A Theoretical Market Model for National Parks of Different Ecological Character Managed by One Agency

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1. Introduction

Interest in natural history was a fashionable pursuit by the leisured classes of western society during the latter part of the nineteenth century. National parks, as an expression of this movement, were reserved first in the USA, Yosemite in 1864 and Yellowstone in 1872. In Australia, Port Hacking was declared in 1879.

Interest in environmental matters grew slowly from this start, spreading from a relatively small body of intellectuals to larger sections of society. Such growth is evident from the development of a number of intellectual disciplines and world-wide socio-political movements associated with natural history. In Queensland, the growth in interest and preservation in the natural environment has culminated in the passage of the *Nature Conservation Act 1992* and the *Environmental Protection Act 1994*.

The *Nature Conservation Act 1992* governs the management of national parks in Queensland. It states that the State's national parks are to be managed to provide for the permanent preservation of each areas' natural condition, and to ensure that the only use of each area is nature-based and ecologically sustainable [s.17(1)]. Ecologically sustainable use is defined as use within the capacity to sustain natural processes by maintaining the life support systems of nature. Use by the present generation should not diminish the potential to meet the needs and aspirations of future generations (s.11).

Historically national parks have been managed as a public good, and use of parks for recreation has been available free of charge or for a nominal fee. The purpose of this policy was to build a constituency for government policy of reserving areas, usually of scenic beauty and often of marginal potential for supporting primary industries, and to encourage healthy outdoor recreation. However, national parks are not pure public goods. Crowding may occur. Possible consequent decreases in the utility of visitors and degradation of the parks' ecosystems contravene the attribute of non-rivalry exhibited by public goods[1]. In addition, over-use may jeopardise the goal of conservation and retention of biodiversity. Conflict between the twin goals of management is evident in the more popular parks, especially in peak use periods. Resolution of the problem is possible, once governments admit that reform is necessary.

Disaggregation of the benefits provided by national parks is a course of action which will assist in policy formation. National parks provide benefits to both visitors and non-visitors. Visitors benefit from direct participation (user benefits). Non-visitors benefit from knowing parks exist (existence benefit), from retaining the option to make a decision about their alternative use in the future (option benefit), and a host of other identified benefits. There are thus two distinct groups of beneficiaries, heterogeneous no doubt in their individual wants and not necessarily mutually exclusive in their persons. Whilst the benefits to non-visitors may be provided as public goods, there is a good case for user benefits to be provided by some form of user-pays such as in the case of club or private goods. Public goods are generally considered to be best provided from taxation.

This paper develops for national parks of different ecological character and different levels of infrastructure a theoretical market model, which predicts socially optimal prices and outputs. Charging socially optimal prices will give managers control over levels of visitation and serve to avert or at least ameliorate over-use and its concomitant costs.

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[1] The other important characteristic of public goods, non-excludability, also does not apply, because management are able to exclude people if they wish.

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The model incorporates ecological and other external costs, an area which has largely not enjoyed primary focus in outdoor recreational research. In addition, it examines closely the nature of costs incurred by parks' management agencies in order that the recovery of costs may be accurately matched with the benefits provided. The model is constructed on the principle that the cumulative effects of day visitors and camping visitors, often disregarded by park managers, be taken into account and proposes a method to achieve that end. Moreover, the proposed method overcomes the theoretically difficult area of disaggregating joint costs of supply.

This paper is organised so that the next part considers briefly some of the pertinent published literature, and the Part 3 develops the theoretical model. That part includes several sub-sections - consideration of the supply function and its components and the aggregation of demand curves for the products of parks. A further sub-section examines the definition of the unit in which output is measured. Part 4 describes the synthesis of the model, and the paper concludes with some policy recommendations.

2. Some Published Research

Buchanan's paper proposing an economic theory of clubs remains a landmark in the extension of economic theory to collective consumption arrangements. A characteristic of collective use is the possibility of congestion and decreasing individual utility or benefits as the number of people using a facility increases. This characteristic is absent in the consumption of purely private goods. The cost of using a facility is likely to fall for individual users as costs are shared among more users. Vital to the theory is the ability to exclude potential users by the enforcement of property rights. Buchanan concludes the optimal size of a club or communal-use facility, for a given size of the facility, occurs where the cost of admission of an additional member equals marginal benefit.

Berglas (1976, 1981) developed club theory further. Berglas shows that profit maximisation under conditions of perfect competition would result in a Pareto optimum, if the appropriate pricing mechanism were used.

With regard to the use of land for outdoor nature-based recreation, Fisher and Krutilla were concerned to maximise the value of a tract of wilderness[2] land devoted to low density recreation. A necessary condition is that the optimal density be known. Their paper assumed a multi-modal distribution of preferences in densities of people at recreational sites; that is, users of areas for nature-based recreation could be divided into discrete groups based on their preferences for numbers of fellow users. The admission of each new group with a higher tolerance of increased density of fellow users would mean a gain in aggregate utility, but would be accompanied by a loss in utility by people with a low tolerance of their fellow users. Fisher and Krutilla conclude that admission of additional users could continue, and density of users increase, until aggregate net benefits were maximised.

