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Rationing Recreational Access to Wilderness and Other Natural Areas

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ABSTRACT

An unusual feature of the management of wilderness and other natural areas is that price is rarely used to ration recreational access. This often leads to queuing for access. At the same time there is often a relatively poor level of infrastructure provided for recreation. This paper argues that it is the relatively high level of public and political involvement in the management of wilderness and other natural areas that is ultimately responsible for the particular way in which recreational access is allocated. This introduces two 'biases' into managerial objectives. Queuing and infrastructure distortion are the symptom of these biases.

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* I would like to thank Sarah Jennings for useful comments on an earlier draft. All errors remain my responsibility.

Rationing Recreational Access to Wilderness and Other Natural Areas

It is common for managers of publicly owned wilderness and other natural areas to limit the level of recreational access to these areas. The justification given for restricting access is to limit environmental degradation and congestion that is caused by recreation. Legislation usually requires managers to limit these effects. For example, the United States Wilderness Act requires lands to be managed "for the use and enjoyment of the American people" and "for the protection of these areas, the preservation of their wilderness character" (Brunson, 1998). With increased use these goals become incompatible. Some rationing of recreational access is required to maintain the wilderness character of natural areas. For instance, management often imposes use limits on trails in popular and/or sensitive areas. Use limits are imposed by park management in the backcountry of Yosemite and Denali National Parks in the United States. They are also imposed on the Milford Track (South Island of New Zealand) and on the Overland Track (Tasmania, Australia).

An unusual feature of the management of publicly owned wilderness and other natural areas is that price is rarely used to ration recreational access. In the case in which a non-zero price is charged for access, it is usually well below the market clearing level. For instance, in the United States price is rarely used to eliminate the excess demand for walking trails in wilderness areas, even though charging for recreational access is permitted under the 2004 US Federal Lands Recreation Enhancement Act (USREA).[1] [2]

[1] Scope existed under the previous US legislation, the 1996 Fee Demonstration Program, to charge for recreational access to wilderness areas.
[2] Similarly no fee is charged for the use of popular New Zealand trails such as the Milford Track. Fees are unusual for access to Australian wilderness. A fee was recently introduced for access to the Overland Track, but it is insufficient to eliminate excess demand.

The absence of market clearing prices leads to queuing in popular areas.[3] From an economic perspective the time cost associated with queuing is purely a waste of resources. At the same time there is often a relatively poor level of infrastructure provided to support recreation. Infrastructure includes visitor centres, access routes to the natural area, trail development, trail marking, provision of huts, toilet facilities etc. One indication of this low level of infrastructure is the maintenance backlog present in many reserves. However restrictions on infrastructure levels, particularly in the backcountry of national parks, are often embedded into management plans through a system of zoning. Often a management plan does not allow any infrastructure in a zone which is designated 'wilderness'. The extent of infrastructure in the park is set by determining the extent of the zones.

This paper argues that it is the relatively high level of public involvement in the management of wilderness and other natural areas (through various political processes) that is ultimately responsible for the particular way in which recreational access is allocated and infrastructure level determined. Public involvement in the operation of national parks has a long history. Most public lands which incorporate wilderness and other natural areas are run according to management plans, and these frequently call for public and/or recreational user involvement in decision making. For instance, the USREA requires US federal agencies to involve the public before introducing or changing a fee. Such involvement introduces two 'bias'' into managerial objectives.

The first bias in managerial objectives is one in favour of politically dominant classes of users. Public representatives are often disproportionately drawn from particular class of users. For example, user representatives on consultative committees are more likely to be drawn from local communities than from distant communities. There are three reasons this

[3] Queuing can take many forms, depending on the rationing mechanism adopted. For example, suppose places on a trail are limited. If permits on the trail are available only from the park on the day that the walk commences, a queue will literally form outside the park office. In this event, prospective walkers may have to wait a number of days simply to obtain a permit before walking. This is the case for popular units (zones) of Denali National Park during summer months. Alternatively park management may allow bookings. There are two ways the market will clear in this case. First, prospective walkers will attempt to book very far in advance to ensure a place on the track, and then be forced to live with the inflexibility this imposes. For instance, Yosemite National allows bookings for a proportion of the free permits to use backcountry trails. These are often booked out far in advance. For example, at 23 March 2007 no reservations were available on the Happy Isles-Little Yosemite Valley trail on 80 of the 93 days between 25 May to 25 August 2007. (Source: http:/home.nps.gov/archive/yose/rptFullTrailheadDates.htm, accessed on 23 March 2007.) Places on the Mt. Whitney Main Trail in the Inyo National Forest are initially allocated by lottery in February for the period 1 May to 1 November. This allocation method imposes "queuing" cost from inflexibility and misallocation across consumers. Whichever non-price rationing mechanism is used, it will generate queuing costs which are sufficient to clear the market.

may be the case: (i) national (federal) legislation, such as the USREA, may require local community involvement[4], (ii) in some jurisdictions the management of the natural area is appointed by local jurisdictions, and thus the local political process will inevitably be biased in favour of locals [5], and (iii) individual 'tourists' are likely to make far fewer visits than locals and thus (individually) have less of an interest in the management of the natural area. Similarly, regular recreational users of a particular natural area are likely to be more politically organised than casual users, and thus will exert a disproportionate political influence.

The second bias relates to the weighting of profit in managerial objectives. The dominance of user interest in the political process means that governments are often willing to subsidise recreation. More specifically, management assigns profit a lower weighting in its objectives than it assigns the benefit of recreation to the dominant group of users. Thus the objectives that guide the management of wilderness and other natural areas are not those of a textbook 'social welfare maximiser'. Rather, in undertaking pricing and infrastructure decisions, management under-weights profits and favours a dominant group (or dominant groups) of users.

