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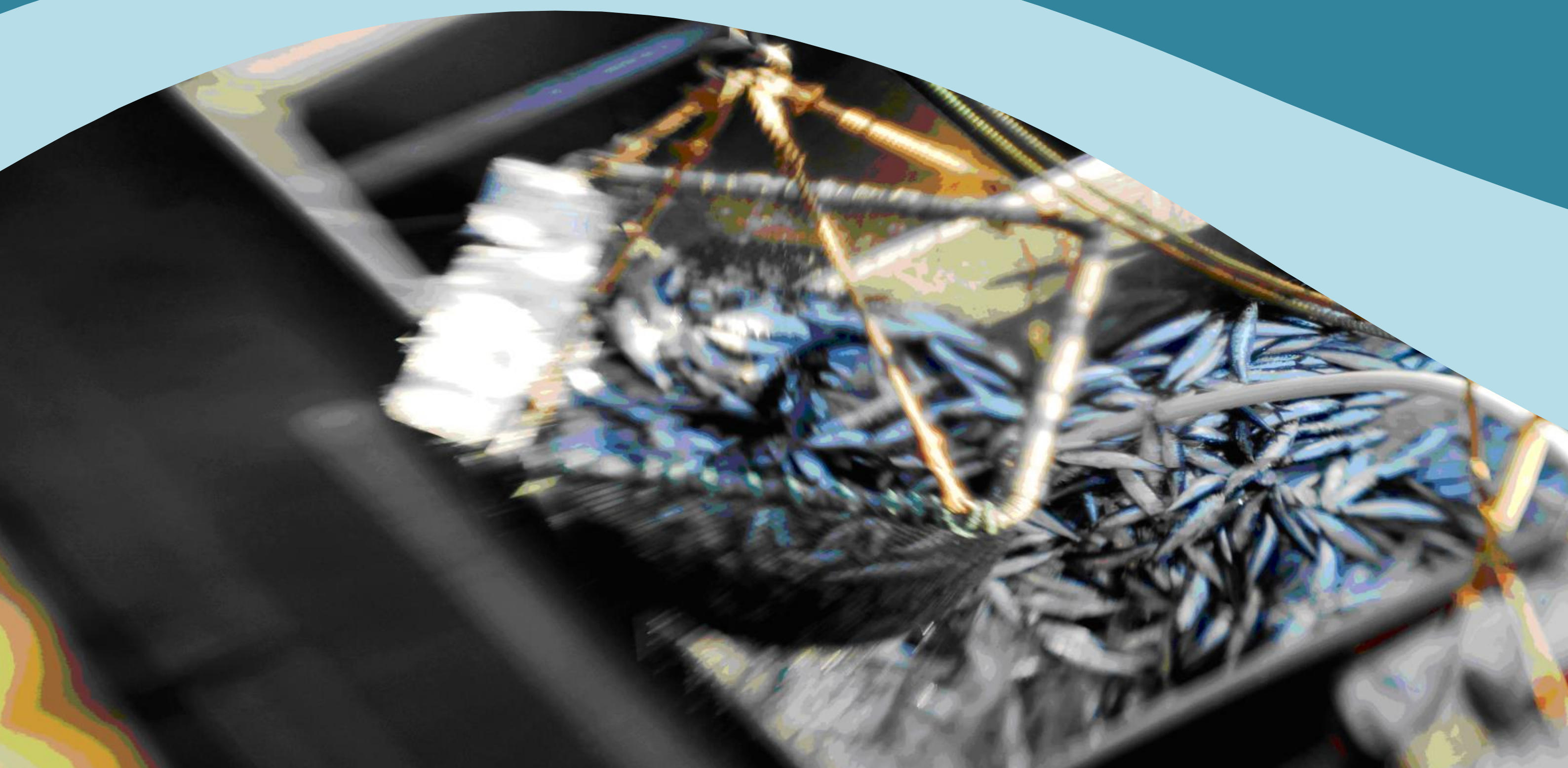
Comparing Industry Sector Values, With a Case Study of Commercial Fishing and Recreational Sea Angling



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For UKFEN, supported by Seafish, Defra and Marine Scotland.

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Executive Summary

This report seeks to identify, explain and summarise methods of assessing and comparing the contributions of different sectors to national and local economies. These methods are illustrated with a case study of commercial fishing and recreational sea angling.

Economics and political decision making are both concerned with the allocation of scarce resources among competing ends. In seeking to influence decision processes, stakeholders often turn to economics to build arguments about the relative values of different options for resource allocations. Two main analytical frameworks are common:

- Economic impact assessment (EIA) is a used to estimate changes in levels of economic activity within a specific area.
- Total economic value (TEV) is the foundation for human welfare-based assessments of value and the cost benefit analysis (CBA) framework.

The report explains in brief the different value judgements and analytical methods underpinning these frameworks. It stresses the importance of clearly establishing baselines and boundaries for any assessment, and the importance of comparing like with like whenever using assessments to compare different resource uses. In particular, it stresses that estimates made within the EIA framework are not comparable with estimates from the TEV framework.

Both frameworks look at impacts in different ways, with different assumptions, strengths and weaknesses. If the main interest is in effects on income and employment, then EIA is appropriate. If interest is rather in impacts on social welfare, TEV is appropriate. These are not mutually exclusive interests – decision makers and stakeholders may wish to consider both. Different sets of indicators measuring economic activity and welfare impacts should not be compared, but can both be useful in informing decisions.

The report then turns to the use of comparisons where there are decisions to make about allocations of scarce resources between competing sectors, using the example of the allocation of fish stocks between commercial fishing and recreational sea angling. The different components making up the TEV of commercial fishing and recreational angling are discussed. Evidence on the economic impacts and the TEV of these activities is reviewed.

The report emphasises that static comparisons of current relative ‘importance’ – whether in EIA or TEV terms – is not in itself particularly relevant for the policy question of how to change resource allocation to optimise values. Total value estimates provide an interesting snapshot of actual relative contributions to the economy. But common methods of EIA (based on Input Output analysis) make strong assumptions about fixed prices and technological coefficients that mean the results do not represent the likely consequences of significant changes in an activity. Similarly, comparisons of total TEV do not have any direct link to estimating optimal resource allocations.

Section 4 of the report turns to the general question of “Extracting best values from resources”, and explains the importance of the ‘equimarginal principle’: resource allocations are optimised (with respect to any chosen indicator, e.g. TEV) by equating the *marginal* values of competing uses. Comparing marginal value estimates reveals the possible consequences of slightly changing allocations – if one sector has higher marginal value, shifting allocation to that sector will increase total values. For more consequential changes, modelling is required to take account of how marginal values change. This requires research to estimate demand curves and associated elasticities: how activity levels and values change when allocations and conditions change, at the

margin. For the fisheries case, if some commercial stock / quota is shifted to recreational use, the key questions are:

- The marginal change in *participation* in recreational angling: do more people go fishing? And with what benefits and what expenditures?
- The marginal change in *benefits* (welfare) for existing participants: how much does their benefit per trip increase?
- The marginal change in activity, catches, costs and *profits* for commercial fishers.

One implication of this perspective is that we should not be contrasting commercial and recreational fishing as stark alternatives, but rather looking at the combined impacts, and considering the appropriate ways of managing these sectors together.

In summary, the key to proper comparison is simply comparing like with like. The key to *policy-relevant* comparison is to tailor analysis to policy contexts. The most important context is usually the allocation of scarce resources between competing ends. Research and analysis seeking to inform this question has to be targeted on the *changes* in values that would arise from *changes* in resource allocation. This calls for assessment of demand curves and elasticities that go beyond the evidence available from static assessments of current economic impacts or values.

1. Introduction

This report seeks to identify, explain and summarise methods of assessing and comparing the contributions of different sectors to national and local economies. These methods are illustrated with a case study of commercial fishing and recreational sea angling.

From time to time, policy makers and lobbyists make varying claims and comparisons about the importance to the economy of different sectors or different options for resource use – for example, the economic contribution of commercial fishing compared to recreational sea angling.

Often, these debates can be criticised for failing to compare like with like, or for discussions that confuse objective aspects of data quality and technical approaches with normative aspects of indicator and method choice, or the determination of temporal, spatial and economic boundaries for assessment.

Furthermore, comparisons of the total contributions of sectors, while interesting and widely used in advocacy, may not be particularly policy relevant. The fact that a sector makes a large (or small) total contribution does not in itself imply that more (or less) resources should be devoted to it. Resource allocation decisions can be better informed by consideration of the resulting *changes* in outcomes of interest – such as economic values, income, employment, social and environmental indicators – and this implies a focus on *marginal* values rather than totals.

Seafish, Defra and Marine Scotland have supported the development of this report by the UK Fisheries Economics Network (UKFEN) and eftec to explain and review industry valuation techniques for comparing sectors in terms of their total and marginal returns. The report has a general scope, and considers as a case study the comparison of values of commercial fishing and recreational angling. The report has been prepared through a literature review, followed by an expert technical workshop to discuss and agree content, report writing and peer review.

1.1 Objective and Scope

The study aimed to review and clarify the methods used to estimate the value of industry sectors to the wider economy, in particular, to:

- Identify, explain and summarise methods of assessing and comparing the contributions of different sectors to national and local economies, and
- Illustrate application of these methods with a case study of commercial fishing and recreational sea angling.

The objective is to improve readers' understanding of the methods used to assess and compare economic contributions to society. Key to this is the recognition that there are two principal analytical frameworks, each predicated on different value judgements that determine what parameters should be evaluated. It follows that the results from the application of one analytical framework cannot be compared directly with the results from another. Against that background, it is therefore crucial that users of economic evaluations fully understand the underlying value judgements and why particular parameters have been estimated. A failure to understand these foundations could result in logically incoherent discussion and misuse of economic evaluations.

1.2 Report structure

The report is structured as set out below:

Section 2: "Methods for comparing industry sectors" introduces the main analytical frameworks: economic impact and economic value. It stresses the importance of defining baselines for assessment. It explores the methods for assessing economic impacts, in particular input-output models and associated multipliers. It then moves to present the economic value framework, and methods by which economic value can be estimated. The section concludes by summarising and contrasting the analytical frameworks.

Section 3: "Case study of commercial fishing and recreational sea angling" first briefly reviews the commercial and recreational sea fishing sectors in the UK. Different approaches to assessing them are reviewed, along with the implications for comparing the sectors. The additional evidence required to inform policy is discussed.

Section 4: "Extracting best values from resources" extends from the previous one into the more general question of assessing competing resource uses, and how to derive most value to society from resource use, keeping a focus on fisheries.

Section 5: "Conclusions and recommendations" draws out the key messages from the review and case study.

2. Methods for Comparing Industry Sectors

Economics is founded on the principle that "scarcity implies choice" (Robbins, 1935): it is not possible to achieve all objectives simultaneously, so trade-off, whether implicit or explicit, is inevitable. Where there are alternative uses of resources, economics seeks to evaluate the impact of resource allocation decisions on human populations. This is challenging both because resource allocation decisions impact on the welfare of the human population in multidimensional and complex ways, and because measuring and projecting these changes is often difficult.

It follows that judgments have to be made about which of the many impacts on human populations matter most, and about how to estimate and evaluate these impacts. We may consider impacts on incomes, employment, the enjoyment of the environment, the value of capital assets and so on. We can also describe the impact of resource allocation initiatives in terms of the consequences for particular groups of humans, including populations of identifiable geographical areas at different scales (e.g. Whitby, Borough of Scarborough, North Yorkshire, England, the UK, the EU) and/or specific 'communities' of interest (e.g. commercial fishers, recreational anglers, the tourism industry). Similarly, assessments may focus more on present day and near future interests and impacts, or may take account of the long term impacts on future generations.

In other words, applied economics is an activity in which value judgements have to be made: any analysis has to choose **"what matters?", "to whom?", "over what period?" and "how is this measured?"** Economics embraces different analytical frameworks, each shaped by underlying value judgements that define the conceptual and spatial boundaries of an assessment and the appropriate indicators and measurements. Similarly, the application of each analytical framework may take a partial equilibrium approach, focusing on just one market, or a more complex general-equilibrium approach that recognises inter-sectoral interaction. Analyses can be comparative-static, focused on equilibrium states, or dynamic, allowing for different rates of adjustment and feedbacks.

This means that great care is required if comparing assessments of different sectors or resource uses. For such comparisons to be meaningful, it is essential to compare like with like. For them to inform policy and debate in a useful way, they need to match the value judgements, boundaries and concerns of policy makers and stakeholders. An appreciation of the different frameworks and associated value judgements is crucial to a better understanding of which measures can be logically compared or added together.

For economic evaluations to inform policy and debate in a useful way, the value judgements underpinning each analytical framework need to match the value judgements, boundaries and concerns of policy makers and stakeholders. In the remainder of this section, we review the two main analytical frameworks, the assumptions underpinning them, and their use for comparing different uses of resources.

2.1 Analytical frameworks for measuring economic changes

The ultimate aim of defining and measuring values is to include this information in the decision-making process. Particular areas where valuation can assist include, for example: the demonstration of the economic importance of a good or service; policy, programme and project appraisal; setting priorities within a sector plan or across different sectors; accounting; setting socially desirable levels for taxes, subsidies, permits and other instruments; and determining compensation when economic or environmental damages are caused.

There are two major analytical frameworks, each predicated on a different set of value judgements. The frameworks are **Economic Impact Assessment (EIA)**[1] and the **Total Economic Value (TEV)** framework. These are explored separately below.

- EIA is a quantitative method used to estimate the economic benefits that a particular project or industry brings to the area where the specific project or industry is located. It usually measures changes of output, gross value added (GVA), employment and tax revenues associated with changes in the level of economic activity resulting from the project or industry being analysed. It also measures changes in business revenue and profits, personal wages, and/or jobs. In general, economic impacts can be estimated at the direct, indirect and induced levels.
- TEV is the foundation for welfare-based assessments of value and the cost benefit analysis (CBA) framework. CBA is a widely used technique which is used to examine a policy or decision in terms of its consequences and costs and benefits. The aim of a CBA is to weigh up the costs and benefits of the policy to determine if the benefits outweigh the costs of the policy. The purpose of a CBA is to provide a consistent and transparent procedure for evaluating decisions in terms of their consequences.

Both approaches are quite different from financial appraisal, which is concerned with profitability of an investment and with cash-flow issues. EIA and TEV are concerned with measures of impacts to society. So the focus is different, and it may be necessary to carry out two or even three assessments: financial appraisal to check the cash flow associated with public investment is

[1] Not to be confused with government Impact Assessment, which is a comprehensive approach to policy evaluation that generally includes TEV assessment (cost benefit analysis) along with assessment of economic impacts and other such assessments as may be required (e.g. environmental impact assessment).

sufficient, EIA to assess impacts on local economic activity, and TEV to assess social desirability of the investment.

In both EIA and TEV, values can be presented in different ways: as totals, averages or marginal values; and as stock (asset) or flow (service) values.

- **Stock** concepts relate to the amount and/or value of a resource at a given point in time. This can be physical resource, or its monetary value – for example the tonnage of vessels making up a fishing fleet, or the monetary value of the vessels.
- **Flow** concepts are changes in the amount and/or value of a stock per unit of time, for example the annual depreciation on the stock of vessels. Using the sum of discounted values, annual financial flows over time can be converted to single capitalised ('stock') values;
- **Total value** Total value refers to the sum of all the flows of a good or service during a defined time period, or the entire value of a stock at a point in time.
- **Average value** is the per unit value, calculated by dividing the total by the physical quantity (e.g. area, mass, volume, households) – for example the average value per tonne;
- **Marginal value** is the additional value gained or lost by an incremental change in provision of a flow, or in the level of a stock – for example, the additional value from one additional fishing day. Marginal values may stay roughly the same over a modest range (elastic functions) or may change very rapidly (inelastic functions).

These categories can be applied both to monetary and physical units. A common characteristic of economics analytical frameworks is that, by and large, they use monetary units as a measuring rod. But they may also use the same economic variables (such as profit or market values) in slightly different ways. This can cause confusion for non-economists and can result in the inappropriate adding together or comparison of measures from different analytical frameworks. For example, estimates of total revenues might be compared with gross value added, but that would be inappropriate because GVA subtracts intermediate consumption ('costs') from total revenues. Or, estimates of market values might be compared with estimates of total economic value, but that would be inappropriate because TEV includes consumer surplus.

The frameworks differ in various ways, deriving from the different value judgements underpinning them. In particular, the welfare-basis for TEV means that consumer surplus is counted, whereas EIA focuses on exchange values that exclude consumer surplus. And they often have different boundaries (with TEV focusing on national or global welfare, and EIA often focused on a narrower region, leading to different assessments of baselines and of additionality and displacement. These factors are discussed in more detail below.

2.2 Defining the baseline

Any form of economic appraisal involves the comparison of different "states of the world" – the state of the world under 'baseline' or 'counterfactual' conditions (i.e. without the change(s) that are the subject of appraisal), and one or more states of the world with the change(s) or intervention(s) that lead(s) to different outcomes. This can apply to comparisons of total values of whole sectors (though such comparisons do not usually correspond to realistic policy options) as well as to rather more realistic assessments of marginal changes in resource use and access.

When considering comparisons across different uses of resources, one essential issue is to compare like with like. Establishing a consistent and appropriate baseline against which comparisons can be made is therefore a key step in providing an accurate assessment of changes in resource allocation.

The baseline has a variety of slightly different definitions, depending on the context in which it is used. HM Treasury in the Magenta Book defines the baseline as "the situation before the policy" is implemented (HM Treasury, 2011). The European Commission (EC, 2009) states that the aim of the baseline is "to explain how the current situation would evolve without additional public intervention – it is the 'no policy change' scenario" (EC, 2009). Defra (2010) focuses on the "change in the provision of the policy good" which is the difference between the level of provision without the decision being appraised (the 'baseline') and the level of provision with the project or policy. This change can be measured as a quantity change (e.g. an increase in fish catch) and/or a quality change (e.g. an improvement in average fish size), and may be described qualitatively or measured quantitatively. Whilst the three baselines appear to be similar, the EC and Defra are dynamic baselines which suggest that the economic evaluation needs to predict what would happen in the absence of the policy initiative. Thus the economic practioner might have to predict what the future would look like both with and without the policy. Since predicting the future is problematic, economic evaluations may develop a number of policy impact secenarios, such as optimistic and pessimistic outcomes. In some circumstances it may also be appropriate to also develop a number of dynamic baseline scenarios, and the simultaneous use of both baseline and policy impact scenarios can lead to quite complex evaluations.

A good baseline should have a strong factual basis and, as far as possible, be expressed in quantitative terms. It should also be set for an appropriate time horizon (neither too long to be practicable nor too short to cover all relevant impacts). The baseline projection has to provide a clear indication of how serious the problem is, or to what extent it would become more serious without immediate intervention, and whether there are irreversible consequences (EC, 2009).

However, the choice of counterfactual is not always clear-cut, and under some circumstances, prediction of the baseline scenario(s) can be as crucial and uncertain as the policy impact prediction(s). Changing conditions (such as social, economic, technological and climate changes) mean that the counterfactual is not simply a static 'status quo' scenario. Indeed, the choice of comparison case may depend on the specific question to be answered. It is not necessarily the 'most likely' alternative scenario in the absence of a specific policy intervention (though it often will be) and can in some cases be more of a 'baseline' than a realistic counterfactual. Many options can be identified: and some are easier to define and measure than others, and data requirements differ.