The essence of all the above-mentioned analyses is that optimal capacity for a site is dictated by its users' perceptions of, and preferences for, congestion. Fisher and Krutilla extend their argument to include the possibility of extensive or permanent ecological damage and concluded correctly that optimal capacity is reduced if ecological impacts have a positive marginal cost.

Notwithstanding Fisher and Krutilla's contribution, consideration of the cost of ecological damage and indeed other external costs, apart from the costs of congestion, have received little attention in the literature. Walsh makes the point that in the USA recreational managing agencies are not legally required to reimburse agents on whom these costs fall. Perhaps this is one reason that there has not been a great research commitment to these issues. In the USA, much of the outdoor recreation research has been legislatively and judicially driven, and this has focussed research on demand and benefit issues.

Whilst the examination of the joint costs of supply has aggregated to a modest literature across many branches of the economics discipline, most work has been completed by petroleum economists concerned with the joint costs of finding and supply of oil and gas. Livernois, for example, dealt with the problem by estimating a multiple-output exploration cost function. This method has potential in the resolution of the problem of the joint supply of recreational opportunities for day visitors and campers in national parks.

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[2] Wilderness is usually taken to mean a tract of land substantially unchanged from its natural state at least by European immigrant humankind. (It might actually be an artefact of management by indigenous peoples.)

3. Development of the Theoretical Model

The theoretical market model for recreation in national parks developed in this paper focuses on the incorporation of *additional* costs incurred by the management agency by permitting recreational use, plus ecological costs and other external costs of recreation, so that the full social cost of recreation is accounted for in the determination of optimal capacity[3]. In addition, the model embraces the legal requirement, at least for national parks in Queensland, that use (output) be limited to the ecologically sustainable capacity. This legal restriction means that the limit on capacity is an ecological and scientific matter as well as an economic issue. Outputs predicted by the model are thus within ecologically sustainable limits. Moreover, the model incorporates consideration of a new unit in which to measure the output of recreational opportunities for day visitors and campers to overcome the difficulty in cost allocation where there are joint costs of supply.

3.1 The Supply Function

This section discusses the rationale underlying the supply curve for recreation and its components parts, marginal agency cost (MAC)[4] and marginal external cost (MXC). The section finally presents graphical representation of supply curves for parks of different character and/or different levels of infrastructure.

A firm's supply function for a good describes how much of the good the firm will be prepared to produce and sell at various market prices, with the prices of inputs, prices of related goods, the state of technology and other factors which affect supply all taken into account. The time underlying the supply curve is necessarily fixed and a short period.

In the short-run in perfectly competitive markets, the supply curve of a firm is conventionally considered to be the marginal cost (MC) curve above the intersection with the average variable cost (AVC) curve[5]. In any situation where a producer has a degree of monopoly control over the market, the firm faces a downward-sloping demand curve. The marginal revenue curve will share the same intercept and have twice the slope of the demand curve. Thus, at any output level, marginal revenue is less than price, and at any dollar value of marginal cost, the output which maximises profits for the monopolist is less than that for a producer who sets *price* equal to marginal cost. The profit-maximising monopolist thus acts to restrict supply and there is thus *no unique supply curve for the firm*, because the firm is reacting to changes in market demand conditions.

Even though it may be in a position to act as a monopolist, the public sector management agency, on the other hand, should price at marginal cost for efficiency[6]. The national parks manager has no need to *act* as a monopolist. In the interests of efficiency, acting as a perfectly competitive firm will not unnecessarily restrict supply.

Apart from efficiency, equity, or fairness in the distribution of society's goods, is another area of concern in the supply of government services. If there were fixed cost and MAC were constant (i.e. TAC = a+bQ) for the supply of recreation in national parks, and price were set at the marginal agency cost of recreation, taxpayers would be called upon to subsidise visitors because the set price would be less than average agency cost (AAC) at all levels of output (see Figure 2 for the region). If, on the other hand, in addition to the above agency cost there were external cost which were positive and increased with output, and a single entry price were set at the marginal social cost of recreation (MSC), visitors would be paying the full price commensurate with the additional costs incurred by their visits[7]. If equity is an important consideration to

[3] Determination of the full social cost of recreation necessitates exacting disaggregation of accounting and economic costs to isolate those costs which accrue to the provision of recreation alone, rather than to the provision of the park for the retention of biodiversity and other benefits.

[4] Where a good is produced by private enterprise and there is recognised external cost as well as the cost of production, the internal cost is often called 'private' cost. Total social cost thus comprises private cost plus external cost. In this case of public provision of the good, the term 'private' appears inappropriate, and is replaced by the term 'agency cost', which is not to be confused with the term, 'agency costs', explored by Jensen and Meckling.

[5] A firm may rationally operate and make losses for a short period at outputs where MC is less than AC but greater than AVC, because a part of fixed cost is recovered.

[6] Hotelling argued the case for this principle; it has been generally accepted by economists since. Efficiency here is allocational efficiency: resources are allocated so that no change will make some people better off without making others worse off.

[7] A subsidy would be also required at low outputs where MSC is less than average social cost (ASC).

government, this pricing rule is valid, and the supply curve would be the MSC curve above the ASC curve (as in Figure 2). MSC is vertical at capacity. The equity consideration of allowing poor people free entry to parks involves either subsidisation by other visitors or subsidy by taxpayers in the place of the theoretically more correct direct transfer payment by the relevant government agency to increase their incomes.

