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"Fish and Flows in the Murray-Darling Basin"

Murray-Darling Basin Socio-Economic Values of Native Fish and Recreational Fishing - Scoping Project – Final Report

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Contents

Glossary

Anthropocentric - relating to humans

Benefit transfer - the transfer of value estimates from nonmarket valuation studies into other situations

Choice modelling - a stated preference valuation method that elicits peoples' values for changes in the levels of different attributes of a good or service

Consumer surplus - a measure of value to consumers that is equal to consumers' willingness to pay minus consumers' expenditure

Contingent behaviour travel cost method - a revealed preference method of valuing a nonmarket good or activity, from the costs of travel to acquire the good or activity, and how this value may change given a variation in the good or activity

Contingent valuation method - a stated preference method that elicits peoples' values for a change in the level of a good or services

Cost benefit analysis - a method of systematically comparing the benefits and costs of competing alternatives relative to a base case

Demand - the quantity of a good that an individual, household, or firm, wants to purchase at a given price

Economic value - consumer surplus and/or producer surplus associated with a good or services

Environmental accounting - an extension of national accounts that attempts to incorporate changes in the environment

Expenditure - the cost to consumers or producers of acquiring a good or servicing. It is not a measure of value to consumers or producers but a cost to consumers or producers.

Flow - a quantity over a period of time

Hedonic price technique - a revealed preference technique that estimates the value of a nonmarket cost or benefit using the market price of a related good

Marginal benefit - benefit (additional producer surplus and/or consumer surplus) associated with a change

Marginal cost - cost (reduction in producer surplus and/or consumer surplus) associated with a change

Market values - values (producer and consumer surplus) determined by the exchange of goods or services in the market

Multi criteria analysis - a suspect method that uses criteria scores and weights to evaluate alternative policies or proposals

Nonmarket valuation methods - methods used to estimate values for goods and services that are not exchanged in a market

Nonmarket values - values of goods and services that are not exchanged in a market

Non-use value - value that people hold for a good or service even if they do not use it; for example, just knowing that it exists.

Producer surplus - benefit to producers of goods and services equivalent to the price they receive less the costs of production

Random utility method - a method that combines travel cost data from a standard Travel Cost Method application with site attributes data for multiple alternative fishing sites to examine how different levels of site attributes influence fishing site choice.

Random utility model - a statistical model that is based on the probabilities of choosing different outcomes with different levels of predefined attributes.

Replacement value method - a method that places a value on a good or service by estimating the cost of replacing it. It is not a valid valuation method as it does not estimate producer or consumer surplus and the replacement of the good or service is hypothetical and does not indicate what people would actually do.

Revealed preference valuation methods - methods of eliciting peoples' values for a good or service based on observing their behaviour

Stated preference valuation methods - methods of eliciting people's value for a good or service based on asking them their preferences

Stock - a quantity that is measurable at a particular point of time

Supply - the quantity of a good that a firm will sell at a given price

Method - a revealed preference method of valuing a nonmarket good or activity, from the costs of travel to acquire the good or activity

Use value - value associated with the use of a good or services

Utility - the notion of human satisfaction, happiness or well-being

Well-being - human satisfaction or happiness

Willingness to accept - is the minimum amount of money that a person is willing to accept to give up a good or to put up with something negative

Willingness to pay - is the maximum amount an individual is willing to sacrifice to enjoy a good or avoid something undesirable

Executive Summary

The scope of this study is to develop a valley-scale assessment methodology for valuing native fish and recreational fishing in the Murray-Darling Basin. It is specifically focused on economic values that are suitable for inclusion in Cost Benefit Analysis of alternative policy initiatives. Cost Benefit Analysis provides a means of consistently and rationally organising information and assessing the relative desirability of competing alternatives in terms of their economic worth to society. The results of Cost Benefit Analysis provide an important input into decision-making.

The project aims to identify economic valuation methods and develop a process that can be applied in a pilot valley and subsequently transferred to other valleys in the Murray-Darling Basin, using a rigorous **conceptual framework** that is based in economics.

Economic values are focused on the well-being of people as measured by the surpluses (*consumer and producer surpluses*) experienced by those who use and provide resources. For native fish and recreational fishing, consumer surplus is the relevant measure of economic value.

Measures of expenditure are not economic value estimates but relate to the contribution of a resource to the size of the economy. This information may be relevant for some stakeholders but is not the primary issue of concern when evaluating policy options. Expenditures (including on employment) are costs and as such are detractors from value.

Changes in economic value (marginal values), relative to the counter factual, are the relevant measure for the evaluation of policy initiatives. For recreational fishing, it is change in consumer surplus that is relevant. However, before changes in economic value can be estimated, the ecological consequences of alternative policy initiatives need to be understood - this is the realm of the bio-physical scientists.

Economic values can involve direct contact with a resource (use values) or not (non-use values). The value people obtain from a resource or changes in a resource is the main focus of economics rather than the reasons why people hold these values.

The **methods** used to estimate economic value are classified as either revealed or stated preference techniques.

Some valuation methods estimate only current values, others estimate current values as well as changes to current values given alternative policy initiatives, while other methods only estimate the change in values given a policy change.

Different methods are suited to different contexts depending on the values to be estimated (e.g. use and/or non-use values), whether the current values and/or a change in value is the focus, and practicalities about data availability and collection.

The *Travel Cost Method* is suited to the estimation of use values such as those enjoyed by recreational fishers and can be supplemented with a *contingent behaviour* question to estimate changes in values with a policy change.

Where non-use values are also of interest, applications of the *Contingent Valuation Method* or *Choice Modelling* would be required. A single Choice Modelling application can generate value estimates for a wide array of ecological and social outcomes that arise from different management change options and hence is generally preferable to the Contingent Valuation Method.

The Travel Cost Method, Contingent Valuation Method and Choice Modelling are survey-based methods but vary in the population surveyed. Some survey the general population (e.g. Contingent Valuation Method and Choice Modelling approaches where both use and non-use values are relevant). The Travel Cost Method involves surveys of users, either at the site of interest or by filtering for users across the broader population.

Different valuation methods have different data/survey/sample requirements.

Some techniques that are frequently described as being suited to the estimation of values (e.g. replacement value/price of a substitute) lack a sound base in welfare economics and should not be used, particularly for Cost Benefit Analysis.

Most **existing studies** reviewed do not relate to recreational fishing in inland rivers. They are broader or different in scope, but offer some insights into methods and approaches.

Fundamentally, there is little primary research into economic values (consumer surplus) of native fish and recreational fishing in inland rivers in NSW and how these might change with changes in water management or other management regimes.

Expenditure has tended to be the most widely used economic measure in recreational fisheries. However, expenditure is not an appropriate measure of the economic value of recreational fishing.

Where economic value or expenditure has been reported, the unit of measurement varies, making comparisons difficult. For instance, consumer surplus estimates for recreational fishing include per day and per visit, as well as for an additional fish caught. Expenditure estimates include per trip, per adult fisher per trip, per day, for locals versus visitors. Combined use and non-use values attributes valued using the Contingent Valuation Method or Choice Modelling also varied from a percentage increased in Murray Cod and other threatened native fish to a reduction in time taken to catch an Australian Bass.

Choice Modelling was the most common nonmarket valuation method reported in the literature reviewed - estimating both use and non-use values. These studies often included an attribute for fish populations or species. However, it is not possible to isolate the recreational fishing values from these studies as they also include non-use values or ecosystem services.

The Travel Cost Method has been used to estimate existing recreational fishing use values. Slight modifications to existing recreational fishing surveys would enable implementation of the Travel Cost Method. In some instances, additional travel information collected from these large-scale surveys may not be sufficient to carry out Travel Cost Method estimations for specific locations. Therefore, targeted nonmarket valuation studies may be required in specific regions to help with specific resource access and allocation issues.

The Travel Cost Method can be applied so that expenditure data are collected. Hence, its application can also facilitate the modelling of regional or state-wide expenditure impacts of recreational fishing expenditure.

Application of the standard Travel Cost Method to estimate the economic values of recreational fishing in a location requires data on:

- location of a fishing spot - this could be defined as a specific fishing spot or river within a catchment;
- 'distance travelled' as a trip from home (place of usual residence) to a fishing spot and then home again;
- location of point of origin;
- annual frequency of visits to the fishing spot;
- the type of transport (car and engine size, plane, bus, boat and size etc.) for a trip from home to a fishing spot. If a combination of transport mode was used to travel from home to a fishing spot, distance travelled using each of the transport modes should be provided;
- trip expenditure (e.g. accommodation, fishing gear, consumables etc.)
- the main purpose of the trip; and,
- socio-demographic information.

Screening questions can also be required where trips do not have the fishing venue as their sole destination. Note that catch data are not a normal requirement of the standard Travel Cost Method.

Existing databases provide some potential to inform a pilot study.

The NSW Recreational Fishing Survey includes questions relevant to undertaking a standard Travel Cost Method study.

There is potential to undertake a standard Travel Cost Method study for a specific catchment using the 2013/14 Recreational Fishing Survey data set, subject to a determining if a suitable sample size of fishers to a study catchment exists.

There is potential to 'piggy back' on the 'wash up/attitudinal survey' for the 2017/18 NSW Recreational Fishing Survey that is due to begin in October 2018, to undertake a standard and contingent behaviour Travel Cost Method study for a specific study catchment. This would be subject to determining if a suitable sample size of fishers to a study catchment exists.

Recommendations

- A pilot study should involve the application of the contingent behaviour Travel Cost method to estimate the existing value of recreational fishing activity and how this would change with a specified policy change. The Burrendong Classic fishing competition should be investigated as a cost-effective means of surveying fishers in the Macquarie-Castlereagh valley.
- The expenditure data collected in the course of the contingent behaviour Travel Cost Method should be used to estimate regional economic activity of existing recreational fishing activity and how this would change with a specified policy change.
- Non-use values experienced by the general public of NSW as a result of policy changes should be estimated using the Choice Modelling technique.
- Before commencing onsite Travel Cost Method surveys for a study catchment, the 2013/14 and 2017/18 NSW Recreational Fishing Survey data sets should be examined to determine if the sample size for a selected study area is sufficient to undertake a Travel Cost Method study.

1. Introduction[1]

The Commonwealth Water Act 2007 established the Murray – Darling Basin Authority (MDBA) and tasked it with the preparation of a Murray – Darling Basin Plan ("Basin Plan") to provide for the integrated management of the Murray-Darling Basin (MDB)'s water resources (MDBA 2010; Commonwealth of Australia 2012). The Basin Plan required the development of an Environmental Watering Plan (EWP) to ensure that the size, timing and nature of river flows will maximise benefits to the environment. The intent is for the EWP to protect, enhance and nourish the rivers, wetlands, and floodplains of the MDB together with their plants and animals including native fish and other aquatic biota. At a local scale, Long Term Water Plans (LTWP; see Chapter 8 of the Basin Plan) and Water Resource Plans (WRP; see Chapter 10 of Basin Plan) will drive and inform environmental watering to ensure consistency in the implementation of the Basin Plan and EWP's across the MDB.

The Basin Plan represents a major investment in water reform to achieve environmental, social and economic outcomes. Implementing, assessing and potentially amending the Basin Plan are tasks that require information on the outcomes achieved. A key component of this information need relates to native fish and recreational fishing.

State fisheries and water management legislation also include drivers for 'triple bottom line' outcomes and sustainable management. The NSW Fisheries Management Act 1994 objectives include conservation of fish stocks and key fish habitat, threatened species, populations and ecological communities of fish, and promotion of ecologically sustainable development, including the promotion of quality recreational fishing opportunities and to provide social and economic benefits for the wider community of NSW.

There is a range of existing studies on the economic and social outcomes of recreational fishing and the likely impacts of the Basin Plan implementation at the Basin scale. However, this existing work at the Basin-wide scale is largely 'broad brush' in approach and recent recreational fisher surveys have not specifically included any detailed economic questions relating to the community's value for such outcomes.

There is therefore a need for integrated, detailed and valley-scale research to understand better the economic and social values associated with native fish outcomes (and their related environmental 'goods and services') in the MDB.

The purpose of this study is to develop a methodology to estimate the socio-economic outcomes of native fish species management for the people of NSW. The methodology is aimed for implementation at the valley-scale, suitable for use in the context of conducting an assessment of the socio-economic impacts of the Basin Plan in regards to native fish and recreational fishing. The approach taken in designing the assessment methodology involves a combination of theory and application experience.

[1]The material for this section was provided by NSW Department of Industry and is drawn from a draft report on fish and flows in the Southern MDB (Ellis et al. 2017), a report published by NSW DPI on Fish and Flows in the Murray Catchment (Ellis et al. 2016) and an unpublished report produced by NSW DPI for the Joint Ventures Steering Committee (JVSC) for a National Fisheries Genetic Resources Program. The references cited in this section are included at the end of this report.

As well as providing estimates of aggregate economic and social impacts of native fish, the methodology will also allow for the estimation of impacts resulting from changes in environmental flows associated with the Basin Plan. These are the 'marginal impacts'. The conceptual foundations of this report and the recommended methodology are drawn from the discipline of economics.

The development of the methodology takes account of the data already assembled as well as the prospects for collecting new data required to fill 'gaps' in what already exists.

1.1 Context

1.1.1 Flows in the Murray-Darling Basin

In Australia's MDB, as in river systems worldwide, altered flow regimes have resulted in substantial negative impacts to fish communities. Managing river health through considered water delivery targeting protection or re-instatement of natural flow regimes can be an effective way to support native fish and help restore populations. In recent years, the process of restoring more natural flow regimes, augmented by the delivery of environmental water, has become a key aspect of ecosystem management in the MDB.

Effective flow restoration requires an understanding of the relationships between hydrology, life history and population dynamics of river and floodplain biota, which then needs to be linked to management decisions. To manage riverine fish populations we therefore need to understand the drivers that support healthy fish populations and communities, and the threats and pressures impacting on them.

1.1.2 The importance of flow

Whilst it is generally understood that water is fundamental to fish, the movement of water within and between waterbodies (i.e. flow) also has a major influence on their life history and population processes. Flows promote the exchange of nutrients and productivity in aquatic ecosystems, and provide connectivity between aquatic habitats (e.g. rivers and floodplain habitats, valleys or reaches within a valley). Put simply, flow influences fishes life cycles and hence their survival and persistence. Furthermore, different species of fish have particular habitat, food and lifecycle needs, which are linked to the availability of water and the way it flows in the landscape in which the species exists. Different species also respond uniquely to changes in flow regimes. The biological rhythms of fish are often linked to flow so that opportunities for spawning, growth and dispersal are synchronised. For example, survival of eggs and larvae may also be dependent on flow in order to transport them to suitable nursery habitat, or to maintain habitat while the eggs hatch and larvae develop. This means that assuming any water will have positive outcomes for all fish is too simplistic.

In river systems worldwide, the alteration of flow regimes has resulted in a range of negative impacts to fish communities. Historically, diversity and variability in flowing conditions was a natural feature of the MDB to which fish and other aquatic biota are adapted. Human influences and the exploitation of freshwater resources have substantially altered flow regimes throughout much of the MDB in less than 200 years. The resulting impacts to native fish include reduced flow variability and hydraulic complexity, seasonal flow reversal, loss of small to medium floods, permanent inundation of some areas and altered connectivity. Furthermore, regulatory structures prevent or impair the movements of fish, and cold water releases from the larger dams can severely impact the breeding cycles of native fishes in downstream reaches. Hence, many native fish species in the MDB have suffered a decline in their abundance and distribution, with some now absent throughout much of their former range. Improvements to native fish populations in the MDB will not be achieved without

continued concerted management efforts and the incorporation of recently generated knowledge (Koehn et al. 2014a).

1.1.3 Flow management and environmental water

Managing river health through the protection or re-instatement of natural flow regimes can be an effective way to support native fish and help restore or recover their populations. In recent years, the process of restoring more natural flow regimes, augmented by the delivery of environmental water, has become a key aspect of ecosystem management in the MDB (Arthington 2012; Koehn et al. 2014b; Mallen-Cooper and Zampatti 2015c). However managing riverine flows for consumptive and agricultural use whilst considering flow restoration for environmental purposes can be challenging and may lead to conflict (e.g. over water buybacks and environmental water management) (Arthington 2012; Koehn et al. 2014b). Thus, the need to maximise environmental benefits and minimise the costs of unwanted outcomes has increased the expectation for science to underpin and justify water management and the delivery of environmental flows (Beasley et al. 2011; Koehn et al. 2014b).

Environmental watering is a relatively new management action, and as such our ecological knowledge is still evolving, particularly with regard to how different fish species may be affected by flows, including natural events, environmental watering and other water management actions. Water managers are currently unable to return large volumes of water to mimic natural flooding cycles due to limited water availability and physical and operational constraints. Managed flows could also potentially infer negative outcomes such as increased recruitment of non-native fishes (Stuart & Jones 2006; Beesley et al. 2012), hypoxic blackwater events (King et al. 2012; Beesley et al. 2013), or sedimentation (Lyon & O'Connor 2008). Infrastructure constructed to facilitate environmental watering could also infer unexpected outcomes. For example, regulators which artificially inundate floodplains by backing up water rather than delivery of a downstream pulse of flood-water, could also lead to negative impacts (e.g. increases in residency times, reduction in hydraulic variability, fish passage obstruction and proliferation of non-native species) (Koehn et al. 2014b; Baumgartner et al. 2014).

Effective flow management requires an understanding of relationships between hydrology, life history and population dynamics of biota, which can then be linked to management decisions (Arthington et al. 2006). Flows need to be managed at spatial scales that match the life cycles of fish. While wetland specialists like Southern Pygmy Perch or Murray Hardyhead may benefit from localised management actions, spawning and recruitment of flow pulse specialists like Silver Perch require flow management much larger scales (100s to 1000s of km), over extended time periods (Mallen-Cooper & Zampatti, 2015b).