A model is presented which captures the above bias in managerial objectives. Queuing may arise in this model when profits are under-weighted and the dominant user group has a lower opportunity cost of time than other user groups. In this case queuing can bias the allocation of access toward the dominant group. Some features of recreation in natural areas suggest that the dominant group might have a relatively low opportunity cost of time. Wilderness areas, for example, are situated in locations that are remote from industrialised and economically dynamic areas. In this event, locals are thus likely to have a lower hourly wage rate than tourists. Similarly, those users who have a relatively low cost of time face a lower cost associated with becoming involved in clubs and societies. This might result in their preferences having a greater weight in managerial objectives

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[4] Under the USREA, the US Forestry Service and US Bureau of Land Management must establish, *regionally* based committees to advise on matters concerning recreation fees. In addition, under the USREA, the intention of an agency to change or introduce a fee need only be notified locally.

[5] In Australia management of wilderness and natural areas is a state government responsibility. The authority that manages Tasmanian wilderness areas (Tasmanian National Parks Service) established a committee of local interest groups (Bushwalking and Track Review) to advise on issues related to recreational access to wilderness areas.

The dominant group of users is also likely to have a greater familiarity with a particular natural area or outdoor recreation in general. This group is relatively less reliant on infrastructure. For instance, locals are familiar with the national parks in their region, and thus receive less benefit from signage than do tourists. Similarly the locals may be more used to local terrain, and thus less reliant on track works, shelters and visitor centres than are tourists. This difference in benefit of infrastructure between locals and tourists provides another mechanism by which management can advantage the dominant group. By reducing infrastructure, management can raise the total cost of access to tourists relative to that of locals. When total access is restricted, locals are able to achieve greater access by restricting infrastructure and thus lowering the demand from tourists.

Queuing and infrastructure distortion are, in effect, covert mechanisms to advantage users who have a relatively low opportunity cost of time. The discriminating effect of these mechanisms is not immediately apparent, as they do not overtly treat members of different user groups differently. However, it is shown in this paper that these mechanisms would not be used by management if it could overtly engage in third degree price discrimination by charging different fees to members of different user groups. When third degree price discrimination can be used, price bears the full burden of advantaging one group over another. In practice management might not be able to use third degree price discrimination. It may not be able to distinguish classes of users for the purpose of setting differential prices. Alternatively, political or legal constraints may preclude the overt favouritism implied by the implementation by management of third degree discrimination. In any event, it will be shown that adoption of third degree price discrimination does not yield efficiency (in spite of it precluding queuing and infrastructure distortion) if management distorts its pricing structure to advantage the dominant group of users.

The economics literature has addressed the issue of the efficient pricing of outdoor recreation. Fischer and Krutilla (1972) identify the optimal recreational use level (carrying capacity) as occurring at the use level where the marginal benefit from recreation equals the marginal cost (which includes the ‘external’ costs of congestion and environmental degradation).[6] Wilman (1986) considers efficient allocation across groups that differ in their willingness to pay. Turner (2000) considers the efficient allocation across groups that undertake differing activities. This paper differs from these studies by focusing on the method

[6] See also Alldredge (1973) and Wagar (1974).

management uses to allocate recreational access in practice, rather than focussing on determining the efficient level of recreational access.

Section 1 of this paper introduces a model of managerial decision-making regarding recreation in wilderness and other natural areas. Section 2 derives the equilibrium of the model under a number of institutional settings. Using these results, Section 3 discusses policy options. The paper concludes with Section 4.

1. Management of recreational access

Consider a natural area that is used for recreation by two types of users. Each recreational trip imposes a total cost, p_i, on type i users:

$$p_i(P,a,y) = P + a_i w_i + a w_i - t_i y \qquad (1)$$

where i=1,2, P is the price of access, a is the time spent queuing, a_i is the total remaining time (including travel time) spent on the trip with zero infrastructure, w_i is the wage of the type i users, t_i is the time saving and y is the level of infrastructure. Formally the term $t_i y$ represents the value of time saved by the presence of infrastructure. The term, $t_i y$, could also be interpreted, more loosely, as a measure of the additional convenience infrastructure provides.

Denote the consumer surplus of type i users as $v_i(p_i)$. Use, x_i, by type i users is given by:

$$x_i(p_i) = - v_i'(p_i) \qquad (2)$$

Let total demand, x(P,a,y), be given by:

$$x(P,a,y) \equiv x_1(p_1)+x_2(p_2) = x_1(P+ (a+a_1)w_1-t_1y)+x_2(P+ (a+a_2)w_2-t_2y) \qquad (3)$$

The profit made from recreation by the management of the resource is:

$$\Pi(P,a,y) = (P-c)\, x(P,a,y) - Y(y) \qquad (4)$$

where c is marginal use cost and Y(y) is the (pecuniary) cost of infrastructure level y. Assume that $Y'(y)>0$ and $Y''(y)\geq 0$.

Management decisions influence environmental quality. Increased use can lead to environmental degradation. Infrastructure has the potential to protect against such degradation. For instance, track hardening can halt erosion on a high use trail. Let the benefit of environmental quality be denoted g(x,y). Environmental quality is assumed to decrease the total number of uses and increases with y, the level of infrastructure, i.e. $g_1<0$ and $g_2>0$.

The objective of the manager may be differentially influenced (or 'captured') by the different groups of users. The manager may also be under pressure from government to minimise the extent to which recreation is subsidised, or possibly even to return a profit from recreation. In addition, legislation usually requires management to protect environmental quality. In the spirit of Evans and Garber (1988) and Sharkey and Sibley (1993) assume that the manager has a utility function which is the weighted sum of these influences:

$$M(P,a,y) = m_1 v_1(p_1) + m_2 v_2(p_2) + m_3 \Pi(P,a,y) + m_4 g(x(P,a,y),y) \qquad (5)$$

where $m_i \in [0,1]$ are the relevant weightings. The weightings reflect the relative strength of the various influences on manager motivations. They ultimately reflect the institutional environment, which will differ from jurisdiction to jurisdiction. These effects are exogenous for the purpose of analysing the pricing decision.

