NRA

ECONOMIC APPRAISAL OF LOW FLOW ALLEVIATION

GUIDELINES ON DESK TOP ANALYSIS

DRAFT
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1. INTRODUCTION

1.1 Background

These guidelines have been drafted at the request of regional Water Resource Managers to assist in preparation of cost-benefit analyses of proposed low flow alleviation schemes. The aim of these guidelines is to assist in the preparation of desk-top studies, which may then provide the basis of formal project submissions or for commissioning field studies (e.g. a contingent valuation survey) should the desk study indicate the results of further studies are critical to decision making.

The guidelines draw upon a range of documents which should be available to NRA staff. These include:

- the *Economic Appraisal Manual* released in May 1993;
- the cost-benefit analysis prepared for the River Darent; and
- the study carried out for Head Office on *Evaluation of Use Values from Alleviation of Low Flows.*

In addition, throughout these guidelines recommendations are given, where appropriate, on other references which may be of use (if staff experience difficulties in obtaining these references please contact Meg Postle). It is also recommended that those unfamiliar with the preparation of economic appraisals for formal submission to the Department of Environment should refer to the Treasury Guidelines on *Economic Appraisal in Central Government* (HM Treasury, 1991).

Should users of these guidelines experience difficulty with the economic terminology used, the glossary provided in the NRA *Economic Appraisal Manual* should be of assistance.

Note that throughout the guidelines example sets of calculations are provided to illustrate the approaches discussed in Sections 2 to 7.

1.2 Potential Costs and Benefits

For any project involving changes in river flows there are a range of potential costs and benefits which should be considered. These include those under the following categories:

- **Private Sector Effects:** impacts on availability of water for potable water supplies or industrial water supplies;
- **Agriculture:** impacts on yields/productivity or on costs of water supply provision;
- **Commercial Fisheries:** impacts on operating costs and on frequency/size of fish kills;

- **Recreational Fisheries:** impacts on the value of the riparian rights associated with both coarse and game angling and impacts on the enjoyment experienced by anglers from an angling day;

- **Informal Out-of-Stream Recreation:** impacts on the enjoyment experienced by those walking along rivers or partaking in other activities such as photography, birdwatching, etc.;

- **In-stream Recreation:** impacts on the level of, or enjoyment of, activities associated with boating, canoeing, etc.;

- **Amenity:** impacts on property values as a result of improvements in the river environment;

- **Ecosystem/Conservation:** impacts on the ecosystem value of the river; and

- **Non-use related benefits:** benefits associated with individuals' desires to conserve and preserve river environments even though they are not direct users.

The impacts listed above under the various headings will vary in importance for different river systems. **In many cases, detailed consideration of only one or two of these impacts may be warranted.** For completeness, all potential impacts should be considered prior to dismissing them as not applicable or insignificant.

1.3 General Issues

Net National Benefit

An economic appraisal should estimate net national costs and benefits (i.e. the costs and benefits to the nation as a whole). It should therefore include the costs borne by bodies other than the NRA, such as the water companies, English Nature, Wildlife Trusts and the European Union (e.g as part of LIFE funding). Although it can be informative to examine NRA's costs in isolation from the costs of others, the appraisal should not be restricted to this.

Definition of Options

The approach which has been adopted to date concerning the definition of ALF options is to first define a minimum environmentally acceptable flow regime and then to develop engineering measures to meet this regime. It should be noted that this approach was questioned by the DoE on the River Darent. The DoE argued that this approach did not conform to the guidelines set out by Treasury regarding the use of CBA. Instead, potential engineering solutions should be identified, their impact on flows determined and the environmental benefits associated with incremental increases in flow predicted. The analysis should start, therefore, at a different point than that set using a minimum flow criterion.

When is a Benefit a Benefit?

Although the preceding section indicated that it is important to be comprehensive in the coverage of potential costs and benefits, it is equally important that there is real justification for claiming that a certain type of benefit would occur. For example, no benefits should be claimed with regard to the creation or improvement of a fishery,

unless the other factors required by fisheries (such as a suitable habitat, no downstream obstacles, etc.) are also met.

It is also important to ensure that in estimating recreation benefits (angling, informal, boating, etc.), those benefits relate to either creation of a new opportunity for which there is a demand or significant improvements in the enjoyment gained from current activities. If a "new" recreational resource is being created, care must be taken to ensure that those predicted to visit the site are not just transferring existing visits from another site. Should the latter be the case, then the benefits associated with the new site are only the savings in travel costs and any increases in enjoyment due to the characteristics or higher quality of the "new" site. This point is picked up again in the relevant sections below.

Standard Values

The guidance given below relies on the use of values developed in field research for other river sites, or indeed appraisal purposes. The process involving the use of such values is known as "benefit transfer" in economics jargon. There is currently some debate about the validity and feasibility of benefit transfer approaches in the UK due to the limited set of existing valuation studies. By way of example, there are only two studies providing data on the informal recreation benefits directly associated with low flow alleviation. Similarly, valuation of recreational fisheries relies on a limited number of studies, most of which were undertaken 10 years ago or more.