The model is based on the principle of the identification of the costs incurred by the management agency and their classification in terms of the supply of its various functions. The supply function included in the model relates only to the recreation function. Because the model is concerned with the recognition and recovery of the incremental costs relating to the recreation function and the setting of minimum market prices, the arbitrary allocation of the cost of infrastructure shared between functions is avoided.

Similarly, questions involving equity among different classes of users (for example, overseas, interstate and home-state visitors), such as the method of cost recovery for estate management infrastructure which home-state taxpayers have funded, need not arise. The entry fees for recreational use include no component of the cost of such infrastructure. The paper argues that these fixed costs are best funded by taxation, because the provision of the estate is a public good, which is enjoyed by all interested persons[8].

3.2 Agency Cost of the Recreation Function

The management agency provides services enjoyed by both users and non-users: supply of estate, recreational infrastructure and services to visitors and supply of estate, infrastructure and services to non-visitors to conserve biodiversity, retain habitat for other species, conserve cultural heritage, and so on. If the policy decision were made to recover the costs of providing and managing parks from the two groups, it could be achieved by having non-visitors pay through an allocation from their taxation and having visitors directly charged through entry fees. This cost allocation is in line with the principle argued by Baumol that the people who benefit most from publicly-provided services should contribute the most. An entry fee for visitors is thus more equitable than higher taxation, where individual beneficiaries are not identified, and relates payment to use.

If the costs incurred in the provision of parks are to be shared between taxpayers and visitors, a decision must be made as to where that division will be in the spectrum of costs. Hendry opted for variable costs to be recovered from users. Since variable costs by definition vary with output, and in the long run all costs are variable to some extent, this canon gives little guidance. A decision made by this principle is essentially political.

Veal and Costello both argued that taxpayers should fund existence values. This principle provides a conceptually more acceptable foundation, and a decision to exclude a particular cost would be made on the basis of whether the expenditure provided benefits to be enjoyed into the long term (or, in the vernacular, 'for ever'). Thus, expenditure on the land, management infrastructure, and natural resource management and research would fall into one group of costs which directly relate to management of the resource for non-visitors and future generations.

Expenditure on recreation infrastructure, that part of plant and equipment used to maintain recreation areas, day-to-day recreation management and interpretation for visitors constitute a separate group of costs directly related to use. The analyst is on much more solid ground in arguing that all taxpayers should fund the first group of expenses and visitors the second[9]. This

[8] This point is apparently open to question. An anonymous reviewer has asserted that, 'for the provision of joint use facilities (e.g. roads, car parks, tracks), there are fixed cost components which are distinct from estate management and relate directly to use and need to be allocated to the use function'. The author has taken the view that roads and walking tracks, whilst certainly jointly used, would be provided for estate management, were the park not open to visitation. The fixed costs relate to estate management, and the incremental costs associated with visitors are variable costs relating to the recreation function. On the other hand, a case can be made that car parks are not jointly used facilities, but are associated with the recreation function alone. In this case, both the fixed and variable costs are relevant to the recreation function.

[9] This principle was supported by the Resource Assessment Commission in the Coastal Zone Enquiry (RAC, p.115). Principles 10 and 11 stated that 'prices charged for access to public resources should reflect all short-term and long-term economic, environmental and social costs directly associated with use of those resources ...the costs arising directly from use of a resource- such as costs of repair and rehabilitation of environmental damage, abatement of pollution and the provision of infrastructure - should be borne by users rather than society as a whole'.

division of the costs of supply identifies the additional costs that providing recreational opportunities imposes and establishes a basis for equitable cost recovery.

In terms of this framework, costs incurred by the management agency would be classified according to function and, further, as relevant and irrelevant in relation to *visitation*. The classification is presented in Figure 1. To identify legitimate relevant and irrelevant costs, some costs must be disaggregated. Labour cost, for example, must be allocated between recreation, estate management and natural resources management. Similarly, the cost of operations must be allocated among the three functions.

Figure 1: Relevant and Irrelevant Costs for Visitation

Relevant costs	Irrelevant costs
Recreation infrastructure plant labour operations	**Land reservation** **Estate management** infrastructure/plant labour operations **Natural resource conservation** labour operations

The model which follows is constructed on the premise that the costs which are relevant to the entry pricing decision are the costs of providing the recreation function in parks. It could well be argued that some portion of the joint overhead costs, that is, the costs of management of the estate and natural resources, should also be attributed to users, but theory provides no guidance to the proportion.

3.3 The Behaviour of Costs

The model is developed for a group of parks of different character managed by a single agency. The chief executive controls the budget allocations for all parks, and thus controls the cost structure for each individual park. Hence, parks in the region can be likened to a multi-plant firm. In addition, each park produces a range of products, of which some are unique in the view of some visitors[10]. Some products will stem from the knowledge, wants and physical abilities of visitors and others will be produced by the ecological and access characteristics of the park. Thus, parks in the region could also be characterised as a multi-product firm. The argument which follows essentially characterises parks in the region as a multi-product firm with different products produced in different plants.

