Developing cost-effective socio-economic monitoring for inland recreational fisheries in NSW

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Executive Summary

Background

This project presents a proposed approach to cost effective, scalable social and economic monitoring in inland recreational fisheries, which aims to provide managers and angler bodies with relevant information at regular intervals. This approach was developed by establishing a core set of variables for monitoring that are achievable within the constraints of a 15-minute interview, and have the capacity to indicate (but not necessarily comprehensively assess) meaningful changes over time.

These efforts seek to support a general move towards adaptive management and stakeholder inclusive approaches in recreational fisheries. Adaptive management refers to management and decision-making which is responsive to changes in the fishery over time, through means of a transparent, structured and evidence-based decision-making cycle. In the freshwater context, NSW DPI has begun instituting a systematic approach to the management of inland recreational fisheries via the NSW Trout Strategy in 2017, and via the 'Building a stronger more sustainable freshwater recreational fishery in NSW' 2018-2021, also funded by the Recreational Trust, as well as through the development of the state-wide Recreational Fisheries Monitoring Program. These efforts aim to develop stakeholder inclusive processes where explicit goals are set with recreational fishers and representative bodies, management actions are tied to those goals, and monitoring processes established to track achievement of those goals. So far, the NSW Trout Strategy and the wider freshwater fishery projects have instituted monitoring of biological and environmental variables, such as trout and native stocks, water temperature, habitat, and catch at key monitoring sites. However, there is not yet any collection of social or economic data, which can be important for understanding angler behaviour, the contribution of recreational fisheries to rural and regional communities, and the outcomes of management efforts.

Monitoring framework and survey methods

Working with the freshwater fisheries scientists in NSW Fisheries, and with inputs from fisheries managers and fisheries scientists responsible for a range of recreational fisheries, a monitoring framework and pilot survey was developed to broadly address these needs for social and economic data, with a conceptual framing of the overall angler experience being the focus of monitoring. In this approach, the following elements guided overall indicator and survey development:

- **Demand for recreational fishing,** which can be understood broadly in terms of the perceived desirability of fishing at a site. This influences choices to go fishing at all, and site selection. A key aspect of the approach methodologically to be tested is that recreational fishing demand can be tracked through economic data, which in turn provides a proxy for likely fishing effort.
- **The recreational fishing experience**, measured by participation rates, and can also be segmented according to angler motivations, which indicate the associated objectives of different types of anglers.
- **Outcomes from recreational fishing**, which includes the catch, and its linkages to biological outcomes, as well as management effectiveness, which can be measured by both evaluating catch and catch rates against objectives, as well as through measuring angler satisfaction.

The following table includes a basic monitoring framework based on this approach and specifying indicators based on catch, economic, and social data.

Framework element	Type of data	Indicators for monitoring
Demand	Participation	Average trips per year
	Economic expenditure	Average expenditure per trip Average willingness to pay Average consumer surplus
Activity	Participation	Trips per year
	Demographics	Age, gender, household income.
	Angler motivation	Angler motivations
	Economic expenditure and trip data	Average consumer surplus Average willingness to pay
Outcome	Catch and effort data	Catch data summaries Catch rates
	Economic expenditure data	Average expenditure per trip
	Angler satisfaction	Overall angler satisfaction Satisfaction in different cohorts Average consumer surplus

Explanatory points on economic indicators

Average expenditure per trip is the total dollar amount spent by a respondent on a trip across range of categories, averaged across all respondents at a site.

Average willingness to pay is the maximum amount an angler would be willing to pay for the angling experience at a site.

Consumer Surplus (CS) is an economic measure of the enjoyment an angler experiences. CS is calculated by demonstrating a relationship between the number of trips to a site, the cost of those trips, and the average willingness to pay, given multiple options available with respect to alternative recreational activities and alternative sites available for angling.

Survey instrument

The pilot survey, designed to collect data that can calculate these indicators, included four main sections as follows:
- Angler demographics
- Catch, trip and effort information
- Economic expenditure
- Angler motivation and satisfaction

The survey instrument is included in Appendix A.
The survey was trialled through data collection at three pilot sites in NSW inland fisheries, to cover the main iconic species targeted by recreational fishers. Snowy Lakes (Trout and Salmon), Lake Windamere (Golden Perch - *Macquaria ambigua*) and Copeton Dam (Murray Cod - *Maccullochella peelii*). A total of 204 survey responses were received.

Results

It is important to note that many of the key contributions from monitoring data are evident once a time-series is established, so that trends in variables can be determined that may inform management efforts or investments in improved fisheries and related infrastructure. However, from this pilot we can

offer insights into comparative analysis between sites, and on the value of monitoring data for ongoing management and decision-making purposes.

Comparison between sites

We highlight here four overall findings from this initial set of monitoring data, which are both of interest generally, but more specifically, display the value of comparative data across sites that covers multiple types of indicators (biological, economic, social).
1. Very wide variation in catch rates across sites, which reflect the site and fishery characteristics.
2. Variations in average expenditure per trip across sites, which reflect the site and fishery characteristics.
3. Consistency in angler motivations across sites despite variations in 1 and 2.
4. Consistently very high satisfaction levels across sites despite variations in 1 and 2.

The following table combined these different data points to display these key indicators.

Site	Catch rate (fish/hour)	Average expenditure per trip	Highly rated angler motivations (>50% of respondents)	Overall satisfaction in last 12 months (highly satisfied, satisfied combined)
Copeton Dam	0.084	$826.27	- Availability of target species - Catching trophy/high quality fish - Escapism - Socialising - Mastery	92%
Windamere Lake	0.798	$758.49	- Availability of target species - Catching trophy/high quality fish - Escapism - Socialising - Mastery	79%
Snowy Lakes combined	0.461	$502.36	- Availability of target species - Catching trophy/high quality fish - Escapism - Socialising - Mastery	88%

Additionally, we highlight here findings on the wider regional economic contribution that were able to made based on the NSW State-wide Economic expenditure survey dataset and utilising trip data from the monitoring pilot to calculate the specific contribution of recreational fishing in the Snowy Mountains to the regional economy.

The regional impact for the Snowy Mountains trout fishery is estimated to be 58% of the South Coast and Inland regions total fishing expenditure ($86.5m direct contribution and $150m added

value), giving an associated output of $68.4m, an added value of $34.22m, household income of $23.2m and supporting 319 jobs.

These findings show that gathering site specific data such as average spend per trip alongside regional/state-wide data such as total contribution of recreational fishing to the region, allows for a detailed picture to emerge of the social and economic dimensions of recreational fishing.

Value of data for recreational fisheries management
The following observations are made about the value of indicators collected, with specific focus on social and economic data points, noting that catch and catch rates are already part of standard monitoring informing management processes. This is, in effect, our observations on the additionality of proposed data collection over and above existing monitoring.

Trip indicators

- A change in the average trips per year, average percentage of time spent fishing, average # of days per trip, will indicate to management that fishing effort (and so fishing pressure on the stocks) has changed – this may indicate a need for fisheries management interventions such as changes to stocking, bag limits, seasonal closures, or changes in angler amenities.

Economic indicators

- A change in the average spend per trip (per capita) will demonstrate a change in the economic value being generated to local economies from recreational fishing – a change does not necessarily trigger a management response but declines in the indicator may warrant further exploration as to the reason for the decline.
- A change in consumer surplus (CS), assuming average angler costs remain constant, can indicate changes in angler demand, which can be understood as a proxy for the overall desirability of the site, and therefore indicate possible changes in effort. Most importantly, this can under some circumstances indicate the potential for effort substitution either into the site/angling, or away from the site/angling. It can also provide information on changes in the nature of trips taken to the site, such as a change in the number of locals visiting the site rather than visitors from outside the region. This will provide a more nuanced view of trends in effort than trip data alone. Changes in the desirability of site and possible effort substitution may indicate a need for fisheries management interventions such as changes to stocking, bag limits, seasonal closures, or changes in angler amenities.
- Willingness to pay (WTP) combines the consumer surplus and average travel cost to the site, and so provides information additional to the consumer surplus indicator. Similar to consumer surplus, a change in willingness to pay per trip can demonstrate a change in the demand for the site as shown through changes in angler effort. If the overall desirability of the site has diminished, the willingness to pay for the site should be lower. But more nuance can be gained by looking at consumer surplus and willingness to pay together. If willingness to pay has increased from the previous year, but consumer surplus has decreased, everything else being equal this would mean that the average travel cost to the site has increased, which should indicate that more visitors to the site came from outside the region. This may be indicative of a good management outcome (e.g. reputation for good trophy fish has spread) or a potential problem (e.g. more interstate visitors potentially crowd out locals from their fishing spots).
- A change in trips per year, WTP and CS will all have the ability to indicate in different ways whether previous efforts to change amenity of site (facilities etc) or intervene in stocks (stocking efforts, trophy management etc) are having an effect. The ability of these indicators to display change over time of relevance will be dependent on the specifics of the site/fishery and the intervention being pursued.

Social indicators

- A change in angler motivations would likely indicate a change in the objectives of anglers at a site. This may indicate a need for fisheries management planning, to account for new

objectives into a strategy or plan for a site, and this may in turn lead to new interventions to meet these objectives, such as changes to stocking, bag limits, seasonal closures, or changes in angler amenities.

- A change in angler satisfaction would indicate a change in overall fishery performance. This may indicate a need for fisheries management interventions such as changes to stocking, bag limits, seasonal closures, or changes in angler amenities.
- A change in Consumer Surplus will indicate that the overall enjoyment that an angler experiences, measured economically and in relation to other available options (other angling sites or other recreational activities), has increased or decreased. In short, a larger consumer surplus indicates that the overall "benefit" an angler receives, in this case the enjoyment an angler experiences, measured in terms of the relationship between the # of trips taken and the cost of fishing, is greater than a smaller consumer surplus. This means that consumer surplus can be considered a proxy measure for angler satisfaction. Considering trends in consumer surplus against trends in angler satisfaction may provide additional information on angler outcomes than satisfaction indicators alone, and allow further testing of the usefulness of CS as a measure of angler satisfaction.

With respect management objectives and issues identified in the introductory sections, we highlight the possible value of indicators collected for informing these issues:
DPI strategic plan objectives.

- **Ecological:** Improve sustainability of freshwater recreational fishery. Catch and effort data, trip data, economic data displaying demand, and angler motivation data can all inform considerations around the sustainability of a fishery.
- **Social:** Increase participation, community support, accessibility and satisfaction in recreational freshwater fishing. Trip data, economic data displaying demand, angler motivation and angler satisfaction data can all inform considerations around participation and satisfaction in a fishery.
- **Economic:** Increase contribution of recreational fishing to economy. Expenditure per trip can indicate the contribution of recreational fishing at a site to the economy.

Specific issues noted in project workshops.

- **Stocking.** # of trips, catch rates, and angler satisfaction indicators can all provide information of value to assessing the performance of stocking regimes.
- **Promotion of successful fisheries to support new development.** Economic expenditure data can provide information on the benefits of new fisheries developments to regional economies, albeit these cannot quantify the total economic contribution as these data do not provide an estimate of total participation.
- **Changing seasonal closures.** Unclear whether monitoring data in this framework can inform this, as the proposed method is to collect data once a year, rather than throughout the year, which may indicate times when seasonal closures would have least impact on angler participation.
- **Climatic influence - especially drought.** Placing year on year monitoring data alongside climatic data would allow managers to make arguments beyond only the fisheries management sphere, such as by being able to show the impacts of wider, well-known changes in climate, such as on catch and catch rates, # of trips per year, and angler satisfaction.
- **Patterns of effort substitution.** Changes in Consumer Surplus values can indicate the likelihood of changes to fishing effort at a site in the future, should circumstances change significantly. A change in the CS values towards $0 would indicate a higher likelihood of effort substitution away from that site, or away from recreational fishing, where sites or activities with higher CS values are accessible to those anglers.
- **Access.** Economic expenditure data can demonstrate the benefits to community of freshwater recreational fisheries and help make the public interest case to Crown Lands to retain these access points rather than sell off these parcels of land.

Conclusions and recommendations

Based on this trial, we make the following conclusions.

1. Cost-effective, site specific social and economic monitoring is possible for NSW recreational fisheries, and has the potential to value add considerably to existing monitoring systems informing management.
2. Data collected has value for comparative studies (i.e. across multiple sites) and longitudinal studies (i.e. over multiple years). In particular, the establishment of a time series of data will enable trends in key variables to be displayed.
3. Economic expenditure data is capable of providing nuanced site-specific information on recreational fishing demand, which can assist in illuminating the outcomes of management interventions and investments in improved fisheries and associated infrastructure.
4. Angler motivation and satisfaction data (including that collected via direct measures or economic expenditure proxies) can provide nuanced, site specific information that helps illuminate the likely objectives of anglers at a site, and the performance of fisheries management and investments in improved fisheries, in meeting these objectives.

Based on this trial, we make the following recommendations.

1. That site specific social and economic monitoring of recreational fisheries according to the proposed framework in this report be implemented at a wider set of priority sites.
2. That a time series is generated (i.e. datasets over multiple years) to allow for further exploration and demonstration of the value of this data in indicating key trends in variables of interest to fisheries management and angler bodies.

Introduction

This project presents a proposed approach to cost effective, scalable social and economic monitoring in inland recreational fisheries, which aims to provide managers and angler bodies with relevant information at regular intervals.

This approach was developed by establishing a core set of variables for monitoring that are achievable within the constraints of a 15 minute interview and have the capacity to indicate (but not necessarily comprehensively assess) meaningful changes over time. These variables were then trialled through data collection at three pilot sites in NSW inland fisheries, to cover the main iconic species targeted by recreational fishers. Snowy Lakes (Trout), Lake Windamere (Golden Perch) and Copeton Dam (Murray Cod).

Through doing this project aims to contribute to the following wider objectives:
- Increased ability to monitor angler behaviour of relevance to the management of key freshwater fish stocks. This information can be provided to anglers and managers to inform the decisions made to improve the sustainability and the performance of recreational fisheries.
- Increased capacity to monitor the social and economic value of freshwater recreational fisheries. This can provide information to anglers that can assist them in highlight the contributions inland recreational fisheries make to individuals, families and wider communities, when in discussion with governments.
- Provide information that can support future processes of prioritising management efforts and resources based on a) patterns of usage (e.g. level and nature of participation) b) identification of objectives for management (preferences of anglers for catch and release, catch and kill, trophy fisheries, family fisheries etc.) and c) the value of those fisheries to the community.
- Increased knowledge of angler behaviour and social and economic values at 3 key sites covering the main iconic inland recreational fishing species – Snowy Lakes (trout), Lake Windamere (Golden Perch), Copeton Dam (Murray Cod).
- Development of a scalable approach and a practical strategy for implementing cost-effective social and economic monitoring in inland recreational fisheries.

In doing so this work will value-add to the larger state-wide monitoring program - Building a stronger more sustainable freshwater recreational fishery in NSW- Phase 2, and the ongoing implementation of the statewide Recreational Fishing Monitoring Program. At a more local/species specific level, this work will also support the achievement of existing goals under the NSW Trout Strategy – specifically, to "undertake and facilitate monitoring and research on a range of aspects of the trout fishery in order to provide data for informed management decisions." A secondary objective of the Trout Strategy this work will contribute to is to "work co-operatively with the trout acclimatisation societies to categorise and prioritise rivers to be stocked to optimise trout stocking effectiveness." The project methods also potentially provide a template for similar work in coastal/saltwater recreational fisheries.

Adaptive management and monitoring of inland recreational fisheries in NSW

The use of adaptive management broadly speaking is by now a well-accepted best practice in fisheries management generally (Hilborn et al, 1998, Walters 2007, Edmonson & Fanning 2022), and increasingly being explored in recreational fisheries (Marttunen & Vehanen 2004, Hansen et al 2015, Arlingshaus et al 2017, Camp et al 2020). Adaptive management refers to management and decision-making which is responsive to changes in the fishery over time, through means of a transparent, structured and evidence-based decision-making cycle. In fisheries the most advanced and well elaborated method for implementing adaptive management is via a harvest strategy, which is "a framework that specifies pre-determined actions in a fishery for defined species" which "requires fishery managers and scientists to work together with fishers and other stakeholders to evaluate,

determine and document appropriate responses to various fishery conditions (desirable and undesirable), ideally before they occur." (DPI 2021).

In the freshwater context, NSW DPI has begun instituting a systematic approach to the management of inland recreational fisheries via the NSW Trout Strategy in 2017, and via the 'Building a stronger more sustainable freshwater recreational fishery in NSW' 2018-2021, also funded by the Recreational Trust. These efforts aim to develop stakeholder inclusive processes where explicit goals are set, management actions are tied to those goals, and monitoring processes established to track achievement of those goals. So far, the NSW Trout Strategy and the wider freshwater fishery projects have instituted monitoring of biological and environmental variables, such as trout and native stocks, water temperature, habitat, and catch at key monitoring sites. However, there is not yet any collection of social or economic data.