Flow regulation and changes to the natural flow regime are only one of the threats implicated in the decline of native fish in the MDB. A range of external influences will impact of the health of the rivers and wetlands and therefore on the status of fish communities. These include riparian and instream habitat degradation, reduced water quality, barriers which impede fish movement, loss of fish through irrigation diversions and pumping, competition and/or predation by non-native species, exploitation through fishing activities, disease, loss of genetic integrity and fitness and regional climate change. The potential for achieving long-term ecological outcomes through environmental water management is likely

to be increased by undertaking parallel complementary actions, such as re-snagging rivers, removal of pest species and stream bank stabilization works.

Native fish have evolved in a highly variable system that is characterised by extreme environmental conditions (Humphries et al. 1999; Baumgartner et al. 2013). From diverse wetting and drying cycles, to fluctuating temperatures, these conditions provide important seasonal cues for native fish, with hydrological variability in particular playing an integral role in influencing the structure and diversity of aquatic communities (Baumgartner et al. 2013; Rolls et al. 2013). A variety of life history and recruitment styles are expressed by different fish species in response to the range of environmental conditions experienced across the MDB and there is a need to cater for these differences across various spatial and temporal scales.

Flows, habitat and connectivity are essential for healthy native fish populations, with flows playing a range of important roles, including:

- The creation of hydrodynamic diversity needed for fish habitat (particularly for species that rely on flowing habitats, such as Murray Cod, Silver Perch, Trout Cod and Macquarie Perch).
- Maintaining health of in-stream and emergent vegetation and other habitat features needed by many fish species.
- Influencing quality, size and persistence of refuge habitats in dry periods.
- Inundation of benches and floodplains to support carbon and other nutrient cycling, which is important for system productivity and fish maintenance, recruitment and condition.
- Enabling access to a range of aquatic habitats and providing cues that stimulate movement, such as for spawning or larval dispersal, with movement opportunities including upstream or downstream, and lateral movement into off-channel habitats such as wetlands (MDBA 2014a).

While flow management has often focused on hydrology (water volume or threshold, duration, seasonality and timing), the hydrodynamics of flow is equally important (Mallen-Cooper & Zampatti 2015a). This includes parameters such as flow depth, width, velocity, direction and turbulence. River regulation is particularly detrimental to flow hydrodynamics, often leading to still or slow flowing aquatic environments. In addition, water quality is as important as water quantity, including appropriate water temperature, levels of oxygen, pH, salinity, chemical cues and food content, and is equally influenced by river regulation (MDBA 2014a; Mallen-Cooper & Zampatti 2015a). It is possible to establish relationships between hydrology and hydraulics based on gauged stream flow data and stream cross-sectional data (i.e. what type of flow results in velocities greater than 0.3 m/s and weir drown out flow rates for stretches of rivers).

Fish use flows at a variety of scales, from the 'micro-level' (less than 100 metres) to medium scale (100s of metres to 10s of kilometres) and macro-scale (from 10s of kilometres to 100s of kilometres) (Mallen-Cooper & Zampatti 2015a). Effective flow management for native fish therefore requires consideration of flow aspects at different spatial scales, as well as the consideration of flow variability, with different parts of the hydrograph playing important roles for fish lifecycles:

- Cease to flows (series of disconnected pools) can create risks to fish in perennial streams, but are a natural feature of intermittent systems. Cease to flow periods can play an important role in these streams by promoting growth of biofilms and productivity. Rates of wetting and drying are important. Cease to flow can also be useful in controlling Carp populations, and would generally occur annually in highly intermittent systems.
- Base flows (not relevant to intermittent systems) are important in maintaining aquatic habitat for fish, plants and invertebrates. They also provide drought refuges during dry periods and contribute to nutrient dilution during wet periods or after a flood event. Base flows may also support winter conditioning and oxygenation through riffle habitats for Blackfish species and Galaxids, and historically may have benefited small-bodied native species in terminal wetlands. Base flows are maintained by seepage from groundwater and low surface flows (MDBA 2014). They would generally occur on an ongoing basis in perennial systems.
- Small in-channel pulses (freshes without bench inundation) are generally short in duration and can provide some productivity benefits by replenishing soil water for riparian vegetation, maintaining in-stream habitats and cycling nutrients between different parts of the river channel. They can also inundate key aquatic habitat such as snags and aquatic vegetation. Small pulses may trigger movement or spawning and recruitment for some species (such as Australian Smelt, Bony Bream and Blackfish). Murray Cod and Freshwater Catfish spawning and recruitment could also occur with sufficient hydraulic diversity. Pulses may also trigger hatching for Macquarie Perch and Galaxids. These flow events would generally occur annually for highly intermittent systems and also potentially annually (up to two or three a year) in perennial systems.
- Large in-channel pulses include freshes that provide lateral and longitudinal connectivity and inundation of in-channel features such as benches as well as anabranches with low commence to flow thresholds. These can be important in supporting productivity through inundation of channel benches, riparian zone, anabranches with low commence-to-fill thresholds and flood runners. Large pulses can trigger spawning and recruitment for all species and also promote movement and production (for events of significant duration). These flow events are also important for maintaining refuges and minimising geomorphological impacts of regulation. These events may occur once every two years in highly intermittent systems, and between three and five years for perennial systems.
- Overbank events (including floodplain and off-channel inundation) are important in providing broader connectivity to floodplains and other off-channel habitats and providing for ecosystem ‘re-setting’ and large-scale nutrient and sediment cycling. These are important for spawning, recruitment, movement, productivity, maintenance and condition. These flows can create some risk of Carp movement and breeding, particularly regular long duration events in off-channel wetlands. Overbank events generally occur between two and twenty five years for both intermittent and perennial systems.

1.1.4 Functional groups of fish

For most fish species in the MDB, hydrology is linked to recruitment and population health via its influence on productivity (growth and condition), habitat availability and connectivity (facilitating dispersal to appropriate habitats) and recruitment.

The range of life history strategies and movement behaviours exhibited by native fish of the MDB means a single flow regime cannot provide equal benefits for the whole fish community (King et al. 2003; Baumgartner et al. 2013; Ellis et al. 2016). Classifying fish species into functional groups based on flow related attributes (e.g. spawning, recruitment or movement) can assist with simplifying flow requirements for fish, to inform flow management decision making and enhance fish outcomes (Baumgartner et al. 2013; Mallen-Cooper & Zampatti 2015a).

A hybrid approach to fish functional groups, combining elements of the reproductive spawning-movement and eco-hydraulic groups has recently been developed for fish of the MDB by DPI Fisheries, which assigns each species to a functional group (NSW DPI 2015; Ellis et al. 2016). These functional groups were established in consultation with experts to assist in development of specific long term environmental watering requirements and flow related management actions. Elements considered included:

- Cues for migration (dispersal and recolonization) and spawning (temperature and/or flow).
- Spatial scales of spawning and dispersal movements (10's – 100's of m; 100's of m – 10's of km; 10s - 100s of km).
- Reproductive mode and fecundity (e.g. broadcast spawning, nesting species, adhesive eggs).
- Spawning habitats in still/slow-flowing water or in fast-flowing habitats.
- Egg hatch time (short 1 – 3 days; medium 3 – 10 days; long > 10 days) and egg morphology.
- Scale of larval drift and recruitment.

Five functional groups were identified based on key life-history traits that can be linked to flow characteristics:

- **Flow pulse specialists -** Flow pulses (within or overbank) are generally required to generate a spawning response. Adults are highly fecund and may make long migrations in response to flow (but can delay spawning). Eggs and larvae drift for weeks, potentially dispersing over long distances. Growth and recruitment success potentially enhanced by flows that inundate and transport drifting young to off-channel habitat (i.e. increased connectivity and ecosystem productivity). Flow pulses required to cue movements and provide connectivity for upstream re-colonisation movements by juveniles. Medium to long-lived fish not necessarily requiring spawning and recruitment every year, but healthy populations consist of multiple year classes and demonstrate some recruitment in the majority of years (e.g. Golden Perch, Silver Perch).
- **River specialists** (lotic or lentic preferences) - Adults may make short migrations to spawn in response to increased temperature. Moderately fecund, spawn in nests or have specific spawning substrate preferences, often with parental care. On leaving their nests larvae drift over short to moderate distances for dispersal, with recruitment success potentially enhanced by flows that inundate and transport drifting young to off-channel habitat (i.e. increased floodplain productivity and connectivity). Periodic in-channel pulses provide connectivity for upstream recolonization movements by juveniles. Not necessarily requiring spawning and recruitment every year, but healthy populations consist of multiple year classes and demonstrate some recruitment in the majority of years.

- River specialists can be further categorises as having a preference for either lotic habitat (e.g. Murray Cod, Macquarie Perch) or lentic habitat (Freshwater Catfish, Purple Spotted Gudgeon).
- **Floodplain specialists** – Adults may make short migrations to spawn in response to increased temperature, into or within lentic (or slow-flowing) off-channel habitats. May have specific spawning substrate preferences, hence increases in inundation extent can enhance breeding opportunities by creating additional spawning habitat and floodplain productivity benefits. Relatively short-lived with low fecundity, with most species requiring annual spawning and recruitment events for survival of populations. Overbank flooding is required (not annually) to facilitate dispersal for re-colonisation and establishment of new populations, and mixing between populations (e.g. Southern Pygmy Perch, Olive Perchlet, Murray Hardyhead and the non-native Gambusia).
- **Generalists (native)** – Display flexible spawning strategies, but generally linked to increased temperature. Survive in-channel during low flows or on floodplains during overbank inundation. Adults move short distances and may spawn more than once in a year. Short periods of larval drift occur, and small flow pulses may enhance dispersal by inundating in-stream habitat and connecting drought refuges. Larger flows that inundate off-stream habitat can also promote growth and recruitment (i.e. increased floodplain productivity and habitat availability). Generally short-lived with low fecundity requiring regular (ideally annual) spawning and recruitment events for persistence (e.g. Australian Smelt, Carp Gudgeon, Mountain Galaxias, Un-specked Hardyhead).
- **Generalists (alien)** - Adults may make short migrations to spawn in response to increased temperature. Highly fecund and may spawn multiple times in a year. Flows that inundate and connect off-channel habitats can promote spawning and recruitment, whereas low within channel flows produce reduced spawning outcomes. Larval drift over short to moderate scales may be exhibited. (e.g. Carp, Goldfish, Redfin Perch).

1.1.5 Fish in the Murray-Darling Basin

There are 60 native fish species in the Basin as a whole, with 44 freshwater species of which 16 species are restricted to the Basin. Native fish are highly valued by people, including totemic and cultural values for Aboriginal communities. Recreational fishing is an important pastime throughout the Basin. Many native fish species were once widely distributed in the Murray-Darling Basin. However, changes to natural flow regimes have degraded fish habitat and reduced habitat connectivity across the Basin. Populations of native fish species in the MDB have declined to as low as ten percent of pre-European settlement levels.[2]

[2] Lintermans (2009)

The Basin's estimated 430,000 recreational anglers target several native fish species, primarily Murray Cod and Golden Perch. Both Murray Cod and Golden Perch are known to respond to changes in flow management, with Murray Cod being defined as an in-channel specialist and Golden Perch as a flow pulse specialist under the "Fish and Flow" management framework. While both species are subject to largescale stocking programs, Murray Cod is also listed as a threatened species under Commonwealth environment legislation and is the subject of a National Recovery Plan.

1.1.6 Cross-jurisdictional management of the MDB

The MDBA was established as an independent statutory agency by the *Water Act 2007* (C'th). Governance of the Authority is illustrated in **Figure 1** below.

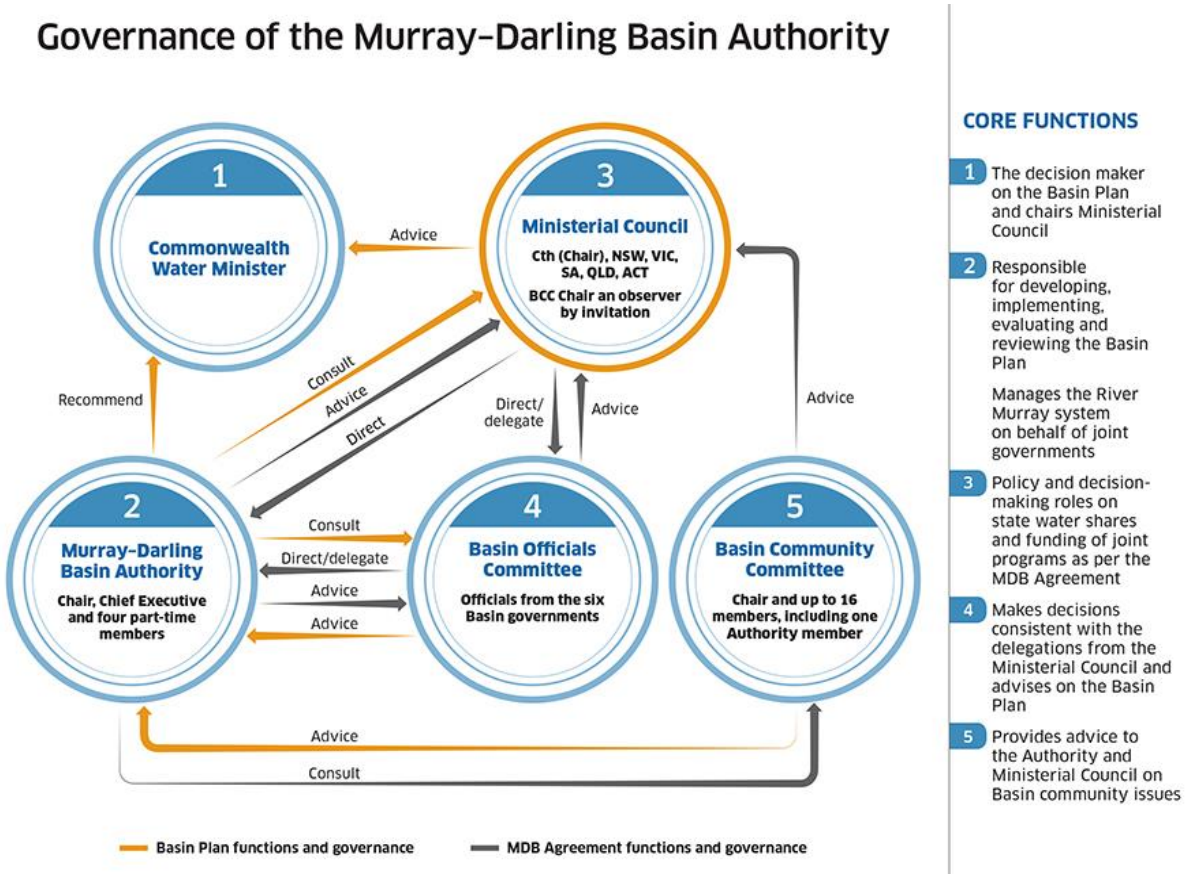

Figure 1: Governance of the MDBA (source MDBA website)

As demonstrated in **Figure 1,** the governance structure brings together the various Basin jurisdictions at three levels (ministerial, executive and community).

The MDBA has responsibility to develop and implement a Basin Plan for the balanced sharing of Basin water between all users. An important 'user' is the Commonwealth Environmental Water Holder (CEWH). The CEWH is an independent statutory office established by the *Water Act 2007*. The CEWH 'is responsible for making decisions relating to Commonwealth environmental water, including the management of the Commonwealth water portfolio so that it maximises environmental outcomes across the Murray-Darling Basin over time'[3]. The CEWH is supported by the Commonwealth Environmental Water Office (CEWO).

The current Basin Plan came into effect in November 2012. It contains, *inter alia*, outcome targets for river flows and connectivity, vegetation, waterbirds and fish associated with increased environmental water flows. To help achieve these, targets for fish have been developed in the associated Basin-wide Environmental Watering Strategy (BWS)[4], and these focus on:

- Improved distribution of key short- and long-lived fish species across the Basin;
- Improved breeding success for various species;
- Improved populations of various species; and
- Improved movement of fish.

An evaluation framework[5] is in place that outlines how the MDBA will work with partner governments and the community to evaluate the implementation and effectiveness of the Basin Plan and whether the targets are being achieved. Basin jurisdictions have responsibilities under the Basin Plan to report particular information on progress toward and the achievement of environmental outcomes.

Management decisions regarding the future use of water resources in the MDB involve complex ecological interactions, tough trade-offs between alternatives and a range of impacts on society. To enhance the capacity of government agencies to make such decisions, information across the three pillars of 'triple bottom line' assessment – the ecological, social and economic – is key.

First, the ecological consequences of alternative management actions need to be understood. This is the realm of the bio-physical scientist. Once the physical outcomes of alternatives can be predicted, the consequences for society arising from those alternative outcomes, need to be understood. In particular, where competing management alternatives are being considered, *the value to society* of the physical outcomes of each alternative needs to be evaluated. This allows decisions to be made as to which alternative would provide society with the 'best' outcomes. Different management actions will generally deliver different physical outcomes that will provide society with different values.

[3] www.farmers.org.au/content/nff/en/community/blog/water-series-cewh.html
[4] MDBA (2014a)
[5] MDBA (2014b)

As a simple example, consider the decision between extracting water from a river for irrigated agriculture and leaving it in the river to promote its environmental condition. The alternative management options give rise to different physical outcomes including aspects such as irrigated crop production and native fish populations. With information on the *relative values* of these different physical outcomes, the tough trade-offs between competing management actions can be evaluated.

Progress has been made in understanding and predicting the physical outcomes of alternative management actions. The relationships between water application and agricultural production are well documented. The relationships between the extent and timing of water releases from storage dams and environmental outcomes such as native fish species diversity and abundance are not as well understood. However, considerable research effort is being devoted to enhancing that knowledge.

Information on the values driven by those physical outcomes that are commercial goods and services is also well established. For instance, the value of a tonne of cotton is readily accessed from market data. Less well established are the values associated with non-marketed goods and services associated with environmental outcomes. Where information is available on such values, it has tended to be at a 'broad-brush' level and across the whole of the MDB. Nor has the information been set within a single conceptual framework that facilitates decision-making. Studies that have been done have tended to be lacking a rigorous conceptual base or have relied on a variety of frameworks that do not allow integration or comparison.