Central management has control of the allocation of labour and capital between parks. All the policy decisions and the tasks undertaken in parks which ensue from those decisions relate to the three main functions - management of the estate infrastructure, management of the natural environment and management of the recreation function. The timing of work on the construction and maintenance of infrastructure and on natural resource management is reasonably flexible, so labour can be drawn from these areas to the recreation function in peak visiting periods[11]. So long as the overall allocation of workers between parks is maintained at a level where there are no workers in excess of those needed to perform the work load in a particular park, the availability of the other two functions suggests that the employment of labour on the recreation function is likely theoretically to be highly efficient.

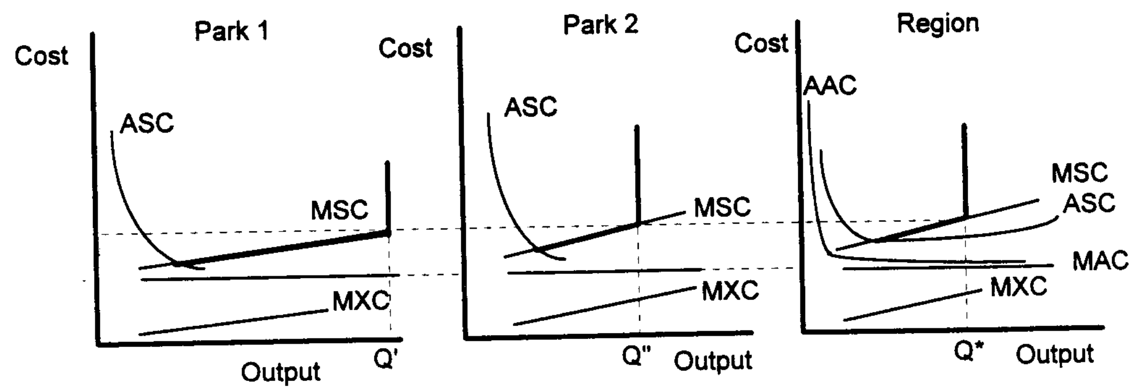
Consequently, the marginal cost of labour for providing recreation services is likely to approach a constant figure. Because the cost of labour is the chief component of the costs of the recreation function, the shape of the MAC function will be influenced principally by the behaviour of that cost[12]. Recreational infrastructure can be closely matched to output requirements; thus annual unit cost of infrastructure may be expected to be constant over a range of capacities. A similar situation applies to plant. A tractor used for mowing camping grounds can be fitted with a hydraulically-operated bucket, a blade or a spray tank, for example, to carry out estate development or maintenance tasks.

[10] A tourist to Carnarvon Gorge, for example, might well argue there is no other place like it. A more scientific visitor may conclude that seeing the ancient and rare king fern (*Angiopteris evecta*) standing in running water in a side-gorge was a unique experience (even though there is one other stand of the species known in Queensland).

[11] Rangers in Queensland parks are multi-skilled and are involved in a range of duties, including the physical construction work, interpretation of nature, monitoring of natural ecosystems and office work.

[12] The cost of labour comprises about 70 per cent of the cost of the recreation function in many national parks in Queensland (Beal, 1996).

Figure 2: Individual Parks and Regional Social, Agency and External Cost Curves



On the basis of this reasoning, it is anticipated that marginal agency cost (MAC) tends to be constant over a wide range of output in all parks. This would suggest total cost is linear. Because fixed costs are only a small component of total cost of recreation, average cost (AAC) is sharply decreasing at minimal outputs and approaches marginal cost at higher outputs. Average cost would then be greater than marginal cost at all outputs, but only by a small increment, depending on the size of the fixed cost component which must be allocated over output (Figure 2).

3.4 External Cost of the Recreation Function

Apart from the internal costs to the management agency, there is also the possibility of external costs. *Externalities* or external costs are defined as those costs which fall on others and for which the management agency bears no financial responsibility (Walsh). Such costs may take the form of loss of benefits or amenity to parties external to the managing agency.

External costs could include costs of congestion to visitors as envisaged in club theory, costs borne now and in the future by neighbours and costs borne by society ultimately in the loss of biodiversity. The external costs to neighbours may take the form of community disruption by the influx of visitors such as congestion on roads and the cost of repair of gravel roads after damage by four-wheel drive vehicles in wet weather, polluted surface water within parks flowing downstream, and the spread of weeds by visitor traffic. Ecological costs resulting from damage to ecosystems ultimately may prove of greater importance than the other external costs. Postulating that a cost is imposed on society by ecological damage has been supported by a great deal of research, but the cost is difficult to quantify. Economic measures of loss generally attempt to measure the cost of the provision to the owner of a damaged asset of a level of well-being equivalent to that enjoyed before the damage (Kopp and Smith, 1993a). Whilst some natural assets may be 'owned' by the state, rather than by individuals, natural assets provide services to people and contribute to an individual's total utility. Damage to natural assets thus reduces utility and well-being. An estimate of the cost of damage should theoretically be the value of lost services from the time of the damage to the time of natural recovery or the sum of the value of lost services and the cost of restoration, if restoration is technically feasible and is attempted to assist, or shorten the period before, natural recovery.