This paper is not concerned with analysing the impact of the relative balance of profit and environmental quality in managerial objectives. It is thus useful to define the operational surplus, π, as the following sum of pecuniary profit and the benefit of environmental quality:

$$\pi(P,a,y) = \Pi(P,a,y) + q(x(P,a,y),y) \qquad (6)$$

where $q(x(P,a,y),y) \equiv (m_4/m_3) g(x(P,a,y),y)$. The function $q(x,y)$ measures environmental quality in units of 'profit'. Thus the operational surplus measures the net benefit of the non-recreation activities from the perspective of management. In this case the managerial objective function (or utility), (5), can be written as:

$$M(P,a,y) = m_1 v_1(p_1) + m_2 v_2(p_2) + m_3 \pi(P,a,y) \qquad (7)$$

In reality the weights in (7), which represent managerial objectives, will be the outcome a complex interaction of legislative restrictions, funding and political motivations by government and the controlling government agency (e.g. National Parks Service), local management and various community organisations. However the outcomes of these processes are succinctly captured by (7). Bargaining between user groups, local management, government agencies and the government are, therefore, subsumed into the manager's utility (objective) function.

The above model is best analysed by considering special cases of managerial objectives:

<u>Definition 1</u>: A manager is called:

(i) unbiased if $m_1 = m_2 = 1$;

(ii) captured if $m_1 = 1$ and $m_2 = 0$;

(iii) customer disinterested if $m_1 = m_2 = 0$;

(iv) operations orientated if $m_3 = 1$;

(v) operations indifferent if $m_3 < 1$.

The manager would act to maximise social welfare if they are unbiased and operations orientated. If “locals” (type 1 users) dominate decision making, managers are captured, operations indifferent. Managers are operations maximising if they are customer disinterested and operations orientated.

If price is set below the market clearing level queuing occurs. Queuing time is obviously non-negative, so:

$$a \geq 0 \tag{8}$$

The managerial optimisation problem is:

$$\max_{P\,a\,y} M(P,a,y) \text{ subject to (8)} \tag{9}$$

The first order conditions of the optimisation problem (9) are given in the appendix.

2. Equilibrium with various managerial biases

If management is unbiased and operations orientated then it acts to maximise the social surplus. In this case the equilibrium price, queuing and level of infrastructure provision are efficient. The following proposition characterises this outcome

Proposition 1: Suppose management is unbiased and operations orientated ($m_1= m_2= m_3 =1$). Then management sets the efficient price:

$$P = c - q_1(x,y) \tag{10}$$

Management sets the efficient level of infrastructure, which is given by:

$$Y'(y^*) = q_2(x(P,0,y^*),y^*) + t_1x_1(P^*+ a_1w_1-t_1y^*)+t_2x_2(P^*+ a_2w_2-t_2y^*) \tag{11}$$

There is no queuing.

Condition (10) is the usual efficiency condition that price equals marginal cost. As queuing represents wasted resources, the efficient level of queuing is zero. Equation (11) states that the level of infrastructure is efficient when its marginal benefit equals its marginal cost. The marginal benefit is measured by the sum of the marginal improvement in environmental quality from an increase in infrastructure and the increase in consumer surplus that accompanies an increase in infrastructure.

The equilibrium described by proposition 1 is illustrated in figure 1. The demand curve for user i, $x_i(p_i^*)$ is shown, where:

$$p_i^* = P+ a_iw_i-t_iy^* \tag{12}$$

And where the level of infrastructure, y*, is assumed to be chosen efficiently. Queuing is assumed zero. Total demand is given by x(P,0,y*). The equilibrium (and efficient) price P* occurs at the point at which the demand curve cuts the (vertical section) of the marginal cost. At this price, type i users consume x_i^* and total use is x*.

The following definition is useful in describing movements away from the efficient outcome:

Definition 2: Infrastructure is said to be downwardly (un-, upwardly) distorted if in equilibrium an increase in infrastructure, while holding total use and queuing constant, increases (leave unchanged, lowers) the social surplus.

It is shown in the mathematical appendix that the condition for the presence of downwardly (un-, upwardly) distorted infrastructure is:

$$Y'(y) < (=,>) \; q_2(x(P,a,y),y)+t_1x_1(P+(a+a_1)w_1-t_1y)+t_2x_2(P+(a+a_2)w_2-t_2y) \qquad (13)$$

Infrastructure is downwardly distorted if, in equilibrium, the sum of the marginal environmental quality and marginal consumer surplus of infrastructure is greater than its marginal cost.

Many present institutional arrangements cause management to be captured and operations indifferent. The following proposition highlights the salient predictions of the model under these circumstances:

Proposition 2: Suppose management is captured and operations indifferent ($m_1=1$, $m_2=0$, $m_3<1$). Then:

(i) Infrastructure is downwardly (upwardly) distorted if $t_1<(>)t_2$.

(ii) A necessary, but not sufficient, condition for queuing is that $w_1<w_2$.

(iii) Suppose $w_i=\alpha t_i$, $\alpha>0$. If queuing is present then infrastructure is chosen so that $Y'(y)=q_2(x,y)$.

