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Informing B-MEY targets in the harvest strategy for recreational fishers by surveying the Elephant Rock & North Bay research area reopenings

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Executive summary

Elephant Rock and North Bay were two areas closed to rock lobster and abalone fishing in 2008 for a short-term research project and scheduled to reopen to recreational fishing in 2011. This reopening was delayed for several reasons until late 2023. The stock of lobsters in these areas had increased and the opening was used to examine the behavioural response of recreational lobster fishers to higher stock abundance than what is typically observed on the rest of the east coast of Tasmania.

The objective of the study was to determine the value of rebuilt stock areas to recreational rock lobster fishers, compared to areas where stocks are more depleted. To do this, we took advantage of the newly reopened research areas with higher biomass and compared it to other areas of "normal" biomass on the east coast of Tasmania. By investigating where fishers chose to travel to fish (i.e. travelling further than they normally would to be able to fish inside these areas). We sought to put a value on these areas using economic modelling based on choice behaviour.

In this experiment we gain insight into recreational economic yield[1] using an individual Travel Cost Method (TCM) which involves surveying fishers at boat ramps on the east coast of Tasmania after the opening of Elephant Rock and North Bay. It assumes that fishers travel further if they perceive the extra travel is worthwhile in terms of a better recreational fishing experience. The individual TCM uses additional costs that recreational fishers have spent to gain access to an area with a higher catch rate (in comparison to areas with a more 'regular' fishing experience) to estimate their overall willingness to pay for fishing in these re-built areas.

In this experiment, any fisher living a distance away (i.e. outside of the immediate post code of the closest ramp access) from the reopened areas and who was setting out to fish in the weeks immediately after the re-openings was faced with a choice: do they choose to fish in one of the newly opened areas (with abundant large lobsters but constrained by a bag limit of 1 lobster per person) or do they fish somewhere closer to home (with lower lobster abundance but a bag limit of 2 lobsters per person)? This was an experimental test of what recreational fishers prefer for the future of this fishery (i.e. do they prefer higher bag limits but more depleted stocks or lower bag limits and higher catch rates)?

The survey found that the number of participants fishing in the reopened areas was lower than expected. Expected retained catch across all survey areas was higher than actual retained catch, but size expectation of lobster was generally similar for expected versus actual retained catch.

Results from the TCM highlighted the significant economic value of rock lobster potting, with an average consumer surplus of $190.13 per day (compared to an average daily travel cost of just $22.61; where the consumer surplus is the difference between the value of the average fishing day to the sample group and the average daily travel cost). Fishers would have been willing to pay an additional $55.60 per day[2] to access reopened research areas, indicating a modest preference for stock rebuilding.

[1] In this study, the phrase 'recreational economic yield' refers to the total consumer surplus received by recreational fishers for their fishing activity over a particular season. The consumer surplus is the area below the non-market demand curve for recreational fishing days and above the non-market price of recreational fishing days. This non-market price is the related to the total expenditure on a fishing day, and forms part of the basis for the travel cost method.

[2] In this context, $55.60 per day represents the difference in average consumer surplus per day for rock lobster fishing in general areas ($190.13 per day) and rock lobster fishing in one of the reopened areas,

Access to areas with higher catch rate provided no evidence of increasing participation rate, noting the increased abundance of lobsters on the east coast that has occurred over the last decade through the East Coast Stock Rebuilding Strategy. Fishers were generally happy to fish at their normal fishing spots, rather than travel to the rebuilt areas to access the better catch rates and large lobsters available there.

Given these results, a harvest strategy for rock lobsters off eastern Tasmania could appropriately continue to use target reference points developed for commercial fisher economic yield and anticipate that this would benefit recreational fishers also. Targets for commercial fishery biomass are typically around 50% of unexploited biomass, with current levels in the east coast lobster fishery around 20%. Therefore, substantial further rebuilding would be required to optimise economic yield for both sectors. Recreational fisheries often prefer even higher biomass than would be optimal for commercial fishers to provide higher catch rates and more “trophy size” fish. These higher biomass levels require lower catch limits. This research project indicated that no separate recreational target is required.

inclusive of the lower bag limit control. Noting that these numbers are figures relating to the average fishing day, and the per-day consumer surplus would be higher for some days and lower for others in the season (and will presumably be near zero for the final days of fishing undertaken by any individual over the season).

Introduction

Elephant Rock and North Bay research areas

Elephant Rock (northwest of St Helens) and North Bay (northwest of the Forestier Peninsula, Figure 1) research areas were closed to recreational and commercial fishing in 2008 as areas to research the effects of large lobsters on the range-extending long spined sea urchin, *Centrostephanus rodgersii* (Redd et al. 2014, Smith et al. 2023). Research in these two closed areas was expected to occur between 2009 and 2011, but due to delays in the reopening of these areas once the research was completed, they were closed for an extended period. In 2023, it was announced that these areas would be reopened as recreational only fishing areas, with expectations of high catch rates and large lobsters due to the recovery of the stocks in these areas (Fishing Tasmania 2023).

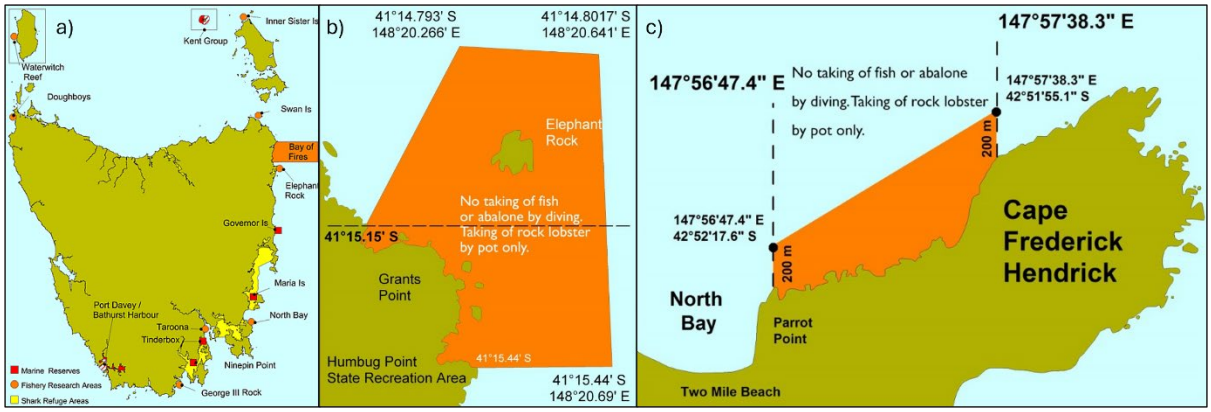

Figure 1. Map of the newly reopened research areas where a) is map of all research and refuge sites around Tasmania, b) is the Elephant Rock Research Area and c) is the North Bay research area. Figure from Fisheries Tasmania.

The reopening of Elephant Rock and North Bay provided an important opportunity to research how recreational fishers respond to improved fishing opportunities, and the value of these opportunities relative to conditions that they are otherwise accustomed to. As a result of different rules that were applied for fishing from the newly reopened areas (recreational rock lobster potting only, and daily bag limit of one lobster per licence holder), the reopening of these areas has provided an opportunity to better understand the trade-offs inherent in recreational catch management.

Recreational economic yield

Unlike commercial fishing, which has its value directly linked to the profit gained from selling fish, the recreational fishing experience cannot be bought or sold in a market. Therefore, its value cannot be measured directly from market prices. Instead, the individual fisher is both the producer and consumer of their own recreational fishing (i.e., they purchase/provide the inputs required to undertake their fishing, including their time, and 'consume' that day of recreational activity).

The value of a fishing day consequently has multiple dimensions (e.g., catch volumes, fishing location, time of year/season) referred to as attributes. Each day represents a bundle of these attributes at different levels. The fisher has a rate (implicit or otherwise) at which they trade off these attributes against each other, and which is revealed within their overall willingness to

pay for a given fishing day. If it were possible to express these rates in a market, they would translate to the relative prices for each of the dimensions of value.