It is also noteworthy that harvest strategies for commercial fish stocks with significant recreational take have begun to be implemented in NSW with the participation of recreational fisheries (Fowler at al 2023, 2022). However, they are not yet systematic and not yet implemented in the context of fisheries where recreational take is the sole or principal source of fishing effort or catch. While there are unique conditions that pertain to recreational fisheries that make the use of harvest strategies in some cases challenging, their broad appeal as "best practice" in fisheries management indicates a general turn in recreational fisheries management towards adaptive management approaches.

In this context, this pilot of socio-economic monitoring in inland fisheries represents an opportunity to explore the value of regular data for informing decisions both for efforts such as the Trout Strategy but also for other recreational fisheries, where a spectrum of possibilities exists with respect to how well elaborated the adaptive management cycle in any specific recreational fishery may be, and therefore how the monitoring data may be utilised. At one end of a spectrum, the simple availability of regular data on issues of interest to managers and anglers alike will, without any further elaboration of an adaptive management cycle, likely provide some level of benefit to the overall fishery and its management. Where a highly elaborated and pre-determined adaptive management cycle is implemented, such as in the case of a formalised harvest strategy, then detailed data which is collected to inform specific decisions, to a high degree of certainty, can in theory be collected and utilised within the cycle.

Existing monitoring in recreational fisheries and the value of socio-economic data

The following data is either already being collected, or has been identified as of value, with respect to socio-economic aspects of recreational fisheries in NSW.

At a state-wide level, monitoring and evaluation systems for recreational fisheries have been developed over the last 10 years supported by funding from the Recreational Trust. These programs seek to provide managers with accurate information to support evidence-based management decisions at a broad scale, and are an important part of a robust management system supporting the sustainability of recreational fisheries socially and ecologically. The most prominent example of this is the NSW Recreational Fishing Survey (RFS) which captures at a broad scale angler catch across species and regions (see Murphy et al., 2022, West et al. 2016), and is now being conducted every 2 years as part of the statewide Recreational Fishing Monitoring Program.

There has been less research on the economic contributions of inland Recreational fishing, and no systematic efforts to address social aspects of recreations fisheries in the context of monitoring systems. The most recent economic project was to develop cost-effective methods for state-wide economic valuations of recreational fisheries (McIlgorm & Pepperell 2013). This estimated inland fisheries expenditures in 2012. There was also a notable specific expenditure study of the Snowy Mountain Trout Fishery in 1999 by Prof McIlgorm (Dominion Consulting 2000). There has since been an update of the 2013 study (McIlgorm & Nichols 2023) which provides more recent information on expenditure on inland fishing at an aggregated, region-wide level across all species, which can feed into the development of an ongoing Inland fisheries social-economic monitoring framework which will be more site specific (See below).

While current economic and social information is limited, parallel and previous studies have shown that anglers recognise the regional economic contributions and social importance of these fisheries to their communities. Having economic information has enabled the angling community to stress the range of economic, business and employment benefits gained from recreational fishing and present it to local and state governments. Anglers in the inland fisheries also know there are social and wellbeing benefits arising from fishing to young people, families, the community and these are recognised nationally by tourists and visitors. However, the monitoring of such social benefits has been limited.

NSW DPI began instituting a systematic approach to the management of inland recreational fisheries via the NSW Trout Strategy in 2017, as noted so far the NSW Trout Strategy and the wider freshwater fishery projects have instituted monitoring of biological and environmental variables, such as trout and native stocks, water temperature, habitat, and catch at key monitoring sites. To provide managers with a robust information base in inland recreational fisheries, social and economic indicators stand to play an important role, particularly if a systematic approach to management is to be successfully applied.

For example, angler behaviour is key to informing appropriate management actions under many circumstances. This information has been used to improve the effectiveness of stocking regimes in trout fisheries (see e.g. Askey et al., 2013, Ward et al., 2013), and to assess the impact of angler fishing effort on a variety of fisheries, to ensure the long term sustainability of wild fish populations (Greiner et al., 2013, Ward et al., 2013). Angler behaviour studies also commonly track information on the preferences and objectives of anglers, which have been used to informing stocking regimes and management measures so that these interventions can meet the objectives of angling groups and increase angler satisfaction (Askey et al., 2013, Dabrovska 2017).

Angler behaviour may be tracked effectively using a range of measures, from basic participation statistics, or where angler behaviour is heterogeneous, through economic data (Pokki et al 2020, Johnson et al, 2010) and a variety of social survey methods (Dabrovska 2017, Greiner et al 2013). A key advantage of using economic and social data to monitor angler behaviour is that it also enables analysis of the social and economic benefits arising from recreational fisheries, such as spend in the local economy, and improved health and wellbeing outcomes from fishing, which can be important for demonstrating the value of recreational fisheries to the wider community and maintaining social license (McIlgorm & Pepperell 2013). Social license is an increasingly important issue in recreational fisheries and was a key theme at the 2019 National Recreational Fishing Conference. Having a sound evidence base on which to demonstrate the value of recreational fisheries to the wider community is therefore strategically valuable in the current climate. For example, economic valuations have been used to demonstrate the value to society of improving wild fish populations (Dalton et al., 1998) and stocking regimes (Johnson et al., 2011) elsewhere. In Australia, the ability to demonstrate the economic and social value of freshwater fishing in NSW can provide similar justifications for ongoing public investment in hatchery facilities, or improvement of in-stream habitat and environmental restoration efforts.

Finally it is worth noting that angler behaviour (and therefore social and economic values) varies across species targeted (e.g. trout, murray cod, golden perch) and in many cases across particular sites. Therefore aggregated data at a state-wide or regional level alone will not be sufficient to capture important trends that can inform effective management.

Considering the primarily broad scale nature of angler catch and economic data in NSW recreational fisheries at present, regular and cost-effective monitoring of the social and economic aspects of key fisheries at a localised scale is seen as of value, and represents a substantial gap in existing monitoring systems. In particular the use of, and links with, the bi-annual state-wide catch survey are an important aspect of longer term efforts, in order to get cost effective outcomes for monitoring by management. Compatibility with state-wide economic surveys that may occur periodically, can further help validate localised monitoring trends that have been observed.

Localised monitoring, nested under wider efforts, allows tracking of important management relevant changes in between larger broad scale survey evaluations (Catch every 2 years and Expenditure every 5 years). Our approach is to assess a range of available social/economic data points that can be readily integrated with regular catch monitoring to minimise the need to develop a standalone

social/economic monitoring system. This maximises cost-effectiveness for the RF Trust, and expands on the progress of the state-wide investments in catch monitoring and economic valuations, and environmental and catch monitoring in the NSW Trout Strategy.

Identifying objectives and key management issues

In a systematic or pre-defined management approach, a clear set of objectives is ideal, against which progress is measured using monitoring data (see Fowler et al 2022). The objectives are effectively a statement of what is being optimised within the fishery. That being said, developing and selecting objectives, and appropriate indicators, can be a tricky process. It requires a mix of support from managers and stakeholders, and a set of information that can effectively track the objective, which may not be readily available. In the absence of clear objectives, research and monitoring can also be constructed around a set of management relevant issues. As research advances and knowledge of the issue is built, a clear objective can be developed and systems established around it to collect relevant data. In some cases this can be optimal so as to allow for a general issue of concern for all to be investigated, with the aim of a clear objective and associated indicator being defined at a later date.

This raises the issue that a large amount of work of importance to ongoing monitoring can be done with managers and researchers inside DPI, to establish a clear understanding and set of processes with respect to what information will be used for. Development of an effective monitoring system requires information to be clearly tied to objectives, requires a clear understanding of how to interpret a change in an indicator, which ties that change to specific pre-defined actions. This takes time to establish and can be an iterative process between researchers, managers and stakeholders. The next two sections therefore summarise existing statements on objectives that could be relevant to the current project, and a set of management relevant issues raised in the workshop, which could also form the focus of research.

Potential objectives and management relevant issues for freshwater recreational fisheries

The following possible objectives of interest have been included from existing documents. The DPI strategic plan includes the following:

- Ecological: Improve sustainability of freshwater recreational fishery
- Social: Increase participation, community support, accessibility and satisfaction in recreational freshwater fishing
- Economic: Increase contribution of recreational fishing to economy.

The following broad issues were identified as of potential relevance to this project during the discussion with DPI fisheries managers, in terms of how SE monitoring information might be used over time.

- Stocking – in all 3 impoundments identified for possible fieldwork, stocking plays a key role. Tying monitoring to enhancing stocking strategies is a potentially valuable end use for this pilot and ongoing monitoring.
- Promotion of successful fisheries to support new development. Copeton Dam for example is entirely based on stocking and is a recently established fishery. Can monitoring data demonstrate the benefits of these to the community, to be able to support similar efforts elsewhere?
- Changing seasonal closures. Can monitoring data help inform whether some fisheries should or could be opened where seasonal closures currently exist, for example?
- Climatic influence - especially drought. The impacts of the drought on angler participation and therefore benefits to the community were very clear in recent years. Being able to put monitoring data alongside climatic data to allow senior managers to make arguments beyond only the fisheries management sphere would be of value.
- Patterns of effort "substitution" – A general issue of relevance to management is knowing under what conditions anglers are likely to substitute fishing at a site for another activity. This

may include switching angling effort to other sites (which is important for overall maintenance of sustainable fishing levels), or may include switching to non-fishing recreational activities. Understanding thresholds that may be associated with reductions or increases in effort for particular sites can assist in balancing multiple objectives within fisheries management.

- Access. Crown road closures are reducing stream access in the state. Being able to demonstrate the benefits to community of freshwater rec fisheries can help make the public interest case to Crown Lands to retain these access points rather than sell of these parcels of land.

- In general improving information systems and quality of data is seen as a valuable piece of capacity building within the department that supports any style of management. At this point, improving attitudinal and perception questions in the RFMP surveys, having a better sense of what are the changing patterns of participants and fishing approaches are, and able to verify the split between fresh and saltwater anglers (currently understood as 70/30 but this is a coarse view), to develop more nuanced understandings of angler behaviour and attitudes, are seen as of wider value.

Methods and approach

Key concepts and framing

A monitoring framework and survey was developed to broadly address these needs, with a conceptual framing of the overall angler experience being the focus of monitoring. In this approach, the following elements guided overall indicator and survey development:

- Demand for recreational fishing, which can be understood broadly in terms of the perceived desirability of fishing at a site. This influences choices to go fishing at all, and site selection. A key aspect of the approach methodologically to be tested is that recreational fishing demand can be tracked through economic data, which in turn provides a proxy for likely fishing effort.
- The activity of recreational fishing experience itself, measured by participation rates, and can also be segmented according to angler motivations, which indicate the associated objectives of different types of anglers.
- Outcomes from recreational fishing, which includes the catch, and its linkages to biological outcomes, as well as management effectiveness, which can be measured by both evaluating catch and catch rates against objectives, as well as through measuring angler satisfaction.

The following table includes a basic monitoring framework based on this approach and specifying indicators based on catch, economic, and social data.

Framework element	Type of data	Indicators for monitoring
Demand	Participation	Average trips per year
	Economic expenditure	Average expenditure per trip Average consumer surplus Average willingness to pay
Activity	Participation	Trips per year
	Demographics	Age, gender, household income.
	Angler motivation	Angler motivations
	Economic expenditure and trip data	Average consumer surplus Average willingness to pay
Outcome	Catch and effort data	Catch data summaries Catch rates
	Economic expenditure data	Average expenditure per trip
	Angler satisfaction	Overall angler satisfaction Satisfaction in different cohorts Consumer surplus

Explanatory points on economic indicators

Average expenditure per trip is the total dollar amount spent by a respondent on a trip across range of categories, averaged across all respondents.

Average willingness to pay is the maximum amount an angler would be willing to pay (in terms of travel cost) for the angling experience at a site.

Consumer Surplus (CS) is an economic measure of the enjoyment an angler experiences. CS is calculated by demonstrating a relationship between the number of trips to a site, the cost of those trips given multiple options available with respect to alternative recreational activities and alternative sites available for angling.

The theory of consumer surplus states that where a certain amount of available disposable income exists in a given economy for a particular good or service, expenditure above the cost of those goods and services, up to the willingness to pay of the consumer (understood as surplus expenditure), can be delivered to either producers as profit (known as producer surplus) or to the consumer (known as consumer surplus). A higher consumer surplus indicates a greater overall benefit to the consumer in the transaction, and therefore provides insights about consumer behaviour (in this case anglers), with respect to the affordability and benefits derived from recreational fishing relative to other available leisure options. According to the theory of consumer surplus as an indicator of behaviour, the closer to the maximum willingness to pay that CS gets, the less enjoyment a consumer receives per unit of expenditure, and therefore the more likely a consumer is to switch to alternative options to meet their needs from a limited pool of disposable income.

Pilot survey

The pilot survey, designed to collect data that can calculate these values, included four main sections as follows:
- Angler demographics
- Catch, trip and effort information
- Economic expenditure
- Angler motivation and satisfaction

The survey instrument is included in Appendix A.
Angler demographics primarily informs participation related social indicators, as well as some economic indicators and includes the following data points.
- Home postcode
- Age
- Gender
- Employment status
- Approximate gross household income

Catch, effort and trip data

DPI conducts numerous catch-based surveys across a range of freshwater fisheries and species. These range from the NSW Recreational fishing survey (a catch diary method), to creel surveys at specific sites, and survey methods aimed at developing catch rate indices. Consultation with DPI staff managing the freshwater fishing research program was the primary means by which this work was included into the design of the survey and overall framework and led to a specific section on catch rates being included in the survey.

The survey included the following data points:

Catch and effort data per trip reported according to the following data points per day:
- Total fish caught
- Trophy fish caught
- Trophy fish encountered but not caught
- Start and finish times for each fishing session for all days of a fishing trip.

Trip data was recorded primarily to input into analysis of economic and participation indicators. This included:

- number of trips per year to this site

- number of days in a typical trip
- % of time spent fishing
- whether the trip was primarily a fishing trip, or fishing was part of a multiple activity trip.

Economic expenditure data

Review of the NSW Economic Expenditure state-wide survey-based dataset by project economists led to the following inputs into this survey:

- Identification of the travel cost method as an appropriate overall approach to collection of site specific economic data, to be able to calculate economic expenditure indices and a Willingness to Pay and Consumer Surplus per site. A detailed appraisal of the Travel Cost method is provided in Appendix 1.
- Identifications of key economic expenditure data points to support these methods.
- Ability to utilise the state-wide dataset as a baseline set of data which supports estimates of Consumer Surplus and Willingness to Pay in project sites that are robust.
- Identification of sample size of ~50 respondents per site, to be able to meaningfully calculate WTP against the state-wide data-set.

The survey included the following data points on economic expenditure:

- Fishing tackle (hooks, lines, sinkers, lures etc.)
- Bait/Berley Boat fuel (if applicable)
- Car fuel (one way)
- Accommodation Food and Drink (groceries, takeaway, pub meal etc)
- For each expenditure, data point whether spent locally (i.e. in nearby towns) or elsewhere.

It is noteworthy that the travel cost method is by now a commonly used method for understanding the value of "non-market goods and services" - i.e. those that are not directly bought or sold on a market and so do not have a readily available price that can inform economic analysis of consumer behaviour. Recreational experiences are one such example of a non-market good and a number of studies have applied non-market valuation via the travel cost method to Australian recreational fisheries (see e.g. Sheufele and Pascoe 2023, Yamazaki et al., 2013).

Angler motivation and satisfaction data

Including angler motivations allows for the broad objectives of anglers at a site to be understood (Mcilgorm 2016). Including satisfaction allows for the outcomes of the angling experience to be directly tracked in the form of the anglers own view of that experience (see e.g. Gundelund et al., 2022, Birdsong 2021). Including angler motivation variables also allows for catch and expenditure related variables to be stratified according to types of anglers (e.g. avid/non-avid, catch and cook/catch and release). Segmenting information according to angler motivation and other characteristics is a commonly used method in recreational fisheries elsewhere (see Birdsong et al, 2021, Connelly et al., 2001, Fisher 1997).

Review of McIlgorm et al (2016) and a draft attitudinal survey under development by DPI at the time of the survey provided a detailed set of categories related to angler motivations which were considered when drafting the survey instrument. The draft attitudinal survey also provided a template for angler satisfaction questions that aligns with the wider DPI efforts to produce broadly comparable data from this project.

Angler motivations categories included 7 categories in the survey, within which a range of specific activities or more detailed reasons people go fishing could be categorised, including the following: Catch related motivations**:**

- Availability of target species/being able to catch something
- Catching large numbers of

- Catching trophy or high quality fish
- Keeping and consuming fish

Non-catch related motivations
- Mastery - Relates to the desire to build skills and knowledge, compete, experience a challenge and/or achieve personal milestones.
- Escapism - Relates to the desire to be outside, relax, get away from life's demands.
- Socialising - Relates to the desire to be with family and friends, sharing in recreation and fun

Anglers were asked to identify whether
- A particular motivation was important to them (very important/quite important/not very important/not at all important/unsure)
- For those motivations that were very of quite important, were they satisfied with their fishing experience (highly satisfied/satisfied/neutral/dissatisfied/highly dissatisfied).