- "No activity": this may be appropriate for estimating the current total value of a sector. The counterfactual is a hypothetical situation where the entire sector instantaneously ceases to exist. Of course, this is almost always a quite unrealistic scenario, except at very local scales. In fact the question "*what is the total value of XXX?*" may be considered largely irrelevant for policy making. Economic evaluations are better able to inform current policy debates when they focus on relative or marginal changes rather than absolute values: the key indicator of value, price, reflects market equilibrium conditions, and can be very different, much higher and difficult to estimate for hypothetical very low levels of activity in a sector. However, because of the impressively large values often generated for, say, the number of jobs or profits currently supported by the sector, such figures are often used by stakeholders in advocating for more resources.
- "Status quo": this represents the most recent possible historical baseline, and one with substantial policy relevance, because policy options involve changes from current practices. Its main strength is that, in principle anyway, it can be directly measured. However it may be too static, ignoring technological and other changes and trends. Other historical baselines may be used (e.g. pre-industrial or pristine conditions) though these are generally used for environmental rather than economic concerns.

- "Business as usual": similar to "status quo", but a dynamic counterfactual, taking into account our best estimates of the likely evolution of activities in response to key drivers such as technological and climate change.
- "No active policy intervention": this is a baseline for policy analysis that considers hypothetical no-active-policy-intervention-from-now conditions. This does not imply "no activities", but rather an absence of active management. It can be hard to determine how activities would evolve in the absence of management interventions, though for unowned resources such as sea fisheries there is a good understanding of the consequences of completely open access.

In any particular case, additional considerations arise concerning the determination of system boundaries in space and time – essentially, all changes between the counterfactual and the scenario under analysis need to be taken into account, and we need guidelines to ensure the boundaries are set appropriately to allow for this.

This does not necessarily mean that the area under analysis should be extended to encompass all impacts. A local authority or tourist board, for example, may be entirely justified in limiting attention to impacts that occur within their areas of competence. A national authority might carry out assessment of the same change with different boundaries, leading to a different result. Again, the point is not that either approach is better than the other, but rather that different approaches are appropriate for different questions. Hence, when considering different analyses, it's important to check that like is being compared with like.

Similarly, the time horizon needs to be set in a manner appropriate to the questions at hand. Generally, decision makers are concerned with more than just the immediate impacts of decisions, and so assessment of resource allocation decisions with long-term or irreversible consequence call for long time horizons in the assessment. Questions relating to more easily reversible decisions, or comparisons of current flows of value, may reasonably focus on immediate or short-term impacts.

In economic appraisal, the use of discounting makes costs and benefits far in the future much less important than present costs and benefits. There is some debate concerning the appropriate use of discounting for ecosystem services, in particular for the far future; hyperbolic discounting (that is discounting, but at a declining rate) has been proposed. In the UK this is the official approach, with the discount rate dropping from 3.5% in years 1 to 30, to 3% in years 31 to 75 and 2.5% in years 76-125 (HM Treasury, 2003).

With a dynamic counterfactual, we need to account not only for current services and changes to them, but also future potential services and changes to them. For example, an area currently little-used for recreation may nonetheless have substantial future recreation value potential, if one or more of the following occur:

- Infrastructure is improved;
- Alternative recreation sites deteriorate;
- Site characteristics change;
- Local human population or population characteristics change, and
- Climate changes.

A study which (say) took into account the recreation improvements arising from the policy proposal, but failed to take into account possible recreation improvements in the baseline (that would happen anyway even without the policy), would risk overstating the benefits of the policy proposal. Thus a baseline should be defined in terms of how all the relevant factors are likely to be / change in the baseline, including but not limited to environmental, economic and social.

Unfortunately, some EIA do not explore baselines directly, but rather draw on estimates of expenditures without exploring the counterfactual. Where some part of the assumed changes would have occurred anyway, without the policy or intervention under consideration, this is termed "deadweight", and failure to account for it can result in values being overstated. A particular issue for the fisheries sector is baseline assumptions regarding stock dynamics: if in the baseline it is simply assumed that harvesting is sustainable, values of the baseline may be overestimated if in fact stocks are being depleted. This would result in underestimation of the value of stock-conserving policies (because a policy intervention which lowered harvesting levels would be even more imperative than anticipated by the baseline). Full consideration of counterfactuals can help to account for these potentially complex dynamic effects.

2.3 Economic Impact Assessment

The basis of EIA is an underlying judgement that "what matters" is the impact of policy on economic activity.[2] Economic impacts can be studied from monetary perspective, but also in real terms, notably in terms of employment, or sometimes in terms of resource and energy use. For any given case, 'economic impact' refers to changes in the level of economic activity that occur in an area as a result of a sector, project or policy. Changes in economic activity can be measured by a variety of indicators, including gross and net expenditure, value added (a measure of output), household incomes (aggregate wages and salaries), or employment (e.g. number of full-time equivalent jobs). These indicators are not independent, but represent different ways of looking at a change in activity - for example, both changes in employment and changes in income generated result from changes in expenditure on an activity, so they are not independent. In general, the primary focus of an EIA analysis is the consequences for:

- Income, usually measured by estimation of Gross Value Added; and/or
- Employment, usually measured in Full Time Job Equivalents.

An EIA has to be undertaken with reference to an identifiable constituency, and this is usually a geographical area. For many policy contexts the most relevant constituency is a whole country, but other constituencies are also common – assessments at the regional level, or for a specific administrative region or local community. It is important to remember that the results of an EIA analysis are sensitive to the constituency selected, so results from EIAs with different constituencies cannot be compared directly. For example, the creation of 200 jobs in Dumfries and Galloway (or Cornwall) does not necessarily imply there will be a 200 net increase in Scottish

[2] For further information on the system of national accounts, see http://unstats.un.org/unsd/nationalaccount/sna.asp For details in the UK context, see http://www.ons.gov.uk/ons/guide-method/method-quality/specific/economy/national-accounts/index.html For GVA at the regional level, see http://www.ons.gov.uk/ons/guide-method/method-quality/specific/economy/regional-accounts/index.html For EIA methods generally, see http://www.ons.gov.uk/ons/rel/regional-analysis/measuring-the-economic-impact-of-an-intervention-or-investment/measuring-the-economic-impact-of-an-intervention-or-investment/economic-impact--paper-one.pdf

(or English) employment. The benefits calculated for the specific constituency under analysis may in part be losses ('displacement') from elsewhere.

EIA recognises that the various sectors which make up the economy are interdependent. Changes in activity in one sector will have impacts on the sectors that support it through providing inputs. At the same time, changes in incomes will lead to changes in expenditures, with consequences for other sectors. So EIA covers three different levels of impact:

- Direct impacts related to the specific sector under analysis: for example, jobs and incomes in sea fishing;
- Indirect impacts related to other sectors supporting it: for example, incomes and jobs in fish processing, marketing, vessel maintenance and other sectors supporting sea fishing; and,
- Induced impacts that result from those involved in the sector spending their income within an area in the community: for example, incomes and jobs supported by fishing families' expenditures on goods and services.

These impacts are often estimated using multipliers derived from Input-Output analysis, discussed below. For most applications, use of published I-O tables and associated multipliers is likely to be the most practical solution.[3] General equilibrium modelling (see below) is more suited to large-scale macroeconomic analysis and less likely to be a suitable choice for comparisons of sectors. The methods are applicable wherever the question (or one of the questions) of interest is the impact on economic activity and employment, but they do not reveal anything directly about impacts on human welfare overall.

2.3.1 GDP and GVA

Gross domestic product (GDP) is a key indicator of the state of the whole economy, measuring the totality of the national income. GDP is theoretically the amount that is currently being paid to households in the form of wages, profits, rents and interest. Other things being equal, a higher GDP is preferred to a lower level because this would enhance our potential level of consumption of goods and services. If it can be measured, the GDP of a particular sector would be the contribution of that sector to the national / household income. Arguably, GDP itself is only important because it measures our income and therefore our nation's ability to consume now (or in the future, should we choose to save some of that income).

Three main approaches can be used to estimate GDP and therefore the national income (all of which are used, in order to give a more robust overall picture of the economy):

- The production approach to estimating GDP looks at the contribution of each economic unit by estimating the difference between value of an output (goods or services) and the value of purchased inputs used in that output's production process. This difference is Gross Value Added and is an approximation of the amount distributed by each unit to households in wages, profits,

[3] Guidance for the UK is provided by http://www.ons.gov.uk/ons/rel/regional-analysis/measuring-the-economic-impact-of-an-intervention-or-investment/measuring-the-economic-impact-of-an-intervention-or-investment/economic-impact--paper-two.pdf

rents and interest (though the government may appropriate parts of these flows before or after households actually receive these payments).

- The income approach to estimating GDP measures directly the incomes earned by individuals (e.g. wages, profits rents and interest).
- The expenditure approach to estimating GDP measures total expenditure on finished or final goods and services produced in the domestic economy. The expenditure on finished or final goods is equivalent to the sum Gross Value Added (i.e. household income) associated with the production of all goods (raw materials, intermediate and final goods)

There have been many critiques of GDP, including in recent years the Beyond GDP Conference (2007), EC Communication "GDP and beyond: Measuring progress in a changing world" (2009), Parliament Resolution (2011), and the Stiglitz/Sen/Fitoussi report (2009) on the measurement of economic performance and social progress. In the UK, ONS is developing well-being indicators.[4] Nevertheless, GDP and associated indicators remain the most widely used and recognised indicators of economic performance. Like EIA, they do not seek to represent social welfare or wellbeing, but limit attention to measures of national income. An alternative, welfare-focused approach to assessing changes in resource allocation is provided by the TEV framework, discussed further below in section 2.4.

In the UK, Input-Output Supply and Use Tables are used to reconcile these three different approaches (production, income and expenditure approaches) to measuring GDP, explaining any differences between the calculations by linking the inputs used, GVA and the outputs produced in a coherent overall framework (Akers & Clifton-Fearnside, 2008).

2.3.2 Input-Output analysis

Input-output (IO) analysis represents the interdependencies between industries in an economy.[5] It is a model of an economy where the transactions between each industry sector, the household sectors, and the economies outside the economy are summarised in a matrix (Ivanova and Rolfe, 2011). The coefficients in the matrix show the proportions of each industry's gross output that are attributable to inputs from other industries. The matrix provides a static and mechanistic overview of the relationships within an economy at a given point in time, giving insight into the value of economic transactions between different sectors in an economy, including outputs for exports, capital formation (investment) and final government and private consumption. Input-output tables can then be used to calculate the added value that each sector contributes to the final output of an economy.

The IO tables can therefore be used for industrial analyses and EIA consistent with the national accounts. This is generally carried out in terms of changes in GVA, or expenditure as a proxy for

[4] http://www.ons.gov.uk/ons/guide-method/user-guidance/well-being/index.html

[5] For further details and information on IO methods, and the selection and use of multipliers, see Miller, R. E., & Blair, P. D. (2009). Input-output analysis: foundations and extensions. Cambridge University Press. For use and data sources in the UK context, see http://www.ons.gov.uk/ons/guide-method/method-quality/specific/economy/input-output/articles-and-analyses/index.html and in particular the downloadable glossary and bibliography.

GVA, to assess the contribution to the economy of each industry or sector (ONS, 2015), in terms of direct impacts, direct and indirect impacts, or direct, indirect and induced impacts (see above).

The ONS regularly produces IO tables for the UK, and Eurostat produces tables for the EU. These tables are important in national accounting (see below) and can be used to carry out EIA. However, applying a national IO model would overstate the multiplier effects if the boundaries of the assessment are sub-national. This is because some part of the impacts of a change in the local economy will take place outside of the local economy. Input-output analysis can be modified for regional level by simple adjustment of coefficients using local employment data, if these data are available.

Monetary IO tables can be 'extended' with environment-related information for each sector, such as its emissions, primary (natural) resource use, land use and other external effects per sector. These environmental externalities may be expressed in monetary terms as well (EU and JRC, 2006). These methods are still under development (see for example http://creea.eu/ for details of the EXIOBASE model) along with a recent focus on extending the United Nations System of National Accounts to cover environmental and ecosystem accounting.

2.3.3 Multipliers for direct, indirect and induced impacts

Once direct impacts of (changes in) expenditure have been assessed, the indirect and induced impacts are generally estimated through use of multipliers derived from IO tables. The calculation of multipliers provides a useful tool in the form of an easy estimate of the wider economic impacts of a change (GHK, 2007). Multipliers can be derived for various indicators, including output, employment, and gross value added. Two main types are used:

- Type I multipliers cover direct and indirect effects only. This means they only estimate industrial impacts, thereby underestimating the total effect on the economy. But this avoids some unrealistic assumptions.
- Type II multipliers cover induced effects as well, thereby covering both industrial and consumption impacts. However, this requires the assumption that final consumers do not change their final consumption patterns in response to changes in income. ONS (2010) reports only Type I multipliers, partly because the assumption of no income effects is too unrealistic, and partly because suitable employment data are not available.

More generally, EIA based on IO models assumes that incomes and employment can increase as an outcome of expenditures without causing any wage or price increases. This is grounded in the assumption that previously unused or underused resources can be employed. This may be approximately correct for small changes in activities, or where resources are underused – in particular, where there is significant unemployment in the labour market. However the assumption is quite questionable for larger changes. An EIA will not give the full consequences of completely stopping an important activity in an area, for example, since this could lead to impacts that are not addressed in EIA – impacts on local wages and prices, for example, and people moving to other areas for work.

In practice, there are various reasons why multipliers based on IO models might give misleading results in any given case (Boardman et al, 2008, 124-5). Firstly, as the name suggests, multipliers estimate impacts as multiples of the direct impacts. Hence, any over-estimation of the direct impacts will result in over-estimation of the indirect and induced impacts.

Secondly, there are often transfers or displacement effects, where increased spending in one area simply displaces spending from another area. In effect this is a failure of the assumption about pools of unemployed resources – investment in tourism facilities, for example, will lead to greater tourist expenditure in an area, but only part of that will be truly additional, with the remainder being displaced from other tourist areas. This may or may not be relevant to a particular analysis, depending on the boundaries – specifically, are the areas from which expenditure is displaced inside or outside the boundaries of interest?

Thirdly, leakage effects may arise, whereby some part of the indirect and induced effects will occur outside the area of interest, with the goods and services required to support a sector being sourced from outside, and the incomes being spent outside, the boundaries. This also applies to enterprises that are owned largely or wholly by people outside the area, for example branches of large national or international industries that are listed on stock exchanges. Leakage is often expressed as a percentage of total impacts, based on averages from literature or on original research. Leakage does not mean that the impacts do not occur, just that they occur outside the area of interest – how important this is depends on the specific details of the analysis.

Finally, there can be second-order economic effects not represented in the fixed-price IO model that affect people living within the boundaries of the assessment. On the negative side, increased competition for space and goods can lead to increased prices and congestion. On the other hand, suppliers may be able to take advantage of economies of scale and reduce costs accordingly. So the net direction of these effects is unclear and depends on the specific case.

It should be noted that displacement and leakage both depend on the boundaries of assessment, in opposite ways. Thus if the area of assessment is small (a single tourist resort for example), there may be little concern about displacement (expenditure being displaced from other resorts is not an issue) but leakage may be very important (not only will resources be sourced from outside the town, but employees may live and spend their incomes in other areas). Conversely, for a regional or national level analysis, there may be relatively little concern about leakages (except for imports, but these are already identified in IO tables) but substantial displacement of economic activity.

For these reasons, use of multipliers from IO models has been controversial. Some have argued that they should not be used at all - that '*economic impact studies based on multipliers are quite clearly an improper tool for legislative decision-making*' (Hunter, 1988, p.16) – but multiplier-based analysis is widespread, and can be useful if carried out and interpreted carefully. It is clear that multipliers based on IO models give a relatively quick and straightforward method for estimating direct, indirect and induced economic impacts. It is also clear that these measures rest on some questionable assumptions, as well as depending on the quality of data used to produce them, and so should not be interpreted as precise estimates. Furthermore, the results of any assessment are crucially dependent on the choice of the boundaries – which areas/populations are considered relevant, and which are excluded – and multipliers estimated for one scale cannot simply be transferred for use at another scale. And it should always be kept in mind that EIA focuses only on economic impacts and employment, so other facets that should enter decision processes – environmental impacts, social justice and so on – might need to be considered alongside EIA results. Overall, results of EIA based on IO models should be interpreted with care, and should be seen as a means of simplifying complex information and relationships to support thinking about resource allocation decisions, and not as a form of hard-and-fast decision rule.

2.3.4 General equilibrium models

Partial equilibrium analysis of single markets makes the 'ceteris paribus' assumption that 'all else remains equal' – this means that it holds all prices/quantities other than for the specific good of interest constant, focusing on equilibrium in the specific market under analysis (hence, 'partial equilibrium') and ignoring knock-on changes in equilibria in all other markets (i.e. the 'general equilibrium' in the whole economy). Input-output models allow for some changes to ripple through other sectors, but hold prices and coefficients constant, in effect assuming that there are pools of unemployed resources that can be drawn on, or added to, with no impacts on prices or technological choices. For anything above marginal changes, these are very shaky assumptions.

One approach to relaxing the assumptions of fixed technological coefficients and perfectly elastic supply of factor inputs is to expand the IO model to include a supply-side, developing an econometric model allowing for price and quality adjustments and changes in output:input ratios and consumption patterns (Rey, 2000). This allows a combination of the sectoral detail of IO models with dynamic price forecasting in regional econometric models. However, Hunt et al (1996) and Hunt & Snell (1997) report little consistency across the results and methods of these models – the differences are explained by the structures of the models, the data sets and data treatment.

Computable General Equilibrium (CGE) models[6] also relax the assumptions of IO and allow for indirect/induced effects where changes in one market influence supply curves and alter the equilibrium for the whole economy. To do this, they replace the assumption of unemployed resources with one of perfect market clearing, i.e. there are never any unemployed resources. This too can be criticised, for being unrealistic in the other direction.

A CGE model is based around an I-O table augmented with elasticities that define how behaviour responds to price changes. Each transaction flow in the I-O table is disaggregated into two components, price and quantity, that both adjust in response to changes under analysis. Comparative-static CGE models allow for price adjustments but do not include a specific time dimension: this means that they capture quite complex behaviour regarding current resource allocation decisions, but ignore intertemporal choices about savings and investments. Recursive-dynamic CGE models add this temporal dimension, but require many additional assumptions, including definition of future steady-state conditions for the economic structures (since the models cannot be solved over infinite time). Dynamic stochastic CGE models allow for random shocks to the economy and include utility and production functions, in principle consistent with (neo-classical) microeconomic theory, but this represents another layer of assumptions. The models are highly complex, difficult to construct and solve, and generally involve less sectoral detail than IO models.

Overall, while CGE models add some realism regarding price and technology effects, this comes at the cost of much greater complexity, reducing the sectoral detail, and the introduction of additional assumptions and expert judgement of modellers. The results are sensitive to these choices, in a way that makes it difficult to compare the results from different assessments. The more complex dynamic and stochastic CGEs are primarily intended for macroeconomic forecasting

[6] For further details of CGE models and their application, see Dixon, P. B., & Jorgenson, D. (Eds.). (2013). Handbook of Computable General Equilibrium Modeling SET, Vols. 1A and 1B. Newnes.

and analysis of associated policy (e.g. changes in taxes and tariffs) rather than for comparison of specific sectors or resource uses.