For this reason, it may be necessary to undertake some field study work for projects which would involve significant levels of capital or revenue expenditure.

Participation Rates

The use of standard values also requires information on user numbers or participation rates. There are a number of ways in which this information can be developed. The most reliable method is through discussions with relevant organisations, club secretaries, etc. There are also some formulae which can be used to predict visitor numbers. These are outlined below in the sections on recreational fisheries and recreation.

Assumptions made concerning visitor numbers/participation rates can be critical to the appraisal. Experience indicates that appraisals are generally more sensitive to these assumptions than to those concerning the value of a visitor or recreational day. It will be important, therefore, to carry out sensitivity analysis on these assumptions. At the simplest level, this may mean assuming only 50% of the rates predicted by a given formula. Similarly, the number of visitor days required for a project to break even (i.e. the point where the value of benefits equals costs) can be compared to those indicated by the formulae or by more reliable information (such as that provided by angling club secretaries).

Use versus Non-Use

To date, very few studies have attempted to estimate the non-use values associated with changes in the water environment. The only means of developing non-use estimates is through the use of contingent valuation methods (and more recently contingent ranking or conjoint analysis), and indeed there remain questions over what is actually being valued and individuals' ability to respond to such questions in a meaningful manner.

The only low flow study which was specifically designed to estimated such values was that carried out for the River Darent. Only a portion of those sampled in the Head Office study (Middlesex University (1994) - NRA R&D Note 258) were asked about non-use. Thus, the values quoted below will need to be treated with caution.

In addition, the reliance of non-use values as a key component of a cost-benefit analysis (CBA) may not be acceptable to the DoE or others. In the case of the River Darent, the NRA did not need to rely upon non-use values in providing justification for the scheme. Use values alone were more than double engineering cost estimates. With regard to the water environment, there are no decisions which set a precedent concerning government acceptance of directly estimated non-use values.

Frequency of Effects

Low flow problems are likely to be intermittent, occurring say once in every three, five or ten years. As a result, the change in frequency of effect will need to be taken into account in the appraisal (except where otherwise stated).

The approach which should be adopted in accounting for frequency is as follows:

The annual benefits of low flow alleviation for a Effect A, Option B are £1,000:

- Current risk of low flow problem: 1 year in 5 = 0.20
- Risk of low flow after alleviation: 1 year in 100 = 0.01

Annual value of benefits £k = (£1,000 x 0.20) - (£1,000 x 0.01) = £190.

Note that different options may well have different implications in terms of the frequency of low flow in the future. For example in comparison to Option B described above, Option A changes the frequency of such events from once in every 5 years to once in every 15, at a much lower cost than the works associated with Option B. These differences may be important to the end comparison of options.

2. PRIVATE SECTOR EFFECTS

Although unlikely, low flow alleviation may allow small abstractors (e.g. domestic supplies or small industry) with existing but unused licences to reinstate their use of river flows as opposed to mains supplies. This may result from changes in either river flows or in the quality of flows where alleviation works would provide significant quality improvements.

The NRA's *Economic Appraisal Manual* (Chapter 4.2) reviews the approach which should be adopted in assessing the benefits associated with changes in supply source. To summarise, the approach involves determining the change in per unit costs of supply multiplied by annual consumption.

3. AGRICULTURE

Improvements in river flows may lead to two general categories of benefit to the agricultural sector: the ability to use river (or groundwater) flows for abstraction purposes; and changes in yields due to increased irrigation and/or improvements in water quality.

Again, valuation of these types of changes is discussed in the NRA's *Economic Appraisal Manual* (Chapter 5). Other useful references include Rees et al (1992), Murphy (1992) and the annually updated *Farm Management Pocketbook* by Nix.

In estimating benefits associated with increased crop yields, care must be taken for crops which are affected by EU or other quotas, such as those set by the Potato Marketing Board.

4. FISHERIES

4.1 Commercial Fisheries

Commercial fisheries are separated here from recreational fisheries due to the differences in approaches used in valuing costs and benefits. There are two different types of impacts on commercial fisheries which merit consideration with regard to flow alleviation:

- impacts on commercial trout farms and ornamental fish farms; and
- reductions in fish kills either due to the maintenance of flow levels or increased dilution and thus reduced effects of poor water quality, including those related to saline intrusion, etc.

Again, the NRA *Economic Appraisal Manual* (Chapter 6) discusses valuation of these types of effects. Other useful references not quoted in this Chapter include the work undertaken by the University of Portsmouth on trout farming in the UK (Varley, 1986a and 1986b).

4.2 Recreational Fisheries

4.2.1 *Introduction*

There are three types of benefits which might arise from increases in river flows related to recreational fisheries:

- **Restocking Costs:** improved annual flows may result in a reduction in the number of reduced fish kills in a river; where NRA policy (or that of a fishery manager) is to restock following such kills, the costs of restocking represent the economic value of damages;
- **Economic Rent**: this is simply the returns earned by the owner of the riparian rights to a fishery minus any management costs;
- **Consumer Surplus:** anglers will enjoy benefits above what they pay on club, permit and licence fees; these benefits relate to what economists' call consumer surplus and can be measured through travel cost and contingent valuation techniques.