One set of physical outcomes where there are concerns about the lack of pertinent value information relates to native fish. This report pays specific attention to establishing a way forward to redressing those concerns.

1.2 Scope of the Study

The scope of this study is to develop a valley-scale assessment methodology for valuing native fish and recreational fishing in the MDB. It is specifically focused on economic values that are suitable for inclusion in Cost Benefit Analysis of alternative policy initiatives. Cost Benefit Analysis provides a means of consistently and rationally organising information and assessing the relative desirability of competing alternatives in terms of their economic worth to society. The results of Cost Benefit Analysis provide an important input into decision-making. Other approaches, while not fitting within an economics framework, may still provide valuable information to inform policy decisions. These alternative approaches are not the focus of this report. Here, the economic approach to assessment as implemented through Cost Benefit Analysis is the focus.

The project identifies economic valuation methods and develops a process that can be applied in a pilot valley and subsequently transferred to other valleys in the Murray-Darling Basin. It is additional to other projects and programs such as the National Carp Control Plan, National and NSW recreation fishing survey, MDBA social and economic valuation frameworks and NSW Department of Industry WRP socio-economic objectives research.

In this context, the first goal of this report is to provide a rigorous conceptual framework for future research that will explore values associated with native fish, with a particular focus on the value of native fish in recreational fishing.

The conceptual framework will be established in section 2 of the report. This is done with a view to providing information on native fish related values that will be relevant to decision makers in the MDB in their determination of appropriate future resource use strategies. The framework will embody the rigours of welfare economics.

The second goal of the report is to recommend methods that are appropriate to the process of value estimation within the conceptual framework, and can be applied at the valley-scale. The recommended methods will maintain the rigour of the conceptual framework while being suited to practical implementation, where possible relying on already collected data. To achieve this goal, a range of potential methods available to estimate values is set out in section 3. To show how the conceptual framework and the available methods have (or indeed haven't) been used in past studies, a literature review of pertinent studies is conducted in section 4. This look back, as well as a review of the available data sets that have been collected (set out in section 5), allows for the development of specific recommendations for taking next steps. Those recommendations are detailed in section 6.

Achieving the two goals of setting up a rigorous conceptual framework and making methodological recommendations will provide a 'road map' for the steps to be taken to provide the information on native fish values that will be relevant to resource management in the MDB, and can be applied at the valley-scale. That information will add to the existing stock of value information relating to other resource use outcomes to provide a more complete and consistent base for decision-making.

1.2.1 Project objectives

The overall aim of the project is to improve understanding and communication of the benefits of environmental water for fish, targeting recreational fishers as a key audience. The project has been funded by the MDBA in partnership with NSW DPI Fisheries. Other components included the Murray-Darling Basin Native Fish Forum held in Canberra in August 2017 (https://getinvolved.mdba.gov.au/Nativefishforum2017) and development of communication products (infographics and a short video) on fish and flows for recreational fishers (released in Jan 2018 and available on DPI's website at https://www.dpi.nsw.gov.au/fishing/habitat/rehabilitating/fish-and-flows).

The objectives of the socio-economic values component are to:

- Determine the feasibility of using a socio-economic analysis of recreational fishing associated with native fish outcomes from Basin Plan implementation at a valley scale (focusing on recreational fishing, but also incorporating appropriate fish data and fisheries information related to ecosystem services).
- Based on best available information and expert knowledge, recommend an integrated and rigorous methodology for this socio-economic analysis, including recommendations for next steps and identification of possible funding sources.
- Enhance communication and collaboration amongst and between economists, social scientists/researchers, fisheries and water scientists and managers and recreational fishers to maximise the value of information being collected on the values of native fish and recreational fishing in the Murray-Darling Basin.

1.2.2 Project methodology

Professor Jeff Bennett (Environmental and Resource Economics) and Dr Rob Gillespie were engaged by NSW DPI Fisheries Aquatic Habitat Rehabilitation in late 2017 to deliver this scoping project. The project has been overseen by a DPI Fisheries Project Control Group and Steering Committee with members from NSW DPI Fisheries, NSW DPI Strategy and Policy, NSW DPC and NSW OEH. Key deliverables for the project included a literature review/preliminary report and establishment and consultation with an Expert Panel including expertise in environmental economics, recreational fishing representatives, freshwater fish ecologists and relevant government representatives (including expertise in localised assessments. The role of the Expert Panel included identifying relevant 'grey literature' and unpublished work (if not included in the Preliminary Report) and providing expert judgment to inform:

- Development of a proposed methodology for valley-scale focused assessments of socio-economic values of native fish in the Murray-Darling Basin.
- The possible application of the proposed methodology in a proposed pilot valley (Macquarie-Castlereagh)
- Recommend a preferred approach for project implementation.

The Expert Panel met by teleconference on 22 February 2018 (summary of workshop outcomes including a list of participants at Appendix 2) and provided comments on the draft preliminary report and final report in March 2018. This version of the final report addresses and incorporates comments and issues identified by members of the Expert Panel and the Project Steering Committee and Project Team.

2. Conceptual framework

Key messages

- Economic values are focused on the well-being of people.
- Economic values relate to the surpluses (consumer and producer surpluses) experienced by those who use and provider goods and/or services. For native fish and recreational fishing, consumer surplus is the relevant measure of economic value.
- Measures of expenditure are not economic value estimates but relate to the contribution of a good and/or service to the size of the economy. This information may be relevant for some stakeholders but is not the primary issue of concern when evaluating policy options.
- Measures of costs (including employment) are detractors from value.
- Changes in economic value (marginal values), relative to the counter factual, are the relevant measure for the evaluation of policy initiatives. For native fish and recreational fishing, it is change in consumer surplus that is relevant. However, before changes in economic value can be estimated, the ecological consequences of alternative policy initiatives need to be understood – this is the realm of the bio-physical scientists.
- Economic values can involve direct contact with a resource (use values) or not (non-use values). The value people obtain from a good and/or service or changes in a good and/or service is the main focus of economics rather than the reasons why people hold these values. Notwithstanding, the value estimated incorporates psychological, social and physical health motivations.

Implications for a pilot study

- Economic values relate to the well-being of people and hence their measurement will require on-site and/or general population surveys.
- Values associated with native fish pertain to use values (recreational fishing) and non-use values (species abundance and diversity)
- Change in value (with a new policy relative to the existing policy known as the 'counterfactual') is the main focus of economics. However, before any change in value can be estimated, the bio-physical consequences of alternative policy initiatives need to be understood.

The key concept under consideration in this report is 'value'. The broad approach taken is to use the principles of economics to define value.

1. Value is an 'anthropogenic' concept

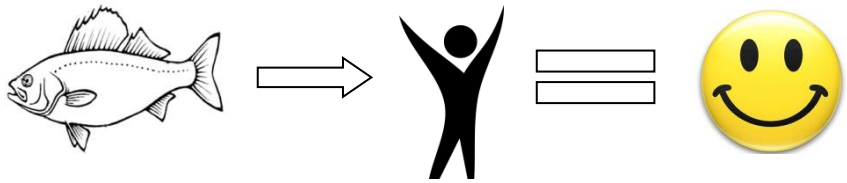

Figure 2: Economic value is anthropocentric

It is people who gain value from their use of a resource (as illustrated in **Figure 2**). The implication of this is that resources do not have 'intrinsic value': resources are not valuable in and of themselves but rather can only become 'valuable' if people want them.

For example, under this definition, a Murray Cod has a value only when people gain well-being from it.

2. Value relates to the well-being of people

The value concept is therefore 'utilitarian' as it focuses on the utility (or well-being) of people. An increase in value is defined as an improvement in the well-being of people. This is a benefit. However, a loss of value sees people being made worse off. This is a cost.

For example, fishing and/or catching a fish creates a value for an angler because it improves their well-being (illustrated in **Figure 3**). They enjoy a benefit from the experience. However, they also experience some costs. Paying for petrol to drive to a river to go fishing creates a loss of well-being. That cost comes about because the money spent on the petrol could have been used for something else[6]. Foregoing the well-being that could have been enjoyed makes the angler worse off. Overall the angler would not fish unless the benefit to them exceeded the cost. The level of this net benefit is the value to the fisher.

Figure 3: Fishing creates value for the angler

[6] More formally, this cost is called an 'opportunity cost' because it relates to the loss of the foregone opportunity to gain well-being.

3. Value and time are related.

A resource is regarded as a 'stock' or an asset that exists at a specific time. From that stock, values are generated as 'flows' over a period of time. Hence, a river is a natural resource stock, from which various values are generated over time. One value generated from a river would be the benefits enjoyed by people though time from fishing and/or catching fish. The size of the 'stock' can change over time as can the values that are generated. The 'flows' of value that are generated from a 'stock' over time can be summed to give a value to the 'stock'. This is known as an asset value. Hence, values can be assigned to specific value 'flows' OR in aggregate, to a resource 'stock'.

For example, consider a river that is valuable because it produces a flow of values associated with its resident population of native fish. Each day, people gain value from fishing in the river. That is the 'flow' value. If those flow values are summed over time, an estimate of the value of the river for fishing can be calculated[7,8].

4. Values can be for flows or stocks in aggregate or they can be for changes to flows and stocks.

Changes to values are known as 'marginal values'. For example, a fish stock that creates a flow of recreational fishing values may be valued over a specified period of time, say ten years. If a change in river management causes the fish stock to change, then the resultant changes in flow values (from the recreational fishing) and the asset value of the river are the marginal values arising.

Specifically, if the management of water leads to an increase in native fish populations, then an increase in well-being occurs and a marginal benefit is created. In contrast, if the actions of river managers lead to a reduction in native fish populations, a marginal cost results as recreational fishing values decline.

These marginal values are 'relative' measures. They are values relative to some base level (known as the 'counterfactual'). In the fishing example, changes in water management that benefit native fish and the subsequent increase in recreational fishing values is measured relative to the case where water management remains unchanged from current patterns. The change scenario and the counterfactual are sometimes referred to as the 'with and without change' scenarios. For example, in **Figure 4** values of recreational fishing are plotted over time into the future for two scenarios. The first labelled 'without' is the counterfactual case.

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[7] Note that the summation of flow values must take account of time. This is achieved through the calculation of the present value of future flow values and involves the process of 'discounting': Future values are converted to present values by applying a discount factor $1/(1+i)^n$ where I is the discount rate and n is the year into the future that the value is experienced.

[8] Note that in this context, the word 'flow' does not relate directly to the physical flows of water in a river, as in 'environmental flows'. Rather it relates to the values that are derived from the river over time.

It involves no new policy measures. The second labelled 'with' plots the comparable value over time with the introduction of a policy change. The difference between these two plots of value represents the marginal value of the change in policy at any given point in time.

Hence, at time t, the marginal benefit driven by the change in policy is 'bd'. This increases to 'ce' in time period t+1.

Marginal values are of particular importance in the evaluation of alternative resource management strategies. If a resource manager is considering a change in strategy, such changes in water management that benefit native fish and can be linked to increased recreational fishing values, the summation of the marginal benefits arising from a change can be compared against the summation of all the marginal costs caused. This allows an understanding of the net effect of change on the community at large. This is the fundamental notion behind the practice of Cost Benefit Analysis.

Figure 4 illustrates the demand and supply relationships.

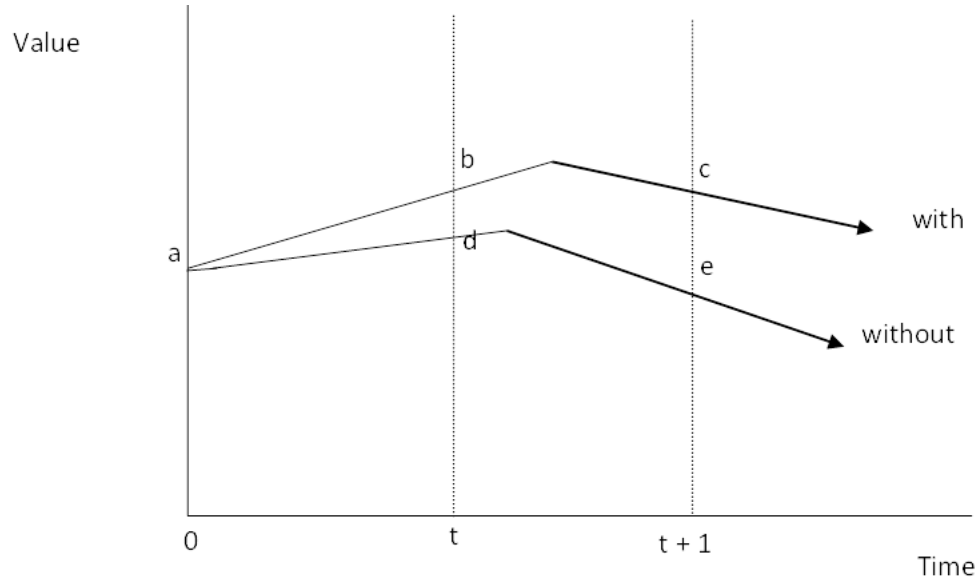

Figure 4: Flows of value over time

5. The definition of value can be formalised with reference to the economist's concepts of supply and demand.

The demand that people have for goods and/or services reflects the value they gain from them. The supply of goods and/or services that people want to make available to others reflects the costs they have to endure to make them available – these are the values of the opportunities that they could have enjoyed if they had not decided to make goods and/or services available to others. Demand can be represented in monetary terms by the price that people are willing to pay for more of a good and/or service. Similarly, supply can be represented by the price people are willing to accept as compensation for providing more goods and/or services. That is the amount that it costs them to supply the additional goods and/or services (their opportunity costs).

In general, the price that people are willing to pay for more goods and/or services goes down as people have more of them. Hence, demand can be represented as a negative relationship between value and quantity: As the price goes up, people will want to buy less.

Likewise, because the costs of producing more generally goes up as supply expands, supply is a positive relationship between costs and quantity: as price goes up, suppliers will want to sell more.

The following diagram (**Figure 5)** illustrates the demand and supply relationships.

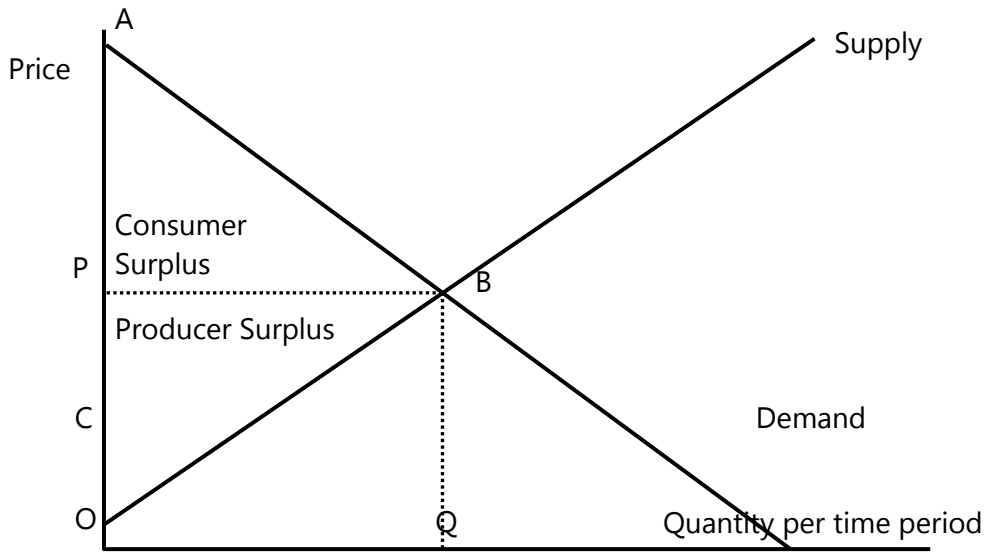

Figure 5: Supply, demand and economic value

In circumstances where those with demands for a good and/or service interact with suppliers in competitive markets, a price per unit is negotiated that 'clears' the market. At that price, the amount people want to buy is exactly equal to the amount people want to sell (P in **Figure 5**).

Those who buy the good and/or service do so because the amount they value an extra unit of the good and/or service (their willingness to pay as shown by the demand curve) is greater than the price they have to pay. They are motivated to buy the good because of this 'surplus' they enjoy. The difference between the price people are willing to pay and the price they have to pay is defined as the net value they enjoy from consumption. It is called the 'consumer surplus' and is shown in the diagram as the area ABP.

Those who sell the good and/or service are motivated by a different type of surplus. It's the difference between the costs they bear from producing more of the good and/or service and the price they receive from its sale. With costs reflected by the supply curve, this net value enjoyed by sellers, known as the 'producer surplus', is illustrated in the diagram as the area PBC.

Together, the consumer and producer surplus represent the values generated by the good and/or service (area ABC in **Figure 5**).

Sometimes, markets don't form to facilitate exchange between those who want a good and/or service and those who can provide it. That doesn't imply that there are no values associated with the good and/or service. It does mean however, that the concepts of producer and consumer surplus do need to be re-thought somewhat. With no market, there will be no price paid by those who want the good and/or service. Nor will there be any price received by those who could provide the good and/or service. This means there is little if any incentive for people to provide the good and/or service. In the absence of any private sector incentive to provide a good and/or service, government may step in and provide the good and/or service. That doesn't mean there are no costs of supply. Rather, the costs are borne by taxpayers. For those who use the good and/or service, they enjoy a value and often don't pay anything for it. Hence, their consumer surplus is the difference between what they would be willing to pay and a zero price.

It's important to note three more concepts pertinent to the analysis of value that can be illustrated using the diagram at **Figure 5**.

First, the amount spent by consumers of the resource is equal to the price paid multiplied by the total amount they buy. This is the area PBQO in the diagram at **Figure 5**. It is also equal to the revenue collected by producers. This is the amount that is included in measures of economic activity collected by the Australian Bureau of Statistics such as Gross Domestic Product. It is a measure of the amount of economic activity (purchases and sales) recorded in the economy. However, it is not a measure of 'value' as defined here, in so far as it is not a measure of peoples' well-being. 'Valuation' studies that present data on the amounts people spend to enjoy a resource are therefore NOT providing estimates of value as defined in terms of contributions to peoples' well-being or utility. Rather they are presenting data on the contribution made to the size of the economy as measured by spending. Some studies of this kind are presented as examples of 'environmental accounting or 'natural capital accounting'.

