Modelling Recreational Fishing Behaviour

Report for WAMSI Mode 4.5.2

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TABLES

FIGURES

1 Summary

A model of recreational fisher behavior is developed in which fishers optimize fishing time per trip and the number of trips per year conditional on fishing opportunities, constraints on fishing and the opportunity cost of their rime. It shows that as binding constraints are implied (e.g. tighter bag limits) fishers behaving rationally will shorten trip time, shorten fishing time and will shift a portion of trip time to other non fishing activities.

A 2003 survey of individual fishers from the West Coast Demersal Survey was used as the benchmark for the unconstrained fishing case. Although bag limits were in place at this time, they were largely nonbinding on individual fishers. In 2010 bag limits were tightened substantially and recreational fishing licenses, including boat licenses were introduced along with a closed season, ending on Dec 15 2010.

A 2010 survey was undertaken in April/May to 2010 to collect data on fishing behavior post the implementation of the new regulations.

Comparison across the surveys illustrates how fisher behavior had changed. The analysis produced several findings. Trips times have reduced significantly. Total trip time, ocean time and time spent fishing for bottom fish and other species has reduced significantly. Non fishing time per trip has increased significantly. All the differences in means for these trip time variables are statistically different between the two surveys.

Consistent with the intent of the rule, catch per trip is significantly less for the prized and high risk demersal scale fish. Also consistent with this satisfaction scores for catch, species caught, time to catch fish and size are all significantly lower in the 2010 survey. However, satisfaction with the overall fishing experience and with time on the ocean is not significantly lower.

This is an important finding. Fishers have reduced trip and fish times consistent with the model; catches are lower. The lower satisfaction scores for catch variables reflects this. However, it appears that they have been able to adjust such that overall satisfaction is not significantly reduced.

Catch rate is found to be significantly connected to trips per annum in both surveys. As expected catch rate increases the number of trips rises but at a decreasing rate. If regulations that reduce effort have the effect of improving catchability and catch rates, then there is expected to be some positive trip response. The analysis indicates that the probability of going bottom fishing weekly and fortnightly as opposed to monthly increases significantly with catch rate.

2 Introduction

Western Australia has embraced EBFM as the core of its approach to fisheries management. This incorporates the notion of a 'whole of stock' approach to fisheries management. However, EBFM goes beyond IFM because it embraces a wider definition of relevant and competing uses. An important precursor to EBFM was the introduction of IFM. This was a first step in moving beyond separate management of competing sectors to formally treating each sector as competing for the same stock. In effect IFM recognized the idea of management as a zero sum game based on the assessment of the total amount of the resource that should be harvested on a sustainable basis, and the allocation of this total sustainable harvest level amongst the relevant fishing sectors (e.g.

Customary, recreational and commercial fishing). Ideally, the allocation to each sector would also be managed in the same way, thereby ensuring optimization of the social and economic benefits to the relevant community.

Under EBFM, the challenge is to implement management regimes to conserve, develop, and share the fish and aquatic resources so as to optimize the ecological, social and economic benefits for present and future generations from the sustainable use of these resources.[1]

In this paper, we explore some of the challenges in implementing IFM in the context of managing WA finfish fisheries, and in particular the West Coast demersal scale fish fishery. We also examine the role that modelling recreational fisher behaviour can play in understanding how fishers are affected by policy changes and react to them.

The West Coast demersal scale fish fisher is one of the most significant recreational fisheries in the State, with an estimated 445,000 fishers. In particular, the demersal species like pink snapper, dhufish, and baldchin groper, have a high social value, and are especially sought after by both recreational fishers and local retail fish consumers. There would be a considerable loss of utility for Western Australians if wild capture finfish stocks were to collapse.

Recently, several of the individual species in the fishery have been identified as at "high risk". This means that future sustainability is contingent on reducing fishing effort to allow biomass to re build. To this end, more stringent fishing restrictions have been implemented for both commercial and recreational fishers.

The commercial sector has been effectively banned from the fishery within the metropolitan area, whereas the recreational sector has had its bag limits severely reduced. The current limits are shown in Table 1. The sector remains open access apart from a closed season between October 15th and December 15th.

Table 1: Current Restriction for 2010 Seasaon

Seasonal Closure	Two-month demersal scale fish closure 15 October to 15 December (inclusive).
Daily bag limit	Limit of two High Risk demersal scale fish and two pelagic fish.
Boat limit	Limit of two dhufish per boat (six for charter boats).
Fish release	Compulsory possession of a 'release weight' when fishing for demersal scale fish.
Fishing Licence	Recreational Fishing from Boat Licence from 2 March, 2010.

A key to success for these policies is an understanding of the way recreational fishers will respond in terms of the effort (time) that they will put into fishing, adjustments they will make in terms of their fishing activities and the consequences for catch mortality and biomass. This analysis is also

[1] Integrated Fisheries Management is being developed in Western Australia as a component of Ecologically Based Fisheries Management (EBFM) which is interpreted as a broader approach to fisheries management where the interconnection of a range of ecosystem values with the management of the fish resource is taken into account.

important for understanding how recreational fishing value is influenced by catch rules and changes in biomass.

Understanding how fishers respond to the various management options that confront them presupposes that we have an understanding of the basic drivers of fishing behaviour.

A basic model of recreational fishing behaviour is presented in section 2 that will allows the role of recreational fisher modelling in the assessment of management options for the West Coast Demersal Fishery to be better understood.

Section 3 establishes some benchmarks for fishers in the Coast Demersal Fishery by going back to survey results collected prior to the recognition of stock problems and the new rules.

Section 4 presents results from a recent survey and compares them to the previous results and considers whether the differences are significant. It derives a marginal rate of substitution between species and compares this to the estimated marginal rate of substitution in the unconstrained case.

3 Model of Recreational Fisher Behaviour

3.1 A Simple Model of Recreational Fisher Choice

In order to understand how policies such as bag limits may impact on behaviour, we need to develop a model of the choices that recreational fishers make, and how those choices will be influenced by various policy options.

Consistent with economic theory, the individual fisher is treated as a utility maximising consumer who makes choices based on maximizing their individual welfare subject to a budget constraint.

The key choice variables for a recreational fisher are days fished per year, fishing time per trip, retained and released catch, and size of fish kept. Of particular interest in this model of individual recreational fishing behaviour is;

- the way that fishing time is analysed.
- the way catch and size tradeoffs are analysed, and
- the way “catch and release” and “catch and keep” are analysed.

Broadly three factors can be treated as substitutes or complements, and this treatment influences the form of the model and its predictions.

In the following sections we consider various models based on different treatments of these three variables, and the implications that these models have for recreational fishing behaviour. In particular, we consider a benchmark case of no or minimal management compared to a management regime that entails restrictions such as bag and size limits.

In effect, we think of the fisher as a typical utility maximiser who must make trade-offs between fishing and other activities. Depending on the nature of the fishing constraints, the fisher may also have to make trade-offs within the recreational fishing activity, for example between catch and size.

3.2 The Basic Model

In the literature a common specification is to have fisher utility defined as follows;

$$U = U(d, x, e(s_k, t_f, l_k)) \quad (1)$$

Where:

U is the utility derived from recreational fishing,

d= number of days fishing per year,

x= "other goods",

and e = the fishing experience.

Once out on the water, the fisher achieves a fishing experience which is a function of the size of fish caught and kept, s_k, the fishing time, t_f, the fish caught and kept, l_k. It is assumed that the fisher can gain benefit from both catch and keep and size and will be better off the larger the fish caught.

There are several simplifications in this model. Two key ones are the tacit assumptions that all water time is fishing time, and that there is no formal allowance for catch and keep. Woodward (2003) and Anderson (1993) use a model of this general form. In addition there is, either explicitly or implicitly, only one species. If multi species, the model assumes that all species are equally vulnerable to fishing effort, and equally valuable to the fisher.

Each fisher must access the fishing areas by boat and has a cost per trip that consists of boat costs, c_b and fishing costs c_f. Hence the individual fisher as a consumer faces the budget constraint:

$$c_b + c_f + x \leq M \quad \text{.....(2)}$$

The starting assumption is that each trip costs the same no matter which boat ramp or location are used for fishing.

The biology impacts the fisher through stock abundance. Abundance will influence the catchability of the fish for the fisher and will therefore impact upon the time (and cost) to catch fish. We assume that the fisher takes the biology as given. That is, the fisher experiences the biology as a harvest that depends on the biomass or stock at any given time.

The variables *d*, *e* and *x* work directly on utility and are assumed to have a positive marginal impact upon the utility of fishing as follows:

$$\frac{\partial U}{\partial d} > 0, \frac{\partial U}{\partial e} > 0, and \frac{\partial U}{\partial x} > 0 \text{.....(3)}$$

The variables, $t_f, l_k, s_{k,} h$ all impact utility indirectly through the fishing experience. The marginal impacts on the fishing experience are assumed to be positive as follows;

$$\frac{\partial e}{\partial t_f} > 0, \frac{\partial e}{\partial s_k} > 0, \frac{\partial e}{\partial l_k} > 0, \frac{\partial e}{\partial h} > 0 \text{.....(4)}$$

Different fishers will assign different marginal values to size, catch and time and will have a different willingness to trade off between catch and size.

As is usual for consumer choice, all the relevant second derivatives are negative.

We can use this basic model to consider various "scenarios' and how the fisher would behave in each. Relevant scenarios to consider are:

- No bag or size limits
- Bag limits
- Bag limits and size limits.

The key questions are:

- Are there distinct fisher types?
- How does fishing time(effort) respond to bag and size limits?
- How does catch (keep and release) respond to bag and size limits?
- How does the annual number of days fishing respond to bag and size limits?
- What role does price(cost) play in supporting bag and size limits?

3.3 No restrictions (no size or bag limits)

If there are no restrictions then the fisher has the task of optimizing *d, h,* t_f,, l_k and s_k based on maximizing utility subject to the budget constraint.

There are two points to note about this case. First, without any bag limits no distinction needs to be made between the harvest, *h*, and fish kept, l_k as all fish caught can be kept. Moreover, at this point, catch and release is not a variable in the utility function, so we must assume that fish caught will be kept.[2] Second the number and size of fish caught will depend on the biomass or abundance, and fishing effort measured as fishing time t_f. We can write this as:

$$l_k = h = h(t_f : A) \quad \text{.....(5)}$$

Under this option of no fishing restrictions there are no discards so we can follow Woodward (2003) and assume that the angler's average catch size would be a reflection of the "quality" of the biomass. This can be expressed as:

$$s = s(A) \quad \text{.....(6)}$$

This average size will be the average for the relevant size distribution. The size distribution of fish caught can be represented as $f(s|A)$. This can be assumed to be uniform (0 , 1) in which case the smallest fish caught is size 0, the largest is size 1 and the average size of the fish harvested is 0.5. This assumption is one which needs to be tested against the actual data.

[2] This assumption is relaxed in subsequent analysis,

The tradeoffs inherent in the fisher's decision making process will drive their behaviour. Without restrictions, on any given trip the fisher is free to optimize the catch and can trade off size and catch. That is they can catch more to secure the preferred size.

For this to occur there must be (a) a marginal willingness to substitute between catch and size and (b) an ability to do it. The first arises because we assume a positive marginal utility from both size and from catch so there is a marginal rate of substitution defined by $\frac{\partial e}{\partial s_k} / \frac{\partial e}{\partial l_k}$. The second arises because fishers can mix the fishing activity between catch and keep or discard. This offers the potential to adjust the average size of the catch and keep component by 'discarding' fish into the catch and release activity. Again different fishers will behave differently in this regard.

At this point it is convenient to treat the fisher decision as a two stage process. At one level, the fisher must determine the number of trips per year, *d*. Then for any given trip the fisher must determine, t_f, l_k, h and s_k.[3]

It is assumed that the fisher will maximise the fishing experience $e(s_k, t_f, l_k)$. It is assumed that there are positive marginal benefits from each argument in *e* so that $e_{s_k} > 0, e_{l_k} > 0, e_{t_f} > 0$. At this point a question arises as to the interaction across these variables. We assume that they are independent so that all cross derivatives are zero. This means for example that a higher catch has no impact on the marginal value of size.

The primary function of the trip is assumed to be to catch and retain fish. In optimising the fisher can therefore be considered as choosing the optimal combination of catch and keep and size of fish kept, s_k^*, l_k^*. The catch or harvest is determined by the fishing effort of t_f, and the abundance, *A*. Total catch is $l = h\left(t_f : A\right)$ and the assumption is that $l = l_k$.

For every level of fishing time the fisher will optimize catch and size. The fisher also needs to optimize fishing effort or fishing time t_f.

At the margin the value of fishing time is $\frac{\partial U}{\partial e}\frac{\partial e}{\partial t_f}$

However, although time is conceptualized as "fishing time", it can be thought of as having a direct and indirect effect on the fishing experience. The indirect effect arises through fishing time resulting in a harvest that allows the fisher to optimize catch and size. The indirect effect arises because the process of fishing adds value to the experience over and above that which is accounted for by fishing outcomes measures and catch and size.[4] The marginal value of fishing time can therefore be written as:

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[3] Technically we assuming a separable utility function.

[4] One interpretation is that it is an experiential value. This value may a reflect a variety of dimensions. In a previous study of the West Coast demersal fishery, Nicholls and McLeod (2004) found that attributes such as "spending time with the family" were an important aspect of the fishing experience and appeared to be independent of the actual fishing outcomes.

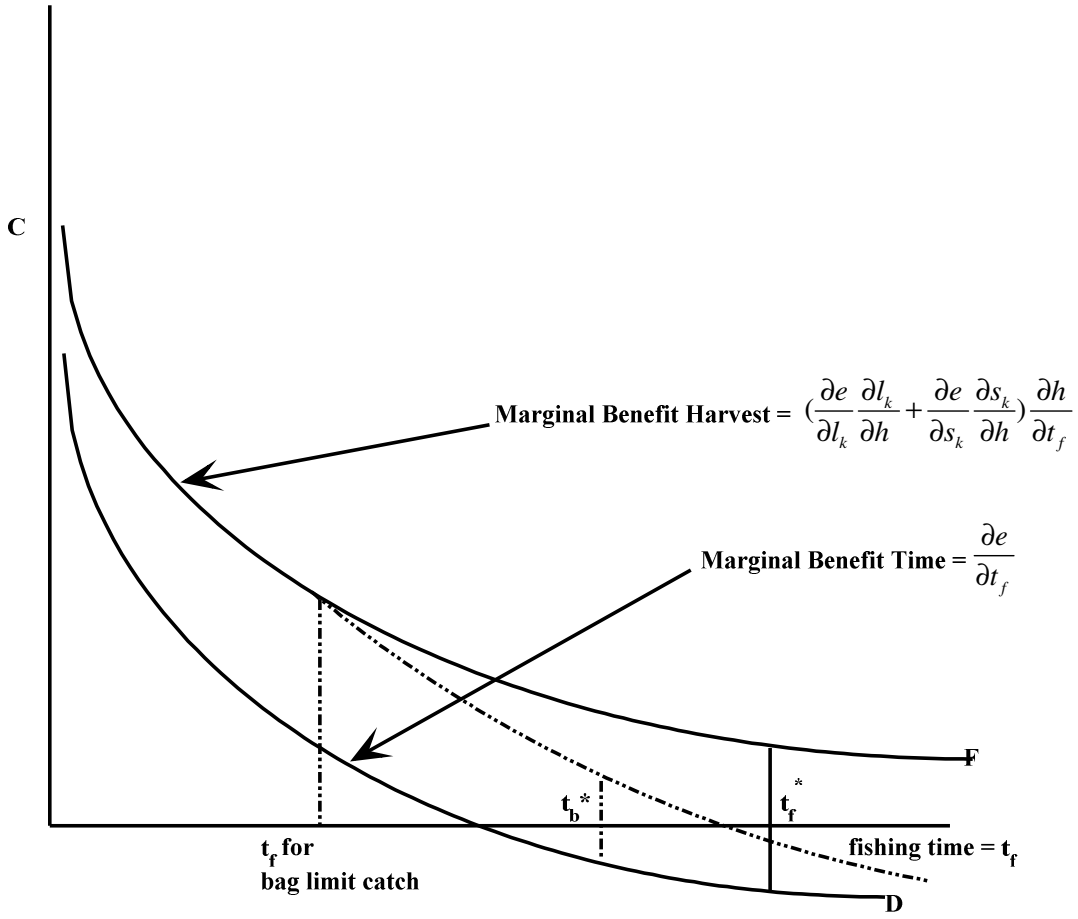
$$\frac{\partial e}{\partial t_f}+\frac{\partial e}{\partial l_k}\frac{\partial l_k}{\partial h}\frac{\partial h}{\partial t_f}+\frac{\partial e}{\partial s_k}\frac{\partial s_k}{\partial h}\frac{\partial h}{\partial t_f}=\frac{\partial e}{\partial t_f}+(\frac{\partial e}{\partial l_k}\frac{\partial l_k}{\partial h_k}+\frac{\partial e}{\partial s_k}\frac{\partial s_k}{\partial h})\frac{\partial h}{\partial t_f}\text{ .....(7)}$$

The fisher will optimize by pushing to the point where the marginal value of additional time is zero. In this case we have the following condition for optimizing fishing time :

$$-\frac{\partial e}{\partial t_f}=(\frac{\partial e}{\partial l_k}\frac{\partial l_k}{\partial h}+\frac{\partial e}{\partial s_k}\frac{\partial s_k}{\partial h})\frac{\partial h}{\partial t_f}\text{ .....(8)}$$

The relationship can be illustrated in the following diagram. The optimal fishing time is t_f* where the marginal benefit of fishing time (time only) is equal to the marginal benefit of fishing time (catch and size). Clearly anything that reduces (increases) the marginal benefit of fishing time (catch and size) will have a tendency to reduce (increase) fishing or trip time.