Proposition 2(i) can be explained using figure 1. Infrastructure distortion allows management to reallocate use to advantage type 1 users relative to type 2 users. To show this, suppose that management were to initially set the efficient combination of price, queuing and infrastructure. Now define:

$$\delta p_i \equiv aw_i - t_i(y-y^*). \qquad (14)$$

δp_i represents the variations of p_i from p_i^*. A reduction in infrastructure below the efficient level causes δp_i to be positive. Thus p_i falls, leading to a fall in x_i. Assuming $t_1<t_2$ then $\delta p_1<\delta p_2$. In figure 1 this is shown as a fall in total use from x^* to $\overline{x}^1$, and a fall in use of type i from x_i^* to $\overline{x}_i^1$. Now to compensate for the rise in p_i on demand, price can be lowered to P^1, at which point the initial use level (x^*) is again achieved. The combination of the fall in y and P is that, in equilibrium, $p_1 < p_1^*$ and $p_2 > p_2^*$ and thus $x_1(p_1) > x_1(p_1^*)$ and $x_2(p_2) < x_2(p_2^*)$. The consumer surplus of type 1 users is raised relative to the efficient allocation while that of type 2 users is lowered. The effect on profit is ambiguous. Price, and thus revenue, is lowered. However the cost of infrastructure has also been lowered.

A similar explanation can be provided for proposition 2(ii). Again starting from the efficient allocation, an increase in queuing raises p_2 more than p_1 provided $w_1 < w_2$. A reduction in P can restore the initial use level, however p_2 remains higher than p_1. The increase in queuing thus raises the consumer surplus of type 1 users relative to the efficient allocation while that of type 2 users is lowered. Profit is unambiguously lowered.

These results suggest that management would prefer to lower infrastructure than to introduce queuing in an effort to advantage type 1 users. The former provides a cost saving while the latter does not. Proposition 2(iii) confirms this intuition. In this part of the proposition, the time saving (t_i) of each user types is proportional to their opportunity cost of time (w_i). Thus infrastructure reductions and queuing have the same relative effect on p_i. Proposition 2(iii) suggests that queuing is only used once the opportunity for inducing differences in p_i from infrastructure reductions have been exhausted. If reductions in infrastructure levels alone are not sufficient to advantage type 1 users, queuing is also required. Specifically, infrastructure is chosen to maximise its net benefit (i.e. $q(x,y) - Y(y)$) to management, and the level of queuing is chosen to provide the optimal advantage to type 1 users.

The low weighting of operations and zero weighting of type 2 consumer surplus assumed in proposition 2 causes the total use level to differ from the efficient use level. In addition, the distortion of infrastructure and the presence of queuing yield an inefficient allocation across user groups. There is an inefficiently high level of use by type 1 users and an inefficiently low level of use by type 2 users. Furthermore, when queuing is present, the queuing cost $a(w_1x_1+w_2x_2)$ represents an additional source of inefficiency.

The following proposition indicates that management's attitude to the operational surplus is critical to determining if queuing can be present in equilibrium.

Proposition 3: Suppose management is captured and operations orientated ($m_1=1$, $m_2=0$, $m_3=1$). Then:

(i) $P>c-q_1$

(ii) infrastructure is downwardly (upwardly) distorted if $t_1<(>)t_2$ and

(iii) no queuing occurs.

Under the assumptions of Proposition 3 management weighs operations and the consumer surplus of type 1 customers equally. However because the consumer surplus of type 2 users does not influence management utility, management increases its utility by raising price above marginal cost: when price is equal to marginal cost the loss of type 1 user's consumer surplus is more than offset by the increase in profit. Management can use infrastructure levels to advantage type 1 customers as discussed above. However, as queuing means a loss of potential profit, it is never used by management.

The following proposition highlights the role of managerial bias toward particular customer groups in determining the character of equilibrium.

Proposition 4: Suppose management is unbiased and operations indifferent ($m_1=1$, $m_2=1$, $m_3<1$). Then in equilibrium:

(i) $P < c - q_1$

(ii) if $t_1<t_2$ infrastructure is downwardly (upwardly) distorted when the elasticity of demand of type 1 users is greater (less) than type 2 users

(iii) for queuing to occur it is necessary that the elasticity of demand of type 1 users is greater (less) than that of type 2 users .

Under the assumptions of Proposition 4 profit is less important to management than the consumer surplus of both customer types. Thus in equilibrium management sets price below the equilibrium level. Under the assumptions of Proposition 4 the main goal of management is to maximise total consumer surplus. This is achieved by lowering p_1 relative to p_2 if type 1 has more elastic demand than type 2 users. As above, this can be achieved by downwardly distorting infrastructure or introducing queuing.

The final proposition describes equilibrium when management does not take account of the interests of either user type.

Proposition 5: Suppose management is customer disinterested and operations orientated ($m_1=0$, $m_2=0$, $m_3=1$). Then:

(i) no queuing occurs and

(ii) if $t_1<t_2$ then infrastructure is downwardly (upwardly) distorted when the elasticity of demand of type 1 customers is less (more) than type 2 customers.

As with Proposition 3, no queuing occurs when management is operations orientated. Queuing represents a loss of prospective profit. By analogy with Ramsey pricing, the monopolist benefits by increasing sales to the group with the most inelastic demand. If type 1 customers have the most inelastic demand, overall use can be shifted toward them by downwardly distorting infrastructure.

3. Policy Implications

A necessary condition for management to adopt a strategy that generates queuing is that the operational surplus, particularly profit, is under-weighted in its objective function. Queuing may occur if management is either captured or unbiased. Proposition 4 indicates that if management is unbiased, queuing is only observed when locals (type 1 customers) have more elastic demand than tourists (type 2 customers). This might occur if locals may have greater access to substitute activities, and hence have more elastic demand. However, it is exceptionally unlikely that this condition would hold universally. Given the widespread use of queuing as a 'response' to high demand, the model presented above suggests that, in many jurisdictions, management is commonly both captured and operations indifferent.