Estimation of restocking costs is discussed in Chapter 6 of the *Economic Appraisal Manual.*

The approaches which can be used for assessing economic rent and consumer surplus are described below. With regard to consumer surplus, in particular, it is important to

distinguish between the creation of "new" opportunities and the creation of a new site which will only result in existing anglers switching the location of their activity.

Creation of a "new" opportunity corresponds to meeting currently unmet demands for angling. This may occur where there are waiting lists for angling clubs which would be reduced or a shortage of sites in a given area. In such cases, benefits will correspond to the full value of consumer surplus per angler day.

In other cases, there may be a number of close substitute sites to the river in question. As a result, although new anglers may not be entering into the activity, existing anglers may shift their place of activity. In these cases, the benefits are not the full value of consumer surplus per angler day, but the change in the travel costs incurred by anglers.

The approaches which should be used in valuing both "new" opportunities and transfer of activities from one site to another are described below in Section 4.2.5, while Sections 4.2.2 to 4.2.4 first present the standard values available for use in desk top analyses.

4.2.2 *Coarse Fisheries*

Economic Rent

There has been no formal work concerning the capital value of coarse fisheries. On a project-by-project basis, where creation of a new fishery might occur average lease values or day ticket sales may provide a means of estimating benefits to the riparian owners (see also the discussion on trout fisheries below).

Consumer Surplus

There are two studies relevant to the valuation of the impacts of low flow alleviation on coarse angling. It should be noted that these values are applicable only in cases where a new fishery would be created. They cannot be used to estimate the benefits associated with higher quality coarse fisheries - unless such improvements lead to the creation of new opportunities.

One of the earliest studies on coarse angling was undertaken by Stabler and Ash (1977 and 1978) for the canal network. Their work involved a survey of 137 anglers on a number of canals and at a number of sites. The study found that the average angler's travel costs were £20.54 per year (1974 prices) with the average angler making 23 canal visits (of a day) per year (30 angling trips in total to canal, river and lake sites). On this basis, the estimated value per angler day in 1994 prices is about £4.65.[1]

The other relevant study is the ALF study carried out by Middlesex University (1994). Angler's were surveyed to determine their willingness to pay for the reinstatement of fisheries in the Misbourne and Ver as a result of low flow alleviation works. The surveys were undertaken at fishing tackle shops located within a 20 mile radius of either river, with a total of 371 anglers being interviewed. The study found that anglers' willingness to pay ranged from a mean of about £5.00 to £8.80 per visit depending upon the river.

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1 This is based on direct travel costs of £8.00 and valuation of time at £12.54 where the latter was estimated from 25% of national earnings. Note that Green et al (1992) have quoted a value of £6.20 on the basis of this study, but it is not clear from reference to the original work how this higher value was derived.

The lower bid values correspond to a rural river, while the higher values relate to a river in an urban setting.

In terms of their use in a desk top study, it is recommended that the range represented here is used for the purposes of sensitivity analysis as follows:

- Rural river: £4.65 as a lower bound; £5.00 as the upper bound;
- Urban river: £4.65 as the lower bound; £8.80 as the upper bound.

4.2.3 *Trout Fisheries*

Economic Rent

For their study on the costs and benefits of reduced acid deposition, ECOTEC (1993) reviewed information on the permit or site licence fees paid by anglers for different trout fishing beats. This approach allowed them to develop average cost per day figures for different types of waters. The average costs estimates are as follows:

- £11.30 for stocked waters;
- £4.10 for wild fisheries in upland waters; and
- £10.20 for wild fisheries in lowland rivers.

These estimates provide a means of estimating the economic rent to the riparian fishery owner from the creation of a "new" trout fishery through ALF. But, these values should be used cautiously. If site or area/region specific values are available these should be used in preference. Note, as for consumer surplus, calculation of rent based on these figures requires prediction of participation rates.

Consumer Surplus

The survey work carried out by ECOTEC (1993a) also indicated that anglers maximum willingness to pay for a days fishing was typically about 50% greater than the mean cost of a fishing day. On this basis, they concluded that the gross economic value of a recreational trout fishery was about 150% of the total market value. Applying these percentage figures to the above average cost figures, indicates that consumer surplus ranges from about £2.05 to £5.65 per day. These values are significantly lower than the earlier estimates derived by Smith and Kavanagh (1969).

Smith and Kavanagh (1969) used a zonal travel cost method (TCM) to estimate the value of trout fishing at Grafton Water in Huntingdonshire. The study was undertaken soon after fishing was first permitted at the reservoir in 1966. Good visit data were available as every angler was required to enter address details in a visitors book. Anglers were required to pay £1 for a permit to fish at the reservoir with 21,143 doing so in 1967. The overall recreational benefits consisted of two elements, the charges actually paid (£21,143) and the travel costs (£18,801)[2]. For 1967, the overall benefits were found to be £39,944 or £1.89 per angler day. This corresponds to a value of about £13.90 in 1994 prices.