Figure 1: Optimal Trip (Harvest) Time



The fisher harvests from a given biomass. The biomass is represented by a standard growth equation as follows;

$$\Delta A = G(A) - \sum_{i=1}^{n} l_{k_i} \quad \text{.....(9)}$$

Where G(A) is the natural growth rate, net of natural mortality, l_{ki} is the catch for each fisher. In equilibrium we have;

$$G(A) = \sum_{i=1}^{n} l_{k_i} \quad \text{.....(10)}$$

3.4 Restrictions -Bag Limits

A bag limit restricts effort if it is binding. In Nicholls and McLeod (2004) survey results for fishers in the West Coast demersal fishery indicated that for a majority of fishers the recreational bag limits at that time were not binding. This can be taken to be an approximation of the no restriction case. However the new tighter limits are expected to be binding and have a consequent impact on fisher behaviour.

In the presence of binding bag limits, the consequences for behaviour and therefore for fishing outcomes (catch and size) depend on how fishers react to bag limits in terms of compliance.

The bag limit is a mandatory restriction that places an upper limit on the number of fish that an angler can retain during a fishing trip. The current rules are set out in Table 1, but are essentially 2 per trip for high risk species. The bag limit is defined in this model as l_k^b and means that $l_k \le l_k^b$ for every angler.

In the extreme case fishers may simply cheat on the bag limit and this would then result in no discernible impact on the harvest and therefore on the fishing mortality. However there are well known penalties for non compliance and fishers are therefore expected to comply with the limit and not be in blatant breach.

There are still a number of ways that a fisher can react to the bag limit in the fishery. First, the fisher may comply by stopping fishing for the particular fish (e.g. dhufish) when the bag limit is reached. Second, fishers may actively "high-grade". In this case they hold fish caught and then dispose of smaller fish only if larger fish are caught later in the day if a later larger catch takes the fisher over the bag limit. Whereas catch and release will have mortality commensurate with release procedures followed, high grading is likely to have higher mortality, perhaps 100%.

At this stage with no catch and release in the model, we assume discards from high grading have a release mortality of $\rho = 100\%$.

3.4.1 Absolute Compliance

With absolute compliance, l_k is reduced to comply with the bag limit. Without the bag limit mortality is total harvest or $l_k = h = h(t_f : A)$. The bag limit restricts catch and keep and so actual catch is reduced from the harvest level to the bag limit level. The change in catch is therefore $l_k = h(t_f : A) - l_k^b$. If compliance is absolute, fishers will fish to the bag limit and then stop. In this case the previous expression also captures the reduction in mortality. There would be no change

in size of fish caught. If fishers' choose to high grade then fish caught earlier in the day are "released" in order to increase average size of fish kept. In this case, mortality is greater than l_k^b because total catch exceeds the bag limit to allow for high grading.

Clearly, because absolute compliance reduces *h*, it would reduce t_f. The bag limit reduces harvest, reduced retained catch, reduces trip time and has the desired effect on reducing mortality.

However, absolute compliance ignores the marginal value of size as reflected in equation (1) where trip experience depends on s_k, which depends on the harvest via fishing time, t_f.

The extent to which actual catch exceeds the bag limit will depend on the way in which size is affected by fishing time and abundance and the nature of the individual fisher's trade-off between catch and size.

The optimality condition in equation (8) now needs to be modified to allow for the fact that the fisher is on the bag limit and can only adjust the fishing experience at the margin by adjusting s_k. A rearrangement of (8) to allow for this would give:

$$-\frac{\partial e}{\partial t_f} = \frac{\partial e}{\partial s_k}\frac{\partial s_k}{\partial h}\frac{\partial h}{\partial t_f} \quad \text{.....(11)}$$

The marginal return to fishing or trip time now is confined to the ability to increase the average fish size within the bag limit. The average size goes up with fishing time but the marginal value of size goes down. The marginal catch is now set at whatever the marginal value of catch is at the bag limit. Catching more fish adds to value based only on the marginal value of size, not catch, so at the bag limit harvesting more fish adds less to the experience value than it did under an unrestricted regime. If the unrestricted optimal catch/size combination yields e* then:

$$\frac{\partial e}{\partial s_k}\frac{\partial s_k}{\partial h}\frac{\partial h}{\partial t_f} < \frac{\partial e^*}{\partial h}\frac{\partial h}{\partial t_f} \quad \text{.....(12)}$$

Than is the marginal value of time harvesting is reduced because of the bag limit. In effect, because of the bag limit the fisher is only harvesting for size.

This can be illustrated in Figure 1. Once the fishing time t_f, needed for the bag limit catch is reached, further time rewards the fisher only through increased fish size and so the overall marginal benefit falls to the dashed line. Assuming the marginal value of time (time only) is unaffected, then the optimal fishing time is now t_f^{b*} which is less than the unrestricted fishing time t_f^*. Therefore a utility maximising fisher will pursue fish beyond that required to simply fill the bag limit but the trip time will still be less than for the unrestricted case. With harvest related to fishing time as per equation (5), this reduction in trip/fishing time means that overall harvest will fall, relative to the unrestricted case.

In mortality terms we have: unrestricted mortality $l_k = h(t_f^* : A)$; absolute compliance mortality $l_k = l_b$ and optimal bag limit mortality $l_k = h(t_{bf}^* : A)$.

If the fishers in the West Coast demersal fishery behave according to the above model then the key to understanding the mortality consequences of bag limits is to understand the marginal value of size as opposed to the simple catch quantum and to understand the proportion of fishers who will be "absolute compliers" versus "self interested optimizers".

However, before we take this analysis further there a number of further sophistications that need to be considered for the model.

4 A More Complex Interpretation

There are two important ways in which the above model may fail to capture the detail of a recreational fishery like the West Coast demersal fishery. First, catch and release as a positive component of the overall fishing experience is not allowed for in the above model. Discards with a 100% mortality are included only as a way to achieve higher size within the given bag limits. However, catch and release can have a positive value as part of the fishing activity. To some extent this is recognized within the new management regime. A release weight is to be used when fish are released to help with reducing the mortality rate. Second the fishery is a multi species fishery with a variety of fish and a variety of bag and size limits. Second, fishers may not fish for the entire trip time, as the previous model assumed, and may be willing to substitute between non-fishing and fishing time. Non fishing time in this context yields benefits unconnected to fishing outcomes. Third, like many recreational fisheries, the West Cost demersal fishery is multi-species. Fishers can switch/substitute between species. Each of these possible variations needs to be considered to make the model better approximate what actually happens in the fishery.

4.1 Non fishing time and catch and release

If we allow for non fishing time , then we must have trip time broken down between fishing time, t_f and water time, t_w where the latter exceeds the former by the amount of non fishing time, t_{nf}. Similarly, if we allow for voluntary catch and release then we must have total catch l, broken into retained catch, l_k, and released catch, l_r. The utility function consistent with this can be expressed as;

$$U = U(d, x, e(s_k, t_f, t_{nf}, l_k, l_r)) \quad \text{.....(13)}$$

U is the utility derived from recreational fishing, d= number of days fishing per year, x= "other goods", and e = the fishing experience. Once out on the water the fisher achieves a trip experience which is a function of the harvest of fish , h, size of fish kept, s_k, the fishing time, t_f, the fish caught and kept, l_k, fish caught and released, l_r, and non fishing time t_{nf}.

It is assumed that the fisher can gain benefit from catch and keep and will be better off the larger the fish caught.

As previously, the fisher optimizes with a budget constraint:

$$c_b + c_f \leq M \quad \text{.....(14)}$$

As previously, the effect on utility of each variable is positive. Therefore we have;

$$\frac{\partial U}{\partial d} > 0, \frac{\partial U}{\partial e} > 0, and \frac{\partial U}{\partial x} > 0 \text{ .....(15)}$$

And

$$e_{s_k} > 0, e_{l_k} > 0, e_{t_f} > 0, e_{t_{nf}} > 0, e_{l_r} > 0 \text{ .....(16)}$$

Fishing time impacts the fishing trip experience, *e*, through the harvest, *h*, and fish caught and kept and caught and released. Non fishing time directly contributes to *e*.

4.2 No restrictions (no size or bag limits)

If there are no restrictions then the fisher has the task of optimizing *d, h,* t_f, $t_{nf.}$ Within the fishing time the fisher optimizes l_k,s_k and l_r and s_k.

In the previous case, without bag limit we assumed that was no distinction to be made between the harvest, *h*, and fish kept, l_k as all fish caught could be kept. In this model specification catch and release offers a positive contribution to *e* and so some voluntary catch and release is feasible at the equilibrium.

The number and size of fish caught will depend on the biomass or abundance, and fishing effort measured as fishing time t_f. We can write this as:

$$l = l_k + l_b + h = h(t_f : A) \text{ .....(17)}$$

The fisher's average catch size would be a reflection of the "quality" of the biomass. This can be expressed as:

$$s = s(A) \text{ .....(18)}$$

This average size will be the average for the relevant size distribution. The size distribution of fish caught can be represented as $f(s|A)$. This can be assumed to be uniform (0, 1) in which case the smallest fish caught is size 0, the largest is size 1 and the average size of the fish harvested is 0.5. This assumption is one which needs to be tested against the actual data.

As with the previous specification, the tradeoffs inherent in the fisher's decision making process will drive behaviour. Without restrictions, on any given trip the fisher is free to optimize the catch/keep, catch/release and can trade off size and catch, fishing time and non fishing time. It is assumed that fishers would be willing to trade off between average fish size and catch, between catch and keep and catch and release and between fishing and non fishing time. Different fishers will have different marginal willingness to substitute between these.

It is again convenient to treat the fisher decision as a two stage process. At one level, the fisher must determine the number of trips per year, *d*. Then for any given trip the fisher must determine, t_f,t_{nf}, l_r, l_k, *h* and s_k.

It is assumed that the fisher will maximise the fishing experience $e(s_k, t_f, t_{nf}, l_k, l_r)$. It is assumed that there are positive marginal benefits from each argument in *e* so that

$e_{s_k} > 0, e_{l_k} > 0, e_{t_f} > 0, e_{t_{nf}} > 0, e_{lr} > 0$. At this point a question arises as to the interaction across these arguments. We assume that they are independent so that all cross derivatives are zero. This means for example that a higher catch has no impact on the marginal value of size or a higher non fishing time has no impact on the marginal value of catch and keep.

The primary function of the trip is assumed to be to catch and keep. In optimising the fisher can therefore be considered as choosing the optimal combination of catch and keep, catch and release and size of fish retained, s_k^*, l_k^*, l_r^*. Total catch is $l = h\left(t_f : A\right)$ and the harvest is allocated across $l_r + l_k$.

In optimizing catch and size the fisher optimizes effort or fishing time $t_{f..}$ The fisher also optimizes non fishing time, $t_{nf.}$ At the margin the value of fishing time is $\frac{\partial u}{\partial e}\frac{\partial e}{\partial t_f}$, the value of non fishing time is $\frac{\partial u}{\partial e}\frac{\partial e}{\partial t_{nf}}$.

The marginal value of fishing time cab written as:

$$\frac{\partial e}{\partial t_f} = \frac{\partial e}{\partial l_k}\frac{\partial l_k}{\partial h}\frac{\partial h}{\partial t_f} + \frac{\partial e}{\partial s_k}\frac{\partial s_k}{\partial h}\frac{\partial h}{\partial t_f} + \frac{\partial e}{\partial l_r}\frac{\partial l_r}{\partial h}\frac{\partial h}{\partial t_f} = (\frac{\partial e}{\partial l_k}\frac{\partial l_k}{\partial h_k} + \frac{\partial e}{\partial s_k}\frac{\partial s_k}{\partial h} + \frac{\partial e}{\partial l_r}\frac{\partial l_r}{\partial h})\frac{\partial h}{\partial t_f} \text{....(19)}$$

The fisher will optimize the allocation of trip time by adjusting fishing and non fishing time to keep their marginal values the same, that is: $\frac{\partial e}{\partial t_f} = \frac{\partial e}{\partial t_{nf}}$. Total time will then be determined by the opportunity cost of time. If we assume that this is ω then the optimal amount of trip time, optimally allocated occurs where $\frac{\partial e}{\partial t_f} = \frac{\partial e}{\partial t_{nf}} = \omega$.

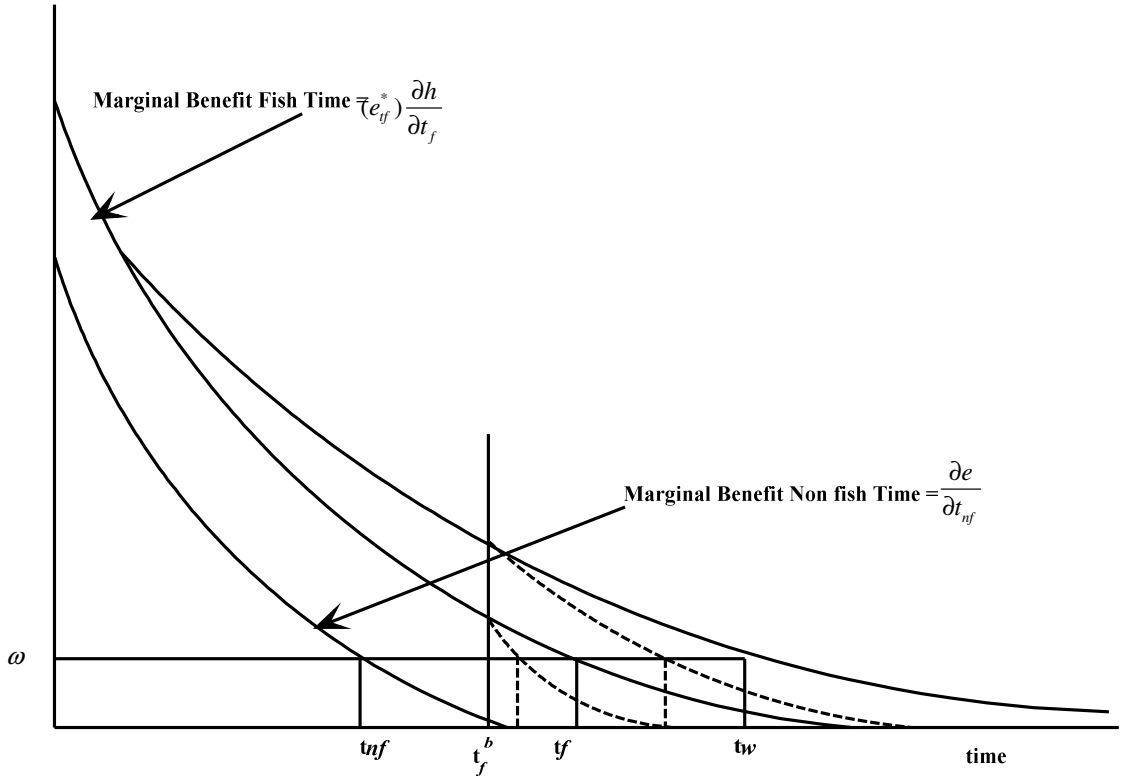
$$\frac{\partial e}{\partial t_{nf}} = (\frac{\partial e}{\partial l_k}\frac{\partial l_k}{\partial h} + \frac{\partial e}{\partial s_k}\frac{\partial s_k}{\partial h} + \frac{\partial e}{\partial l_r}\frac{\partial l_r}{\partial h})\frac{\partial h}{\partial t_f} \text{.....(20)}$$

Or

$$\frac{\partial e}{\partial t_{nf}} = (e^*)\frac{\partial h}{\partial t_f}$$

The relationship can be seen in Figure 2. The optimal total time is t_w^* which is split between the optimal fishing time, t_f^* and optimal non fishing time, t_{nf}^*. Clearly anything that reduces (increases) the marginal benefit from fishing time will tend to reduce (increase) fishing and trip time. Anything that increases (decreases) the trip cost will tend to decrease (increase) overall trip time as well as decreasing both fishing and non fishing time.