It might be thought that a simple response to persistent queuing (which arises from inappropriate weights in the managerial objective function) would be to require management to price so as to eliminate queuing. This could be achieved by auctioning permits for recreational access, or allowing transferability and re-sale of permits. (One might imagine an e-bay style allocating mechanisms for allocating access at given periods of time.) However, although this policy would eliminate the waste from queuing, it need not necessarily yield an improvement in efficiency. The model suggests that if queuing is eliminated, management would shift the burden of manipulating the relative value of total price, p_i, across customer types to infrastructure. Thus distortion in infrastructure would increase. Indeed the distortion in infrastructure could be sufficiently great that it outweighs the efficiency gains from the abolition of queuing. Thus requiring management to set the market clearing price need not, by itself, increase efficiency.

A questions suggested by the above analysis is whether management could raise efficiency by charging type 1 and type 2 customers different price (third degree price discrimination). This would, of course, rely on management being able to identify each group and then legally act on this information. If management could do this:

<u>Proposition 6</u>: Under third degree price discrimination there is no queuing and infrastructure is not distorted (irrespective of the values of m_i).

It is unnecessary for the manager to use either queuing or infrastructure to advantage one or both types of customers. This can be achieved more effectively by charging different prices to different customers. Of course this action itself results in a misallocation across customer types. So third degree price discrimination results in inefficiency. However third degree price discrimination does have the advantage that the bias of management is obvious to all observers. If type 1 customers capture management they will be offered a lower price than type 2 customers.

The source of the inefficiency discussed above is, of course, the inappropriate weights management allocates to operations and the consumer surplus of all users in its decision making. Clearly the first best option would be to restructure the institutional arrangements so that managers weigh all users' consumer surplus and operational surplus equally. A formal analysis of this is outside the scope of this paper, as the above model takes the institutional arrangements as exogenous. Indeed, as jurisdictions differ in their institutional arrangements, such an exercise would need to be conducted on a jurisdiction by jurisdiction basis.

Nonetheless it is worth noting that such a change is likely to be far from straightforward. For instance, suppose legislation was changed to require management to introduce administrative processes that ensure all interests are appropriately accounted for. In principle this policy would achieve an efficient outcome (whether management was currently captured or unbiased). However such a proposal faces a number of obstacles in practice. Firstly, it is not clear that the economic measures of profit and consumer surplus and the concept of common weights could be effectively translated into legislation. (For instance, the recent USREA emphasises (pecuniary) cost recovery as a basis for recreational fees, rather than efficient resource allocation.) If economic concepts are not accurately translated in to new legislation, it might itself be a source of additional distortion in the weightings. Even if such legalisation was written and passed, it may not be effective in the face of differences in political influence between groups. Politically powerless groups may not be able to ensure their interests are accounted for in decision making. Further, in practice these requirements may be difficult to implement. They require management to identify not only the interests of all current groups using the natural area, but also the interest of prospective users who are not currently using the natural area. Efficiency requires that management identify these groups and estimate their demand. This could be a difficult task, given that outdoor recreation is an experience good, and prospective users might not be fully aware of their prospective demand. In practice, therefore, legislative attempts to ensure that management gives equal weight to the interests of all groups may only be partially successful.

In summary, none of the mechanisms considered above would entirely overcome the bias in managerial preferences and result in an efficient allocation. They do not allow for the full benefit of recreation derived by type 2 users to be accounted for in equilibrium. However the above discussion suggests that a combination of appropriate legislative and administrative reform and use of third degree price discrimination might ameliorate some of the undesirable effects of managerial bias. While legislative and administrative reform may not completely eliminate managerial bias (as discussed above), it might nonetheless cause management's weightings to be more balanced. Price discrimination makes any managerial bias apparent, and thus may provide a moral pressure on managers to be more balanced in their decision making. The use of price discrimination also eliminates the loss of efficiency due to queuing and infrastructure distortion.

4. Discussion

A popular rhetorical justification for the low price charged for recreational access to national parks is that parks should be "available to all". Indeed this sentiment is to some extent reflected in legislation. However these arguments ignore the environmental and social constraints imposed by the finite nature of the resource. To maintain the quality of recreation and provide protection to the environment some rationing must occur. The central economic question is how this rationing is best achieved.

This paper presents a theory of the pricing of publicly owned natural areas that allows for a variety of influences on managerial objectives. In the model, utilising queuing and infrastructure distortion enables management to change the relative total price faced by different user groups. In contrast to the rhetoric claim above, the existence of a low price combined with queuing and infrastructure distortion can be interpreted as a mechanism to advantage a dominant group of users over other groups.

Advancing the interests of the dominant group of users through 'non-price' means leads to inefficiency. When it occurs, queuing represents a clear waste of resources. The presence of infrastructure distortion is harder to identify, and the inefficiency is less apparent. An inefficiently low level of infrastructure can always be (incorrectly) justified by management as being appropriate for environment and/or social reasons. For example it is easily claimed that "we can't place a hut in this region as it will interfere with the wilderness character of the region required by the management plan". The use of third degree price discrimination (where practical) has the advantage that the result of the bias in managerial objectives is transparent and there is no incentive for management to adopt queuing or infrastructure distortion. It should be emphasised, however, that adoption of third degree price discrimination cannot be guaranteed to lead to increased efficiency.

It is argued in this paper that, in many jurisdictions, the dominant user group typically has a relatively low opportunity cost of time. Demographic changes and/or technological improvements could change this. For instance, improvements in information technology might allow skilled (and thus high wage) users to live in remote areas, thus change the socio-economic characteristics of the 'locals' compared to the 'tourists'. In this event queuing is no longer optimal as a rationing mechanism. However, if local knowledge substituted for infrastructure, it would still be the case that (high wage) locals would benefit less from infrastructure than do tourists. In this case infrastructure would be downwardly distorted. For instance, locals would prefer reduced information (e.g. signage) about the natural area, thus reducing demand and the equilibrium price.