Methods for the estimation of the cost of losses of non-market commodities such as natural assets have focused on the valuation of lost services, the cost of preventing loss or the cost of remediation (Russell, Izac and Cramb; Kopp and Smith, 1993b). One method used to estimate the value of lost benefits or services involves survey or contingent valuation method (CVM) techniques. CVM could be used, for example, to find the additional amount visitors would be willing to pay for entry to an uncongested campground. This amount may then be regarded as the cost of congestion.

A second method which is allied to CVM in that the willingness to pay is the basis of the estimation is the cost of preventing degradation. This method differs from the more conventional CVM technique of surveying the relevant public, because the public are not consulted. Instead responsible authorities are asked for their estimates of the cost of preventing environmental damage. This method is likely to be based on the examination of accounting records or interviews with senior management of the entities responsible for the environmental damage.

Another general method for the measurement of external cost involves the estimation of the cost of remediation of damage. When a readily produced or repaired asset is damaged, the cost of the damage is the cost of replacement or repair. The asset is then able to continue providing the same quality and quantity of services as before the damage. In contrast, when a damaged asset has some rare or unique characteristics, repair or replacement with an identical asset is more difficult or may be impossible.

Russell, Izac and Cramb pointed out that the cost of remediation ignores the cost of net damage, or the damage not repaired for various reasons. These reasons may include lack of effectiveness of repairs, technical infeasibility and economic infeasibility. A similar objection may be raised to the cost of control measures as a proxy for the cost of damage - the value of net damage is ignored.

Nevertheless, visitation brings change with it. The effluent from the treatment of sewage, the soapy water from showers, the trampling of vegetation and the hard-packing of soil in pathways, for example, are all agents of unintended and unwanted change. Thus, no matter how carefully managing rangers in parks have calculated the capacity of parks, there will be ecological costs. It is thus postulated that marginal external cost (MXC) is an increasing function of output, and that the slopes of these functions are different in each park, because of variation in ecological characteristics and differences in the amount and type of infrastructure[13]. MXC curves may be linear or non-linear. They are very likely non-linear, but are shown here to be linear for ease of explanation.

An aggregate MXC curve for the *region* can be computed by the horizontal summation of MXC curves for all parks in the region. Aggregation is necessary so that the regional manager may discern the behaviour of MXC for the whole region and decide what is the maximum acceptable level ecologically and in accord with legal requirements[14].

3.5 Social Cost of the Recreation Function and the Supply Curve

Social cost in any park or indeed for the whole region is the vertical sum of agency cost and external cost. Hence, marginal social cost (MSC) is the vertical sum of marginal agency cost and marginal external cost.

MSC = MAC + MXC

Because MXC is hypothesised as rising, MSC will also rise as output increases, and average social cost (ASC) will be cut by the rising MSC curve. Figure 2 illustrates these cost curves for two parks of different character and in combination. To determine the curves for the administrative region as a whole, the individual park MSC curves are horizontally summed. The regional MSC curve shows the combined MSC - that is, for a particular output level, some part of the output will come from one park and some from the other. The incremental unit of output will always be supplied by the park with lower MSC[15]. At any total regional output level, the MSC at each park will be approximately equal.

Once the chief executive determines the level of regional MXC which is ecologically, socially and legally acceptable, the output of individual parks can be determined. The chosen MXC may not be exceeded in any individual park. The capacity limit for each park will

[13] For any individual park, it is possible that the ecosystems are sufficiently robust and the infrastructure sufficiently large that MXC originates at some non-zero level of output (Pearce and Turner, p.64), but for simplicity this possibility will be ignored.

[14] A reviewer has pointed out that this argument implies a 'top-down' decision process. This is correct, in as much that the central manager is responsible for the setting of standards for his whole region, but the information on which he makes his decision (the behaviour of individual park MXC functions) comes from park managers - a 'bottom-up' process. A system of setting individual park outputs based solely on the ecological limits of acceptable change within each park without reference to a regional standard neutralises the role of central administrators and also denies the role of economics.

[15] A reviewer has asserted that 'a regional park provider would rather try to manage demand and supply so as to equalise the marginal net benefits obtained in each park'. The author has obviously suggested an alternative approach. In the absence of evidence, it is not possible to say which is the preferred approach.

thus be established where MXC has just risen to the given level. As would be expected, Park 2 in Figure 2 with a greater value of the slope coefficient in its MXC function and thus greater ecological fragility and/or less robust or less suitable infrastructure for the demands placed upon it has a lower capacity limit (Q") than Park 1 (Q'). The supply curves for each park and the region are shown in the figure by the bold lines.

3.6 Demand for Recreation in Parks

Demand is a necessary component of any market model. Whilst the demand for recreation in parks within the region is, to a large degree, outside the control of managers, it can be influenced by them. Demand has a large number of determinants, some of which relate to the attractiveness and characteristics of the park and availability of substitutes, some to the potential users and some to other factors such as travel time and size of the population of potential visitors. Demand will differ for each park. In addition, many parks produce more than one product in that both camping and day visitation are allowed[16]. The exceptions to this occur in isolated parks where there are few day visitors, and in the parks where camping is not catered for nor permitted.