The expected value of the activity to the fisher exceeds the cost of its inputs for most days of recreational fishing (with the exception mainly of the final, or at least the last few days, of fishing for the season). The difference between the total value of the recreational fishing days undertaken over a season and the total expenditure required for those days is the total consumer surplus of one or a group of recreational fishers for that season.

Economic yield in recreational fisheries is defined in this document as being measured by the total enjoyment that all participating recreational fishers gain from the experience. This is akin to the consumer surplus, which in turn is a proxy for the total utility[3] of the experience to an individual or group of recreational fishers.

A recreational fishery moves closer towards its own 'recreational' maximum economic yield through a combination of more people participating and an increase in the average utility (consumer surplus, Arrow 1951, Willig 1976) achieved by each person. Please note, the calculation of a maximum economic yield for an entire fishery, with multiple user-groups, generally involves the application of the equimarginal principle as described below.

Expenditure by recreational fishers tells us little about economic yield except that it reveals a minimum utility of all recreational fishers. A recreational fisher would not keep spending say $200 per recreational fishing trip unless they were getting a utility of at least $200 per trip. If this was not the case, then they would do something else with their time. What a fisher spends on recreational fishing per day is an expression of the value[4] that they obtain from their *final day* of fishing for the season. This value will have several components, one of which might generally be the value they have for the fishing experience, whereas another would be the value of the fish caught by them on the day.

Please note, neither information on the expenditure by recreational fishers nor on the total economic yield of recreational fishers, really helps to maximise total economic surplus from a given resource allocation. In theory, total economic surplus (value) for both commercial and recreational fishers will only have been maximised when such situations apply the equimarginal principle. This requires that catch is allocated between sectors based on the value that each sector holds for that catch. For example, this study has measured a marginal willingness to pay per kg of lobster retained by recreational fishers of $16.40 per kg. Under the equimarginal principle, this would be compared with the profitability of the same kilogram of harvest to the commercial sector (which would be expected to be somewhere around the rental yield on quota).

Total economic yield increases when more people participate in recreational fishing, since more people are gaining utility from the fishing experience (and so the total 'utility gained' increases). Therefore, more participants are generally an indication of more community utility for a recreational activity. This increase in community utility might also, in some areas, come at the cost of some inshore commercial catches; and hence the consideration of the trade-off

[3] Utility is a cardinal measure representing an individual's preference ordering over bundles of market and non-market goods (Arrow 1951). Changes in utility can be represented using compensating and equivalent variation; however, these are not directly observable measures. Willig (1976) established the use of consumer surplus as a proxy for the unobservable measures of compensating variation and equivalent variation. The demand curve estimated by the Travel Cost Method (TCM) allows for consumer surplus to be calculated. In this study, the total utility of all recreational fishers refers to the consumer surplus of the sample group, and average utility has a corresponding meaning for the sample group.

[4] Value, utility and consumer surplus are interchangeable terms in this context.

in benefits between commercial and recreational catches (described above) becomes a more material consideration at very high levels of recreational participation.

Recreational fishery management should aim to maximise sustainable recreational economic yield, but this is difficult to measure given that most economic benefit is non-financial. For this reason, methods to measure the economic yield of recreational fishers tend to rely on observations of their behaviour. The Travel Cost Method (TCM) is one common approach. It assumes that people will be less willing to invest their own time and finances in travelling longer distances unless they gain increased economic value. That is, they will be willing to travel further for more enjoyable experiences.

Surveying people about their travel to go fishing tells us whether they gain more benefit from management that provides higher catch rate (strike rate) (going to Elephant Rock or North Bay) at the expense of lower overall catch (bag limit of one). It also tells us whether managing for higher stocks, but with lower bag limits, encourages more recreational fishers to participate.

In this experiment we gain insight into recreational economic yield using an individual TCM (Shaw 1988, Englin & Shonkwiler 1995, Heberling & Templeton 2009, and for example, Ezebilo 2016) which involves surveying fishers at boat ramps along the east coast after the opening of Elephant Rock and North Bay. Our individual TCM uses the additional costs that recreational fishers are willing to spend to gain access to an area with larger or potentially easier to catch lobsters (in comparison to other areas with a more 'regular' fishing experience) to determine their willingness to pay for fishing in those areas.

The project can be used to inform policy for lobster rebuilding targets on the east coast. For example, if fishers prefer policy directed to giving access to larger catches (higher bag limits) then this means a more depleted stock and lower biomass targets. In contrast, if fishers prefer higher catch rates, then they will need to forego catch (smaller bag limits).

Objective

To test whether regulating for lower catch / higher stock increases economic yield in the Tasmanian recreational rock lobster fishery. *(Are recreational rock lobster potters willing to forego catch if it means they can have higher catch rates, a lower risk of empty pots, and the potential for larger lobsters?)*

Methods

Survey design

The survey was designed to capture the proportion of fishers who travelled to fish in the newly reopened research areas as well as the amount fishers may be willing to pay for access to these rebuilt stock areas.

Boat ramp surveys

Surveys were conducted at boat ramps along the east coast of Tasmania: Binalong Bay and Burns Bay ramps near St Helens, the Gulch ramp in Bicheno, Triabunna marina ramp, Boomer Bay ramp, and the Pirates Bay ramp (Figure 2). Surveys were conducted on the opening weekend of the East Coast Stock Rebuilding Zone (starting 2nd December 2023) and two subsequent weekends of the season.

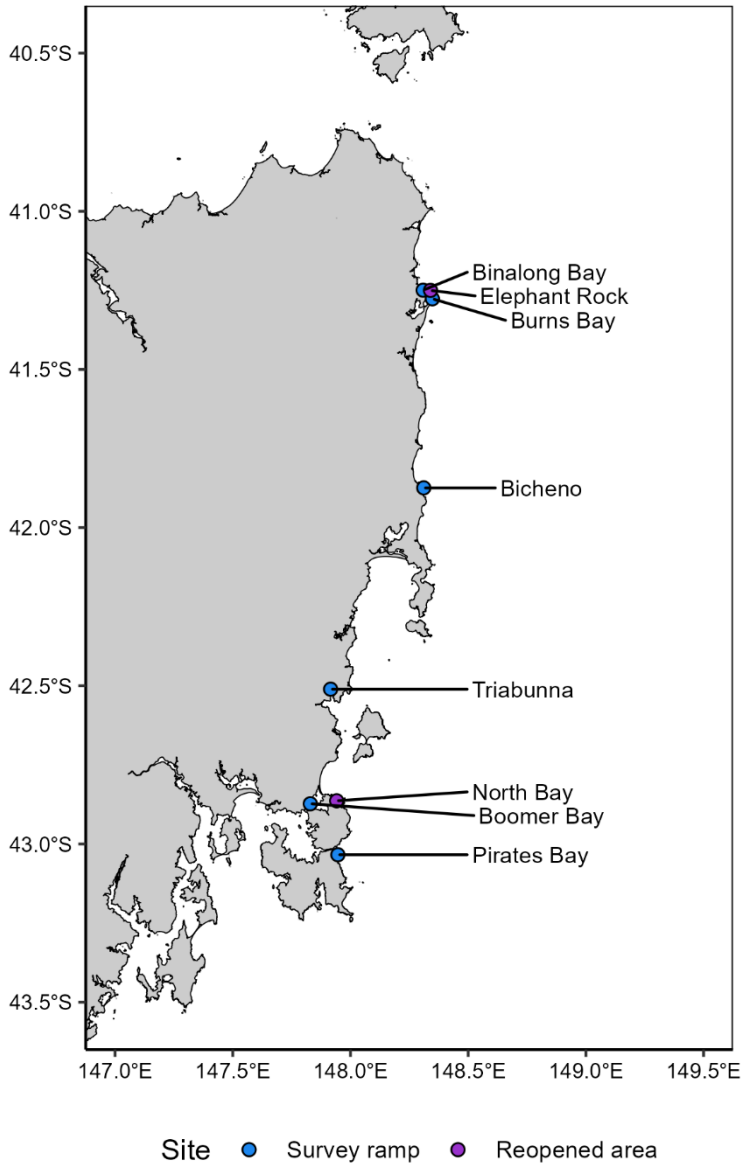

Figure 2. Map of the east coast of Tasmania marked with surveyed boat ramps in blue and newly reopened areas in purple.