An alternative interpretation of the model presented in this paper is that management acts in the interests of the ‘poor’. In this interpretation the ‘poor’ represent user group 1, and they only appear to be dominant because management is particularly concerned that they receive ‘fair’ access. However this argument stands in contradiction to standard economic reasoning, in which economic agents act in their own self interest. Consider the model of this paper being extended to include three classes of user: the poor, locals (middle income) and tourists (high income). If the locals are dominant, the pricing and infrastructure decisions made by management would be much as described in this paper. The political influence of locals will have, *only incidentally*, benefited the poor. However, claiming that the low price is intended to help the poor provides a convenient justification for management’s inefficient pricing and infrastructure decisions.

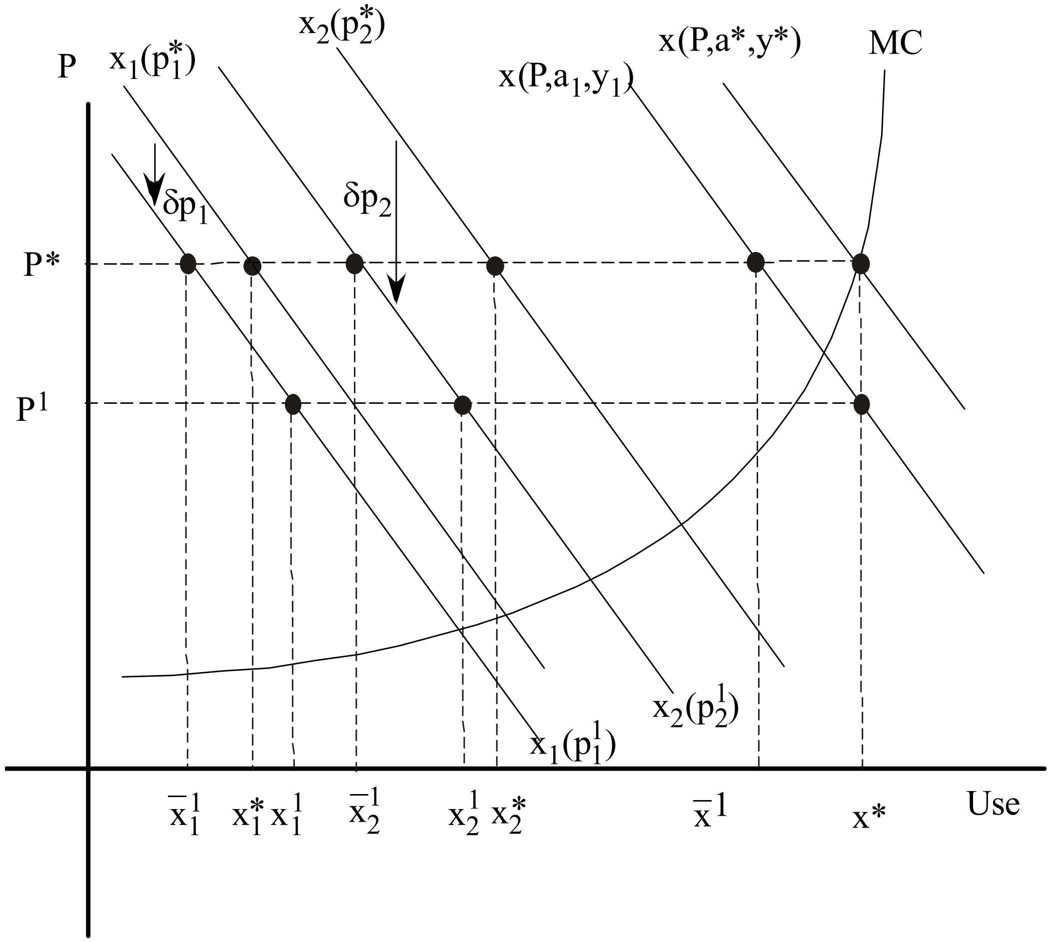

Figure 1. The effect of rationing and distortion of infrastructure on the efficient allocation.

Appendix: Mathematical Proofs and Derivations

The first order condition for the optimisation problem (9).

The Lagrangian is:

$$L=m_1v_1(p_1)+m_2v_2(p_2)+m_3\{(P-c)[x_1(p_1)+x_2(p_2)]-Y(y)+q(x_1(p_1)+x_2(p_2),y)\}+\mu a$$

where $\mu \geq 0$ is the Lagrange multipliers. The Kuhn Tucker conditions yield:

$$\partial L\partial P = -m_1x_1(p_1)-m_2x_2(p_2) + m_3\{x_1(p_1)+x_2(p_2)+(P-c)[x_1'(p_1)+x_2'(p_2)]+q_1[x_1'(p_1)+x_2'(p_2)]\}$$

$$\partial L\partial P = 0 \Rightarrow \; m_3[(P-c)+q_1] = \frac{(m_1-m_3)x_1(p_1)+(m_2-m_3)x_2(p_2)}{x_1'(p_1)+x_2'(p_2)} \qquad \text{(A1)}$$

$$\begin{aligned}\partial L\partial y = {} & m_1t_1x_1(p_1)+m_2t_2x_2(p_2)\\ & + m_3\{(P-c)[t_1x_1'(p_1)+t_2x_2'(p_2)]-Y'(y)+q_1[t_1x_1'(p_1)+t_2x_2'(p_2)] + q_2\}\end{aligned}$$

$$\partial L\partial y = 0 \Rightarrow$$

$$\begin{aligned}& m_3\{Y'(y)-q_2(x,y)-t_1x_1(p_1)-t_2x_1(p_2)\}\\ & \quad =(m_1-m_3)t_1x_1(p_1)+(m_2-m_3)t_2x_1(p_2)+m_3((P-c)+q_1)[t_1x_1'(p_1)+t_2x_2'(p_2)]\end{aligned}$$