As a final question, anglers were asked to rate their overall satisfaction over the last 12 months, and if they responded dissatisfied of very dis-satisfied, they were asked to give up to 3 reasons why they were not satisfied.

Site selection and data collection

Initial discussions with DPI staff suggested 3 pilot sites in which existing biological monitoring occurs that could be built on productively to build a strong overall information base - Snowy Lakes for Trout, Copeton Dam for Murray Cod and Windamere Dam for Golden Perch. These sites are advantageous for a pilot due to the following reasons:

1. Each focus on an iconic recreational fish species.
2. These sites are distributed widely in inland NSW, providing a variety of contexts within which to consider the dynamics of recreational fisheries, and the contributions these fisheries make to surrounding communities.
3. These sites are all impoundments that receive stocking, and so provide a test of at least and (and potentially more) of the key management issues identified in discussions with DPI.
4. These sites are all relatively "contained" or closed systems. This means firstly that inputs (e.g. stockings) in theory can be tied, at least to some degree, to outputs (e.g. angler catch), such that a formalised adaptive management approach may be possible to develop in the future. Secondly, this means that discrete access points exist that allow for relatively efficient data collection process over a defined period.

Data collection was undertaken across 4 sites over a 5 month period during late 2022 and early 2023. The primary method of data collection was in person surveys administered by project researchers on site, with recruitment occurring at typical access points for each site, such as boat ramps or road accessible lakeside campgrounds. The target per site was 50 surveys, which would be sufficient to give an indication of the key values in the monitoring framework, and was also sufficient to allow for economic values to be cross-checked against the state-wide economic expenditure dataset to assist in calculating reliable WTP and Consumer Surplus values. Anglers were also provided the option of self-administering the survey via an online portal.

An important aspect of this sampling approach is that this is not intended to be a full quantitative assessment of catch, economic or social values of each site. Instead, as a pilot of an indicator framework, this approach and sample size aimed to be cost-effective, able to administered by a fisheries officer level employee within a 15-20 minute time frame, and able to indicate trends over time, assuming regular time series data is collected. In this approach, one aspect of interpreting indicators is to be able to understand when a change in an indicator from one year to another provides a trigger for a management intervention. One type of management intervention available is to commission full quantitative assessments to substantiate the magnitude or reasons for change in a

given case. In this context it is worth noting the definition of an indicator provide by the OECD which states that an indicator is:

> A quantitative or qualitative factor or variable of interest, related to an intervention and its results, or to the context in which an intervention takes place. An indicator is always approximate only (i.e. not an exact measure) and requires interpretation and explanation, even if assessed accurately (OECD 2002)

The raw dataset initially contained 214 respondents across four freshwater sites of interest; Copeton Dam, Windamere Dam, Lake Eucumbene and Lake Jindabyne. Initial examination revealed 10 respondents had failed to state which site they fished at, and had in fact failed to complete the survey at all. These were removed from the dataset, leaving 204 responses. These responses are summarised in the tables and figures below.

The total respondents per site were:
- Copeton Dam 52 respondents
- Snowy Lakes combined 109 respondents (Eucumbene 87, Jindabyne 22)
- Windamere Lake 43 respondents
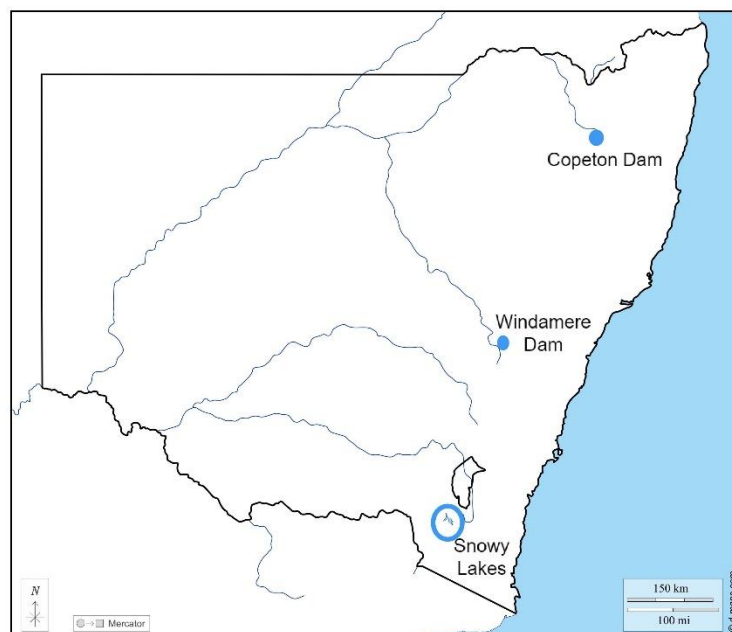
Figure 1. Pilot survey sites

Results

All sites

Angler demographics

59% of respondents were aged between 30 and 50 years old, with 27% being over 60. Most respondents stated they earned less than AUD$150,000 per annum as gross household income, with the majority earning between $50,000 and $100,000. The respondents were overwhelmingly male, with only 16 female respondents across all sites.

Copeton Dam	**52**
Female	3
Male	49
Lake Eucumbene	**87**
Female	5
Male	80
Did not say	2
Lake Jindabyne	**22**
Female	1
Male	21
Windamere Lake	**43**
Female	7
Male	36
TOTAL	**204**

Age distribution

2% < 20, 10% 20-29, 13% 30-39, 19% 40-49, 27% 50-59, 29% 60+

Approximate gross household income across sites

Income range	Number of respondents
$0-50k	22
$50-100k	56
$100-150k	44
$150-200k	25
Over $200k	20
Prefer not to say	37
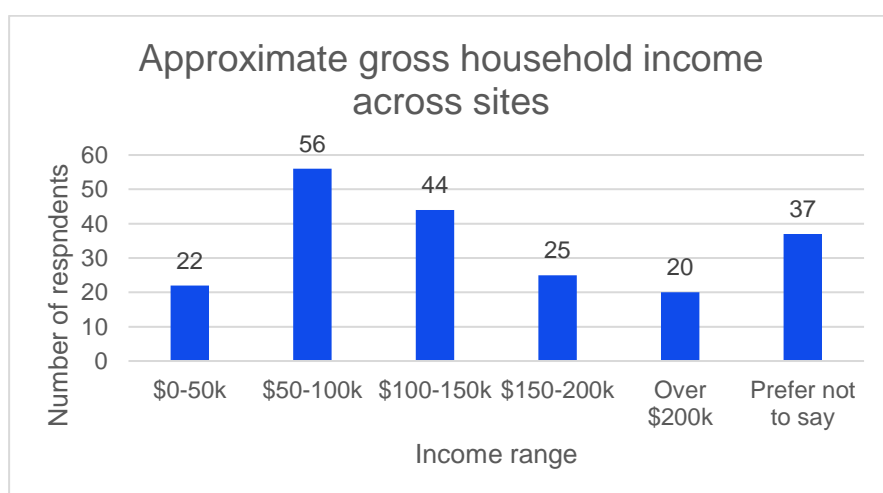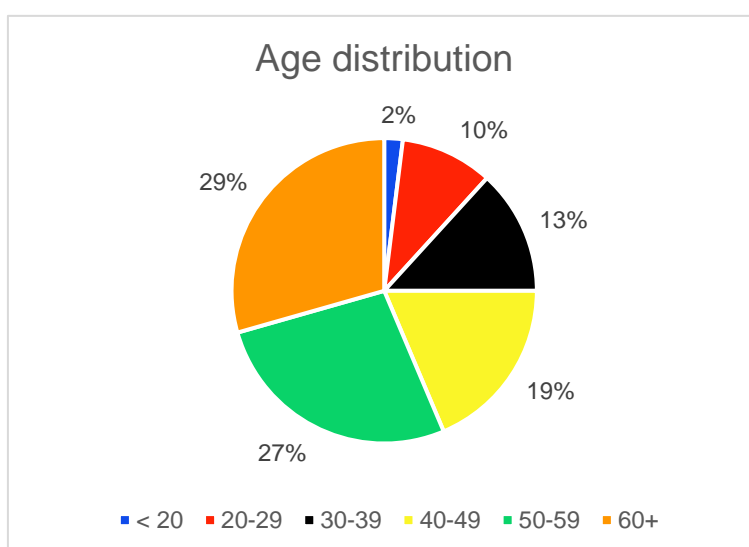
Visitation to sites

Most respondents said they visited their site fewer than five times per year, with 40% saying they only visited once or twice per year. 14% stated they visited up to 10 times per year, with 14% visiting more

than 10 times. These higher-frequency visitors included some residents who stated they visited a site more than 80 times in a year (Eucumbene and Copeton specifically).

Respondents were asked how long their typical trips to the site were, and whether they undertook other activities while at those sites. Respondents tended to undertake multi-day fishing trips, with relatively fewer undertaking day trips to sites (however, relatively more people undertook day trips to Lakes Eucumbene and Jindabyne compared to Copeton or Windamere). Relatively high proportions of people visiting Copeton Dam or Windamere Lake undertook multi-day trips where fishing was only one intended activity (40% and 49% respectively).

Number of visits to sites

- Once or twice per year
- A few times per year
- Between 5 and 10 times per year
- More than 10 times per year
- Did not say
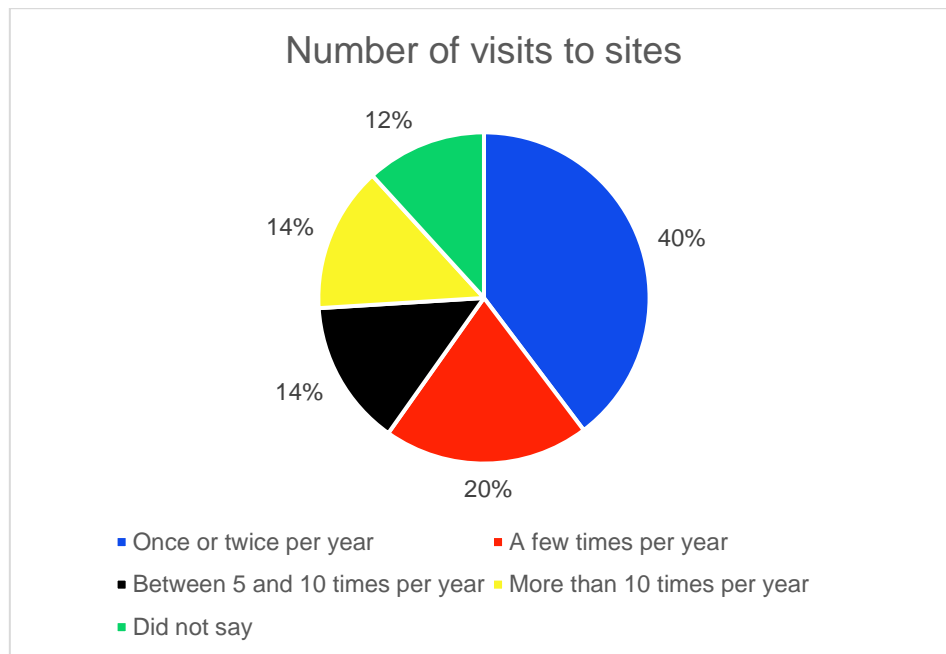
Visitors to sites came predominantly from NSW (68%), with Victoria contributing a large number of visitors to Lake Eucumbene (20%). The ACT also contributed a relatively large number of visitors to Lakes Eucumbene and Jindabyne (30% combined).
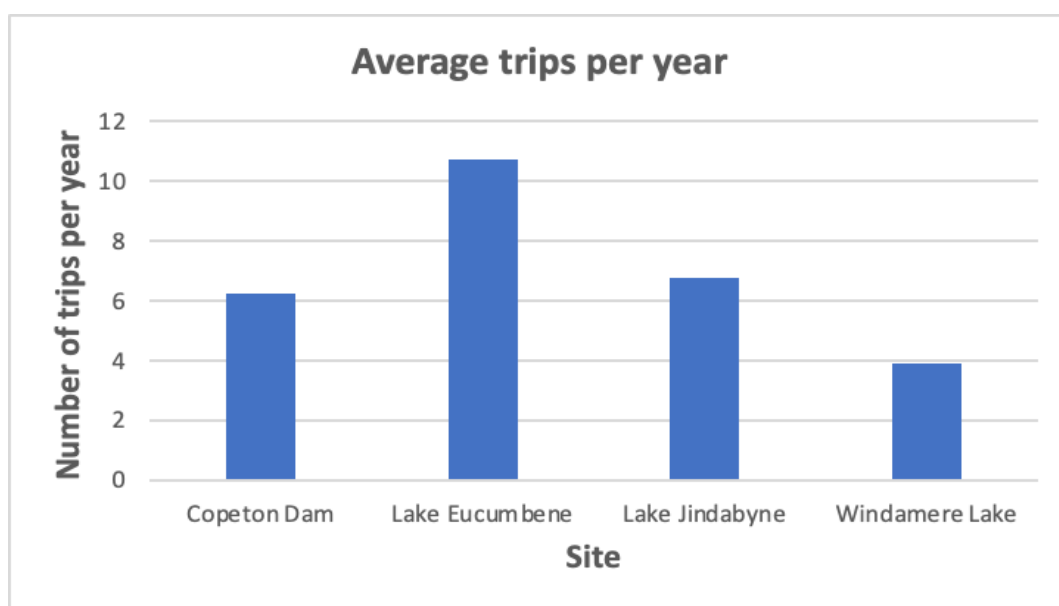
Respondents on average indicated they would make 6.22 trips to Copeton per year, 10.71 to Lake Eucumbene, 6.77 to Lake Jindabyne and 3.9 to Lake Windamere.

Catch summaries

Location	Number of respondents	Total fish caught	Species name	Number of fish caught	Number of respondents that caught this species	Percentage of respondents that caught this species
			Catfish	121	24	11.7
			Golden Perch	51	15	7.3
			Murray Cod	12	3	1.5
			Rainbow Trout	341	34	16.6
			Brown Trout	263	32	15.6
			Salmonids (unspecified)	386	32	15.6
All sites	204	1181	Unspecified	7	3	1.5

Catch rates per site
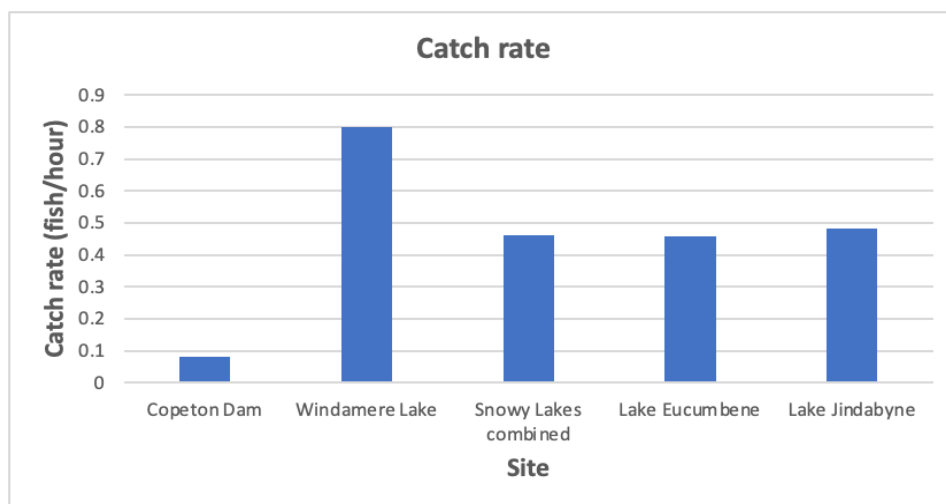
Site	Total hours fished	Total fish caught	Catch rate (fish/hour)
Copeton Dam	843	71	0.084
Windamere Lake	211	168	0.798
Snowy Lakes combined	1,372	632	0.461
Lake Eucumbene	1,175	537	0.457
Lake Jindabyne	197	95	0.482

Economic expenditure per trip

	AVERAGE SPEND PER TRIP			CONSUMER SURPLUS	Average Travel Cost (return trip)	Average Willingness to Pay
	Local	Elsewhere	Total			
All sites	$471.47	$167.45	$638.91	$273.22	$318.96	$596.74
Copeton Dam	$663.48	$162.79	$826.27	$335.57	$430.46	$766.03
Windamere Lake	$574.74	$183.74	$758.49	N/A[1]	$213.94	N/A[1]
Snowy Lakes Combined	$339.12	$163.24	$502.36	$290.64	$309.06	$599.70
Lake Eucumbene	$349.13	$192.22	$541.34			
Lake Jindabyne	$299.55	$48.64	$348.18			

[1] Windamere Consumer Surplus and Willingness to Pay could not be calculated due to lack of statistical significance. This is due to Windamere having the weakest demand relationship, limiting analysis in a situation with limited sample size (see Figure 2b in appendix).