These sites were selected to enable data to be collected from fishers who were fishing at the newly opened sites *plus* fishers who chose to fish somewhere else. While not specifically targeted, we were especially interested in fishers who were traveling from Greater Hobart as these fishers had many other choices of fishing locations before reaching the opened areas. Any fisher who travelled to the open areas from Greater Hobart was choosing to invest more travel time to access sites with more lobsters and larger lobsters.

At these ramps, one or two IMAS interviewers were stationed over the weekends in the early to mid-mornings and late afternoons to maximise the likelihood for interactions with rock lobster pot fishers who most often return from fishing at these times. Fishers launching boats at these ramps were approached either before they left the ramp to fish or after they returned and asked if they were rock lobster potting on that day. If they were rock lobster potting, they were provided with a survey information sheet and asked if they would be willing to participate in the study about their rock lobster fishing for that day.

Fishers who consented to be surveyed were first asked about their fishing activities that day, specifically whether they were leaving/returning from checking or setting their pots. Depending on whether they were setting their pots (i.e. if they had not yet caught anything) or checking their pots (i.e. have results of their fishing regardless of outcome) the nature of the questions changed from expectations of what they may catch and retain (retained catch) versus what they did catch and retain that day. For example, if the fisher was returning from setting their pot or leaving to set/check their pot, they were asked how many lobsters they expected to catch and retain when they next checked their pots. Alternatively, if the fisher was returning from checking their pot, they were asked how many lobsters they caught in their pot.

Secondly, it was determined if the fisher intended to, or did fish, inside one of the newly reopened areas. This question was only asked at the ramps in the vicinity of the newly reopened areas (i.e. Binalong Bay, Burns Bay, Boomer Bay and Pirates Bay) based on the assumption if people wished to fish these areas, it was highly unlikely they would travel by boat from the other ramps (Bicheno and Triabunna). If they were not intending to fish inside the research areas, they were asked where they intended to fish instead. In addition, fishers were asked the approximate time it would take/took to set their pots (time it would take/took to reach the site from the boat ramp in minutes, one way only).

The next set of questions asked about the fishers expected or actual retained catch. If the fishers had not yet checked their pots, they were asked about their confidence in successfully catching lobster on their current trip (scale of 1-10 where one was not confident and 10 was highly confident), how many lobster their entire fishing party would catch on that trip, and how big they expected the lobsters to be (scale of 1-5 with 1 being just legal and 5 being ‘huge’ or approximately 2kg). If fishers were returning from checking their pots, they were asked how many lobsters their fishing party caught and kept on their trip, how big the lobsters they caught were (scale of 1-5 with 1 being just legal and 5 being ‘huge’ or approximately 2kg) and how satisfied with their fishing trip they were (scale of 1-5 with 1 being not satisfied and 5 being more than satisfied).

Fishers were then asked if they expected to return to the area to fish again in the next 12 months to pot for lobsters, and if they had conducted any other fishing on the current trip (e.g. line fishing).

Once they were questioned about their fishing activities, travel distance and cost questions were asked to determine how far they had travelled to get to their fishing location. They were asked their town and postcode of residence, if they would have travelled to this location if they were not fishing, did they purchase accommodation for this trip and were they travelling with any other adult fishers.

Finally, demographic information was collected including gender, age group and employment status.

Only one member of each fishing party was interviewed, with combined catch and size estimations for the party divided by the total number of fishing adults in the party.

Data analysis

The data was analysed for participation by boat ramp and date, number of fishers accessing the newly reopened areas, expectation of retained catch versus actual retained catch and expectation of lobster size versus actual size.

The individual TCM was then fitted based on survey responses collected from on-site sampling to describe the sample demand curve for respondents during the time of the survey (the opening weekend, and three subsequent weekends, from the beginning of the season). The individual TCM combines information collected from on-site sampling at boat ramps to estimate a downwards sloping demand function for recreational rock lobster potting which accounts for how factors such as fishing area also impact on value.

Samples (interviews) were taken from boat ramps in a wide geographic area on Tasmania's east coast (a popular recreational fishing region), and which included ramps both adjacent to, and non-adjacent to, a couple of recently re-opened research areas (Elephant Rock and North Bay).

This allowed for estimates of economic value (willingness to pay) to be calculated for observed or expected catch-weight (kgs) of lobsters, days of fishing (the general fishing experience outside of the research areas), and days of fishing when they occur in the re-built research areas (which included a more restrictive bag-limit than other areas of the fishery).

Results

Survey results

A total of 531 surveys were conducted at all sites across the three weekends surveyed. Most surveys were conducted in the St Helens area (Binalong Bay and Burns Bay ramps), compared to the rest of the east coast (Figure 3a).

The opening weekend (2nd and 3rd December 2023) was the busiest day at most ramps (Binalong Bay, Bicheno, Boomer Bay and Pirates Bay, Figure 3b).

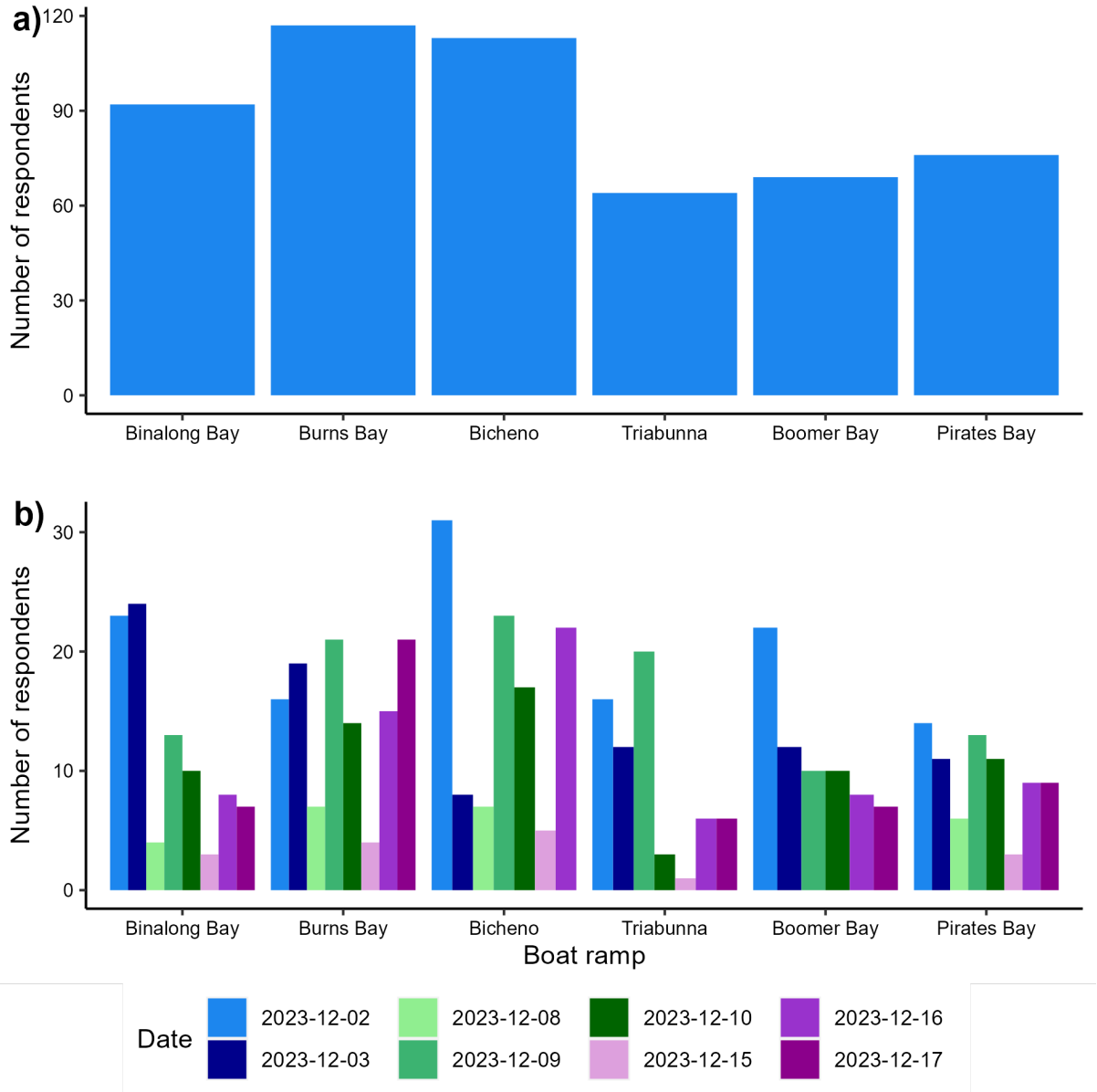

Figure 3. Number of survey respondents a) per ramp in total over the three weekends of sampling and b) per day surveyed, where blue colours indicate the first weekend of sampling, green the second weekend and purple the third weekend of sampling.