Substituting (A1) gives

$$m_3\{Y'(y)-q_2(x,y)-t_1x_1(p_1)-t_2x_2(p_2)\}= (t_1-t_2)\Gamma \qquad \text{(A2)}$$

$$\text{where } \Gamma= \frac{x_1(p_1)x_2(p_2)}{x_1'(p_1)+x_2'(p_2)}\left((m_1-m_3)\frac{x_1'(p_1)}{x_1(p_1)}-(m_2-m_3)\frac{x_2'(p_2)}{x_2(p_2)}\right) \qquad \text{(A3)}$$

Γ is the difference in weighted demand elasticities.

$$\partial L\partial a = -m_1w_1x_1(p_1)-m_2w_2x_2(p_2) + m_3((P-c)+q_1)[w_1x_1'(p_1)+w_2x_2'(p_2)]+ \mu$$

$\partial L \partial a = 0 \Rightarrow$

$$\mu = m_1 w_1 x_1(p_1)+m_2 w_2 x_2(p_2) - m_3((P-c)+q_1)[w_1 x_1'(p_1)+w_2 x_2'(p_2)] \qquad (A4)$$

or:

$$\mu - m_3(w_1 x_1(p_1)+w_2 x_2(p_2))$$
$$=(m_1-m_3)w_1 x_1(p_1)+(m_2-m_3)w_2 x_1(p_2)+m_3((P-c)+q_1)[w_1 x_1'(p_1)+w_2 x_2'(p_2)] \qquad (A5)$$

Substituting (A1) gives:

$$\mu - m_3(w_1 x_1(p_1)+w_2 x_2(p_2))=(w_1-w_2)\Gamma \qquad (A6)$$

<u>Proof of Proposition 1.</u>

When management is unbiased and operations orientated then $m_1= m_2= m_3=1$. Then (A1) gives:

$$P = c - q_1$$

When $\lambda=0$ then $P=c$ and $x<\bar{x}$. If $\lambda>0$ then $x=\bar{x}$. Given $m_1= m_2= m_3=1$ then $\Gamma= 0$ hence:

$$Y'(y) = q_2(x,y) + t_1 x_1(p_1)+t_2 x_2(p_2) \qquad ||$$

<u>A test for infrastructure distortion</u>.

The surplus is given by:

$$S = v_1(p_1)+v_2(p_2)+(P-c)[x_1(p_1)+x_2(p_2)]-Y(y) + q(x(P,a,y),y)$$

Hence:

$$\partial S/\partial y = t_1 x_1(p_1)+t_2 x_2(p_2)-Y'(y) + q_2(x,y)$$
$$+(P+q_1-c)[(x_1'(p_1)+x_2'(p_2))dP/dy+(w_1 x_1'(p_1)+w_2 x_2'(p_2))da/dy+t_1 x_1'(p_1)+t_2 x_2'(p_2)]$$

It is assumed total use is held constant. Hence

$$[x_1'(p_1)+x_2'(p_2)]dP/dy + [w_1x_1'(p_1)+w_2x_2'(p_2)]da/dy + t_1x_1'(p_1)+t_2x_2'(p_2) = 0$$

Hence:

$$\partial S/\partial y = t_1x_1(p_1) + t_2x_2(p_2) - Y'(y) + q_2$$

Infrastructure is thus downwardly (un-, upwardly) distorted if:

$$Y'(y) < (=,>)\ q_2(x(P,a,y),y) + t_1x_1(P+(a+a_1)w_1-t_1y)+t_2x_2(P+(a+a_2)w_2-t_2y)$$

That is, infrastructure is downwardly distorted in equilibrium if the marginal cost of infrastructure is less than the sum of marginal environmental quality and marginal consumer surplus. By (A2) infrastructure is downwardly (un-, upwardly) distorted if, in equilibrium,

$$(t_1-t_2)\Gamma < (=,>)\ 0. \qquad \text{(A7)}$$

<u>Proof of Proposition 2.</u>

When management is captured then $m_1= 1$ and $m_2=0$, and operations orientated then $m_3<1$. By (A1):

$$m_3[(P-c)+q_1] = \frac{(1-m_3)x_1(p_1) - m_3x_2(p_2)}{x_1'(p_1)+x_2'(p_2)} \qquad \text{(A8)}$$

and by (A3):

$$\Gamma=\frac{x_1(p_1)x_2(p_2)}{x_1'(p_1)+x_2'(p_2)}\left((1-m_3)\frac{x_1'(p_1)}{x_1(p_1)}+ m_3\frac{x_2'(p_2)}{x_2(p_2)}\right) > 0$$

(i) If $t_1< (>)\ t_2$ then the LHS of (A7) is negative (positive), and hence infrastructure is downwardly (upwardly) distorted.

(ii) From (A6) it is necessary that $w_1<w_2$ for $\mu=0$.

(iii) If queuing occurs by (A6), and using $w_i=\alpha t_i$:

$$(t_1-t_2)\Gamma + m_3(t_1x_1(p_1)+t_2x_2(p_2))=0$$

Then by (A2) $Y'(y)=q_2(x,y)$. ||

Proof of Proposition 3:

In this case $m_1= m_3= 1$ and $m_2=0$. Hence by (A1):

$$P-c+q_1 = \frac{-x_2(p_2)}{x_1'(p_1)+x_2'(p_2)} > 0.$$

and:

$$\Gamma= m_3\frac{x_1(p_1)x_2(p_2)}{x_1'(p_1)+x_2'(p_2)}\left(\frac{x_2'(p_2)}{x_2(p_2)}\right) \quad >0.$$

(i) Rearranging yields $P = c - q_1 - \frac{x_2(p_2)}{x_1'(p_1)+x_2'(p_2)} > c- q_1$.