Figure 2: Optimal Trip (Harvest and Non Harvest) Time



The fisher harvests from a given biomass.

The biomass is represented by a standard growth equation as follows;

$$\Delta A = G(A) - \sum_{i=1}^{n} l_{k_i} \quad \text{.....(21)}$$

Where G(A) is the natural growth rate, net of natural mortality, $l_{ki\ is}$ the catch and kept. In equilibrium we have;

$$G(A) = \sum_{i=1}^{n} l_{k_i} \quad \text{.....(22)}$$

4.3 Restrictions -Bag Limits

A bag limit restricts effort if it is binding. In the previous model specification, the bag limit, if strictly adhered to, reduces catch and keep to the bag limit. In the current specification catch and release is a positively valued fishing activity, so while the bag limit now restricts catch and keep, catch and release is still valuable at the margin.

The consequences for behaviour and therefore for fishing outcomes depends on how fishers react to bag limits in terms of compliance and their willingness to substitute catch and release for catch and keep.

The bag limit is a mandatory restriction that places an upper limit on the number of fish that an angler can retain during a fishing trip. The bag limit is defined in this model as l_k^b and means that $l_k \le l_k^b$ for every angler.

As previously, fishers may simply cheat on the bag limit. There would be no impact on the catch and keep harvest and therefore on the fishing mortality. However, as explained previously, there are penalties for non compliance and fishers are therefore expected to comply with the limit and not be in blatant breach.

There are a number of ways that a fisher can react to the bag limit in this model. First, the fisher may comply by stopping fishing for the particular fish (e.g. dhufish) when the bag limit is reached and terminate all fishing at this point. Second, fishers may actively "high-grade". In this case they hold fish caught and then dispose of smaller fish only if larger fish are a caught later in the day if a later larger catch takes the fisher over the bag limit. Third they may continue to fish for catch and release. This could be done in strict compliance with the bag limit or with some high grading involved. Catch and release will have mortality commensurate with release procedures followed, with $\rho < 100\%$. High grading is likely to have higher mortality, $\rho = 100\%$.

4.4 Absolute Compliance

With absolute compliance, l_k is reduced to comply with the bag limit. Without the bag limit mortality is total kept harvest plus a proportion of the release harvest. The harvest is $l = h = h(t_f : A)$. Mortality is $l_k + \rho l_r$.

The bag limit restricts catch and keep and so actual catch and keep is reduced from the harvest level to the bag limit level. The change in catch is therefore: $h(t_f : A) - (l_k^b + l_r^b)$

If compliance is absolute fishers will fish to the bag limit and then stop. In this case the reduction in mortality is: $l_k + \rho l_r - l_k^b - \rho l_r^b = (l_k - l_k^b) + \rho(l_r - l_r^b)$.

The effect on fishing time, harvest, catch and release and non fishing time will depend on the extent to which the fisher sees catch and release as a substitute for catch and keep.

If catch and keep and catch and release are independent, then the restriction of the bag limit has no impact on catch and release. In this case, $l_r = l_r^b$ changes in catch are defined by the bag limit changes and there would be no change in size of fish caught. This is shown in Figure 2 by the dashed lines. Beyond the new lower fishing needed for catch. Fishing time and total trip time fall, as do catch and mortality.

If fishers choose to high grade then fish caught earlier in the day are "released" in order to increase average size of fish kept, but this is high grading as opposed to positive catch and release. In this case the effect may be to increase the mortality rate associated with catch and release.

If catch and keep and catch and release are interdependent they may be substitutes or complements. Either way a change on the bag limit will influence catch and keep.

If they are substitutes then:

$$\partial(\partial e / \partial l_r) / \partial l_k, < 0 \text{ …….(23)}$$

In this case, as l_k falls, l_r increases, with the exact response depending on the shape of the fisher's indifference curve.

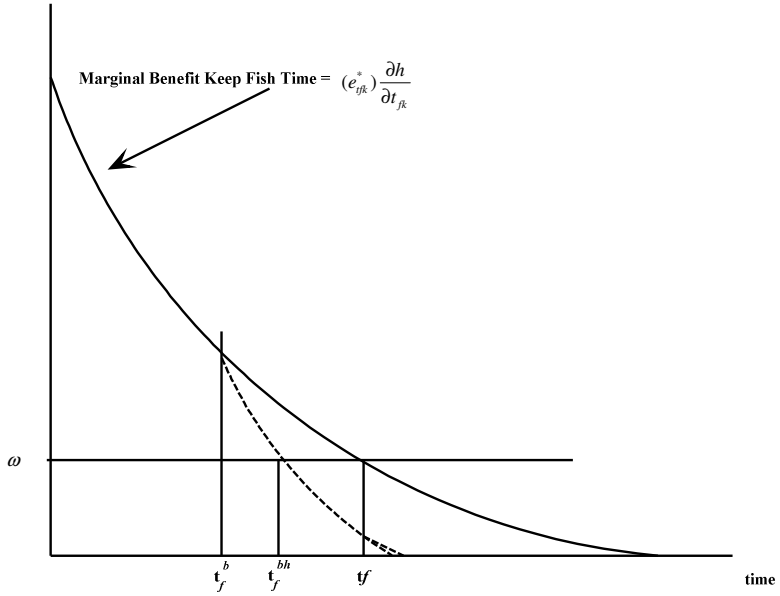
If they are complements then:

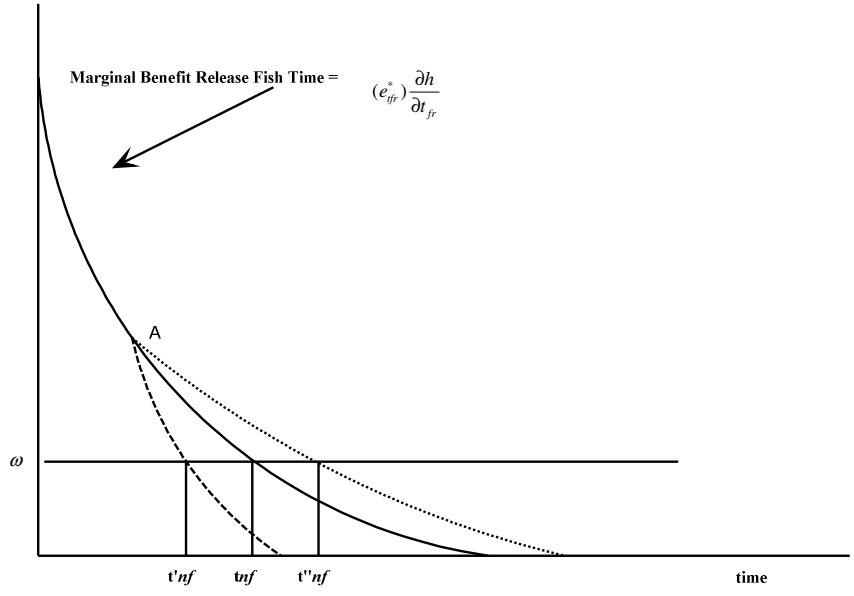
$$\partial(\partial e / \partial l_r) / \partial l_k, > 0 \text{ …….(24)}$$

In this case, as l_k falls, l_r decreases, again the exact response depends on the shape of the fisher's indifference curve.

Figure 3 illustrates this effect with fishing time partitioned into catch and keep time, t_{fk} and catch and release time, t_{tr} .

Figure 3: Optimization of Fishing Time Across Catch and Keep and Catch and Release Time





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5 Benchmark results for recreational fishing from the unconstrained case- the 2003 recreational fisher survey.

In order to understand the significance of recent surveys, a reference point prior to the introduction, or even the expected introduction, of the new rules was needed.

This was achieved by referring back to a telephone survey of recreational fishers done in 2003 for the West Coast Demersal Fishery covering the region Augusta to Kalbarri. The focus of this survey was on the catch and related fishing behavior for the prized species – dhufish, pink snapper and baldchin groper.

At that time there was no restriction on recreational fisher participation in the West Coast Demersal Fishery.

This was prior to the introduction of the recreational licence fee, but recognizing the need for a boat to access the fishery, the registration data on pleasure craft from the then Department of Infrastructure and Planning (Marine Transport Division) was used as the sampling frame. This gave around 70,000 craft that were potentially capable of being used to fish for these species.

Charter boat operators were not included in this survey.

5.1 Fishing Regulations in 2003

5.1.1 Daily Bag Limits[5]

Under fishing regulations applying at that time each recreational fisher was limited to a maximum daily take of 4, dhufish and a mixed bag limit of 8 reef fish, including pink snapper and baldchin groper.

These catch limits were under review at the time with the Fisheries Department of Western Australia releasing for public comment the possibility of halving the daily bag limit at the time of this case study. However, as outlined below, even a halving of the daily bag limit would effectively leave fishers unconstrained.

5.1.2 Size Limitations

A legal minimum fish size applies to each of these species that recreational fishers wish to retain. These were 500mm for dhufish, 400mm for baldchin groper and 410mm for pink snapper.

5.1.3 Seasonal Limitations

At the time of the 2003 survey, fishing for pink snapper in Cockburn Sound was closed from the 15 September to the 31 October.

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[5] The 'official' daily bag limit should not be confused with the range of daily catch limit offered to surveyed recreational fishers. The number of fish in the 'offered' range varied and went above and below the official bag limit.

5.2 Recreational Catch

There were no catch surveys close to the 2002/03 period. However, a Western Australian Fisheries Department 1996/1997 survey estimated recreational catch of the prized case study species – dhufish, pink snapper and baldchin groper- to be around 182 tonnes.

These data are shown in Table 1 below. They indicate just how far the fishes at that time appeared to be below the daily bag limit. Hence we take this as an approximation to actual unconstrained behavior.

Table 2: The West Coast Wetline Fishery: Recreational Dhufish, Baldchin Groper and Pink Snapper Catches (a): 1996-1997 Recreational Fishing Survey

Species	Retained Catch (tonnes)	High Catch Locations	High Seasonal Catches	Catch Rate
Dhufish	132	Jurien Bay, Lancelin, Geraldton	Summer	0.42/angler trip
Baldchin Groper	23	Jurien Bay	Summer/Autumn	NA
Pink Snapper	27	Mandurah	Spring	0.27/angler trip
Total	182			

(a)Excludes recreational catches from commercially operated recreational charter vessels.

Source: Western Australian Department of Fisheries

McLeod and Nicholls (2004) scaled up the 1996/97 catch data to approximate 2003 based on the national recreational survey results and the growth in the number of pleasure vessels. The resulting estimate was a recreational catch between 300 and 350 tonnes as shown in Table 3. Given the estimated growth in boats and fishes this still left per fisher/trip catches well below the catch limits.

Table 3: Scaled Estimates of the Recreational Catch of Dhufish, Baldchin Groper and Pink Snapper in the West Coast Demersal Fishery (a)- 2001-2002

Species	Low Estimate	High Estimate
Dhufish	193	228
Baldchin Groper	47	53
Pink Snapper	60	69
Total	300	350

5.3 Survey Questionnaire for 2003

The data collected during the 2003 season was a telephone survey designed to elicit willingness to pay have the possibility of catching additional prized species fish. Although the focus was contingent

valuation questions designed to elicit willingness to pay, the survey collected data on catch and keep, catch and release as well as data on attitudes to fishing and core socio demographic variables. Data was also collected on the time spent fishing, time spent travelling and time spent accessing the fishing locations.

5.3.1 Survey Population and Sample Size

Recreational fishing licences did not exist in 2003. Therefore the sampling frame was the pool of 70,000 pleasure craft registrations held by the Marine Section of the Department of Planning and Infrastructure in Western Australia. A stratified, random sample based on postcode locations of 2,000 pleasure craft owners were contacted (in writing) by the Marine Section asking them to advise the Department if they were not agreeable to their contact details being released for possible participation in our recreational survey. The Department made a sample of 1,734 contacts available.

5.3.2 The Sample Group and Response Rate

Of the 500 pleasure craft owners randomly selected from the 1734 contacts provided by the Marine Section of the Western Australian Department of Planning and Infrastructure, 380 (or 76 per cent) completed the telephone survey. This is typical for a telephone survey. Of the 380, 12 had trip length greater than one day leaving n=368 trips of less than a day. This is the primary data base for analysis.

5.3.3 Socio Economic Composition

Respondents were predominately male (96 per cent) and were mostly in the 30 to 60 years age group (75 per cent). Retirees and pensioners were around 17 per cent of the sample. The majority were engaged in full time employment.

Disclosed annual incomes (before tax) of respondents are summarized in Table 4. The incomes were oriented towards the higher income groups with 35 per cent earning above $51,999 annually. Median and average income was in the range $26,000 to $51,999. The average annual earnings for fully employed males in Western Australia at the time were $46,581.

Table 4: Income Distribution for 2003 survey

Annual Incomes	Percentage of Respondents
Less than $8,319	6
$8,320 to $15,599	7
$15,600 to $25,999	11
$26,000 to $36,399	17
$36,400 to $51,999	24
$52,000 to$77,999	20
$78,000 or more	15

5.3.4 Boat Use

On average, respondents' recreational fishing in the West Coast fishery for the case study species accounted for 53 per cent of the usage of their boats over the previous twelve months. These boat usage data are shown in Table 5.

Table 5: Percentage of Boat Use Spent fishing offshore in the West Coast Wetline Fishery for the Targeted Case Study Species

Percentage of Boat Use	Frequency (%)
10 per cent or less	24
11 per cent to 30 per cent	15
31 per cent to 50 per cent	18
51 per cent to 70 per cent	5
71 per cent to 90 per cent	6
91 per cent to 100 per cent	32

5.4 Fishing Behaviour

5.4.1 Number of trips

On average, respondents went 'bottom fishing' 12.8 times in the West Coast Wetline fishery over the previous twelve months. Around 30 per cent fished 5 times or less, whilst 94 per cent fished 30 times or more. Two fished around every third day over the past twelve months. These data are shown in Table 6.

Table 6: Number of Fishing Trips in the West Coast Demersal Fishery for the Targeted Case Study Species

Number of	Trips Frequency (%)
10 trips or less	58
11 to 20 trips	28
21 to 30 trips	8
31 or more trips	6

Fishing trips typically involved two or three people, representing three quarters of the survey responses; although as many as 6 persons was not unusual. Most were either friends or family.

5.4.2 Trip Times and Fishing Times

For almost all (97 per cent) of the sample group, fishing trips in the West Coast Demersal Fishery for the case study species were of one day's duration or less. The mean fishing trip was 7.16 hours duration with the range from less than 2 hours to 17 hours. These data are shown in Table 7.

Table 7: Length of time, on average per trip, spent fishing in the West Coast Demersal Fishery by Respondents who spent less than one day fishing

Hours	Frequency (%)
2 to 3 hours	5
4 to 5 hours	22
6 to 7 hours	33
8 to 9 hours	21
10 hours or over	19

The pattern of trip time and fishing time for the 2003 survey is shown in Table 8. Mean total trip time was 7.9 hours. Of this travel to boat ramp and back was 1.3 hours and time on the water was 6.6 hours. Of the 6.6 hours of ocean time, 4.9 hours was spent fishing and 1.2 ours was spent in other activities. Bottom fishing was 3.8 hours of the 4.9 hours of fishing time.

Table 8: Trip Times and Fishing Times 2003

	Obs	Mean	Std. Dev.	Min	Max
Trip Time	363	7.88	3.24	2.00	20.50
Bottom Fishing	363	3.76	1.97	0.00	16.00
Travel to Ramp	363	1.28	1.97	0.00	14.00
Ocean Time	363	6.60	2.74	1.70	20.00
Fishing Time	363	4.89	2.59	0.14	15.73
Other Ocean Time	363	1.72	2.12	0.00	16.00

5.4.3 Fishing Costs

A range of cost data was collected in the 2003 survey.

Annual fishing costs for the previous twelve months are shown in Table 9.