Participants who intended to fish in, or did fish in, the newly reopened areas left only from the ramps closest to these areas (Figure 4). This was Binalong Bay and Burns Bay ramps for access to the Elephant Rock area, and Boomer Bay ramp for the North Bay area. Some fishers fished both inside and outside of the areas, indicating a hedging of bets for catch in these areas and indicated by the Y/N answer in Figure 4.

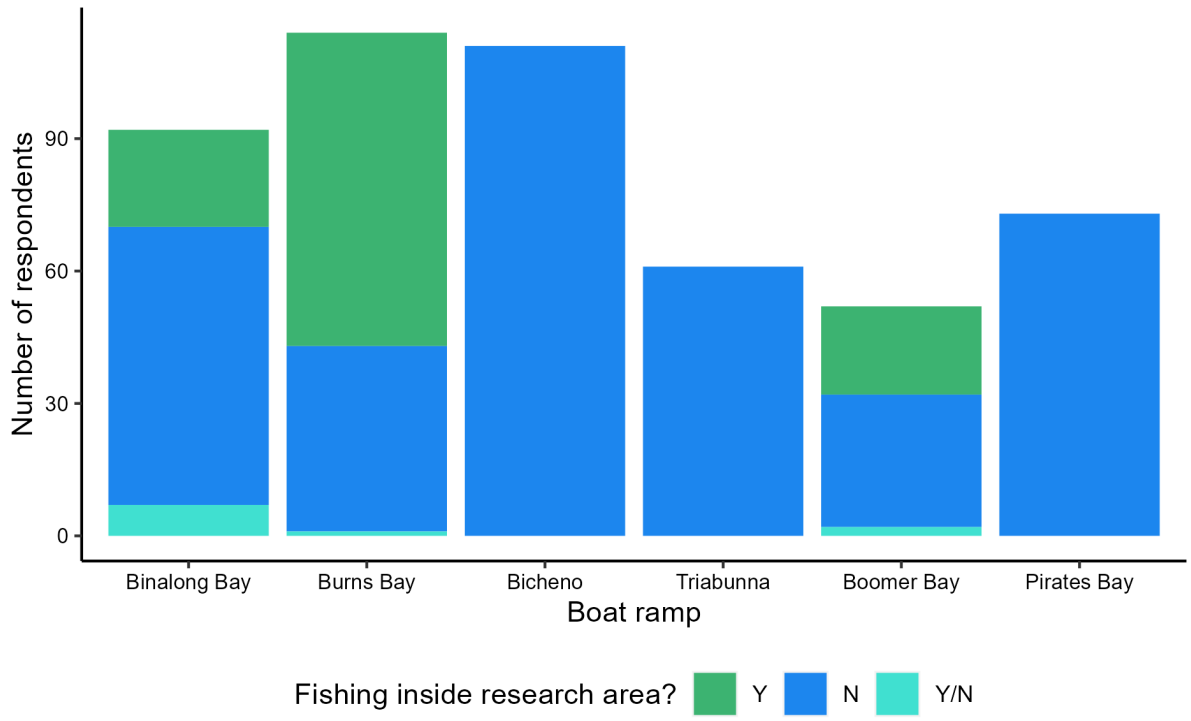

Figure 4. Number of participants fishing inside (Y) and outside (N), and both inside and out (Y/N) of the newly reopened areas across all ramps.

Expected retained catch was on average higher than the actual retained catches experienced by participants, with this pattern apparent across all boat ramps (Figure 5). The largest discrepancy between expected and actual retained catch was at Triabunna boat ramp, and the smallest at Burns Bay.

This was important to measure because fishers choose to travel to a location to fish based on their expectations of catch rate, not on their actual catch rate.

Fishers leaving from the Burns Bay ramp had the second lowest expected retained catch rate of any of the sites. This site was the most important ramp in our survey for fishers accessing the reopened areas with the highest proportion of people fishing inside the Elephant Rock research area from this ramp. The lower expected retained catch appeared to be caused by fishers understanding that their bag limit would be limited to one lobster per person. Fishers at other sites appeared to anticipate that they'd catch and retain two lobsters per person, but their actual catch underperformed their expectations. Burns Bay (near Elephant Rock) was the site where the actual catch experience most closely matched the fishers' expectations.

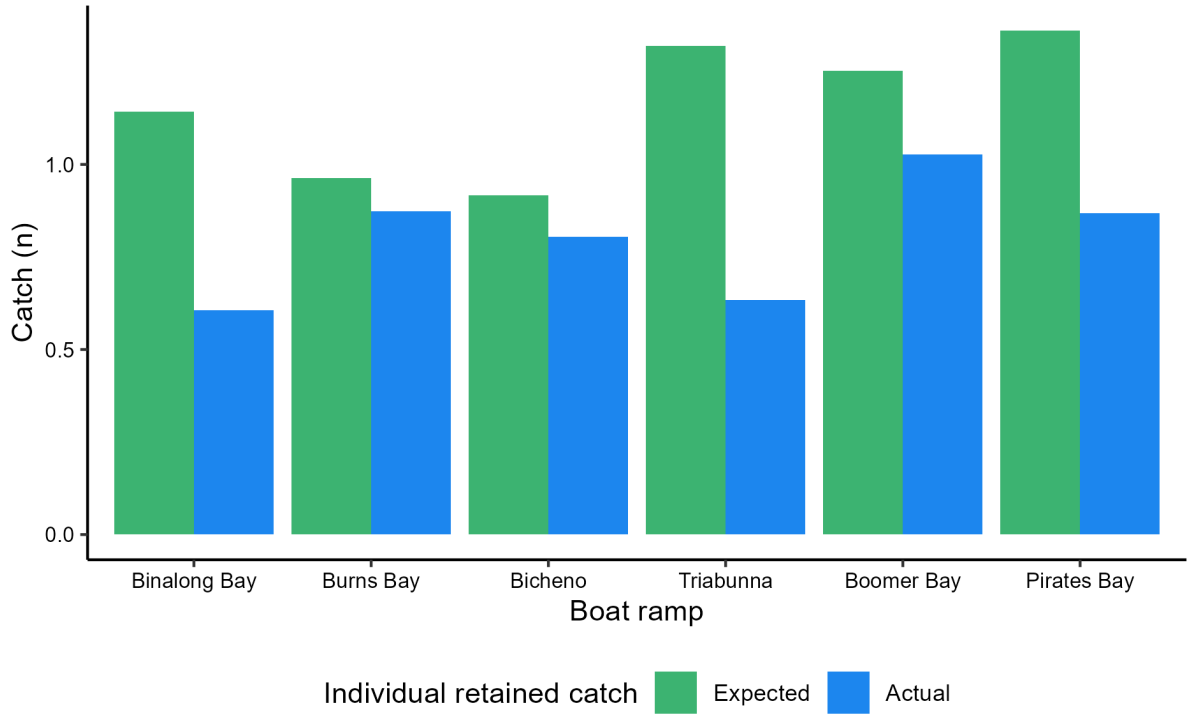

Figure 5. Comparisons of expected and actual retained catch of lobsters across all ramps and locations fished. Note catch here is individual retained catch estimates (calculated by dividing the party retained catch value by the number of people in the fishing party).