They use expenditure as their base NOT values as measured by surpluses. As such they are inconsistent with the economic principles of value and are unsuitable for use in Cost Benefit Analysis of policy options[9].

Second, the cost of supplying the good and/or service is the total of all the amounts producers are willing to accept for supplying. This is the area under the supply curve (CBQO in the diagram). It is the amount that society gives up in the form of values that could have been enjoyed had the good and/or service been used in its next best alternative (the opportunity costs). These costs are also not a measure of the value of the good and/or service in its current allocation. It is the amount that is netted out of willingness to pay to determine the surpluses enjoyed by consumers and producers that we use to define well-being.

Finally, it is also important to note that 'price' is not the same as 'value' (as illustrated at **Figure 6**). Price paid is a detractor from 'value' for consumers because they have to pay it. Price is part of the value that producers enjoy but it has to be made net of costs.

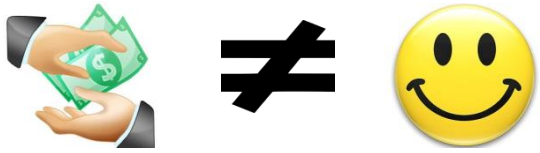

Figure 6: Expenditure is not equivalent to economic value

6. There are numerous types of values.

Two basic types of values generated by natural resources are widely recognised: 'Use values' and 'non-use' values. Use values involve people having direct contact with the resource. In the context of native fish, recreational fishing is defined as generating a use value. To enjoy non-use values people are not required to have direct contact. In a native fish context, people may enjoy a value simply from knowing that the Murray Cod is NOT extinct. This is known as an 'existence' benefit. Another non-use value can occur within the current generation if they want native fish to continue to populate Australian rivers so that their children and grandchildren can gain value from them. This is known as a 'bequest value'. Option values can arise if people value retaining the option to use an environmental resource at some future date. **Figure 7** shows these various types of economic values.

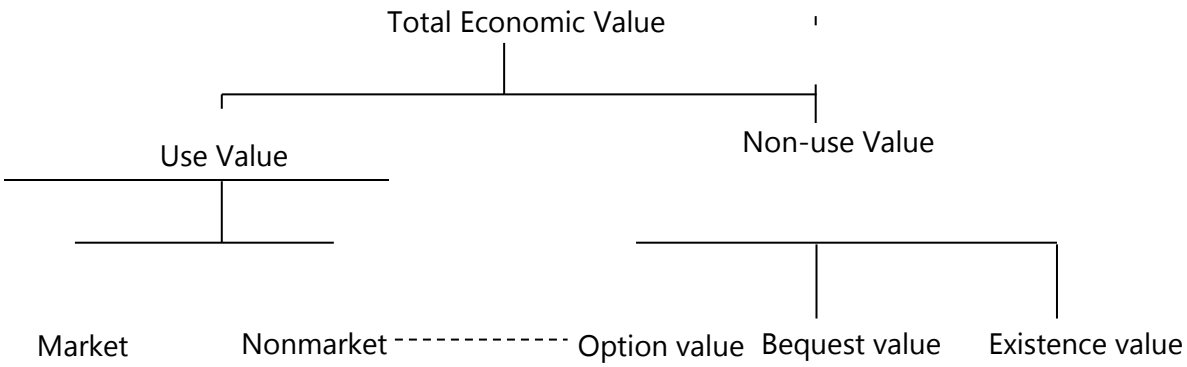

Figure 7: typology of economic values

[9] Note that part of expenditure is producer surplus and part is resource costs. Only when costs are netted out of expenditures can the remainder by classed as a value: the producer surplus.

3. Methods to estimate values

Key messages

- Economic value estimates can be made by using revealed and stated preference techniques.
- Some valuation methods estimate current values only, others estimate current values as well as changes to current values with alternative policy initiatives, while other methods only estimate the change in values with a policy change.
- Different methods are suited to different contexts depending on the values to be estimated (e.g. use or non-use values), whether the current values as well as change in value is the focus, and practicalities about data availability and collection.
- The Travel Cost Method is suited to the estimation of use values such as those enjoyed by recreational fishers and can be supplemented with a contingent behaviour question to estimate changes in values with a policy change. Because the method also collects data on expenditure, this additional information can be used to estimate the contribution that fishers directly make to regional economies.
- Where non-use values are also of interest, the Contingent Valuation Method or Choice Modelling would be required. A single Choice Modelling study can generate value estimates for different ecological outcomes from a wide array of management change options, and hence is generally preferable to the Contingent Valuation Method.
- All valuation methods (apart from the hedonic pricing technique) are survey-based but vary in the population surveyed. Some survey the general population e.g. Contingent Valuation Method and Choice Modelling approaches were both use and non-use values are relevant. Other (revealed preference) methods such as the Travel Cost Method involve surveys of users, either at the site of interest or by filtering for users across the broader population.
- Different valuation methods have different data/survey/sample requirements.
- Some valuation 'techniques' (e.g. replacement value/price of a substitute) lack a sound base in welfare economics and should not be used, particularly for Cost Benefit Analysis.

Implications for a pilot study

- The Travel Cost Method is the simplest method for estimating existing recreational fishing values and can be supplemented with a contingent behaviour question to also elicit changes in values with a policy change.
- Choice Modelling is the preferred method for estimating changes in non-use values associated with native fish.
- The Travel Cost Method generally requires onsite surveys of recreational fishers while Choice Modelling requires online survey of a population sample.

3.1 Introduction

The focus of this report is on the estimation of the surpluses arising from native fish in a valley within the MDB. Both use and non-use values are targeted. Changes in values arising from changes in resource management (marginal values) are a focus because these values are relevant for inclusion in Cost Benefit Analysis of proposed policy initiatives for the Basin. The value of the native fish resource over a period of time is also considered.

3.2 Market values

Where markets have formed for resources, data from those markets can be used to estimate the consumer and producer surpluses arising. Estimates of changes to those surpluses under different management policy contexts can also be made with reference to market data. The process of estimation involves the collection of sales data so that econometric models can be formulated for both supply and demand conditions. Interacting these models allows the simulation of prices and the quantities bought and sold under different scenarios. Integral to these simulations are predictions of the physical outcomes of different management actions.

Because markets exist for many of the resources that are used in the production of a resource and because users of a resource pay prices for access, it is relatively straightforward to estimate consumption expenditures and the costs of production. However, as pointed out in the previous section, these are not valid estimates of value as defined in terms of peoples' well-being.

In line with this differentiation between expenditure-based and value-based estimates, it is also worth noting that a number of other metrics have been used as 'surrogates' for expenditure. These include measures of gross output (value of sales rather than values of expenditure, but the two are equal) and employment created. The latter is a particularly prevalent metric politically because it shows the number of jobs created by the use of a resource.

From the perspective of value, it is a cost and, as such, a detractor from value. This is because workers have alternative employment that should be recognised as an opportunity cost: If employment opportunities are created, they can take workers away from other jobs. The exception is where employment opportunities are solely taken up by the otherwise unemployed. However, this is a rare occurrence when unemployment rates are at or below their 'natural'[10] levels of around five percent.

[10] The 'natural rate of unemployment' takes into account those, for example, who are physically unable or unwilling to work as well as those who are in between jobs. It is argued that reducing the rate of unemployment below this 'natural rate' cannot be achieved through short-term macro-economic policy measures.

3.3 Nonmarket values

In some circumstances markets do not form. This primarily occurs when the resource under consideration has public good characteristics, particularly when property rights to the resource are impossible or at least very costly to define and defend. In such circumstances, estimates of values arising from the resource cannot be based directly on market data. Two alternative methodological pathways are available in such cases.

3.3.1 Revealed preference methods

First, data from markets for other resources that are in some way related to the resource being valued may be used. Value estimation techniques falling under this category are known as revealed preference techniques. Two prominent revealed preference techniques are the Travel Cost Method and the Hedonic Pricing Technique.

The Travel Cost Method

The standard Travel Cost Method involves people who use a resource (such as recreational fishers) being interviewed to find out the extent of their expenditures relating to accessing the resource. Of principal interest in these costs are those relating to their travel. User rates of visitation over a specified time period is then related to their travel costs. This 'trip generation function' is then used to simulate a demand relationship between a hypothetical entry fee and the numbers of visitors. Users are assumed under this method to react to a potential entry fee in the same way as they react to increases in travel expenditures: As travel expenditures increase, the frequency of visitation decreases. The average consumer surplus per visitor can then be calculated from the area under the demand curve. Multiplying the average value per visit by the number of visitors over a time period gives an estimate of the total use value in that period. If a change in management would yield an increase in fishing trips, the number of additional fishing trips multiplied by the average value would provide an estimate of the marginal use benefit of the management change. This enables Travel Cost Method results to be used as inputs into Cost Benefit Analysis of management changes.

The Travel Cost Method can be implemented in its zonal or individual forms. The zonal version involves the trip generation function being specified as the relationship between the number of visitors per population size for defined geographic 'zones' of visitors' points of origin. As travel costs increase, the numbers of visitors per head of population decreases. This format is useful in cases where most visitors only visit once per annum. Because it reduces the trip generation function to a relatively small number of zones, it suffers from a lack of empirical precision.

In contrast, the individual version allows empirical precision because the trip generation function is estimated on the basis of individual visitors. This version can only be applied where visitors have a diversity of annual frequency of visitation to a site.

To implement the Travel Cost Method usually involves on-site collection of data relating to visitors' places of residence. Basic Travel Cost Method questionnaires can be limited to asking respondents the postcode of their home address but more sophisticated and hence more accurate studies will involve additional questions regarding costs incurred, characteristics of their trip as well as socio-economic characteristics. Sampling needs to cover different times of the day, week and year to ensure representation of the population of visitors. Where the destination site is geographically spread (as for a river or catchment), sampling must also ensure respondents are representative across space as well as socio-economic characteristics.

The appropriate sample size for a Travel Cost Method study will depend on the heterogeneity of the population (across space, time and socio-economic characteristics). To ensure

statistical rigour, a minimum sample size of around 200-300 respondents would be required. Greater heterogeneity would require a larger sample size and a sampling process that was able to capture the differences between sites and visitors.

Because the Travel Cost Method collects data on expenditure this additional information can be used to estimate the contribution that fishers directly make to regional economies. It is important to note, however, that the Travel Cost Method itself delivers estimates of consumer surplus. The technique uses information about people's expenditures in travelling to a recreational (fishing) site to infer estimates of what they are willing to pay to make a visit. The expenditure data are therefore not used directly to estimate 'value'.

The Hedonic Pricing Technique

The Hedonic Pricing Technique also focuses on the estimation of use values. It involves the estimation of the relationship between the price of a marketed good and a non-marketed factor that has an influence on price. For example, the prices of real estate may be influenced by the distance from a popular fishing site. The contribution made to price by the properties' locations is known as the 'implicit price' of the fishing site and can be used as a surrogate for the average value held for that site by the property owners. The sum of implicit prices multiplied by the number of properties gives an estimate of the value of the fishing site and its associated use values. If changes to management at the fishing site cause the prices of properties to rise, the increased implicit price can be used as a surrogate for the marginal value. With appropriate caveats regarding this surrogate role, Hedonic Pricing Technique derived estimates may be used in Cost Benefit Analysis of management changes.

The Hedonic Pricing Technique is a data intensive technique. In its most common real estate focused application, property prices must be explained as a function of a wide array of independent variables. Collecting data on these variables may be done remotely (through internet searches of real estate web pages or using mapping tools to estimate distances) but direct measurement of some property characteristics (such as the view of a river) may also be needed. Because of its heavy data requirements, the Hedonic Pricing Technique depends on sufficient observations of transactions being available. This is frequently a limitation of the technique in rural and regional areas where property sales are less frequent.

The number of observations required to implement the Hedonic Pricing Technique depends on the number of independent variables that have an impact on price in the market and the heterogeneity of the sales history. The more independent variables, the more observations required to deliver the necessary 'degrees of freedom' to ensure statistical rigour. In a relatively homogeneous property market, there could be up to 30 independent variables playing a role in determining property price. This would imply the need for at least 200 records of sales for the Hedonic Pricing Technique to deliver rigorous results.

3.3.2 Stated preference methods

The second methodological pathway that can be taken when values are not marketed involves stated preference techniques. These involve surveys being taken of people likely to be impacted by changes in physical outcomes. Value estimates are made on the basis of questions relating to respondents' willingness to pay to gain access to the potential benefits of change. These techniques are thus targeted at estimating values associated with change: the marginal values. As such they provide estimates that are directly suited for inclusion in Cost Benefit Analysis of management changes.

Stated preference methods are also more flexible than revealed preference techniques in so far as they can estimate non-use as well as, or in addition to, use values. Because of this flexibility, caution is needed when using revealed and stated preference estimates of value

together. The danger is that there may be an 'overlap' in the values being estimated. This can result in the problem of 'double counting' values because the same value is estimated under both types of application.

Two stated preference techniques are prominent: The Contingent Valuation Method and Choice Modelling.

The Contingent Valuation Method

The most widely accepted version of the Contingent Valuation Method involves survey respondents being asked whether or not they would be willing to pay a pre-assigned amount for a change in management that would provide a benefit. This is known as the dichotomous choice Contingent Valuation Method. The analysis of the probability of agreeing to pay as a function of the amount asked for as well as a range of socio-economic factors allows the inference of average willingness to pay for the change. This is the average of the marginal values associated with the change. Multiplying this average by the estimated size of the population affected gives the aggregate marginal benefit. The technique does not estimate the values of resources in a time period, only marginal values.

The dichotomous choice Contingent Valuation Method relies on a number of sub-samples of respondents being asked if they are willing to pay differing pre-assigned amounts. The implication is that, as a minimum, five independent sub-samples of respondents must be selected and each sub-sample must have a sufficient size to ensure that their respondents are representative of the population. Hence, to estimate the value of one change in management requires a minimum of 150 respondents (given a sub-sample size of 30). Greater population heterogeneity would require a higher sample size. If multiple management change scenarios are to be valued, another 150 respondents would be required. One rationale for including at least one additional scenario in a Contingent Valuation Method survey is to conduct a 'scope test'. This test is designed to ensure that the values estimated are sensitive to the extent of the management change being proposed. For example, if the Contingent Valuation Method is being conducted to estimate the value of an increase in native fish population by 50%, then a scope test would involve a parallel valuation exercise for an 80% increase in population size.

Finding a statistically significant difference between the two estimated values would provide confidence that respondents had carefully considered the willingness to pay question.

Delivery of a Contingent Valuation Method questionnaire can be by personal interview, printed copy or a web site. Flexibility of delivery is only limited by the material needing to be delivered (especially visual material) but response rates vary widely across delivery modes. Web-based surveys are now the most common delivery mode given poor response rates to mail-out questionnaires and difficulties (and expense) with accessing respondents for in-person interviews. Where the focus of a Contingent Valuation Method application is on the estimation of use values or if the values of visitors to a site are being estimated, on-site delivery is likely to be best means of targeting relevant respondents.

Choice Modelling

Choice Modelling is also designed to estimate marginal values. It is a development from the idea underpinning the Contingent Valuation Method. Survey respondents are asked to choose between a range of alternative resource management strategies, each of which is described to respondents in terms of a set of ecological and social outcome attributes. With one attribute being a cost, the values associated with each nonmarket attribute can be inferred from the choices respondents make. The individual attribute values can be associated with projected outcomes to form estimates of the values from specific management changes.

Choice Modelling is able to estimate per unit values of each nonmarket attribute. For example, in a fisheries context, two nonmarket attributes that are impacted by changes in management may be the diversity of native species and the size of the population of native species. Different policies may affect diversity and size in different ways. Hence, the values generated by different management options can be estimated by combining the differing attribute levels and their individual per unit values. This means that a single Choice Modelling application can generate value estimates for different ecological and social outcomes from a wide array of different management change options. This is in contrast to the Contingent Valuation Method which requires separate parallel studies to estimate values for the outcomes of different management strategies.

However, Choice Modelling involves respondents answering numerous choice questions and it is the norm that up to five sub-samples of the population are required to ensure that the necessary number of choice questions are presented to respondents. The implication is that a minimum sample size for a Choice Modelling application is 150. Population heterogeneity requires greater sample size.

Typical applications of Choice Modelling involve surveying a representative sample of the population from an online panel. Because Choice Modelling is focused on use and non-use value it is the general population rather than the population of fishers that is sampled.

Validity

Both stated preference techniques are subject to concerns regarding the validity of their estimates because of the hypothetical nature of the questions asked. A vast literature has explored the prospects of 'strategic bias' (whereby respondents deliberately misrepresent their stated preferences in order to influence the policy debate), hypothetical bias (whereby respondents give answers to the willingness to pay questions that are not well deliberated), amongst other forms of bias. Specific survey and questionnaire design features must be used to ensure that biased estimates of values are not produced.

These include ensuring that surveys are considered to be 'consequential' by respondents (in that their answers will have an impact on policy) and the incorporation of a 'provision rule' in the payment section of the questionnaire (whereby the management change will only occur if a sufficient proportion of the sample agree to it). The 'state of the art' for stated preference surveys has recently been set out in Johnston et al. (2017)[11].

