacity against accurate visitor datasets, and subsequent revision of TPI scores where necessary, will enhance the capacity to proactively manage visitation levels within protected areas. This component of research will form the focus of future endeavours to provide protected area managers with tools that can accurately assist in the identification of focal sites for visitors and their ongoing sustainable use. Specifically, new STCRC-funded monitoring and indicator development projects will utilise the TPI model to identify sites, activities and degrees of potential visitor impact across a wide range of ecosystems and sites within protected areas.

Chapter 2

EARLY WARNING AND MANAGEMENT ACTION VISITATION THRESHOLDS AS DETERMINED USING THE TOURIST PRESSURE INDEX: A CASE STUDY OF APPLYING THE MODEL TO THE DUNE LAKES ON FRASER ISLAND

In response to the growing visitor numbers to the World Heritage Listed Fraser Island, Hadwen, Arthington and Mosisch (2003) developed a formula for a Tourist Pressure Index (TPI) that facilitated predictions of visitor numbers at 15 lakes within the region. As explained in Chapter 1, the equation from Hadwen, Arthington and Mosisch (2003) used to calculate a Tourist Pressure Index (TPI) for lakes on Fraser Island is as follows:

$$\mathbf{TPI= \{(P + R + A) / [(lowest\ of\ B\ or\ S) + C + T)]\} \times 100}$$

Where: **P** = publicity surrounding site (0=unknown, 1=on postcards, QNPWS flyers etc, 2=extremely well known)
R = road quality – relates to ease of travel (0=closed road, 1=used road, 2=scenic drive)
A = accessibility of lake to parking facilities (0=no track, 0.5=long track, 1=medium length track, 2=short track)
B = distance to nearest barge landing (kms)
S = distance to nearest settlement (kms)
C = distance to nearest camping area (kms)
T = distance to nearest toilet facilities (kms)

High TPI scores are indicative of anticipated high visitor numbers, as the index is calculated on the basis of a range of accessibility, aesthetic and facility-based values. Hadwen, Arthington and Mosisch (2003) calculated TPI scores that ranged from 2.65 (White Lake) to 61.22 (Lake McKenzie) and these were, as expected, strongly influenced by lake accessibility and popularity, or the reputation and publicity of the site (Table 1). Hadwen, Arthington and Mosisch (2003) also found that some of the highest TPI scores were for the most oligotrophic (low nutrient) lakes on the island, suggesting that despite indications of high visitor numbers, visitors had not yet significantly influenced lake ecosystem health as measured by typical water quality and productivity (algal concentration) measures. They concluded that lakes McKenzie, Allom and Birrabeen were particularly at risk of visitor-mediated impacts both by virtue of their high TPI scores and their low nutrient and algal (chlorophyll a) concentrations.

Hadwen and Bunn (2004) further examined the explanatory power of the TPI model of Hadwen, Arthington and Mosisch (2003) in their investigation of food web structure and function in five lakes on Fraser Island. Significantly, they found that lakes with the highest TPI scores tended to have food webs with a greater relative contribution of algal (autochthonous) carbon sources to consumers. Put simply, the food webs of lakes with high visitor numbers were found to have higher contributions of algae than those with relatively lower modelled visitor numbers. In the context of findings of Hadwen, Bunn, Arthington & Mosisch (2005) and Hadwen and Bunn (2005), these results suggest that visitor-mediated increases in algal production and biomass accrual (presumably via nutrient additions) are reflected in the food web data. By examining an ecological process rather than a water quality parameter, Hadwen and Bunn (2004) had effectively demonstrated that visitors could influence aquatic ecosystem dynamics. Significantly, these process-level changes were occurring without observable changes in measures of water quality like those frequently monitored by Environmental Protection Agency staff on Fraser Island (e.g. nitrogen, phosphorus and chlorophyll a).

Methods and Results

In response to the various findings of Hadwen, Arthington and Mosisch (2003), Hadwen and Bunn (2004), Hadwen et al. (2005) and Hadwen and Bunn (2005), we sought to examine the potential of the TPI model in developing Early Warning and Management Action thresholds to guide natural resource managers in their mitigation of visitor-mediated changes in lake health. To achieve this goal, we first endeavoured to group the 15 lakes assessed by Hadwen, Arthington and Mosisch (2003) into three broad categories, namely those that were variously i) not threatened, ii) threatened, and iii) impacted by visitor activities on the basis of our existing knowledge of their water quality and productivity. The groupings and TPI scores of these lakes are presented in Table 1.

Table 1: Groupings of Fraser Island lakes with respect to visitor activities

Lakes and Groupings	TPI Scores
Not Threatened	
White	2.65
Coomboo	6.05
Boomerang North	6.91
Boomerang South	11.52
Benaroon	14.29
Barga	14.36
Threatened	
Basin	17.86
Garawongera	19.05
Jennings	22.86
Impacted	
Wabby	15.68
Ocean	21.16
Boomanjin	27.47
Birrabeen	34.29
Allom	35.71
McKenzie	61.22

Sources: Hadwen 2003; Hadwen, Arthington & Mosisch 2003

There were significant differences between the mean TPI scores across the not threatened, threatened and impacted lakes ($p = 0.009$), highlighting the relationship between model scores and predicted endangerment of these aquatic ecosystems (Figure 1).

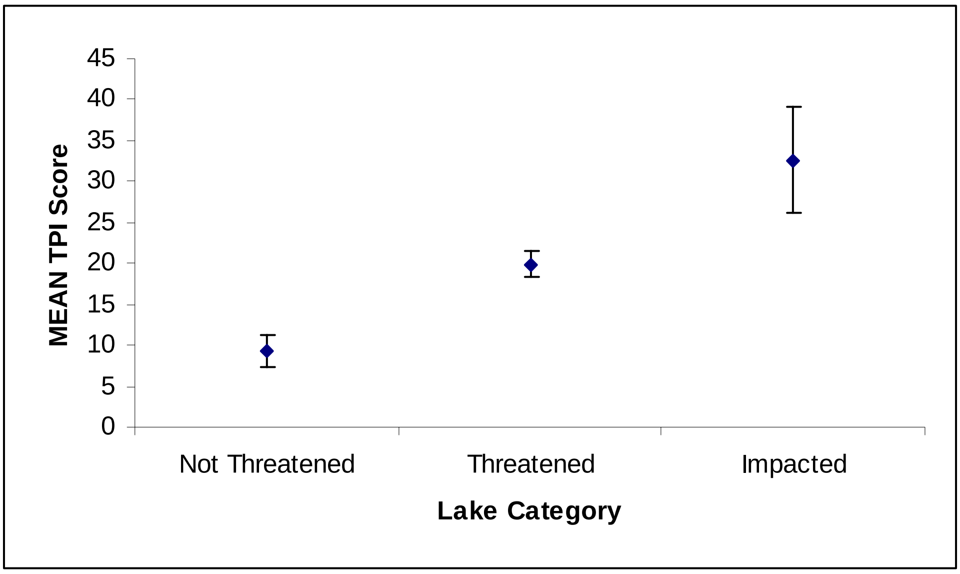

Figure 1: Mean (± SE) TPI scores for Not Threatened, Threatened and Impacted Lakes on Fraser Island

Source: Hadwen, Arthington & Mosisch 2003

The significant differences between lake groupings (not threatened, threatened and impacted) were used to establish preliminary Early Warning (20) and Management Action (35) thresholds for TPI scores (Figure 2). It is anticipated that Early Warning thresholds should alert resource managers to potential impacts at these sites. The Management Action threshold is one step further along in the evolution of visitor use and suggests that resource managers may need to take strong actions to ameliorate or mitigate the likely impacts of such visitation levels.

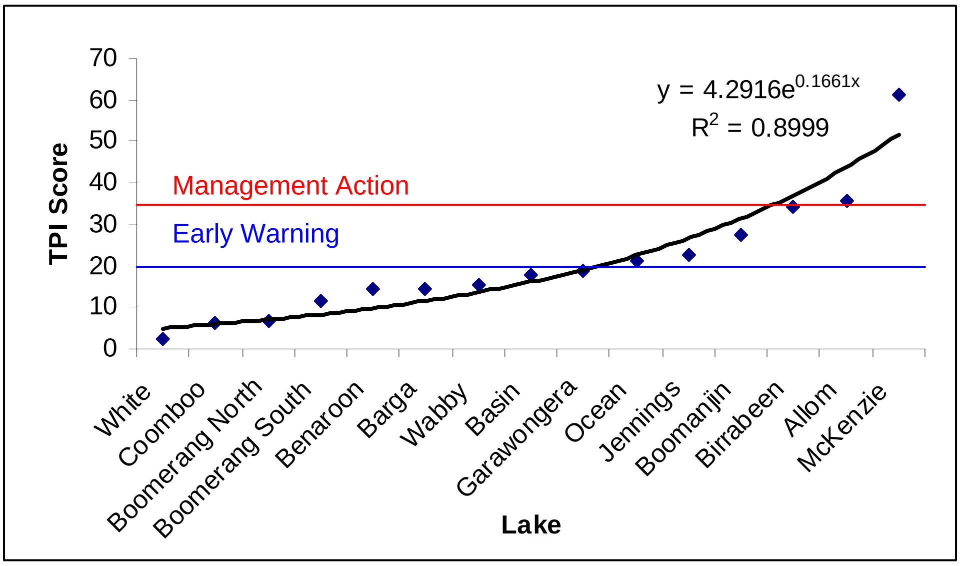

Figure 2: TPI scores for 15 lakes on Fraser Island, with nominated Early Warning and Management Action thresholds

Source: Hadwen, Arthington and Mosisch 2003

At the Early Warning threshold we would recommend the implementation of a detailed and scale-sensitive monitoring program. In addition, managers may like to begin planning and/or implementation of hardening infrastructure (i.e. boardwalks at Eli Creek), to reduce the likelihood that the site will proceed into the Management Action category. To this end, the aim of the Early Warning threshold is to alert resource managers to the potential impacts that may occur at sites with these levels of visitation load and intensity. Whilst it is ultimately the responsibility of the protected area agency and managers as to what management actions are implemented and when, we would suggest that mitigating actions at this level would vastly improve the condition of the system and the ecological components within it, by providing conditions and constraints that limit the proliferation of undesirable changes driven by visitor use.