Average Expenditure: All Sites Combined
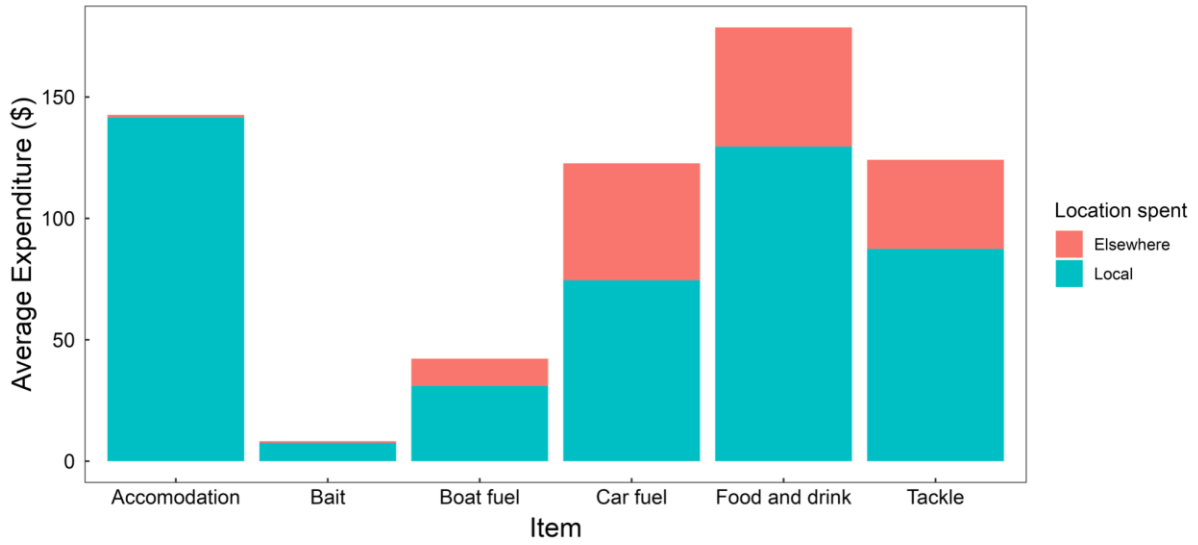
	Tackle		Bait		Boat fuel		Car fuel		Accommodation		Food and drink		
	Local	Elsewhere	Local	Elsewhere	Local	Elsewhere	Local	Elsewhere	Local	Elsewhere	Local	Elsewhere	**TOTAL**
Copeton Dam	$157.98	$46.92	$9.04	$0.00	$25.00	$11.35	$125.38	$39.90	$177.71	$0.00	$168.37	$64.62	**$826.27**
Lake Eucumbene	$33.85	$36.99	$5.75	$0.46	$26.84	$9.71	$67.61	$80.57	$134.09	$4.20	$80.99	$60.29	**$541.34**
Lake Jindabyne	$8.64	$15.45	$1.82	$0.00	$12.95	$0.00	$32.05	$22.27	$151.82	$0.00	$92.27	$10.91	**$348.18**
Windamere Lake	$149.30	$47.44	$13.40	$2.44	$59.53	$23.51	$73.07	$49.88	$102.70	$0.00	$176.74	$60.47	**$758.49**
ALL SITES	**$87.11**	**$39.40**	**$7.77**	**$0.71**	**$31.76**	**$11.99**	**$79.65**	**$57.45**	**$140.50**	**$1.79**	**$124.66**	**$56.10**	**$638.91**

Angler motivation and satisfaction

Overall satisfaction

Overall Satisfaction (last 12 months)

- Highly satisfied
- Satisfied
- Neutral
- Dissatisfied
- Highly dissatisfied

Overall, how satisfied with your angling experience are you for this site over the last 12 months?

Number of respondents				
Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
90	60	16	5	1
Percentage of respondents				
52.3	34.9	9.3	2.9	0.6

Satisfaction by motivation class

Catch related reasons to go fishing						
	Number of respondents					
Reason	Very important	Quite important	Neutral	Not very important	Not at all important	Unsure
Availability of target species/being able to catch something	104	56	0	11	3	0
Catching large numbers of fish	19	46	0	96	12	0
Catching trophy or high quality fish	60	70	0	34	9	1
Keeping and consuming fish	20	44	0	40	70	0

Catch related reasons to go fishing: If rated as important to some degree, what is your level of satisfaction on this trip?					
	Number of respondents				
Reason	Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
Availability of target species/being able to catch something	61	66	31	15	2
Catching large numbers of fish	18	53	91	12	1
Catching trophy or high quality fish	37	60	63	14	1
Keeping and consuming fish	15	51	97	7	4

Non-catch related reasons to go fishing						
	Number of respondents					
Reason	Very important	Quite important	Neutral	Not very important	Not at all important	Unsure
Mastery - Relates to the desire to build skills and knowledge,	49	72	0	48	6	0

compete, experience a challenge and/or achieve personal milestones.					
Escapism - Relates to the desire to be outside, relax, get away from life's demands.	143	30	0	1	1	0
Socialising - Relates to the desire to be with family and friends, sharing in recreation and fun	117	31	0	19	7	1

Non-catch related reasons to go fishing: If rated as important to some degree, what is your level of satisfaction on this trip?					
Reason	**Number of respondents**				
	Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
Mastery - Relates to the desire to build skills and knowledge, compete, experience a challenge and/or achieve personal milestones.	45	65	63	2	0
Escapism - Relates to the desire to be outside, relax, get away from life's demands.	128	41	6	0	0
Socialising - Relates to the desire to be with family and friends, sharing in recreation and fun	104	43	27	1	0

Copeton Dam

Total respondents were 52 for Copeton Dam, and on average indicated they would make 6.22 trips to Copeton per year.
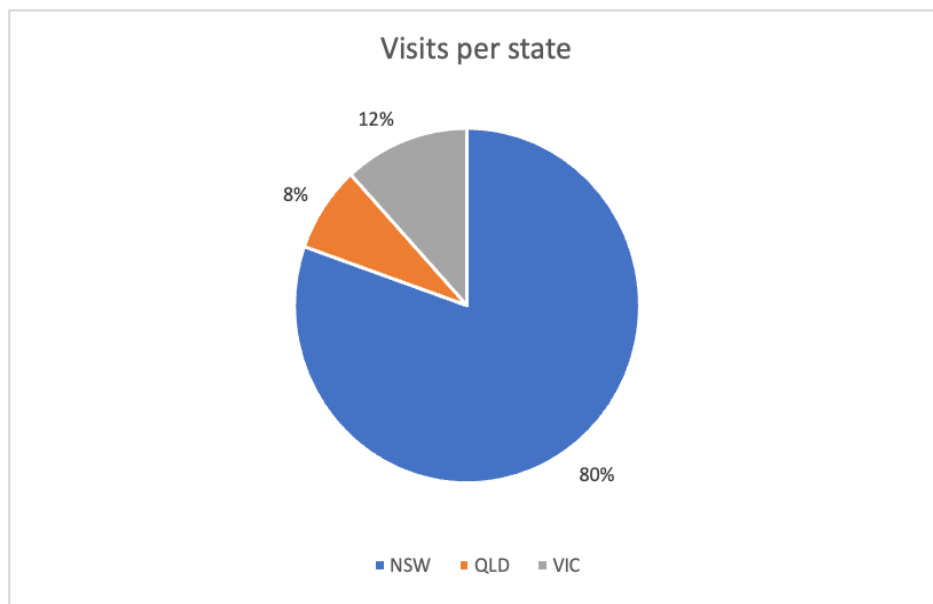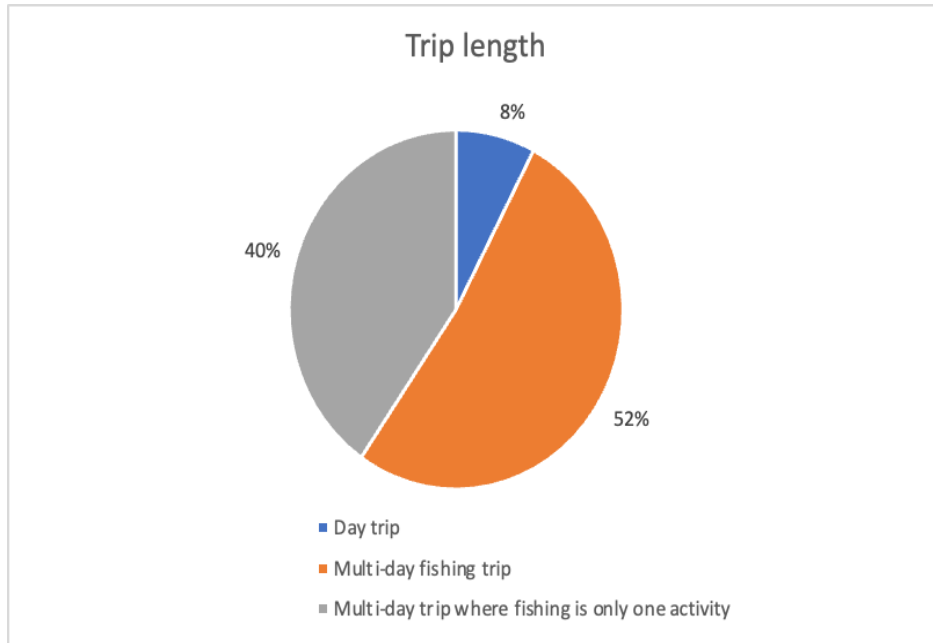
Trip length

- Day trip: 8%
- Multi-day fishing trip: 52%
- Multi-day trip where fishing is only one activity: 40%

Visits per state

- NSW: 80%
- QLD: 8%
- VIC: 12%

Catch summaries

Number of respondents	Total fish caught	Number of respondents that caught no fish	Percentage of respondents that caught no fish
53	74	35	66.0

Species name	Number of fish caught	Number of respondents that caught this species	Percentage of respondents that caught this species
Catfish	32	12	22.6
Golden Perch	23	8	15.1
Murray Cod	12	3	5.7
Unspecified	7	3	5.7

Catch rates

Number of respondents*	Total hours fished	Total fish caught	Catch rate (fish/hour)
50	843	71	0.08

*Number of respondents that reported time spent fishing

Economic expenditure per trip

	AVERAGE SPEND PER TRIP			CONSUMER SURPLUS	Average Travel Cost	Average WTP
	Local	Elsewhere	Total			
Copeton Dam	$663.48	$162.79	$826.27	$335.57	$430.46	$766.03
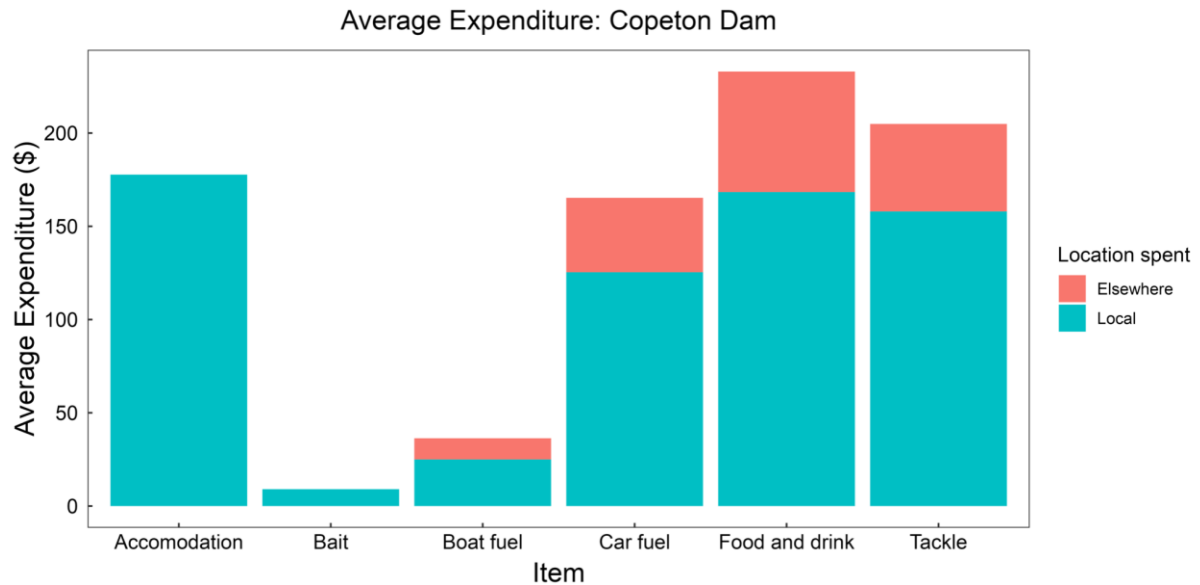
Average Expenditure: Copeton Dam

Average Expenditure					
Tackle		**Bait**		**Boat fuel**	
Local	Elsewhere	Local	Elsewhere	Local	Elsewhere
$157.98	$46.92	$9.04	$0.00	$25.00	$11.35
Car fuel		**Accommodation**		**Food and drink**	
Local	Elsewhere	Local	Elsewhere	Local	Elsewhere
$125.38	$39.90	$177.71	$0.00	$168.37	$64.62

Angler motivations and satisfaction

Overall satisfaction (last 12 months)

Overall, how satisfied with your angling experience are you for this site over the last 12 months?				
Number of respondents				
Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
29	20	1	2	1
Percentage of respondents				
54.7	37.7	1.9	3.8	1.9

Issues driving overall dis-satisfaction

All three respondents who reported dis-satisfaction cited the lack of access to a boat ramp at 100% capacity as the main issue. At time of survey Copeton was at unusually high levels due to persistent La Nina conditions.

Angler satisfaction by motivation class

Catch related reasons to go fishing						
	Number of respondents					
Reason	Very important	Quite important	Neutral	Not very important	Not at all important	Unsure
Availability of target species/being able to catch something	28	20	0	4	0	0
Catching large numbers of fish	6	16	0	29	1	0
Catching trophy or high-quality fish	27	16	0	7	1	1
Keeping and consuming fish	1	12	0	9	30	0

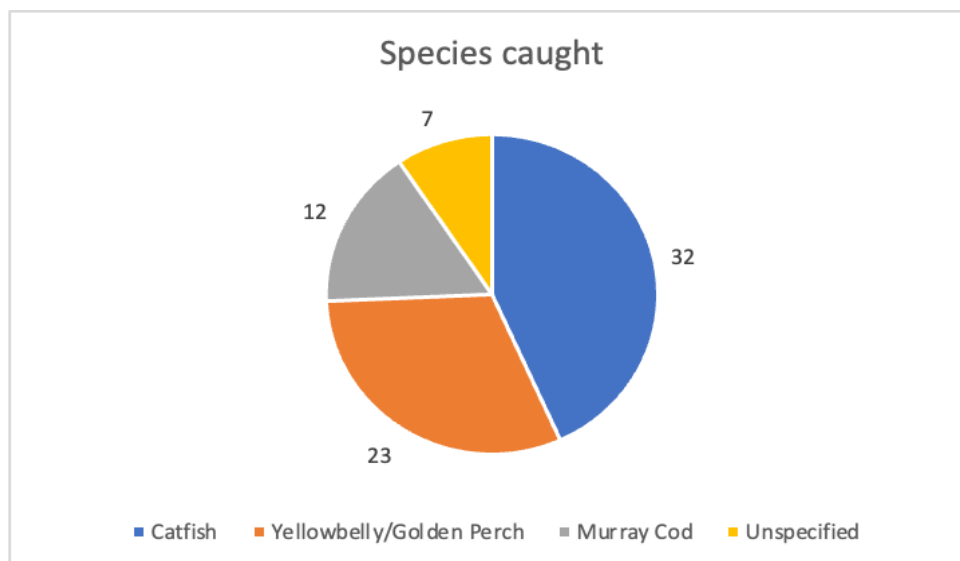| Catch related reasons to go fishing: If rated as important to some degree, what is your level of satisfaction on this trip?				
	Number of respondents			
Reason	Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
Availability of target species/being able to catch something	9	23	13	8	0
Catching large numbers of fish	1	13	33	6	0

Catching trophy or high quality fish	8	19	20	6	0
Keeping and consuming fish	0	7	39	5	2

Non-catch related reasons to go fishing						
	Number of respondents					
Reason	Very important	Quite important	Neutral	Not very important	Not at all important	Unsure
Mastery - Relates to the desire to build skills and knowledge, compete, experience a challenge and/or achieve personal milestones.	12	19	0	22	0	0
Escapism - Relates to the desire to be outside, relax, get away from life's demands.	44	9	0	0	0	0
Socialising - Relates to the desire to be with family and friends, sharing in recreation and fun	44	5	0	3	0	1

Non-catch related reasons to go fishing: If rated as important to some degree, what is your level of satisfaction on this trip?					
	Number of respondents				
Reason	Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
Mastery - Relates to the desire to build skills and knowledge, compete, experience a challenge and/or achieve personal milestones.	8	18	27	0	0
Escapism - Relates to the desire to be outside, relax, get away from life's demands.	44	8	1	0	0
Socialising - Relates to the desire to be with family and friends, sharing in recreation and fun	41	8	4	0	0