Looking into more detail of expected and actual catch to see if this was driven by participants fishing inside the newly reopened research areas, we found that at Burns Bay and Boomer Bay boat ramps, the expected catch inside the research areas was similar to the actual retained catch with a slight disparity between expected and actual retained catch for Binalong Bay ramp (Figure 6a). For participants fishing outside of the research areas, expected retained catch was overall higher across all ramps compared to actual retained catch (Figure 6b). The only ramps where actual retained catch was higher than expected retained catch was from Burns Bay and Boomer Bay ramps, though this was marginal.

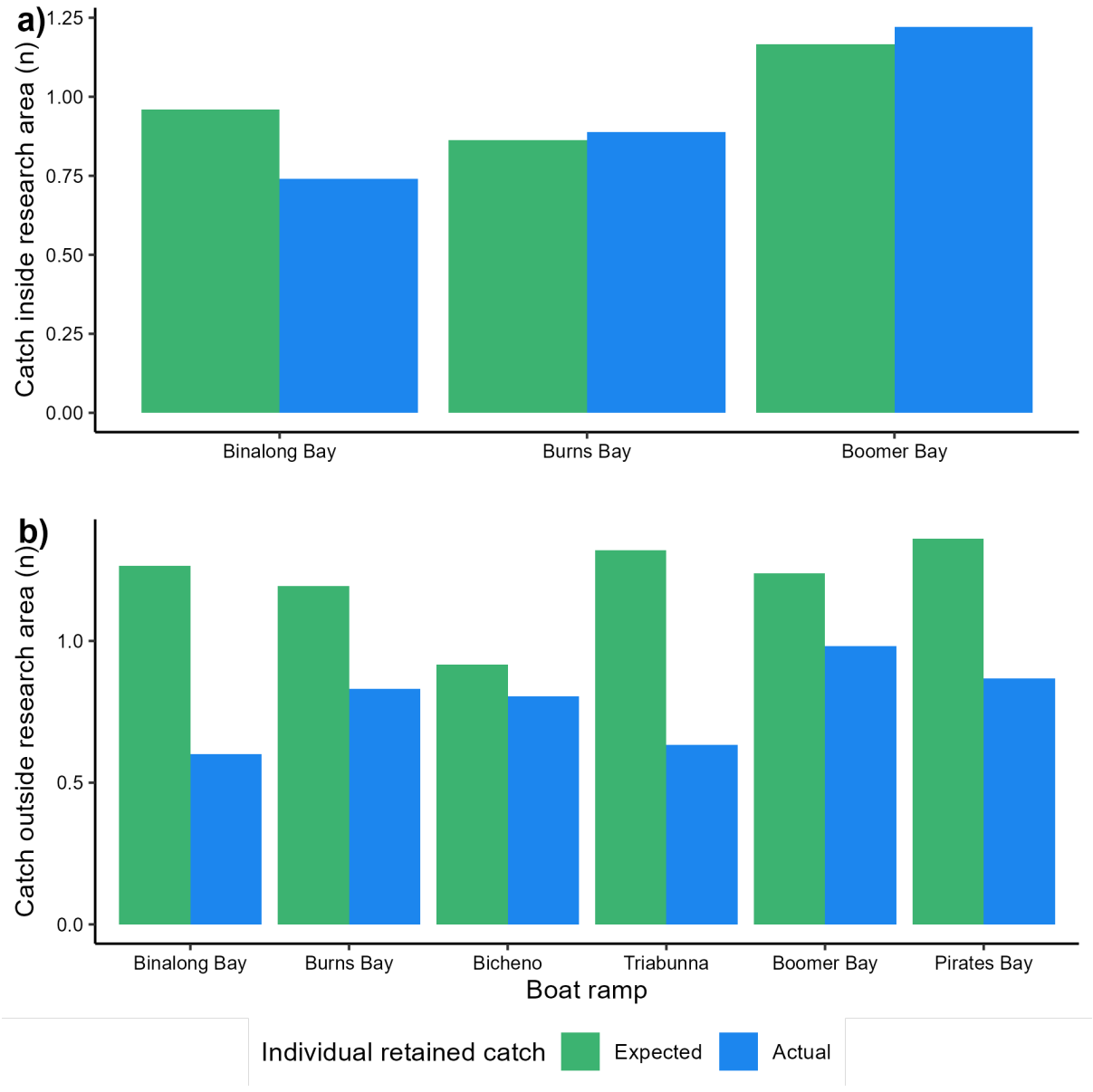

Figure 6. Comparisons of expected and actual retained catch of lobsters a) inside the newly reopened research areas and b) outside the research areas. Note catch here is individual retained catch estimates (calculated by dividing the party retained catch value by the number of people in the fishing party).

Actual size of lobsters caught was higher in most cases that expected lobster size, with only Triabunna having a slightly larger expected lobster size than reality (Figure 7). Note this was based on a scale of 1-5 with 1 being just legal and 5 being ‘huge’ or approximately 2 kg, not actual measured lengths or weights.

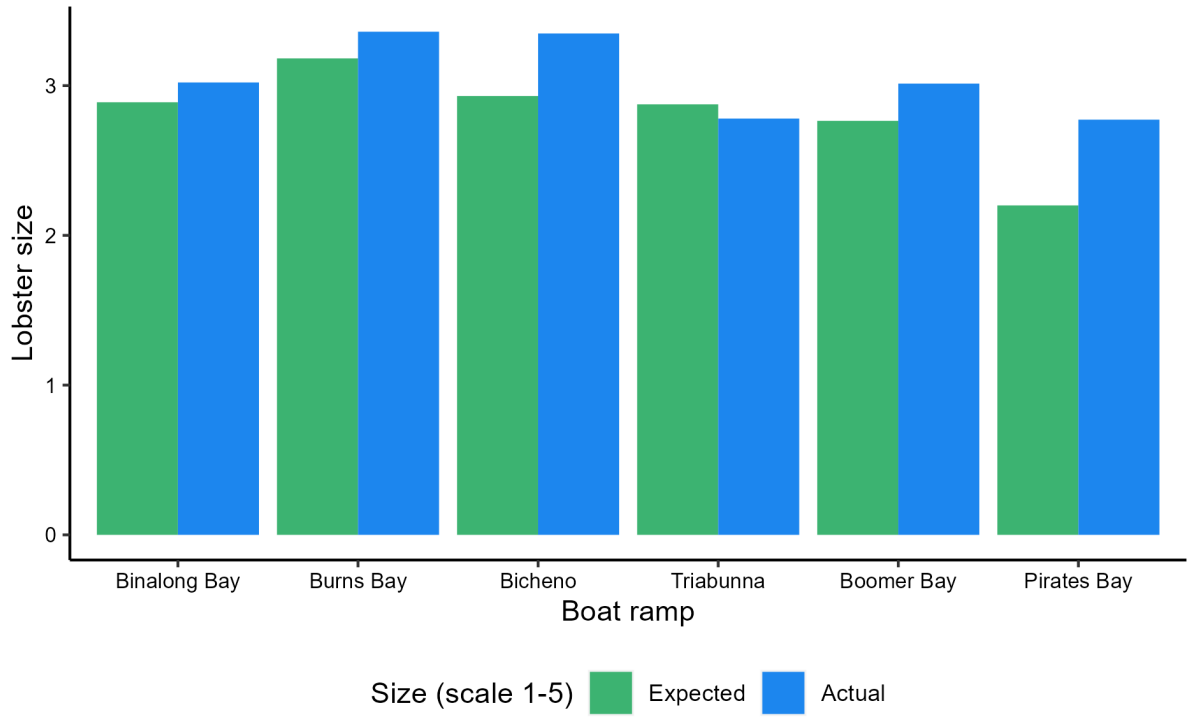

Figure 7. Comparisons of expected and actual size of lobsters caught across all ramps and locations fished. The scale of size was 1-5, with one being just legal sized and five being a large lobster of approximately 2 kg.

Again, to determine if there were any differences in expectations and reality for those fishing inside the newly reopened areas compared to outside, we looked further at these two groups. Expected and actual size was very similar for those fishing or expecting to fish in the Elephant Rock area from Binalong and Burns Bay ramps, with fishers experiencing slightly larger expectations than reality when fishing in the North Bay area from Boomer Bay ramp (Figure 8a). As above, only those fishing from Triabunna has smaller sized lobsters than expected for those fishing exclusively outside of the newly reopened areas (Figure 8b).