Beyond the Management Action threshold, we would expect sites to be feeling the effects of heavy traffic and visitor use. At this threshold, we recommend the implementation of strict regulations on visitor numbers and/or the types of visitor activities permitted at these sites, to mitigate damage and safeguard the site from further degradation.

It should be noted that hardening and other forms of management intervention may lead to increases in site TPI scores as they may become more attractive to visitors owing to improved access and/or facilities. Increased TPI scores following management actions relate only to visitation levels and the relationship with visitor numbers and potential impacts should change as a result. In other words, although management actions may lead to increases in the TPI for a particular site, the likelihood of impacts should decrease if hardening reduces the susceptibility of the site to degradation. We stress that it is important, whenever any hardening of sites occurs, to monitor the consequences for visitor numbers and further impacts.

Whilst TPI scores may increase with hardening and management action, it is also possible that actual visitation levels may drop in response to this degree of site management and intervention. As Hadwen and Arthington (2003) reported, many visitors to wilderness areas resent hardening and facilities, as they feel that these management activities reduce the aesthetic appeal of the site. We would recommend extensive visitor survey work before the implementation of hardening and other structures around natural areas of significance, as this field of endeavour is not as advanced as it needs to be in terms of providing useful information to managers and planners with respect to the broader social (and economic) effects of their activities.

Following on from the above analysis and in light of the aim to develop the model to predict visitation intensity at non-lake sites of interest, 11 additional sites on Fraser Island were included in subsequent TPI model analyses. Scores for these sites (and the 15 lakes examined above) are presented in Table 2. The new sites added to our analysis of visitation pressure on Fraser Island revealed that there were numerous non-lake sites that fall in our Early Warning and Management Action groupings. Specifically, we found that many of the iconic sites on

Fraser Island, like The Maheno wreck, Eli Creek, Pile Valley, Indian Head, The Pinnacles and Central Station were under considerable visitation pressure.

Discussion and Conclusions

The TPI of Hadwen, Arthington and Mosisch (2003) has been shown to be a useful predictor of visitation and potential environmental responses at sites of interest (Hadwen & Bunn 2004). In this chapter, we examined the applicability of the TPI model, in conjunction with detailed limnological and visitation information, to provide thresholds of concern for protected area managers on Fraser Island. Specifically, we have demonstrated the usefulness of predictive models in being able to guide protected area managers with their decision-making (relating to site use and impacts) when actual visitation data and ecological data are often otherwise scant. This extension of the work started by Hadwen, Arthington and Mosisch (2003) provides a valuable management contribution and has the potential to assist on-the-ground staff in their management of sites within their protected areas that are known visitation hot spots.

Significantly, through the determination of Early Warning and Management Action thresholds, we give protected area managers the wherewithal to proactively respond to trends in visitation and associated visitor impacts at key sites. Experience from aquatic sites that are focal for tourism and recreation activities, suggests that without early warning mechanisms, incremental changes mediated by visitors are likely to significantly and irreversibly alter the ecology of the system. To the best of our knowledge, the approach and application detailed herein provide one of the first opportunities for protected area managers to proactively identify and ameliorate tourism and recreation threats before they adversely influence the ecology of wilderness and heritage-listed sites.

Table 2: TPI scores for sites on Fraser Island

Sites and Groupings	TPI Scores	Sites and Groupings	TPI Scores
White	2.65	*Ocean*	*21.16*
Urang Creek	3.82	*Jennings*	*22.86*
Coomboo	6.05	*Boomanjin*	*27.47*
Boomerang North	6.91	*The Maheno*	*31.61*
South White Cliffs / ‘Palmer’ wreck	7.20	*Eli Creek*	*32.47*
Boomerang South	11.52	*Birrabeen*	*34.29*
Hammerstone Sand Blow	14.07	*Pile Valley*	*34.67*
Benaroon	14.29	**Allom**	**35.71**
Barga	14.36	**Indian Head / Champagne Pools**	**36.44**
Wabby	15.68	**The Pinnacles**	**51.02**
Wungul Sand Blow	17.01	**McKenzie**	**61.22**
Rainbow Gorge	17.68	**Central Station**	**64.94**
Basin	17.86		
Garawongera	19.05		

Note: Sites with scores beyond the Early Warning and Management Action thresholds are indicated in italics and bold text, respectively.

Structuring TPI model output under Early Warning and Management Action headings also provides us with the opportunity to simplify model output and graphically represent the current predicted status of focal sites used by visitors to Fraser Island. We suggest that this approach greatly increases the applicability of the model and should also aid discussions between on-the-ground staff and higher-level management charged with protecting these sites.

Chapter 3

REFINING THE TOURISM PRESSURE INDEX FOR FRASER ISLAND SITES: ADDITIONAL FACTORS INFLUENCING PREDICTED VISITATION LEVELS AND POTENTIAL IMPACTS

Continued development and consideration of the Tourist Pressure Index (TPI) of Hadwen, Arthington and Mosisch (2003) revealed that several potentially influential factors were omitted from the original model. Specifically, the original TPI model did not include three key aspects of site appeal. The original model did not account for differences in access relating to track grade (or quality), or differences in site appeal on the basis of shower facilities and provision of drinking water. These later two factors are considered to be particularly important in more remote settings where overnight stays are necessary, especially when the quality of water for drinking purposes is uncertain (Buckley, Clough, Warnken & Wild 1998), but they may also influence visitor decisions over shorter time spans, particularly in summer months.

Methods

To address the potential influence of additional factors on the TPI model predictions, we developed a revised TPI model. These additions require more data inputs and potentially more knowledge of site characteristics that cannot be directly pulled from a map, but certainly have the potential to influence model output on the basis of the known influence of track grade and the provision of water, showers and toilets on visitor perceptions and motivations (Ryan & Sterling 2001). The original TPI model (Equation 1), therefore became our revised TPI model (Equation 2).

$$\mathbf{TPI = (R + P + A) / (B \text{ or } S + C + T) \times 100} \qquad \text{(Equation 1)}$$

$$\mathbf{Revised\ TPI = [R + P + (A \times G)] / (B \text{ or } S + C \text{ or } H + T + F + W) \times 100} \qquad \text{(Equation 2)}$$

Where: **R** = road quality
P = public knowledge of site
A = ease of walking access to site from carpark
G = grade of walking track

B = distance (kms) to barge landing site
S = distance (kms) to nearest settlement
C = distance (kms) to nearest camp ground
H = distance (kms) to nearest housing or non-camping accommodation
T = distance (kms) to nearest toilet facilities
F = distance (kms) to nearest shower facilities
W = distance (kms) to nearest source of drinking water

As for the original TPI model (Hadwen, Arthington & Mosisch 2003), numerators in the model tend to be categorical variables (Table 3), whereas the denominators are generally numerical (distance) measures that are included on the basis of their likely influence on visitation levels on the basis of site accessibility, proximity and/or remoteness. To examine the influence of the additional factors on TPI model output, we re-ran our analysis of visitation pressure for the 26 Fraser Island sites examined in Chapter 2. We were specifically interested in how, not only the TPI score, but also the rank of sites differed between the models as this provides us with a clear indication of the explanatory power of the new factors in predicting visitor numbers.