Snowy Lakes

Total number of respondents was 87 for Lake Eucumbene and 22 for Lake Jindabyne for a combined total of 109 respondents. Respondents on average indicated they would make 10.71 to Lake Eucumbene, and 6.77 to Lake Jindabyne per year.
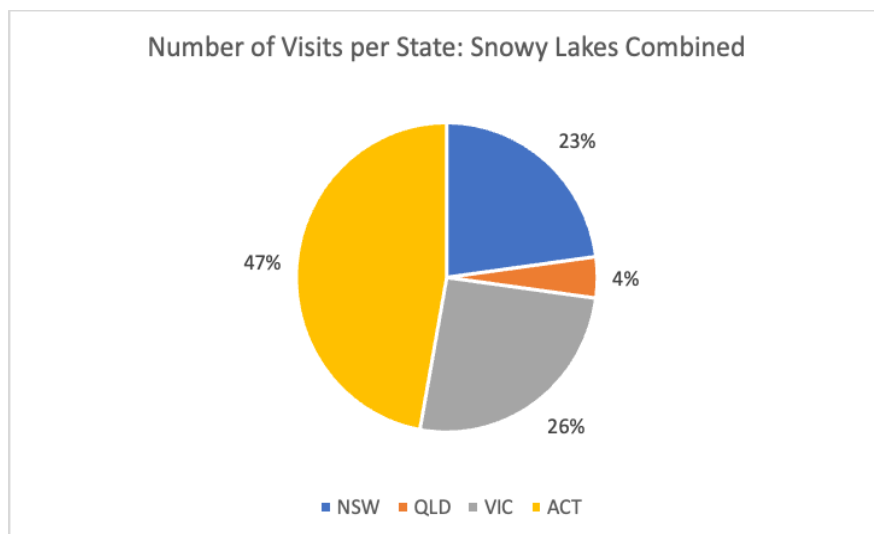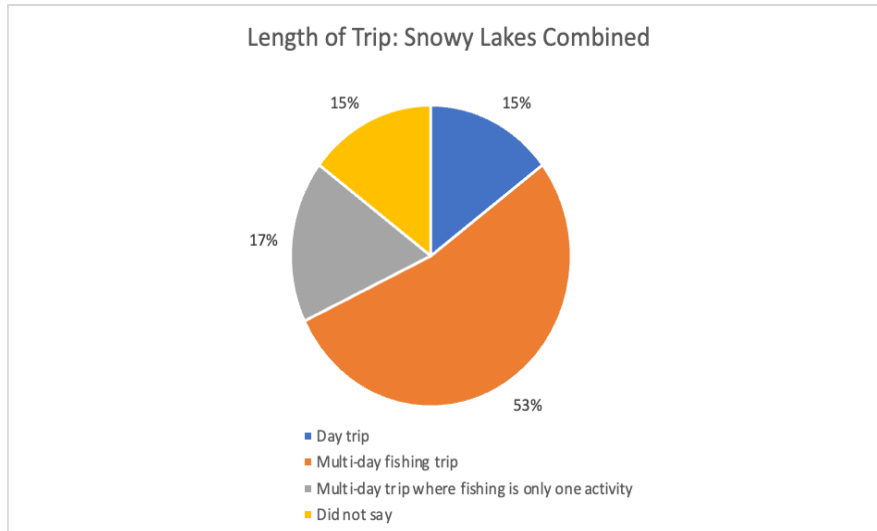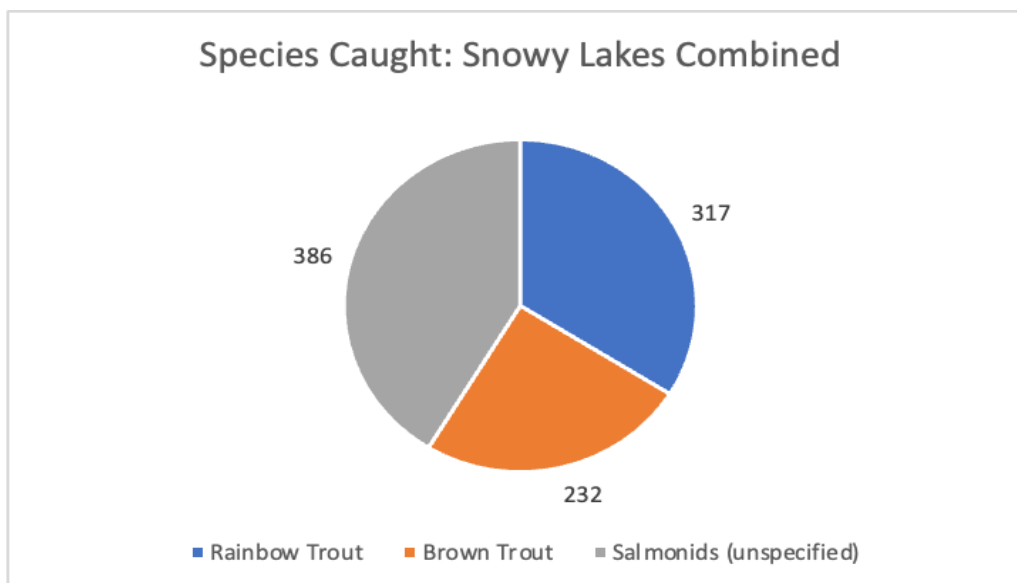
Length of Trip: Snowy Lakes Combined

- Day trip — 15%
- Multi-day fishing trip — 53%
- Multi-day trip where fishing is only one activity — 17%
- Did not say — 15%

Number of Visits per State: Snowy Lakes Combined

- NSW — 23%
- QLD — 4%
- VIC — 26%
- ACT — 47%

Catch summaries

Species Caught: Snowy Lakes Combined

386 317

232

■ Rainbow Trout ■ Brown Trout ■ Salmonids (unspecified)

Location	Number of respondents	Total fish caught	Number of respondents that caught no fish	Percentage of respondents that caught no fish
Snowy Lakes combined	109	935	38	34.9
Lake Eucumbene	87	790	28	32.2
Lake Jindabyne	22	145	10	45.5

Location	Species name	Number of fish caught	Number of respondents that caught this species	Percentage of respondents that caught this species
Snowy Lakes combined	Rainbow Trout	317	33	30.3
	Brown Trout	232	30	27.5
	Salmonids (unspecified)	386	32	29.4

Lake Eucumbene	Rainbow Trout	252	29	33.3
	Brown Trout	214	27	31.0
	Salmonids (unspecified)	324	24	27.6
Lake Jindabyne	Rainbow Trout	65	4	18.2
	Brown Trout	18	3	13.6
	Salmonids (unspecified)	62	8	36.4

Catch rates

Site	Number of respondents*	Total hours fished	Total fish caught	Catch rate (fish/hour)
Snowy Lakes combined	74	1,372	632	0.461
Lake Eucumbene	61	1,175	537	0.457
Lake Jindabyne	13	197	95	0.482

*Number of respondents that reported time spent fishing

Economic expenditure per trip

	AVERAGE SPEND PER TRIP			CONSUMER SURPLUS	Average Travel Cost	Average WTP
	Local	Elsewhere	Total			
Snowy Lakes combined	$339.12	$163.24	$502.36	$290.64	$309.06	$599.70
Lake Eucumbene	$349.13	$192.22	$541.34			
Lake Jindabyne	$299.55	$48.64	$348.18			

Average Expenditure: Snowy Lakes Combined
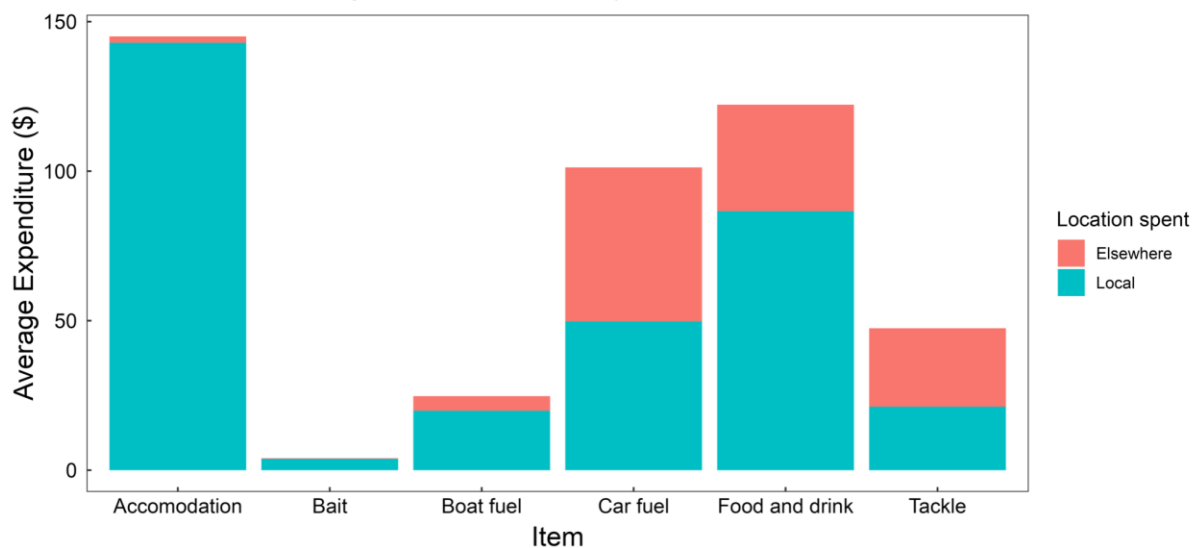
Site	Average Expenditure					
	Tackle		**Bait**		**Boat fuel**	
	Local	Elsewhere	Local	Elsewhere	Local	Elsewhere
Snowy Lakes Combined	$28.76	$32.64	$4.95	$0.37	$24.04	$7.75
Lake Eucumbene	$33.85	$36.99	$5.75	$0.46	$26.84	$9.71
Lake Jindabyne	$8.64	$15.45	$1.82	$0.00	$12.95	$0.00

Site	Average Expenditure					
	Car fuel		**Accommodation**		**Food and drink**	
	Local	Elsewhere	Local	Elsewhere	Local	Elsewhere
Snowy Lakes Combined	$60.43	$68.81	$137.67	$3.35	$83.27	$50.32
Lake Eucumbene	$67.61	$80.57	$134.09	$4.20	$80.99	$60.29
Lake Jindabyne	$32.05	$22.27	$151.82	$0.00	$92.27	$10.91

Expenditure contribution to regional economy for Snowy Lakes

From State-wide Survey (NSW) – McIlgorm & Nichols 2023. For Snowy Mountain region (Lakes Eucumbene and Jindabyne).

Economic background to the Snowy Mountain trout fishery- 2023 State wide survey results.
The state-wide economic expenditure survey in 2021-22 surveyed 1,223 anglers fishing in NSW (McIlgorm and Nichols, 2023), and was based on the travel cost method implemented in this pilot monitoring project. The Snowy Mountains (SM) trout fishery was included as part of the larger **South coast inland** (SCI) **study region** in the state-wide survey. The SCI region represented ACT, Queanbeyan and the Snowy mountain areas, and the more coastal lower south coast SA3 (8) was not included in analysis (see McIlgorm and Nichols, 2023). As a result, most of the inland fishing expenditure for the state-wide study in the SCI regions is likely to have occurred in the Snowy Mountains area.

The individual expenditure by fresh water anglers in the SCI region was $308 per trip on fishing equipment, $385 per trip on fishing trips, a total of $693.48 per trip. Freshwater fishers spent $2,205 on fishing boat costs annually (McIlgorm and Nichols, 2023; Table 6b).

The regional total annual expenditure by fresh water anglers in the SCI region was $31.4m on fishing equipment, $62.23m on fishing trips, a total of $17.82m on fishing boat costs annually, a total of $114.3m for the region in 2021-22 (McIlgorm and Nichols, 2023; Table 8a &c). The source of $98.1m of trip expenditure was $30m from interstate anglers, $2.2m N. Coast and North west, $5.5m from the south coast, $43.2m from within the SCI region itself, $6.0m from the south west and $11.2m from Sydney (McIlgorm and Nichols 2023; Table 10b).

To calculate these figures for the Snowy Mountain region, we first estimate that Snowy Mountain trout fishing accounted for 70% of trip expenditure in the SCI region, as evidenced by the high number of external visitors to the area and particularly a significant number of ACT residents fishing in the Snowy Lakes within the sample collected for this pilot monitoring project.

This gave $68.7m trip and $17.8m boat expenditure – a total of $86.5m for the Snowy Mountains in year 2021-22. The survey recalled the year prior to August 2022 and was impacted by Covid-19 "lock downs" which likely reduced the number of anglers travelling to the SM. Conversations with accommodation providers indicated that uncertainty around lock downs, travel prohibitions and government advisory notices reduced tourist numbers in the survey period. The estimates are proposed as being a minimum.

Regional impacts in SCI and Snowy Mountains

Box 1: Regional impact of FW fishing in SCI region
The regional impact of all RF fishing expenditure in the SCI was estimated as $150m (includes SW expenditure), had an associated output of $118m, an added value of $59m, household income of $40m and supporting 550 jobs. When flow-on effects are taken into account, the recreational fishing contributes the following to the economy of South coast Inland NSW:

• 554 jobs, including 117 in the hospitality sector, 101 in accommodation, 59 in other manufacturing, 38in the retail trade sector, and 29 in automotive repair and maintenance;

• $40m in household income with 15.7% in manufacturing of other products, 10.9% accommodation, 8.7% in hospitality and 12.3% in personal service sectors;

• $59m in industry value added, representing 0.11% of total regional value added of the NSW South Coast Inland region; and

• $118m in output.

Recreational fishing will contribute 0.17% of employment in the South coast Inland region when flow-on effects are taken into account as well as 0.12% of household income and 0.11% of the estimated gross regional product of the South coast Inland region.

The regional impact for the Snowy Mountains trout fishery is estimated to be 58% of the SCI regions total fishing expenditure ($86.5m/$150m), giving an associated output of $68.4m, an added value of $34.22m, household income of $23.2m and supporting 319 jobs. The areas of the local economy indirectly impacted are as in the Box above. The difference in regional benefit for SCI and SM regions is understood to be primarily related to the expenditure of ACT fishers on freshwater fishing trips and equipment, especially freshwater fishing boats which are frequently used in the Snowy Lakes to a greater degree than other areas within the broader SCI region.

Angler motivations and satisfaction

Overall satisfaction (last 12 months)

Overall, how satisfied with your angling experience are you for this site over the last 12 months?				
Number of respondents				
Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
37	31	6	3	0
Percentage of respondents				
48.1	40.3	7.8	3.9	0.0

Issues driving dis-satisfaction

Only three anglers, all at Lake Eucumbene, reported dissatisfaction with their fishing experience. With respect to the reason/explanation for their dis-satisfaction, one noted a lack of fish due to the weather, one noted a lack of time to fish due to rising costs of living, and another noted a lack of sufficient access without providing further explanation.

Satisfaction by motivation class

Combined Snowy Lakes.

Catch related reasons to go fishing						
	Number of respondents					
Reason	Very important	Quite important	Neutral	Not very important	Not at all important	Unsure
Availability of target species/being able to catch something	51	22	0	4	2	0
Catching large numbers of fish	8	18	0	45	7	0
Catching trophy or high quality fish	19	38	0	17	5	0
Keeping and consuming fish	16	21	0	24	18	0

Non-catch related reasons to go fishing						
	Number of respondents					
Reason	Very important	Quite important	Neutral	Not very important	Not at all important	Unsure
Mastery - Relates to the desire to build skills and knowledge, compete, experience a challenge and/or achieve personal milestones.	29	30	0	16	4	0
Escapism - Relates to the desire to be outside, relax, get away from life's demands.	65	14	0	0	0	0
Socialising - Relates to the desire to be with family and friends, sharing in recreation and fun	42	15	0	15	7	0

Non-catch related reasons to go fishing: If rated as important to some degree, what is your level of satisfaction on this trip?					
	Number of respondents				
Reason	Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
Mastery - Relates to the desire to build skills and knowledge, compete, experience a challenge and/or achieve personal milestones.	19	33	25	2	0
Escapism - Relates to the desire to be outside, relax, get away from life's demands.	47	28	4	0	0
Socialising - Relates to the desire to be with family and friends, sharing in recreation and fun	27	30	22	0	0

Lake Eucumbene

Catch related reasons to go fishing						
	Number of respondents					
Reason	Very important	Quite important	Neutral	Not very important	Not at all important	Unsure
Availability of target species/being able to catch something	45	16	0	3	2	0
Catching large numbers of fish	7	17	0	36	5	0
Catching trophy or high quality fish	14	36	0	12	4	0

Keeping and consuming fish	13	15	0	20	18	0

Catch related reasons to go fishing: If rated as important to some degree, what is your level of satisfaction on this trip?