Generally speaking, parks cater for both types of visitors and thus are taken to produce two separate products. It is hypothesised that these demand curves will have different price elasticities. Further, the demand for day visits to parks reasonably close to large population centres will be generally more price elastic than the demand for camping, because potential visitors may react to an entry price increase by seeking out substitute recreation venues. Similarly, substitute privately-supplied camping sites outside the boundaries of a park will influence the price elasticity of demand for camp sites inside the park. On the other hand, for isolated parks where accommodation has been built nearby to service visitors who do not wish to camp in the park, demand for day visitation is likely to be less price elastic, because visitors have made a greater commitment of funds to visit the park where commercially available accommodation is used and the entry fee is a small proportion of the total holiday budget.

An aggregate demand curve for each park which combines the demand for day visits and the demand for camping may be estimated and is necessary for managers to appreciate the potential impact of visitors on the ecosystems of the park[17]. In addition, aggregating the separate outputs of the numbers of camping visitors and day visitors in terms of a suitable joint-demand unit overcomes the problem of joint costs of supply.

An aggregate demand curve may be estimated for each individual park by horizontal summation of the demand curves for camping and for day visitation. Whilst horizontal summation is a conventional technique in economics, it is usually attempted with functions which relate to the same product[18]. In this case, the products are different, but they are related on the basis of time and are produced largely by joint costs. The final sub-section of this part briefly discusses the unit in which output is measured.

Figure 3 illustrates the demand situation in any individual park. Dc represents the demand for visits by campers and Dd the demand by day visitors. These two demand curves can be aggregated horizontally after being expressed in standard units to produce D, which is the aggregate demand curve for an individual park.

3.6 The Unit of Output

The internationally recognised units in which the recreational output of parks can be measured and aggregated include visits, days and *recreational visitor days* (RVD). An RVD is equal to 12 visitor-hours; thus numbers of camper-nights (assumed to measure camping visitation in terms of 24 visitor-hour units) may be aggregated with numbers of day visitors, assuming they stay for 12 hours, by doubling the number of campers. This process involves a conversion factor of two.

The aggregation of the demand curves for the two products relies on the ability to convert the units of output in which demand is measured to standard units.

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[16] The various activities that may be enjoyed in parks may be viewed as separate products, but for simplicity, and in accord with normal pricing arrangements, the type of visit is considered the basis of product distinction and entry the basis of pricing.

[17] A reviewer has objected to the aggregation concept and suggested alternatively that the total available visits may be viewed as a finite resource stock and the different classes of users would have different cost functions. It is correct that campers impose higher infrastructure costs but,once away from the campground, campers and day visitors behave essentially in a similar manner and impose similar costs on a unit of time basis. Hence, whilst the two approaches might be successfully developed, the author chose to develop the aggregation method.

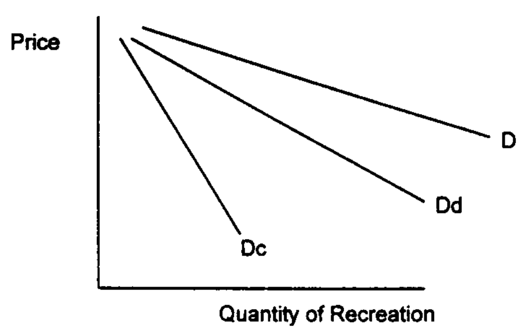
[18] For example, in relation to price discrimination models.

Obviously the standard units for demand must be acceptable as units for which to measure costs. The legitimacy of the RVD and its underlying conversion factor is not a foregone conclusion. Beal (1994) reports research at one national park in Queensland and found a factor of four or five would probably be more appropriate, especially where emphasis is placed on ecological sustainability.

4. Synthesis of the Model

The diagrams for supply and demand in the recreation market as developed above may be integrated into market diagrams which can be applied to determine the equilibrium quantities and prices of recreation services in parks of different character (Figure 3).

Figure 3: Demand Curves for Recreation in Any Individual Park



MAC is assumed to be constant over the relevant range of output for the region and for all parks. AAC for the region falls sharply over low levels of output to approach constancy and MAC. These costs are controlled by staff at regional headquarters, not by park staff. Hence, costs are determined by the region (panel 3) and passed down the line to individual parks.

MXC rises with output in each park at different rates as a result of the different levels of infrastructure, resultant propensity for congestion and different degrees of fragility of ecosystems in the parks. MXC for the region is the horizontal summation of individual park MXC curves and thus is the combined MXC for the region. For any particular output of recreation for the region, part of that output will come from the first park and part from the second park, with the proviso that each incremental unit of output will be provided by the park which can produce it at the lower MXC. Hence, at any total regional output level, the MXC of the supply from each park will be approximately equal.

Marginal Social Cost (MSC) for individual parks and the region is the vertical sum of MAC and MXC in each case. The regional MSC curve shows the combined MSC for output from all the parks in the region and, in common with the case for the regional MXC, part of the output making up a total regional output will come from each park on the condition that incremental units of output will come from the park which can produce it at the lower MSC. ASC is the vertical sum of AAC and AXC. The attributes of individual parks and actions of their managers thus affect these social costs and the social cost functions of the region are the summation of those for the individual parks.

The market model may also be represented algebraically.