2.4 Total Economic Value and Cost-Benefit Analysis

In contrast to the EIA approach, the Total Economic Value (TEV) framework is based on working out how individuals are willing to trade-off between resources.[7] The measure of value used is individual Willingness to Pay (WTP) for an improvement or to avoid deterioration. There is also Willingness to Accept Compensation (WTA) as a monetary measure of trade-offs: individuals may be willing to accept compensation to forgo an improvement or to tolerate a loss.[8] As money is exchanged for changes in quality and quantity of resources, WTP is a monetary expression of how individuals are willing to trade-off across different goods and services. In all practical cases, it is also necessary to aggregate these values across individuals in society, to provide a monetary measure of society's preferences for alternative uses of its scarce resources. In effect, social preferences are taken as the aggregate of the individuals' preferences. So this approach involves five main value judgements or assumptions:

1. What "matters" are the preferences of individuals in society;
2. Individual are the best judges of their own welfare and preferences;
3. Individuals express preferences through rational economic choices via their 'willingness to pay' (WTP) or 'willingness to accept compensation' (WTA) for goods and services;
4. Since WTP is constrained by *ability* to pay (wealth and income), the method in effect judges that the income distribution in society (under existing arrangements for redistribution via the tax and benefit system) is in some way 'fair' or acceptable; and
5. It is valid to add up individuals' expressions of WTP (or WTA) to reach societal values.

The defined "society" is usually taken to mean the entire population of a country, though it could be smaller regions or in some cases global population.

It should be clear that the scope of TEV is different and much broader than EIA. In particular, TEV covers willingness to pay for anything that might affect an individual's well-being as they themselves define it. It should be appreciated that the ultimate aim is to estimate the change in TEV (or NEV) for society as a whole. From this standpoint if one individual transfers a given sum of money to another (e.g. a wage payment), there is no net gain to society, it is simply a transfer. The TEV framework therefore ignores transfer payments between individuals, or between individuals and government.

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[7] For details of the TEV framework, see Pascal, U., Muradian, R., Brander, L., Gomez-Baggethun, E., Martin-Lopez, B., Berma, M., & Christie, M. (2010). TEEB Chapter 5 The Economics of Valuing Ecosystem Services and Biodiversity. The Economics of Ecosystems and Biodiversity.

[8] In principle WTA should be used when the context is one of loss compared to the existing situation. Because of difficulties assessing WTA, however, most studies use WTP in lieu of WTA. This is problematic, since there are good reasons why WTA may be higher than WTP (loss aversion, endowment effects…). This is too technical an issue to cover in this report: interested readers could see Horowitz & McConnell (2002) for comparisons, and Fujiwara & Campbell (2011) for UK guidance on the issues.

The TEV framework is not inherently selfish, despite being based on individuals' preferences (Figure 1). People often have altruistic preferences for others, for future generations and for the natural resources themselves. These are referred to as altruistic value, bequest value and existence value, respectively (or non-use values), in the TEV framework. There are also use and option (future use) values, which are the motivations resulting in individuals' WTP expressions. A simple example of individuals' WTP on altruistic grounds is their charitable donations. Nevertheless, it is inherently anthropocentric and focused on individual preferences not social goals. Other ethical systems can give rise to different evaluation frameworks and decision rules.

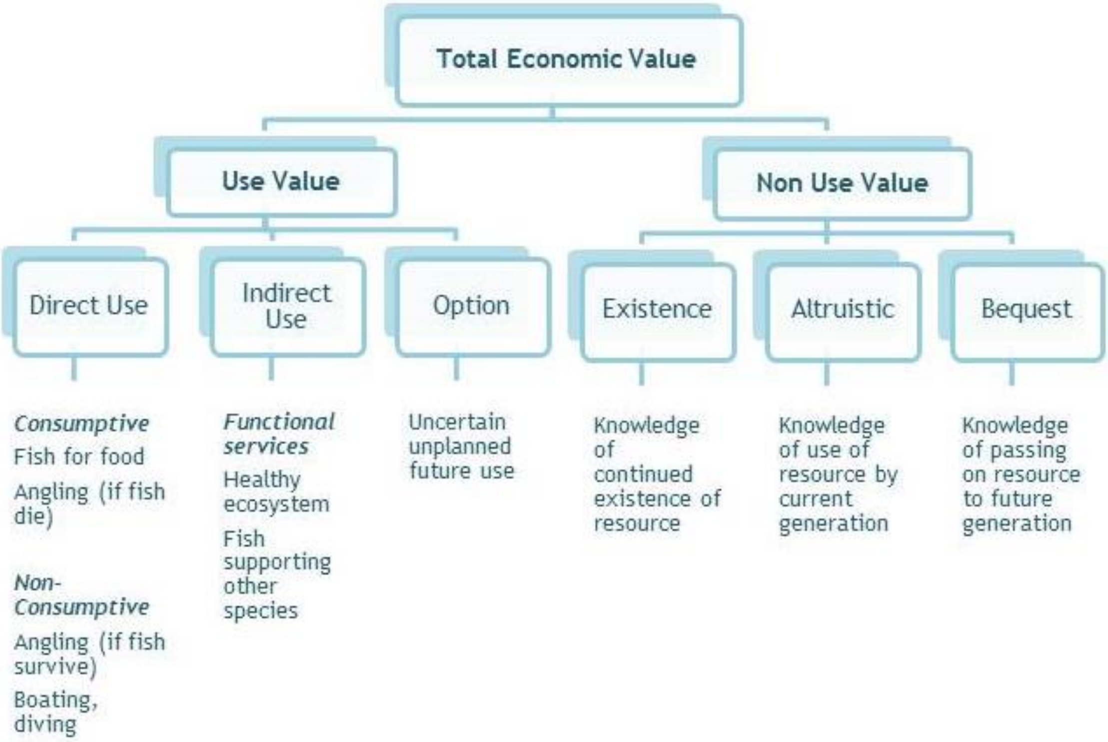

Figure 1: TEV framework (source: adapted from Tinch and Mathieu 2011)

Economic valuation methods seek to determine individual's preferences, whatever the individuals' tastes, motivations, status or knowledge - though in practice, most applications will use averages for a representative group of individuals, rather than identifying impacts for each individual. The strength of an individuals' preference is usually measured in terms of the level of their WTP. The basic idea is that the more positively (or negatively) individuals are affected by a change the more of their finite income and wealth they will be willing to pay in order to secure (or prevent) the change. This approach to assigning value is conceptually straightforward and can be applied to a very diverse range of goods and services. And resulting monetary valuations can be compared and aggregated across individuals.[9]

However, the approach can be criticised on the basic value judgements and assumptions it makes as listed above. Firstly, individuals being the best judges of their own welfare is demonstrably untrue in some cases (e.g. drug addiction) but by and large, for many classes of activity, democratic societies basically reflect this view and allow wide freedom of choice within a framework of rules and regulations to curb any excesses (for example to regulate pollution and anti-social behaviour).

Secondly, accepting individual behaviour/statement as the indicator of preference assumes that individuals are capable of expressing values in this way, and that such preferences are stable. Again, institutions in democratic societies are generally consistent with this view, within certain limits including restrictions on advertising and requirements for trade descriptions and product labelling. That said, it can often be argued that individuals are poorly informed of the consequences of their choices – indeed, it may be rational to be poorly informed, especially where the cognitive costs are high and the consequences indirect or delayed. Furthermore, familiarity with pricing mechanisms for market goods does not necessarily imply that people are well able to express market-style values for goods and services that are not actually traded in markets, and indeed stated preference methods in particular are often criticised on these grounds.

Thirdly, WTP values expressed through market behaviour are constrained by incomes / ability to pay, and are then aggregated across individuals in a way that assumes £1 to Joe Bloggs is worth the same, in terms of marginal welfare, as £1 to Fred Smith, irrespective of their incomes. Thus, in effect, using these figures to derive estimates of social value assumes that existing income distributions are desirable, or at least acceptable. Again, democratic societies generally follow rules consistent with this approach, including policies to redistribute incomes via taxes and benefits, such that actual distributions can be deemed at least in part a reflection of democratic decisions. But this does not necessarily imply that WTP-based values for those goods and services that are actually provided *outside* markets should be considered valid measures of their social value.

So there is no suggestion that TEV is "right" and EIA "wrong". Both approaches look at impacts in different ways, with different assumptions, strengths and weaknesses. The key points to recognise are that these differences mean the values cannot be compared directly, and that neither approach offers a silver bullet for informing decisions – there are assumptions and value judgements underlying any assessment. If the main interest is in effects on income and employment, then EIA is appropriate. If interest is rather in impacts on social welfare, TEV is appropriate. It should also be noted again that these are not necessarily mutually exclusive interests – decision makers and stakeholders may wish to consider both analyses.

Putting the caveats to one side, the TEV approach assesses the value of the 'goods and services' produced by a sector (e.g. annual fish output, angling) as what people are willing to pay for it. The

[9] It should be stressed that the WTP concept is independent of the means of measuring it – it is a common error to think that WTP refers only to the results of stated preference valuation studies, but WTP is defined in relation to individual utility functions, and can be estimated in various ways, including through observation of prices and markets (market demand curves are a function relating quantity to marginal WTP).

flow of goods and services includes items that have market prices (e.g. fish) but also things that have no market price (e.g. the experience of walking on the beach) and even flows that generate well-being in the absence of any direct use (e.g. people may value the existence of cold water corals, and be prepared to contribute to their conservation, with no thought of ever seeing or otherwise benefiting from them directly) (Box 1).

Box 1: Environmental and Social Impacts

In addition to economic impacts, most activities have social and environmental impacts. Social impacts could be argued to be partly included in EIA via the use of jobs as an indicator, but more generally the social and environmental aspects are not included directly – they can be considered alongside EIA results in decision processes. In the TEV framework, it is more common to attempt to account for these impacts, particularly the environmental ones, using non-market valuation techniques (see section 2.4.4).

Recreational fishing, for example, supports economic activity but also presents substantial social benefits, including relaxation and exercise, and has impacts on the environment.

Social benefits such as health and well-being (including relaxation and physical exercise) are attributed to recreational sea angling activities. The results of a social benefits survey conducted with sea anglers in Armstrong et al. (2013) show that the main motivation for going sea angling for 47% of respondents was to be “outdoors and active”; 55% of respondents also stated “to relax and get away from things” as a reason for undertaking the activity. Sea angling being their main way of “experiencing nature” and being important to their quality of life were also mentioned by the sea anglers surveyed, which also reflects the contribution of the activity to health and well-being.

Though there have been attempts to place a value on features such as heritage values of traditional fishing methods, or health benefits of recreation, these remain controversial. They may be used in some projet appraisal (such as Severn Barage for which eftec (2009) give examples of valuation studies used to valuing the non-use value of the Severn Estuary salmon, and determining the public WTP for maintaining a minimum level of activity within the River Severn Estuary fishery) but are often seen as insufficiently robust estimates. Different sectors and resource uses may have different impacts on these indicators, but comparing these in monetary terms is difficult and may focus attention on arguments about validity of particular numbers or data points, rather than the fundamentals of choices at stake. Instead, it may be preferable in most cases to list and discuss these changes, while acknowledging that their robust monetary valuation is not feasible at present or with existing data and resources.

According to neoclassical economics, for an individual, total economic value (TEV) represents all the ways that goods/services influence utility, as reflected through the preferences of the individual, acting under a budget constraint, expressed as their ‘willingness to pay’ (WTP). At a societal level, TEV represents the aggregated sum of these individual values. Integrating these values over time and using discounting to convert future values to present equivalents gives the net present value of these flows. Assuming calculable risk about future flows, these values are often expressed as expected values, though other statistical treatments are also possible. TEV values form the basis of cost-benefit analysis (see 2.4.1), which uses values derived from markets (see 2.4.2), or, in cases of ‘market failure’ (see 2.4.3), values derived from non-market methods (see 2.4.4).

2.4.1 Cost-benefit analysis

Cost-benefit analysis (CBA) is a decision support method which compares, in monetary terms, as many benefits and costs of an option (project, policy or programme) as feasible, including impacts on environmental goods and services. CBA is designed to target two of the most crucial appraisal questions: "Is a given objective worth achieving?" and if so, "What is the most efficient way of doing this?" Inevitably, however, there are data gaps and uncertainties in all applications. CBA should not be seen as a way of resolving these policy questions, but rather as a way of structuring the available information in such a way as to help decision-makers to understand the trade-offs involved in decisions. CBA is an aid to deliberation, not a replacement for it.

CBA is widely used in public sector policy appraisal - in the UK, the HM Treasury 'Green Book' is the main reference for public sector CBA guidance.[10] CBA is grounded in the TEV framework: in principle, positive improvements are valued through WTP and deteriorations through WTA, though in practice WTP values are generally used for all changes (Communities and Local Government, 2009).

CBA uses net present values (NPV) to compare options, calculated as total discounted benefits minus total discounted costs, expressed in monetary terms:

$$NPV = \sum_{t=0}^{T} \frac{(B_t - C_t)}{(1+\delta)^t}$$

where $\mathbf{B_t}$ is the benefit, and $\mathbf{C_t}$ is the cost, in each period **t**, **δ** is the discount rate, and **T** is the time horizon for the assessment (in almost all cases, **t** is expressed in years).

One use of CBA is to compare options for resource use in a specific decision or case. Another is to rank / prioritise spending possibilities in terms of their internal rate of return. For present purposes, the former is the more relevant, since it involves using CBA to assess (compare) alternative uses of a resource. Provided all relevant options are considered, and all costs and benefits can be included in the analysis, the option with the highest NPV is revealed as the economic optimum (in TEV terms). In practice, there are often some non-marketed costs or benefits for which values are not available, so most real CBA is 'constrained' by these unpriced impacts that need to be considered separately.

Allocation problems in economics can be broken down into efficiency and fairness components. Efficiency is a matter of maximising value to society, and depends on equating the marginal values of resources to different activities. Achieving efficiency is largely determined by the effectiveness of markets and of policy aimed at correcting market failures (such as open access). Fairness is about distribution of benefits, and is often determined by allocation of property rights, or other rules about the conditions under which different people can access a resource. Efficiency and fairness are in principle separate issues: where efficiency arguments suggest that one user should

[10] For details of CBA theory and methods, see Mishan, E. J., & Quah, E. (2007). *Cost-benefit analysis*. Routledge. For guidance on application in the UK public sector, see HMT Green Book at https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent

have more rights to resources (because marginal values are higher), fairness arguments might suggest that those with less access should be compensated.

CBA is based on maximising (the NPV of) TEV. Thus it is not directly concerned with fairness of allocations: a positive NPV shows the winners *could* compensate the losers, but that does not mean that they do. This applies both across time periods (intergenerational equity) and within a time period (intragenerational equity). In principle, CBA can be carried out with distributional weighting, in order to put more emphasis on benefits to the less wealthy members of society. The HMT Green Book (Annex 5) explains that "the empirical evidence suggests that as income is doubled, the marginal value of consumption to individuals is halved: the utility of a marginal pound is inversely proportional to the income of the recipient. In other words, an extra £1 of consumption received by someone earning £10,000 a year will be worth twice as much as when it is paid to a person earning £20,000 per annum". In practice, however, income weighting is not common for assessments concerned with environmental goods and services, because impacts are rarely identified for separate income groups. Slightly more common is the practise of identifying groups of winners and losers separately from the main CBA results (not necessarily by income group – this can be groups of residents, or groups with shared characteristics (such as 'inshore fishers' or 'recreational sea anglers') so that decision makers can take these distributional impacts into account.

2.4.2 Market prices

For most economic goods and services, preferences are revealed via the markets in which individuals purchase goods and services, and sell their labour. Prices and quantities are observable features of markets, but a distinction must be made between value and price. Price is what a person actually pays for a good or service; value is the impact on that person's utility, and can be conceptualised as the maximum price that person would have been willing to pay. The locus of maximum willingness to pay (WTP) across all consumers constitutes the 'market demand curve' for a good or service. Since the market demand curve reflects marginal willingness to pay it is society's valuation of the marginal unit. It can be called the Marginal Social Benefit (MSB) function for provision of the good in question. Consumer surplus is the gap between WTP and price, and is a central concept in the calculation of TEV (Figure 2).

It should be noted that demand curves almost always slope down, because the value (the willingness to pay) for additional units declines with increasing consumption. For recreational fishing, for example, this can be interpreted at the individual level *within* a trip (the marginal value of catching the n^{th} fish[11] is likely to be lower than the marginal value of catching the $(n-1)^{th}$ fish), *across* trips (the marginal value of the n^{th} trip in any given year will be less than the marginal value of the $(n-1)^{th}$ trip) and across individuals (e.g. people who are attracted to fishing by a slight improvement in conditions will generally be people who value fishing less than those who were already taking part under poorer conditions). These observations are particularly relevant to changes in resource allocations, since assumptions that marginal values are constant are generally inappropriate for substantial changes.

If markets exist and there are no market failures, prices observed in the market reflect willingness to pay for marginal quantities. For larger quantities we need to estimate the area under the

[11] Considering number of fish caught for simplicity, while recognising that many other factors influence value.

demand curve which is composed of consumer expenditure (price times quantity) plus consumer surplus (the extra that consumers would have been willing to pay, but did not have to).

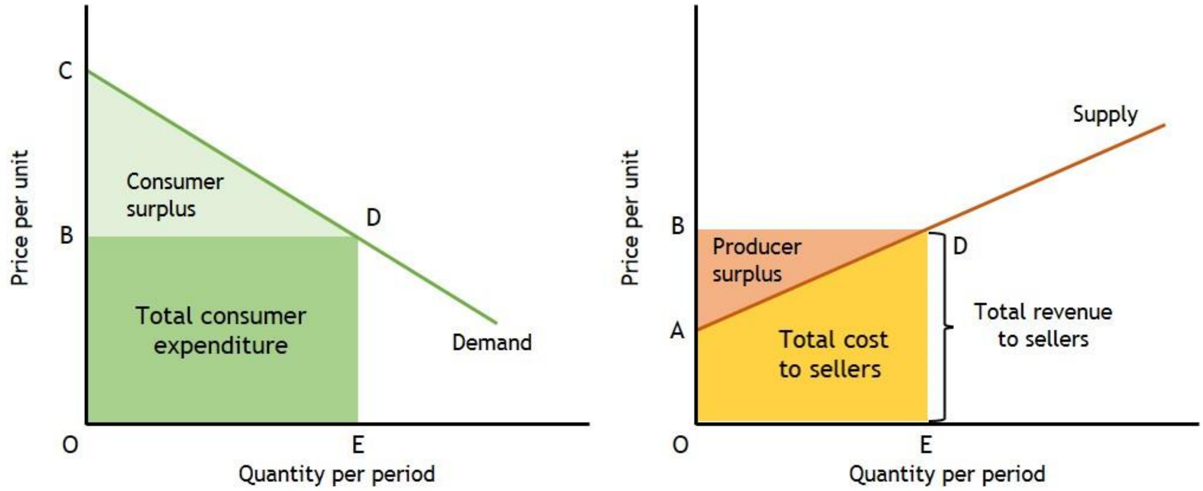

Figure 2: Consumer surplus, producer surplus, resource cost

Similarly, the supply curve represents marginal willingness to provide goods/services, which is based on the costs of production, so that total revenues (also price times quantity) can be broken down into the total cost to sellers, and the producer surplus. From society's perspective, the resources suppliers use to produce goods and services could have been used to produce something else - the value of this foregone alternative is termed Opportunity Cost. The Net Economic Value (NEV) is obtained by subtracting the opportunity costs of the resources used from TEV. In applied economic work it is usual, and often reasonable (but see below), to assume that the market value of resources used (e.g. energy, labour, raw materials) reflects society's marginal opportunity costs and therefore its Marginal Social Costs (MSC). We are left with the NEV to society from a particular good or service being the sum of consumer surplus and producer surplus (Figure 3). Net economic values are also used in cost benefit analysis, where the benefits minus costs for each period are identified, discounted to present day values and aggregated to net present values.