Reason	Number of respondents				
	Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
Availability of target species/being able to catch something	27	22	9	6	2
Catching large numbers of fish	8	21	31	5	1
Catching trophy or high quality fish	14	20	25	6	1
Keeping and consuming fish	9	25	28	1	2

Non-catch related reasons to go fishing

Reason	Number of respondents					
	Very important	Quite important	Neutral	Not very important	Not at all important	Unsure
Mastery - Relates to the desire to build skills and knowledge, compete, experience a challenge and/or achieve personal milestones.	24	24	0	14	4	0
Escapism - Relates to the desire to be outside, relax, get away from life's demands.	55	11	0	0	0	0
Socialising - Relates to the desire to be with family and friends, sharing in recreation and fun	33	14	0	14	5	0

Non-catch related reasons to go fishing: If rated as important to some degree, what is your level of satisfaction on this trip?

Reason	Number of respondents				
	Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
Mastery - Relates to the desire to build skills and knowledge, compete, experience a challenge and/or achieve personal milestones.	18	26	20	2	0
Escapism - Relates to the desire to be outside, relax, get away from life's demands.	40	22	4	0	0

Socialising - Relates to the desire to be with family and friends, sharing in recreation and fun	24	25	17	0	0

Overall, how satisfied with your angling experience are you for this site over the last 12 months?				
Number of respondents				
Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
30	25	6	3	0
Percentage of respondents				
46.9	39.1	9.4	4.7	0.0

Lake Jindabyne

Catch related reasons to go fishing						
	Number of respondents					
Reason	Very important	Quite important	Neutral	Not very important	Not at all important	Unsure
Availability of target species/being able to catch something	6	6	0	1	0	0
Catching large numbers of fish	1	1	0	9	2	0
Catching trophy or high quality fish	5	2	0	5	1	0
Keeping and consuming fish	3	6	0	4	0	0

Catch related reasons to go fishing: If rated as important to some degree, what is your level of satisfaction on this trip?				
	Number of respondents			
Reason	Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
Availability of target species/being able to catch something	5	6	2	0	0
Catching large numbers of fish	1	4	8	0	0
Catching trophy or high quality fish	2	3	7	1	0
Keeping and consuming fish	2	7	3	1	0

Non-catch related reasons to go fishing						
	Number of respondents					
Reason	Very important	Quite important	Neutral	Not very important	Not at all important	Unsure
Mastery - Relates to the desire to build skills and knowledge, compete, experience a challenge and/or achieve personal milestones.	5	6	0	2	0	0
Escapism - Relates to the desire to be outside, relax, get away from life's demands.	10	3	0	0	0	0
Socialising - Relates to the desire to be with family and friends, sharing in recreation and fun	9	1	0	1	2	0

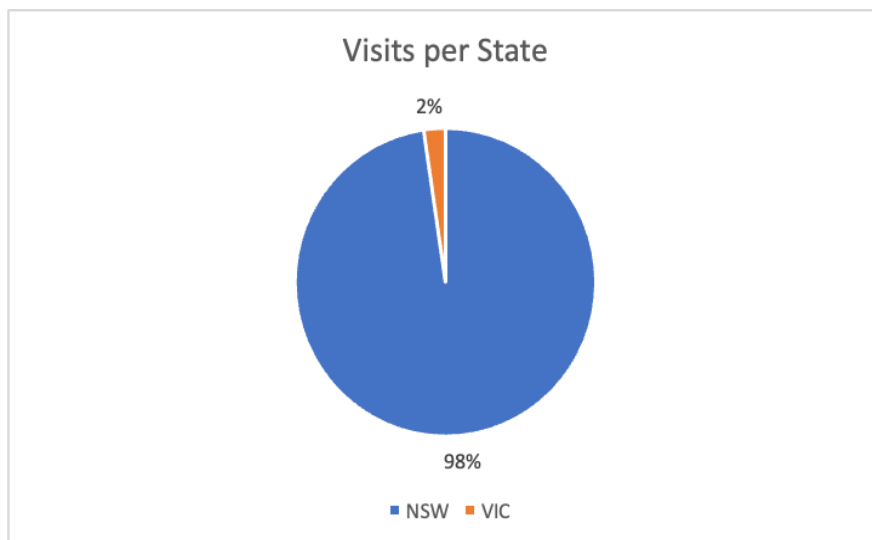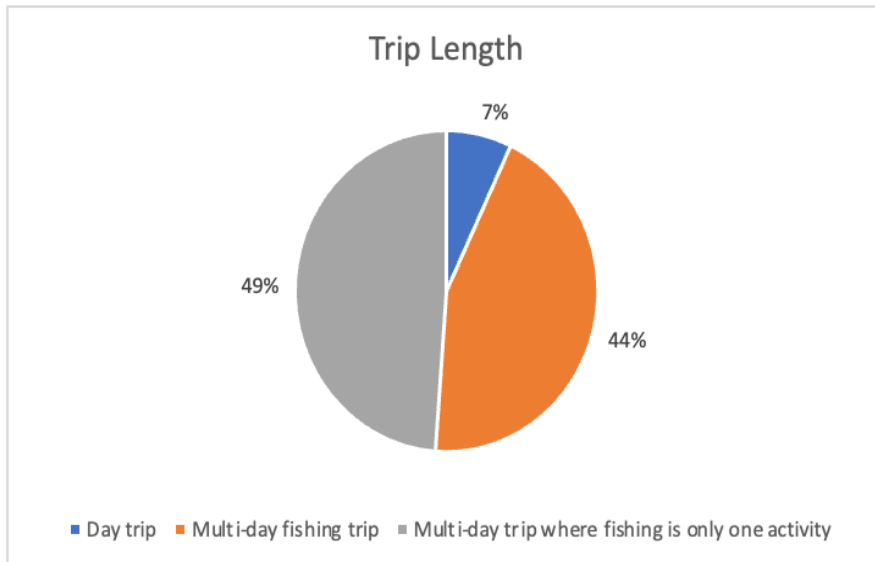| Non-catch related reasons to go fishing: If rated as important to some degree, what is your level of satisfaction on this trip?					
	Number of respondents				
Reason	Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
Mastery - Relates to the desire to build skills and knowledge, compete, experience a challenge and/or achieve personal milestones.	1	7	5	0	0
Escapism - Relates to the desire to be outside, relax, get away from life's demands.	7	6	0	0	0
Socialising - Relates to the desire to be with family and friends, sharing in recreation and fun	3	5	5	0	0

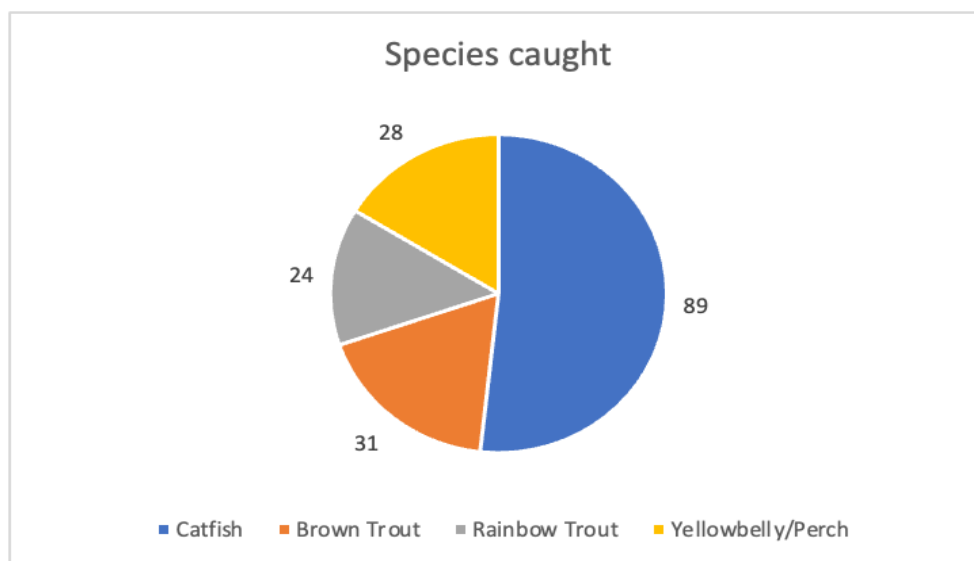| Overall, how satisfied with your angling experience are you for this site over the last 12 months?				
Number of respondents				
Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
7	6	0	0	0
Percentage of respondents				
53.8	46.2	0.0	0.0	0.0

Issues driving dis-satisfaction
There were no respondents reporting dis-satisfaction.

Windamere

Total respondents were 43 people for Lake Windamere. Respondents on average indicated they would make 3.9 trips to Lake Windamere per year.

Trip Length

7%

44%

49%

- Day trip
- Multi-day fishing trip
- Multi-day trip where fishing is only one activity

Visits per State

2%

98%

- NSW
- VIC

Catch summaries

Number of respondents	Total fish caught	Number of respondents that caught no fish	Percentage of respondents that caught no fish
43	172	27	62.8

Species name	Number of fish caught	Number of respondents that caught this species	Percentage of respondents that caught this species
Catfish	89	12	27.9
Brown Trout	31	2	4.7
Rainbow Trout	24	1	2.3
Golden Perch	28	7	16.3

Catch rates

Number of respondents*	Total hours fished	Total fish caught	Catch rate (fish/hour)
33	211	168	0.80

*Number of respondents that reported time spent fishing

Economic expenditure per trip

	AVERAGE SPEND PER TRIP			CONSUMER SURPLUS	Average Travel Cost	Average WTP
	Local	Elsewhere	Total			
Lake Windamere	$574.74	$183.74	$758.49	N/A	$213.94	

Average Expenditure: Windamere Lake
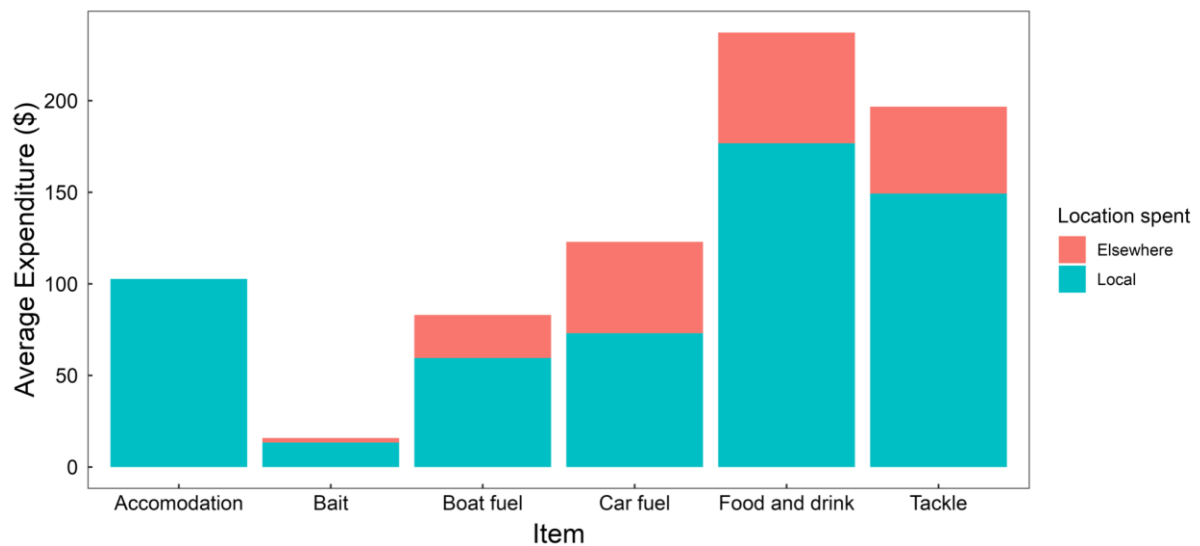
Expenditure					
Tackle		**Bait**		**Boat fuel**	
Local	Elsewhere	Local	Elsewhere	Local	Elsewhere
$149.30	$47.44	$13.40	$2.44	$59.53	$23.51
Car fuel		**Accommodation**		**Food and drink**	
Local	Elsewhere	Local	Elsewhere	Local	Elsewhere
$73.07	$49.88	$102.70	$0.00	$176.74	$60.47

Total average expenditure per trip at Windamere Lake: $758.49

Angler motivations and satisfaction

Overall satisfaction (last 12 months)

Overall, how satisfied with your angling experience are you for this site over the last 12 months?				
Number of respondents				
Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
24	9	9	0	0
Percentage of respondents				
57.1	21.4	21.4	0.0	0.0

Issues driving dis-satisfaction

There were no respondents reporting dis-satisfaction.

Catch related reasons to go fishing						
	Number of respondents					
Reason	Very	Quite	Neutral	Not very	Not at all	Unsure

	important	important		important	important	
Availability of target species/being able to catch something	25	14	0	3	1	0
Catching large numbers of fish	5	12	0	22	4	0
Catching trophy or high quality fish	14	16	0	10	3	0
Keeping and consuming fish	3	11	0	7	22	0

Catch related reasons to go fishing: If rated as important to some degree, what is your level of satisfaction on this trip?

	Number of respondents				
Reason	Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
Availability of target species/being able to catch something	20	15	7	1	0
Catching large numbers of fish	8	15	19	1	0
Catching trophy or high quality fish	13	18	11	1	0
Keeping and consuming fish	4	12	27	0	0

Non-catch related reasons to go fishing

	Number of respondents					
Reason	Very important	Quite important	Neutral	Not very important	Not at all important	Unsure
Mastery - Relates to the desire to build skills and knowledge, compete, experience a challenge and/or achieve personal milestones.	8	23	0	10	2	0
Escapism - Relates to the desire to be outside, relax, get away from life's demands.	34	7	0	1	1	0
Socialising - Relates to the desire to be with family and friends, sharing in recreation and fun	31	11	0	1	0	0

Non-catch related reasons to go fishing: If rated as important to some degree, what is your level of satisfaction on this trip?					
	Number of respondents				
Reason	Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
Mastery - Relates to the desire to build skills and knowledge, compete, experience a challenge and/or achieve personal milestones.	18	14	11	0	0
Escapism - Relates to the desire to be outside, relax, get away from life's demands.	37	5	1	0	0
Socialising - Relates to the desire to be with family and friends, sharing in recreation and fun	36	5	1	1	0

Discussion

It is important to note that many of the key contributions from monitoring data are evident once a time-series is established, so that trends in variables can be determined that may inform management efforts or investments in improved fisheries and related infrastructure. However, from his pilot we can offer insights into comparative analysis between sites, and on the value of monitoring data for ongoing management and decision-making purposes.

Comparison between sites

Here we highlight four overall findings from this initial set of pilot monitoring data, which are both of interest generally, but more specifically, display the value of comparative data across sites that covers multiple types of indicators (biological, economic, social).

1. Very wide variation in catch rates across sites, which reflect the site and fishery characteristics.
2. Variations in average expenditure per trip across sites, which reflect the site and fishery characteristics.
3. Consistency in angler motivations across sites despite variations in 1 and 2.
4. Consistently very high satisfaction levels across sites despite variations in 1 and 2.

The following table combined these different data points to display these key indicators.

Site	Catch rate (fish/hour)	Average expenditure per trip	Highly rated angler motivations (>50% of respondents)	Overall satisfaction in last 12 months (highly satisfied, satisfied combined)
Copeton Dam	0.084	$826.27	- Availability of target species - Catching trophy/high quality fish - Escapism - Socialising - Mastery	92%
Windamere Lake	0.798	$758.49	- Availability of target species - Catching trophy/high quality fish - Escapism - Socialising - Mastery	79%
Snowy Lakes combined	0.461	$502.36	- Availability of target species - Catching trophy/high quality fish - Escapism - Socialising	88%

			- Mastery	

There are considerable differences between sites in the nature of the fishery and the nature of the anglers, which are evident in catch rates and average expenditure.

In the case of Copeton, a relatively low catch rate (<0.1 fish per hour) is indicative of the relatively low numbers of larger cod that are typically caught in Copeton. The relatively high expenditure rates are reflective of relatively high percentage of multi-day trips, including both a high number of respondents who reported travelling there from interstate for specialist fishing trips (which again speaks to Copeton's reputation for larger trophy fish), as well as a relatively high number of anglers reporting trips in which angling is only one activity. This suggests a cohort of general holiday makers alongside specialists.

In the case of Windamere, a relatively high catch rate (~0.8 fish per hour) is indicative of a mixed fishery with high numbers of overall fish including trout, golden perch and redfin, rather than being a specialist trophy fishery, although Windamere does have a reputation for trophy golden perch. The relatively high average expenditure is again indicative of a higher amount of multi-days trips, including, again, a relatively high number of anglers reporting trips in which angling is only one activity. Again, this suggests a cohort of general holiday makers undertaking some angling.

In the case of Snowy Lakes, the mid-range catch rate (~0.45 fish per hour) is indicative of these lakes reputation as consistent producers of average sized rainbow and brown trout, with the opportunity for trophy/high quality fish for those anglers who are willing to invest time and effort. The relatively low average expenditure is potentially a function of a higher percentage of day trips which is also corroborated in a high percentage of visitors from ACT (47%) which is approximately a 2 hour drive from each of the Snowy Lakes sites. A relatively high number of interstate visitors from Victoria and ACT and a high number of specialist fishing trips (single day and multi-day) with lower levels of multi-day trips where angling is only one activity suggests that Eucumbene and Jindabyne are destinations for anglers particularly. This suggests less overlap between recreational activities in the Snowy Lakes compared to Windamere and Copeton, which may be explained by the wide array of high-quality camping options in the Snowy Mountains for holiday makers to choose from where non-angling recreational activities are included.