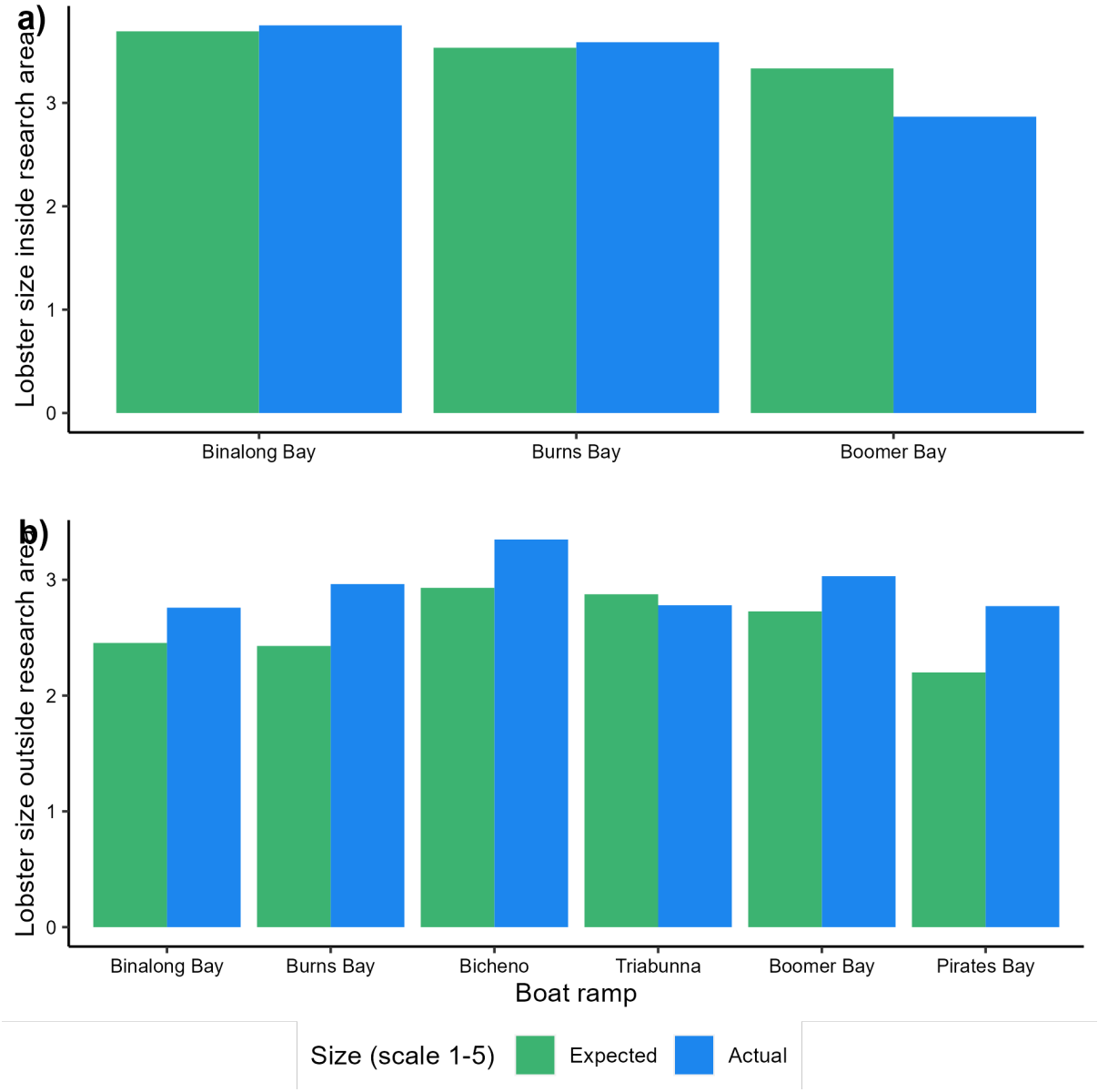

Figure 8. Comparisons of expected and actual size of lobsters caught a) inside the newly reopened research areas and b) outside the research areas. The scale of size was 1-5, with one being just legal sized and five being a large lobster of approximately 2 kg.

Travel cost model

Results for a count-data model fitted to individual travel cost information collected from recreational rock lobster fishers at boat ramp surveys on Tasmania's east coast at the beginning of the 2023/24 season (*n=487*) is shown in Table 1. These results show a demand function pertaining to the survey group. The results are based on testing down (*α=20%*) from an initial model comprised of independent demand functions for returning and leaving fishers. The dependent variable *Ln(q)* (semi-log demand) represents the natural logarithm of the number of days rock lobster potting done by each respondent over the previous 12 months (*q*), and which is used as a proxy for recreational demand over the coming year for each respondent.

Note: Estimation was via numeric maximisation of the Log Likelihood function, and the significance tests as well as the Likelihood Ratio (LR) test reported in Table 1 are asymptotic results. The significance tests in Table 1 are based on the Cramer-Rao Lower Bound and are derived from the Hessian matrix evaluated at the identified maxima of the Likelihood function. These estimating methods are standard. The reliance on asymptotic properties can result in unreliable significance tests in small sample sizes (fewer than 30 participants). Numeric maximisation may also converge to local rather than global maxima.

Table 1. Individual travel cost model results for the survey group (negative binomial).

Variable	**T.C. Model coeff. (std. err)**
Constant	2.734 (0.074)***
Travel_cost	-0.005 (0.001)***
Catch	0.082 (0.044)*
Research_area	0.279 (0.105)***
Alpha	0.912 (0.059)***
Consumer Surplus^	$190.13
LogL	-1852.83
Chi-sq. stat.	29.68***
Num. obs.	487

*** Sig. at 1%; ** sig. at 5%; * sig. at 10%
^ Consumer surplus is shown per individual per fishing day.

The model constant (*2.734*) in the first row of Table 1 determines the horizontal intercept (quantity intercept) of the demand curve for given values of the other non-price components of demand (Table 1). Since the model constant is significant in our results (*α=1%*), in theory this might suggest that the experience of lobster potting, regardless of whether fishers anticipate catching any lobsters, carries some value for the survey respondents. However, none of the fishers interviewed headed out fishing anticipating that they would catch nothing, and hence this interpretation of the intercept would involve substantial extrapolation outside the range of actual data. It is fair to assume that fishers enjoy being on the water but would not go lobster fishing if they really believed they had no chance of catching lobsters. The constant term in our model therefore more likely captures the effect of 'other' covariates not investigated as they either did not vary, or varied very little, over the period of the study.

The variable *Travel_cost* measures the trip costs calculated from respondents' roundtrip travel distance and accommodation expenses indicated at the time of the interview. The coefficient of *Travel_cost* vis negative (*-0.005*), and significant at *α=1%*, consistent with the expected relationship between quantity demanded and price for a downwards sloping demand curve that relates to a normal economic good.

Respondents intending to fish, or having fished, in a re-opened research area is captured by an indicator variable *Research_area*, which is set (=1) for those respondents fishing in a re-opened research area at the time of interview. The coefficient of *Research_area* (*0.279*) is positive (at *α=1%*), indicating that fishing in the reopened North Bay and Elephant Rock research areas added value (on average) for respondents during the period of this survey.

As expected, *Catch* is positively related to demand (coefficient of *0.082* at *α=10%*). For returning fishers, *Catch* represents the average weight (kg) of lobster caught (retained) by members of the fishing party. For leaving fishers, *Catch* is an anticipated value of the same measure.

The dispersion parameter *Alpha* of the negative binomial distribution is shown in row five of Table 1. This parameter represents a difference between first and second moments of the probability distribution and distinguishes the negative binomial from the Poisson model (e.g., Meisner et al. 2008). The heterogeneity parameter is statistically significant (*α=1%*) in our model, indicating that the negative binomial is a preferable model for this data.