Different sorts of valuation evidence are used for different contexts. For example, for comparability with the System of National Accounts and measures of GDP, natural capital accounting uses exchange values (market prices multiplied by quantities, excluding consumer surplus) rather than the surplus values used in NEV analysis. Natural capital accounting is an area of rapid development, but we will not dwell on it here, as it is not really designed for comparison of sectors / resource uses (see Box 2).

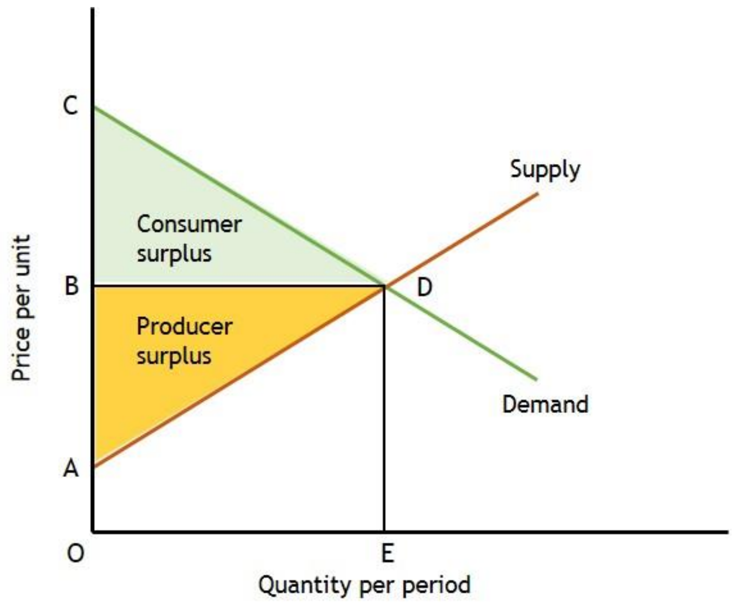

Figure 3: Market equilibrium and net benefits

2.4.3 Market failures

Using market values and estimating areas under market demand and supply curves works well for perfectly competitive markets. However, various ‘market failures’ mean that the demand curve and the area under it does not always reflect social benefits and/or the supply curve does not reflect social opportunity costs. In these circumstances private market values do not always reflect societal values. These include, in particular:

- *externality*: economic activity creates pollutants or other external damages (or in some cases external benefits) that are not fully considered by the actors creating them thus driving a wedge between private market and social values;
- *imperfect competition*: market power (e.g. monopoly) allows some market participants to manipulate market prices for their own benefit;
- *imperfect information*: choices are made without full information, leading to ‘mistakes’ in the sense of private choices that do not reflect social values;
- *transaction costs*: the administrative, mental, financial costs of carrying out a mutually beneficial trade are unnecessarily higher than the value of the trade, so it does not take place; and,
- *missing markets*: where property rights are not defined, there can be no market, and therefore no forum for expression of social values. A particular issue arises in the case of open access resources, such as an unregulated fishery: although the fish *once harvested* are owned and traded, the stock *in situ* is neither owned nor traded, so resource users have no incentive to consider long-term impacts on the resource stock.

So though market prices often guide the behaviour and choices of individuals, they do not always reflect social values. In appraisal, prices often need to be adjusted to correct for market failures in deriving better measures of social benefits and social costs. For example ‘shadow wages’ are used in cost-benefit analysis to account for the influence of unemployment, which makes the opportunity cost and therefore social cost of labour lower than its market cost. Similarly, non-market valuation techniques may be used to estimate social benefits and costs for impacts not (usually) traded in markets, for example pollution.

Box 2: Natural capital accounting

Natural capital accounting is being developed along slightly different lines by different groups. The WAVES[12] approach is based on TEV valuation and is closely related to cost-benefit analysis. The UN System of Environmental Economic Accounting (SEEA[13]), in contrast, focuses on comparability with the System of National Accounts (SNA[14]: i.e. calculations of GDP) and therefore focuses on exchange values (price multiplied by quantity). The SEEA Central Framework[15] includes measurement in three main areas:

- The physical and value flows of materials and energy: supply and use tables in physical and monetary terms showing flows of natural inputs, products and residuals; these tables must respect the supply-use identity;
- Stocks of environmental assets: accounts for individual environmental assets in physical and monetary terms showing the stock of environmental assets at the beginning and end of each accounting period and the changes in the stock; and
- Economic activity and transactions related to the environment: sequence of economic accounts that highlights depletion adjusted economic aggregates, and functional accounts which record transactions and other information about economic activities undertaken for environmental purposes.

In monetary terms, the asset boundaries of the SEEA Central Framework and the SNA are the same. Thus, only those assets that have an economic value following the valuation principles of the SNA are included in the Framework. In physical terms, the asset boundary is broader and includes all natural resources and areas of land of an economic territory that may provide resources and space for use in economic activity. Thus the scope in physical terms is not limited to those assets with economic value.

In the SEEA Central Framework environmental assets are measured as individual assets, such as timber resources, land, mineral and energy resources, and water resources. In contrast, SEEA Experimental Ecosystem Accounting[16] measures environmental assets from the perspective of ecosystems and considers how different individual environmental assets interact as part of natural processes within a spatial area to provide a range of services for economic and other human activity. While ecosystem accounting does consider ecosystems and the economy to be different systems, they are analysed jointly reflecting the fundamental connections between them.

[12] http://www.wavespartnership.org/en

[13] http://unstats.un.org/unsd/envaccounting/seea.asp

[14] http://unstats.un.org/unsd/nationalaccount/sna.asp

[15] http://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf

[16] http://unstats.un.org/unsd/envaccounting/eea_White_cover.pdf

2.4.4 Non-market valuation methods

Economists have developed several methods for estimating the social value of goods and services that are not traded in markets. These can be broadly split into

- Cost-based methods;
- Revealed preference methods; and,
- Stated preference methods.

Cost-based methods assume that the cost of taking a particular action reflects the value generated by that action. For example, a value can be estimated based on the cost to replace some good or service. This is often a lower-bound estimate, if the service is essential and would have to be replaced, but can be an over-estimate where the cost of replacement are higher than the consequences of losing the services. This is in conflict with the economic theory underpinning TEV as the cost of an action may be greater or less than the WTP. This is perhaps best illustrated by considering the potential circularity of appraisal based on cost-proxies: if a habitat or services is 'valued' at the cost of replacing it, then a cost-benefit analysis of a decision regarding replacement of the habitat would be pointless. The estimated benefit would be identical to the cost, giving a cost-benefit ratio of 1 – being indifferent between taking and not replacing the habitat.

Nevertheless, these proxies are quite commonly used in the absence of other evidence. Generally the services valued are a subset of those assessed, so complete circularity is avoided, and on the practical grounds that including a cost-based proxy may often be a better estimate than the default value of zero. There are two types of cost based method:

Revealed preference methods exploit the relationships between the demand for some market-priced goods and preferences for related non-market goods and services. Two fundamental requirements are that changes in the non-market good actually influence some observable customer behaviour (i.e. demand for the market good) and that changes in demand are measurably responsive to changes in the non-market good. These caveats limit the scope for applying revealed preference methods. Examples where expenditure on market good(s) can be observed to vary with the provision of non-market good(s)/service(s) include:

- House prices and rentals varying with environmental features (such as noise, environmental quality or proximity to waterfronts or scenic views) – referred to as hedonic property pricing method;
- Demand for recreation sites varying with site features (such as environmental quality, provision of facilities, presence of specific species) – referred to as travel cost;
- Demand for products that compensate for losses in the provision of specific environmental services – avertive behaviour or expenditure, and
- Labour supply (wages) varying with danger and discomfort of an occupation – referred to as hedonic wage.

There are three basic relationships of interest, which centre on the benefit that an individual ordinarily derives from the provision of the non-market good:

- The market and non-market goods are *substitutes*: in this case an individual can derive similar benefit from consumption of either the market good or the non-market good. This is the basis for avertive behaviour approaches (e.g. based on behaviour relating to source and treatment of drinking water);

- The market and non-market goods are *complements*: in this case an individual requires the joint consumption of both the market good and the non-market good to derive the benefit. This is the underlying principle for 'traditional' travel cost methods, which examine demand for visits to recreation sites where time and money spent on travel to a site is complementary to recreation; or,
- The non-market good is a *characteristic or attribute of the market good*: the classic examples are demand for housing, where along with the characteristics of properties, the attributes of the local neighbourhood and environment are key determinants of demand, and choice of recreation site to visit, where the characteristics of the site are key determinants of demand. The former is the basis for hedonic pricing approaches; the latter, discrete choice / random utility models.

Stated preference methods obtain values for non-market goods by enabling a representative sample of individuals to state their preferences in terms of WTP or WTA through a carefully structured and worded questionnaire. The questionnaire or 'survey instrument' creates a hypothetical market in which respondents can trade-off the provision of non-market good(s) of interest with their household income, thus providing an estimate of WTP. The two most commonly applied methods are contingent valuation and the choice experiment. The former is characterised as an approach that obtains the individual maximum WTP for specified (discrete) change in the level of provision of the good (e.g. all the benefits of a given policy action). In the latter, individuals are presented with alternative goods that are differentiated by a set of characteristics (attributes and their levels) (e.g. different likely benefits from a given policy action or different scenarios for the policy action), and are asked to choose their most preferred alternative. The choice experiment approach is equivalent to the random utility model in the revealed preference methods family, except that it relies on stated preference data (rather than observed market data).

The flexibility of stated preference methods, through which any conceived hypothetical market can be presented to individuals, conceptually at least implies that it is suited to all non-market goods or services. In particular it represents the only set of methods that can capture non-use values. There are, though, challenges in constructing credible valuation scenarios and ensuring that individuals understand the trade-offs that are presented and WTP values are valid/robust.

2.5 Summary

Economics offers two main tools for comparing different sectors or uses of resources:

- Economic Impact Assessment of Gross Value Added and employment
- Cost-Benefit Analysis using Total Economic Value

The analytical frameworks seek to estimate different things, and therefore cannot be directly compared. They are not mutually exclusive and indeed should be complementary, because they both focus on the consequences of policy initiatives for the human population. Thus armed with both a CBA and an EIA, decision makers would have a very comprehensive picture of potential policy impacts.

Again, neither of these analytical frameworks is necessarily 'better' than the other: both are logically coherent, with their own assumptions, strengths, weaknesses and applicability. Within each analytical framework there are also different methods that can be used to estimate the key parameters. For example, use of Type 1 or Type 2 multipliers, where Type 2 are more comprehensive but less reliable. Similarly, in CBA non-use values may be an important component of TEV, but are often left out because of concerns that estimates are not sufficiently robust.

That said, if the interest is human welfare (whether at national or local levels), the TEV framework has the advantage of taking account of all influences on individual welfare, and of focusing on the result (welfare) rather than the income of some subset of society. An additional advantage of the CBA framework is that it explicitly treats time, considering costs and benefits for each year, in contrast to EIA which is based on a static ‘snapshot’ of the economy. This can be particularly important for industries subject to fluctuation and change (such as fisheries), or where policy aims to effect a fundamental change in structure (such as targets for returning depleted fish stocks to healthy levels).

Whether one or the other or both informs policy should depend on whether its value judgements align with the value judgements of those making decisions, though it is possible that decision makers may often select those estimates which validate their prejudices.

Further, it is important to bear in mind that these methods do not give “the answer” to social and political issues – rather, they each provide a way to structure and process information, based on particular assumptions. They are useful tools for reducing complex relationships to understandable figures, but are based on strong assumptions, and should always be interpreted as aids to thinking and deliberation, not as ways of taking decisions.

In particular, it is relevant that neither EIA/GVA nor CBA/TEV say anything directly about fairness. Fairness is a subjective issue, and while economics can inform debates about fairness – for example by identifying winners and losers, and by calculating how much compensation would be required to offset losses to the losers – ultimately decisions about resource allocations have strong normative, political components that are outside the realm of economic analysis.

3. Case Study: Commercial Fishing and Recreational Angling

Comparisons of economic activity are common where there are decisions to make about allocations of scarce resources between competing sectors, and one particular example of this is the allocation of certain fish stocks between commercial fishing and recreational angling. Indeed, already 25 years ago Edwards (1990) reported that "one can scarcely find a management plan or amendment that does not at least refer to the relative food and sport values of fish and to how expenditures by commercial and recreational fishers on equipment and supplies stimulate the economy." However, as Edwards noted, many of the arguments used are "incomplete, distorted, and even incorrect." Below, we consider some of the arguments, explain why most often the arguments used are not particularly relevant to questions about resource allocation, and discuss further evidence that is needed to inform these questions.

3.1 Overview of commercial fishing and sea angling in UK

Recreational sea angling is fishing with a hook and a line for non-commercial purposes (Pawson et al 2008)[17]. The catch may be returned to sea or kept for consumption, but not sold or given in exchange for other goods. In the UK, the activity does not require a licence, although permits may be necessary to fish off piers and jetties in some harbours. Most recreational fisheries operate under 'regulated open access management' since recreational anglers have to respect fishing gear restrictions and catch restrictions (such as minimum landing sizes) under EU, national and local regulations. However, as Abbot (2015) stresses, these measures may limit the landings of a given angler on a specific trip, but place little restriction on total recreational effort or fishing mortality.

In addition to anglers themselves, many different stakeholders are involved in supporting the activity, including "tackle shops and tackle manufacturers, bait suppliers, charter-boating, recreational boat builders and chandlery suppliers, marine operators and specialised angling media, angling tourism and other related businesses and organisations as well as the whole management environment (e.g. public agencies) to varying degrees dependent on, or directed at, recreational angling" (Pawson et al. 2008)

Commercial fishing involves presenting catch for sale. In the UK, commercial fishing from a powered vessel requires a licence; commercial fishing from the shore or using an unpowered boat does not. Beyond that, a wide range of different techniques are used, ranging from very small-scale 'traditional' fishing to industrial-scale trawling. In addition to the direct fishing activity, there is a sizeable industry in processing and marketing products, in port facilities, in provisioning and maintaining the fishing fleets, and in fisheries management, enforcement and analysis. It should be noted that a significant part of the processing and marketing sectors deal with imported fish and shellfish, so the extent to which they are dependent on UK landings is not clear.

There are many estimates of catches, values and participation rates for commercial fishing and for sea angling in the UK and elsewhere. These estimates will often feature in argumentation relating

[17] This is a subset of "recreational fishing", defined by the ICES Working Group on Recreational Fisheries Surveys (2013) as "the capture or attempted capture of living aquatic resources mainly for leisure and/or personal consumption", with a note that in Norway recreational fishers are permitted to sell catch.

to these sectors and policy affecting them. However like-for-like comparisons are often difficult to make, because the figures are based on slightly different units or areas.

For example, the number of commercial fishers in Great Britain is estimated at 12,152 (MMO, 2014), and there are an estimated 1.08 million anglers in Great Britain (Armstrong et al., 2013). These figures might be used as evidence of participation in the activities, but such a comparison is not relevant from an economics perspective. In economic terms, commercial fishing is often described in terms of the value of fish and shellfish landed (£718 million in 2013 in the UK: MMO, 2014) or fleet operating profits (£149 million in 2012[18] in the UK). Angling, by contrast, is often discussed in terms of expenditures (for example, the direct expenditures of sea anglers resident in England was estimated at £831million in 2012: Armstrong et al., 2013) or sometimes the total economic value experienced by anglers, in total or per trip.

Central to the arguments put forward in this report is the fact that such figures are generally not directly comparable. While they may be useful in demonstrating overall role of these sectors in the economy, direct comparisons require much more careful attention to comparing like with like. For instance, much of the commercial catch comes from fisheries of little or no interest to recreational anglers. The relevant resource allocation questions – and therefore the relevant comparisons - arise where angling and commercial fishing are in conflict for the same stocks. Furthermore, the mere fact that one or other sector provides more total expenditure in society does not imply that more resources should be devoted to it, nor that it should have priority in claims on fish stocks. Changes in resource allocation should be assessed in terms of their marginal impacts, not the total values of the sectors concerned. And economic efficiency is only one criterion on which decisions should be judged – other criteria, such as fairness and sustainability, are also relevant.

3.2 NEV and Sea Angling

Primarily, anglers seek enjoyment from a recreational experience, and landing sea fish may be only one among many dimensions of the whole experience (e.g. relaxation, solitude, companionship, enjoyment of scenery and the natural world).

The “output” produced by the fishing trip is the sea angler’s own enjoyment/pleasure, the gross value of which is measured by the sea angler’s WTP for it. Thus, society’s TEV of sea angling is the aggregate WTP of all sea anglers.

Anglers incur costs in acquiring the necessary “inputs” such as travel, accommodation and equipment. If these fishing costs exceeded the angler’s WTP, then logically the angler would not participate in the activity. From society’s perspective, these physical resources could (most probably) have been used to produce something else for which there is also a WTP. From society’s perspective, there is therefore an Opportunity Cost to be considered.

In these circumstances, NEV is found by estimating WTP (i.e. TEV) and then subtracting the market value of the physical resources used by sea anglers. The market value of these resources is equivalent to anglers’ actual expenditure on physical resources such as tackle, petrol, bait, accommodation and so on.

[18] http://www.seafish.org/research-economics/industry-economics/fleet-statistics

In simple terms, NEV represents the difference between what society values angling experiences and what it has to sacrifice in order to have them. Society's NEV of its recreational sea fisheries is equivalent to sea anglers' Consumers' Surplus.

In applied studies of recreational fisheries, anglers' consumers' surplus (CSa) is an important concept because, in the circumstances described above, it represents the NEV to society of the activity. Changes in CSa represent changes in anglers' welfare. The greater the difference between the amount the angler is willing to sacrifice for the enjoyment of the trip (WTP) and the actual expenditure, the greater is the contribution of angling to her/his overall well-being. For example, if the maximum amount an angler is WTP for the enjoyment of a fishing trip is £30 and the actual costs of travel etc. are £20, then the excess of worth over actual payment is £10. This is the angler's consumers' surplus (i.e. £10). Therefore the total WTP for the enjoyment of the trip (£30) does not reflect the change in angler well-being from being deprived of the trip. If the trip is lost, the angler foregoes the £30 worth of enjoyment. However, at the same time he/she saves the £20 that is required to produce it in the first place. Logically, the angler should therefore only require a minimum compensation of £10 voluntarily to forego the fishing trip.

It is interesting to note that since consumers' surplus is a measure of the net 'worth' to anglers of their sport (as evidently the greater the difference between what they are prepared to pay and what they actually do pay, the 'better off' they are) it follows that the more anglers spend (for fishing experiences of a given quality) the worse off they are. In the TEV/CBA framework, anglers' expenditure alone therefore measures neither the net worth to anglers nor the net economic value to society of sea angling. It is quite wrong to suggest that the more expensive an activity is, the more 'valuable' it necessarily becomes.

Whilst the consumers' surplus might be described as a 'direct consumptive user values', it is conceivable there are other less obvious sources of the NEV to society from the activity of sea anglers. It is appropriate to articulate all these possibilities, because they potentially extend the individuals affected by fisheries policy beyond sea anglers.