Table 3: Details of the four categorical variables used in the numerator of the TPI model

Factor	Relevance	Symbol	Measurement	Scoring Details
Road Quality	Only in protected areas with roads	R	Relates to quality of vehicle track and associated access issues to site	0 = walking track only 1 = 4WD vehicle only 2 = unsealed road 3 = sealed road
Publicity	All protected areas	P	Relates to visitor awareness (presence of site in promotional materials)	0 = not well known 1 = reasonably well known 2 = extremely well known
Access	All protected areas	A	Relates to ease of walking access to site from carpark	0 = no track 1 = long track (> 5kms) 2 = medium length track (2-5kms) 3 = short track (< 2 kms)
Track Grade	All protected areas	G	Relates to quality of walking track	1 = difficult grade 2 = medium grade 3 = easy grade 4 = wheelchair access

Results

Application of the refined TPI model to the Fraser Island dataset altered both the TPI scores and the rank order of scores for most sites (Table 4), highlighting the potential importance of the new factors in influencing visitor visits to the various sites. Several sites had dramatic shifts (>6) in their TPI ranks and for these sites, the inclusion of aspects of track grade and access to drinking water seemed to play an important role in these shifts. Specifically, the TPI rank of Indian Head / Champagne Pools fell by nine places. This result was largely driven by the absence of drinking water at the site, as access to the site is relatively easy. In contrast, Lake Wabby fell seven TPI rank places by virtue of the combined effects of the absence of drinking water at this site and the long and steep walk required to gain access to the lake's edge. Sites that gained a large number of ranks (Lake Benaroon up seven and Wungul Sand Blow up 12) did so on the basis of the ease of access, or the combined influence of distance from carpark and track grade.

Table 4: Rank and scores of original and refined TPI models applied to Fraser Island focal tourism and recreation sites

Site	Original TPI Score	Refined TPI Score	Original TPI Rank	Refined TPI Rank	Change in Rank
White Lake	2.65	3.58	26	25	Up 1
Urang Creek	3.82	14.01	25	22	Up 3
Lake Coomboo	6.05	11.58	24	23	Up 1
Lake Boomerang North	6.91	1.74	23	26	Down 3
South White Cliffs / 'Palmer' wreck	7.20	17.95	22	21	Down 1
Lake Boomerang South	11.52	19.16	21	20	Up 1
Hammerstone Sand Blow	14.07	25.21	20	19	Up 1
Lake Benaroon	14.29	50.42	19	12	Up 7
Barga Lagoon	14.36	39.46	18	17	Up 1
Lake Wabby	15.68	10.58	17	24	Down 7
Wungul Sand Blow	17.01	85.03	16	4	Up 12
Rainbow Gorge	17.68	48.70	15	15	Even
Basin Lake	17.86	28.57	14	18	Down 4
Lake Garawongera	19.05	57.14	13	10	Up 3
Ocean Lake	21.16	47.62	12	16	Down 4
Lake Jennings	22.86	48.80	11	14	Down 3
Lake Boomanjin	27.47	65.93	10	8	Up 2
The 'Maheno'	31.61	54.25	9	11	Down 2

Eli Creek	32.47	85.71	8	3	Up 5
Lake Birrabeen	34.29	61.22	7	9	Down 2
Pile Valley	34.67	69.69	6	7	Down 1
Lake Allom	35.71	80.36	5	5	Even
Indian Head / Champagne Pools	36.44	49.83	4	13	Down 9
The Pinnacles	51.02	71.43	3	6	Down 3
Lake McKenzie	61.22	122.45	2	2	Even
Central Station	64.94	155.84	1	1	Even

Discussion and Conclusion

Additional factors influenced TPI scores for most sites examined in this study. Indeed, only four TPI ranks remained unchanged between the scores generated for the original and refined TPI models. Notably, two of these sites (Lake Allom and Lake McKenzie) were some of the most impacted and significant aquatic sites on Fraser Island (Hadwen, Arthington & Mosisch 2003) and had characteristically high scores on the basis of the original TPI output.

Given this degree of apparent influence, it was deemed necessary to further examine the influence of factor weightings on model predictions. To do this, we developed targeted surveys that aimed to collate data on the relative importance of a wide range of factors that might influence visitor behaviour and decision-making processes with respect to site selection and visitation within protected areas (see Chapter 4).

Chapter 4

APPLYING THE REFINED TOURISM PRESSURE INDEX MODEL TO ADDITIONAL PROTECTED AREAS IN AUSTRALIA

The refined TPI model developed in Chapter 3 was designed to be applicable to a wide range of protected areas throughout Australia. To examine its broad applicability, this refined model was applied in three case study protected areas—Cooloola National Park (Queensland), Moreton Island National Park (Queensland) and Freycinet National Park (Tasmania). Each of these areas receives significant visitor numbers and all are internationally recognised as wilderness areas of exceptional environmental values with a range of natural sites likely to be important as focal sites for tourism and recreation (Queensland Government 2005a, Queensland Government 2005b, Tasmanian Government 2005).

To examine the applicability of the TPI model to each case study area, we obtained detailed maps of heavily trafficked areas within each. For Cooloola and Moreton Island National Parks, we obtained these maps from the Queensland Environmental Protection Agency / National Parks and Wildlife Service website (Queensland Government 2005a, Queensland Government 2005b). For Freycinet National Park, a map of Coles Bay / Wineglass Bay and surrounds was obtained from the Tasmanian National Parks and Wildlife Service website (Tasmanian Government 2005).

Case Study National Parks

As application of the TPI model requires some level of understanding and awareness of key sites (and their accessibility and appeal), the case study sites were specifically chosen as they have all been visited by Wade Hadwen (report author) within the past five years. Furthermore, Cooloola and Moreton Island protected areas are well-known to Angela Arthington (report author) from previous research within the region (Arthington & Watson 1982; Outridge, Arthington & Miller 1989). In addition to our knowledge and understanding of focal sites within these protected areas, maps provided by the state agencies assisted in the identification and estimation of focal tourism and recreation sites. This is a key requirement for TPI factor enumeration and was undertaken with access to additional information for each protected area, principally from the aforementioned state government websites.

Freycinet National Park

Freycinet National Park is a coastal National Park on the east coast of Tasmania. It is recognised as an outstanding example of coastal wilderness in Tasmania and is an increasingly popular tourist destination. Based on the available map information (Figure 3) and previous knowledge of the area, we identified six key sites that were likely to be variably attractive to visitors to Freycinet National Park. We also examined the potential influence of camping (within the National Park at designated camp sites) versus offsite accommodation on visitation levels, as this influences the distance from accommodation to each site. Furthermore, we examined the influence that access to drinking water is likely to have on visitor numbers to key sites, as drinking water is scarce throughout most of the National Park (Tasmanian Government 2005).

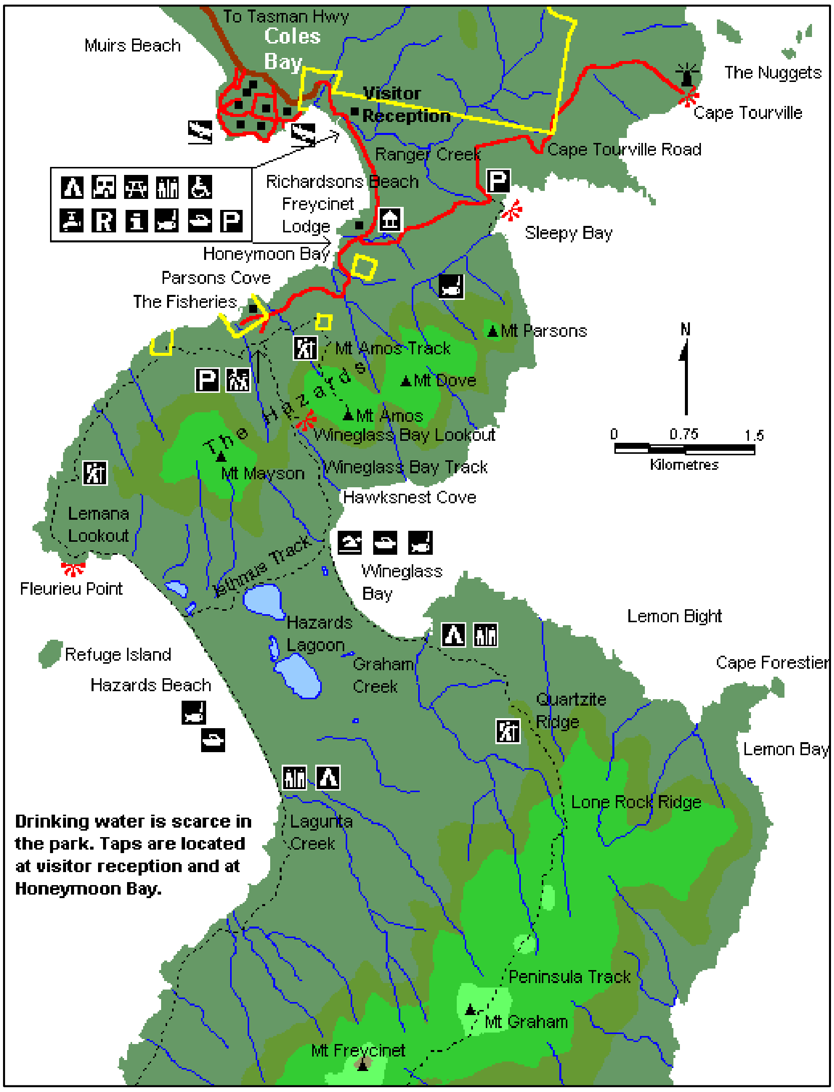

Figure 3: Map of Freycinet National Park, with walking tracks, key sites and some visitor activities listed

Source: Tasmanian Government 2005

Moreton Island National Park

Moreton Island National Park is similar to the Fraser Island Great Sandy National Park and World Heritage Area examined in the previous chapters and by Hadwen, Arthington and Mosisch (2003). Since islands represent the best kind of remote wilderness area, we chose a similar protected area to examine how the refined TPI model could be applied to a new and relatively remote protected area. We identified 17 significant sites for tourism and recreation on the island on the basis of available map information (Figure 4) and previous knowledge of the area. As for the Freycinet National Park evaluations, we explored the potential influence of camping, housing and access to drinking water in addition to the original TPI factors developed by Hadwen, Arthington and Mosisch (2003).