3.3.3 Combined revealed and stated preference methods

Some valuation approaches involve the merging of stated and revealed preference techniques. For instance, to estimate the value enjoyed by recreational fishers, the Travel Cost Method may be used. However, if the value of interest relates to a change in resource management that improves the quality of the fishing experience, a stated preference question may be added to the Travel Cost Method questionnaire. This 'contingent behaviour' question would ask how the fishers would change their visitation patterns as a result of the quality change. The answer allows the estimation of a second trip generation function so that 'with and without' values can be estimated. The increase in consumer surplus so calculated could then be used directly in a Cost Benefit Analysis of the policy option. Including the contingent behaviour question does not require an expansion of the sample used for a standard Travel Cost Method application but it does require an extension to the length of the questionnaire. The bio-physical conditions currently experienced by visitors, and those which would be experienced if a management change was enacted need to be defined and communicated in the questionnaire. An extra set of questions relating to visitation under the proposed new conditions is then required. A limitation of the combined contingent behaviour and Travel Cost Method approach when applied to an improvement in conditions at the recreational (fishing) site is that it only estimates the value of the improvement for the existing visitors. Any increase in value resulting from an increase in new visitors is not estimated. This results in an under-estimation of the increase in consumer surplus. This limitation is not experienced when a decline in conditions is the focus of the valuation exercise. Because a decline in condition could be expected to cause some existing visitors to stop coming to the site and a diminished per visit value, both of those elements of the loss in value can be estimated by interviewing current visitors.

A variant on the contingent behaviour plus Travel Cost Method approach (known as the random utility model Travel Cost Method) follows the Choice Modelling method. Fishers in a survey are asked not only about their current fishing trip but are also asked to choose between a range of other fishing trips. Those trips are described in terms of the associated travel costs and an array of other attributes such as fish take. The trade-offs people display in making their stated choices, together with their revealed preference for their current fishing trip, allows the inference of values for the nonmarket values associated with fishing.

[11] Johnston, R., K. Boyle, W. Adamowicz, J. Bennett, R. Brouwer, T. Cameron, W. Hanemann, N. Hanley, M. Ryan, R. Scarpa, R. Tourangeau and C. Vossler (2017). 'Contemporary Guidance for Stated Preference Studies', *Journal of the Association of Environmental and Resource Economists*, 10.1086/691697

This 'merging' of actual choices and hypothetical choices is also a useful technique to 'anchor' respondents' stated preferences to their real behaviour. The prospect of bias in the hypothetical context questions is reduced using this approach.

3.3.4 Benefit transfer

The benefit transfer method is sometimes erroneously referred to as a valuation technique. Strictly speaking it is not a method that involves the estimation of values. Rather it involves the use of values estimated by other studies in other contexts as an approximation for the values experienced in the context of current concern. For benefit transfer to be valid, the 'source' study must approximate the 'target' study context in terms of physical and social conditions. Transfers can be of specific values or of value functions. Where numerous source studies exist, 'meta analyses' can bring together all source studies to provide a more robust estimate of the values at the target site. A specific issue relating to the process of benefit transfer is the difference in scale between the source and the target cases. Differences in scale (for instance, between values estimated for one valley compared to values estimated across a whole river basin) will cause differences in per unit values estimated. It is important then for the appropriate use of benefit transfer that adjustments for different scales of application are taken into account.

3.4 Non-economic 'valuation' methods

It is important to note a number of other methods that purport to estimate 'values' associated with resource use. They are detailed here to show why they are not appropriate to the task of informing policy decision making.

Value indicators or indices are composites of various criteria that are argued to constitute value to society. The criteria are measured using a range of metrics before they are each assigned a weight and aggregated. This follows the approach of Multi Criteria Analysis. This approach is not structured around a cohesive conceptual foundation and faces the difficulty of adding unlike elements. This issue is dealt with through the use of weights which are inherently subjective. The result is a measure of 'value' that is unit-less and unable to be compared across alternative options.

The same criticism applies to studies that use 'happiness' scores as a measure of value. The lack of a common unit of measurement across the diversity of people makes these scores inherently unreliable and unsuitable for comparisons. They are inherently subjective.

'Motivation' studies of value stress the importance of why people experience values. These studies fall into the realm of psychology rather than economics. Economic analysis tends to study the outcomes of choices rather than the reasons why people make their choices. Economic analyses frequently attempt to correlate choices made against the socio-economic characteristics of the people who make the choices but this more as effort to test hypotheses of consistency in behaviour or as the precursor to predicting behaviour rather than an exploration of motivation. Notwithstanding, the value estimated using nonmarket valuation methods incorporates psychological, social, catch and physical health motivations.

3.5 Summary of valuation methods

Table 1 provides a summary of the valuation methods discussed above (including those methods that don't adhere to the primary focus of estimating people's well-being), with focus on the value type estimated, the link to different types of analysis, data requirements and focus of the survey sample. Only valuation methods 3 to 8 strictly conform to the economic evaluation conceptual framework. The appropriate method will vary on a case by case approach depending on the values to be estimated (e.g. use and/or non-use values), whether the current values as well was change in value is the focus, and practicalities about data availability and collection.

The standard Travel Cost Method is the simplest form of estimating recreational fishing values and can be supplemented with a contingent behaviour question to also elicit changes in values with a policy change. The survey questions required to implement this method include information on expenditure of visitors and hence data collected can be used for economic evaluation (Cost Benefit Analysis) as well as importance of recreational fishers for regional economies.

The Random Utility Model Travel Cost Method is more sophisticated than the single Travel Cost Method but is much more data intensive. The Contingent Valuation Method and Choice Modelling can elicit both use values as well as non-use values. However, Choice Modelling has a number of advantages over Contingent Valuation Method.

Table 1: Summary of valuation methods

No.	Method	What is estimated			Analysis link	Data Requirements	Location of survey
1	Expenditure survey	Expenditure/output	Use	Economic activity	Regional impact	Expenditure (by item and region)	Onsite visitors or fisher population sample
2	Replacement value/price	Expenditure/output	Use	Hypothetical	None	• Catch • Nutritional value • Price of substitute	Onsite visitors
3	Hedonic pricing technique	Economic value – consumer surplus	Use	Implicit price per property of being located near a fishing site	Cost Benefit Analysis	• Property information • Property sales values • Distance from fishing sites	Property data

4	Travel Cost Method – Standard	Economic Value- Consumer Surplus	Use	Average value of a site	Cost Benefit Analysis with assumption about how many visits and value change with an environmental change	• Group size • Postcode of trip origin • Mode of transport • Annual frequency of trip • Expenditure to get to site • Importance of site visit to total trip	Onsite visitors although also possible to survey fisher population
5.	Travel Cost Method – Contingent Behaviour	Economic Value – Consumer Surplus	Use	• Average value of a visit PLUS • Change in average value of a visit with an environmental change.	Cost Benefit Analysis	• As above, PLUS • Change in frequency of trip with environmental change • Socio-demographic data	Onsite visitors although also possible to survey fisher population

6.	Random Utility Travel Cost Method	Economic Value – Consumer Surplus	Use	• Average value of a visit PLUS • Change in average value of a visit with a change in site attributes	Cost Benefit Analysis	• Fisher trip diary • Multiple fishing site attributes	Fisher Population Sample
7.	Contingent Valuation Method	Economic Value – Consumer surplus	Use and non-use	• Change in average value per household per time period with an environmental change.	Cost Benefit Analysis	• Response to WTP question • Socio-demographic data	General population sample
8.	Choice modelling	Economic Value – Consumer surplus	Use and non-use	• Change in average value per household per time period with an environmental change	Cost Benefit Analysis	• Response to choice sets • Socio-demographic data	General population sample
9.	Benefit Transfer	Any	Any	Any	Any	• Relevant literature	None

4. Literature review

Key messages

- Most studies reviewed do not relate to recreational fishing in inland rivers. They are broader or different in scope, but offer some insights into methods and approaches.
- Fundamentally, there is little primary research into economic values (consumer surplus) of native fish and recreational fishing in inland rivers in NSW and how these might change with changes in water management or other management regimes.
- Expenditure has tended to be the most widely used economic measure in recreational fisheries. However, expenditure is not an appropriate measure of the economic value of recreational fishing.
- Where economic value or expenditure has been reported, the unit of measurement varies, making comparisons difficult. For instance, consumer surplus estimates for recreational fishing include per day and per visit, as well as for an additional fish caught. Expenditure estimates include per trip, per adult fisher per trip, per day, for locals versus visitors. Combined use and non-use values attributes valued using stated preference methods are also varied for a percentage increase in Murray Cod or other threatened native fish to a reduction in time taken to catch an Australian Bass.
- Choice modelling was the most commonly used non-market valuation method undertaken in the literature reviewed – estimating both use and non-use values. These studies often included an attribute for fish populations or species. However, it is not possible to isolate the recreational fishing values from these studies as they also include non-use values or ecosystem services.
- The standard Travel Cost Method has been used to estimate recreational fishing use values. Slight modifications to existing recreational fishing surveys would enable implementation of the standard Travel Cost Method. In some instances, travel information collected from these large scale surveys may not be sufficient to carry out Travel Cost Method estimations for recreational fishers. Therefore, targeted non-market valuation studies may be required in specific regions to help with specific resource access and allocation issues.
- The standard Travel Cost Method can be applied so that expenditure data is collected. Hence its application can also facilitate the modelling of regional or statewide expenditure impacts of recreational fishing expenditure.
- Application of the standard Travel Cost Method to estimate the economic values of recreational fishing in a location requires data on: location of a fishing spot; return distance travelled; location of point of origin; annual frequency of visits to the fishing spot, river reach, or catchment; the type of transport used; trip expenditure; whether fishing is the main purpose of the trip away from home; and socio-demographic information.
- Screening questions can also be required where trips do not have the fishing venue as the respondent's sole destination. Note that catch data is not a normal requirement of the standard Travel Cost Method.

Implications for a pilot study

- There are limited applications of contingent behaviour Travel Cost Method and Choice Modelling to native fish in inland river catchments.
- It is not possible to isolate the recreational fishing values from choice modelling studies that include attributes for native fish populations. Separate Travel Cost method studies are required.
- Expenditure data collected from Travel Cost Method surveys can also be used to estimate economic activity generated in a regional economy from recreational fishing.

4.1 Introduction

In this section, a review of the Australian literature that has focused on the value of the environment, paying specific attention to the valuation of inland fisheries, is reported. The overseas literature has not be examined as this is less reliable for benefit transfer in an Australian context due to differences in populations and their preferences, and the natural environments being examined. In total, 92 studies were reviewed[12]. The relevance of these past studies to any future valuation effort is noted. In this regard, how they relate to the conceptual framework set out in section 2 and the methodological framework set out in section 3 is described.

4.2 Summary of Study Themes

The studies reviewed have been grouped into a number of themes based on the primary, and in some cases, secondary economic analyses that have been undertaken (Table 2). Some studies have multiple dimensions and hence some subjective judgement was used to classify studies according to their primary economic focus. While some studies did not relate to recreational fishing or to inland rivers *per se* they contained ecological or economic aspects considered of relevance to the current study.

[12] Refer to Appendix 1 where each study is numbered. Reference to studies in this section is via this numbering system.

Table 2: Summary of study themes

Themes	**Number of studies**
Non-economic	6
Ecosystem services	3
Environmental accounting	3
Well-being	6
Motivations	2
Expenditure, Catch and Effort plus Regional Impacts	17
Survey Method	1
Economics and Nonmarket Valuation General	23
Nonmarket Valuation Applications	
Replacement Value	2
Contingent Valuation Method	1
Choice Modelling	8
Travel Cost Method -Standard	1
Travel Cost Method – Contingent Behaviour	1
Travel Cost Method - RUM	2
Benefit Transfer	6
Bio-economic Modelling and Valuation	1
Cost Benefit Analysis	6
Incentive Mechanism	1
Total	**92**

4.3 Noneconomic

A range of studies were classified as primarily noneconomic in nature, containing demographic data of recreational fishers (2), discussion of social (13, 62, 78) and indigenous (39) objectives of fisheries management, environmental flows or beaches and headlands.

4.4 Ecosystem Services

Three studies were classified as involving discussions of ecosystem services as their primary focus (64, 15, 5). However, 34 studies couched their assessments within an ecosystem services framework. The ecosystem service framework generally classifies the services provided by ecosystems into 'provisioning services' such as food and water; 'regulating services' such as regulation of floods, drought, land degradation and disease; and 'cultural services' such as recreational, spiritual, religious and other nonmaterial benefits. Earlier frameworks such as the Millennium Ecosystem Assessment (MEA) include a fourth category, 'supporting services', which includes soil formation and nutrient cycling. However, valuation of supporting services poses a double-counting risk since they may be considered as intermediate effects that then impact the provision of final ecosystem services and goods. Thus recent frameworks, including that developed by The Economics of Ecosystems and Biodiversity (TEEB) project, subsume supporting services and identify a fourth category of 'habitat services' which provides a final benefit in its own right (CSIRO 2012).

Notwithstanding the classification system used, ecosystem services are the aspects of ecosystems that may contribute to human wellbeing (CSIRO 2012). Provided human wellbeing is improved or diminished by changes in the level of provision of ecosystem services, they have economic value. These values are usually decomposed into the use and non-use values.

4.5 Environmental Accounting

Three studies had an environmental accounting framework (20, 24, 75). National accounts are focused on market activity and expenditure type of indicators. Extension of these frameworks to include the environment also tends to focus on expenditure type indicators as well as total values rather than marginal values (Varcoe et al. 2016) (75). Eigenraam et al. (2016) (24) for example value recreational fishing in terms of expenditure and value ecosystem services in terms of the price of fish that an ecosystem produces. As identified in section 2, these measures are not consistent with the economic value framework.

Varcoe et al. (2016) (75) note that environmental accounting and valuation can be linked but are generally used for different purposes. The purpose of environmental accounting is to provide consistent and comparable information on ecosystem assets and the services they provide, along with performance measures of resource use and emissions in the economy (e.g. water, energy, carbon). Environmental valuation is used to assess the benefits provided by environmental assets and places a value in monetary terms, which enables appraisal of competing use of resources, alternative policies or investments.

4.6 Well-being

Six studies (76, 77, 68, 4, 52, 53) use a non-economic 'well-being' framework to examine benefits of recreational fishing, aquaculture and professional fishing. These identify a link between fishing and well-being and a number of different potential motivations or key domains of well-being to which fishing contributes. Benefits remain qualitative in these studies although one study - Barclay et al. (2016) (4) - that focused on aquaculture did identify regional economic impacts (in terms of expenditure) of the sector for three regions on the NSW coast. As identified in section 2, this measure is not consistent with the economic value framework but is relevant to the economic activity framework.

4.7 Motivations

Two studies (50, 51) focused on the motivations and attitudes of recreational fishers, including catch related motivations (e.g. catching something, number of fish caught, size of fish caught) and non-catch motives (mastery, escapism and socialisation). However, these studies did not have an economic dimension. As identified by Griffiths et al. (2014) (33), when asked in the National Recreation and Indigenous Fishing Survey (NRIFS) about reasons for fishing, primary motivations for recreational fishers included 'to relax and unwind', 'to spend time with family', 'fishing for sport' and 'to be outdoors'. This points to difficulties in linking increases in economic value to fishing catch alone.

As identified in section 2, from an economic perspective the reasons underpinning recreational fishing are less important than the willingness to pay of fishers for the fishing experience and how this may change (for whatever reason) under different policy or management options.

4.8 Expenditure, Catch and Effort Plus Regional Impacts

Perhaps the greatest focus of the studies reviewed, in particular those related to recreational fishing, is on physical metrics, such as catch and effort, and the metric of expenditure.

While some studies use catch as a proxy for economic value (see discussion of the replacement value approach later), expenditure has been the main focus of the economic dimension of recreational fishing. Indeed, Colquhoun (2015) (16) in a paper aimed at establishing a national economic valuation approach for the Recreational Fishing sector concluded that expenditure based valuation approaches are the most appropriate way to value the economic contribution of the recreational fishing sector.

Colquhoun (2015) (16) recommended that all fishers, policy makers and other stakeholders immediately adopt this standard valuation method across the national recreational fishing sector. Colquhoun (2015) (16) also recommended that an expenditure-based valuation approach be adopted as the basis for the proposed second national recreational fishery survey.

An expenditure-based approach does allow benchmarking and comparison with industries such as golf, and horse racing and commercial fishing (Colquhoun, 2015) (16) and can be extended via input-output modelling to examine economic activity that it contributes to a regional economy (another common application to recreational fishing) (21, 22, 23, 37, 49, 66, 38, 32, 46, 89). Expenditure data are also an essential input to valuation using the Travel Cost Method.

However, as identified by Georgeson et al. (2015) (28), expenditure data alone provide little information that could be used for determining efficient resource access and allocation arrangements between users, including recreational and commercial fishers. In the case of a resource sharing issue between two or more sectors, the net benefit of each sector in a particular area should be considered and evaluated to ensure that resources are allocated to their optimal use.

In this respect, as identified in section 2, expenditure is a cost and not a net benefit. Expenditure based metrics do not give an indication of the economic value of recreational fishing to individuals. They are inappropriate for inclusion in policy evaluation frameworks such as Cost Benefit Analysis.

4.9 Economics and Nonmarket Valuation - General

Twenty-three studies primarily provide a conceptual discussion of aspects of economic valuation and various nonmarket valuation methods. Perhaps of most relevance to this study, is Hassall and Associates and Gillespie Economics (2004) (34) which provides a detailed discussion of the economic values of Marine National Parks, economic demand and supply models for identifying the economic values, and the data required to estimate values. While that study related to Marine National Parks, the conceptual framework it relies on is relevant to inland rivers and waterways and recreational fishing and is consistent with conceptual framework that set out in section 2.

4.10 Economics and Nonmarket Valuation - General

A number of different nonmarket valuation methods were utilised in the studies. These are briefly discussed below.

4.10.1 Replacement values

A number of studies imputed the value of recreational fishing catch by multiplying the catch weight (kg) by the price of fish per kg (40, 73). A variant of this in relation to indigenous non-fish catch e.g. turtles, was to use the price per kg of food of equivalent nutritional or energy value. However, this is at best a gross value and does not reflect the consumer surplus to fishers and indigenous people. As well as relying on an expenditure-based metric, which as identified in section 2 is not equivalent to economic value, it also makes the dubious assumption that commercially caught fish are perfect substitutes for own catch.

Colquhoun (2015) (16) reports that in a recent national workshop stakeholder groups agreed that Gross Value Product equivalent valuation – calculated as the estimated landed weight of fish multiplied by an estimated average value per kilogram – is the most feasible measure that can be used for comparing the respective value of commercial and recreational fisheries. However, again this is not an appropriate measure of economic value.