Producer Surplus in Supplying Angling Services: there could be producer surplus within businesses supplying angling services such as accommodation, travel, food and drink. In general, however, it is assumed that these businesses generate only normal profits (part of resource costs/opportunity costs), so producer surplus is ignored.

Existence and Bequest Value of Sea Angling: some individuals in society may derive an 'existence value' from knowing that sea angling activity exists and is enjoyed by others. They would be willing to pay something to preserve the activity for the enjoyment of their contemporaries (existence value, EVa) and/or for future generations (bequest value, BVa). The common feature of BVa and EVa is that they derive from the individual's appreciation of a consumptive use of a natural resource by others. These are passive values but relate to a consumptive use value. Essentially, if they exist, they arise from the altruism of individuals. It is possible but unlikely that members of the non-angling public have vicarious concern for anglers (and some view angling as an undesirable activity because of its impacts on fish welfare); it is more likely that anglers may have an altruistic concern for fellow anglers now and in the future. However, in practice it might be difficult to separate EVa and BVa from CSa.

Option Value of Sea angling (OVa): if there is uncertainty about the future availability of an activity or about future preferences for engaging in angling, and if we assume that individuals show 'risk-aversion', then there is the possibility of another category of value.[19] We presume that anglers would be prepared to pay a premium to avoid risk, and then this gives rise to their ***Option Value (Ova)***.

Sea Angling and Stock Effects (SEa): Sea angling could be having on-going adverse effects on commercial fishing operating through decreases in fish stocks decreasing commercial catch per unit and increasing the costs of catching fish. In reality, for most sea fisheries in the UK the increased mortality due to angling probably has a minimal effect on commercial catch per unit of effort. Anglers also catch fish that would otherwise be available to spawn. The magnitude of SEa is therefore largely conditional on the proportion that anglers catch, the underlying stock and recruitment relationships and the extent to which catch and release reduces mortality. It is possible that SEa could be relatively insignificant, except for specific fisheries with high levels of recreational angling mortality, where at local scales the effects could be important.

It should be noted that the 'values' discussed in this section are intrinsically additive since they are based on a common assigned value (i.e. WTP) and constituency (i.e. society as a whole). It is also possible to assess the sensitivity of NEV to changes in circumstances, such as changes in the use of a resource or changes in fish abundance. In conclusion, the NEV of sea angling is as follows:

Total NEV of Sea angling = Anglers' Consumers' Surplus (CSa)
+ Existence Value (EVa)
+ Bequest Value (BVa)
+ Anglers' Option Value (OVa)
- Stock Effects (SEa)

3.3 NEV and Commercial Fishing

Whereas the 'product' of the recreational fisheries is angling experiences, the main product of commercial fisheries is fish for the table; there are further products through the direct experience of fishing or boat owning, and the social status of being an owner/skipper within a fishing community. The sector operates within a market and Consumers' Surplus and Economic Rent are therefore equally applicable to commercial fisheries. NEV in the commercial fishery is thus made up of the sum of Consumers' Surplus and Producer Surplus. Although not directly equivalent, we use the term Economic Rent, rather than producer surplus (as explained below).

Consumers' Surplus from Commercial Fishing (CScf): In the context of the commercial fisheries, **Consumers' Surplus (CScf)** is the aggregate WTP of consumers for sea fish less the total amount that they actually do pay. As a general observation, Consumers' Surplus is low if a product has close substitutes. The logic is that if consumers have good alternatives, the lower will be their WTP over

[19] Risk-averse individuals would, for example, prefer a certain outcome of £100 to a gamble having the same aggregate outcome (e.g. a 50% chance of £50 and a 50% chance of £150).

and above what they are required to pay (i.e. the price). For example, if imported cod were only marginally more expensive than UK caught cod, fish consumers would not be unduly disadvantaged about the loss of UK cod fish.

Economic Rent in Commercial Fisheries (ERcf): Economic rent is the total income to the operator in excess of the opportunity costs (from society's point of view) of the resources used[20]. Payment made for the output of the commercial fishery at first sale represents the gross revenue from the catch. It is assumed, not unreasonably, that the costs to the commercial fisherman of the resources purchased from other firms (fuel, for example, or miscellaneous items such as fish boxes) reflect society's opportunity costs. The first stage in calculating Economic Rent is to subtract these costs from the gross revenue to give **Value Added**[21].

However it is important to appreciate that in the commercial fishery (in contrast to the recreational fishery) labour is the resource which accounts for most of the (variable) costs. From Value Added the owner/operator has to pay crew, if any: value added less payments to crew is defined as **Gross Profit**. The owner/operator's **Net Profit** is what remains after other expenses such as the maintenance of physical capital (e.g. fishing gear and boat). Again, it could reasonably be assumed that these costs reflect society's opportunity costs of the resources used. We can therefore calculate the total payments to labour as the sum of payments to crew and net profit.

If labour used in the commercial fisheries has alternative uses, then labour costs reflect society's opportunity costs and should therefore be subtracted when calculating economic rents. In this case, ERcf would then be that part of net profit that remains after deduction of the opportunity costs of the owner/operator's own labour. If a positive ERcf emerges from this process, then the owner/operator (and society as a whole) receives a return in excess of alternative uses for the resources used to catch sea fish.

If, on the other hand, both the owner/operator and crew would be unemployed in the absence of the fishery, and if there was no compensating increase in employment elsewhere, then the payments to labour would have no resource allocation implications from society's point of view, i.e. no opportunity cost, and labour costs should not be subtracted when calculating rent.

The most likely situation in reality is that there is some opportunity cost, but less than the total cost of labour – without fishing, there would be some increase in unemployment, and some redeployment of fishing labour to other jobs. In these circumstances it would be appropriate to use a 'shadow price' for labour to reflect this – the shadow price represents the true opportunity cost, and would have to be calculated. It should also be recognised that many commercial fishers enjoy their job and derive utility and social status from doing it: these are benefits to society (because the fishers are members of society) that are additional to the economic rent.

A zero shadow price is one option, but is tantamount to assuming that labour would be permanently unemployed and the value of their leisure time was zero. This is not tenable for all sea fishing

[20] This is very closely related to producer surplus, the distinction being that rent is considered with reference to a factor of production (here, fish stocks) rather than individual producers. This is common and useful in analysis of natural resource industries, without changing the basics of the analysis methods.

[21] Value added is defined as the difference between gross revenue and the cost of purchased inputs.

activity. UK commercial fishing is heterogeneous and it would be unwise to make a blanket generalisation about the opportunity cost of labour. If **Net Profit** is used as a proxy for ERcf and some labour would remain unemployed then Net Profit would underestimate ERcf. On other hand, a zero shadow price would overestimate ERcf if labour does have alternative uses.

Other sources of NEV of Commercial Fishing: Commercial fishing can be part of the cultural fabric of coastal areas. If fishing has this status there is possibility of ***Existence Value (EVcf)***, if some members of society might be willing to pay something to preserve an emblematic activity. Some individuals may derive some satisfaction from knowing that future generations will still be able to practice this traditional activity and might be willing to pay something to ensure this. This is ***Bequest Value (BVcf)***.

When discussing angling we reasoned that some members of society might be willing to pay to preserve the option of participating in sea angling. It is unlikely that this would apply to a highly specialised activity such as commercial fishing, except in the case of a small number of people in strong traditional fishing communities. Thus ***Option Value (OVcf)*** is unlikely to be significant and is not considered further.

Commercial Fishing: Stock and other Externalities: With respect to sea angling, it was argued that stock effects were uncertain but possibly not significant, except for some specific fisheries. The stock and other effects associated commercial fishing could be substantial. At one level some commercial fishers catch the fish that other commercial fishers, anglers and predator populations would catch. Other forms of commercial fishing are more destructive because they drag gear across the sea bed, which can cause habitat damage and effects on demersal fish populations, especially in nursery areas, and some other species e.g. pelagic sharks. Depending on the commercial fishery under consideration there are probably four categories of stakeholders who might be adversely affected by commercial fishing, and who might benefit from decreased levels of fishing activity.

> *Other Commercial Fisheries:* Commercial fishers impose costs on other commercial fishers because they catch the same target species and this drives down other fishers catch per unit of effort. In some fisheries effort is above the level that maximises sustainable yields or profits. In these areas, yields and profit from the fishery might increase if fishing effort were reduced. Thus in a few areas, additional vessels might already be adding more to costs (their costs and the costs they impose on fellow operators) than they are adding to revenue from the fishery. In addition the more destructive forms of fishing could adversely affect commercial fishing for demersal stocks through discards and habitat change.
>
> *Recreational Users:* Among marine recreation interests, there is probably a spectrum of sensitivity to changes is fish populations. At one end, there are sea anglers and marine divers whose recreational experience involves direct interaction with fish stocks. Further along the spectrum there is bird watching and marine/coastal wildlife tours and charters whose sensitivity to changes in fish stocks operates through changes in fish predator populations such as sea birds and sea mammals. At the other end of the spectrum might be sea kayakers, sailors and informal visitors to coastal areas. For these groups a decreased probability of sightings dolphins, porpoise, minke whales, seals, sea eagles, puffins etc. would detract from their experience. With respect to the well-being of participants, it is axiomatically true that their well-being would to a greater or lesser decline with a reduction in the quality of their recreational experience. As the quality of the recreational experience declines so does activity levels and expenditure and this lowers the income and employment of those supplying services, such as equipment, accommodation, food and drink, charter vessels, transport etc. Reductions in marine recreational activity might therefore have additional adverse consequences for other sections of society.

Informal Coastal Visitors: Visitors probably prefer a diversity of on-going activity in the coastal communities they visit, including different types of commercial fishing, more divers, more anglers, more wildlife charter vessels etc. In the long run, excessive levels of trawling and dredging might mean that there is less diversity in coastal activity, while less intensive and smaller-scale fishing activity likely bring benefits, up to a point.

Non-Users / General Public: There is a proportion of the general public who have an altruistic or vicarious concern for the well-being of natural assets both sentient and non-sentient. These concerns are independent of the actual use or direct contact with the marine environment. Such individuals are therefore not indifferent to adverse impacts on the marine environment and, other things being equal, would prefer that these impact were not occurring. This is similar to the existence value for commercial fishing (EVcf) discussed above, but relates to a value that is diminished by fishing activity.

The effect on the NEV of these four groups might be difficult to quantify, but conceptually their possible existence should be recognised. When we add these values the NEV components of commercial fishing are as follows:

Total NEV of commercial fishing = **Economic Rent (ERcf)**
+ Consumers' Surplus (CScf)
+ Existence Value (EVcf)
+ Bequest Value (BVcf)
- change in NEV of other commercial fishers
- change in NEV of Marine Recreation
- change in NEV of informal coastal visitors
- change in NEV of the General Public

It is conceivable that the NEV for some of the more destructive forms of commercial fisheries might actually be negative and for the majority of commercial fisheries in the long run NEV might increase with reductions in fishing effort.

3.4 Valuations of commercial fishing

Commercial fishing and fish processing contribute to the UK economy: the MMO (2014) reports that in 2013, 6,399 vessels and 12,152 fishers landed 624,000 tonnes of fish and shellfish at a value of £717 million. There are substantial imports and exports of fish and fish products, and an important processing industry.

3.4.1 EIA valuations of commercial fishing

Many studies look at the value of commercial fisheries, using various indicators such as landings value, GVA, resource rents, or employment (Rose et al 2001, Whitmarsh et al 2000). Resource rent is the economic rent arising from exploitation of a resource, defined (DFID 2004: p1) as "the amount which is left over when all exploitation costs have been deducted from revenues"[22].

[22] Noting that if any subsidies are counted in revenues, the costs of providing the subsidies should be included as a cost; subsidies are a transfer payment, not economic rent.

Coglan & Pascoe (1999) explain different ways in which resource rents can be considered and evaluated. ONS (2014) do not attempt to produce monetary values for fisheries in the natural capital accounts, since standard procedures result in negative resource rent estimates (similar to the Physical and Economic Accounts for UK Fisheries, ONS, 2003) – in other words, the value of fish harvested is less than the total cost of harvesting them. This is relaxed, however, in work by eftec for Defra on scoping marine natural capital accounts for the UK and in eftec (2015) that includes modelling of future values with stock recovery. But the fact that current commercial rents tend to be low is a reflection of historically poor management leading to depressed stocks and an inefficient industry structure: there is little doubt that, with recovered stocks and improved management, fisheries' rents could be greatly improved.

Seafish (2006) present Input-Output analysis of the UK sea fishing and fish processing sectors, breaking down analysis by type of fishing, distinguishing between the impacts of landings from UK and foreign vessels, and providing estimates of regional impacts (Figure 4). The analysis uses Type II multipliers, meaning indirect and induced impacts are covered. This gives a more complete view of the economic impact of the sector, but risks overstating the GDP and employment consequences because supply-side, wage and price adjustments are not considered in the fixed-coefficient IO method. The estimates of marginal changes in activity will be more robust, since any wage and price impacts would be minor for small changes.

		GDP change (£m)	%change in GDP	Employment (FTEs)
Sea fishing	Demersal	-319.2	-0.04%	-12,939
	Shellfish	-217.5	-0.02%	-13,106
	Pelagic	-136.2	-0.01%	-2,654
Fish processing	Demersal	-2,630.4	-0.29%	-82,985
	Shellfish	-1,435.9	-0.16%	-48,263
	Pelagic	-284.9	-0.03%	-6,624
All fishing sectors		-672.7	-0.07%	-28,691
All fish processing		-3,891.1	-0.43%	-118,320
All sea fishing and fish processing sectors		-4,342.2	-0.48%	-137,601

Figure 4: Results of IO analysis of total loss of the UK fisheries sector, using Type II multipliers (source: Seafish 2006; values in 2002)

These figures are similar to those provided by the Cabinet Office (2004) for the UK fishing sector for approximately the same period. With a focus on the fish catching sector alone (i.e. excluding fish processing), they report at least 12,000 direct jobs, and "the UK catching industry lands over £540 million in catches each year, resulting in between £800-1200 million of economic activity in the UK". They also note that half of UK fish catch (by value) is exported.

In both cases the figures are now somewhat dated, and the multipliers will have changed somewhat, however the general picture of landings supporting a larger volume of economic activity, processing, exports and employment broadly reflects the situation.

3.4.2 NEV valuations of commercial fishing

In cost-benefit analysis under the TEV framework, commercial fisheries are usually considered simply in terms of market values, less costs. In principle, if one were seeking to estimate NEV, resource rent in commercial fishing would be only the starting point. One would then add on any Consumers Surplus from consuming fish. The next step would be to identify market imperfections and external effects, insofar as data permit. These other values include both benefits (for example, consumers' surplus, tourism values for seeing fishing boats and equipment, non-use values for conserving traditional fisheries, fishers enjoyment of their occupation) and costs (for example conservation and non-use values associated with fish stock depletion and habitat damage), as explained in section 3.3 above. However, expressing these in NEV terms is challenging and rarely attempted.

3.4.3 Summary of valuations for commercial fishing

Simple statistics on landings and sale values are common, while more detailed analysis using IO models is possible and enables a more detailed demonstration of economic impacts. Uncertainties remain regarding the consequences of major changes in commercial activity levels, associated with uncertain supply-side, wage and price adjustments (not covered by IO analysis) and uncertainties about displacement and substitution. NEV assessments tend to be limited to resource rent calculations: though in principle non-market impacts should be taken into account, in practice these are hard to measure robustly and are generally either assumed to be minor or discussed in non-monetary terms

3.5 Valuations of recreational angling

Sea angling is a popular activity in the UK with over 1 million participants in 2012, spending a total of almost 4 million days fishing every year (Armstrong et al., 2013). This activity, like commercial fishing, contributes to the UK economy. Given that the catch is not sold, different methods and data can be used to measure the economic impacts of recreational angling; the main approaches are:

- Regional economic impact modelling, grounded in multipliers applied to angler expenditure (a form of EIA), and
- Welfare based evaluations of angler utility through revealed preference (travel cost) or stated preference methods (under the TEV framework).

3.5.1 EIA valuations of recreational angling

Brownscombe et al (2014) note that "compared to the commercial fishing sector, which is well studied and monitored … recreational fisheries are poorly understood." Even basic information on participation is often lacking; or unreliable. They report an exception, Canada, with large, nation-wide survey data every 5 years from 1975 to 2010.[23] Angling participation peaked in 1985 at 5.2 million, and has since declined to 3.6 million; the average age of anglers has increased from 41 in 1975 to 50 in 2010. These figures relate primarily to freshwater (93% of fishing days) in Canada, so

[23] See www.dfo-mpo.gc.ca/stats/rec/canada-rec-eng.htm - with over 30,000 respondents in each survey, and low coefficients of variation, the data are considered to be highly reliable, with low probability of bias.

the trend is not transferable to UK marine angling, but serves to illustrate that shifts in demand over time may warrant consideration in long-term planning.

Since there is usually no direct monitoring of angler activity or expenditure, key steps in EIA evaluation are generally to estimate the total number of anglers, or the number of trips, for the area of interest, and to estimate the expenditure per angler per year or per trip as appropriate. Total expenditure on sea angling can include fishing gear, bait, transport and parking, food, accommodation, competition, magazines, boats and insurance, charter fees, harbour dues, and other expenditures. Estimates can be derived from survey data, either through omnibus surveys, bespoke surveys of known anglers, or via regular national surveys.

In England, the Monitor of Engagement with the Natural Environment (MENE)[24] has the advantage of recording responses year on year and has now built up 5 years of data, including information on outset and visit locations, and some expenditure details, and the data are freely available. The survey does not distinguish different types of recreational fishing, but does record details of location type, meaning that marine and freshwater fishing can be clearly distinguished. Bespoke surveys allow much more detailed questioning relating to specific activities and expenditures, but are expensive.

There are several examples of studies looking at the value of recreational angling to the economy, at different scales and with slightly different methodologies. One of the main problems is finding the 'right' multipliers for a particular fishery or activity. Displacement and leakage are key issues in any evaluation. The linear assumptions behind multipliers need not hold true for any major changes. In the case of a cessation of commercial fishing for a particular stock, it is possible that the economic impacts could be greater or less than anticipated, and using IO modelling to predict consequences of major changes (such as complete cessation of an activity) is likely to involve significant error.

Notable studies include Radford et al (2009) who estimated the direct, indirect and induced economic impacts of sea angling in the eight Scottish Economic Development Office areas, using data from, in particular, an Omnibus survey to determine participation rates and an angler survey to determine angling locations and expenditures. Data were analysed using the Detailed Regional Economic Accounting Model (DREAM®), a combination of local IO tables with a trade model to identify purchases from outside the area and a tourism satellite account to convert tourism expenditures to commodity terms (Figure 5).