(ii) As $\Gamma>0$, then the LHS of (A7) is negative (positive) if $t_1< (>)\ t_2$, and hence infrastructure is downwardly (upwardly) distorted

(iii) By (A4) $\mu > 0$ as $P-c+q_1>0$. Hence no queuing occurs.

Proof of Proposition 4:

(i) From (A1):

$$P-c+q_1=\frac{(1-m_3)[x_1(p_1) + x_2(p_2)]}{x_1'(p_1)+x_2'(p_2)} < 0.$$

Hence $P < c - q_1$

(ii) From (A3):

$$\Gamma=\frac{(1-m_3)x_1(p_1)x_2(p_2)}{x_1'(p_1)+x_2'(p_2)}\left(\frac{x_1'(p_1)}{x_1(p_1)} - \frac{x_2'(p_2)}{x_2(p_2)}\right) = \frac{(1-m_3)x_1(p_1)x_2(p_2)}{(x_1(p_1)+x_2(p_2))\varepsilon^x}\,(\varepsilon_1^x-\varepsilon_2^x)$$

Thus $\Gamma >$ (=,<) 0 if $\varepsilon_2^x <(=,>) \varepsilon_1^x$. Thus by (A2) when $t_1 < t_2$ infrastructure is downwadly (un-, upwardly) distorted if $\varepsilon_2^x <(=,>) \varepsilon_1^x$.

(iii) From (A5) it is a necessary condition that $\varepsilon_2^x < \varepsilon_1^x$.

<u>Proof of Proposition 5.</u>

In this case $m_1 = m_2 = 0$ and $m_3 = 1$.

$$P - c + q_1 = \frac{P}{\varepsilon_x} > 0$$

(i) From (A5) then, in this case, $\mu > 0$ and there is thus no queuing.

(ii) Further:

$$\Gamma = \frac{x_1(p_1)x_2(p_2)}{x_1'(p_1)+x_2'(p_2)}\left(\frac{x_2'(p_2)}{x_2(p_2)} - \frac{x_1'(p_1)}{x_1(p_1)}\right) = \frac{x_1(p_1)x_2(p_2)}{(x_1(p_1)+x_2(p_2))\varepsilon^x}(\varepsilon_2^x - \varepsilon_1^x)$$

Thus $\Gamma >$ (=,<) 0 if $\varepsilon_2^x >(=,<) \varepsilon_1^x$ ||

<u>Proof of Proposition 6.</u>

Suppose management charges type i customers price P_i. In this case (1) is modified so that:

$$p_i(P,a,y) = P_i + a_i w_i + a w_i - t_i y$$

The Lagrangian for management's optimisation problem is:

$$L = m_1 v_1(p_1) + m_2 v_2(p_2) + m_3\{(P_1 - c)x_1(p_1) + (P_2 - c)x_2(p_2) - Y(y) + q(x,y)\} + \mu a$$

where $\mu \geq 0$ is the Lagrange multipliers. The Kuhn Tucker conditions yield the first order condition for the price charge type i users:

$$\partial L \partial P_i = -m_i x_i(p_i) + m_3\{x_1(p_1) + (P_i - c + q_1)x_i'(p_i)\}$$

$$\partial L \partial P_i = 0 \Rightarrow \; m_3(P_i\text{-}c + q_1) = \frac{(m_i\text{-}m_3)x_i(p_i)}{x_i'(p_i)} \qquad \text{(A9)}$$

The first order condition for infrastructure is:

$$\partial L \partial y = m_1 t_1 x_1(p_1) + m_2 t_2 x_2(p_2) + m_3\{(P_1\text{-}c)t_1 x_1'(p_1) + (P_2\text{-}c)t_2 x_2'(p_2) - Y'(y)$$
$$+ q_1[t_1 x_1'(p_1) + t_2 x_2'(p_2)] + q_2\}$$

$$\partial L \partial y = 0 \Rightarrow$$

$$m_3\{Y'(y) - q_2 - t_1 x_1(p_1) - t_2 x_1(p_2)\}$$
$$= (m_1\text{-}m_3)t_1 x_1(p_1) + (m_2\text{-}m_3)t_2 x_1(p_2) + m_3(P_1\text{-}c + q_1)t_1 x_1'(p_1) + m_3(P_2\text{-}c + q_1)t_2 x_2'(p_2)$$

Substituting (A9) gives

$$Y'(y) = q_2(x,y) + t_1 x_1(p_1) + t_2 x_2(p_2)$$

Hence there is no distortion in infrastructure.

The first order condition for queuing is:

$$\partial L \partial a = -m_1 w_1 x_1(p_1) - m_2 w_2 x_2(p_2) + m_3(P_1\text{-}c + q_1)w_1 x_1'(p_1) + m_3(P_1\text{-}c + q_1)w_2 x_2'(p_2) + \mu$$

$$\partial L \partial a = 0 \Rightarrow$$

$$\mu = m_1 w_1 x_1(p_1) + m_2 w_2 x_2(p_2) - m_3(P_1\text{-}c + q_1)w_1 x_1'(p_1) - m_3(P_1\text{-}c) + q_1)w_2 x_2'(p_2) \text{(A4)}$$

Substituting (A9) gives:

$$\mu = m_3(w_1 x_1(p_1) + w_2 x_2(p_2)) > 0.$$

Hence no queuing occurs. ||

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