Let b be the constant MAC

if TAC is linear with both fixed and variable costs,

let $TAC = a + bQ$;

thus $AAC = aQ^{-1} + b$

if MXC is linear, positive and passes through the origin[19], let $MXC = cQ$, thus $TXC = 0.5\,cQ^2$ and $AXC = 0.5cQ$

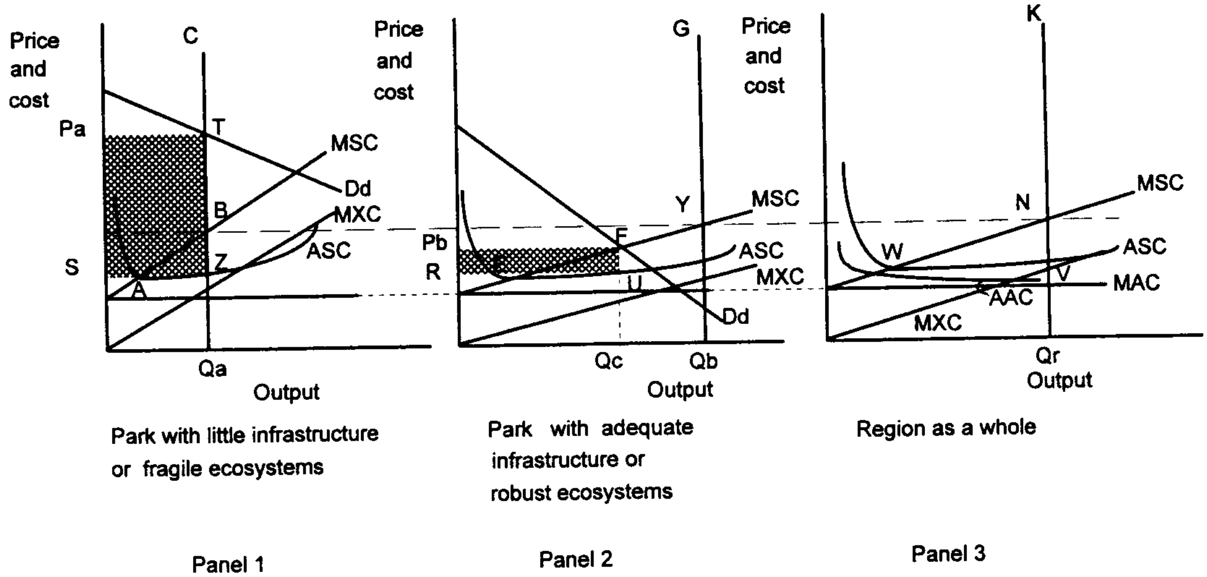
$$MSC = MAC + MXC = b + cQ$$

$$ASC = AAC + AXC = aQ^{-1} + b + 0.5cQ$$

MSC cuts the ASC curve at the point where ASC is minimal or where $\frac{dASC}{dQ} = 0$. At that point, $aQ^{-2} = 0.5c$. The supply curve for each park is thus the MSC curve above the point where $Q^2 = 2ac^{-1}$.

[19] MXC is the first derivative of TXC and $AXC = \frac{TXC}{Q}$.

Figure 4: Theoretical Market Model of National Parks Within an Administrative Region of Queensland



In Figure 4, VN is the maximum MXC which park management believe complies with ecological, social and legal requirements. It thus sets an administered limit to MSC and a limit of Qr to output in the region from all parks. MSC is not allowed to rise above this level in any park. For ease of explanation, a line of equivalence is extended on the diagram to show the level of output indicated for each park. Each indicated output is the absolute capacity for that park under current conditions and together the two outputs aggregate to the regional output. It would be possible to change the slopes of the MXC and consequently the MSC functions in any park by changing the amount of capital investment, either in infrastructure to reduce congestion or, for example, by introducing better technology to reduce the risk of environmental degradation. Under conditions of constant costs, infrastructure, and technology, Qr is the maximum capacity for the region and Qa and Qb the capacity maxima for each park.

The supply curves for each park, which by definition show the quantities of the goods which will be supplied at each price, thus become vertical at the point where the capacity constraints cut the MSC curve. After this point of intersection, no more of the goods can be supplied in each park no matter what price is offered[20]. The supply curves for each park are thus ABC and EYG respectively and WNK the supply curve for the whole region.

Aggregate demand for each park is the horizontal sum of demand for camping and demand for day visits. Price elasticity of aggregate demand will differ between parks. There are three possibilities with respect

[20] Beyond the point of intersection, the park MSC curves may rise sharply or less sharply depending on the individual conditions in each park.

to the equilibrium of supply and demand[21]. In Panel 1, demand exceeds supply at the maximum capacity Qa, but Pa must be charged if price is to be used as the rationing mechanism. Thus, given the individual conditions in this park, the infrastructure, the ecological conditions and the demand exhibited by visitors, Qa is the socially optimal output and Pa is the socially optimal entry fee. If a lesser entry fee is charged, there will be more demand than it is possible to satisfy, and some form of non-price rationing must be used.

In Panel 2, demand is less than the maximum capacity, Qb, set by the maximum MSC limit. If price is set at MSC, Qc will be demanded at a price of Pb. Qc will be the socially optimal output and Pb the socially optimal entry fee. This park is experiencing less visitation than its current maximum capacity.