Table 9: Annual Fishing Costs for Previous 12 Months, 2003

	N	Mean	Min	Max
Fishing-related equipment for a motor vehicle such as roof racks or a tow bar?	378	59.56	0	7,500
Life jackets and safety gear?	378	51.65	0	5,050
Recreational fishing club membership?	378	10.41	0	300
Rods, reels or other fishing equipment?	377	405.65	0	25,000
Books, magazines, videos etc on boat fishing, locations, fishing gear, etc to help you find and catch fish	379	45.26	0	1,600
Angling Club membership fees	378	7.32	0	600

The mean boat value was $30,494. The maximum was $900,000. A small number of respondents9N=8 recorded boat values <$1000.

Fishing dominates boat use. Table 10 shows that for the 2003 respondents, on average 75 percent of the boat use time was fishing activities.

Table 10: Percentage of Time Boat Used for Recreation, Fishing and Other Activities.

Variable	Obs	Mean	Min	Max
Recreation	380	15.36	0	95
Fishing	380	75.50	2	100
Other	380	9.14	0	98

Boat related expenditures are shown in Table 11.

Table 11: Boat Related Expenditures

New equipment such as GPS or sounder or motor?	361	842.24	0	18,000
Parts for boat, boat motor or trailer	362	492.25	0	10,000
Maintenance of boat, motor or trailer	362	403.52	0	10,000
Insurance for boat, motor or trailer	350	357.03	0	8,000
Boat and trailer licence fees.	338	182.92	0	3,000
Boat club membership and pen fees	362	191.07	0	6,500

5.5 Bag Limits and Catches

In the previous twelve months, 81 per cent of the respondents had specifically targeted dhufish when they went fishing, 64 per cent targeted pink snapper and 44 per cent baldchin groper. This affirmed

strong preferences attaching to dhufish among recreational West Coast Demersal fishers. Sixty three per cent of the respondents also targeted other species besides the case study species.

5.5.1.1 Catch and Keep

Over the previous twelve months, on average per trip, over 90 per cent had not achieved daily bag limit catches, in aggregate or individually, of the case study species whilst fishing in the West Coast Demersal fishery. Indeed, for each of the case study species, most respondents had not caught and kept any of the case study species. These data are shown in Table 12 and Figure 4.

Table 12: Distribution of Respondents by Retained Catch by Species in the West Coast Demersal Fishery 2003 Survey

	Percentage of Respondents			
Number of Fish/Trip	Dhufish	Baldchin Groper	Pink Snapper	Other Species
0	37.1	71.3	54.5	16.1
1	34.7	16.8	23.4	10.0
2	17.9	7.1	13.7	17.2
3	5.5	1.3	2.9	9.5
4	2.1	1.8	2.9	8.4
5	0.5	0.5	0.8	6.6
6	1.3	0.5	0.5	9.8
>6	0.8	0.5	1.3	22.4

Figure 4: Distribution of Respondents by Retained Catch by Species in the West Coast Demersal Fishery 2003 Survey

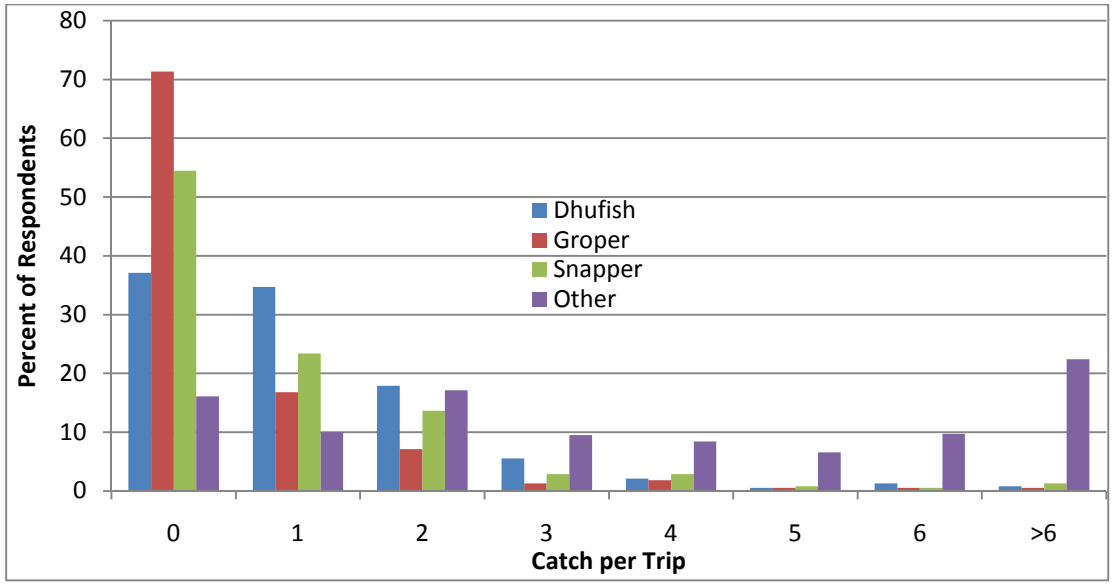

Table 13 shows summary statistics for retained catch. During the previous twelve months, the mean dhufish catch/trip was just over one, with a range from 0 to 9. For pink snapper, the mean catch/trip

was just under one, with a range from 0 to 15. For baldchin groper the mean catch/trip was just 0.46, with a range from 0 to 6.

Catches of "other species" were important. The mean catch/trip for other species was 5.82. Only 16 per cent of respondents had zero retained catches of other species and the range was 0 to 60.

Table 13: Summary Statistics for Retained Catch 2003 Survey

	Dhufish	Pink Snapper	Baldchin Groper	Other Species
mean	1.07	0.88	0.46	5.82
min	0	0	0	0
max	9	15	6	60

5.5.1.2 Catch and Release

Over the previous twelve months, on average per trip, most respondents had not caught and released any of the case study species whilst fishing in the West Coast Demersal fishery. These data are shown in Table 14 and Figure 5.

Table 14: Distribution of Respondents by Released Catch by Species for the West Coast Demersal Fishery 2003 Survey

Number of Fish	Percentage of Respondents			
	Dhufish	Baldchin Groper	Pink Snapper	Other Species
0	36.9	85.8	52.0	29.6
1	22.2	6.3	12.4	7.7
2	16.9	4.2	13.5	11.5
3	10.8	0.8	5.3	9.1
4	4.5	1.6	3.7	5.6
5	2.4	0.3	2.9	4.8
6	3.4	0.5	5.3	8.3
>6	2.9	0.5	5.0	23.5

Figure 5: Distribution of Respondents by Released Catch by Species for the West Coast Demersal Fishery 2003 Survey

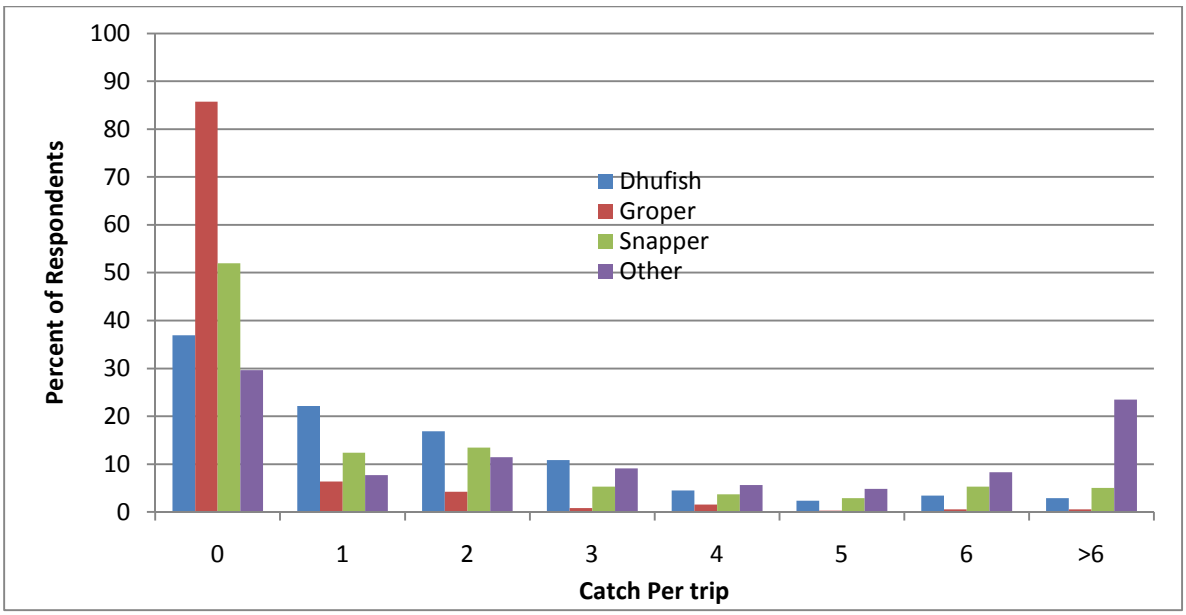

Table 15: Summary Statistics for Released Catch 2003 Survey

	Dhufish	Pink Snapper	Baldchin Groper	Other Species
mean	1.7	2.0	0.3	5.0
min	0	0	0	0
max	30	50	10	50

Table 15 shows summary statistics for released catch during the 2003 survey. For the previous twelve months, the mean released catch of dhufish was 1.7, with a range from 0 to 30. For pink snapper the average was 2.0, with a range from 0 to 50. For baldchin groper the average was just .3, with a range from 0 to 10.

Other species were also important in catch and release. For "other species" the average catch and release per trip was 5.0, with 30 per cent of the respondents having zero released catches of other species and a range of 0 to 50.

The following table shows the combined data for dhufish, pink snapper and baldchin groper. The average per trip for the combined retained and released catch was 6 fish with a range of 0 to 77. Only 15 percent of respondents had neither retained nor released catches over the past 12 months for the case study species.

Table 16: Aggregate Retained and Released Catches by Respondents in the West Coast Demersal Fishery for the Three Key Species over Previous 12 Months in 2003 Survey

	N	Min.	Max.	Mean	Std. Devn
Aggregate retained and released catch for dhufish, pink snapper, baldchin groper.	367	0	77	6.38	8.09
Aggregate retained catch of dhufish, pink snapper, baldchin groper.	368	0	21	2.42	2.76
Aggregate released catch of dhufish, pink snapper, baldchin groper.	367	0	70	3.97	6.61

Whilst catches of dhufish, pink snapper and baldchin groper were modest for most fishers, most fishers had positive catches when other species are included. In particular the average of retained and released catch for combined dhufish, snapper, groper and other species is 17.2 fish. Only 1.1 percent of respondents had zero for combined retained and released catch. For retained catch the average for combined dhufish, snapper, groper and other species is 8.2 fish. Only 2.9 percent of respondents had zero retained catch. For released catch, the average released catch for combined dhufish, snapper, groper and other species is 9.0 fish. Only 7.7 percent of respondents had zero released catch.

Therefore while virtually all fishers were catching only limited catches of the prized species and fell well short of the set bag limits, catching other species more than doubled the catching experience and very few fishers experienced zero catch when this activity is taken into account.

5.6 Satisfaction with the Fishing Experience

A range of questions were included in the survey dealing with the degree to which fishers were satisfied with various aspects of their fishing experience. The scores for each aspect ranged from 1(very unsatisfied) to 5(very satisfied). The list of attributes considered and the mean scores are given in Table 17.

Table 17: Mean Satisfaction Scores for Dimensions of Fishing Experience 2003 Survey

	Mean Score
No congestion at the boat ramp	3.69
Catching as many fish as you expect to	3.47
The number of fish you catch and keep	3.59
The size of the fish you catch and keep	3.67
The species of the fish you catch and keep	3.73
The time it takes to catch the number of fish you expected to	3.54
The time it takes to catch the number of fish you want to keep	3.51
Catching enough fish for a decent feed	3.65
Enjoying the fishing experience, regardless of the number of fish caught and kept	4.50
Having an enjoyable time out on the ocean	4.67

On balance fishers in 2003 were well satisfied. Very high satisfaction scores were assigned to both the overall fishing experience and the overall experience of time on the ocean. The satisfaction scores for the broader fishing activity at above 4.5 are higher than the mean scores for any of the direct fishing activities. For the rest, respondents were reasonably happy.

5.7 Most Recent Fishing Experience in West Coast Wetline Fishery

For the most recent fishing experience, that is the most recent trip made prior to the survey, two thirds of the respondents indicated that they had not caught as many of the case study species as they wanted, although almost one quarter indicated that they had caught as many as they thought they would within the catch limit. Less than 2 per cent of the respondents indicated bag limit catches.

In relation to the most recent fishing trip, 62 per cent of the respondents thought they would have caught more fish, whilst 34 per cent indicated that they had caught as many as they thought they would. Only 4 per cent thought they would have caught less.

In terms of fish kept, one half thought they would have kept more, whilst 47 per cent indicated that they had kept as many as they thought they would. Only 2 per cent thought they would have kept less.

Despite outcomes below expectations from their most fishing experience in the West Coast Wetline fishery it as still the case that:

- two-thirds were happy with the number of fish they caught,
- two-thirds were happy with the number of fish they kept,
- 71 per cent were happy with the size of the fish they caught,
- three-quarters were happy with the type of fish kept, and
- three-quarters were happy with the type of fish they kept.

6 Post Regulation: The 2010 Survey Results For Recreational Fishing in the Constrained Case.

The 2010 followed on from changes in the rules for fishing. These rule changes were made because of a threatening decline in stocks and the need to reduce both commercial and recreational fishing effort The telephone survey was conducted in April/May 2010.

6.1 The 2010 Rules

By the time of the 2010 season, the rules reflected a more extensive closed season and much stricter bag limits. A summary of the revised rules is given in Table 18.

Table 18: Revised Rules for 2010 Season

Seasonal Closure	Two-month demersal scale fish closure 15 October to 15 December (inclusive).
Daily bag limit	Limit of two High Risk demersal scale fish and two pelagic fish.
Boat limit	Limit of two dhufish per boat (six for charter boats).
Fish release	Compulsory possession of a 'release weight' when fishing for demersal scale fish.
Fishing Licence	Recreational Fishing from Boat Licence from 2 March, 2010.

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The closed season and tighter bag limits applied across a wide range of demersal scale fish in the West Coast region. Breaches of the closed season regulation were subject to a fine of $5 000 for a first offence and a fine of $10 000 for a second offence.

The closed season was the period between 15 October and 15 December, both dates inclusive. The demersal scale fish to which this applied are show in Table 19.

Table 19: Demersal Scale fish subject to Closed Season in 2010

Cod	Groper, Bass
Cod, Grey Banded Rock	Groper, Western Blue
Coral Trout	Hapuku
Coronation Trout	Nannygai
Dhufish, West Australian	Parrot Fish
Emperor and Seabream	Seaperch, Tropical
Emperor, Red (Government Bream)	Snapper, Pink
Snapper, Red (Redfish)	Snapper, Queen (Blue Morwong)
Foxfish, Western and Pigfish	Swallowtail
Groper, Baldchin	Trevalla
	Tuskfish

Outside of the closed season, the revised bag limits per day are those shown in Table 20. These limits are less than 1 and are much closer to the actual catches that fishers have been experiencing even as far back as 2003.

Table 20: Daily Bag Limits for 2010

SPECIES	SCIENTIFIC NAME	MINIMUM LEGAL SIZE	BAG LIMIT
Cods (includes breaksea cod, harlequin fish, grey banded rock cod and Chinaman cod)	Family Serranidae	Epinephelus sp. (such as malabar cod and estuary cod) over 1,000 mm or 30 kg are protected (except grey banded rock cod) Breaksea – 300 mm Estuary – 400 mm	2
Coral trout and **coronation trout** – combined	*Plectropomus* spp. and *Variola louti*	Coral – 450 mm	1
Dhufish, Western Australian	*Glaucosoma hebraicum*	500 mm	1 Boat limit - 2 (6 on charter)
Emperors (“**nor’ west snapper**”)	Family Lethrinidae	Spangled – 410 mm Blue-lined (black snapper) – 320 mm Other emperors – 280 mm	2
Foxfish and pigfish	*Bodianus* spp.	Not applicable.	2
Groper, baldchin and **tuskfish**	*Choerodon* spp.	Baldchin, blackspot & blue tuskfish – 400 mm	2
Groper, western blue	*Achoerodus gouldii*	500 mm. Protected in the Rottnest Island Reserve	1
Hapuku/bass groper and **trevella**	*Polyprion* spp. and Family Centrolophidae	Not applicable.	2
Parrot fish	Family Scaridae	Not applicable.	2
Pink snapper	*Pagrus auratus*	410 mm 500 mm (South of 31° degrees south latitude, just north of Lancelin)	2
Queen snapper (blue morwong)	*Nemadactylus valenciennesi*	410 mm	2
Red snapper (includes bight redfish, nannygai and swallowtail)	*Centroberyx* spp.	300 mm	2
Tropical snappers and **sea perch** (includes red emperor, mangrove jack,	Family Lutjanidae	Red emperor – 410 mm Fingermark, mangrove jack and stripey sea perch – 300 mm	2

ruby snapper, job fish, stripey sea perch etc.)			