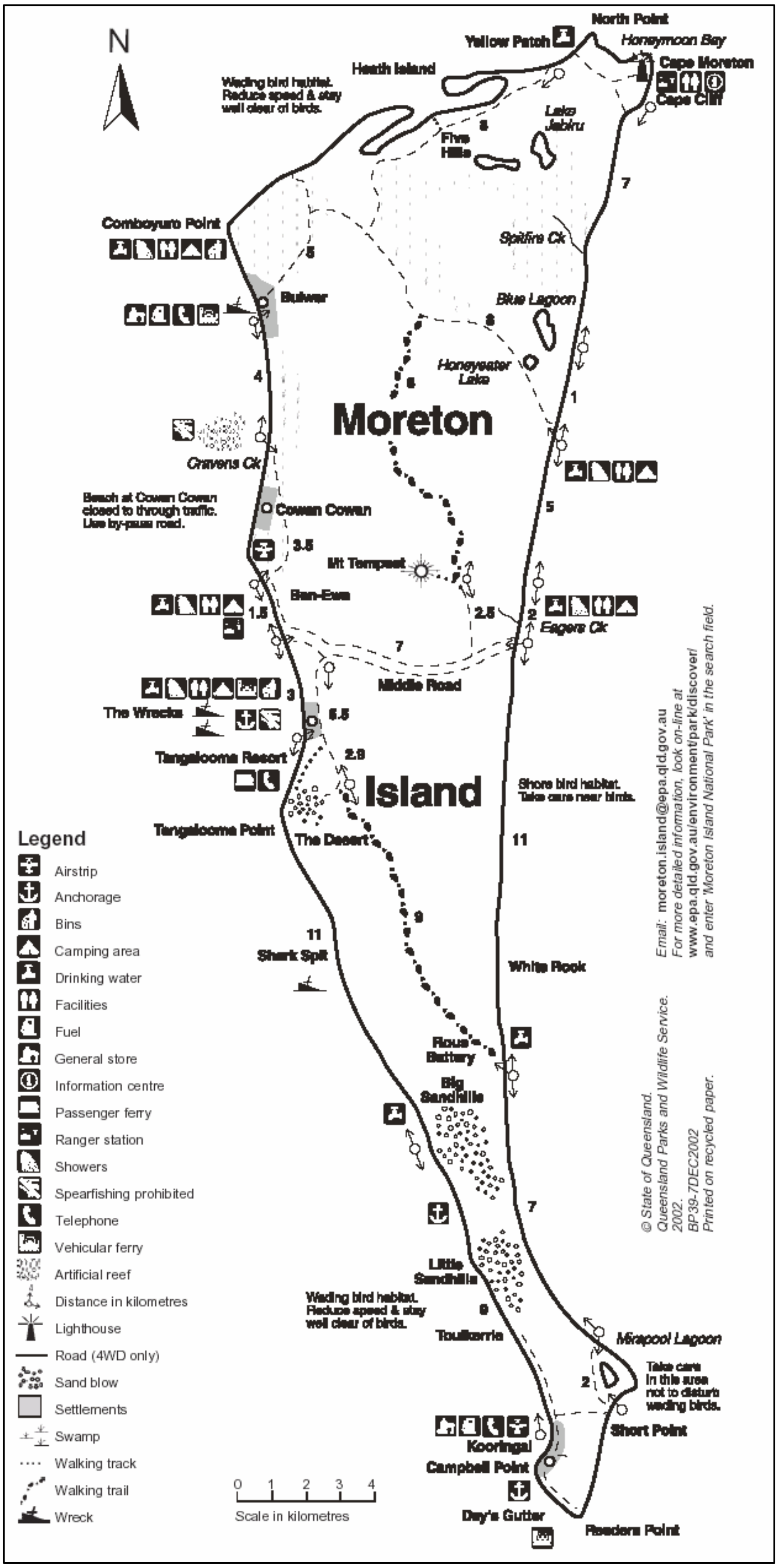

Figure 4: Map of Moreton Island, complete with details of camping sites, walking and vehicle tracks and facilities relevant to visitor use

Source: Queensland Government (2005a)

Great Sandy National Park—Cooloola Section

Cooloola National Park is a coastal protected area to the south of Fraser Island (Great Sandy National Park and World Heritage Area). The area was originally included in the World Heritage application with Fraser Island, but was not originally granted this listing. A wide range of recreational activities are undertaken within Cooloola National Park, including, fishing, hiking, camping, swimming and canoeing. On the basis of map information (Figure 5) and personal experience, we identified 18 key sites likely to be visited by visitors to the region.

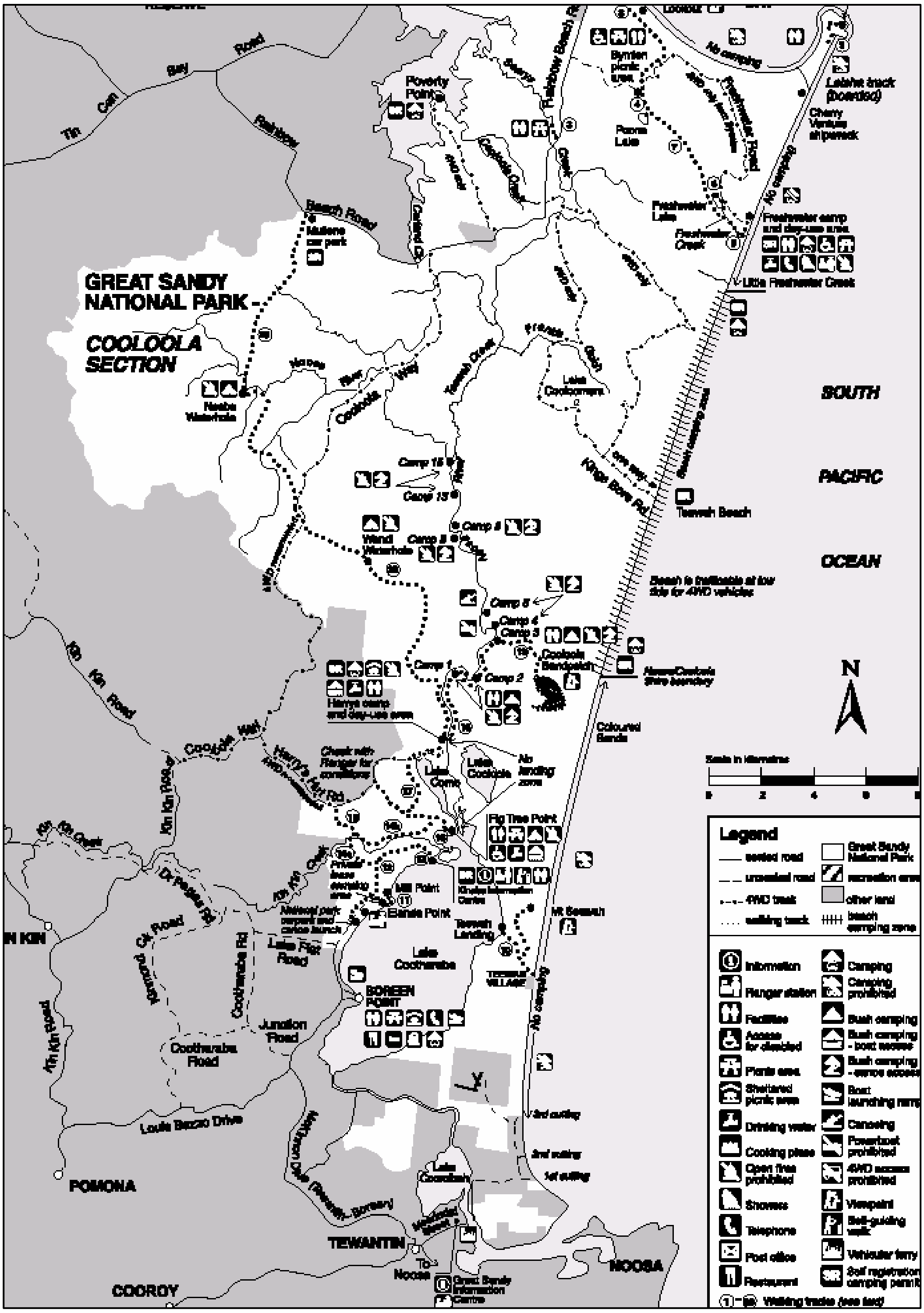

Figure 5: Map of Cooloola National Park, complete with details of campsites, walking and vehicle trails and facilities for visitors

Source: Queensland Government (2005b)

Results

Freycinet National Park

TPI scores calculated for sites in Freycinet National Park ranged from 15.30 to 69.44 and varied according to the factors used in the model (Figure 6). For example, TPI scores calculated with regard to drinking water availability were consistently lower than scores calculated without reference to drinking water (Figure 6), highlighting the shortcomings of the original TPI model in instances where the availability of drinking water is low and/or spatially restricted. In addition, given the improved proximity of campers to key sites, scores calculated on the basis of nearest campsite accommodations were generally higher than those calculated on the basis of house, home or hotel accommodation near the park entrance.