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2 Travel costs were calculated from running costs estimated by the Automobile Association. At around 4d per mile these can be said to equal average cost estimates. Lower bound estimates are petrol only costs (2d per mile) and upper bound estimates include depreciation costs (10d per mile). The valuation of travel time is not included.

Given the range in values found by these two studies, it is recommended that the ECOTEC results (£2.00 - £ 5.65) are used as a lower bound to benefits, while the Smith and Kavanagh results are used as an upper bound.

Again, these values can only be used as part of benefit transfer for valuation of the creation of a "new" fishery or for the creation of new opportunities in an area with an un-met demand.

4.2.4 *Salmon Fishing*

Economic Rent

An Economic Valuation of Salmon Fisheries in Great Britain (Radford et al, 1991) provides estimates of the economic rent associated with salmon fisheries. This study was able to adopt a more sophisticated approach toward the valuation of the economic rent. In this case, economic rent was calculated on a capitalised basis by consideration of the market value of fishing rights.

Only the "principle" salmon rivers (i.e. those with a mean annual reported salmon catch in excess of 30 fish) were considered and estimates of the market value of fishing rights were obtained from the owners of the rights via questionnaires. Data were also collected on five year average catches, the number of anglers, etc. The data were gathered in 1988/9 at which time anglers were required to obtain a licence from the NRA for the region in which they intended to fish and for the species which they intended to catch. This allowed region and species specific expenditure and participation data to be obtained.

Through this approach, the mean per capita fishery values (e.g. a once-off value accruing in the year at which the per unit increase occurs) across the (original) NRA regions with salmon fisheries were calculated. These figures are provided in Table 4(a). The average value across all regions was estimated at about £5,750 (1994) per additional fish.

Table 4(a): Mean per Capita Fishery Values in England and Wales (£ 1994)

NRA Region	No. of Records	Mean per Capita Value
Northumbrian	8	3,525
North West	25	4,920
Severn-Trent	4	695
Southern	2	10,310
South West	50	6,730
Welsh	83	5,900
Wessex	7	3,380
Yorkshire	1	10,160
All	180	5,750

In order to calculate the marginal change in the market value of fisheries for a change in the number of fish caught, a functional relationship was developed for all rivers[3]. This relationship considered a range of characteristics in addition to catch including the number of named pools, double or single bank rights, etc. The relationship indicated diminishing returns as it found that, all other things being equal, a 10% increase in the overall 5-year average salmon catch would result in a 5.5% increase in the capitalised economic rent.

Thus, in cases where it is predicted that increases in flow would lead to the creation of a salmon fishery, the above figures can be used to calculate the change in economic rent. The key problem in using this information is determining at what point the relationship concerning 10% catch increase: 5.5% value increase should come into force. It seems unrealistic for this to enter into the calculation of benefits at low catch rates, but further guidance from fisheries personnel will be needed to set an appropriate threshold. Once this threshold has been set, benefits should be calculated as follows:

- increases in catch < threshold valued at Regional mean per capita value as a lower/upper bound and at national average as an alternative value;
- for every 10% increase in catch > threshold, an increase in rent by 5.5% (for both the Regional mean and national average).

Remember that these values represent once-off increases in the value of the riparian rights. Thus for each additional fish caught, benefits to the owner should only enter the equation once.

Consumer Surplus

In an earlier study, Radford (1984) derived a value of about £14.80 (1994 prices) per angler per day for the benefits of salmon fishing. This estimate was derived through the application of the TCM to anglers on the River Wye in the Welsh Region. The 1991 study did not repeat this exercise; instead it draws on these results by concluding that consumer surplus is likely to be significant and be of the same order as estimates of economic rent.

As with the estimates presented above for coarse and trout angling, these estimates are only of assistance in valuing the creation of a new fishery or new opportunities as a result of changes in water quality.

4.2.5 *Valuation Approaches*

As discussed in Section 4.2.1, benefits will accrue to anglers from the creation of a new fishing site where:

- there is an unmet demand for angling (for example, due to a shortage of suitable angling sites or due to restricted club access); and/or

[3] It was possible to develop one functional form for all rivers as it was found that there were no statistically significant differences between the observed mean per capita values for each river (i.e. when expressed in terms of per fish caught, the mean market value of a fishery was comparable across all regions).

- the new site is closer than existing sites so resulting in a reduction in anglers' travel costs.

Unmet Demand

The valuation of the benefits associated with meeting a previously unsatisfied demand for angling requires:

- definition of the type of angling to be created (coarse, trout or salmon);
- an estimate of the level of unmet demand in terms of angler days per year; and
- valuation using the figures given in Sections 4.2.2 to 4.2.4 above.

Whether or not there is an unmet demand for angling can be established from discussions with local angling clubs. Where there is an unmet demand, the level of this demand may be estimated from the length of club waiting lists and data on the average number of angling trips per angler per year. Where local, site specific estimates of angling rates are not available, there are a range of estimates for the average number of trips made per annum per angler which can be used:

- 17-21 as a lower bound, 27 as a middle estimate and 46 as a high estimate of trips per coarse angler;

- 20 trips as a lower bound and 46 as an upper bound per trout angler per annum; and

- 22 as a lower bound and 30 as an upper bound for salmon anglers.