[24] https://www.gov.uk/government/collections/monitor-of-engagement-with-the-natural-environment-survey-purpose-and-results

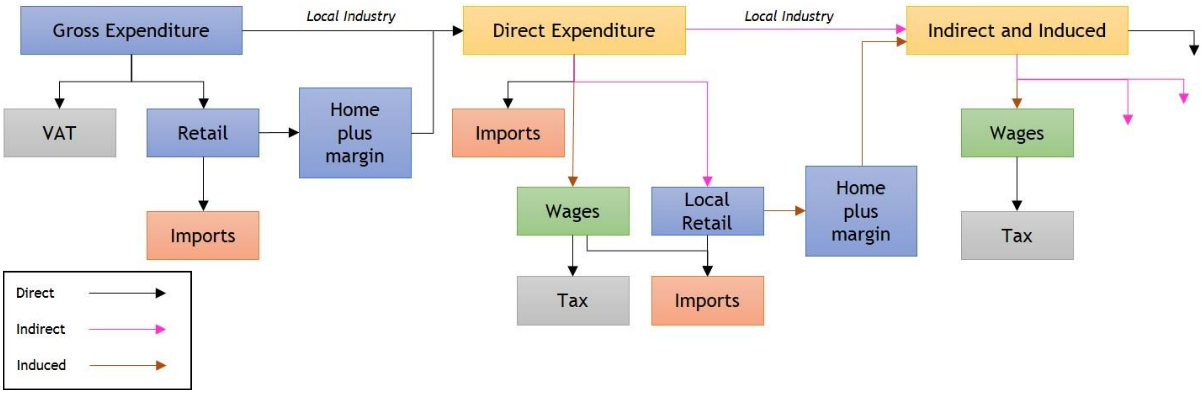

Figure 5: The DREAM model (source: adapted from Radford et al 2009)

For Scotland as a whole, they estimated that in 2009 sea angling generated £141m in gross expenditure, which after deduction of taxes and imports represented £71m of direct expenditure. and a further £85m of indirect and induced expenditure. In income terms (wages, self-employment income, rents and profits), this represented £70m for Scottish households, and supported 3,148 FTE. It should be noted that the baseline here was the complete loss of all sea angling and the main contribution of this work might be in terms of providing information about average values. For example, we can calculate the number of sea angler days required, on average, to generate one additional job or an additional £10,000 of household income. These averages could approximate to marginal values, IF we assume relationships are broadly linear, especially over small ranges.

The most recent assessment at England level is the Sea Angling 2012 project. The website[25] gives the rationale that there was very little information on catches or the number of angling trips, making it difficult to integrate sea angling within inshore fisheries management, and that the European Data Collection Framework and Control Regulation requires member states to collect and report data on recreational catches of certain species to give a clearer picture of how fishing activities are affecting the stocks. The project, funded by Defra, was the biggest ever national survey of sea angling, and aimed “to find out how many people enjoy the sport, how many fish they catch, how many fish they return to the sea and how important the sport is to the country’s economy.” It is noteworthy that this brief does not cover the TEV of angling, nor does it mention marginal values associated with changing resource allocations.

The results (Armstrong et al 2013; Brown et al 2013) show that total resident sea angler spending (including trip and major spend items) in England was estimated to be £1.23bn. The annual spending figure of £1.23bn falls to £831m once account is taken of imports and taxes. This £831m of spend is estimated to directly support some 10,400 FTE jobs and £360 million of income / GVA. When indirect and induced effects are included, this rises to over 23,600 jobs and almost £980 million of GVA.

25 https://www.gov.uk/government/policies/reforming-and-managing-marine-fisheries-for-a-prosperous-fishing-industry-and-a-healthy-marine-environment/supporting-pages/sea-angling

3.5.2 NEV valuations of recreational angling

Drew Associates (2004) estimated both economic impact and welfare effects. The study included a series of surveys to collate information on the economic contribution of sea angling (from shore and boat, including private and charter):

- General public survey to estimate the number of people engaged in sea angling in England and Wales;
- User survey to establish sea anglers' patterns of activity and expenditure; and
- Business survey to estimate employment and income effects of expenditure on sea angling.

The study reports on a contingent valuation question, a choice experiment and a travel cost method, as well as estimation of expenditure by sea anglers. The results are combined to produce a "total value of the angling experience" (between £600m and £1.3bn per year) based on summing actual expenditure per day and consumer surplus estimates:

- Shore angling (£224m - £473m per year): £21.6 expenditure per day, £5.7 - £35.5 consumer surplus per day (= £27-57/day); 0.61m households; 13.62 days angling per household per year.
- Charter boat (£102m – £189m per year): £67.7 expenditure per day, £18.4 - £90.9 consumer surplus per day (= £86-159/day); 0.24m households; 4.96 households days angling per household per year.
- Private boat (£329m - £635m): £87.9 expenditure per day, £14.3 - £108.7 consumer surplus per day (=£102-197/day); 0.26m households; 12.41 days angling per household per year.

The consumer surplus estimates are welfare-based (TEV) estimates; as noted above, producer surplus is considered negligible if suppliers make only normal profits. The results can also be used for EIA purposes, with annual expenditure ranged from £964 per year (shore angling) to £2,566 per year (private boat). This implies a range for expenditure per day angling of £22 per day (shore) to £88 per day (private boat). Total expenditure by sea anglers resident in England and Wales was estimated as £538m per year from 12.7m angling days. Around half of expenditure was by private boat owners (52%), which includes capital expenditure on boats and equipment. Shore anglers accounted for 37% of expenditure. Overall expenditure on angling was estimated to account for approximately 19,000 jobs and £71m supplied income. Multiplier effects were not accounted for, however, so these figures are not directly comparable with studies that also cover indirect and induced effects.

Arlinghaus and Mehner (2004) argue for a combined approach using surveys that assess the economic impact of angling through total expenditures (supporting EIA), and then ask anglers how much additional money they would be willing to pay before deciding to stop the activity (allowing estimation of TEV). They argue this form of stated-preference is well-suited to recreational angling since the good is familiar to respondents, they are generally used to paying for participation, and the recap of actual expenditure serves as a reminder of budgets and costs. NOAA Fisheries has carried out research[26] using a split-sample method, contrasting (1) hypothetical willingness to pay

[26] http://www.st.nmfs.noaa.gov/Assets/economics/fisheries/commercial/allocation-workshop/steinbackAllocationRecLicenseSilverSpring.pdf

for a recreational fishing permit, (2) hypothetical willingness to accept compensation for giving up a permit and (3) actual offers of compensation for giving up a permit. They found hypothetical WTA much higher than hypothetical WTP (a common finding), but actual WTA falling halfway between the other estimates. This suggests that WTP methods may underestimate the losses that recreational anglers might experience from a loss of access to fishing opportunities, though there may be less important differences between WTP and WTA for smaller changes in the quality of fishing available.

3.5.3 Additionality / displacement and substitute activities

Edwards (1990) notes that often evaluations of recreational fishing treat consumption of goods and services which are unrelated to fishing trips (such as meals and souvenirs) as "direct" effects, even when recreational fishing comprises only part of a trip or holiday. Drew Associates (2004) stress that much of the estimated expenditure on sea angling, and associated jobs and income, could be considered displacement, in the sense that the resources would be diverted to other uses if sea angling were not an option. Some authors have addressed this issue directly. Cappell and Lawrence (2005) identify alternative activities via a survey of sea anglers in the South West of England. They found that:

- One third of the sea anglers surveyed would take up coarse angling as an alternative to sea angling;
- 26% would carry on sea angling elsewhere in the UK;
- 22% would undertake other types of outdoor activities, such as walking, golf, boating and field sports (including fly fishing and shooting);
- 12% would go sea angling overseas; and
- The remaining 9% would substitute sea angling with other (non-outdoor) activities.

The findings of this study suggest that the main impact of a decrease in sea angling in the South West would be a reduction in anglers' expenditure in the region due to angling being undertaken elsewhere in the UK or overseas.

Radford et al (2009) specifically asked (via internet survey) what sea-anglers would do in such an eventuality – fish in another Scottish region, fish outside Scotland, or not fish. They assume that those who would switch to fishing in other areas represent a regional loss, while those who would not fish do not (since they would spend resources on other activities, likely in the region). They concluded that a cessation of sea angling would lead to a net loss of £37m in annual income, and at least 1,675 FTE – a little over half of the total values estimated as supported by the activity (see above). The difference is due to displacement.

Seemingly similar issues arise in commercial fishing. Where one fishery declines, is closed, or is subject to tighter quota restrictions, commercial fishers may switch to other fisheries, areas and gear types. However if these other fisheries are near or beyond capacity, this may not be possible, or will involve losses for other fishers and/or stock depletion. The same may be true for some displaced recreational activities – if displacement is to activities where there is no spare capacity – while if there is spare capacity (no overcrowding) the shift may involve little loss overall. For both commercial and recreational fisheries, the sizes of these displacement and substitution effects remain key uncertainties.

3.5.4 Summary of valuations for recreational angling

Overall, the evidence suggests that expenditure and associated GVA and employment are significant, but with uncertainty regarding the consequences of changes in activity levels, due to lack of reliable data on additionality/displacement and substitute activities. In addition, there is clearly significant consumer surplus associated with angling, that is not taken into account in an EIA approach.

3.6 Comparisons of commercial fishing and recreational angling

The first step in approaching comparisons of commercial fishing and recreation angling is to ask: What is the policy context for this comparison? Total values of sectors, and comparisons of them, are not particularly relevant from a policy perspective. Policy analysis is more concerned with the consequences of changes in policy and resource allocation, and these are rarely all-or-nothing decisions affecting a whole sector. Marginal comparisons could be policy-relevant, however, if there is conflict between different uses of resources, and in this specific case, between commercial fishing and recreation. The most obvious source of such conflict would be through targeting the same stocks, resulting in stocks that are sub-optimally low for one or both sectors, and/or in divergent marginal valuations where greater social value could arise from shifting catch from one sector to the other. In some inshore areas habitat change resulting from the dragging of gear across the sea bed could also have consequences for the recreational sector.

Indeed, many fish stocks are fished too heavily, resulting in a loss of fisheries rents (Arnason 2013): greater catches and values could be achieved if stocks were allowed to replenish (Norman-López & Pascoe, 2011). In the UK, indicator 33 (Sustainable Fisheries) of the National Wellbeing Statistics (ONS 2014a) shows an improving trend, but still reports under half of fisheries as being harvested sustainably and at full reproductive capacity. This impacts on commercial fishing, and also on the value of recreational angling.

The question is important, because the stakes are high. Well-managed fisheries could support healthy levels of commercial fishing, recreational angling, or both. There may be fisheries in which an economic case can be made for one or the other of these sectors to dominate or hold exclusive rights. Indeed there are examples of fisheries that have become exclusively recreational, for example the sea bass fishery in Ireland, where severe depletion led to closure of the commercial fishery in 1990 to conserve stocks, that have since been regarded, and strongly regulated, as an angling species (Inland Fisheries Ireland 2014). There will be many other fisheries in which value is maximised by sharing the resource, with a need to reconcile conflicting management goals. But the worst solution for everyone is overexploitation leading to depleted stocks that provide low value to both sectors.

3.6.1 Competition for fish

There is concern over conflicts between commercial and recreational uses of fish stocks, in many parts of the world (Abbott 2015; Arnason 2009; Arlinghaus 2008; Bower et al 2014; Green 1994; Lloret & Font 2013, MacKenzie & Cox 2013). Some fish species are important for both commercial fishing and recreational angling, and also vulnerable to overfishing – for example sea bass (Cooke & Cowx 2006). Other species that are of value to both commercial fishers and anglers include, for example, mackerel and cod (Cappell and Lawrence, 2005). It should also be noted that there are many species of high importance for commercial fishing and low importance to recreational anglers (e.g. lobsters, crabs, soles, scallops, monkfish, cuttlefish, hake); similarly, some species (e.g. mullet, flounder, wrasse, conger) have little value to commercial fishers and are of high interest to anglers (Cappell and Lawrence, 2005). Consequently, direct competition over stock between recreational anglers and commercial fishers generally concerns a limited number of specific species. However, competition need not be direct (targeting the same fish) but can also be spatial (where commercial fishers and recreational anglers target the same area at a same moment in time), or indirect (through food chain and environmental impacts linking commercial and recreational stocks - Lewin et al., 2006).

The direct impacts are considered for example by Eero et al (2015) who investigate the sensitivity of the calculated commercial total allowable catch (TAC) to including recreational catches in stock assessment. Schuhmann & Easley (2000) model commercial-recreational allocation and catch dynamics. Easley and Prochaska (1987) develop appropriate methods and measures for allocating harvests across competing uses. Some authors also assess conflicts between recreational fishing and conservation, for example Cooke et al (2014) consider the issue of angling for endangered species. In 2013 and 2014, National Oceanic and Atmospheric Administration (NOAA) Fisheries used a bioeconomic simulation model of recreational fishing in order to establish marine recreational fishery regulations for fishery in the United States (ICES, 2014).

Recreational sea angling has been considered as having a relatively small impact on the environment and on the number of fish in comparison with commercial fishing, which has a more significant impact on fish stock and (for certain gear types) inflicts important damage to habitats (Bernan, 2008). Nevertheless, it has become more evident that angling can also lead to a deterioration of fish stocks and have a negative impact on marine ecosystems (Lewin et al., 2006). Globally, recreational catches represent approximately 12% of catches (Cooke and Cowx 2004), and for some fisheries recreational fishing has contributed significantly to overall depletion (Coleman et al. 2004; Cooke and Cowx 2004). Though there are relatively few known cases where recreational fishing has been shown to be the main driver behind stock declines, these declines were "largely unnoticed by fisheries managers, a characteristic that may be widespread in recreational fisheries" (Cooke and Cowx 2006), primarily because recreational catches are generally not recorded. And there are fisheries for certain species where the quantity of fish caught by recreational anglers can be similar to or greater than the commercial catch (Ford and Gilmour, 2013), including some recreation-only fisheries. Cooke and Cowx (2006) argue in particular that "Despite the perception that recreational fishing is a benign activity, participation world-wide is vast … and appears to be increasing in most jurisdictions." This, combined with the fact that most fisheries are fully exploited, overexploited or depleted, means that in many cases, in the absence of strong management measures, both recreational and commercial fishing act to keep stocks depressed, especially at local scales.

A key factor in determining the relative impacts is the fate of discarded and released fish. In both commercial and recreational fisheries, undersized and over-quota / over-bag-limit fish must be discarded/released, and often non-target species will also be discarded. In recreational fisheries, release may also occur for ethical, conservation or sporting reasons. Cooke and Cowx (2006) suggest that about 60% of angled fish are released but stress that the key unknown parameter is what proportion of these fish survive. Ferter et al. (2013) find that in several European countries over half of the total marine recreational catch is released, and for England report 70% for cod, 77% for sea bass and 82% for pollack. However, not all of these fish survive. Millard et al. (2003) report that catch-and-release represents over 90% of catch of striped bass on the east coast of North America, but that mortality of released fish is 28% (with 95% confidence interval 17–44%). Ferter et al (2013) report lower figures often below 15%. Cooke and Cowx (2006) point out that this is not the end of the story, with sub-lethal effects (reduced growth/reproductive fitness, greater susceptibility to post-release predation) poorly understood. Cooke et al (2006) argue that in some cases catch and release could even be compatible with no-take marine protected areas, if lethal and sublethal effects are low, and there are no negative ecological consequences for the ecosystem. The effects are variable across species, water conditions, gear and handling. Similar issues arise for commercial discards, with highly variable mortality rates depending on species, gear and so on. In addition, there are lethal and sub-lethal effects for some fish that are not caught and discarded, but rather damaged by fishing gear, and these do not feature in the discards statistics. Cooke and Cowx cite further common/similar impacts for recreational and commercial fishing, including:

- Size-selective fishing creating natural selection pressures, for example, for smaller size and earlier sexual maturity;
- Ecosystem/food-web impacts; and
- Habitat damage and 'ghost-fishing' from lost gear.

The conclusion from this impacts perspective matches that from an economic 'value-maximisation' perspective: we should not be contrasting commercial and recreational fishing as stark alternatives, but rather looking at the combined impacts, and considering the appropriate ways of managing these sectors together.

Despite this, Abbot (2015) reports that "Compared to commercial fisheries, innovation in the management of marine recreational fisheries has been glacial." Unlike in Australia or the USA, the co-management of fish stocks in relation to recreational angling and commercial fisheries, aiming at balancing the environmental, economic, and social effects of both activities, is not current in Europe (Hyder et al., 2014). One reason for the difficulty in establishing an efficient management of resources is a lack of available data on recreational fishery (including fish mortality from catch-and-release) which introduces errors in fish stock assessments. There is a need, therefore, to improve the evidence base about the values of different commercial and recreational fisheries, and interactions between them, in order to assess and address these possible conflicts.

The situation is changing; since 2002, European countries have been required to quantify recreational catches of specific species such as Atlantic salmon, European eel, European sea bass, Atlantic cod, sharks, Atlantic Bluefin tuna, as well as threatened species (such as the Atlantic cod) important to both activities. In order to obtain information related to recreational fishery, surveys have to be conducted with the population at the national level - unlike commercial fishers, anglers (and their vessels) are not registered. A list of the most recent marine recreational fishing surveys conducted in Europe is presented in ICES (2014). The results are now feeding through into ICES modelling and advice. For sea bass in areas IVbc and VIIa,d-h (North Sea, Channel, Celtic Sea and Irish Sea), for example, the ICES WGCSE Report 2014[27] section 10.1 concludes that "recreational fishing may account for almost 30% of total fishery removals and fishing mortality, and this represents a significant missing catch from the assessment."

3.6.2 Economic comparisons

As part of the overall debate regarding the allocation of fishing rights between different commercial and recreational interests, various studies have sought to compare the economic contributions of different sectors. For example, Southwick Associates (2013) analyse NOAA's recreational and commercial fisheries data for saltwater species in the USA. They report that in

[27] http://www.ices.dk/community/groups/Pages/WGCSE.aspx

2011 anglers landed 204.9 million pounds of saltwater fish, spending $26.8 billion on fishing tackle and equipment and trip-related goods and services. With type II multiplier effects, this generated $70.3 billion in economic output (sales), $32.5 billion in gross value added, and supported 454,542 jobs with $20.5 billion in income. Commercial fishers in the US landed 9.9 billion pounds of fin- and shellfish in 2011 valued at $5.3 billion. Of this, 4.9 billion pounds of finfish were from species frequently targeted by anglers, with a landed value of $2.1 billion. Including multiplier effects along the entire value chain from harvesters to processors to final consumers, commercial finfish harvest of species also sought by anglers generated $20.5 billion of economic output, $10.6 billion in value-added and 304,611 jobs with $7.5 billion of income. These figures establish that more jobs and GVA arise from recreational sea angling than from commercial fishing for the same stocks (i.e. excluding stocks that are only fished commercially). However, they tell us nothing about the marginal benefits of shifting stock allocations between sectors.

Southwick Associates (2005) take a narrower focus, assessing the economic contributions of commercial and recreational fishing for striped bass in estuarine and marine waters from Maine to North Carolina. They consider both economic impacts and economic value. For recreational angling, they limit attention to trips targeting striped bass, and including expenditure for travel and equipment. They make a distinction between ‘economic importance’ covering resident and non-resident spending, and ‘economic impact’ focusing only on non-resident spending. Leaving to one side issues about the distinction between costs and values, there is an issue here relating to inclusion of expenditures such as boat fuel and private transportation costs, most of which immediately leak out of the area. Secondly, some annual expenditures may be used for more than simply bass fishing.

For the commercial sector, the assessment is based on landings values for striped bass, adjusted via multipliers for indirect and induced effects. This is quite different from the expenditure-based approach for recreational fishing. However, on the assumption that commercial fishing is a profitable activity, the landings values must exceed the costs / expenditures. The calculations include the processing and distribution of fish products – not the entire industry, but in proportion to the bass entering the chain.

The findings report that, relative to the commercial fishery, landings are 3.2 times higher, angler expenditures 55.9 higher than commercial sales, the GVA multiplier effect 26.5 times higher, and jobs 12.6 times higher. These figures are comparable in the sense of telling us what the current relative sources of value are, but do not directly reveal anything about the consequences of changing allocations. To do this, Southwick Associates (2005) attempt to assess the consequences of reallocating the 7.1 million lbs of bass harvested by commercial fishers to the recreational sector, assuming that “state authorities would be able to adjust seasons and bag and size limits in a way that permits the harvest of the additional fish”. They base their calculations on the fact that “the average recreational fishing trip landed an average of 0.07 striped bass/trip”, equivalent to 0.6419 lbs per trip. It is not clear how many fish were caught and released, though presumably the proportion is high.