The average consumer surplus per day of recreational rock lobster potting for the survey group ($190.13) is shown in row six of Table 1. Consumer surplus is the value received by the average respondent over and above their travel costs actually paid for an average day's potting. The consumer surplus in Table 1 represents over eight (8) times the cost actually paid by the average respondent ($22.61) for this day during the survey period. This indicates a substantial recreational economic yield generated from rock lobster potting access and activities for participants in our study[5].

Row seven of Table 1 shows the maximised value of the Log Likelihood function, and row eight shows the results of an LR Test for the demand model shown relative to the null model consisting of just the constant term and dispersion parameter (*Alpha*). The test statistic (*Chi-sq. stat.*) for this test is reproduced in row eight and this is significant at the *α=1%* level, indicating that the null model can be rejected with high confidence.

From the semi-log demand function estimated in Table 1, Figure 9 shows the fitted demand curves for respondents potting outside (solid black) and inside (dashed black) the reopened rock lobster research areas (North Bay and Elephant Rock, respectively). The curves are shown for an estimated average catch weight[6] of 1.14kg per individual per day in the survey dataset. The demand curve for fishing within a reopened research area lies above that for the

[5] As noted earlier, there are some days which have a higher value and other days which have a lower value. The last days of the season have approximately a similar value to the travel cost (since there is a typical number of days that fishers spend fishing each season). That is to say, the demand curve is downward sloping, and the cost curve is relatively horizontal. Therefore, the additional consumer surplus from one more fishing day decline as the number of days fished for the season increases. The average day occurs somewhere towards the middle of the demand curve, and when multiplied by the total fishing days for the season, it gives an estimate of what has termed in the report the 'total recreational economic yield'. This represents the total consumer surplus for recreational fishers for the season, which is an established proxy for their total utility.

[6] Estimate of average catch based on the conversion of respondent estimates of size ranking to match a scale where a minimum size of 771g (based on minimum sizes north of Cape Pillar) and a maximum size of 2000g applies.

remaining east coast areas. This reflects the value survey respondents placed on the conditions associated with the reopened research areas over the sample period.

Figure 9 implies that on average, fishers with a higher travel cost will demand (require) fewer days of fishing per year. Having access to a stock with higher lobster abundance increases demand for lobster fishing somewhat, but the scale of this effect is modest.

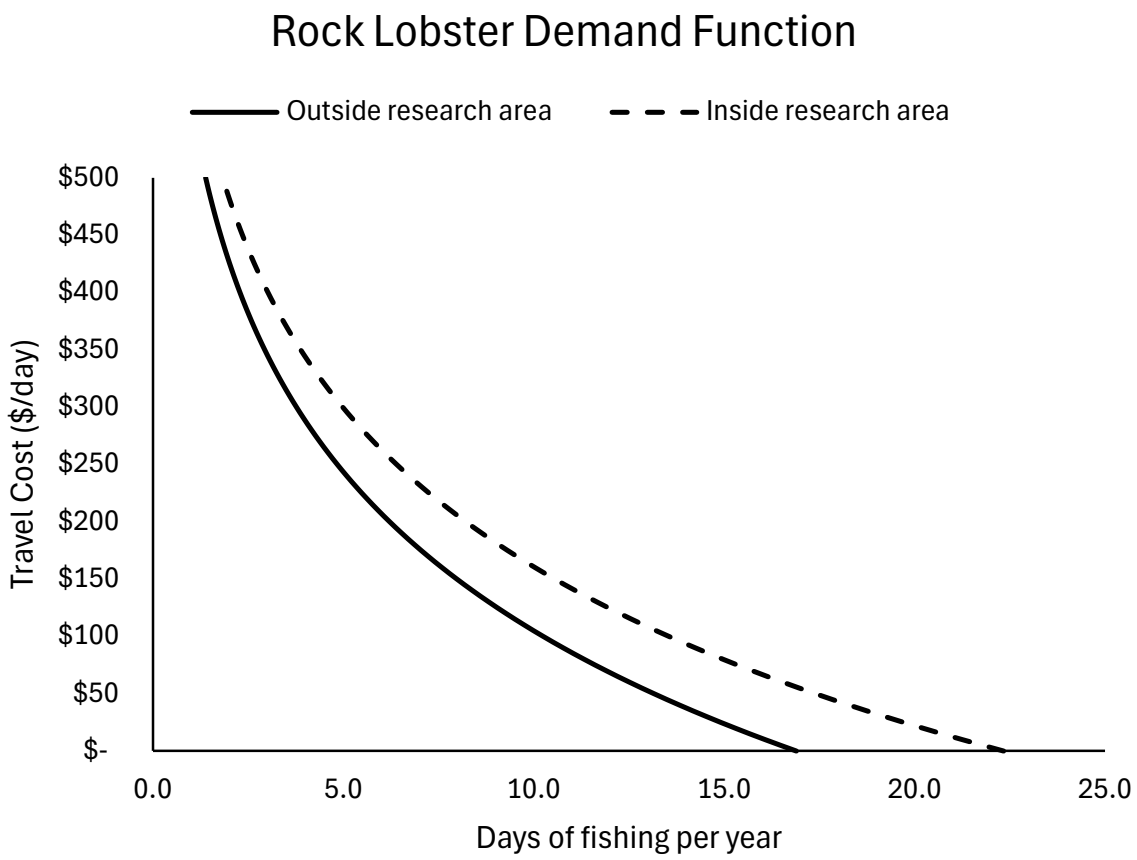

Figure 9. Fitted semi-log demand curves for respondents potting outside (solid black) and inside (dashed black) a reopened rock lobster research area (North Bay, Elephant Rock) over the sample period.

Based on the results in Table 1, Table 2 shows the marginal willingness to pay of an average respondent for (i) additional quantities of catch (kg) whether caught within or outside a reopened research area; and (ii) the fishing conditions within a reopened research area as they applied over the study period (fishing a 10 year rebuilt stock, with a lower bag limit). The results show that additional quantities of catch are worth, on average, $16.40 per kg[7] per fisher per day, and that the combination of traits associated with fishing in the reopened research areas (tighter catch controls, easier catching and bigger individual fish) together increased economic benefit by around $55.80 per fisher per day.

[7] Please note, this does not mean that fishers paid an average of $16.40 more to travel further to those areas of higher catch. It means that, regardless of the fishing area, an additional one kilogram of catch was worth approximately $16.40 to the average respondent of this survey. This value is based on the number of similar days the respondent would demand in a season, using their previous season's fishing days as a proxy.

Table 2. Marginal willingness to pay of an average respondent for (i) additional quantities of catch (kg) whether caught within or outside a reopened research area; and (ii) the fishing conditions within a reopened research area as they applied over the study period (10-yrs rebuilt stock, with a lower bag limits).

	Willingness To Pay	Units
Fishing over a 10-year rebuilt stock, with a lower bag limit	$55.80	$ per day
Additional quantities of catch (regardless of fishing location)	$16.40	$ per kg

Discussion

Elephant Rock and North Bay were reopened for recreational rock lobster potting in December 2023, expecting high catch rates and large lobsters. The study found fishers are willing to pay an extra $55.60 per day to access these areas, showing a modest preference for stock rebuilding. However, most fishers preferred their nearest spots, as boat ramp activity levels stayed the same.

Travel cost model

The TCM analysed data from 487 recreational rock lobster fishers surveyed on Tasmania's east coast at the start of the 2023/24 season. Using a semi-log demand function (*Ln(q)*), the model estimated recreational demand based on the number of potting days over the past year. Results highlighted the significant economic value of rock lobster potting, with an average consumer surplus of $190.13 per day. In addition, an average daily travel cost of $22.61 was measured for the survey respondents. Fishers would have been willing to pay an additional $55.60 per day to access reopened research areas, indicating a modest preference for stock rebuilding (i.e., the consumer surplus for an average day of recreational fishing if inside a research area might have been ~$246.73, whereas it was estimated at $190.13 per day outside a recreational fishing area). Additionally, each extra kilogram of daily catch increases the daily benefit of rock lobster potting by $16.40 per fisher. These findings reveal the economic value of the activity and illustrate how travel costs, catch rates, and stock rebuilding (in reopened research areas) influences fishing demand.