For example, consider a ALF scheme which will result in the creation of a new wild trout fishery in lowland waters in an area where the local angling club has a waiting list of 60 potential members each wishing to fish at least 20 times per year. On this basis, the associated angling benefits (from data presented in Section 4.2.3) will be:

•	Economic rent:	Lower	60 x 20 x 10.20 = £12,240 pa
		Upper	60 x 46 x 10.20 = £28,152 pa
•	Consumer surplus:	Lower	60 x 20 x £5.10 = £6,120 pa
		Upper	60 x 46 x £13.90 =£38,364 pa
•	Total:	Lower	£18,360 pa
		Upper	£66,516 pa

Reduction in Travel Costs

The benefits associated with the reduction in anglers' travel arising from the creation of a new angling site can be estimated from the following 8 step methodology which can be applied to coarse, trout or game fishing. The methodology is based on data presented in *Assessing the Benefits of River Water Quality Improvements*, a manual developed by the Foundation for Water Resources (FWR, 1994). Staff involved in water quality planning should have a copy of this document, but it should be noted that it is still an interim research document and as such has a few warts etc.

1. Mark the river stretch of concern (i.e. the new angling site) on a map of the area.

2. Identify the population within an 80km radius of this river stretch by superimposing the boundaries of local town and county council authority areas onto the map.

2. Identify all substitute sites within the 80km radius and any other important sites outside of this area and mark these on the map. Substitute sites are other water bodies (e.g. reservoirs, river stretches) which are currently used for the type of angling of concern (note that these must be accessible to anglers).

4. Establish the population of each authority area by reference to census data held by OPCS.

5. Estimate the numbers of anglers in each population area. It is likely that this will need to be estimated from a general figure for the proportion of coarse anglers within the NRA region as a whole which can be estimated from information on:

   - the population within each NRA region;
   - the number of anglers within each region (from data on current rod licences - although this may in reality be an underestimate); and
   - the proportion of anglers involved in coarse fishing (from old rod licence data which gave break downs of anglers by type).

   For example, it may be the case that:

   - the NRA region has a population of 5,800,000;
   - there are 350,000 rod licence holders; and
   - the old rod licence scheme suggests that 65% of anglers are involved in coarse fishing.

   On this basis, the proportion of coarse anglers within the NRA region as a whole (and within each population area) will be:

   $$(350{,}000 \times 0.65)/5{,}800{,}000 = 0.039\ (3.9\%)$$

   For simplicity, this angling population can be considered to be positioned at one point within each area. This is known as the "centre of gravity" of each area and relates to the largest concentration of population (e.g. the largest town) in the area.

6. Estimate the total number of angling trips per annum for each population area from data on the average number of angling trips per angler per year (use the values given above in the Section on valuing unmet angling demand).

7. Consider the availability and quality of angling in the area at present in order to make a judgement as to whether the new site will result in changes in travel costs. This requires consideration of the distance between population centres and angling sites and the data presented in Table 4(b). These give the percentage of angling trips which fall in particular distance bands and are based on data gathered by OPCS.

   Changes in travel costs can then be estimated for those cases where, for a given population centre, the new site falls into a distance band (length of trip in Table

4(b)) which does not have an existing substitute site or where the existing site is of poor quality.

Table 4(b): Proportion of Angling Trips by Distance	
Length of Trip (km)	**Percentage of Trips**
<16	35.2%
16 - 32	17.2%
32 - 48	9.4%
48 - 64	7.3%
64 - 80	7.1%
> 80	23.7%

8. Savings in travel costs per angling trip are estimated from considering the reduction in distance travelled (i.e. the difference between the travel distance to the nearest substitute site and the new site) and the value of that reduction as given by the information presented in Table 4(c)[4]. Table 4(c) gives the value of travel time (in terms of pence per minute) for a number of different income groups[5]. The income of a given population may be available from OPCS data, however, where this is not known then the middle range (£15,500 to £23,300) should be used as this corresponds to the "average" UK wage.

Table 4(c): Values of In-Vehicle Time (1994 prices)	
Income (£per annum)	**Car (pence/minute)**
<7,750	5.6
7.750 - 15,500	6.1
15,500 - 23,300	6.5
23,300 - 31,000	7.1
> 31,000	7.8

4 Values of in-vehicle time have been updated from 1985 prices and are taken from "The Value of Travel Time Savings" by The MVA Consultancy, Institute of Transport Studies University of Leeds and Transport Studies Unit University of Oxford, Policy Journals, 1987.

5 It should be noted that these values do not include travel costs such as petrol and vehicle depreciation (thus, they are conservative).