They use these figures to suggest that allocating the commercial catch to recreational fishing would enable a maximum of additional 11 million trips, based on this 0.6419 lbs per trip estimate. This is about the same as the current number of trips targeting bass; they assume only 31% of the potential new trips would target bass, suggesting an additional 3.4 million trips. They wrongly suggest that this scenario “assumes demand for fishing would remain static at 2003 levels”, but this would only be true if demand were assumed to be a linear function of fish catch. Other evidence presented suggests that demand for trips is roughly linear in the fish stock size, but that is not at all the same thing.

These calculations rest on very extreme assumptions. Since on average only 0.07 striped bass are landed from each trip, it is rather clear that actual landings are not the driving factor in fishing trips. To spell the assumption out differently, it assumes that each individual fish not caught by a commercial vessel will result in a maximum of 14 additional recreational trips to catch it, reduced to 4.3 trips because only 31% of trips target bass. There is basically no justification for this assumption, and no consideration here of the demand for fishing trips. It would be much more plausible (though still an 'extreme' assumption) to suppose that roughly the same number of trips would take place, with each experiencing a slightly better fishing experience – perhaps landing more, or perhaps just catching and releasing more. Some more anglers may be attracted to the fishery, and some existing anglers may take more trips, but these crucial elasticities are not discussed. The authors recognise, but do not adjust for, the fact that much of the expenditure is not directly related to the number of trips, or the number of fish caught.

To be clear, the criticism of the Southwick Associates findings is not directed at the initial estimates of relative landings, GVA or jobs supported. There are debates to be had about the correct multipliers and boundaries, but by and large these figures do demonstrate that recreational fishing for striped bass was 'bigger' in economic terms than commercial fishing for the same stock. The point rather is that this finding is largely irrelevant to the question of optimal resource allocation, and the attempted extension to demonstrate the consequences of changing allocation is fatally flawed. It is entirely possible that shifting allocation from commercial to recreational fishing in the striped bass case *could* increase social values, but the Southwick Associates estimates do not cast light on this question. To do this, we would need to use market studies and surveys to explore the *demand* for angling – how would angling trips and values respond to changes in allocation? And, given the evidence that landings are not the driving factor behind angling – catch rates and maximum sizes are more important – it is likely that we should consider stock improvements rather than simple shifting of fishing mortality.

In the UK, MRAG (2014) makes direct comparison of the economic impact of recreational and commercial bass fishing off the Sussex coast. With various assumptions and uncertainties, they estimate the total landings from each sector – about 250 tonnes from commercial and 17-31 tonnes from recreational, with an estimate of 12-22 tonnes killed (kept, or dying after release) in 2012. Based on expenditures and multipliers, they further estimate that recreational fishing for bass supports £31m GVA and 353 FTE, compared to £9m and 111 FTE for the commercial fishery. Values per tonne are also presented, and are orders of magnitude higher for recreational fishing: £1.6–3.0m in terms of final economic output and 18–34 FTEs per tonne removed, compared to £0.04m in terms of final economic output and 0.45 FTEs.

The MRAG report was a rapid assessment, primarily using existing data, and it highlighted various data gaps and assumptions that needed to be made to fill them. It could be argued, therefore, that refined data (or different assumptions) might somewhat change the results – for example, some part of the angling expenditure is probably not additional (i.e. it is displacement from other expenditure), not all expenditure is exclusively bass-fishing related, and the benefits to anglers may be dependent on more features than just the tonnage of fish captured. Nevertheless, within the caveats noted, the figures do establish that the recreational fishery currently brings greater economic impact than the commercial fishery, although the commercial fishery has a much more significant impact on stocks (higher mortality/removals).

At the same time, the report cites evidence that "It is widely acknowledged that the continued overfishing and downward trend in the health of the stock will have implications for the future viability of fishing activities and communities which are socially and economically reliant on bass." This is strongly suggestive that total mortality should be reduced, at least for a time, in order to allow the stock to recover. The policy dilemma underpinning the MRAG report was the need to establish where such reductions of effort should fall in the short term.

The report demonstrates higher economic benefits from recreational fishing, but it also stressed that commercial fishing creates benefits beyond the provision and sale of fish, including positive contributions to coastal communities, the important role that they can have as an 'indigenous industry', the cultural traditions of inshore fishing and contributions to the social fabric of coastal communities. The MRAG study also identified that bass were important to particular segments of the commercial fishing industry because of a combination of high market value, seasonality, small quota allocation for other species (e.g. cod and plaice) and the non-quota nature of bass. For these fishers bass can play a role in overall fishing operations that would be difficult to replace, making restriction harder to bear than for other segments.

The policy question of where to make short-term reductions in current effort (or mortality) given the actual stock levels could be extended to a more general policy question of optimal management of fish stocks that includes consideration of what the stock size should be in a well-managed and sustainable fishery. Given the relative values presented, it is entirely possible that there could be more recreational angling in a recovered fishery: this depends on demand for angling, which is not directly covered in the report, but it can be assumed based on other studies that better angling conditions (higher stocks, bigger fish) would (1) probably attract more anglers/trips and (2) improve values per trip for existing anglers. While (1) may represent displacement from elsewhere, some of that may be from overseas and so represent a net gain to the UK; (2) may not be detected in expenditure terms, but is a welfare gain for anglers. It is also likely that increased angling could take place without imposing major pressure on stocks, especially if catch and release is prevalent.

What is less clear is how this would influence commercial landings, long term. Some initial restraint in catch levels, to allow stocks to recover, is likely to be desirable. But once stocks have recovered, it may in some cases be possible to continue commercial fishing at levels not too different from today's, at the same time as providing improved recreational opportunities (though environmental changes could alter stock dynamics and also need to be considered). It may be possible to increase angling with relatively small increase in mortality, through encouraging and/or requiring catch and release, although catch and release levels are already high and some mortality of released fish is inevitable.

The key questions relevant to policy for optimal long-term stock management would therefore be rather different from the issues regarding short-term effort reduction:

1. Would higher bass stocks lead to greater recreational fishing activity, and/or greater value per angling trip?
2. At optimal stock levels, what allocation of fishing mortality between commercial and recreational fishing maximises welfare?
3. Should there be – primarily as a matter of distributional policy not efficiency – any compensation to 'losers', or payment from 'winners', following any change in allocation?

These important questions are not really tackled by comparisons of the current total values supported by the sectors. These are 'snapshots' that ignore stock dynamics, expenditure displacement and demand features, in particular the relationship between recreational catches, the value of the angling experience and the number of angling trips. To test the optimal allocation of stocks between the sectors, stock modelling and marginal valuation would be required, in particular for angling values. It would also be necessary to consider how changes in bass allocations might influence angling and commercial fishing on other stocks, in particular if any reduction in commercial bass allocation made fishing activity overall unprofitable for some fishers.

Although there is substantial research on commercial fishing on economic impact of tourism, and on the TEV of recreation including angling, there is rather little research on the marginal values of specific fish stocks to anglers, or of the marginal value of catching fish to anglers (Farr, 2013). Most studies do not distinguish between fish and non-fish characteristics of a fishing trip, do not treat any difference in value between retained and released catches, and do not focus on the factors influencing decisions to go fishing at particular places/times. Brown et al (2013) report from the Sea Angling 2012 research that "motivations for going sea angling are predominantly non-catch based" but also that "Better fish stocks was cited most often as the factor that would increase participation in sea angling, with declining fish stocks most often cited as a factor that would decrease the amount of sea angling undertaken." This is not as contradictory as it may at first appear – the former suggests that what people get out of sea angling goes well beyond simply catching fish, but at the same time the latter suggests that catching fish is an essential component of the overall experience.

Beardmore et al (2014) report that while it is recognised that anglers generally prefer high catch rates and large fish, the relative importance of these catch outcomes for catch satisfaction has not been established across species and angler types. Focusing on freshwater species in Germany, they find that catch satisfaction was primarily determined by catch rate and fish size in all fish species; but the relative importance varied considerably across species and among angler types (assessed by commitment to angling). They found diminishing marginal satisfaction for increasing catch rate, but monotonic increase in satisfaction for increasing size of largest retained fish. The number of other anglers seen had significant negative influence on catch satisfaction. Diversified trips increased satisfaction, and (all else being equal) specialized anglers increased catch satisfaction from fishing time. Johnston et al (2010) differentiate between generalist, consumptive and trophy angling styles, reporting different attitudes towards key fish-related factors including catch rates, mean size, maximum size, and minimum landing size, as well as non-fish factors such as crowding and cost. These factors influence behaviour (such as choice of fishing trips and catch and release) and also the values derived from different fisheries conditions.

It is by no means clear to what extent the above findings would transfer from Germany to the UK, or from freshwater to sea angling. However, the results suggest that managers (and analysts) need to consider not only the species but also the mix of anglers – for example, the preferences of anglers focusing on bass are likely to be different from generalists – and that further research into the determinants of demand for (and value of) sea angling could be beneficial.

3.6.3 Elasticities

The answers to the key questions about marginal values of changes in resource allocations depend on elasticities. Elasticities measure the amount by which a variable changes in response to changes in another variable. Key elasticities in economic analysis include:

- Own price elasticity, measuring the extent to which demand decreases when price increases. In almost all cases own price elasticity is negative, i.e. demand falls as price rises.
- Cross-price elasticity, measuring the extent to which demand for a good changes when price of another good changes. If cross-price elasticity is positive, the goods are substitutes; if negative, they are complements.

- Income elasticity, measuring the extent to which demand for a good increases when income increases. A ‘normal’ good has income elasticity between 0 and 1, a ‘luxury’ good greater than 1, and an inferior good less than 0.
- Expenditure elasticity, measuring the extent to which expenditure on a good increases when expenditure overall increases (this is used as a proxy for income elasticities)

However the elasticity concept can be applied to any changes; for current purposes, a particularly interesting elasticity is the elasticity of demand for recreational fishing with respect to size of the fish stock. If this demand is elastic (>1), this means a 1% increase in fish stocks would lead to more than 1% increase in recreational fishing; if inelastic (<1), it would lead to less than 1% increase.

Unfortunately, evidence on key elasticities is often lacking, and when it does exist, is specific to particular markets and times – although if it can be argued that situations, populations, tastes, incomes and economic structures are very similar, the elasticities are also likely to be similar. Large datasets and detailed statistical analysis are needed to produce robust estimates. Generally assessments are focused on specific markets, but one exception is a major 1996 international comparisons project (Seale et al 2003, Regmi & Seale 2010: see Figure 6; Table 1) that reports elasticities for recreation, food and fish (as part of food).

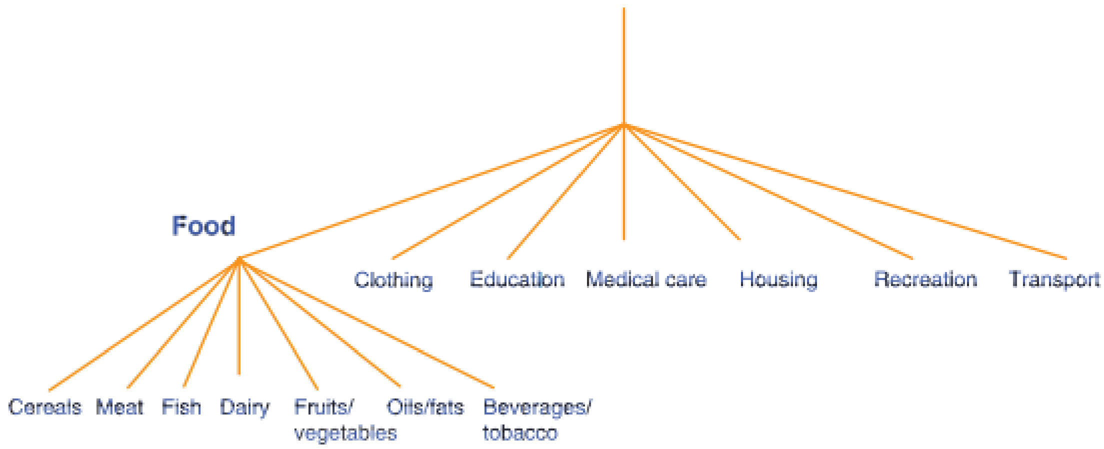

Figure 6: Two-stage budgeting model used by Seale et al (2003)

Table 1: UK elasticities from international comparison model (Seale et al 2003; Regmi & Seale 2010)

Elasticity	Recreation	Food	Fish
Income	1.298	0.330	
Expenditure	1.270	0.322	0.387
Own price (-)*	0.959-1.050	0.249-0.316	0.306-0.313

*Range from different methods (Frisch, Slutsky, Cournot, unconditional) of calculating elasticities.

These elasticities are based on old data (1996) but are broadly representative of elasticities estimated for high-income countries at that time. The key point to note is that in the UK (and more generally, in high income countries) recreation is clearly a luxury good, while food and fish are normal goods. For a 1% income increase, expenditure on recreation increases by about 1.3% while expenditure on food and fish increase by about 0.3% and about 0.4% respectively. Demand for recreation is quite sensitive to changes in recreation price, while demand for food is quite insensitive to changes in food prices. This is because food is a necessity. It is worth noting however that long-term elasticities for products like fish could be rather higher – people have consumption habits that may be quite inflexible in the short-term, especially for products that are a very small proportion of total budgets (e.g. fish), but that respond more to price in the longer term as substitutes are increasingly used. One implication of these elasticities is that if people become wealthier on average (due to economic growth) they will spend proportionately more on recreation and proportionately less on food and on fish.

Lack of data, in particular to estimate elasticities for recreational angling, makes assessment of impacts difficult. In consequence, analysis often resorts to the use of "strong and potentially consequential assumptions, such as perfectly elastic demand within the recreational sector" (Abbot 2015), as seen in the discussion above.

More generally, data quality is an important issue. There is potential for bias if survey response or data self-reporting over-represent the more committed participants, for example.

3.7 Conclusions

Comparing like with like is important. Many estimates of the value of recreational sea angling draw on welfare-based values in the TEV / NEV framework, while market values in the EIA framework form the basis of assessment of commercial fisheries and studies of the economic impact of angling. Many other indicators are also used (employment, GVA and so on). The key points are to make sure like is compared with like, and that values used are appropriate to the decision contexts: for example, exchange values for national accounting; welfare values for cost-benefit analysis of policy.

For EIA of commercial and recreational fishing, comparing like with like is very challenging. Fundamentally, the relevant concepts for analysis are different. For commercial fishing, catching and selling a profitable number of fish is for all practical purposes the whole point of the activity. For recreational angling, catching fish is important, but so are relaxing, getting outside, being by or on the water. Anglers spend money on items like hotels, meals and drinks that can be considered both to be a benefit in themselves (largely independent of the fish catch) and in part a displacement (they would spend these resources on some other activities if they were not angling in the area). The displacement might be to angling-related activities in other areas, to different activities in the same area, or to different activities in different areas – with different implications depending on the boundaries of the assessment. So while it is possible to compare the activities in terms of the current economic impact of landings and economic impacts of expenditures, this does not directly reveal the implications of changing levels of the activities.

It should also be recognised that static snapshots (such as provided by IO analysis) are often not suited to situations in which resource stocks could change significantly. According to the revised CFP, fishing opportunities are to be managed following a precautionary approach and ensuring exploitation rates according to the MSY ('maximum sustainable yield'). The MSY exploitation rate "shall be achieved by 2015 where possible and, on a progressive, incremental basis at the latest by 2020 for all stocks." The importance of considering possible changes in profitability due to stock changes is stressed by Whitmarsh et al (2000), who point out that "this calls for the commissioning not just of regular costs and earnings studies…but a modelling framework that can answer 'what-if?' questions about the way economic performance might be altered or improved under different policy scenarios."

The implication of the above arguments is that comparisons in terms of current economic impact, though feasible, do not reveal much about the economic implications of changes in activity levels – for this, more detailed consideration of elasticities, displacement and stock effects would be required, for both recreational and commercial fisheries. Furthermore, EIA assessments are not directly useful from the perspective of deciding optimal allocation of fish resources, which requires assessment of marginal values in a TEV/NEV framework. This leads on to the question treated in the next section, how to assess best values from resource stocks.

However, it should also be recognised that, in reality, policy or management decisions which are being informed by economic analysis may always have to be taken based on imperfect or incomplete findings or analyses. The suggestion that further research is required to determine in more detail the impact of possible changes should not be interpreted to mean that decision makers must always obtain every possible economic analysis before reaching a decision, nor that decision makers should favour economic information as being more important or relevant to their decisions than other considerations such as social justice or fairness.

4. Extracting best values from resources

The matter of assessing and comparing the economic contributions of different can be set in the broader context of seeking to extract best value from competing uses of scarce resources: given a scarce resource, such as a stock of sea bass, which activities can use it best to produce value for society? The classical economic approach to management of a resource is to determine the optimal value of some control variable(s) which will maximise the economic return from the resource – where 'economic return' in principle includes all the factors set out in sections 3.4 and 3.5. Bioeconomic modelling combined with market and non-market valuation methods can be used to assess the consequences of changes in resource allocations, and to determine economically optimal stocks and distribution of fishing mortality rights. A review of the wide and complex bioeconomics literature is beyond the scope of this report – interested readers could refer, for example, to Anderson and Seijo (2011) or Prellezo et al. (2012). Below, we consider briefly the main policy implications of bioeconomic models. Much of the literature comes from the perspective of maximising returns from a single-stock, whereas in practice most fisheries involve multiple species, and the parts of stocks targeted by recreational sea angling may overlap only partly with those targeted by commercial fishing. So often the idea of 'optimal' management is very hard to pin down or implement, and management is in effect seeking outcomes that are 'acceptable' solutions from various perspectives. Nevertheless, the basic insights of simple bioeconomic models do reveal some important policy-relevant conclusions for resource management.

4.1 Policy implications of bioeconomic modelling

Some bioeconomic models make many simplifying assumptions in order to yield tractable models that can be solved for general cases. The interest in these simplified 'analytical' models is not accurate representation of reality, but rather deriving generalisable insights that can guide thinking about fisheries at a more strategic level. Other models are more complex, but can only be solved numerically (i.e. for specific values of the variables), leading to advice for specific fisheries rather than conclusions about fisheries generally.

Many of the basic insights from analytical models carry forwards to the more complex models. They include, in particular:

- The economics approach of treating fish stocks as capital assets capable of providing a sustainable return over time;
- The trade-off between the productivity of fish left in the sea (through natural growth and the marginal reduction in harvesting costs for higher stocks) and the productivity of the monetary value when harvested (i.e. the return to investing the proceeds of fishing);

- The distinction between economic efficiency, which requires marginal values and marginal costs to be equated across uses of a resource, and fairness, which is a normative societal/political issue about which economics says relatively little[28]; and
- The result that social value is maximised if the marginal returns to different uses of a resource – such as commercial fishing and recreational angling - are equalised.[29]

One key insight from bioeconomic models relates to the impact of the behaviour of fishers. It is clear that, for any of the maxima considered - maximum sustainable yield, maximum sustainable profits, maximum net present value - there can be positive profits earned in the fishery. Gordon (1954) pointed out that positive profits will attract increased fishing effort, changing the equilibrium in the fishery, until a point is reached at which no profits are earned, the open access equilibrium. Here, there are no profits to draw more effort in to the fishery, and all economic rent has been dissipated.