4.10.2 Contingent valuation method

One study (Yamazaki et al. 2011) (90) used the Contingent Valuation Method to estimate the willingness to pay of people for the most recent (last) day they spent recreational fishing in the inshore saltwater fishery and rock lobster fishery of Tasmania. As identified in section 3, the Contingent Valuation Method estimates a marginal change rather than a total value, and provides a measure of value relevant for inclusion in a Cost Benefit Analysis of policy change.

4.10.3 Choice Modelling

A number of studies (11, 63, 58, 7, 9, 10, 86, 8) utilised Choice Modelling to value incremental changes (marginal values) in a range of environmental attributes that are impacted by some policy change. Many of these studies (11, 58, 7, 9, 10, 86, 8) specifically relate to changes in environmental flows. In relation to environmental flows, a common attribute included in the questionnaire design related to native fish e.g. number of native fish species present (7, 8), population of native fish (9, 86) or time taken to catch an Australian Bass (10).

The values elicited for these fish attributes are likely to reflect both recreational fishing values as well as non-use values for the health of the waterways and wetlands, since number of fish, fish species and time taken to catch an Australian Bass reflect both the general health of a waterway and the desirability of a location for recreational fishing. It is not possible to isolate the recreational fishing values from the non-use values of native fish in these studies.

4.10.4 Travel Cost Method

One study (Whitten and Bennett 2002) (88) had a standard Travel Cost Method study as its primary focus (albeit in relation to duck hunting) while a number of others (e.g. 32, 63) also included standard Travel Cost Method results. Gregg and Rolfe (2013) (32) was specifically focused on recreational fishing in Queensland dams. The standard Travel Cost Method estimates the total current value associated with recreational fishing.

Marginal recreational fishing values from an environmental change can potentially be estimated via an extension of the standard Travel Cost Method that involves a contingent behaviour question. This approach is demonstrated by Gillespie et al. (2017) (29) in relation to environmental flows in the Hawkesbury-Nepean River. It involves asking respondents both their current visitation frequency as well has how this will change given a change in environmental condition. Both current demand and future values can then be determined.

A further extension of the standard Travel Cost Method is the use of Random Utility Model framework to explain fisher choice of site locations and their willingness to pay for a fishing trip. Four studies fall into this category (54, 65, 91, 92). The models in studies 54 and 65 relate an angler's decisions to the characteristics of available sites (e.g. availability of fish, distance, etc.), personal characteristics of the angler (e.g. experience, age, gender, income etc.), as well as any other relevant influences (e.g. weather). Willingness to pay estimates can be generated for individual or combinations of site attributes as well as for site access opportunities. Studies 91 and 92 demonstrate an application of the Random Utility Model Travel Cost Method framework to protected area visitation.

Grantham and Rudd (2015) (31) in a review of the current status and future needs of economics research of inland capture fisheries identified that for capturing use values of inland capture fisheries, revealed preference methods (such as Travel Cost Method) are preferable.

The Travel Cost Method is an economic valuation technique that is suited to measuring the use value of recreational fishing locations to users of those locations. Georgeson et al. (2015) (28) reports on a project undertaken within ABARES to investigate how recreational fishing expenditure data collected by future surveys could be modified to enable application of a standard travel cost analysis. The exercise showed that at a relatively low cost, a slight modification of some questions and a few additional questions would assist with applying a standard Travel Cost Method analysis.

Slight modifications to the existing expenditure focused questionnaire were proposed. These would clearly define terminology such as:

- 'fishing trip' as a trip from home (place of usual residence) to a fishing spot;
- 'distance travelled' as a trip from home (place of usual residence) to a fishing spot and then home again; and,
- total distance travelled over the entire duration of a fishing trip (included distance travelled while on a fishing trip).

Additional questions proposed to facilitate application of the Travel Cost Method as part of any future national recreational fishing survey included:

- the name of a fishing spot and a nearby town;
- the type of transport (car and engine size, plane, bus, boat and size etc.) for a trip from home to a fishing spot and if a combination of transport modes was used, the distance travelled using each of the transport modes;
- specifying if the vehicle used for a trip (from home to a fishing spot) was towing a boat;
- the main purpose of a trip; and,
- the main species targeted.

One limitation identified was that for many locations, the number of responses collected as part of a national survey may be too low to allow application of the method.

4.10.5 Benefit transfer

Six studies (19, 41, 44, 56, 46, 18) used benefit transfer i.e. the use of values estimated from studies in other contexts and locations, to value impacts of interest. One of these, Johnstone et al. (2006) (41) used benefit transfer from a meta-analysis - where characteristics and results of primary valuation studies are themselves incorporated into a statistical model to determine how values change with site and study characteristics. Three studies (18, 19, 56,) in particular focused on the benefits of the MDB Plan for the fishing industry (including recreational fishing) (19) and environmental, social and commercial values more broadly (56, 18). In relation to recreational fishing, Deloitte Access Economics (2012) (19) uses expenditure data from other studies and a number of assumptions to infer a consumer surplus per fishing trip and then assumed that a 10% increase in fish numbers from the Basin Plan would increase expenditure for recreational fishing by 5%. In relation to recreational fishing, CSIRO (2012) (18) referred to an Ernst Young (2011) study on total expenditure and potential to use benefit transfer from Morrison and Hatton MacDonald (2010) (56) if a cause-effect relationships to flows could be established. Morrison and Hatton MacDonald (2010) (56) describe how environmental valuation can be used to support the development of sustainable diversion limits (SDLs) in the Murray-Darling and transfer values from a number of studies are referenced.

4.10.6 Survey Method

Georgeson et al. (2015) (28) identifies a framework for regular national recreational fishing surveys. It presents a cost-effective, repeatable framework using 'best-practice' methods for implementing national recreational fishing surveys every five years. This study recognised the shortcomings of recreational expenditure data as a measure of value and identified that at a relatively low cost, a slight modification of some questions and a few additional questions would assist with applying a standard travel cost analysis. These modifications are outlined in Chapter 4 and Appendix B of the Georgeson et al. (2015) (28) study. With an adequate sample size, this could provide a basis for researchers to apply the Travel Cost Method, potentially saving on costs of running a specifically tailored survey.

Nevertheless, in some instances, additional travel information collected may not be sufficient to carry out Travel Cost Method estimations. Therefore, targeted nonmarket valuation studies may be required in specific regions to help with specific resource access and allocation issues.

4.10.7 Bioeconomic modelling and valuation

One study (Fenichel et al. 2014) (26) provides a conceptual discussion of how to combine a bio-economic model and a random utility model to optimise the management of recreational fisheries. This study is theoretical in nature. While the method is economically valid, its complexity makes its use in an imminent pilot study problematic.

4.10.8 Cost benefit analysis

A number of studies (42, 82, 84, 85, 83, 89) provide a conceptual or applied framework for combining economic values into a Cost Benefit Analysis, to identify whether the benefits of a particular management options outweigh the costs. These are not primarily concerned with how to place a value on recreational fishing benefits and so are of general contextual value only to this study.

4.10.9 Incentive mechanisms

One study (Whitten and Bennett 2001) (87) use information on the distribution of costs and benefits of wetland management options between stakeholders to determine potential incentives mechanisms to encourage private sector provision of outcomes with public economic values.

4.10.10 Summary of expenditure and economic values

A summary of recreational fishing expenditure estimates and economic values from studies reviewed is provided in **Table 3.**

Table 3 Summary of recreational fishing expenditure estimates and economic values from studies reviewed

Value type	Unit	Location	Study	Original Source
Expenditure				
$114	Average expenditure Per Fisher Per Trip	Coorong, Lakes Alexandrine and Albert	Colloff, M., Crossman, N. and Overton, I. (2015)	Ernst & Young (2011)
$326	Average expenditure Per Adult Per Trip (excluding boat costs)	Port Phillip Bay	Eigenraam, M.,McOrmick, F. and Contreras, Z. (2016)	Victorian Recreational Fishing Survey (2014)

\$44 \$89	Average day trips angler expenditure per day Non-Sydney Fishers Sydney fishers	Coastal regions of NSW	Dominion Consulting (2003)	
\$124 \$148	Average overnight trips angler expenditure per day Non-Sydney fishers Sydney fishers	Coastal regions of NSW	Dominion Consulting (2003)	
\$42 to \$52 \$200-\$210	Average day trip angler expenditure (local) Average overnight trips angler expenditure per day			
\$269	Average expenditure per recreational fishing trip in the the MDBA by people residing in the MDB	MDB	Deloitte Access Economics (2012)	Ernst & Young (2011)
\$145	Average expenditure per recreational fishing trip in the MDB by people residing in the MDB	MDB	Deloitte Access Economics (2012)	Tourism Research Australia (TRA)

Consumer Surplus – Use Value Only				
$71	Consumer surplus per fishing trip	MDB	Deloitte Access Economics (2012)	Derived
$50	Consumer surplus per day for recreational boating trips	MDB	Marsden Jacobs Associates (2012)	From literature
$355.90	Consumer surplus per person (adult) per recreational fishing visit	MDB	Morrison and Hatton McDonald (2010)	Rolfe and Prayaga (2006)
$58	Consumer surplus per person per visit – water based recreation		Marsden Jacob Associates (2017)	Morrison and Hatton-McDonald (2010)
$78.18 $87.43	Mean willingness to pay for the most recent (last) day they spent recreational fishing	Tasmania inshore saltwater fishery Tasmania Rock lobster fishery	Yamazaki (2016)	
$13 to $70	Consumer surplus per visit	Recreation sites on Hawkesbury-Nepean River		
$2.28 to $15.94	WTP for an additional fish caught			
$5.61	WTP for access to a fishing site per trip			

Consumer Surplus – Use and Non-Use Values				
$1.02 to $1.37	WTP per household per year for a 1% increase in Murray Cod and other threatened native fish	River red gum forests across northern Victoria	Baker and Rutting (2014)	Bennett et al (2007)
$2.11 to $7.37	WTP (one-off) per household per additional native fish species present	NSW Rivers	Bennett (2002)	
$0.34	WTP (one-off) per household for a 1% increase in native fish populations (relative to the year 1880)	Murrumbidgee River Floodplain	Bennett and Whitton (undated)	
$0.31	WTP (per annum for 10 years) per minute reduction in the time taken to catch an Australian Bass.	Hawksbury-Nepean River	Bennett et al. (2017).	

5. Review of databases

Key messages

- The NSW Recreational Fishing Survey includes questions relevant to undertaking a standard Travel Cost Method study.
- There is potential to undertake a standard Travel Cost Method study for a specific catchment using the 2013/14 Recreational Fishing Survey dataset, subject to determining if a suitable sample size of fishers to a study catchment exists.
- There is potential to 'piggy-back' on the 'wash-up/'attitudinal survey' for the 2017-18 NSW Recreational Fishing Survey that is due to begin in October 2018, to undertake a standard and contingent behaviour Travel Cost Method for a specific study catchment. This would be subject to determining if a suitable sample size of fishers to a study catchment exists.

Implications for the Project

- Before commencing onsite Travel Cost Method surveys for a study catchment, the 2013/14 and 2017-18 NSW Recreational Fishing Survey datasets should be examined to determine if the sample size for a selected study area is sufficient to undertake a Travel Cost Method study.
- If a sufficient sample size exists for the 2017/18 survey, the wash-up survey could be used to obtain additional data required to undertake a standard and contingent behaviour Travel Cost Method study.

5.1 Introduction

This section reviews existing NSW fisheries data sets to determine if existing information is sufficient to implement methods to estimate recreational fishing values and what additional information is required.

5.2 NSW Aquatic Ecosystem Research Database

The NSW Aquatic Ecosystem Research Database (AER) has a range of site-specific data and information from various fish-related projects in NSW. It is the most comprehensive body of information regarding fish species/absence in NSW. Information stored in the database includes primary catch data. Biological catch information includes species, length, derived weight etc and could be used to infer recruitment. The AER database has a range of searchable queries, including river system/valley, catch method, catch effort.

For the Macquarie-Castlereagh River systems there are a range of research reports, including fish community response to environmental flows in the mid and lower Macquarie River.

This database does not contain any direct economic information.

5.3 NSW Recreational Fisher Licence Database

The NSW Recreational Fisher Licence Database includes contact information and licence transaction data for fishers who purchased a licence from licence agents (e.g. tackle shops, newsagents etc.) or were purchased via electronic methods e.g. online, over the phone, and other 'touch screen' technologies at various outlets. The majority of the database contains information on long-term licence holders as valid contact information is needed so they can receive a plastic card licence in the mail. There is some short-term (3 days and 1 month) licence data captured - but only for those who purchased a licence via one of the electronic methods (short-term licence holders are not issued with a plastic card). The vast majority of short-term licences are purchased from licence agents and do not require their contact details to be kept in the database. However, statistics on the number of short-term licences sold are kept by the fisheries licencing branch, information on short-term sales are not presented here but are available by contacting the licencing group.

NSW Fisheries investigated the potential of using the database for a survey of recreational fishing in 2013/14. The selection of fishers from the database was intended as a supplement to the main sampling frame (White Pages listings) used for the survey (see West et al. 2015 for full details). These investigations showed that long-term licence holders (1 and 3 years' duration) were responsible for large proportions of the state-wide effort and catch. These findings led to the development of the 2017/18 recreational fishing survey that used the Recreational Fishing Licence database exclusively as the basis for selection of respondents.

Selection of fishers was restricted to long-term licence holders (1 and 3 years) who provided valid contact information. NSW Fisheries also restricted the selection of fishers to those who possessed an active licence as at the end of November 2016. This yielded a list of about 430,000 active or current licence holders.

Prior to selection of survey respondents, several key fields required substantial editing work. For example, to align the residence of fishers to Australian Bureau of Statistics boundaries, a valid suburb and postcode were required. Also, the postcode field contained large amounts of missing data or incorrect postcodes for a given suburb.

Any future use of the database for more recent data (after November 2016) will require similar levels of editing to be able to categorise fishers in any spatial re-ordering of the data (e.g. inland vs coastal). However, recent improvements (about mid 2016) to the database address fields should result in more accurate recording of address data. Address information must now conform to an officially recognised address before data entry can proceed.

5.4 NSW Recreational Fishing Survey

A previous NSW Recreation Fishing Survey was conducted in 2013/14. A 2017/18 Recreational Fishing Survey is currently underway. At the end of the current survey a 'wash up/attitudinal survey' will be conducted.

There is potential to undertake a standard Travel Cost Method study using the 2013/14 data set. There is also potential to 'piggy back' on the 'wash up/attitudinal survey' for the 2017/18 Recreational Fishing Survey that is due to begin in October 2018. This could potentially include a contingent behaviour question.

The 2013/14 and 2017/18 NSW Recreational Fishing survey already includes the major components of a standard Travel Cost Method questionnaire including:

- location of a fishing activity - for every fishing event detailed fishing location information is collected – at the base level waterway (river/creek/dam) and nearest town;
- 'distance travelled' - data is collected on the respondents home location and fishing location – with allocated latitudes and longitudes;
- annual frequency of visits to the fishing spot - real time recording of the fishing activity is collected;
- socio-demographic information – is already collected.

Data missing from the existing data base that would be required for a complete Travel Cost Method application include the type of transport used to travel to fishing, expenditure associated with the fishing trip and whether fishing was the sole purpose of the trips.

However, inferences could be made with respect to these variables for the 2014/15 data set and additional questions, including a continent behaviour question, could be asked in the wash up survey for the 2017/18 survey. The relevant sample of fishers from these data sets is not just those resident in study area, but all respondents who fished in the study area i.e. it would include 'imported' fishers from other regions such as Sydney or neighbouring areas. So additional questions in the wash-up survey would need to extend to all respondents who fished in a proposed study region. An issue to be addressed is the comparability of data collected in the wash up survey and that collected in the diary-based continuous surveying. This is especially worthy of consideration if the sample size is extended beyond those who have been engaged in the diary survey as it involves the comparison between recall and recorded data.

The major uncertainty regarding this approach relates to the sample size of fishers who have fished in a target study area during the Diary Survey period. For example, for the 2017/18 survey approximately 100 persons from the Central/West ABS region which overlaps to a fair degree the Macquarie/Castlereagh catchment and includes the major towns of Bathurst, Orange etc. It is unknown at this stage how many of those respondents have fished the region and how many people from other regions have fished in the proposed study region. A similar issue would apply to other potential study catchments. While it may be possible to boost the sample of licence holders in a particular study catchment during the 2017/18 wash-up survey, it is not just those that live in the region that are relevant. Anyone who fishes in an identified study should be included in a Travel Cost Method study. It is not possible to know in advance the additional licence holders, not already surveyed, who fish in any particular study region.

The data from the 2017/2018 NSW Recreational Fishing Survey may be able to be used as a base for a Travel Cost Method study, with additional data collected via future onsite surveys. The data and database are not suitable for the application of Choice Modelling.

5.5 Atlas of Living Australia

The Atlas of Living Australia is a collaborative, national project that aggregates biodiversity data from multiple sources and makes it freely available and usable online. Different geographical locations can be searched for species occurrence including fish.

5.6 Tourism Research Australia

Tourism Research Australia (TRA) is a branch within the Tourism Division of Austrade. It is a provider of tourism intelligence across both international and domestic markets. TRA undertakes surveys and publishes data in international tourism to Australia, domestic tourism in Australia as well as information on regional tourism. Tourism profiles are provided on a national, state/territory, tourism region and local government area basis. Data provided includes visitation, expenditure, accommodation and activities undertaken.

Activities are grouped into three main categories:

- Culture and heritage – includes: Attend theatre, concerts or other performing arts; Visit museums or art galleries; Visit art/craft workshops/studios; Attend festivals/fairs or cultural events; Experience Aboriginal art/craft and cultural displays; Visit an Aboriginal site/community; Attend aboriginal performance; and Visit history/heritage buildings, sites or monuments.
- Food and wine – includes: Eat out/dine at a restaurant and/or cafe; and Visit wineries.
- Nature based – includes: Visit national parks/state parks; Visit botanical or other public gardens; Whale/dolphin watching; Visit wildlife parks/zoos/aquariums; Bushwalking/rainforest walks; Snorkelling; and Scuba diving.