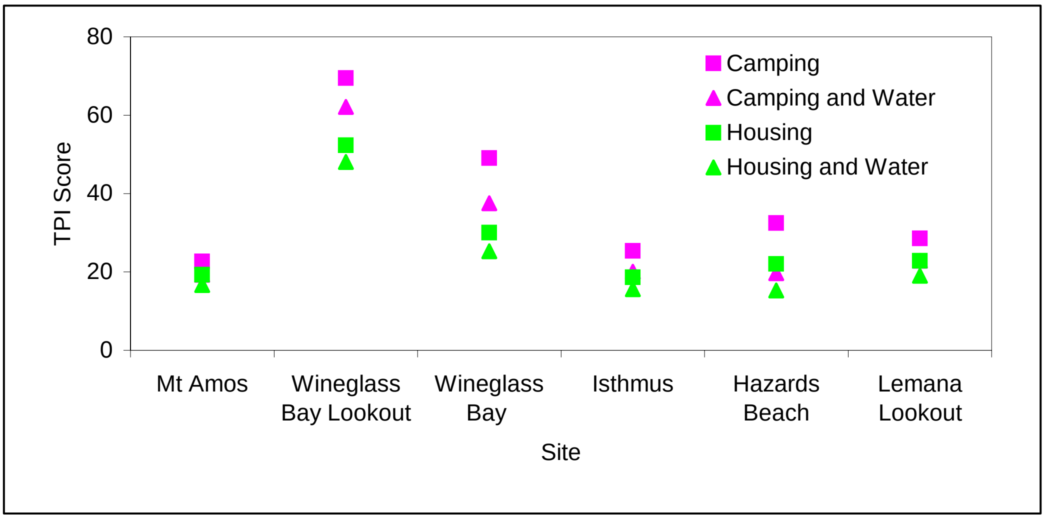

Figure 6: TPI Scores for six sites in Freycinet National Park, Tasmania

Note: Scores were calculated separately to account for potential differences between camping, housing and the provision of drinking water

The highest TPI scores (across all four calculations) were for well-known and extremely popular visitor hotspots (Wineglass Bay Lookout and Wineglass Bay), reflecting the capacity of the TPI model to identify sites with high visitor numbers. The values determined for these sites are indicative of very high visitor numbers and park managers should ensure that visitor numbers and activities in these areas do not exceed the carrying capacity of these sites and their current facilities.

Moreton Island National Park

TPI scores from Moreton Island National Park spanned a huge range, from 5.15 to 214.29 (Figure 7). This range reflects accessibility issues for many of the nominated sites on the island and also the proximity of some key sites (like Comboyuro Point and Bulwer) to designated camping grounds. In contrast to the results from Freycinet National Park, most of the sites examined showed no differences between modes of accommodation (camping and housing). Similarly, there was generally very little influence of the availability of drinking water, which is perhaps a reflection of the abundance of safe drinking water within this National Park.

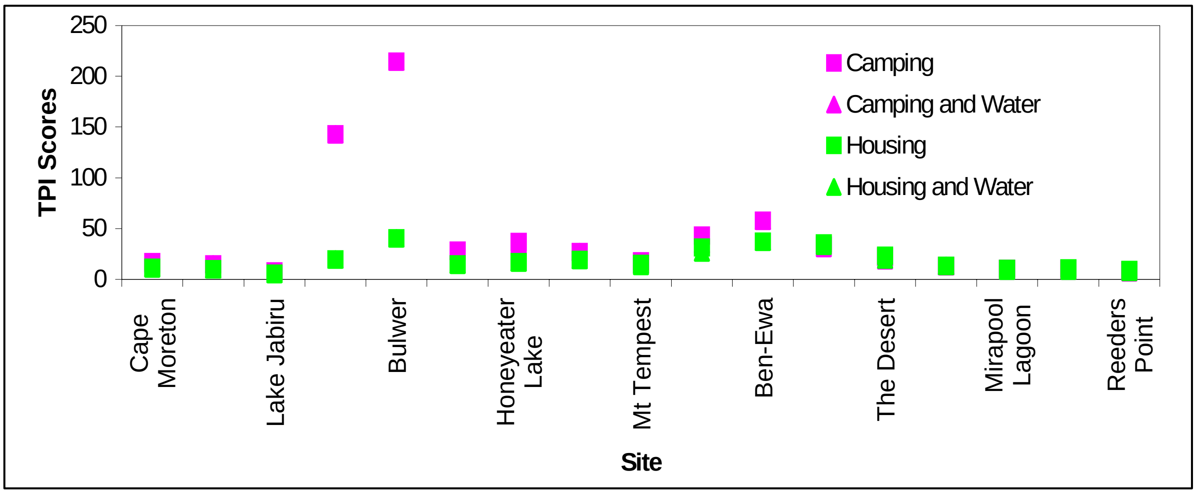

Figure 7: TPI Scores calculated for 17 sites within Moreton Island National Park

Note: Separate TPI scores were calculated for camping and housed accommodations and to examine the influence of the availability of drinking water on visitor numbers

Great Sandy National Park—Cooloola Section

The Cooloola section of Great Sandy National Park is similar to the Moreton Island National Park in that abundant supplies of fresh and potable water mean that the inclusion of water as a factor in the TPI model makes very little difference to the TPI scores. To this end, we eliminated the water factor and simply ran the TPI model with camping and housing factors.

Camping TPI scores were consistently higher than housing TPI scores for most sites, reflecting the accessibility issues for many of the region's natural sites. Furthermore, the positioning of campsites within the protected area ensured that campers were almost always closer to key sites than were visitors who came from outside of park boundaries.

Although we wanted to include Boreen Point (Figure 8) in our analysis, we were unable to calculate a TPI score for either camping or housing modules. This reflects both the fact that there are no accessibility problems at this site and the reality that both camping and housing are nearby.

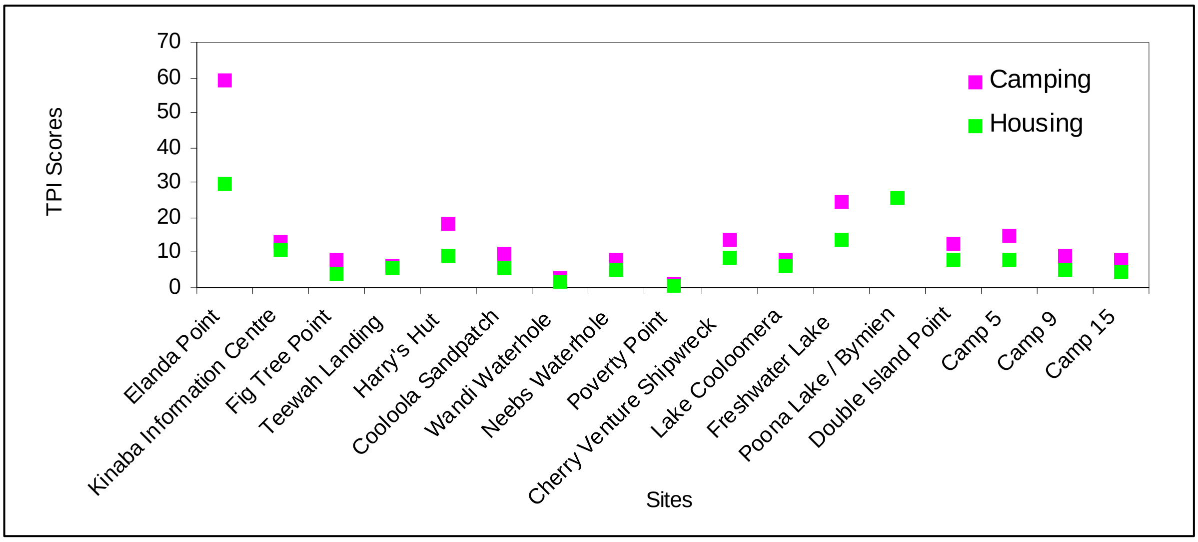

Figure 8. TPI scores for selected sites within the Cooloola Section of the Great Sandy National Park, Australia

Note: Separate TPI scores were evaluated for visitors camping within the National Park and staying in houses and hotels outside of the National Park to evaluate the influence of accommodation type and associated access to each evaluated site

Discussion and Conclusion

Our modified TPI model output reflected some key differences (and similarities) between different user groups within the three assessed National Parks. Significantly, the camping module almost always generated higher TPI scores (reflecting greater relative visitor numbers) than the housing module. We suggest that this finding holds significance particularly for protected areas with limited camping capacity and/or those in close proximity to hotels and homes. Specifically, we suggest that campsites near major sites of interest are likely to stimulate additional visitation pressure. This points to one avenue through which visitor load management may be applied to reduce pressure on popular sites; by limiting or eliminating nearby campsites whilst simultaneously providing more campsites that are some distance away from sites with high visitor numbers.