The difference between total revenue and total social cost, the area SZTPa in Panel 1, is an economic rent[22]. In Panel 2, the area RUFPb is the economic rent. An economic rent will be earned at all levels of output except where demand falls so low that it equals supply at the point of intersection of the ASC and MSC curves.

The model indicates a socially optimal price of Pa for Park 1 and Pb for Park 2. The output of Park 1 will be Qa or the maximum possible output of the park under the given conditions of infrastructure and natural attributes. In Park 2, even though it has a capacity of Qb, only Qc will be demanded at the equilibrium price of Pb. The optimal entry price for Park 1 as predicted by this model is considerably more than the price for Park 2. This is in accord with *a priori* expectations, because Park 1 is more fragile or has less infrastructure. It thus has a *rarity* value, and a higher price would be expected.

5. Policy Implications and Conclusion

The theoretical model has predicted optimal outputs for parks of different ecological character and with different levels of infrastructure. These predictions are in accord with ecological, social and legal requirements. The model has also predicted the prices at which these outputs will just clear the market. Prices for day visits and camping in parks may be computed with their individual demand equations from the prices estimated for aggregate demand units.

The introduction of a fee for a previously free good always needs careful management. This is especially so in the case of a publicly-provided good, because many people will consider taxation already pays for the good. For national parks, in particular, many people will be slow to accept that actually visiting parks can be viewed as a separate class of benefits from existence and option benefits which non-visitors may enjoy and which may be considered a public good. When the two classes of goods are identified and considered as separate benefits of national parks, it is clear that taxpayers have been inequitably subsidising users in cases where the full cost of providing recreation opportunities has not been recovered[23].

The New South Wales National Parks and Wildlife Service (NSWNPWS) charges day entry fees at 13 locations, chiefly parks in and around the metropolis of Sydney, where visitation is high (Costello). When substantially higher fees were introduced in the early 1990s, initially visitors were irate at the imposition of new charges. However, explanation of how the collected monies were being spent and the need for fees to maintain the resource, according to Costello, 'softened the blow to a considerable extent'.

The use of a peak-load pricing scheme or, alternatively, a price discrimination model can be expected to make the introduction of new fees more acceptable to the public. Currently, camping sites at many popular parks are booked out some months in advance. People unable or unwilling to plan their trips in advance are penalised at these times. No matter how much they are willing to pay for a site, they are unable to camp in the parks. A more equitable option is to use price as the rationing device, because people with high-value use will tend to be able to obtain sites. Peak-load pricing may be a valuable component of a marketing strategy.

[21] The case where demand exactly equals supply would be a coincidence and is not illustrated here.

[22] Economic rent is strictly the price paid for the use of land or other natural resources which are completely fixed in supply. More generally, it is the amount earned by a factor of production beyond that needed to call the factor into supply.

[23] Musgrave and Musgrave (p.736) put the general case succinctly: 'general revenue finance may be held inequitable in terms of benefit taxation since the general public is charged for the financing of a specific service, rather than the users who benefit therefrom'.

Additionally, the incorporation of some form of price differentiation may improve economic efficiency. It is efficient to charge various groups of users different prices, if the users have different price and income elasticities, because such a scheme can be expected to reduce the distortion of demand to be expected with a single fee.

Transaction costs of collecting fees may be high if innovative collection methods are not introduced. The fee collection methods for camping fees and day visitation may be different, because campers usually want to book ahead of time to be assured of a camp site. Day visitors, on the other hand, presumably prefer the extra flexibility of unreservable entry. No matter what the method, the cost of fee collection should be minimised and collection should be enforceable, if the method is to be efficient.

Taking reservations for camp sites involves two processes, either noting the booking in parks with limits on numbers but unnumbered sites, or reserving sites by number, and collecting the fees. No extra cost is incurred with charging socially-optimal fees than with charging subsidised fees.

The collection of entry fees from day visitors presents different problems. Where an entry fee is charged, collection must be enforceable or exclusion must be possible for the system to operate satisfactorily. Many parks developed for day visitation would need additional capital investment, if exclusion were to be enforced physically. A cost-effective alternative is provided by the reliance of most people on their vehicles for transport and the development of defined carparks, which would enable managers to use a car permit system for the collection of fees. This system is well established and effective elsewhere in carparks at many types of venues.

With a car permit system, comprehensive fencing is unnecessary. A parking ticket machine, which costs about $9000, may be installed and patrons instructed to buy a ticket and place it prominently on the dashboards of their vehicles. Staff may then patrol at random to ensure fees are paid. On-the-spot fines of double or triple the entry fee for defaulters would mitigate against the system degenerating to a 'wait till you are asked to pay' system. This system is enforceable and would have small transaction costs.

Changes in policy by governments usually affect some people adversely at the same time as improving the lot of others. The policy change suggested in this paper is no exception. Charging socially-optimal prices will alter the present relationship of the funding contributions made by users and non-users and campers and day visitors. However, the new price structure is a manifestation that the management agency is ready to adopt strategies to achieve its twin management objectives in national parks of maintaining biodiversity and allowing use to the ecologically sustainable level.

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