So an open access fishery is one in which the resource is exploited down to the level at which marginal profit equals zero. This is easily explained: in open access, there is no restriction placed upon utilisation of the resource. As a direct consequence, there is no incentive to conserve stock which may otherwise be profitably exploited.

This characteristic of open access is sometimes misguidedly termed the 'tragedy of the commons'. In fact, open access and common property are not the same: common property resources tend to display restrictions on who may exploit the resource and on the manner in which they may do so. Pure open access can be viewed as an extreme case. Nevertheless there are clearly cases in which open access is or has been a good representation of the exploitation of a resource, at least over a certain time period. Whaling is a good example, showing both the potential dangers of open access, and the potential for changing the situation by starting to recognise and manage the resource as common property.

The 'tragedy of open access' argument is one reason why some form of regulation of fisheries is generally seen as essential - whether the control is exercised by government or by local communities owning the resource as 'common property'. In order to reach the optimal fishing levels derived from models, regulation of either harvest or effort is required, since an unregulated, open access fishery will expand until all rent is dissipated. However that is not to say that such regulation must necessarily be centralised or externally imposed on user groups, or even legally formalised; just that some social or legal structure for regulating access is needed to avoid the rent dissipation of open access.

The form that such management should take has been and is the subject of much debate. Many analytical models show optimal policy to be one of 'constant escapement', i.e. leaving the same stock of fish unharvested (to reproduce and grow) after each 'period'. In practical policy terms, constant escapement is quite an unrealistic proposition, because escapement cannot be controlled

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[28] In economic models, fairness is generally treated as a matter of distribution and compensation – if the efficient outcome involves winners and losers, compared to current allocations, should the losers be compensated, and how? – rather than a direct objective in optimisation models.

[29] Assuming an interior solution; where the marginal value of one use is always lower than another, a corner solution with none of the less-valuable use is possible.

directly (controls on catches and/or on fishing effort are the main tools of management) and because natural fluctuations and other uncertainties mean that stocks fluctuate. Nevertheless, simple analytical models can help reveal the different ways in which policy might influence a fishery.

Adding more realism leads to more complex models that generally can only be solved numerically, not analytically. These models tend to be developed for specific fisheries in quite an applied context, for example using Ecopath with Ecosim (EwE[30]) to develop and simulate complex foodwebs and harvesting relationships, and test policy interventions for specific cases. Numerical simulations of models can be used to help build up a picture of the likely effects of policy. Such models could be used to assess the implications for fish stocks, economic impacts and total economic values of different allocations of fishing mortality between different uses, including different commercial fleets and recreational angling.

4.2 Policy and fairness in commercial / angling distribution

Fundamentally, disagreements about the distribution (allocation) of fishing mortality between commercial and angling sectors are not really about which sector produces greater value to society. The arguments are really over who should benefit from access to scarce resources. It is fairly clear that for *some* fisheries, the potential marginal recreational values in wealthy, industrialised countries could exceed commercial marginal values. This is because angling has many participants and relatively few externalities, with a potentially limited impact on fish stocks and the physical environment, especially if catch and release is practiced and survivability is high. In contrast, in some commercial fisheries the revenue generated barely covers the costs of catching fish. Thus economic rents could be low, especially if management has been ineffective in controlling effort (capital invested). At the same time, consumer surplus could be low if there are substitute species or import substitutes. In addition, some commercial fisheries can have a significant level of discards and/or cause habitat damage. These effects could be impacting on other marine recreational activity, such as sea angling as well as general public values, as discussed in section 3.3.

There is often some room for manoeuvre through stock recovery: some stocks are currently overfished, and in these cases there is potential 'slack' to take up in a scenario of stock recovery. Stocks at healthy levels could support greater recreational fishing as well as the same or higher commercial fishing, or in some cases reallocating some part of stock/quota from commercial to recreation could increase total (TEV) values (this depends on the marginal values to each sector, not the totals). Table 2 below summarises some evidence on the potential for improvement in marine fisheries. This does not, however, get round the point that recreational fishers may prefer stocks at higher levels with higher numbers of large fish and quite small mortality levels.

The status quo in many fisheries is that commercial fishers have rights to access fish: the fact that it may be more economically efficient to allocate these fish to the recreational sector does not avoid the fact that this would be a loss to commercial fishers. Furthermore, these are potentially losses in perpetuity (in that maintaining the status quo would imply ongoing resource access rights for commercial fishers). But, if such a reallocation would increase total values, then it also follows

[30] http://www.ecopath.org/

that 'winning' recreational anglers could fully compensate commercial fishers for the loss of quota, and still be better off.

Indeed, Vivid Economics (2008) stress that the distribution of property rights is the fundamental issue in fishing. They argue that, while most rights to sea fishing are *de facto* rights based on historical access, that could not simply be revoked without the risk of a legal challenge, they are not absolute rights. Government has a role of protecting stocks for future generations and their right of access to fish, and food supply more generally. Further, society could legitimately claim some portion of the rents from the productivity of the fishery. They argue that "any solution that is both equitable and feasible will require the fishery to be managed sustainably, with the rents being shared between fishers and society." In economic terms, the question of rent sharing is one of distribution of benefits (or 'fairness'), but the question of which activities should have access to resources is one of efficiency.

Management could seek to move to efficient outcomes by altering stocks and allocations in line with marginal valuations. In principle, accountability and efficiency could be established by creating a quota market with transferability across sectors. Any fisher, recreational or commercial, wishing to increase catch would be required to purchase quota. With a free market in quota, the question of the initial distribution of quota (grandfathered, auctioned…) is essentially one of distribution (fairness) not efficiency. In practice this may be difficult to achieve, but there are various options for 'second-best' solutions that enhance accountability of recreational fishing and introduce means of jointly controlling effort/mortality for both sectors. Granek et al (2008) stress that "recreational fishers can be instrumental in successful fisheries conservation through active involvement in, or initiation of, conservation projects" They present case studies of successful involvement of recreational fishers in conservation and management activities, including enforcement, advocacy, conservation, management design, research, and monitoring.

Abbot (2015) argues, however, that "issues of inter-sector allocation are rarely a first-order concern." He sees this issue as a 'red herring' that soaks up attention while detracting from the more important and thornier problem of "how best to integrate recreational fisheries into the overall fisheries management strategy to achieve objectives of accountability and efficiency both within and between sectors." He argues that efficiency in mixed commercial/recreational fisheries can be split into two separate parts. At the sectoral level, management measures should maximize net benefits for the sector, given the allocation of fishing mortality to each sector. At the national level, total allowable/sustainable fishing mortality should be allocated across sectors so as to maximize total net benefits.

Most analysis focuses on the second part, through the principle of equalising the marginal returns to each sector. However, "comparing the respective marginal values across sectors at the current allocation provides qualitative guidance on the direction in which allocations should be adjusted, but little guidance on the size of the implied adjustment" (Abbot 2015). Abbot does not suggest that the equimarginal principle is incorrect, but rather stresses that in many real fisheries two other considerations may be of more practical importance.

Firstly, inefficient allocation *within* sectors, due to management institutions that do not foster efficiency (for example, commercial fisheries managed by 'total allowable catches' have often seen an inefficient 'race for fish', or virtual lack of control over fishing mortality in recreational fisheries). With inefficient allocations *within* both commercial and recreational[31] sectors, comparisons of marginal values are of very little use regarding attempts to achieve efficient allocation *between* sectors.

Secondly, given the stakes involved in distribution of property rights, changes in allocation only occur after lengthy and often heated debate, generally involve very high transactions costs and rent-seeking behaviour, and may be very difficult to reverse. This could be very important when the optimal outcome changes over time, for example due to natural fluctuations or to changes in demand and other economic factors. Abbot (2015) argues that the “potential for institutional hysteresis or even irreversibility implies that economists with a sincere interest in providing advice for fostering long-run efficiency should exercise caution and contemplate how short-run management decisions either enhance or detract from this objective”. This in itself does not mean that marginal comparisons should not drive decisions, at least in part, but, taken in conjunction with the previous paragraph, it does suggest that priority might be given to sorting out the efficiency within sectors. If at the same time measures can be taken to encourage stock recovery, enhance accountability and develop the necessary reporting and monitoring to assess marginal values, moving to efficient inter-sectoral allocations for recovered stocks may be an easier task.

Given high levels of catch and release in UK marine recreational fisheries, and potential willingness to extend this further, it is entirely possible that solutions could be found that enable better quality angling - with higher stock levels and larger specimens, and measures such as bag limits to limit mortality – at the same time as commercial fishing, with the marginal value of fishing mortality equated between the sectors. It is also possible that some fisheries would maximise value by having all mortality allocated to one or other of the sectors. This needs to be assessed on a case-by-case basis, based on analysis of the marginal values of fishing mortality. Analysis should take account of the impact on equilibrium stock size, which also influences values (through the value of the fishing experience for angling, and through the impact on costs per unit of catch for commercial fishing). Analysis should also take account, where relevant, of the fact that larger specimens are often worth more per unit mass to commercial and especially recreational users. These calculations are feasible, given effort to data collection, modelling and analysis, but they are quite different from static comparisons of total economic impact or total values of fisheries in their current state.

[31] For most recreational fisheries, stock externalities are likely to be minor, but in some fisheries there could be externalities in terms of congestion/crowding, i.e. the presence of ‘too many’ anglers diminishing the value of the experience for each other.

Table 2: Summary of case studies on economic benefits of restoring fisheries

Case study	Details	Cost	Benefits	Reference
UK fisheries	Current patterns of TACs assumed. Economic efficiency in catching to increase rents. Increasing value of the catch (market factors, quality).	Not estimated.	Current resource rents estimated at £50 million per year. Potential resource rent of £573 million per year.	IDDRA, 2010
UK mixed demersal fishery (cod, haddock, whiting)	Recovery of stocks, and removal of excessive effort in the fishery. Takes into account mixed fishery considerations (catch constrained by haddock TAC).	Fishing costs incorporated into the model.	Resource rent could be increased from £13.4 million (2006) per year to £339.2 million.	Bjorndal *et al.*, 2010
UK Western Channel sole fishery	Assessment of current and potential rents in the sole fishery in the English Channel. The substantial sole fishery fleet overcapacity resulted in rent dissipation and reduced landings.	Reduction in short-term landings to allow stock recovery.	Present value of £120m: difference between maximum revenues under stock recovery (£140m) compared to continued overfishing and extinction (£20m).	Bjorndal T, & Bezabih M (2010)
Seven EU fisheries	Simulated the recovery of stocks and elimination of overcapacity. 15-year rebuilding period.	Fleet size reduces from around 7,400 vessels to 5,700 vessels.	Nominal net profit could be increased almost five-fold. Net present value of profits over the 15-year rebuilding period would be an estimated €500 million.	Salz *et al*. (2010)
UK share of North Sea cod	Recovery of stock to MSY - Single species estimate - Single species with multispecies considerations (TAC constrained)	Costs not estimated.	Present value over 50 years between £1,473 million (multi-species, HMT discount rate) and £3,539 million (single species, HMT discount rate).	eftec et al. (2015)
Baltic Sea cod	Four scenarios: - Status quo; - Recovery programme 1, reducing catches for five years then increasing over the next 20 years - Recovery programme 2, reducing catches for five years then increasing over the next ten years; - Hypothesised sustainable catch. 50-year timescale.	The cost was €187 million in direct payments to compensate for lost profits.	NPV of benefits: €1,036 million over 50 years (4% discount rate). Investing in natural capital would provide benefits for discount rates up to 13.4%.	Döring & Egelkraut, 2008

Case study	Details	Cost	Benefits	Reference
49 over-fished North-East Atlantic fish stocks	Restoration of stocks to MSY levels. Assumes a moratorium on fishing to restore stocks in the minimum time.	€10.56 billion to cover crew costs and vessel depreciation (fixed costs, capital costs and interest on the capital were not included). Investment (recovery) period of 9.4 years.	Benefits of €16.8 billion per year (value of catches at MSY). Benefits likely to be overestimated as MSY taken from a study that estimated single-species MSY levels. These are unlikely to be achieved in a multispecies and mixed fishery context. Interim catch losses not fully accounted for.	NEF, 2012

5. Conclusions and Recommendations

Economics and political decision making are both concerned with the allocation of scarce resources among competing ends. In seeking to influence decision processes, stakeholders often turn to economics to build arguments about the relative values of different options for resource allocations. Two main analytical frameworks are common:

- Economic Impact Assessment, which focuses on contributions to economic activity, value added and jobs.
- Total Economic Value, which focuses on contributions to human/social welfare.

These frameworks can be used to assess values at different levels, including marginal values (the consequences of relatively small changes in resource allocation) and total values (the entire contribution of a sector).

Used for comparing sectors, total value estimates provide an interesting snapshot of actual relative contributions to the economy. But common methods based on Input Output analysis make strong assumptions about fixed prices and technological coefficients that mean the results do not represent the likely consequences of stopping a particular activity. Similarly, comparisons of total TEV do not have any direct link to estimating optimal resource allocations.

Comparing marginal value estimates reveals the possible consequences of slightly changing allocations – if one sector has higher marginal value, shifting allocation to that sector will increase total values. For more consequential changes, modelling is required to take account of how marginal values change – i.e. demand curves and associated elasticities must be estimated.

Although analytically these points are well-known, issues about resource allocation are strongly politicised, because the stakes are high. In theory, questions of efficient resource allocation can be separated out from questions about distribution and fairness, since reallocation for value maximisation implies the ability to compensate losers and still increase benefits.[32] However, in practice there is no guarantee that compensation will be forthcoming or durable. Hence, political arguments and rent-seeking behaviour may dominate debate, and economics arguments may be misused, taken out of context, or used for inappropriate comparisons. Borch (2009) for example concluded that attempts to regulate marine fishing tourism in Norway "are more a result of political pressure to regulate the activity than a thorough process of evaluating what would be the best regulatory framework." Edwards (1990) criticises the "improper use of input-output analysis to determine the relative economic value of commercial and recreational fisheries", pointing out that both recreational and commercial lobbies have used this reasoning to construct arguments about resource allocation between competing activities. Such improper use is unlikely to cease, so it is important to be able to recognise and respond appropriately to it. The key points are:

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[32] In economic terminology, efficiency maximising changes are "potential Pareto improvements", i.e. the winners *could* compensate the losers and still be better off, though there is no *actual* compensation. Policies can therefore have winners and losers, but consideration of the 'fairness' of such shifts is considered a matter of distributional policy rather than economic efficiency.

- expenditures are a poor indicator of national welfare changes: the input-output models reveal information about flows through the economy, but are not particularly suited to analysis of change in economic structures or resource allocations.
- an analysis that reveals which resource use provides greater total net economic value (let alone total expenditures) does not necessarily show how resources should be allocated even in purely economic terms, since optimality requires equating marginal values – the totals are largely irrelevant in this respect.
- the key economic issue is the trade-off in net benefits from changes in shares of a resource. Beyond that, other factors such as fairness, provision of food, health benefits of recreation, biodiversity protection (and so on) may also come in to play.

Edwards (1990) stresses the important distinction between the *quality* of an analysis and its *appropriateness*. Quality is constrained by available data, research methodologies, and the time, skills and budgets available. Appropriateness depends on matching methods to policy contexts. For any comparison, it is essential to compare like with like, in terms of methods, boundaries and assumptions. But that in itself is not sufficient to ensure a good fit to policy contexts.

Where the context is allocation of scarce resources between competing ends – and this is the single most important policy context - the key questions regarding optimal resource allocation relate to marginal values and elasticities – how activity levels and values change when allocations and conditions change, at the margin. For the fisheries case, if some commercial stock / quota is shifted to recreational use:

- The marginal change in *participation* in recreational angling: do more people go fishing? And with what benefits and what expenditures?
- The marginal change in *benefits* (welfare) for existing participants: how much does their benefit per trip increase?
- The marginal change in activity, catches, costs and *profits* for commercial fishers.

There are additional issues related to the impact on the resource. Commercial fishing by definition involves removing the fish for sale. Recreational fishing may involve removing fish for consumption, but catch-and-release fisheries are also a possibility (noting that there are both lethal and sub-lethal impacts associated with catch-and-release). It can be argued that the main determinant of benefit for the recreational fishery is not so much the fish kept, as the size of the stock (and within that, the size of the larger specimens). So, arguably, the conflict between commercial and recreational fishing is not so much direct competition for catches, as the impact of both types of fishing on stock sizes and size distributions. These are the questions that require further exploration.

In developing models and analysis to support necessary changes, drawing on this data, it is important to recognise that the ultimate consequence of fishing is changes in stocks, and for this the relevant variable is not catches/landings, but fishing mortality. This is the sum of fish landings and the portion of discards that do not survive (Abbott and Wilen 2009). Depending on the fishery and discarding/catch-and-release practices, this may be significantly different from measurements of landings.

Commercial fisheries policy in Europe is moving towards full catch accountability, with the progressive introduction of a landing obligation under the reformed CFP, leading to zero discarding with all catches counted against quota. Ferter et al (2013) flag the issue of post-release mortality in recreational fisheries, and note that "the question arises whether the high release proportions among marine recreational anglers in Europe are reconcilable" with the stock recovery objectives.

Abbot (2015) stresses that effective management of recreational fishing first requires that recreational anglers be made accountable in the same way as commercial fishers. This means that managers should have reliable and timely estimates of fishing mortality, at least for the recreational sector as a whole, so they can institute policies and enforcement to achieve control over this mortality (MacKenzie and Cox 2013), in the same way as control is enforced over commercial fishing mortality. Deadlow et al (2008) stress the importance of theories of property rights, transaction costs, social capital, and institutional change. These help to identify behavioural strategies and reasons for success or failure of different governance structures to regulate social and ecological problems in renewable resource systems.

Analysis seeking to inform decisions on the allocation of scarce resources between competing ends must be targeted on the *changes* in values that would arise from *changes* in resource allocation, for marginal and for larger changes. This requires data and analysis of the determinants of *behaviours* and *values,* and also modelling of the consequences for the resource stocks on which activities depend. Some of the data required exist, other data and understanding will need to be developed. Assessment of values should take account of the different ways that commercial and recreational values depend on stocks, maximum fish sizes, and mortality, as well as the extent of displacement and substitute resources, using the economically-relevant concept of opportunity cost rather than financial cost. In particular, analysis should use models that recognise the crucial difference between current allocations, management structures and stocks, and the future optimal allocations, structures and stocks to which policy should aspire. As Abbot (2015) argues, current situations are often so inefficient that comparison of marginal values today may tell us little about future optimal policy – the major gains will come from returning stocks to healthy levels and enacting efficient management within commercial and recreational sectors. There will also be cases to be made for redistributing allocations between the sectors, that need to be assessed on a case-by-case basis. Generally, any efficiency improvement offers the potential to compensate all losers and still leave winners better off – this point is not relevant to efficiency, but may well be relevant in the context of distributional policy.

In summary, this report has set out to explain the different methods for assessing economic impact and value, and the conditions under which they can be applied. The key to proper comparison is simply comparing like with like; but the further key to policy-relevant comparison is to tailor analysis to policy contexts. The most important context is usually the allocation of scarce resources between competing ends. Research and analysis seeking to inform this question has to be targeted on the *changes* in values that would arise from *changes* in resource allocation. This calls for assessment of demand curves and elasticities that go beyond the evidence available from static assessments of current economic impacts or values.

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