Water, although a key factor in influencing visitor activities and their spatial distribution within protected areas, was not as influential in the National Parks selected in this chapter as we might have thought. Upon reflection, this relates to the availability of drinking water at multiple locations and natural systems (creeks and lakes) within the Great Sandy National Park – Cooloola Section and Moreton Island National Park regions. For Freycinet National Park in Tasmania, the addition of the water factor consistently reduced TPI scores for most sites, suggesting that limited access to drinking water at remote locations may be an important influence on visitor numbers at particular sites within this park. Future analyses for inland protected areas are likely to more strongly reveal the importance of access to drinking water as a factor which influences visitor activities and decision-making in protected areas.

Our application of these modified modules of the TPI model yielded results that are worthy of further investigation. Specifically, in order to better understand the role of water and accommodation on visitor numbers to key sites within protected areas, we need to both ground truth the model and to gain more accurate information on the degree to which these factors influence visitor decision-making processes with respect to which sites they visit during their stays within protected areas. The first goal lies beyond the scope of this project. The second goal formed the basis of the remainder of this report, as we sought to quantify some of the aspects touched on in this chapter through the development and implementation of an online visitor survey to examine differences in gender, age and visit preference (day visit versus overnight stay) on visitor motivations and likely site visitation patterns.

Chapter 5

ON THE POTENTIAL FOR QUANTITATIVE ADJUSTMENTS TO THE TOURIST PRESSURE INDEX MODEL: WHAT FACTORS INFLUENCE VISITOR DECISION-MAKING PROCESSES IN PROTECTED AREAS?

The refinement and redevelopment of the TPI model of Hadwen, Arthington and Mosisch (2003) outlined above made no inferences regarding the relative importance of the factors in the model. In other words, all factors are weighted equally. Whilst this represents a reasonable first-cut approach to modelling visitation levels within protected areas, it is highly likely that visitors will be swayed by some factors more than others. To this end, we sought to collate information relating to the relative importance of both built and environmental factors that might influence visitor decision-making processes affecting whether they choose to visit particular sites within a protected area. In addition, we wanted to gain some understanding of how the importance of these factors may change with demographics, so we collated sex and age data to isolate the role that the 'type' of visitor might have on which sites get visited in any given protected area.

Methods

We developed two online surveys, one to assess the importance of factors to day visitors (Appendix A) and the other to examine the importance of factors to visitors on overnight visits to protected areas (Appendix B). Should strong differences in visitor attitudes be detected, the quantitative data collected from these surveys was intended to facilitate the implementation of weighting scores for the factors used in the TPI model, to generate TPI scores that more closely reflect visitor attitudes and decisions (about where they go) in protected areas.

The two surveys asked very similar questions (see Appendices A and B) but aimed to determine whether or not some factors were relatively more important to day visitors versus overnight visitors. In addition, we collected information on gender and age group differences that might facilitate the development of demographically based TPI modules. We thought this might be particularly important for protected areas that have strong demographic signatures, as site visitation levels might vary according to these traits. Ultimately, this component of the research project was designed to determine whether or not separate modules of the TPI model should be generated to account for differences in attitudes and decision-making processes among various demographic and visitation type groups of protected area users.

Visitor surveys were developed to canvas attitudinal differences between day and overnight visitors to protected areas. Surveys were developed following earlier survey work of Hadwen and Arthington (2003) and sought to collate information on the relative importance of various built (infrastructure) and environmental (aesthetic) features in influencing their decision-making processes on whether to visit certain sites within a protected area. The surveys were cleared by the Griffith University Human Research Ethics Committee (Permit #AES/HREC/08/05) and were delivered online through a website hosted by Kerry Rosenthal, a Queensland Department of Natural Resources employee and participant member of the Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management (Coastal CRC).

Surveys were made available online for a period of one month from September-October 2005 and were advertised widely through a range of electronic media, including the STCRC electronic newsletter and the Griffith University newsletter.

Results

A total of 163 responses to the online surveys were received by the time they were taken offline in October 2005. This level of response facilitated analysis to examine whether factor weightings were worth pursuing in the revised TPI model across three levels, namely a) Length of stay, b) Gender, and c) Age Demographics.

Day Visits versus Overnight Stays

Statistical comparison of respondent ratings of the importance of factors influencing visitation decisions between day and overnight visitor surveys indicated that only two of the 21 variables (common to both surveys) were significantly different based on type of visit (Figure 9). Specifically, distance to drinking water (P = 0.0001) and distance to showering facilities (P < 0.0001) were significantly more important to overnight visitors than they were to day visitors, reflecting the relatively greater need for these resources by visitors staying within protected areas for longer periods of time.

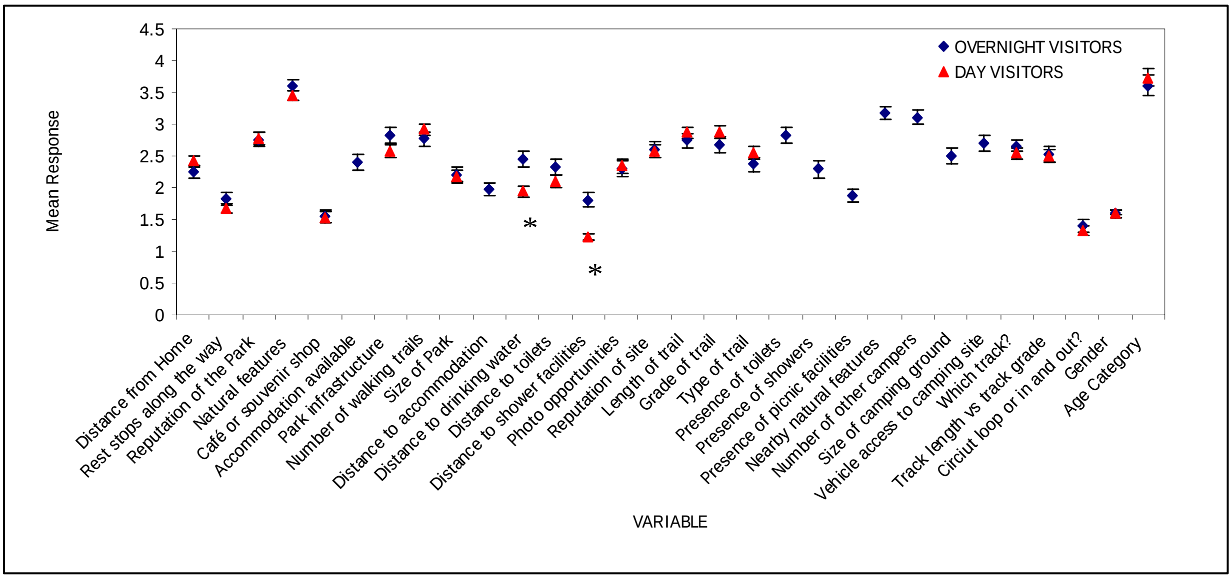

Figure 9: Mean (± SE) response to survey variables by respondents to the overnight and day visitor surveys

Note: Some questions were only asked of overnight visitors, so no scores are provided for day visitor respondents. Significant (p < 0.05) differences between surveys are indicated with an *.

Gender Comparisons

Responses for overnight and day visitor surveys were assessed separately to investigate whether male and female respondents rated factors differently according to the type of visit they were undertaking. We found that for overnight stays (Figure 10), women rated distance to accommodation slightly higher than men (P = 0.07), suggesting that men were willing to drive further to sites (or accommodation) in or near protected areas. Women also rated distance to shower facilities (P = 0.05) and vehicle access to camping areas (P = 0.08) significantly higher than the male respondents (Figure 10).

Male respondents rated photo opportunities higher than women respondents both for the day visit survey (P = 0.028) and the overnight visit survey (P = 0.018). For day visits, men also considered the reputation of a site to be more important than did female respondents (P = 0.041). This latter result presumably relates to the noted importance of photo opportunities to men at particularly scenic or well-known sites.