Fishing is not a specific activity on which data is collected.

6. Recommended approach and methods

The array of potential conceptual approaches and methodologies available for the estimation of the 'value' of recreational fisheries presents a confusing picture for the non-economist. Part of the reason for the confusion is that the variety of approaches and methods has been driven by the wide array of goals being addressed by different 'valuation' studies.

The preceding discussion has sought to clarify the differences between the alternative approaches and methods. In this section, recommendations are made regarding the appropriate approach and methods for the specific task of estimating values that are relevant to an assessment of the Basin Plan, in the context of a valley-wide (rather than a Basin-wide) application. This task will be tackled under two sub-headings. The first will focus on the estimation of use values associated with the recreational fishing activity while the second will look at methods that can extend the valuation task to encompass both use and non-use values. In both sub-sections, the approach to be taken will be the estimation of values that are consistent with the principles of welfare economics, as they apply to the application of benefit cost analysis. This approach is taken so that the values estimated can be directly used in the assessment of aspects of the Basin Plan.

6.1 Estimating recreational fishing use values

The most widely accepted and best-targeted method for the estimation of use values is the Travel Cost Method. Its foundations in welfare economics and hence suitability for use in conjunction with Cost Benefit Analysis, are well established. Its wide spread use over an extended time period has brought acceptability within professional circles. Having a foundation in the revealed preferences of individuals means that it has few questions regarding rigor.

As detailed in Section 3, the Travel Cost Method in its basic format allows the estimation of current use values: Estimates can be made of the value the average user of a site holds for a fishing experience at a specified site. Such value estimates can be aggregated across the population of fishers to estimate the total consumer surplus being enjoyed by people from visits to a site.

Application of the Travel Cost Method in this way involves the collection of information regarding fishing experiences from users of a site. This can be done in two different ways. First, data can be collected on site from recreational fishers, either by personal interview or by the delivery of a hard copy questionnaire to respondents that would be either mailed back or dropped off at a collection point upon completion. Because the 'site' in this context is a river, surveying fishers at a sample of locations along the length of the river would be required. Sampling at differing times of the day/week/year would ensure that differences in use patterns over time are also captured.

The second data collection mode would involve surveying, potentially on-line, fishers who have visited the specified river, identified from the data base of licence holders. The identification process presents some complexity because only a relatively small fraction of licence holders would have visited the specified river. That implies a large scale sampling of licensees with a 'filter' question up front to eliminate all respondents except those who have visited the designated river, say in the last 12 months. The danger with this approach is that a sample size that is insufficient for the application of the Travel Cost Method may be found.

The trade-off then between the two delivery modes is cost versus the risk of an inadequate sample. The on-site delivery mode is likely to be more expensive because of the labour costs. However, it is guaranteed to deliver an adequate sample. The on-line option takes advantage of the existing licensee data base and is thus convenient and lower cost but the risk remains that too few 'eligible' respondents will be found.

The other possibility for an on-line delivery application is to utilise data from the 2013/14 NSW Recreational Fishing Survey and/or to 'piggy-back' the required Travel Cost Method questions onto wash-up for the 2017/18 NSW Recreational Fishing Survey. Only the latter could potentially contain contingent behaviour questions. Again, the geographical dispersion of fishers creates complexity in this format and there may be an insufficient sample size of fishers visiting a study catchment to enable statistically significant analysis.

A bonus associated with new onsite or online Travel Cost Method delivery modes is that data on expenditures can be collected concurrently. This information is not available from the NSW Recreational Fishing Surveys. While expenditure data are not directly relevant to the assessment task performed through a Cost Benefit Analysis it may have other purposes, especially in terms of identifying infrastructure resourcing requirements associated with the recreational fishing activity and assessment of economic activity to regional economies.

Use of the Travel Cost Method (current use) values estimated is somewhat limited in the assessment process. If an alternative management strategy is understood to have increased fishing visits, then the marginal value associated with that change can be estimated by multiplying the average value of a visit (estimated by the Travel Cost Method) by the projected increase in the number of visits. This approach is limited if the change in policy/management cause a change in the quality of the recreation experience. To estimate values associated with quality changes such as better fish catch rates or greater diversity of species caught, the standard Travel Cost Method requires supplementation with a contingent behaviour question. This would involve respondents being asked to state the number of visits they would make if there was a pre-specified change in conditions. The possibility of asking contingent behaviour questions given declining fishing conditions warrants further consideration, given the ability of this method to deal with changes in per visit values as well as the number of visits.

A pre-requisite for the addition of a contingent behaviour question is the input of bio-physical scientists to define the cause-effect relationship between policy/management and the attributes of a fishing experience that influences fishers' visitation patterns. This input allows the specification of the changed conditions so that survey respondents can judge how their behaviour would change.

The addition of the contingent behaviour question allows the estimation of the change in per visit value that result from the management/policy change. This can then be used in the Cost Benefit Analysis of the change either as a multiplicand of the original or the projected number of visitors.

A starting point for analysis of recreational fishing use values would be to examine the 2013/14 and 2017/18 NSW Recreational Fishing data sets to determine if there is a sufficient sample size of fishers to an identified study catchment. If so then a standard Travel Cost Method study could be undertaken and additional questions could potentially be asked in the wash-up survey for the 2017/18 NSW Recreational Fishing Survey.

Because of the risks associated with the on-line mode of delivery, if the NSW Recreational Fishing Survey does not yield sufficient sample size for fishers to an identified study catchment, it is recommended that on-site interviews be the preferred mode of implementation. Local knowledge could be used to identify the most heavily used fishing sites (or boat launch sites). The Travel Cost Method questionnaire should be designed for speedy delivery so as to create less inconvenience for fishers. A sample size of around 400 is recommended to take into account respondent and site heterogeneity. A staged survey approach is recommended with samples being drawn at times according to the frequency of visitation. The possibility of using the Burrendong Classic (a fishing competition held over Easter each year) as a venue for cost-effectively gathering travel cost data warrants exploration. The event brings together over 1,000 anglers in one location. The event organisers already conduct a follow-up survey of participants using email addresses and a web-based 'survey monkey' questionnaire. Additional Travel Cost Method questions including potentially a number of different contingent behaviour questions (each relating to different contexts) could be added to that survey. The prospect of achieving a biased sample through the targeting of a fishing competition at which only dedicated anglers are involved would require careful monitoring and potentially, some additional sampling of more casual anglers to check for representation.

6.2 Incorporating non-use values

Changes in the management of a specified river under the Basin Plan are likely to generate changes in non-use values associated with native fish in addition to use values. Non-use values will be associated with changes in the extent and composition of the native fish stock. Because non-use values are enjoyed by a wider population than recreational fishers, their estimation requires the use of stated preference techniques administered over the whole population of the state.

If these non-use values are of policy interest, it is recommended that Choice Modelling be used as the appropriate valuation technique. Choice Modelling is preferred over the Contingent Valuation Method because of its greater flexibility (capacity to estimate values for multiple scenarios of change) and its capacity to reduce the prospects of bias in responses. Choice Modelling has become a widely accepted estimation technique, given that it is applied with recognition of state of the art requirements. The outputs of a Choice Modelling application are directly available for inclusion in Cost Benefit Analysis of policy/management changes. It does not however produce estimates of current values (as is the case with the standard application of the Travel Cost Method).

Furthermore, while Choice Modelling produces estimates of several attributes associated with native fish (e.g. size of populations and diversity of those populations) it cannot provide a definitive separation of use for non-use values. The outputs are therefore combinations of use and non-use values associated with the different attributes.

Applying the Choice Modelling method would be best achieved through an on-line survey using a sample provided by a commercial market research company. Over-sampling of the population living within the valley of the river being targeted would be advisable to determine if there was any 'distance effect' (whereby value estimates are a function of proximity to the river in question). A sample of 1,000 respondents (with 200 being drawn from 'local' people provided survey panel has sufficient representation) would be necessary to cover heterogeneity in the population. Such on-line surveys are comparatively modest in cost and can be conducted within a very short time period. However, extensive preparatory work is required in the design of the questionnaire. This work is necessary to ensure that the questionnaire communicates effectively with respondents and that the trade-offs made by respondents are readily comprehended and perceived as being consequential. Focus groups are an integral part of the questionnaire's design.

6.3 Way forward for a valley scale pilot

1. Confirm an appropriate valley for implementation of the pilot.

A potential site for application of a pilot project, as suggested by DPI Fisheries and MDBA, is the Macquarie-Castlereagh Valley. This is based on the presence of healthy populations of native angling species (Murray Cod and Golden Perch), relative stability of water management rules in the catchment, an active recreational fishing sector, mix of planned and held environmental water, and connection with the Barwon-Darling.

2. Consider what policy change is to be evaluated and identify how native fish outcomes will differ under this policy relative to continuation of the counterfactual (status quo).

The contingent behaviour Travel Cost Method and Choice Modelling are methods for evaluating changes in values. If a change scenario only impacts one part of a catchment then this would be the focus of studies. The contingent behaviour Travel Cost Method and Choice Modelling cannot be applied to estimating the value of the status quo as a 'stock'. If no change scenario is under consideration then only the standard Travel Cost Method can be applied to identify recreational fishing values associated with the current management regime.

3. Review the 2013/14 and 2017/18 NSW Recreational Fishing Data Sets

Review the 2013/14 and 2017/18 NSW Recreational Fishing data sets to identify the size of the sample of fishers who fished in the Macquarie River valley. Subject to a sufficient sample size undertake a standard Travel Cost Method study of the 2013/14 data.

If the 2017/18 data set is of a sufficient size, consider supplementing the wash-up survey with additional Travel Cost Method questions, such as expenditure and travel method, as well as a contingent behaviour question/s. Subject to the outcome of this review, additional onsite sampling may be required.

4. Identify key fishing areas and/or boat launch areas where onsite Travel Cost Method surveys could be implemented, and the times of year when fishing is most popular

If data from the 2017/18 NSW Recreational Fisher Survey is insufficient, then onsite surveys of fishers would be required to undertake a standard or contingent behaviour Travel Cost Method study. Surveys would need to be undertaken in peak and non-peak periods. However, this step is labour intensive and hence consideration should be given to how best to employ labour resources to distribute these on-site surveys. For instance, is there potential to use existing labour resources rather than engage a specific survey team? The possibility of using the Burrendong Classic as a venue for surveying should be explored, along with incorporation of a survey sample that includes more casual anglers.

5. Design questionnaires

The contingent behaviour Travel Cost Method and Choice Modelling both require the development of questionnaires that would require the input of scientists to predict how biophysical outcomes for native fish and recreational fishing in the valley would change under existing and alternative policy scenarios. A simple standardised contingent behaviour Travel Cost Method questionnaire could be developed for potential incorporation into other information gathering exercises such as the NSW Recreational Fishing Survey.

6. Focus group testing of Choice Modelling questionnaires

Choice Modelling questionnaires are complex and require testing in focus groups to ensure that they are effective at communicating with respondents. Travel Cost Method questions are simpler and do not require focus group testing.

7. Analysis of survey data

Contingent behaviour Travel Cost Method data require analysis using Poisson and negative binomial regression, while Choice Modelling data require analysis using multinomial logit regression and/or random parameters logit regression.

8. Report preparation

Documentation of survey development, implementation and data analysis.

9. Cost and timeframe

A typical Choice Modelling study, conducted using a web-based panel of respondents, would cost in the order of $120,000 plus GST, but is dependent on the number of questionnaires completed, complexity of questionnaire design, number and location of focus groups etc. A timeframe of 4 to 6 months is reasonable.

The cost of a contingent behaviour Travel Cost Method study is harder to estimate as it will depend considerably on how the questionnaire is distributed on-site, the time frame over which it is implemented, the location of key fishing/boat launch sites etc. However, a cost of $100,000 plus GST is indicative. A 4 to 6 months timeframe would be required. If the 2017/18 NSW Recreational Fishing Survey wash-up can be supplemented then costs would likely reduce.

Expenditure data collected during the course of Travel Cost Method studies can be used to estimate the economic activity provided by a fishing trip to the regional economy. Developing an input-output table for the regional economy and modelling the impact would cost in the order of $30,000 plus GST.

10. Potential for benefit transfer

Primary valuation studies in an inland catchment of the MDB will provide a much better basis for benefit transfer of values to other catchments than is available in the existing literature. Replication of the study in an additional catchment and/or replication across different sub-catchments within a valley with comparisons of the results would provide additional evidence regarding the suitability of the results for benefit transfer across the MDB, particularly in terms of the scalability of results.

11. Beneficiary analysis

The valley-scale benefit estimation exercise has the potential to generate information that would be valuable to a range of organisations:

- The Murray Darling Basin Authority: would be able to use the values estimated for improved recreational fisher values resulting from different fishing conditions as an important input into cost benefit analyses of alternative natural resource management policies.
- The NSW Government (multiple agencies): would improve decision making regarding the management of inland rivers and the communities that rely on them.
- Recreational fishers: would be better equipped to advance their cause in policy debates regarding future resource management.
- Local councils covering inland river valleys: would have access to better information regarding the management of their communities.
- Other government agencies: would gain insights into the process of undertaking economic valuation studies and so increase their capacity to carry out similar exercises in differing contexts.

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Appendix 2: Expert Panel Workshop 22 February 2018 – Summary of Outcomes

MEETING	**Murray-Darling Basin native fish socio-economic values scoping project – Expert Panel Workshop**		
MEETING NO.	1	DATE	22 February 2018
LOCATION	By teleconference	TIME	09.30am-12.30pm (Australian Eastern Daylight Savings Time)
PAPER	Meeting outcomes – final		

(**Note:** as of 2 March 2018 changes were received and incorporated from Andy Moore (ABARES), Danielle Spruyt (DPI Strategy & Policy) and Nathan Miles (NSW DPI Fisheries Freshwater Ecosystems Research))

Participants: Professor Jeff Bennett, Environmental and Resource Economics (Chair), Rod Price and Liz Webb (NSW DPI Fisheries, Aquatic Habitat Rehabilitation Unit), Nathan Miles (NSW DPI Fisheries, Freshwater Ecosystems Research), Jeff Murphy (NSW DPI Fisheries, Fisheries Resource Assessment), Danielle Spruyt (NSW DPI Strategy & Policy), Anthony (Andy) Moore (ABARES), Sarah Jennings and Joshua Fielding (FRDC), Stuart Little, Vernon Topp, Rebecca Thornberry and Melanie Cherian (MDBA), Tara Schalk (NSW DoI Water) and Mladen Kovac (NSW OEH).

Apologies: Sam Davis, Anthony Townsend and Matt Gordos (NSW DPI Fisheries, Aquatic Habitat Rehabilitation Unit), Cameron Westaway and Jim Harnwell (NSW DPI Fisheries, Recreational and Aboriginal Fisheries), Martin De Graaf (NSW DPI Fisheries – Freshwater Ecosystems Research) Lindsay White (CEWO), Matthew Hansen and Ken Smith (recreational fishing representatives), Rob Gillespie (Gillespie Economics), Daniel Masters (NSW DPC) and Heleena Bamford (MDBA).

Summary of outcomes

Introduction and project context

Rod Price (NSW DPI Fisheries) opened the workshop at 9.35am. He provided an overview of the broader project funded by the Murray-Darling Basin Authority (MDBA), including project and workshop objectives as outlined below:

Project objectives:

- The overall aim of the project is to improve understanding and communication of the benefits of environmental water for fish, targeting recreational fishers as a key audience. The project has been funded by the Murray-Darling Basin Authority (MDBA) in partnership with NSW DPI Fisheries. Other components included the Murray-Darling Basin Native Fish Forum held in Canberra in August 2017 (https://getinvolved.mdba.gov.au/Nativefishforum2017) and development of communication products (infographics and a short video) on fish and flows for recreational fishers (released in Jan 2018 and available on DPI's website at https://www.dpi.nsw.gov.au/fishing/habitat/rehabilitating/fish-and-flows).
- The objectives of the socio-economic values component are to:
  - Determine the feasibility of using a socio-economic analysis of recreational fishing associated with native fish outcomes from Basin Plan implementation at a valley scale (focusing on recreational fishing, but also incorporating appropriate fish data and fisheries information related to ecosystem services).
  - Based on best available information and expert knowledge, recommend an integrated and rigorous methodology for this socio-economic analysis, including recommendations for next steps and identification of possible funding sources.
  - To enhance communication and collaboration amongst and between economists, social scientists/researchers, fisheries and water scientists and managers and recreational fishers to maximise the value of information being collected on the values of native fish and recreational fishing in the Murray-Darling Basin.

Expert Panel Workshop objectives:

- Consider the draft preliminary report and proposed methodology,
- Identify any additional information sources, knowledge gaps/limitations and feedback regarding the proposed methodology,
- Discuss the proposed priority valley for this work (Macquarie-Castlereagh), and
- Recommend a preferred approach for project implementation.

The workshop was led by Professor Jeff Bennett (Environmental and Resource Economics) with support provided by NSW DPI Fisheries. A set of workshop outcomes (this document) identifying key outcomes and actions are to be incorporated in the final report for the project.

General approach

Professor Jeff Bennett gave a brief outline of key sections of the draft preliminary report (as circulated to the Expert Panel (EP) on 9 February 2018) (conceptual framework, methodology, literature review and recommendations). Workshop participants were asked to identify if they had comments or questions for each of these sections.

The project is a scoping exercise to identify the most suitable methodology(ies) for assessing the valley-scale values of native fish and recreational fishing within a NSW MDB valley (the

Macquarie-Castlereagh). Professor Bennett and his collaborator Dr Rob Gillespie (of Gillespie Economics) have focused on economic valuation techniques suitable for use in Cost Benefit Analysis (CBA). CBA is used widely by government to assess different policy options (in this instance, different water management scenarios). 'Value' in the draft report is defined in terms of the well-being of people as measured by the surpluses (consumer and producer surpluses) experienced by those who use and provide resources. The approach also distinguishes between measures of expenditure (not an economic value estimates and could be considered as a cost or detractor from values) and consumer surplus, which is considered the most relevant measure of economic value for native fish and recreational fishing. Many existing studies of recreational fishing values use expenditure information, but this is not directly comparable with surplus values.