Previous IMAS work undertaken for the 2008/09 fishing season in Tasmania (Yamazaki et al. 2013) measured the value of a day's recreational rock lobster fishing using the contingent valuation method. The study found that the mean willingness to pay for the respondents' final day of recreational rock lobster fishing for the 2008/09 season was $87.43 (most likely value). This compared with the average expenditure reported by respondents on items for that day's fishing, which was $80.76. This consistency suggests that recreational fishers stop fishing for the season once their willingness to pay is approximately equivalent to the daily costs of fishing (a behaviour noted earlier in this report).

This explains why the willingness to pay and consumer surplus estimated for the average day over the season are not comparable to those same measures estimated for the final day of fishing for the season. It also highlights why the equimarginal principle (which relates only to the value from additional units of catch) is the only economically valid mechanism for comparing the recreational use value for fisheries with any other use value of that resource.

However, since there was no variation in bag limit controls for the 2013 study, a day of recreational fishing (at current strike rates) had a steady value in catch for the respondents and no measure of catch value ($ per kg) was able to be determined by the 2013 study.

The difference in the average cost of a day's recreational fishing between our study and the previous IMAS 2013 study ($22.61 versus $80.76) is a significant point of difference and is likely due to the self-reported nature of daily fishing costs in the 2013 study. Rather than being based on observed behaviour, these costs were stated verbally by respondents. The coefficient values therefore have the greatest validity in terms of comparisons between these two studies (i.e., the marginal willingness to pay for fishing in a rebuilt area, and the marginal willingness to pay for additional quantities of catch regardless of fishing location). However, the number of rock lobsters caught, whether kept or released, was not statistically significant in the 2013 model; and similarly, the effect of fishing in newly opened rebuilt areas was not able to be measured in 2013.

The mean willingness to pay reported in the 2013 study was higher among respondents with higher incomes, those who believed the quality of the fishing experience was better, and those who spent more money on their last day's fishing. These are all well-known factors that shift market demand curves in neoclassical economics (see for example Gans et al. 2017), and their directional effect on willingness to pay is consistent with theory.

Participation and access

The number of rock lobster fishers accessing in the newly reopened areas was lower than expected over the period of the survey. Based on the rarity of areas that have been closed to fishing for so long being reopened, and the expectation of access to higher catch rate areas and larger lobsters, it was expected that there would be significant pressure on these newly reopened areas when the season opened. However, most of the fishing occurring in these areas was by locals (those identifying they lived within the same postcode of the ramps surveyed), with few respondents travelling from further afar to fish in these areas. The opening of the East Coast Stock Rebuilding Zone, and these two areas, coincided with bad weather, with the opening weekend was affected by large swell along most of the east coast. This likely impacted overall participation, but it was notable nonetheless that the opportunity to fish locations with high abundance of large lobsters did not appear to be a large enough incentive for people to travel.

We also found that some participants fishing in a party exhibited some ‘hedging bets’ behaviour, with some participants indicating they would drop a pot in the newly opened areas while other members of their party would drop pots outside these areas. This may have mitigated the effect of the one lobster bag limit for those fishing inside the reopened areas by combining catch with their fishing party, others of which may have caught their bag limit of two outside the areas.

Anticipated catch rates

Expectations of retained catch were generally higher than the actual retained catch of respondents and their fishing parties. This was particularly prominent at Binalong Bay and Triabunna ramps, where expectations were almost double the actual catch of lobsters. Interestingly, the expectations versus actual catch at the two ramps near St Helens were very different, with Binalong Bay ramp respondents indicating they expected much higher catches than they caught, with Burns Bay respondents having similar expectations to actual retained catch. This may be due to approximately half of Burns Bay respondents travelling to fish in the Elephant Rock area where the bag limit was one lobster. This, combined with the expectation of high catch rates, meant that most respondents were confident they would catch their one lobster from this area, and that this was reflected in their actual catch for their activities.

The fact that the anticipation of fishers tends to err towards optimism (i.e. higher expected catch that actual) helps explain the lower-than-expected numbers of non-local fishers travelling for the opportunity of fishing in the newly opened areas. Fishers were already expecting their catch to be higher and therefore may not feel the need to travel to increase their catch further. Fishers operating out of places such as Triabunna anticipated that their catch would be higher than at the newly opened areas, despite the reality being that it was lower. They perceived that access to locations with a higher bag limit would provide better fishing opportunities and preferred this over access to locations with high lobster abundance.

Size expectations

For fishers fishing outside of the research areas, at all ramps except Triabunna, respondents caught lobster at sizes that were larger than expected. For those fishing in the Elephant Rock area, the expected and caught size of lobsters was similar. However, for those fishing in the

North Bay area, expected sizes were larger than caught lobsters, indicating higher expectations to results for those fishing North Bay.

Another interesting result was that some of the largest lobsters were perceived to be caught at Bicheno (Figure 7, average size ranking similar to Burns Bay where more than half of the participants were fishing or planning on fishing at Elephant Rock). It was expected that large lobsters would be available to fishers when the research areas reopened but that was not reflected in the expectation responses. Whether this is based on perceptions of size, it is unclear. Fishers were provided with a scale of 1-5 where 1was a just legal sized lobster and 5 was a lobster of over 2kg, to try and standardise responses between ramps however it is unclear if this was successful.

Results compared to the annual RLAB survey

While this survey was a standalone economic assessment to value rebuilt stock areas, further insights were gained from fishers about their views on the reopening of the research areas to fishing via the annual recreational rock lobster and abalone (RLAB) survey (Twiname et al. 2024). In the final interview of the survey, participants were asked about whether they were aware the areas had been reopened to fishing, if they fished in either of these areas and how often, or if they didn't, why not. The RLAB survey found that approximately half of the respondents were not aware the areas had been reopened to fishing in December 2023. From those that were aware of the areas being reopening, only 5% of respondents indicated they fished in either of these areas during the season. For those that fished, most only fished one day (42%), followed by 2-10 days (42%) and more than 10 days (16%). For those that didn't fish in either of these areas, 53% indicated they have their own fishing spots they normally go to, followed by the distance to these areas was too far to travel to (16%), they chose not to or thought the areas should have been left shut (8%), and that these areas were too busy (7%). A small proportion (<2%) indicated that the areas being open to potting only restricted them from accessing the area as recreational rock lobster divers.

These further responses explain the relatively low participation rate observed by the interviewers. Only half of the recreational rock lobster community were aware the areas were open, meaning that the potential benefit of these areas was underutilised by a large proportion of the recreational fishing community. Of those that were aware, most chose to travel to their normal fishing areas rather than travel to Elephant Rock or North Bay.

Conclusion

There was an increase in economic yield for recreational fishers from access to higher stock levels, but this was modest. Most fishers appeared choose their fishing location based on the location of their homes or shacks (i.e. most fishers using the boat ramps were generally from the surrounding postcode), rather than travelling to areas with known higher catch rate opportunity. They gained substantial utility from stocks at current levels.

Access to areas with higher catch rate provided no evidence of increasing participation rate, although the sites in this study only had higher stocks for a short period before being depleted (based on anecdotal evidence). Fishers who access the resource tend to be avid and with substantial investment as part of a coastal lifestyle, often with a holiday home on the east coast. Many of these fishers are skilled in catching lobsters and preferred to operate in locations with higher bag limits, rather than higher catch rates.

This study did not provide support for setting biomass target reference points for recreational fishers that would be substantially different to those used for commercial fishers. This project showed that recreational fishers made similar choices to commercial fishers. They valued access to areas with higher biomass but it wasn't dramatic enough to warrant different target reference points from commercial fishers. Target reference points developed for commercial fishers such as the widely used B48% (48% of the unfished biomass) therefore appear appropriate for Tasmanian recreational lobster fishers also.

Many of the survey respondents commented that they appreciated the increased abundance of lobsters on the east coast that has occurred over the last decade through the rebuilding plan. But they were now confident in catching lobsters in locations that were convenient to them, even with biomass well below levels usually targeted for optimal economic yield.

Given these results, a harvest strategy for rock lobsters off eastern Tasmania could continue to use target reference points developed for commercial fisher economic yield and anticipate that this would benefit recreational fishers also.

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