Age Comparisons

Comparisons of differences between age group responses were conducted separately for the overnight (Figure 11) and day visitor (Figure 12) surveys. Only one significant result was found for overnight respondents (Figure 11), with distance from home proving to be of greater importance to middle-aged (25-44) respondents than to both older and younger respondents (P = 0.037).

There were more significant differences among age groups for the day visitor surveys (Figure 12). For example, the 45-54 year old age bracket rated park reputation significantly lower than all other age groups (P = 0.027). Older respondents (those older than 45 years of age) also consistently rated the presence of cafés and souvenir shops as being of greater importance to their decision to visit a particular protected area than did younger respondents (P = 0.006).

For some factors there was considerable variation in responses, although significant differences between at least one of the age groups and all others were still detected. For example, distance to drinking water (P = 0.050), distance to toilets (P = 0.066) and photo opportunities (P = 0.034) were all rated higher by young and old respondents than by middle-aged respondents.

For activities within protected areas, it appears that the reputation of focal sites was deemed to be an important factor to most respondents, but was rated significantly (P = 0.020) lower in 45-54 age bracket, suggesting that reputation was not an important driving factor for this demographic group. For questions relating to track characteristics, it was observed that older respondents tended to choose easier walking options than younger respondents. Specifically, for the "Which Track?" hypothetical question, there was a strong tendency for older respondents to take the short easy option, rather than the round trip (P < 0.001).

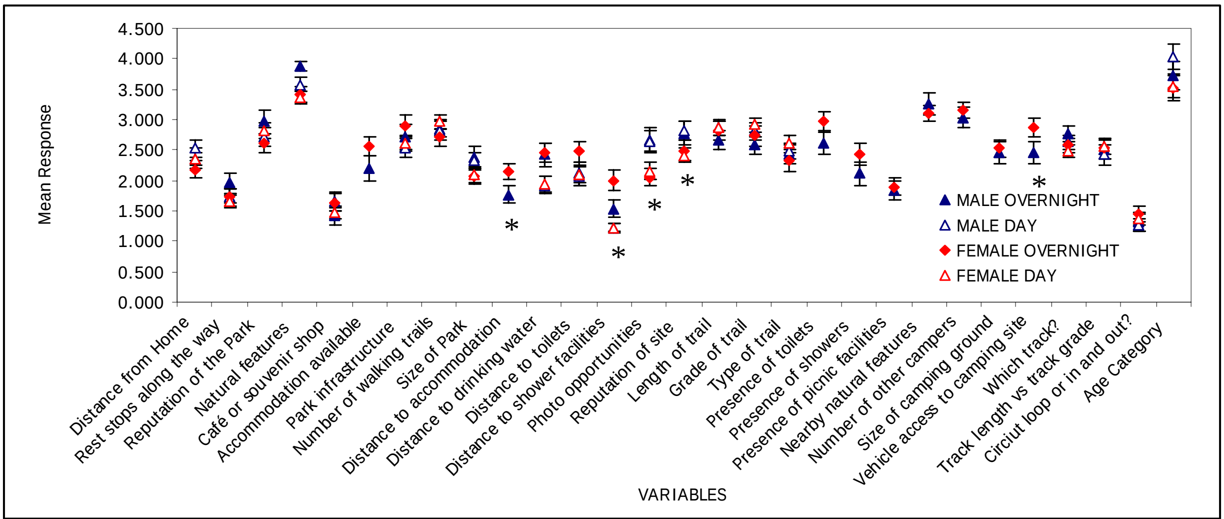

Figure 10: Mean (± SE) survey responses of male and female respondents for overnight and day visitor surveys

Note: Significant (p < 0.1) differences between respondent groups are marked with an *.

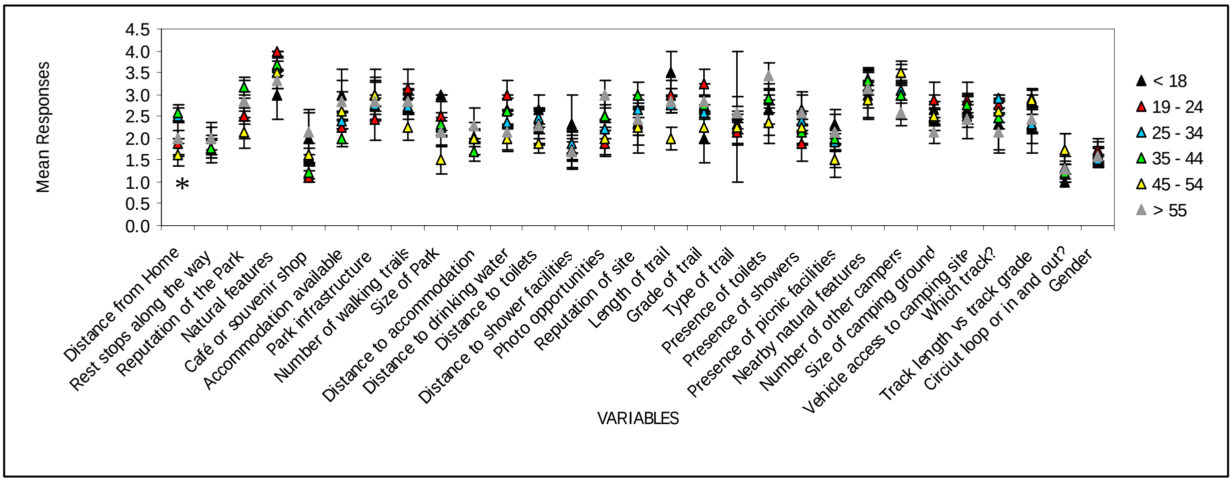

Figure 11: Mean (± SE) responses to overnight visitor survey by age group

Note: Significant (p < 0.05) differences between age groups are marked with an *.

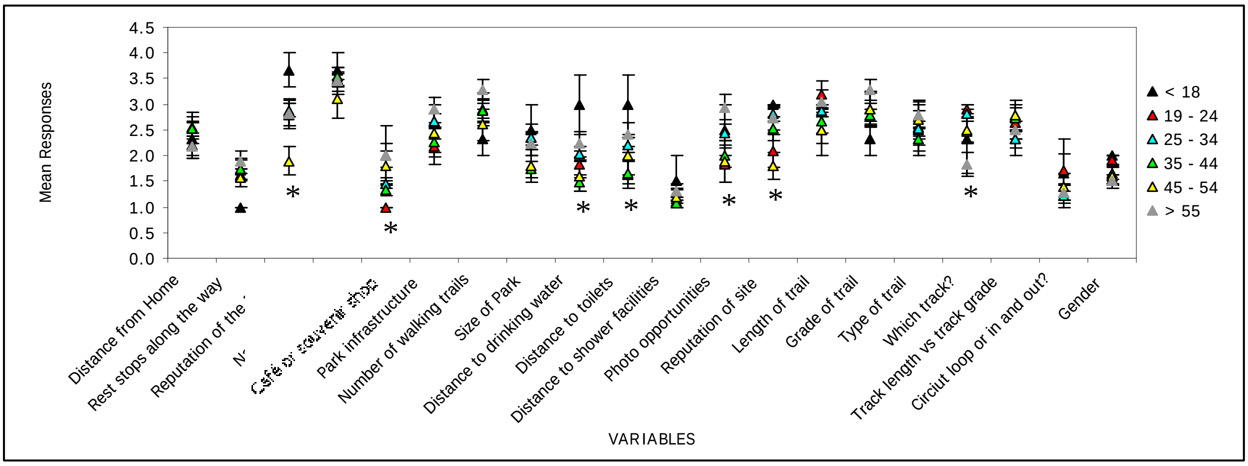

Figure 12: Mean (± SE) responses to day visitor survey by age group

Note: Significant ($p < 0.05$) differences between age groups are marked with an *.

Discussion and Conclusion

Differences in respondents' ratings across the three levels assessed in this study (day or overnight visit, gender and age) suggest that demographic factors and visitor accessibility may influence the degree to which visitors use protected areas. Specifically, we suggest that demographic data collected within protected areas may provide evidence for the case-specific weighting of factors in the modified TPI model. For example, if a large number of visitors to an area are day trippers, then the importance of drinking water and shower facilities is considerably lower than would be the case if the majority of visitors were camping within the region. To this end, protected areas near major cities and towns may provide a case for the development and implementation of a TPI model that is more suited to the types of visitors and visits the area is typically subjected to. Similar examples are likely to arise for any parks accommodating gender-bias visitation and/or parks that particularly attract certain age groups either due to their accessibility or the range of activities generally undertaken within their boundaries.

Whilst there was a range of statistically significant differences in survey responses based on age and gender, the level of disagreement was smaller than that anticipated at the outset of this project. Specifically, many of the more important factors that might contribute to site visitation decision-making processes were not significantly different across gender and age groups. These data suggest that although some quantitative modifications of the TPI model might be appropriate at some sites, the current revised TPI model (presented in Chapter 3) seems to be robust and accounts for the major factors that are likely to influence visitation variability within protected areas.