It should be noted however, that the data on the contribution angling makes to the Snowy Mountains regional economy is not reflected in these average expenditure figures. Despite a relatively low overall average expenditure compared to other sites surveyed, economic contribution of angling to the Snowy region for the year prior to 2022 as a whole is estimated to include a total fishing expenditure $86.5m, giving an associated output of $68.4m, an added value of $34.22m, household income of $23.2m and supporting 319 jobs.

This suggests that average expenditure per trip at a given site is not reflective of total economic contribution from angling, necessarily, but instead provides information that reflects underlying site characteristics, and can show trends over time in economic contribution. That is to say that an increase/decrease in average economic expenditure at a site would indicate a potential change in the total regional economic contribution. However a higher or lower average expenditure between two sites in two separate regions does not, of itself, indicate that the regional economic contribution from angling as a whole is higher or lower for these two regions.

A further point of discussion is related to consumer surplus. Across all sites the estimated consumer surplus value is $273.22 per fisher per trip, on average. This value represents the individual enjoyment value experienced by recreational fishers through engaging with recreational fishing at these sites. Where that figure goes down, one can assume that the total "marginal benefit" received by anglers from the angling experience has reduced, relative to their economic circumstances (assuming these remain constant). For the Snowy Mountains, the estimated consumer surplus was $209.64 per fisher per trip, on average, and fishers at Snowy Lakes report a higher number of trips per year. At Copeton dam, the estimated consumer surplus was $335.57 per fisher per trip, on average, with a lower number of trips per year.

It is important to note that consumer surplus estimates are not directly comparable across sites, due to differences in sample sizes and in the underlying characteristics of the sites themselves (such as species targeted). This means that, for example, we cannot conclude that where Lake A has a consumer surplus of $200, and Lake B has a consumer surplus of $300, that the level of enjoyment of an angler at lake A is less than that at Lake B. However, we can say that where Lake A has a consumer surplus of $200 in *year x*, and $100 in y*ear y*, that the overall level of enjoyment experienced by anglers has reduced at that lake. We can also say that, for example, if a generalised increase in costs occurs (such as a spike in fuel prices), that anglers at Lake A will be more likely to reduce the number of trips per year than anglers at Lake B, as the CS values are already closer to $0 – that is, the relative or marginal enjoyment of the experience is closer to the threshold at which a switch to a different activity or a different site may be likely to occur.

From this initial dataset then we can say that the results suggest that where a generalised increase in costs occur, a reduction in the number of trips per year for anglers surveyed at the Snowy Lakes is more likely than those at Copeton. Interrogation of the underlying data would assist in revealing some of the reasons why, and if this suggestion holds given variations across sites. It is also noteworthy that in this case, given the different species targeted and the fact that these locations are very distant from each other, it is not possible to make any findings as to whether there would likely be switching of effort between these specific sites under changing conditions, however it is possible to establish monitoring regimes utilising consumer surplus that could illuminate such dynamics, for example where it is considered likely that effort switching may be likely to occur between sites. This displays the potential value of utilising CS in a multi-site, longitudinal monitoring system.

With respect to segmenting CS data by angler motivation, a noteworthy finding is that the marginal consumer surplus associated with a "mastery" motivation for fishing was $119.17 per fisher per trip, on average. The marginal consumer surplus associated with a "socialising" motivation was $137.22 per fisher per trip, on average. A fisher with a mastery motivation also takes more trips per year to their chosen site. In contrast, a fisher with a socialising motivation takes less fishing trips per year to their chosen site (demonstrated by the negative coefficient on this variable). This suggests that for those with a mastery motivation, increases in costs may be more likely to reduce the number of trips per year to that location than those with a socialising motivation. Again, we are not able to say that anglers with different motivations have more or less "enjoyment" based on CS value, but with time series data, we would be able to say whether the relative or marginal level of enjoyment of each are shifting closer to a threshold at which they may switch to another activity or site.

Moving on to angler motivation findings, it is noteworthy that, despite the variations across these fisheries that do show up in catch rates and average angler expenditure per trip, angler motivations are largely consistent across sites. With respect to catch related motivations, most people regardless of where they fish appear to want to simply have the opportunity to catch something, which is an expected finding and secondarily, want to catch high quality fish (which is sometimes equated with large/trophy fish). In all sites, catching large numbers of fish, and catching fish to eat was a relatively low priority for anglers. With respect to non-catch related motivations, generally speaking anglers roughly equally valued escapism, socialising, and mastery, with a slight emphasis on escapism. With respect to satisfaction, despite differences in the nature of these fisheries there were consistently very high ratings across the sites. Overall this indicates that anglers viewed the performance of the fishery at the time of surveying, and by extension it's management, as meeting their needs and objectives. This is further reinforced by the fact that only ~2% of anglers expressed dis-satisfaction with their fishing experience over the preceding 12 months. It is noteworthy that at the time of survey there were no major system level issues that were known as impacting on these fisheries, such as recruitment failure, drought or bans on access or stocking, that may be expected to impact on fishing experiences, and which may be considered, or in reality, within the control of fisheries management. It is noteworthy however that the Snowy 2.0 Hydro proposal was at the time of surveying a significant initiative in development in the Snowy Mountains, and that this wasn't specifically highlighted by any anglers surveyed as a cause for concern. One angler reported the potential for invasive species in Snowy Lakes as a possible issue of concern.

Value of monitoring data and relevance to management

The following observations are made about the value of indicators collected for management purposes, with specific focus on social and economic data points, noting that catch and catch rates are already part of standard monitoring informing management processes. This is, in effect, our observations on the additionality of proposed data collection over and above existing monitoring.

Trip indicators

- A change in the average trips per year, average percentage of time spent fishing, average # of days per trip, will indicate to management that fishing effort (and so fishing pressure on the stocks) has changed – this may indicate a need for fisheries management interventions such as changes to stocking, bag limits, seasonal closures, or changes in angler amenities.

Economic indicators

- A change in the average spend per trip (per capita) will demonstrate a change in the economic value being generated to local economies from recreational fishing – a change does not necessarily trigger a management response but declines in the indicator may warrant further exploration as to the reason for the decline.
- A change in consumer surplus, assuming average angler costs remain constant, can indicate changes in angler effort and the overall desirability of the site. Most importantly, this can under some circumstances indicate the potential for effort substitution either into the site/angling, or away from the site/angling. It can also provide information on changes in the nature of trips taken to the site, such as a change in the number of locals visiting the site rather than visitors from outside the region. This will provide a more nuanced view of trends in effort than trip data alone. Desirability of site and effort substitution may indicate a need for fisheries management interventions such as changes to stocking, bag limits, seasonal closures, or changes in angler amenities.
- Willingness to pay combines the consumer surplus and average travel cost to the site, and so provides information additional to the consumer surplus indicator. Similar to consumer surplus, a change in willingness to pay per trip can demonstrate a change in the demand for the site as shown through changes in angler effort. If the overall desirability of the site has diminished, the willingness to pay for the site should be lower. But more nuance can be gained by looking at consumer surplus and willingness to pay together. If willingness to pay has increased from the previous year, but consumer surplus has decreased, everything else being equal this would mean that the average travel cost to the site has increased, which should indicate that more visitors to the site came from outside the region. This may be indicative of a good management outcome (e.g. reputation for good trophy fish has spread) or a potential problem (e.g. more interstate visitors potentially crowd out locals from their fishing spots).
- A change in trips per year, WTP and CS will all indicate whether previous efforts to change amenity of site (facilities etc) or intervene in stocks (stocking efforts, trophy management etc) are having an effect.
- When looking at changes in economic indicators over time, it is important to note that "real changes" are looked at, that is, adjustments for inflation have been made.
- Given the relatively modest sample sizes from each site expected for a cost-effective monitoring framework (around 50), testing of the statistical significance of changes in indicators between years may be appropriate. This will help identify whether a change in indicators is significant to the point of triggering some management response or further exploration of changes.

Social indicators

- A change in angler motivations would likely indicate a change in the objectives of anglers at a site. This may indicate a need for fisheries management planning, to account for new

objectives into a strategy or plan for a site, and this may in turn lead to new interventions to meet these objectives, such as changes to stocking, bag limits, seasonal closures, or changes in angler amenities.

- A change in angler satisfaction would indicate a change in overall fishery performance. This may indicate a need for fisheries management interventions such as changes to stocking, bag limits, seasonal closures, or changes in angler amenities.
- A change in Consumer Surplus will indicate that the overall enjoyment that an angler experiences, measured economically and in relation to other available options (other angling sites or other recreational activities), has increased or decreased. In short, a larger consumer surplus indicates that the overall "benefit" an angler receives is greater than a smaller consumer surplus at the same site. This means that consumer surplus can be considered a proxy measure for angler satisfaction that can be tracked over time with relatively easily collected economic data. Considering trends in consumer surplus against trends in angler satisfaction may provide additional insight on angler outcomes than satisfaction indicators alone, and allow further testing of the usefulness of CS as an alternative measure of angler satisfaction.

With respect management objectives and issues identified in the introductory sections, we highlight the possible value of indicators collected for informing these issues:
DPI strategic plan objectives.

- **Ecological:** Improve sustainability of freshwater recreational fishery. Catch and effort data, trip data, economic data displaying demand, and angler motivation data can all inform considerations around the sustainability of a fishery.
- **Social:** Increase participation, community support, accessibility and satisfaction in recreational freshwater fishing. Trip data, economic data displaying demand, angler motivation and angler satisfaction data can all inform considerations around participation and satisfaction in a fishery.
- **Economic:** Increase contribution of recreational fishing to economy. Expenditure per trip can indicate the contribution of recreational fishing at a site to the economy.

Specific issues noted in project workshops.
- **Stocking.** # of trips, catch rates, and angler satisfaction indicators can all provide information of value to assessing the performance of stocking regimes.
- **Promotion of successful fisheries to support new development.** Economic expenditure data can provide information on the benefits of new fisheries developments to regional economies, albeit these cannot quantify the total economic contribution as these data do not provide an estimate of total participation.
- **Changing seasonal closures.** Unclear whether monitoring data in this framework can inform this, as the proposed method is to collect data once a year, rather than throughout the year, which may indicate times when seasonal closures would have least impact on angler participation.
- **Climatic influence - especially drought.** Placing year on year monitoring data alongside climatic data would allow managers to make arguments beyond only the fisheries management sphere, such as by being able to show the impacts of wider, well-known changes in climate, such as on catch and catch rates, # of trips per year, and angler satisfaction.
- **Patterns of effort substitution.** Changes in Consumer Surplus values can indicate the likelihood of changes to fishing effort at a site in the future, should circumstances change significantly. A change in the CS values towards $0 would indicate a higher likelihood of effort substitution away from that site, or away from recreational fishing, where sites or activities with higher CS values are accessible to those anglers.
- **Access.** Economic expenditure data can demonstrate the benefits to community of freshwater recreational fisheries and help make the public interest case to Crown Lands to retain these access points rather than sell off these parcels of land.

Conclusions and recommendations

Based on this trial, we make the following conclusions.

1. Cost-effective, site specific social and economic monitoring is possible for NSW recreational fisheries, and has the potential to value add considerably to existing monitoring systems informing management.
2. Data collected has value for comparative studies (i.e. across multiple sites) and longitudinal studies (i.e. over multiple years). In particular, the establishment of a time series of data will enable trends in key variables to be displayed.
3. Economic expenditure data is capable of providing nuanced site-specific information on recreational fishing demand, which can assist in illuminating the outcomes of management interventions and investments in improved fisheries and associated infrastructure.
4. Angler motivation and satisfaction data (including that collected via direct measures or economic expenditure proxies) can provide nuanced, site specific information that helps illuminate the likely objectives of anglers at a site, and the performance of fisheries management and investments in improved fisheries, in meeting these objectives.

Based on this trial, we make the following recommendations.

1. That site specific social and economic monitoring of recreational fisheries according to the proposed framework in this report be implemented at a set of priority sites.
2. That a time series is generated (i.e. datasets over multiple years) to allow for further exploration and demonstration of the value of this data in indicating key trends in variables of interest to fisheries management and angler bodies.

Appendices

Economic methods and calculations

1.1. Travel cost method description – from McIlgorm and Nichols (2023).

Recreational fishing generates economic benefits to local communities and economies though expenditures on fishing gear and related apparel and expenditures associated with travel to fishing sites including accommodation, food, fuel and other associated expenditures. However, these expenditures do not reflect the economic benefit gained by the recreational fisher themselves through engagement with recreational fishing. Information regarding expenditures can be used to estimate the consumer surplus recreational fishers receive from going fishing and to better understand the economic value of individual sites and species in NSW.
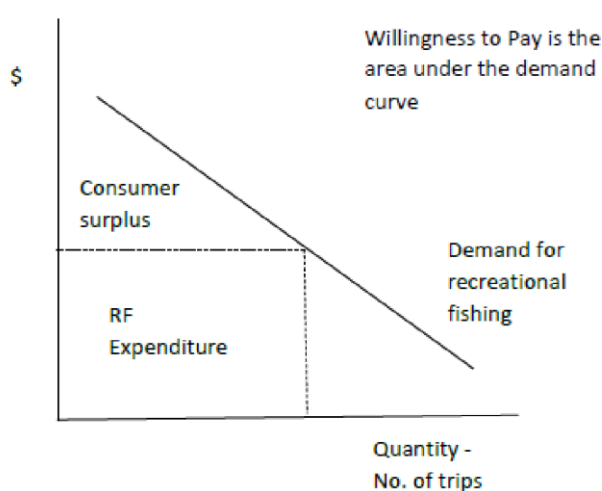
Figure 1: The demand for recreational fishing, where the area under the curve is willingness to pay, with the consumer surplus (top triangle) and the dashed rectangle which is the dollars expended.
In economics, consumer surplus is derived by a consumer when the price they are required to pay to access a good or service is less than the price they were willing to pay. Graphically, this consumer surplus can be shown by the difference between the estimated demand curve and the price paid (see Figure 1 above). In a market, the price paid is set by the interaction between supply and demand curves; in the absence of a market, consumer surplus must be estimated using non-market valuation techniques.

To find the economic value of key NSW fishing areas and species to recreational fishers, we apply a non-market valuation technique called the travel cost method, a revealed preference method commonly used when valuing recreational sites (Parsons, 2017). The travel cost method utilises information 'revealed' through the choices recreational fishers make around the fishing site chosen and species targeted and the cost of fishing related to those choices.
The standard travel cost model has demand (represented by number of trips taken) being a function of the trip cost (i.e. the price of travel) associated with a particular site. It is assumed that there is an inverse relationship between the trip cost and the demand for the fishing site, i.e. as it becomes more expensive to travel to the site, the number of trips to the site will decrease, holding everything else constant.[2]

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[2] Trip costs can include expenditures on fuel, food, car hire, opportunity cost of time and accommodation; can also include the cost of going to a substitute site (i.e. if the cost of going to a substitute site is extremely high (low), will increase (decrease) demand for the site under study). Here, we estimate a travel cost model using only the fuel cost of travel to the site, so as to avoid introducing any bias associated with the attributes of other expenditure categories.

The demand function for a specific fishing site is estimated as follows:

$$Demand_i = \alpha + \beta_{tc_i}tc_i + \beta_y y + \beta_M Motivation + \beta_z z + \varepsilon$$

where $Demand_i$ is the number of trips taken to site *i* over the previous 12 months, tc_i is the travel cost to site *i*, y is the respondent's income, $Motivation$ is the motivation the respondent identified for fishing, and z is a vector of socio-demographic variables.[3]

Once the above model is estimated, consumer surplus is estimated as:

$$Consumer\ surplus = -\frac{1}{\beta_{tc_i}}$$

The relative marginal effect of a specific attribute in the model can be estimated as:

$$Marginal\ effect = -\frac{\beta_x}{\beta_{tc_i}}$$

where β_x is the coefficient of interest. This marginal effect can be used to estimate the additional welfare associated with a recreational fishers' motivation for fishing.

Average Willingness to pay (WTP) is calculated by summing average consumer surplus for a site with the average travel cost associated with that site (Hynes et al 2022).

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[3] This demand is estimated using the Stata 17 nbreg command for negative binomial regression, after statistical tests confirmed a Poisson regression was inappropriate. A truncated negative binomial regression would be preferred (due to non-zero dependent variable), but models failed to converge.