6.2 The 2010 Survey

The extended closed season and the new bag limits change the fishing environment significantly. Whilst the original survey could be regarded as an approximation to unconstrained behavior the 2010 survey was of fishers likely to be experiencing binding catch constraints.

6.2.1 Survey population and sample size.

Recreational fishing licences had commenced for the 2010 survey. Therefore the sampling frame was the data base on recreational fishing licences at that time. This was 26,919 license holders of which 21.045 were in the West Coast Bio region and 15,623 were in the metropolitan region.

A final sample of 798 completed telephone surveys was obtained spread across metropolitan area, South West, Mid West and Kalbarri proportional to the population of license holders. Of these 750 had trip times less than one day.

6.2.2 Socio Economic Composition

Respondents were predominately male (91 percent). Retirees and pensioners were around 17 percent of the sample. The majority (70 percent) were engaged in full time employment.

Disclosed annual incomes (before tax) of respondents are summarized in Table 21. The incomes were oriented towards the higher income groups with 35 per cent earning above $51,999 annually. Median and mean income was in the range $52,000-$88,399. The average annual earnings for fully employed males in Western Australia at the time were $???

Table 21. Income Distribution for 2010 Survey

Annual Incomes	Freq.	Percentage of Respondents
Nil or negative income	21	3.1
$1-$25,999	83	12.24
$26,000-$33,799	51	7.52
$33,800-$51,999	93	13.72
$52,000-$88,399	184	27.14
$88,400-$103,999	109	16.08
$104,000-$129,999	61	9
$130,000-$155,999	36	5.31
$156,000-$207,999	21	3.1
$208,000 or more	19	2.8
Total	678	100

6.2.3 Boat Use

The type of boats owned by respondents is shown in Table 22. As expected the bulk (97%) are power boats. Respondents were asked to indicate boat market value. The mean boat value was $62,271. The minimum value was $1,500 and the maximum was $9 million.

Table 22: Boat Type for 2010.

	Freq.	Percent	Cum.
Powerboat - moored or penned	29	4.78	4.78
Powerboat - transported on trailer	560	92.26	97.03
Sailboat - moored or penned	2	0.33	97.36
Sailboat - transported on trailer	1	0.16	97.53
Other	15	2.47	100
Total	607	100	

Boat usage patterns are shown in Table 23. Only 12 percent of boats are used more than once a week. Around 15 percent are used less than 6 times a year.

Table 23: Frequency of Boat Use 2010.

	Freq.	Percent	Cum.
0 times	6	0.99	0.99
1-2 (rarely)	8	1.32	2.31
3-6 (a few times)	78	12.85	15.16
7-12 (once a month)	129	21.25	36.41
13-24 (twice a month)	187	30.81	67.22
25-50 (weekly)	126	20.76	87.97
51 or more (more than weekly)	70	11.53	99.51
Dont Know	3	0.49	100
Total	607	100	

Fishing dominates boat use. Table 24 shows that for the 2010 respondents, on average 74 percent of the boat uses time was fishing activities.

Table 24: Percentage of Time Boat Used for Recreation, Fishing and Other Activities.

Variable	Obs	Mean	Min	Max
Recreation	598	17.95	0.00	100.00
Fishing	598	74.29	0.00	100.00
Other	598	7.75	0.00	100.00

6.3 .Fishing Behaviour

The number of trips data was not asked in the same format across the surveys. The early survey recorded the exact number of trips in the previous 12 months; the 2010 survey recorded this information in ranges. The pattern of fishing trips for 2010 is shown in Table 25. The median is in the 7-12 (once a month), range. A linear interpolation implies a median of approximately 9 trips per year and a mean of just below 12 trips per year.

Table 25: Distribution of Number of Fishing Trips 2010

Description	Code	2010	
		#	%
1-2 (rarely)	2	110	14.67
3-6 (a few times)	3	211	28.13
7-12 (once a month)	4	205	27.33
13-24 (twice a month)	5	156	20.8
25-50 (weekly)	6	57	7.6
51 or more (more than weekly	7	11	1.47
		750	100

6.3.1 Trip Times and Fishing Times

The pattern of trip time and fishing time for the 2010 survey is shown in Table 26. Mean total trip time was 6.5 hours. Of this travel to boat ramp and back was 1.0 hours and time on the water was 5.5 hours. Of the 5.5 hours of ocean time, 3.4 hours was spent fishing and 2.1 hours was spent in other activities. Bottom fishing was 2.8 hours of the 3.4 hours of fishing time.

Table 26: Trip Times and Fishing Times 2010

	Obs	Mean	Std. Dev.	Min	Max
Trip Time	700	6.55	3.00	0.67	24.00
Bottom Fishing	700	2.77	2.09	0.00	12.00
Travel to Ramp	700	1.04	1.82	0.00	16.00
Ocean Time	700	5.51	2.24	0.33	18.00
Fishing Time	700	3.37	2.34	0.00	15.00
Other Ocean Time	700	2.14	2.00	0.00	10.00

6.3.2 Bag Limits and Retained Catch

The distribution of catch per trip for the previous 12 months in the 2010 survey is given in Table 27 and the average catch per trip is shown in Table 28. In the 2003 species the “other high risk species” category was not used. In order to compare 2010 with 2003 the “other high risk” and “other” species groups for 2010 need to be combined. The final column of Table 27 and Table 28 shows the combined result for “other species”.

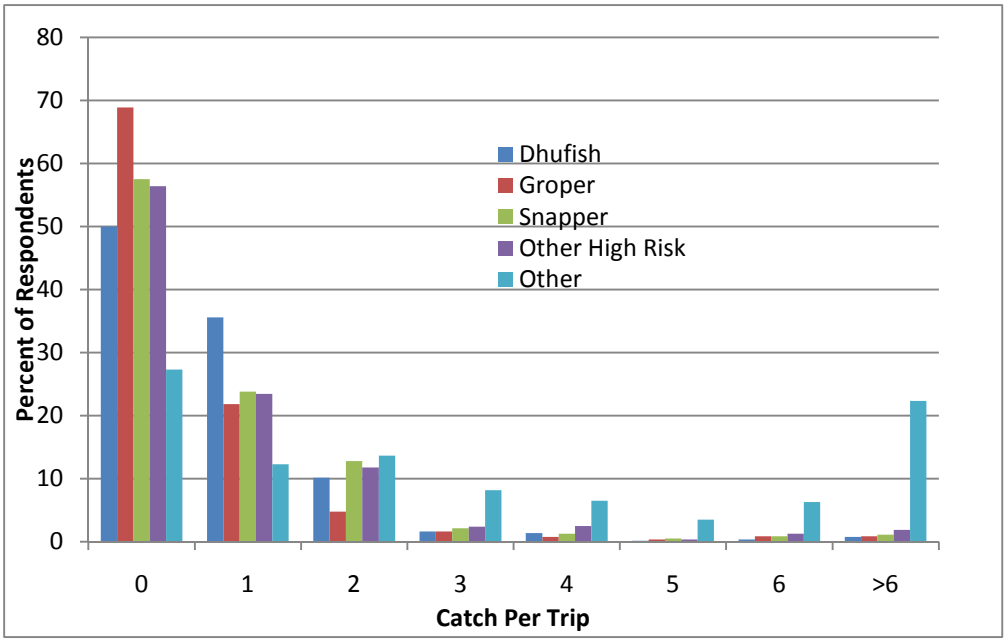
The 2010 survey results indicate that for dhufish, baldchin groper and pink snapper greater than 50% of respondents reported zero catch while over 80% reported catches of one or zero.

Once we come to the “other species” category the distribution spreads with 73% of respondents reporting a catch per trip greater than zero and twenty two percent reporting catch per trip greater than six. The distribution of retained catch per trip is shown in Table 27 and Figure 6

Table 27: Distribution by Retained Catch by Species for 2010 Survey

Number of Fish/Trip	Dhufish	Baldchin Groper	Pink Snapper	Other High risk	Other Species	All Other Combined
0	50	68.88	57.52	56.39	27.32	14.41
1	35.59	21.83	23.81	23.43	12.28	14.16
2	10.15	4.77	12.78	11.78	13.66	14.79
3	1.63	1.63	2.13	2.38	8.15	8.65
4	1.38	0.75	1.25	2.51	6.52	9.27
5	0.13	0.38	0.5	0.38	3.51	4.76
6	0.38	0.88	0.88	1.25	6.27	5.76
>6	0.75	0.88	1.13	1.88	22.31	28.2

Figure 6: Distribution by Retained Catch by Species for 2010 Survey



The retained catch statistics are given in Table 28 The mean catch per trip in the previous twelve months was 0.76 for dhufish, 0.83 for pink snapper, 0.57 for baldchin groper, 0.97 for the other high risk species defined in Table 19 and 5.99 for the remaining species. Combined “other” species have a mean of 6.97.

Table 28: Summary Statistics for Retained Catch 2010

	Dhufish	Pink Snapper	Baldchin Groper	Other High Risk	Other Species	All Other Combined
mean	0.76	0.83	0.57	0.97	5.99	6.97
min	0	0	0	0	0	0
max	12	22	20	30	200	204

6.3.3 Released Catch

Moving to the 2010 season there was a greater emphasis in management on release procedures catch including compulsory possession of a "release weight".

Table 29 shows the distribution of released catch per trip by species for the previous twelve months. Most respondents released none or only one fish.

The mean number of fish caught per trip are shown in Table 30. For dhufish the mean released catch per trip is 1.72 compared to 0.76 retained. For pink snapper the mean released catch per trip is 2.33 compared to only 0.83 retained. For baldchin groper the figure is 0.63 for released catch which only slightly above the mean of 0.57 for retained catch.

The retained catch relied heavily on other species. Other high risk species retained averaged 5.99 per trip but average released catch was less at only 1.11. For the other species category average retained catch was 6.97 per trip whilst average released catch was again less at 5.41.

Table 29: Distribution by Released Catch by Species for 2010 Survey

Number of Fish/Trip	Dhufish	Baldchin Groper	Pink Snapper	Other High risk	Other Species	All Other Combined
0	44.86	81.2	50	64.91	41.6	29.82
1	20.8	8.27	13.66	13.78	8.77	9.77
2	16.42	5.14	12.78	9.27	11.78	11.65
3	5.51	1.38	6.77	3.76	6.77	7.89
4	3.88	1.38	4.89	3.01	4.64	6.64
5	2.51	0.5	2.26	0.63	4.76	6.27
6	1.75	0.5	2.88	1.88	7.27	6.52
>6	4.26	1.63	6.77	2.76	14.41	21.43

Figure 7: Distribution by Released Catch by Species for 2010 Survey

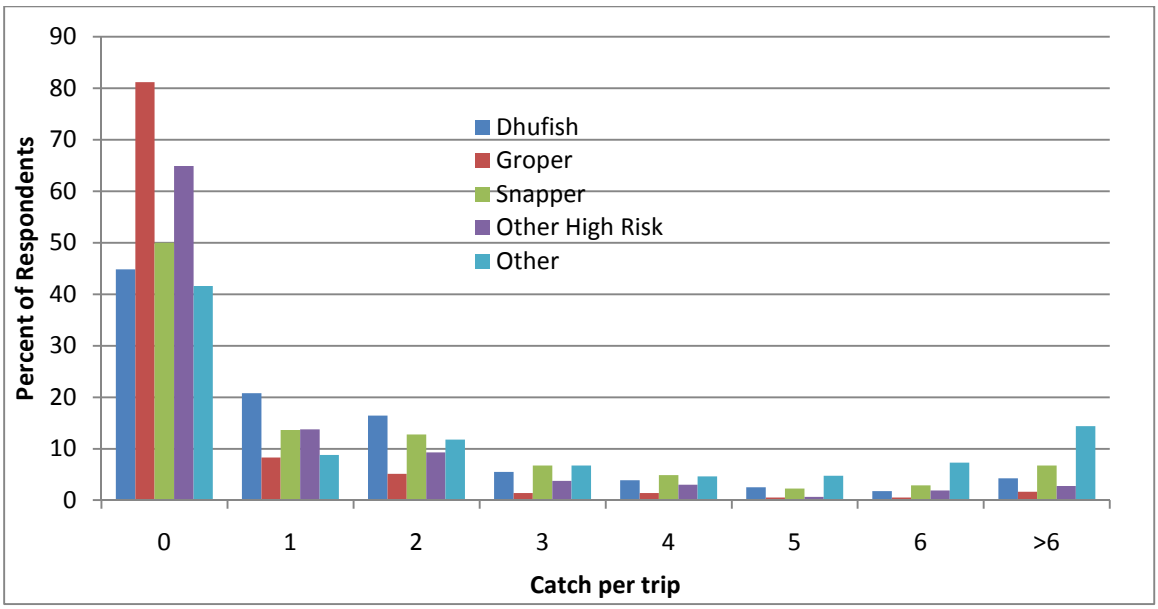


Table 30: Summary Statistics for Released Catch 2010

	Dhufish	Pink Snapper	Baldchin Groper	Other High Risk	Other Species	All Other Combined
mean	1.72	2.33	0.63	1.11	4.31	5.41
min	0	0	0	0	0	0
max	50	100	40	40	100	138

6.4 Satisfaction with the 2010 Fishing Experience

Questions to elicit satisfaction scores were also included in the 2010 survey dealing. These took the same form as for the 2003 survey and covered the degree to which fishers were satisfied with various aspects of their fishing experience. The scores for each aspect ranged from 1(very unsatisfied) to 5(very satisfied). The list of attributes considered and the mean scores are given in Table 31.

Table 31: Mean Satisfaction Scores for Dimensions of Fishing Experience 2010 Survey

	Mean Score
No congestion at the boat ramp	3.49
Catching as many fish as you expect to	3.09
The number of fish you catch and keep	3.32
The size of the fish you catch and keep	3.54
The species of the fish you catch and keep	3.53
The time it takes to catch the number of fish you expected to	3.84
The time it takes to catch the number of fish you want to keep	3.09
Catching enough fish for a decent feed	3.53
Enjoying the fishing experience, regardless	4.70

of the number of fish caught and kept	
Having an enjoyable time out on the ocean	4.79

On balance fishers in 2010 were well satisfied. Very high satisfaction scores were assigned to both the overall fishing experience and the overall experience of time on the ocean. The satisfaction scores for the broader fishing activity at above 4.5 are higher than the mean scores for any of the direct fishing activities. For the rest, respondents were reasonably happy.

6.5 Fishing Costs

A range of cost data was collected in the 2010 survey. Similar data was also collected in the 2003 survey.

Annual fishing costs for the previous twelve months are shown in Table 32.

Table 32: Annual Fishing Costs in 2010.

	N	Mean	Min	Max
Rods, reels, pots	750	671.92	0.00	14,000
Special clothing, incl hats, footwear	750	65.28	0.00	2,000
Diving gear	750	130.35	0.00	7,000
Boats and equip hire	750	372.29	0.00	120,000
Fishig club membership fees	750	35.37	0.00	1,600
Other	89	504.53	0.00	8,000

Very few respondents recorded expenditures over and above the main categories used. Excluding the "other" category the mean aggregate expenditure was $1275.

Boat related expenditures are shown in Table 33.

Table 33: Boat Related Expenditures

Variable	Obs	Mean	Min	Max	% Zero
New Boat or boat equipment (motor, sonar)	529	5305.06	0.00	185000.00	35%
Parts for boat, boat motor or trailer	529	602.37	0.00	35000.00	53%
Maintenance of boat, motor or trailer	529	656.12	0.00	10000.00	25%
Insurance for boat, motor or trailer	529	430.67	0.00	12000.00	24
Boat and trailer licence fees.	529	178.30	0.00	1000.00	2.5%
Boat club membership and pen fees	529	188.07	0.00	6500.00	86%
Other	529	29.63	0.00	5000.00	89%

The bulk of the respondents (86% and 89%) incur no club or pen fees and other costs.