For example, consider a new angling site 10km from population A. There are no substitute sites within this distance band with the nearest angling site being 24km away. Population A has 200 coarse anglers each making 27 angling trips per year (5,400 trips for all anglers). On the basis of the information presented in Table 4(b), 35.2% of all trips (1,900) should be to sites within 16km of home. Assuming that at present, these 1,900 trips are made to the nearest alternative site, the reduction in travel costs will be the cost saving associated with travelling (24-10) 14km less to fish.

Assuming an average speed of 80km/hour (50 miles/hour), travelling 14km less will save 10.5 minutes each way (21 minutes per trip). Thus the reduction in travel costs for anglers in population A associated with the new site will be:

1,900 trips x 21 minutes x £0.065 = £2,593 per year.

Similar calculations should be performed for each population for which a reduction in travel costs can be discerned.

5. RECREATION

5.1 Introduction

Improvements in river flows may, in some cases, benefit both in-stream (e.g. canoeing) and out-of-stream (walking, picnicking, etc.) recreational users. To date, however, economic valuation studies in the UK which are specific to river flows have focused on out-of-stream, or informal, recreation activities.

5.2 Canoeing

Canoeing benefits will arise from the alleviation of low flows if:

- the waterway is wide enough for canoeing to take place;
- the water is sufficiently deep; and
- canoeists can gain access to the river.

Discussions with the British Canoe Union (BC) have indicated that water needs to be between a third and a half a metre deep and that waterways need to be between 1.5 to 2 metres wide for unobstructed canoeing to take place.

As for fisheries, there are likely to be canoeing benefits associated with the alleviation of low flows if there is an unmet demand for canoeing (due to a shortage of suitable sites) and/or where the creation of a new site results in a reduction in travel costs for canoeists in the area. There are no studies which have estimated the economic benefits (in terms of economic rent and consumer surplus) associated with canoeing. Thus, it will only be possible to estimate benefits associated with reductions in travel costs.

If the waterway could be suitable for canoeing after the alleviation of low flows, then discussions with the local branch of the BC should be held to establish:

- the numbers of canoeists (in terms of visits per year) who may be attracted to the site; and

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Varley RL (1986b): *Economics of Trout Farming: Capital Costing Model*, Research Paper 22, CEMARE, University of Portsmouth.

- which sites are currently used for canoeing (in order to estimate the reduction in travel costs).

Then, the reduction in travel costs can be estimated as for angling (as described in Section 4.2.5 and using the values for time savings given in Table 4(c)).

It is important to note that there will be no canoeing benefits if there is no access to the waterway. BC have indicated that it is likely that shallower stretches of waterways (e.g. those affected by low flows) are likely to have no "proven" rights of access. Thus, for canoeing to take place, it will be necessary to establish rights of way or to come to some agreement over access with the landowner. Much of BC activity is associated with gaining access to canoeable waters and they will be able to advise on the probability of gaining access and how long this may take.

If it is not certain that there will be access to the waterway, the probability of gaining access may be taken into account to derive the canoeing benefits. For example, if the probability of gaining access is though to be 0.5 (50%), then the expected value of canoeing benefits (for entry in the analysis) will be 0.5 x the estimated level of benefits (derived from reductions in travel costs).

5.3 Informal Recreation

5.3.1 The River Darent and Head Office studies both used contingent valuation techniques to derive estimates of the value individuals' attach to the use benefit gained from the alleviation of low flows. In the river Darent study the more traditional approach of asking individuals their "willingness to pay" (WTP) was used. For the Head Office study, individuals were asked to indicate the "value of enjoyment" they would gain from flows being returned; however, this question was followed up in some cases by asking whether they would be willing to pay the amount they indicated as their value of enjoyment.

The results from these two studies are presented in 5.3.2 and 5.3.3 below. Section 5.4 presents details on determining numbers of residents and visitor rates for informal recreation.

5.3.2 *River Darent Study*

The River Darent study first asked respondents to indicate their willingness to pay for alleviation of low flows in all 40 priority rivers identified by the NRA. Respondents were asked to indicate their WTP to maintain flows in these rivers and then to increase flows in all 40 rivers. If respondents indicated a positive WTP for all 40 rivers, they were then asked to indicate WTP specifically for maintaining and increasing flows in the Darent. Total WTP was then taken to be the sum of the values for maintaining and increasing flows.

It is important to note the reasoning behind questions concerning first maintaining and then improving flows for the River Darent. At the time, Thames Water was only abstracting around 70% of its licensed amount and it was possible that should the "gentlemen's agreement" between NRA and Thames collapse, Thames could increase abstractions to 100%. Actions such as licence revocation would need to be considered in these cases. Hence, it was important to justify not just increasing flows, but also maintaining current levels.

The use values expressed by residents and visitors are given in Table 5(a). Because these values are for residents near and visitors to the Darent, the mean values estimated for the Darent can be taken as indicating the use-related benefits (informal recreation, amenity effects on property, etc.) associated with the Darent. The values expressed for maintaining and increasing flows in all 40 rivers, however, relate more to a total economic value concept as these bids are obviously likely to include valuations corresponding to non-use for the other 39 low flow rivers. As a result these are not considered further here, but are considered again in Section 6 on non-use.