Chapter 5

PRACTICAL IMPLICATIONS AND RECOMMENDATIONS FOR THE FUTURE USE AND DEVELOPMENT OF THE TOURIST PRESSURE INDEX MODEL

In this study, we refined and redeveloped the TPI model to enhance its general applicability in protected areas throughout Australia. We acknowledge that ground-truthing is the next priority for testing the model, but the lack of quality visitor monitoring data in protected areas (Hadwen, Hill & Pickering in press), which is the very reason behind the development of the model, significantly limits our capacity to undertake these tests. In the absence of actual visitor data, we feel that the good relationship between model output and the best guess of on-the-ground park agency staff suggests that the TPI model does accurately assess the relative importance of all sites as tourist attractions within any given protected area.

Our case study for the establishment of TPI thresholds of concern for Fraser Island sites represents the best practice application of the TPI model to the management of natural sites in protected areas. However, we stress that the development of these thresholds does require site knowledge and that this exercise should not be conducted as a desktop assessment. Furthermore, combined TPI scores and knowledge of site condition should ultimately inform natural resource managers on the appropriate course of management intervention and/or site hardening. Given that the information on site condition is not always available to on-the-ground staff, there is no doubt a solid case for the involvement of scientists in this approach, as per the suggestions of Buckley (2003).

We recommend that the revised TPI model, incorporating aspects of track grade and accessibility to drinking water resources, be used in mainland Australia protected areas, as the results from this current study (and others) have shown that these factors influence visitation patterns. We also suggest that for any protected areas with visitor data that the TPI model can be modified, where necessary, to be more applicable to their situation. Specifically, for protected areas with age- or gender-biased visitor statistics, the results of our survey work suggest that some modification of the TPI model may be appropriate, especially relating to aspects of track grade, facilities and the reputation of sites within the protected area.

Ultimately, we would like to see greater adoption of visitor monitoring strategies in protected areas. Whilst this would lead to a reduced need for the TPI model, it would represent a significant advancement in park management and would also empower protected area agencies with invaluable knowledge relating to how visitors use their parks (Hadwen, Hill & Pickering in press). However, if visitor monitoring is not taken up by park agencies, then the TPI model shows great promise as a management tool to inform management intervention decisions at key sites before visitor-mediated impacts, some of which may not be reversible, occur.

APPENDIX A: SURVEY TO EXAMINE THE IMPORTANCE OF FEATURES INFLUENCING THE BEHAVIOUR OF DAY-TRIPPERS IN NATIONAL PARKS.

Survey to examine the importance of features in influencing visitor behaviour in National Parks

Dr Wade L. Hadwen - Centre for Riverine Landscapes, Griffith University

How important are the following factors in influencing your decision to visit a National Park?	not at all important	somewhat important	quite important	very important	not applicable
1. Distance from your home					
2. Townships and rest stops between your home and the park					
3. The reputation of the park					
4. The range of natural features within the park (eg mountains, lakes, streams, forests, animals)					
5. The presence of a café, food store and/or souvenir shop					
7. The provision of park infrastructure (passable roads, carparks, toilet and shower facilities)					
8. The number of walking trails					
9. The size of the park					

How important are the following features in influencing your decision to visit a particular site within a park?	not at all important	somewhat important	quite important	very important	not applicable
11. The distance to the nearest source of drinking water					
12. The distance to the nearest toilet facilities					
13. The distance to the nearest shower facilities					
14. Ample photo opportunities					
15. The reputation of the site (listed, mentioned and pictured in books, guides, brochures, websites)					
16. The length of the walking trail					
17. The grade of the walking trail (easy-medium-hard-difficult)					
18. The type of walking trail (ie circuit loop, boardwalk etc)					

Here's a scenario: You would like to visit a waterfall in a National Park - access is walking only. The waterfall has two access tracks -

1. a long track of an easy grade, 2. a much shorter track, but with a difficult grade, as it skirts up and over the escarpment.

19. Which of these tracks would you take to the waterfall? (please type '1' in the relevant box)

Long easy track	
Shorter difficult track	
Both, make it a round trip	

20. Is track length or track grade more influential in your decision-making process? (please type '1' in the relevant box)

Track Length

Track Grade

Both, they are weighted equally

Neither make any difference to my decision

21. In general, would you rather walk to a site via a circuit loop or on a single in-and-out track? (please type '1' in the relevant box)

Circuit Loop

In-and-Out Track

Don't know or don't care

Demographic Details:

22. What is your gender? (please type '1' in the relevant box)

Male

Female

23. To which age group to you belong? (please type '1' in the relevant box)

Under 18

19-24

25-34

35-44

45-54

> 55

Would you like to receive an Executive Summary of the results of this survey?

No

Yes

If yes, please enter your email address:

APPENDIX B: SURVEY TO EXAMINE THE IMPORTANCE OF FEATURES INFLUENCING THE BEHAVIOUR OF OVERNIGHT VISITORS IN NATIONAL PARKS

Survey to examine the importance of features in influencing visitor behaviour in National Parks

Dr Wade L Hadwen - Centre for Riverine Landscapes, Griffith University

How important are the following factors in influencing your decision to visit a National Park?	**not at all important**	**somewhat important**	**quite important**	**very important**	**not applicable**
1. Distance from your home					
2. Townships and rest stops between your home and the park					
3. The reputation of the park					
4. The range of natural features within the park (eg mountains, lakes, streams, forests, animals)					
5. The presence of a café, food store and/or souvenir shop					
6. The range of available accommodation (campsites, caravan parks, motels, hotels, resorts)					
7. The provision of park infrastructure (passable roads, carparks, toilet and shower facilities)					
8. The number of walking trails					
9. The size of the park					

How important are the following features in influencing your decision to visit a particular site within a park?	**not at all important**	**somewhat important**	**quite important**	**very important**	**not applicable**
10. The distance to the nearest accommodation					
11. The distance to the nearest source of drinking water					
12. The distance to the nearest toilet facilities					
13. The distance to the nearest shower facilities					
14. Ample photo opportunities					
15. The reputation of the site (listed, mentioned and pictured in books, guides, brochures, websites)					
16. The length of the walking trail					
17. The grade of the walking trail (easy-medium-hard-difficult)					
18. The type of walking trail (ie circuit loop, boardwalk etc)					

How important are the following factors in influencing your decision on where to camp within a National Park?	**not at all important**	**somewhat important**	**quite important**	**very important**	**not applicable**
19. The presence of toilet facilities					
20. The presence of showering facilities					
21. The presence of picnic tables and/or shelters					
22. The nearby natural features (eg lookouts, waterfalls, beaches)					

23. The number of other campers / campsites					
24. The size of the camping ground					
25. The ease of campsite access (by vehicles)					

Here's a scenario: You would like to visit a waterfall in a National Park - access is walking only. The waterfall has two access tracks -
1. a long track of an easy grade, 2. a much shorter track, but with a difficult grade, as it skirts up and over the escarpment.

26. Which of these tracks would you take to the waterfall? (please type '1' in the relevant box)

Long easy track	
Shorter difficult track	
Both, make it a round trip	

27. Is track length or track grade more influential in your decision-making process? (please type '1' in the relevant box)

Track Length	
Track Grade	
Both, they are weighted equally	
Neither make any difference to my decision	

28. In general, would you rather walk to a site via a circuit loop or on a single in-and-out track? (please type '1' in the relevant box)

Circuit Loop	
In-and-Out Track	
Don't know or don't care	

Demographic Details:

29. What is your gender? (please type an '1' in the relevant box)

Male	
Female	

30. To which age group to you belong? (please type an '1' in the relevant box)

Under 18	
19-24	
25-34	
35-44	
45-54	
> 55	

Would you like to receive an Executive Summary of the results of this survey?

No	
Yes	

If yes, please enter your email address:

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SUSTAINABLE TOURISM CRC

The Sustainable Tourism Cooperative Research Centre (STCRC) is established under the Australian Government's Cooperative Research Centres Program. STCRC is the world's leading scientific institution delivering research to support the sustainability of travel and tourism – one of the world's largest and fastest growing industries.

Introduction

The STCRC has grown to be the largest, dedicated tourism research organisation in the world, with $187 million invested in tourism research programs, commercialisation and education since 1997.

The STCRC was established in July 2003 under the Commonwealth Government's CRC program and is an extension of the previous Tourism CRC, which operated from 1997 to 2003.

Role and responsibilities

The Commonwealth CRC program aims to turn research outcomes into successful new products, services and technologies. This enables Australian industries to be more efficient, productive and competitive.

The program emphasises collaboration between businesses and researchers to maximise the benefits of research through utilisation, commercialisation and technology transfer.

An education component focuses on producing graduates with skills relevant to industry needs.

STCRC's objectives are to enhance:

- the contribution of long-term scientific and technological research and innovation to Australia's sustainable economic and social development;
- the transfer of research outputs into outcomes of economic, environmental or social benefit to Australia;
- the value of graduate researchers to Australia;
- collaboration among researchers, between researchers and industry or other users; and efficiency in the use of intellectual and other research outcomes.