7 Comparative Analysis of the Surveys

7.1 Comparing the Number of Fishing Trips Per Year

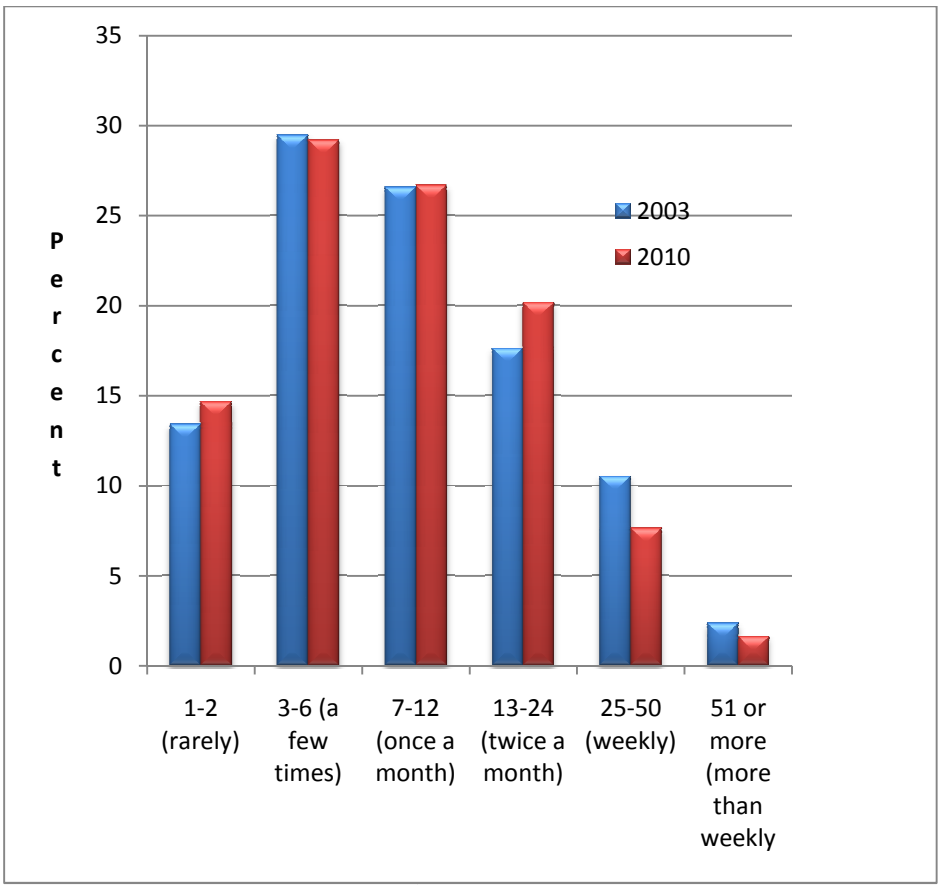
The 2003 survey recorded the exact number of trips in the previous 12 months; the 2010 survey recorded this information in ranges. The earlier survey has been recoded to match the most the ranges. Used in 2010. The results are shown in Table 34.

Table 34: Comparison of Number of trips in the Previous 12 Months 2003 and 2010

Description	Code	2003		2010	
		#	%	#	%
1-2 (rarely)	2	49	13.32	117	14.66
3-6 (a few times)	3	110	29.89	233	29.2
7-12 (once a month)	4	97	26.36	213	26.69
13-24 (twice a month)	5	64	17.39	161	20.18
25-50 (weekly)	6	39	10.60	61	7.64
51 or more (more than weekly	7	9	2.45	13	1.63
		368	100	798	100

Figure 8 shows the two frequency distributions compared.

Figure 8: Comparison of Number of trips in Previous 12 Months 2003 and 2010



The two distributions are not significantly different. The null hypothesis that they are the same cannot be rejected using the standard chi square test.

7.2 Comparison of Trip Time and Fishing time

The comparison of 2003 and 2010 fishing time is shown in Table 35. Mean trip and fishing times are lower in 2010 apart from the category “non Fishing Ocean time”.

Table 35: Trip and Fishing Times 2003 and 2010

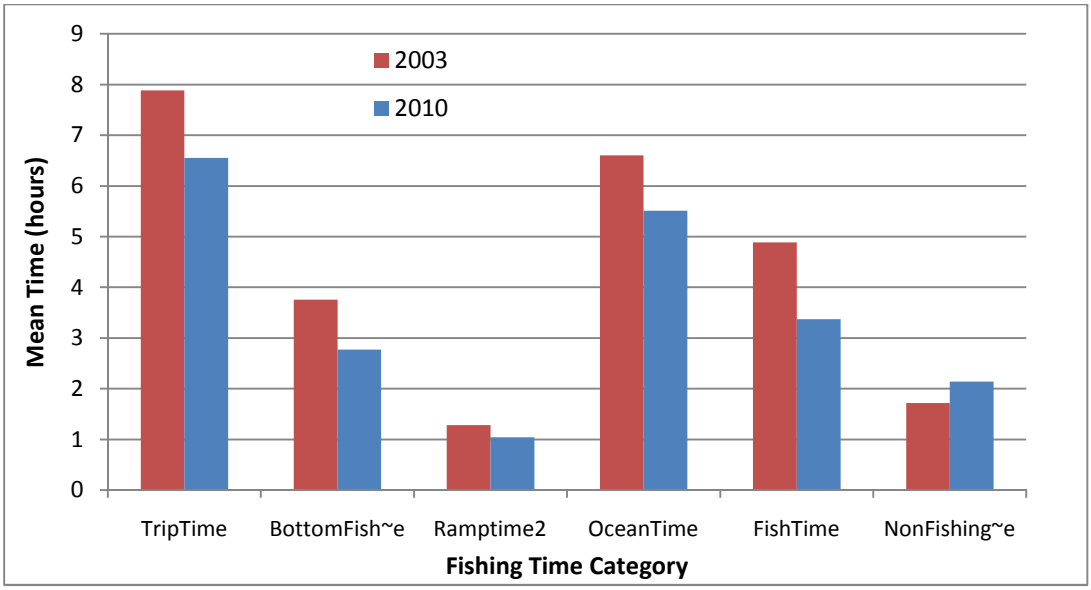


Table 36 shows the comparison between the mean trip and fishing times for 2003 and 2010 together with the t -values for the difference between the means. The differences are significant at 1% or better. The 2010 trip time, ocean time, fishing time, bottom fishing time are all significantly less than 2003. The non fishing time at sea is significantly higher in 2010 than it was in 2003.

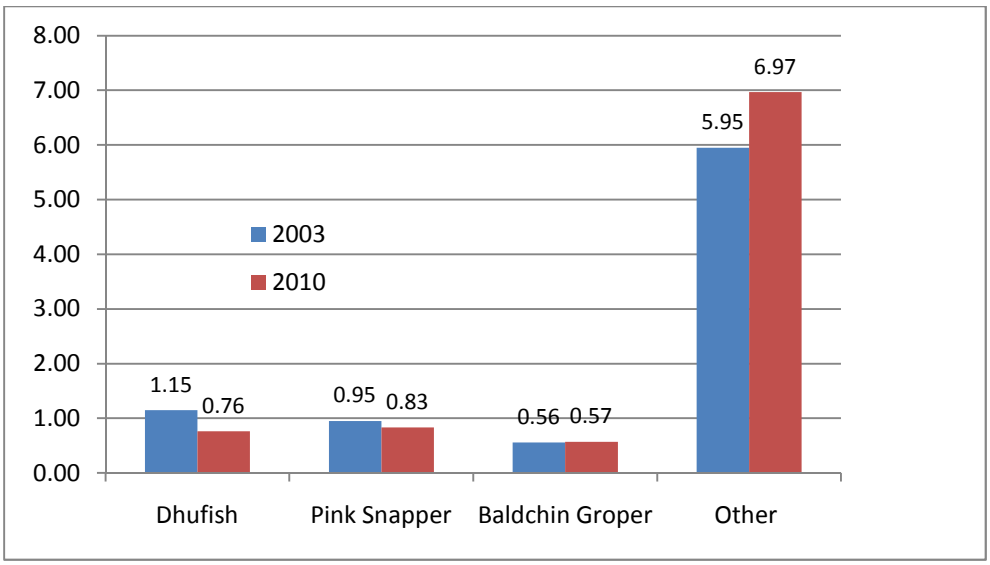
Table 36: Test of Difference in Mean Trip and Fishing Time Between 2003 and 2010.

		2003			2010		T value
	N	Mean	Std Dev	N	Mean	Std Dev	
Trip Time	363	7.88	3.24	700	6.55	3.00	6.5
Bottom Fishing	363	3.76	1.97	700	2.77	2.09	7.6
Ocean Time	363	6.60	2.74	700	5.51	2.24	6.5
Fishing Time	363	4.89	2.59	700	3.37	2.34	9.4
Other Ocean Time	363	1.72	2.12	700	2.14	2.00	-3.1

7.3 Comparing Retained and Released Catch

The catch performance of respondents across the two surveys is compared below. This is done on a retained/released catch basis by species. The mean catch per trip for the 2003 and 2010 surveys is given in Figure 9. Mean catch for dhufish, snapper and groper are marginally lower but higher for other species.

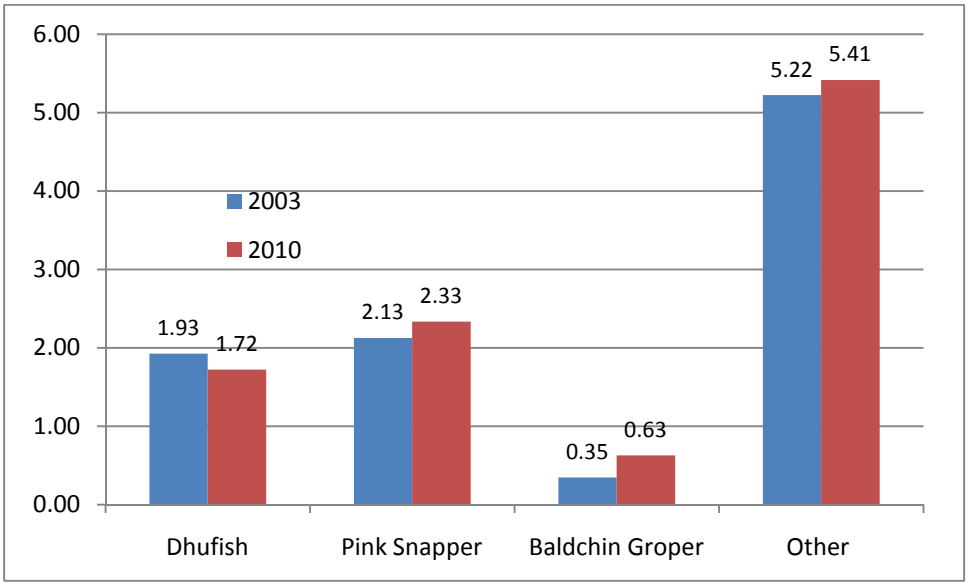
Figure 9: Mean Retained Catch Per Trip 2003 and 2010



The T-test on means indicates that, at the 5% significance level, the mean retained dhufish catch is significantly lower in 2010, but the mean catch per trip for snapper and groper and other species is not significantly different between the two periods.

The mean released catch per trip is shown in Figure 10.

Figure 10: Mean Released Catch Per Trip 2003 and 2010



The T-test on means indicates that, at the 5% significance level, the mean released groper catch is significantly higher in 2010, but the mean released catch per trip for dhufish, snapper and other species is not significantly different between the two periods.

7.4 Comparative Satisfaction Scores for Fishing in the West Coast Demersal Fishery

In the 2003 survey fishers were very satisfied with the overall fishing experience, less so with individual catch experience. (Table 17).

The 2010 survey contained a virtually identical set of questions dealing with the degree to which fishers were satisfied with various aspects of their fishing experience. The scores for each aspect ranged from 1(very unsatisfied) to 5(very satisfied). The mapping of these questions is shown in Table 37

Table 37: Mapping of Satisfaction Scale Questions Between 2003 and 2010

2003 Question		2010 Question	
10ba	No congestion at the boat ramp	15a	Level of congestion at the boat ramp
10bb	Catching as many fish as you expect to	15b	The number of fish you catch
10bc	The number of fish you catch and keep	15c	The number of fish you keep
10bd	The size of the fish you catch and keep	15d	The size of the fish you catch
		15e	The species of fish you catch
10be	The species of the fish you catch and keep	15f	The species of fish you keep
10bf	The time it takes to catch the number of fish you expected to	15g	The time it takes to catch the number of fish you expected to
10bg	The time it takes to catch the number of fish you want to keep		
10bh	Catching enough fish for a decent feed	15h	Catching enough fish for a decent feed
10bi	Enjoying the fishing experience, regardless of the number of fish caught and kept	15i	Enjoying the fishing experience, regardless of the number of fish caught and kept
10bj	Having an enjoyable time out on the ocean	15j	Having an enjoyable time out on the Ocean

The mean satisfaction scores for the two surveys are given in Table 38.

Table 38:Mean Satisfaction Scores 2003 and 2010

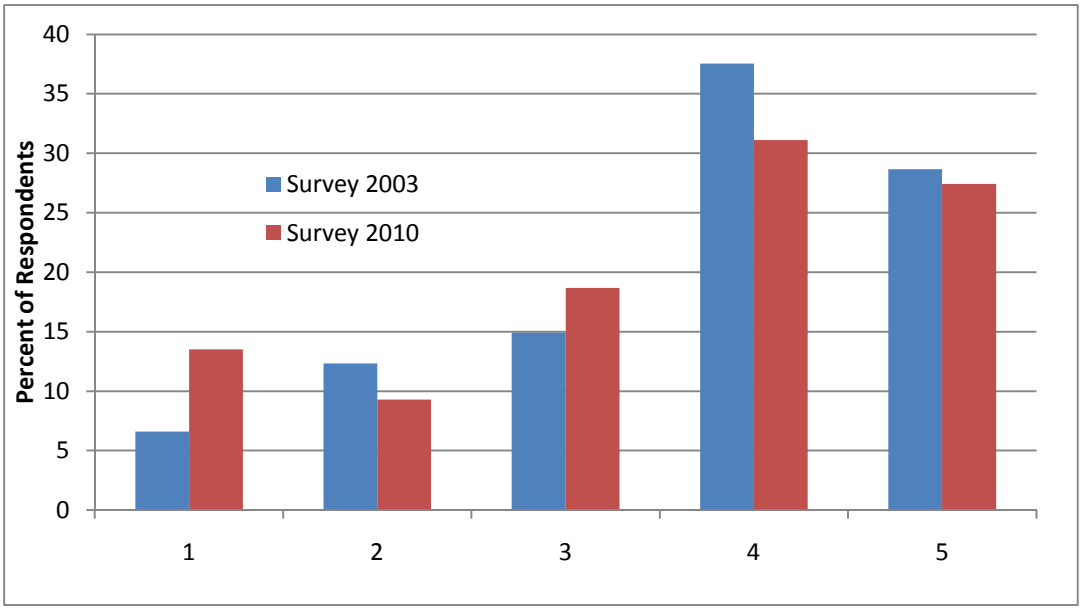
	2003	2010
Level of congestion at the boat ramp	3.69	3.50
The number of fish you catch	3.47	3.09
The number of fish you keep	3.59	3.34
The size of the fish you catch	3.67	3.56
The species of fish you keep	3.73	3.85
The time it takes to catch the number of fish you expected to	3.54	3.11
Catching enough fish for a decent feed	3.65	3.55
Enjoying the fishing experience, regardless of the number of fish caught and kept	4.50	4.69
Having an enjoyable time out on the Ocean	4.67	4.78

There appear to be minor differences in satisfaction but a more detailed analysis will reveal whether these differences are statistically significant.