Table 5(a): WTP Values for the River Darent (£ per household per annum)

Flow Change	Residents	Visitors
Maintaining flows in all 40 rivers	18.45	15.06
Increasing flows in all 40 rivers	12.32	9.76
Maintaining flows in the Darent	10.19	7.16
Increasing flows in the Darent	6.25	4.85

From the above table, it can be seen that the total WTP value assigned to maintaining and increasing flows in the Darent are £16.44 for residents and £12.01 for visitors. Of this total figure, less than half of the value is associated with increasing flows, the majority is related to ensuring flow conditions do not worsen. It is recommended that for most appraisals of other problems just the values associated with increasing flows are used in desk top analyses - unless of course some expenditure would be required to ensure that the current problem does not get worse. This approach may be considered to provide conservative estimates, but it also ensures that the previous values are not mis-used.

5.3.3 *Head Office Study*

The results from the Head Office study on value of enjoyment are given in Table 5(b). As can be seen from this table, the use values expressed by people are higher for a town or urban location which was the site of surveying for the Misbourne as compared to the Wey, where the surveys were undertaken in a more rural area.

Table 5(b): Head Office Use Values

User Group	Value of Enjoyment (£ per adult per visit)		Willingness to Pay (£ per household per annum)	
	Misbourne	Wey	Misbourne	Wey
Resident	4.23	2.78	5.34	5.92
"New" Residents	5.35	3.08	N/A	N/A
Visitor	4.69	N/A	N/A	N/A

The difference in value of enjoyment and willingness to pay (WTP) values is also evident given that the former are per visit values while the latter are per annum values; although it should be noted that the WTP estimates were derived by comparing the WTP values expressed by those visiting rivers as compared to those who did not visit rivers (with the latter group's valuation considered to represent non-use benefits). It is also important to note that the WTP values found by this study are similar in magnitude to those found in the Darent study for increasing flows.

5.3.4 *Upper and Lower Recreation Values*

As has been recommended for fisheries, the values from the Head Office study and the Darent study should be used together to provide upper and lower bounds. It is left to the judgement of those preparing the appraisals as to the whether only WTP values are used, or whether value of enjoyment figures are used to provide an upper estimate and WTP a lower estimate.

It is important, that at least one set of calculations are prepared using the WTP estimates. This recommendation arises from concern that in answering questions about value of enjoyment, benefits were not linked to the need to pay. The willingness to pay questions on the other hand asked "would you as an individual be prepared to pay extra to ensure that the average flow of water in the River Misbourne " is improved. In this context, it is important to note that only 50% of users were prepared to pay extra for improvements on the Misbourne, with 49% expressing a willingness to pay for the River Wey.

The value of enjoyment figures are per adult per visit to the river; while the willingness to pay values given above represent mean values per household per annum. As will be seen from the following calculations, these different units of measure imply significantly different results:

- the proportion of adults in the catchment (2 kms from river) who visit the river is 40%;
- adults per house (given) are estimated at 1.94;
- number of houses (from census data) is 10,000; and
- the visit rate is estimated at 30 times per annum.

On this basis, the estimated benefits for residents would be as follows based on the two different sets of mean benefit values:

- Misbourne: Value of enjoyment (388,000 visits x 4.23) =£1,641,240 pa
  Willingness to pay (10,000 x £5.34) = £53,400 pa

- Wey: Value of enjoyment (388,000 visits x 2.78) = £1,078,640 pa
  Willingness to pay (10,000 x £5.92) = £59,200 pa

To these values would then be added estimates for "new" and existing visitors.

5.4 Participation Rates

5.4.1 *Residents*

In general, most CVM studies assume that residents are those who live within a 2-4 km zone of the river (give or take characteristics of the river catchment such as ease of access). Thus in estimating the benefits of low flow alleviation to residents using the above WTP or value of enjoyment figures, populations within this zone should provide the basis for calculations.

The WTP values given above are the mean values across all households within the 2-4km zone. Thus the aggregate value of per annum benefits to residents is found by determining the relevant number of households and multiplying this figure by the above WTP figures.

Use of the value of enjoyment figures is more complex. In this case, assumptions need to be made on the proportion of adults in the catchment who visit the river, the number of adults per household, number of households and the visit rate per adult (as illustrated in the calculations provided in Section 5.3.4 above). For the rivers Misbourne and Wey, the Head Office study found the following on the basis of survey responses:

	Misbourne	Wey
Proportion who visit	50%	58%
Adults per household	1.94	1.94
Current visit rate	66 pa	76 pa

In addition, attempts were made to predict how visit rates would change with low flow alleviation. This involved calculating the number of additional visits which would occur by those who currently visited and by those who do not currently visit. The relevant rates are as follows:

	Misbourne	Wey
Current visitors:		
- % who would increase visits	45%	43%
- additional number of visits	12 pa	15 pa
New visitors:		
- % who would visit with ALF	77%	36%
- additional number of visits	12 pa	15 pa

5.4.2 *Visitors*

To the above estimates of benefits to residents or local visitors to sites must be added the benefits to non-local visitors. Estimates of non-local visitor numbers are generally developed as part of the survey work undertaken as part of a CVM study. In such cases estimates are based on the responses of those surveyed together with any data on actual numbers counted over a certain period of time.