1.2. Variable description and summary

Variable	Description
Total Trips	The total number of trips a respondent took to the fishing site (Copeton, Lake Windamere, Lake Eucumbene or Lake Jindabyne) over the preceding 12-month period. Trip duration (number of days) varies across respondents.
Travel Cost	The cost of travelling to the most recently visited fishing site, equal to the number of kilometres one way estimated by the respondent, multiplied by a standard allowance of $0.44/km (adjusted for inflation to $0.47/km)[4] based on the results of an Australia-wide survey of vehicle running costs (Australian Automobile Association, 2022), in particular the average annual costs of fuel, servicing, insurance and tyre replacements divided by the average number of km travelled by vehicles in the survey (13,800km), multiplied by 2.
Income	Midpoints of ranges presented to respondents. $0-$50,000 = $25,000 $50,000 - $100,000 = $75,000 $100,000 - $150,000 = $125,000 $150,000 - $200,000 = $175,000 >$200,000 = $225,000
Gender dummy	Equal to 1 if the respondent identifies as male, 0 otherwise.
Employment dummy	Equal to 1 if the respondent was employed full-time, 0 otherwise.
Interstate dummy	Equal to 1 if the respondent was from Victoria or Queensland, 0 otherwise.
Mastery	Equal to 1 if the respondent identified "mastery" as a very important reason for going fishing, 0 otherwise.
Escapism	Equal to 1 if the respondent identified "escapism" as a very important reason for going fishing, 0 otherwise.
Social	Equal to 1 if the respondent identified "socialising" as a very important reason for going fishing, 0 otherwise.

Variable	N	Mean	SD	Min	Max
Number of trips	164	8.63	20.59	0.50	156
Travel Cost	164	$313.26	$287.50	$20.11	$1,287.30
Income	164	$114,329.30	$60,611.72	$25,000	$225,000

Outliers removed	N	Mean	SD	Min	Max
Number of trips	153	7.19	13.22	0.50	100
Travel Cost	153	$262.71	$205.13	$20.11	$954.33
Income	153	$113,235.30	$60,904.56	$25,000	$225,000

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[4] The rate of 0.44c is the same rate used in similar studies undertaken in NSW (McIlgorm and Nichols 2023). Given the slightly later timeframe for this study, we adjust this rate of 0.44c for inflation, increasing the rate by 7.8% based on the consumer price index change between December 2021 and December 2022 (ATO website https://www.ato.gov.au/Rates/Consumer-price-index/).
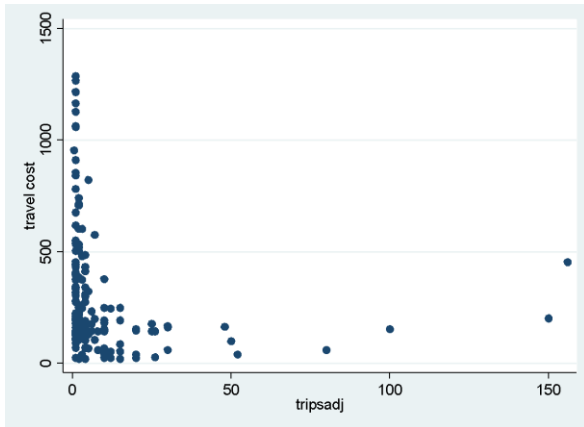
Figure 2a: Demand for recreational fishing across all sites

Figure 2a above shows the relationship between the travel cost and number of trips to a site per year. We observe a general negative relationship (the higher the travel cost, the fewer trips taken), indicating the law of demand is satisfied here and travel cost model can be used to estimate consumer surplus. There are some outliers shown (number of trips > 150, travel cost > $1,000) which may be removed from the sample as a robustness check.
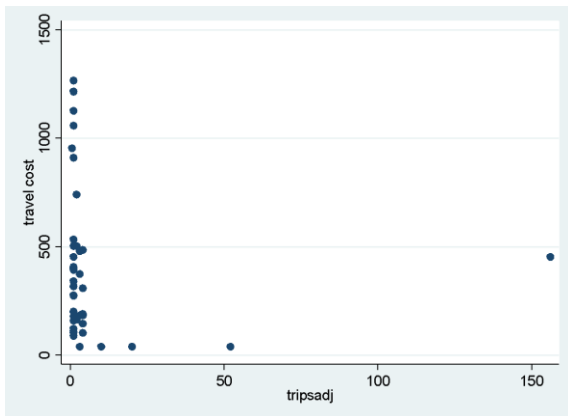
Figure 2b: Demand for Copeton
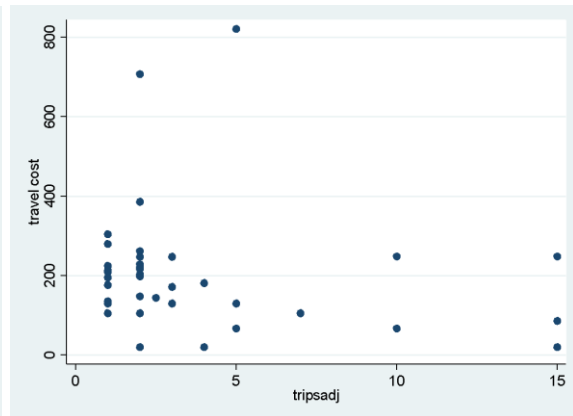
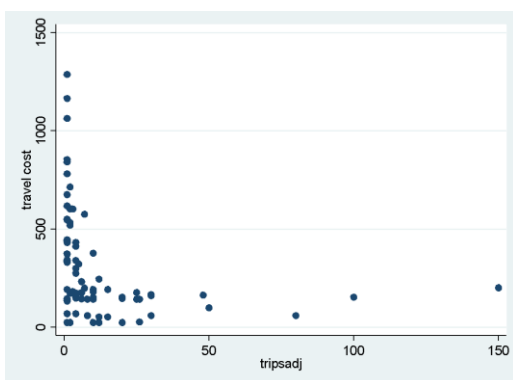**Figure 2c: Demand for Windamere**

Figure 2d: Demand for Snowies

The demand scatter plots for individual sites demonstrate that an extremely weak relationship between travel cost and number of trips exists for Windamere, indicating that a travel cost model may not yield useful estimates for that site. Copeton has many visitors who only travelled once to the site, with outliers present (number of trips > 50 and >150). This may impact consumer surplus estimates.

1.3. Consumer surplus estimates

Two groups of models were initially run; one with the entire dataset (with missing values removed) and one with outliers removed (defined as a trips per year > 140 and travel cost > $1,000). Six models for each group were run. Two models combining all sites were run: one including only travel cost, and another containing dummy variables indicating motivation for going fishing. Models were then run for Copeton, Snowies (combining Eucumbene and Jindabyne) and Lake Windamere. The travel cost models for Copeton and Windamere did not yield significant consumer surplus estimates, and so another model was run combining these two sites; this did not yield significant results either. This was not necessarily unexpected given the scatter plots above (Figures 2b-c). Table 1 contains the baseline group of estimates and Table 2 contains the estimates with outliers removed.

Table 1: Initial travel cost estimates.

Dependent variable: Total trips	All Sites	All Sites	Copeton	Snowies	Windamere	Copeton and Windamere
Intercept	0.869	1.307**	0.137	2.011**	1.939***	1.603**
	(0.576)	(0.605)	(1.134)	(0.962)	(0.715)	(0.775)
Travel Cost	-0.00260****	-0.00248****	-0.000583	-0.00438****	-0.00102	-0.000467
	(0.000409)	(0.000413)	(0.000795)	(0.000734)	(0.000999)	(0.000649)
Income	-0.00000196	-0.000000966	-0.0000141****	-0.000000556	0.00000128	-0.00000500**
	(0.00000174)	(0.00000164)	(0.00000415)	(0.00000243)	(0.00000255)	(0.00000249)
Age	0.0185**	0.0102	0.0146	0.0139	-0.0105	0.00584
	(0.00770)	(0.00728)	(0.0156)	(0.0114)	(0.0111)	(0.0107)
Gender	0.432	0.176	0.718	0.155	-0.439	-0.567
	(0.367)	(0.362)	(0.826)	(0.616)	(0.454)	(0.524)
Employment	1.026****	0.849****	2.474****	0.552*	0.383	1.345****
	(0.217)	(0.212)	(0.481)	(0.298)	(0.371)	(0.320)
Interstate visitor	0.500	0.198	-0.651	1.006***	-0.310	-0.845
	(0.308)	(0.322)	(0.690)	(0.384)	(1.132)	(0.585)
Mastery		1.023****				
		(0.221)				
Escapism		0.140				
		(0.214)				
Socialising		-0.425**				
		(0.207)				
CONSUMER SURPLUS ESTIMATE	$384.62	$403.23	N/A	$228.31	N/A	N/A
Pseudo-R2	0.055	0.081	0.127	0.081	0.019	0.051
AIC	986.801	965.333	241.015	523.121	197.953	453.505
N	164	164	46	80	38	84
Standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01, **** p<0.001						

Once outliers were removed, the consumer surplus estimate for Copeton becomes statistically significant; Lake Windamere did not have any outliers removed and so the result is the same. Consumer surplus estimates reduce across all models (as expected, since especially large travel costs have been removed). The coefficients for the motivation dummy variables also reduce. For the purpose of analysis and interpretation, the second set of models with outliers removed are likely more robust than the full sample, and so will be relied on here.

Table 2: Travel cost estimates with outliers removed.

Dependent variable: Total trips	All Sites	All Sites	Copeton	Snowies	Windamere	Copeton and Windamere
Intercept	1.047**	1.589***	1.108	1.871**	1.939***	2.085****
	(0.506)	(0.568)	(0.882)	(0.927)	(0.715)	(0.556)
Travel Cost	-0.00366****	-0.00360****	-0.00298***	-0.00477****	-0.00102	-0.00238****
	(0.000553)	(0.000549)	(0.000988)	(0.000922)	(0.000999)	(0.000654)
Income	0.000000502	0.000000265	-0.00000538	-0.000000715	0.00000128	-0.000000733
	(0.00000155)	(0.00000152)	(0.00000335)	(0.00000223)	(0.00000255)	(0.00000192)
Age	0.0171**	0.0108	-0.00111	0.0223**	-0.0105	-0.00957
	(0.00664)	(0.00681)	(0.0125)	(0.0109)	(0.0111)	(0.00815)
Gender	0.360	0.151	0.667	0.00955	-0.439	-0.277
	(0.323)	(0.325)	(0.637)	(0.608)	(0.454)	(0.377)
Employment	0.561***	0.586***	1.067**	0.435	0.383	0.660**
	(0.203)	(0.199)	(0.435)	(0.290)	(0.371)	(0.268)
Interstate visitor	0.241	0.247	0.351	0.315	-0.310	0.281
	(0.388)	(0.376)	(0.612)	(0.535)	(1.132)	(0.544)
Mastery		0.429**				
		(0.208)				
Escapism		0.142				
		(0.199)				
Socialising		-0.494***				
		(0.191)				
CONSUMER SURPLUS ESTIMATE	$273.22	$277.78	$335.57	$209.64	N/A	$420.17
Pseudo-R2	0.066	0.078	0.143	0.079	0.019	0.069
AIC	877.897	872.886	179.999	488.063	197.953	370.501
N	153	153	39	76	38	77

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01, **** p<0.001

1.4. Interpretation of results

Consumer surplus across sites

Looking at Table 2, across all sites the estimated consumer surplus value is $273.22 per fisher per trip, on average. This value represents the individual enjoyment value experienced by recreational fishers through engaging with recreational fishing at these sites. For the Snowy Mountains, the estimated consumer surplus was $209.64 per fisher per trip, on average. At Copeton dam, the estimated consumer surplus was $335.57 per fisher per trip, on average. It is important to note that consumer surplus estimates are not comparable across sites, due to differences in sample sizes and in the underlying characteristics of the sites themselves (species targeted and so on).

The marginal consumer surplus associated with a "mastery" motivation for fishing was $119.17 per fisher per trip, on average. A fisher with a mastery motivation also takes more trips per year to their chosen site. In contrast, a fisher with a socialising motivation takes less fishing trips per year to their chosen site (demonstrated by the negative coefficient on this variable). The marginal consumer surplus associated with a "socialising" motivation was $137.22 per fisher per trip, on average. Income was shown to be negative across all models, indicating that income did not have a strong relationship with the number of trips taken to a site across the year. Whether a person was from interstate also did not have any statistical significance.

A maximum willingness-to-pay for a fishing trip can be indicated by the expenditure undertaken to get to a site (travel cost) plus the estimated consumer surplus from visiting that site (Hynes et al., 2022). The average travel cost to all sites was $262.71. Coupled with the estimated consumer surplus for all sites, this gives a maximum willingness-to-pay for recreational freshwater fishing of $535.93 (on average). The average travel cost to the Snowies was $301.57. Coupled with the estimated consumer surplus for the Snowies, this gives a maximum willingness-to-pay for recreational freshwater fishing at the Snowy Mountains of $511.21 (on average).

Survey instrument

NSW Freshwater Socio-economic Monitoring pilot survey

Site

○ Copeton Dam

○ Windemere Lake

○ Lake Eucumbene

○ Lake Jindabyne

Home postcode

_____

Age

_____

Gender

○ Male

○ Female

○ Other

○ Prefer not to say

Employment status

○ Full-time

○ Part-time/casual

○ Not currently employed

○ Prefer not to say

Approximate gross household income

◯ $0-50k

◯ $50-100k

◯ $100-150k

◯ $150-200k

◯ Over $200k

◯ Prefer not to say

What type of fishing do you do here?

☐ Lure/troll

☐ Bait

☐ Fly fishing

Please enter the following catch information for each day of your current trip/the most recent trip you went on.

In each box, first specify the species, then the number of that species caught. (For example - Rainbow trout: 3 Brown trout: 2 Yellowbelly: 2 Murray cod: 4 Carp: 2).

	Species 1	Species 2	Species 3
Day 1			
Day 2			
Day 3			
Day 4			

Please add any other comments or notes on catch (if required)

_____

How many trips per year would you make to this site?

_____

What is a typical trip to this site for you?

◯ Day trip

◯ Multi day fishing trip

◯ Multi day trip where fishing is only one activity

How many days would a typical trip to this site be for you?

_____

For a typical trip to this site

○ Total number of days _____

○ % of time spent fishing _____

For your current trip/the most recent trip you went on, please fill in start and finish times for each day

	Start time	Finish time
Day 1 Session 1		
Day 1 Session 2		
Day 2 Session 1		
Day 2 Session 2		
(add further days as required)		

Please add any other comments or notes on your trip information (if required)

_____

How much do you think you spent on this fishing trip on the following?

	Amount spent locally (nearby towns)?	Amount spent elsewhere?
Fishing tackle (hooks, lines, sinkers, lures etc.)		
Bait/Berley		
Boat fuel (if applicable)		
Car fuel		
Accommodation		
Food and Drink (groceries, takeaway, pub meal etc.)		
Other: please specify		

Please add any other comments or notes on expenditure (if required)

_____

Here are a series of catch related reasons why people go fishing. Please provide ratings for how important these are for your fishing. You do not have to rate all motivations, but make sure you select at least one motivation.

	Very important	Quite important	Not very important	Not at all important	Unsure
Availability of target species/being able to catch something	○	○	○	○	○
Catching large numbers of fish	○	○	○	○	○
Catching trophy or high quality fish	○	○	○	○	○
Keeping and consuming fish	○	○	○	○	○

If rated as important to some degree, what is your level of satisfaction on this trip?

	Highly satisfied	Satisfied	Neutral	Dis-satisfied	Highly dis-satisfied
Availability of target species/being able to catch something	○	○	○	○	○
Catching large numbers of fish	○	○	○	○	○
Catching trophy or high quality fish	○	○	○	○	○
Keeping and consuming fish	○	○	○	○	○

Here are a series of non-catch related reasons why people go fishing. Please provide ratings for how important these are for your fishing.

If these categories are too general, you can provide more detailed answers in an optional section

following this question

	Very important	Quite important	Not very important	Not at all important	Unsure
Mastery - Relates to the desire to build skills and knowledge, compete, experience a challenge and/or achieve personal milestones.	○	○	○	○	○
Escapism - Relates to the desire to be outside, relax, get away from life's demands.	○	○	○	○	○
Socialising - Relates to the desire to be with family and friends, sharing in recreation and fun	○	○	○	○	○

If rated as important to some degree, what is your level of satisfaction on this trip?

	Highly satisfied	Satisfied	Neutral	Dis-satisfied	Highly dis-satisfied
Mastery	○	○	○	○	○
Escapism	○	○	○	○	○
Socialising	○	○	○	○	○

Please add any other comments about your motivations we may have missed

_____

End of Block: Angler motivations

Start of Block: Angler satisfaction

Overall, how satisfied with your angling experience are you for this site over the last 12 months?

○ Highly satisfied

○ Satisfied

○ Neutral

○ Dis-satisfied

○ Highly dis-satisfied

If you are dis-satisfied or highly dis-satisfied, please provide reasons and what you view the cause is

○ Issue 1 _____

○ Cause/reason _____

○ Issue 2 _____

○ Cause/reason _____

○ Issue 3 _____

○ Cause/reason _____

Do you intend to keep fishing here regularly in the future, or are you more likely to fish elsewhere?

○ Yes/No _____

○ Why/why not? _____

Please add any other comments or notes on issues we may have missed in this survey (if required)

_____

End of Block: Angler satisfaction

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