7.4.1 Congestion at Boat Ramps

The satisfaction with boat ramp congestion is shown in Figure 11

Figure 11: Satisfaction Scores for Boat Ramp Congestion 2003 and 2010

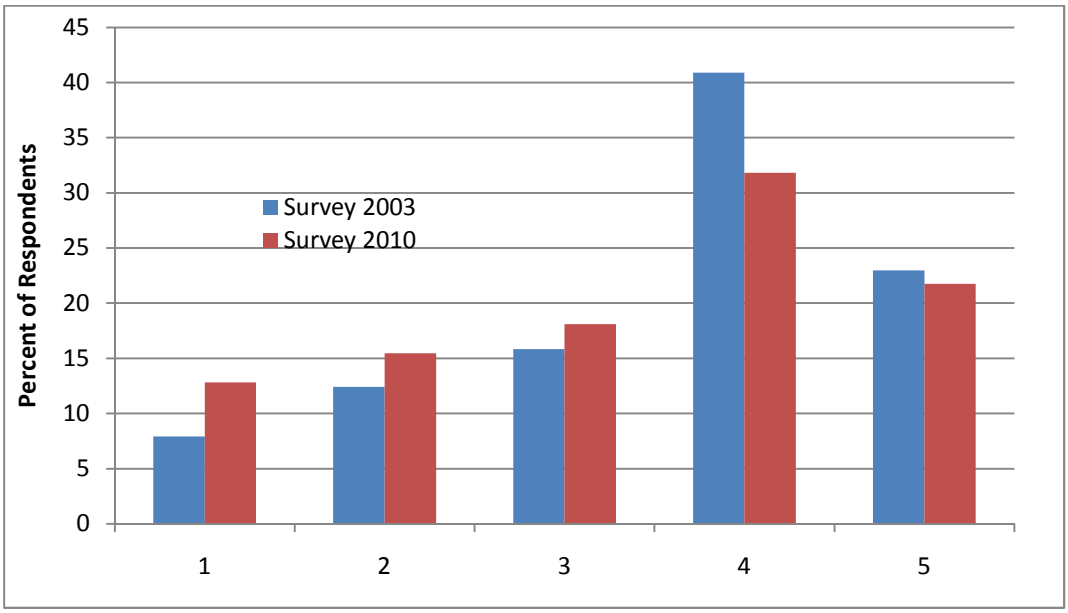


The distributions are significantly different indicating a statistically significant reduction in satisfaction across the two periods.

7.4.2 Fish Retained

Satisfaction with fish retained is given in Figure 12. Mean satisfaction fell from 3.59 to 3.34. The chi square test indicates that the distributions are significantly different. There has been a statistically significant fall is satisfaction with fish caught and kept.

Figure 12: Satisfaction Scores for Fish Retained 2003 and 2010



7.4.3 Size of Fish Retained

Satisfaction with fish retained is given in Figure 13. Mean satisfaction fell from 3.67 to 3.56. The chi square test indicates that the distributions are significantly different. There has been a statistically significant fall is satisfaction with fish caught and kept.

Figure 13: Satisfaction Scores for Size of Fish Retained 2003 and 2010

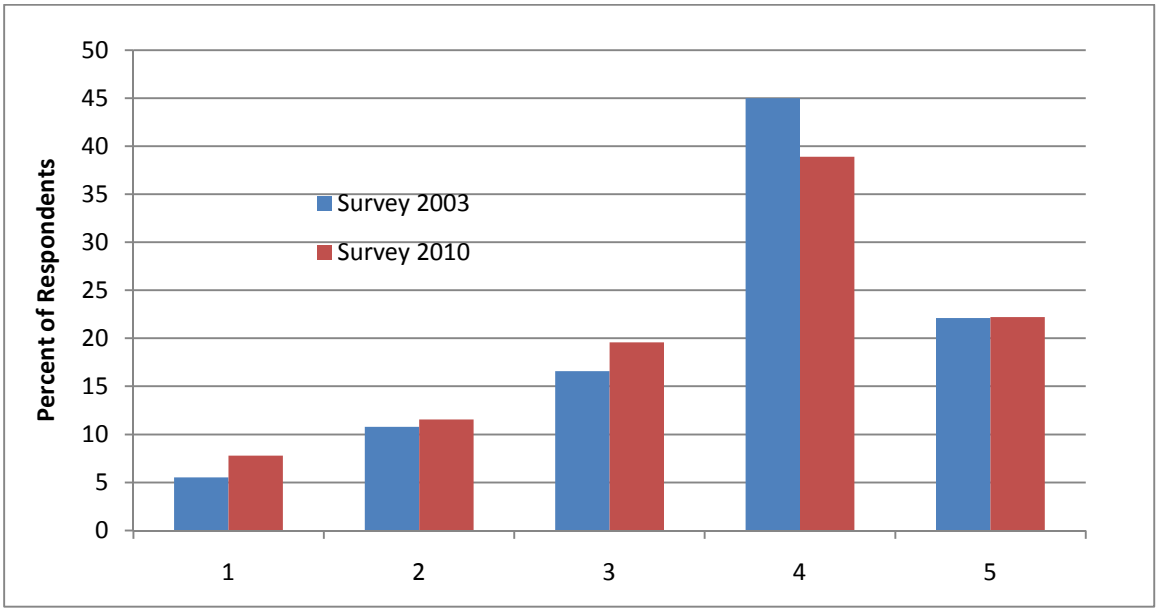
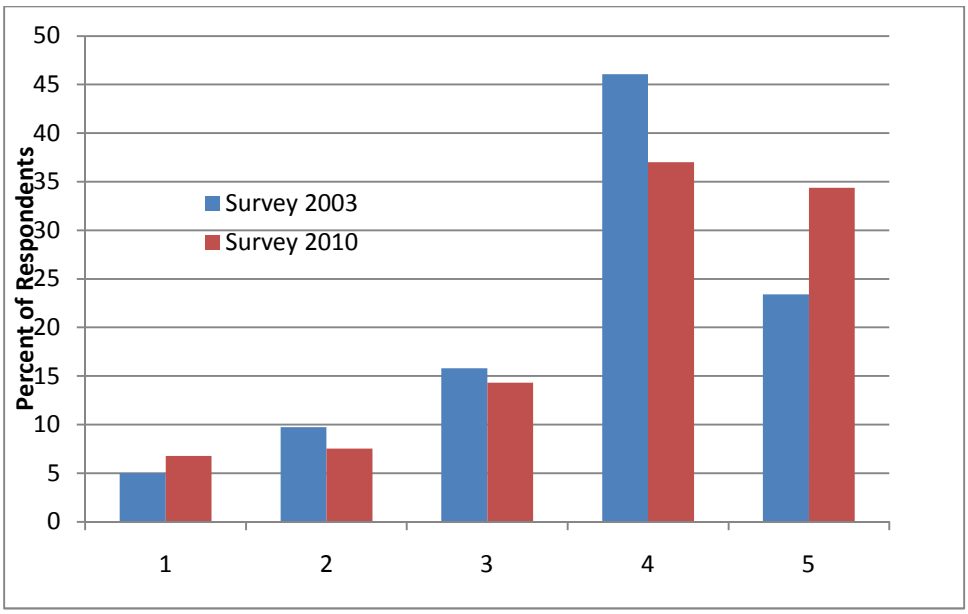


Figure 14: Species of Fish Caught

Satisfaction with fish retained is given in Figure 14. Mean satisfaction in this case actually increased from 3.73 to 3.85. The chi square test indicates that the distributions are significantly different. In this case we can reject the null hypothesis of zero difference in favour of their being an increase in satisfaction with species caught.

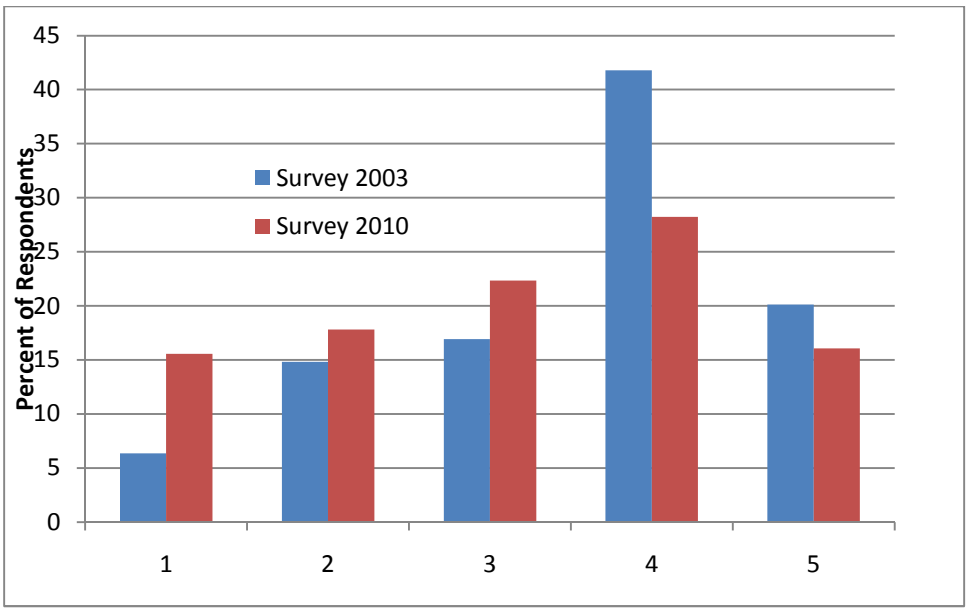
Figure 15: Satisfaction Scores for Species of Fish Caught 2003 and 2010



7.4.4 Time Taken to Catch Fish

In subsequent sections we investigate the role of catch rate in influencing behaviour. Satisfaction with catch rate is given in Figure 16. Mean satisfaction in this case decreased from 3.54 to 3.11. The chi square test indicates that the distributions are significantly different. In this case we can reject the null hypothesis of zero difference in favour of their being a decrease in satisfaction with catch rate.

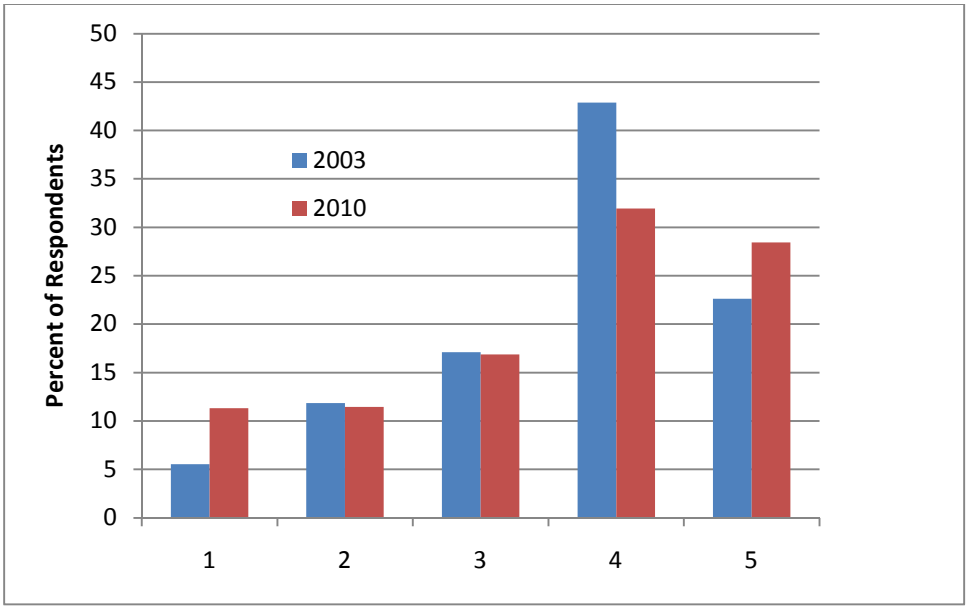
Figure 16: Time Taken to Catch Fish



7.4.5 Enough Fish for a Decent Feed

Satisfaction with catching enough fish for a decent feed is given in Figure 17. Mean satisfaction in this case decreased from 3.65 to 3.55. The chi square test indicates that the distributions are not significantly different. In this case we cannot reject the null hypothesis of zero difference in favour of their being a decrease in satisfaction with catch rate.

Figure 17: Satisfaction Scores for Catching Enough Fish for a Decent Feed 2003 and 2010

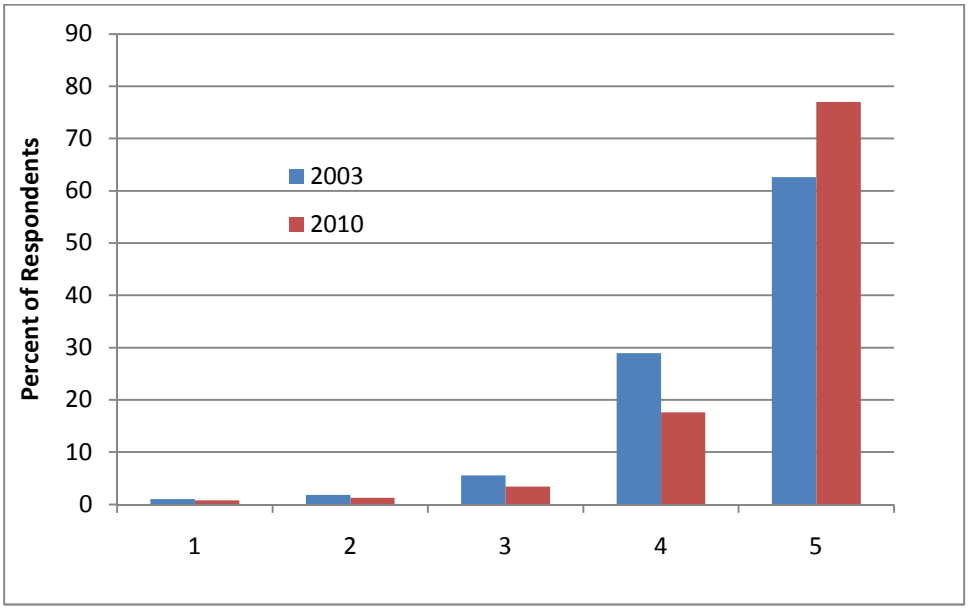


7.4.6 Overall Enjoyment of Fishing Experience

On most dimensions satisfaction scores have declined. The exceptions were satisfaction with species caught which increased and satisfaction with food value which was no different.

Satisfaction with overall fishing experience is given in Figure 18. Mean satisfaction in this case increased from 3.50 to 4.69. The chi square test indicates that the distributions are significantly different. In this case we can reject the null hypothesis of zero difference in favour of their being an increase in overall satisfaction with the fishing experience.

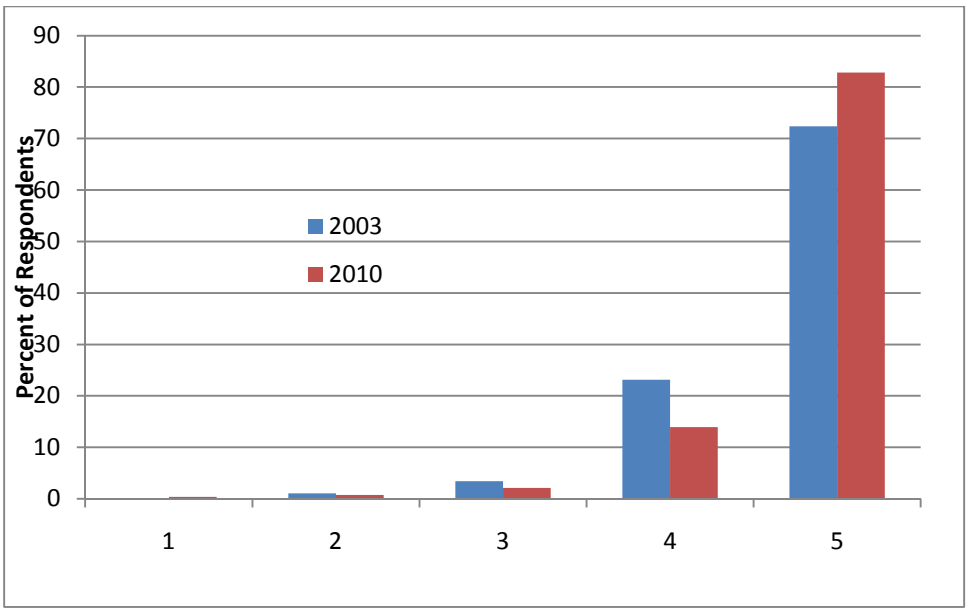
Figure 18: Satisfaction Score for Overall Enjoyment of Fishing Experience



7.4.7 Overall Enjoyment of Time on Ocean

As with the overall fishing experience respondents are also more satisfied with the overall ocean experience. Satisfaction with overall ocean experience is given in Figure 19. Mean satisfaction in this case increased from 4.7 to 4.8. The chi square test indicates that the distributions are significantly different. In this case we can reject the null hypothesis of zero difference in favour of their being an increase in overall satisfaction with the ocean experience.

Figure 19: Satisfaction Scores with Overall Trip on Ocean 2003 and 2010



8 2003 and 2010 Trip Response Functions

The comparison between trip times and catches indicates significant differences between the two surveys. These differences are also reflected in the significant differences in satisfaction between the two surveys. They indicate that fishing behaviour has changed significantly across the two periods.