On the basis of past research, Middlesex developed a standard formula on average participation rate figures to use in estimating the number of informal recreation visits to two types of river corridor recreational sites known as "local parks" and "honey pot" sites. The basic methodology and relationships are outlined below. For further discussion see Chapter 7.8 of the *Economic Appraisal Manual.*

Within this approach, estimates are based on the numbers of people living within visiting distance of the site and a standard visit rate (given in Table 5(c)).

The methodology involves the following three steps:

- decide whether the site is a local park or a honey pot site;
- determine the number of adults living within the visiting distance (e.g. from data on electoral wards available from the Office of Population Censuses and Surveys - OPCS); and
- calculate the total number of adult visits per year.

Table 5(c): Participation Rates for Informal Recreation Visits

Site	Visit Distance Radius from Site	Adult Visits per annum	Site Characteristics
Local Park	500m-800m	upper: 27.6 lower: 15.1	Visitors travel by foot, use restricted to informal recreation (such as dog walking or taking children out to play). Most riverside walks or paths will be in this category.
Honeypot	3km	17	Areas (e.g. country parks) with some visits by car or public transport, uses include more planned activities. Sites >15 acres (excluding open playing fields) and those with car parks, visitor centres or similar facilities should be in this category.

For example, for a local park with 500 adults living within 800m, the lower and upper bound estimates of visits per year will be:

- lower bound: 500 x 15.1 = 7,550
- upper bound: 500 x 27.6 = 13,800

Similarly, for a honeypot site with 6,000 visitors living within 3km, the estimated number of visits per year will be 6,000 x 17 = 102,000.

Note that for local parks, average annual numbers of adult visitors are likely to range from between 10,000 to 30,000 per annum. For honeypot sites, the number of adult visits is normally in the range 60,000 to 250,000 per annum. Thus, estimates of visits in excess of 250,000 should be treated with caution unless backed by actual visitor counts.

6. NON-USE VALUES

6.1 As previously noted, both the study carried out on the River Darent and the work carried out for Head Office on the Misbourne, Wey and Ver estimated the non-use values associated with low flow alleviation.

Also of relevance here are the responses given to questions concerning low flow alleviation included in the Customer Surveys carried out by the water companies.

6.2 River Darent Study

Non-use values were derived through a survey of the general public within 60 km of the Darent, with the end estimates being as follows:

- a willingness to pay of £12.92 per household per annum for increased flows in all forty low flow rivers; and
- a willingness to pay of £3.00 per household per annum for increased flows in the Darent alone.

Not all respondents were able to give a figure specific to the Darent and indicated instead that the appropriate allocation between the Darent and the other 39 rivers should be determined by the NRA. Southern Region developed a simple approach to making this allocation on the basis of estimated capital costs of alleviation works. Estimates of the capital costs for 23 of the 40 rivers were available at the time, and the assumption was made that the distribution of non-use benefits across these rivers would be the same as the distribution of costs. Under this system, four of the ALF schemes (for the Darent, Piddle, Misbourne and Allen) represent almost 60% of the total costs of alleviation for all rivers under consideration. As their is little justification for assuming that projects with high capital costs will result in greater non-use benefits than ones with smaller capital costs, it is not proposed that this approach is adopted elsewhere.

6.3 Head Office Study

The following non-use values were derived:

- £10.47 per household per annum for the Misbourne;
- £7.28 per household per annum for the Wey; and
- £8.87 per household per annum mean value across the two rivers.

These values are greater than that derived for the Darent; it is in line, however with the overall non-use values expressed for increasing flows in all 40 rivers. These relatively high values may indicate that although non-use may be held towards improvements to all resource of a particular nature, a higher weighting is placed on those which are more local as opposed to those located in other parts of the country. Arguments along this line seem intuitively correct.

6.4 Water Company Customer Surveys

The customer surveys undertaken by water companies can sometimes be used to provide an indication of non-use values. For example, the survey undertaken by Bournemouth and West Hampshire Water indicated a mean willingness to pay of £2.75 per customer per annum for the alleviation of low river flows.

This value will include both use and non-use components, but for the purposes of desk-top studies could be considered to pertain more to non-use benefits than use related benefits as one might expect only a small proportion of those surveyed to actually visit or reside near rivers.

6.5 Summary

To be conservative, the following non-use values should be used in appraisals:

- Lower bound estimate: the value of £2.75 (or value specific to customers in the region if available) per water company customer in the region should be used to calculate a total budget for WTP for low flow alleviation. This budget can then be allocated between rivers in a region.

- Medium estimate: the value of £3.00 per household per year within a 60km radius of the river can be taken as a medium to high estimate for individual rivers, particularly where they are of higher profile.

- Upper bound estimate: the values associated with the Misbourne and Wey can be used as providing upper bounds; the value for the Misbourne should be considered as being more relevant to rivers running through towns/villages, while the Wey values apply to rivers of a more rural nature.