The approach also focuses on evaluating marginal values – changes in economic values in response to policy changes relative to the counter factual (what would happen under conditions where the policy change did not occur). In this context, policy change could be changes to water sharing rules, timing of water releases etc. Economic values can involve direct contact with a resource (recreational use values held by recreational fishers) and non-use values (values held by people who are not in direct contact with the resource but still value the health and availability of the resource (e.g. healthy fish communities).

Expert Panel feedback

Dr Sarah Jennings (FRDC) requested clarification on how the socio-economic component directly addressed the broader project aims for improving understanding and communication of the benefits of environmental water for fish, targeting recreational fishers as a key audience. Liz Webb (NSW DPI Fisheries) advised that this project component is intended to improve understanding of the economic values associated with native fish and recreational fishing at a valley scale in the NSW MDB (using the Macquarie-Castlereagh as a pilot valley). Being able to quantify the values and benefits of changes in water management for native fish and recreational fishing will help recreational fishers advocate for their interests being represented in the policy-making process. The project funding agreement identifies that the project is meant to develop a process that can be applied in the pilot valley and subsequently applied to other valleys in the future, with analysis intended to support the MDBA in developing Basin Annual Watering Priorities. Two recreational fishing representatives (Matt Hansen and Ken Smith) were invited to participate in this workshop and invited to comment on the preliminary report. Neither was able to take part, but expressed a keen interest in the project and its outcomes. They will follow up with Jeff Bennett and Rob Gillespie directly to discuss application of the project in the Macquarie-Castlereagh.

Dr Jennings also queried relevance of the term 'socio-economic' for the project, given that an economic valuation framework is used. Professor Bennett suggested that economics is broadly a social science – the values that economics measures represent the values of people which make up society. Economics does not try to understand why people how those values (e.g. psychological, social or physical health benefits) but does estimate the extent of values in society.

Mladen Kovac (NSW OEH) noted that the Travel Cost Method (TCM) could indirectly estimate recreational/health benefits. He queried if broader social values associated with recreational fishing in regional communities (e.g. social cohesion in places where recreational fishers

congregate and spend money?) could be assessed a part of this work. Professor Bennett noted that TCM studies usually involve collecting information on spending patterns of recreational fishers and how these flow through to the broader regional economy (input-output studies), however a broader community survey to better understand the non-use values in the region/valley from the recreational fishing sector could be undertaken as a complementary project.

Methods

Professor Bennett outlined the economic valuation techniques considered in the report.

Revealed preference techniques involve interviews (generally face-to-face) with people engaged in a given activity or industry and asking questions about their actions (e.g. travel costs, spending related to the activity, length of visit and time/distance travelled etc, number of visits within a given time period). Information obtained in these surveys is used to infer the value of a visit. This provides the value under current conditions, but does not assess the marginal values (how values may change if there was a change in resource condition). The travel cost method can be extended to include a stated preference technique (contingent valuation) to ask recreational fishers how their behavior would change if there was a change in conditions). This can be used to compare values between the proposed policy change and the counterfactual.

Other stated preference techniques assess non-use values for people who may not actively use the resource but place a value on continued/improved river health, existence of threatened or iconic species or prevention of ecological collapse. Contingent valuation techniques (CVT) assess comparative values associated with one particular policy change, while choice modelling (CM) is more flexible and provides estimates of a range of different values related to different policy outcomes.

Both TCM and stated preference techniques are survey-based, but stated preference techniques generally use a sample base from the broader community which revealed techniques tend to survey specific populations (e.g. recreational fishers).

Expert Panel feedback

Dr Danielle Spruyt (NSW DPI Strategy & Policy) identified that S&P has also been involved in surveying values associated with recreational fishing in NSW to inform development of the NSW Marine Estate Management Strategy (MEMS), and consulting with recreational fishers regarding scoping means to value recreational fishing more broadly. She recommended that the preliminary report clarify its critique of expenditure as a measure of value, given that the TCM captures information on expenditure (e.g. purchase of fishing equipment). She raised that an on-site survey will not capture people who may visit or relocate to an area because of improvements to river conditions/fishing opportunities (but are not current site-users). Fishing can be a 'cheap' activity delivering multiple benefits (recreation, health, time with friends and family etc) which may not be captured through a simple assessment of travel costs. The methodology is looking to an increase in visits to represent increase in values associated with improved river health. However people may be 'time-limited'; and rather increase in value may be associated with an enhanced fishing experience – can this be incorporated into value calculations?

In selecting a methodology, consider that for the purposes of CBA, the consideration of different scenarios is important. In the absence of policy proposals, is it feasible to consider a range of change scenarios (related to both more and less flows).

In addition, if the project is 'piggy-backed' on the recreational fishers survey, there would be benefit in collecting consistent economic information across NSW that could be used for a range of purposes, and could be coordinated with other projects with DPI Fisheries.

Professor Bennett noted that TCM involves collection of information on travel costs (based on expenditure) to determine the 'net benefit (with expenditure being considered as a cost). The TCM assesses choices about whether or not to visit a recreational site – if the cost of travel to visit a site increases then the frequency of visitation is likely to fall. The travel cost is considered a 'proxy' for a price to generate a demand curve and identify the consumer surplus. TCM relies on expenditure information but does not use expenditure as a direct measure of value. Values associated with people relocating to be closer to a fishing resource may also be captured via TCM, as relocating closer to high quality fishing opportunities would reduce travel costs, enabling fishers to fish more frequently with a higher value from the fishing experience. The TCM does not estimate the 'potential' value of a site for people who do not currently visit to fish but might do so if the condition improved. This is a weakness, but is difficult to address. A broader TCM survey including a contingent behavior (CB) component may capture off-site interests and has been done in some instances. However, this requires a much larger sample size. Targeting larger-scale fishing events (such as the Burrendong Classic) for surveys might provide information on whether better fishing opportunities are drawing fishers from a broader geographic and economic range.

Mladen Kovac (NSW OEH) noted recent work by NSW OEH with John Rose on national park visitation in NSW using a random utility model (drawing on data from a stratified random phone survey of more than 60,000 individuals where interviewers collected detailed information on the number of visits to any and all of the728 protected areas within NSW) (Heagney et al. 2017). This would be worth considering for this project (Mladen to follow up with Jeff Bennett offline), including refining of techniques. The random utility method has some limitations, including whether it would help in identifying people who don't currently visit a given site for recreational fishing but would do given a change (a sampling problem).

Dr Spruyt supported targeted surveys aimed at fishing competitions (or similar large-scale fishing events) for detailed surveys, with the NSW-wide survey including more general questions on economic values for recreational fishing in NSW. The broader Choice Modelling (CM) survey could potentially include visitation questions but may need to ensure over-representation from the Macquarie-Castlereagh.

Jeff Murphy (NSW DPI Fisheries) who manages the NSW Recreational Fisher Database suggested the statewide recreational fisher survey could also identify a broader survey base of rec fishers from other areas. It would also be worth understanding why recreational fishers come to the Macquarie-Castlereagh to fish relative to other areas, and whether this is associated with river improvements over the last 10-15 years (why did you start coming to the area to fish, what was fishing/the river like in the past and what is it like now, why is the fishing here better than elsewhere).

In relation to property values, those who live closer are likely to fish more frequently but there is the possibility of a bigger net values from individual visits (results over a year would be greater than for a fisher who lives a long way away). Traditional TCM is limited in

producing an average value, but there are methods for breaking values down by composition.

Random utility models could potentially address 'degrees of change' (allowing for mixing and matching of characteristics) but requires a more complicated survey. Onsite surveys need to be as simple as possible to avoid alienating participants who are often trying to engage in the activity while being interviewed!

Careful thought is needed to define policy change(s) in question (and associated improvements) as this is crucial to the TCM+CB method. In the absence of a suggested policy change, this could be addressed through a standard TCM questionnaire with a supplementary sequence of questions (much more like a random utility model/choice modelling). Choice modelling is based on the same principles as the random utility model. Choice modelling is a preferred choice for economic valuation for NSW Marine Estate Management, subject to time/resource constraints. TCM + CB for recreational activities in the NSW Hawkesbury/Nepean recently completed by Jeff and Rob suggests that people had limited interest in completing surveys and the survey needs to be as simple as possible.

Should time be considered as a cost in the TCM? Time spent at site as a cost, or time at the site and travel time as a cost? Are there differences between different people's valuation of time?

The report should more clearly identify that the range of values associated with native fish and recreational fishing (including social, health benefits etc) are 'bundled' together in the TCM. While economics does not interrogate the reasons for people's decisions, it can understand the strength of preferences based on the actions people make. Richer or more nuanced information on fishing motivators can also be found through correlating survey responses to motivational information. One of the options in the CB annex to TCM should be a 'negative quality scenario' (what happens if things get worse). This would need careful consideration when conducting surveys to manage political sensitivities. However it is an interesting question which could estimate the decrease per site value and therefore the decrease in the number of people experiencing the value.

Andy Moore (ABARES) who manages the national recreational fisher survey praised the draft report as a useful guidance document for non-economists. He queried how scalability of data and uncertainty are being considered in the sampling framework and design of onsite surveys. Survey design for the TCM is likely to be influenced by logistics and cost. Conducting onsite surveys on freshwater rivers is known to be difficult because of the diffuse and cryptic nature of angling effort (i.e. anglers are rarely aggregated, often spread over large distances, and can be in areas that have little access). If this leads to sampling at fishing competitions, the expenditure data is likely to be skewed towards high avidity anglers, which typically spend more and can result in TCM overestimates. People who fish one day a year represent the highest the highest frequency, followed by people who fish two days, then three days and so on. High avidity anglers only make up a small proportion of the fishing population, yet spend disproportionally more on angling (for example high avidity game fishers often spend thousands or tens of thousands of dollars annually, whereas very low avidity fishers might spend $10 for the same period).

The non-use valuation is likely to be an internet poll of the broader population (but should have over-representation from the Macquarie-Castlereagh valley). Internet surveys are not typically randomly selecting participants from the community and therefore are not

probability based. This limits the scalability of the data to that of the population. The national rec fisher survey is dealing with this issue by using probability based selection of participants that are incorporated into internet surveys.

The project's next steps would involve two survey components:

- TCM and CB - sampling of anglers (fishing competition and selective and cost-effective site sampling). Further consideration is needed on what constitutes a reasonable sample size for TCM in a freshwater system (400 people for a decent study)?
- Stated preference questions relating to non-use values – random sample of the public (1,000-2,000 people) but with over-sampling of local population (not neccessarily recreational fishers). Additional note from Andy Moore (ABARES): 'If you are measuring non-use values you don't want anglers. You want the general public. Getting a randomised sample that is proportional to population in the area you want to survey will be difficult via an internet survey'.

Nathan Miles (NSW DPI Fisheries - Freshwater Ecosystems Research) queried transferability of the results from the pilot study to other areas. DPI Fisheries is considering similar research but using surveys of creel fishers in the NSW Murray in a defined area (50-100 km of river). Benefit transfer is used widely in CBA, but there is mixed evidence on its depending on how comparable the sites are in terms of ecology, watering regimes and recreational fishing communities. Once the Macquarie pilot is completed it could be tested in the Murray and used as a measure to assess benefit transfer. There may also be issues with extrapolating results from one area of the Macquarie to another (within-valley). This could be addressed through rec fisher survey sampling (where one river reach is different splitting the sample between the two reaches as a dummy variable). However this increases the error bands and means a bigger sample size.

Jeff Murphy suggested the current NSW survey could be used to roll out the same set of questions for rec fishers with customization as required for different valleys. Jeff Bennett noted previous work to develop a standardized TCM survey for NSW Parks and Wildlife (Dorrigo and Gilbraltar Range NPs). The survey was designed to be as simple and transferrable as possible while still providing decent data. This methodology could do something similar (developing an indicative set of questions that could be transferred from one valley to another). There was general support for this approach from the Group.

Dr Jennings suggested further discussions (offline) on this approach more broadly, potentially also including marine fishing. Jeff Bennett and Rob Gillespie are involved in a choice modelling project for release of the National Carp Herpes Virus – these sort of survey questions would also be relevant. FRDC has just started a project to audit non-market values related to marine management and robust benefit transfer.

Existing literature and databases

Professor Bennett identified that the report's literature review has found there is not much information available that is directly applicable for this project. Most existing studies looking at valuation of rec fishing values in Australia have focused on expenditure rather than consumer surplus (and therefore not suited to CBA). While choice modelling has been used

widely for non-market valuation, these have generally focused on particular river systems or species (Murray Cod or Australian Bass for example) with benefit transfer being an issue. The focus on expenditure data means that there is information available on recreational fisher spending but this has not been correlated with frequency of visits etc.

Jeff Murphy noted that the literature review was largely confined to Australian examples and suggested considering the extensive use of the TCM in the United States to estimate rec fishing and broader game hunting values.

Most existing databases focus on biophysical characteristics and fish information. Some include expenditure data, but not values. The existing NSW recreational fishing survey could be modified to include key questions on like fishing frequency and location as the basis of a simple TCM however this would not be fairly 'rough and ready', unlikely to provide detailed information.

MDBA does not have any additional database resources not referenced in the report, however the Regional Wellbeing run by University of Canberra (Jacki Schirmer) does include some questions on recreational fishers. There are a range of other wellbeing surveys that would have datasets on rec fishers. Jacki Schirmer is involved in the National Carp Control Plan using the Regional Wellbeing Survey to gain additional information on motivational factors, but not necessarily detailed visitation/travel data required for TCM. Vernon Topp (MDBA) agreed to check with Jacki Schirmer about rec fisher information included in the Regional Wellbeing Survey, including secondary information on the number of fishers per region.

Implementation and funding

The report recommends a pilot in the Macquarie-Castlereagh using TCM supplemented with CB questions to identify benefits from specified policy changes. Expenditure data collected through the TCM would also be used for input-output analysis to understand benefits for the regional economy associated with fishing. The second element is a non-use study of the broader community and non-use values (internet survey or similar).

The survey design/package could be developed as a workable/'low cost' package that could be applied at a range of sites around the state or Basin. Vernon Topp (MDBA) identified MDBA has a strong interest in developing a workable, low cost method for estimating rec fishing values at a Basin-scale, as this information is critical for longer-term evaluation of Basin Plan effectiveness through to 2020 and beyond. While funding is limited and complex, there is likely to be considerable interest in progressing this work.

Vernon Topp queried the cost for implementing the pilot, particularly the cost of the CM exercise ($120,000 ex GST). Costs are mainly associated with design of the questionnaire (including focus groups, hire of rooms, payment to respondents etc).

Professor Bennett queried whether face-to-face surveys for the contingent TCM could be streamlined by working with state fisheries management officers or similar (dropping off and picking up questionnaires etc). The NSW rec fisher survey will include a 'washup' survey in Oct/Nov 2018, which includes information fishing location, length of visit etc and could include complementary expenditure questions. This has the benefit of a relatively large sample size, with participants already engaged/onboard for a survey process. Around 120

respondents from the central west are involved in the statewide survey (average of 1-4 fishing visits per year). A larger sample size from the central west could be drawn from the NSW rec fishing database as 120 respondents is unlikely to be enough for the TCM. Diary respondents for the statewide survey were selected as a representative sample of people who intend to go fishing in the next 12 months (as of Sept/Oct 2017). "Washup' surveys have the issue of 'over-estimation'. The next statewide survey is likely to out in late 2019 to be completed by late 2020.

Andy Moore (ABARES) noted the national rec fisher survey is also working with NSW and other jurisdictions to nest a secondary wash-up survey onto existing state-wide surveys in order to collect total expenditure, travel expenditure and potentially conduct choice modelling. There could be benefit in having a consistent set of questions for all of these processes (NSW rec fisher survey, national survey, this project) which could generate considerable useful information. This would be a 'static TCM', but would not provide information on contingent values which would have to be tailored to specific regions.

Careful consideration will also be needed on underpinning science predicting indicators of river condition that fishers are interested in (in particular fish responses to flow).

The workshop concluded at 11.40am (Australian Eastern Standard Daylight Savings Time). Professor Jeff Bennett and Rob Gillespie (in absentia) were thanked for their time, efforts and professionalism in getting the project to this point. EP members were also thanked for their time and considered contributions and the MDBA and DPI Fisheries Project team acknowledged for their efforts.

Next steps

- EP members to provide comments on the draft preliminary report by COB 23 Feb 2018.
- Liz Webb to circulate draft workshop outcomes by COB 23 Feb 2018 with comments due 28 Feb 2018.
- Jeff Bennett and Rob Gillespie to follow up with Matt Hansen and Ken Smith directly regarding recreational fishing input to the project and application in the Macquarie-Castlereagh.
- Jeff Bennett and Rob Gillespie to follow up with Mladen Kovac directly regarding recent NSW OEH work on valuation of NSW national parks (random utility model).
- Vernon Topp (MDBA) to follow up with Jacki Schirmer/University of Canberra regarding coverage of the Regional Wellbeing Survey for recreational anglers.
- Jeff Bennett/Rob Gillespie/Sarah Jennings/Andy Moore and Jeff Murphy to follow up offline to discuss potential to develop 'template'/package of questions for the surveys
- Jeff Bennett/Rob Gillespie to include beneficiary analysis as part of the final report for the project to form the basis of funding proposals etc.
- Draft final report to be circulated to the EP for comment by 6 March 2018 with comments due by 13 March 2018.
- Final report to be provided to EP for information by April 2018.
- Timing for further EP teleconferences to be confirmed once the Project is finalized and options for next steps clarified.

- (Ongoing) EP members to promote the project and need for funding internally and through their contacts and networks.

References

Heagney, E., Rose, J., Ardeshiri, A. and Kovac, M. (2017). Optimising ecosystem services from protected areas – understanding the role of natural values, built infrastructure and contextual factors. Ecosystem Services https//doi.org/10.1016/j.ecoser.