An important further question is the how the changes in circumstances between the two periods and in the associated regulatory regimes has influenced the responsiveness of fishers to changes in variables such as catch rates and travel times.

There are two forces at work. Based on the model developed in Section 3, for a given number of trips per year, tighter regulations such as reduced bag limits reduce catch. This is expected to trigger changes in behaviour leading to a reduction in trip and fishing time, the substitution of non fishing trip time for fishing trip time. Al of this is consistent with the findings from the two surveys.

Tighter regulations are designed to reduce effort. The initial reduction in catches will give the biomass a chance to build up. Over time this will improve the catchability of the fish. It will also have an impact on the size of fish in the biomass and may result in the average size of fish caught increasing.

Of particular interest is the way fishers respond to changes in catchability and expected average size. The survey results indicate that satisfaction with both these aspects of the fishing experience declined across the two surveys.

8.1 Number of Trips, Fishing Time and Catch Rate

The previous analysis of the two surveys (Table 34) indicated that there was no significant difference between the distribution of trips per year across the two surveys However the analysis of trip times

indicated a significant shortening of trip time, ocean time and fishing time and a significant increase in non fishing trip time (Table 35).

Catchability is not something that can be directly analysed from the survey responses. It is the case that satisfaction with the time it takes to catch the fish declined significantly over the two surveys. This suggests that the perceived time it took to catch a given number of fish had declined. Catch rates can be used as a proxy for catchability, all other things equal.

Data on catch by species and fishing times is available from the survey data. The fishing time data that can be derived applied to the whole fishing activity. Within this time the fisher catches high risk and highly prized demersal scale fish as well as other fish. Hence, although catch data is available by species, it is appropriate to include all catch (all species and catch and release) in the estimated catch rate.

8.2 Analysis of Trips and Catch Rate

The 2003 survey collected data on the number of trips per year. The 2010 survey collected trip data in categories. The 2003 data was recoded to the equivalent categories to allow the following analysis. The comparison of the trip data from the two surveys indicated that the two distributions of trip frequency are not significantly different (Figure 8). The table of trip frequencies is repeated in Table 39.

Table 39: Trip Frequency for 2003 and 2010 Surveys

Description	Code	2003		2010	
		#	%	#	%
1-2 (rarely)	2	49	13.32	117	14.66
3-6 (a few times)	3	110	29.89	233	29.2
7-12 (once a month)	4	97	26.36	213	26.69
13-24 (twice a month)	5	64	17.39	161	20.18
25-50 (weekly)	6	39	10.60	61	7.64
51 or more (more than weekly	7	9	2.45	13	1.63
		368	100	798	100

Using the actual number of trips would enable conventional count data models to be estimated. These models have been used extensively in the literature,[6] including application to fisheries.[7]

When the dependent variable is categorical as in Table 39, ordinary regression or count data models will not suffice. When the outcome variable is categorical and ordinal as in Table 39, where the order of categories is meaningful but the distances between them are arbitrary, the logit model is appropriate. Ordinary regression is not appropriate because 5the it assumes that the distances between categories

[6] Count data models have been used to estimate recreational values routinely in valuation literature (Hausman *et al.* 1984; Shaw 1988; Grogger and Carson 1991; Creel and Loomis 1992; Englin and Shonkwiler 1995; 1995a; Bowker and Leeworthy 1998; Chakraborty and Keith 2000; Eiswerth *et al.* 2000; Ovaskainen *et al.* 2001; Shrestha *et al.* 2002).
[7] See Woodward and Griffin 2003; and Prayaga et al. 2010.

are the same – e.g. the distance from "rarely" and "a few times" equals to that from "twice a month" to "weekly", and this is not appropriate in the current case.

Stepwise ordered logit analysis was used to estimate a trip response function for each of the 2003 and 2010 surveys. The dependent variable was the frequency of trips are set out in Table 39. In both cases the independent variables included catch rate and catch rate squared and travel time to launch location. Explanatory variables were considered included: age, income, employment, gender, boat value, expenditures on various fishing items and satisfaction with the various aspects of the fishing experience. Apart from catch rate, catch rate squared and travel time launch location, the specification was not forced to be similar across the two surveys.

The best fitting ordinal logit model for 2003 is shown in Table 40. The best fitting ordinal logit model for 2010 is shown in Table 41.

Table 40: Ologit Trip Equation for 2003

Number of obs = 314						
LR chi2(9) = 39.59						
Prob > chi2 = 0.0000						
Log likelihood = -486.45068	Pseudo R2 = 0.0391					
McKelvey & Zavoina's R2:	0.13					
Dep. Var= Trip Frequency	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Catch Rate	0.1008	0.0348	2.89	0.004	0.0326	0.1691
Catch Rate^2	-0.0018	0.0008	-2.27	0.023	-0.0033	-0.0002
Travel Time	-0.2363	0.0647	-3.65	0.000	-0.3632	-0.1094
Top 30% income earners	0.5703	0.2335	2.44	0.015	0.1126	1.0279
Boat club pen fees	-0.0003	0.0002	-1.61	0.106	-0.0006	0.0001
Safety gear	-0.0016	0.0008	-2.12	0.034	-0.0031	-0.0001
Rods and reels	0.0003	0.0002	2.15	0.032	0.0000	0.0006
Fish club membership	0.0042	0.0025	1.66	0.096	-0.0007	0.0091
Book, magazines	0.0012	0.0008	1.56	0.118	-0.0003	0.0027
/cut1	-1.6181	0.2241			-2.0574	-1.1789
/cut2	0.0356	0.1929			-0.3425	0.4137
/cut3	1.2383	0.2065			0.8336	1.6429
/cut4	2.3725	0.2430			1.8963	2.8487
/cut5	4.5115	0.4544			3.6208	5.4021

Table 41: Ologit Trip Equation for 2010

Number of obs = 620						
LR chi2(8) = 59.00						
Prob > chi2 = 0.0000						
Log likelihood = -954.0507	Pseudo R2 = 0.0300					
McKelvey & Zavoina's R2:	0.100					
Dep. Var= Trip Frequency	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Catch Rate	0.03239	0.0117	2.78	0.01	0.0096	0.0552
Catch Rate^2	-0.00021	0.0001	-2.46	0.01	-0.0004	0.0000
Travel Time	-0.09433	0.0408	-2.31	0.02	-0.1742	-0.0145
Group Size	-0.16342	0.0634	-2.58	0.01	-0.2876	-0.0393
Satisfaction Overall Experience on Ocean	0.50802	0.1472	3.45	0.00	0.2195	0.7965
Rods and Reels	0.00019	0.0001	2.81	0.01	0.0001	0.0003
Club Membership	0.00159	0.0007	2.17	0.03	0.0002	0.0030
Diving Gear	0.00027	0.0002	1.79	0.07	0.0000	0.0006
/cut1	0.35294	0.7284			-1.0747	1.7806
/cut2	1.87984	0.7330			0.4431	3.3166
/cut3	3.10133	0.7399			1.6511	4.5516
/cut4	4.65376	0.7521			3.1796	6.1280
/cut5	6.55730	0.8071			4.9754	8.1391

Both equations are statistically significant using the Chi-square test indicating that the models are contributing to the explanation of trip frequency. The cut off used for a variable in the stepwise analysis was .15. Catch rate and catch rate squared are highly significant in both cases as is travel time to the boat launch site. After that the significant variables vary across the two periods. Expenditure on equipment is significant in both cases. The annual expenditure on rods and reels was included in both surveys and is significant. For 2003 expenditure on safety equipment such as life jackets and education and information is significant. Neither of these exist in the 2010 survey. For 2010 expenditure on club membership and diving gear is significant. Satisfaction with the overall ocean experience is significant in the 2010 survey but not the 2003 survey.

Using the 2010 function, Figure 20 shows how the probability of fishing more frequently goes up with catch rate. Fortnightly probability increases from .21 to .25 for a doubling of catch rate from 5 fish per hour to 10 fish per hour.

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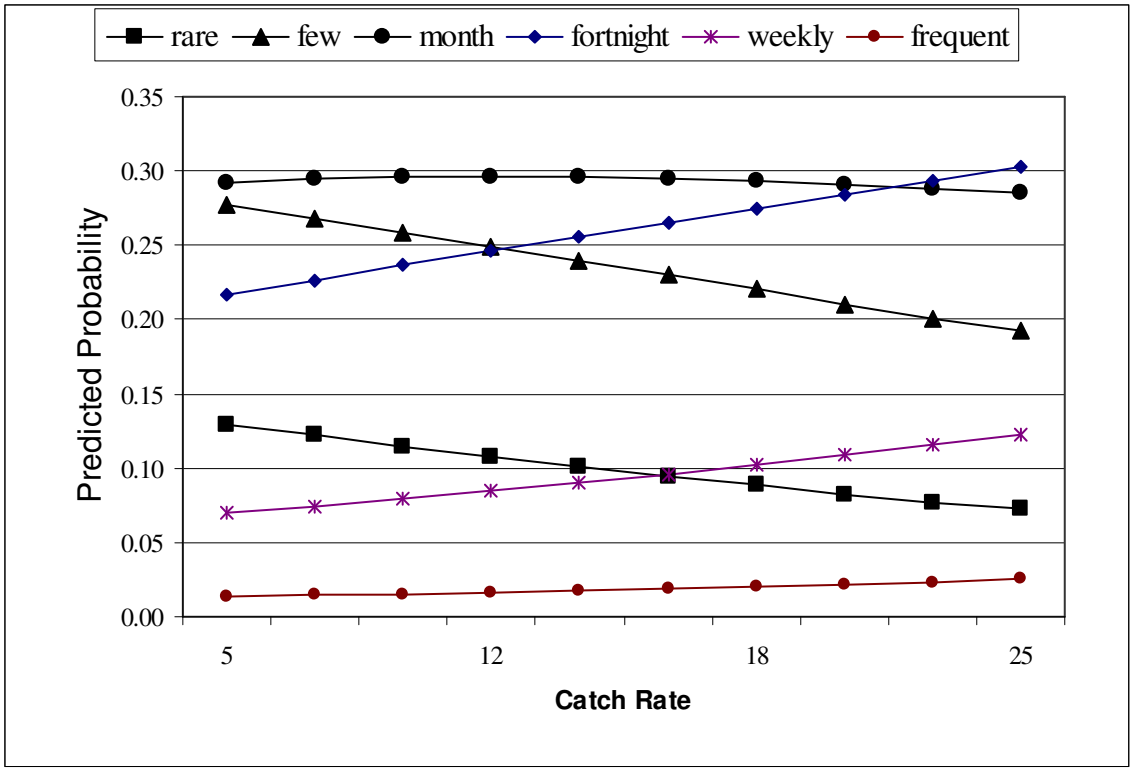
Figure 20: Change in Probability of Trips with Increase in Catch Rate



9 References

Anderson, L.G. 1993. Toward a Complete Economic Theory of the Utilization and Management of Recreational Fisheries. *Journal of Environmental Economics and Management* 24(3):272-95.

Baker, D. L. and Pierce, B.E. (1997) Does Fisheries Management Reflect Social Values? Contingent valuation Evidence from the River Murray. *Fisheries Management andEcology,* 4: pp. 19-15

Campbell, D and Murphy, J. (2005). The 2000-01 National Recreational Fishing Survey: Economic Report. Canberra: Depart of Agriculture, Forestry and Fishing.

Campbell, H. and Reid, C. (2000). "Consumption Externalities in a Commercial Fishery: the Queensland Beam Trawl Fishery." *Economic Record*. 76: pp. 1-14.

Farber, S. (2003). Valuing wild salmon: the economic approach. Chapter 19 in Gallaugher, P. and Wood, L. (eds) *Proceedings of World Summit on Salmon.* Vancouver; Simon Fraser University.

Gillig, D , Ozuna, T. and Griffin, W. (2000). "The Value of the Gulf of Mexico Recreational Snapper Fishery". *Marine Resource Economics*, 15: pp. 127-139.

Johnston, R. et al. (2006). “What Determines Willingness to Pay per Fish? A Meta-Analysis of Recreational Fishing Values”. *Marine Resource Economics*, 21: pp. 1-32.

Lawrence. K..S (2005). “Assessing the value of sea angling in South West England.”. *Fisheries Management and Ecology*, 12: pp. 369-3S75.

McLeod P. and Nicholls J. (2004). A Socio-economic Valuation of Resource Allocation Options Between Recreational and Commercial Uses: Part Four: ,The West Coast Wetline Fishery. Project 2001/065. Canberra: FRDC.

Prayaga. P., Rolfe, J. and N. Stoeckl. (2010). “The value of recreational fishing in the Great Barrier Reef, Australia: A pooled revealed preference and contingent behaviour model.” Marine Policy, 34 244–251.

South Australian Centre for Economic Studies. (1999). Value of New Zealand Recreational Fishing. Adelaide: SACES.

Toivonen. et al. (2004). “The economic value of recreational fisheries in Nordic countries.”. Fisheries Management and Ecology, 11: pp. 1-14.

Western Australian Department of Fisheries (2006). *A Ten Year Strategic Plan for Integrated Fisheries Management.* Perth: Department of Fisheries

Western Australian Department of Fisheries (2006). *A Guide to IFM Integrated Fisheries Management*. Perth: Department of Fisheries.

Western Australian Department of Fisheries. (2007a). *State of the Fisheries Report 2005-2006*. Perth: Department of Fisheries.

Western Australian Department of Fisheries. (2007b). Managing the Recreational Catch of Demersal Scalefish on the West Coast. Fisheries Management Paper No. 225. . Perth: Department of Fisheries.

Whitehead, J. et al. (2002). “Willingness to Pay for a Saltwater Recreational Fishing Licence: A Comparison of Angler Groups.”. Marine Resource Economics, 16: pp. 177-194.

Woodward, R. T. and Griffin, W. L. (2003). Size and Bag Limits in Recreational Fisheries: Theoretical and Empirical Analysis. *Marine Resource Economics* , 18, pp. 239-262

10 Appendices

10.1 2003 Survey

Introduction

Hi, I'm _____ from __ and we're conducting research into recreational fishing. Can I please speak to _____?

You would have received a letter from the Department of Infrastructure and Planning about this recently. This survey is about fishing experiences, particularly in the West Coast Wetline Fishery offshore between Augusta and Kalbarri, and should take about 15 minutes. Your answers are strictly confidential and will be reported in aggregate. ***Nothing in this survey should be taken to be current or intended policy of government or the opposition parties.***

Bottom Fishing Offshore in the West Coast Wetline Fishery Between Augusta and Kalbarri

Q 1 **To start with, do you go 'bottom fishing' (from a boat) in the West Coast Wetline fishery offshore between Augusta and Kalbarri for such species as dhufish, baldchin groper and pink snapper?**

Yes 1
No **(Terminate interview)** 2
Don't know **(Terminate interview)** 3

Q 2 **Over the past twelve months, about what percentage of your boat's use was offshore between Augusta and Kalbarri bottom fishing for such species as dhufish, pink snapper or baldchin groper?**

____ % **(If '0%', terminate interview)**

Q 3 **In the last twelve months, how many times have you been bottom fishing offshore between Augusta and Kalbarri for such species as dhufish, baldchin groper and pink snapper?**

____ times **(If '0 times', terminate interview)**

Q 4 **In the last twelve months, how long on average per trip did you spend bottom fishing offshore (from a boat) between Augusta and Kalbarri?**

_____ days **or** _____ hours

Q 5 **In the last twelve months, where did you go bottom fishing offshore between Augusta and Kalbarri for such species as dhufish, baldchin groper and pink snapper? (Accept multiples) (Probe for departure point and distance offshore, eg 5km off Hillaries boat ramp)**

_____ ..... ( )
_____ ..... ( )
_____ ..... ( )
_____ ..... ( )

Q 6 **In the last twelve months, which of these species did you specifically target when you went bottom fishing offshore between Augusta and Kalbarri? (Read out) (One answer for each species)**

	Yes	No
a) Dhufish	1	2
b) Pink Snapper	1	2
c) Baldchin groper	1	2
d) Other species	1	2

Q 7 **In the last twelve months, on average per trip, how many of the following species did you catch and keep when you went bottom fishing offshore between Augusta and Kalbarri? (Read out) (One answer for each species)**

a) Dhufish ..... _____ fish
b) Pink Snapper ..... _____ fish
c) Baldchin groper ..... _____ fish
d) Other species ..... _____ fish

Q 8 **In the last twelve months, on average per trip, how many of the following species did you catch and release when you went bottom fishing offshore between Augusta and Kalbarri? (Read out) (One answer for each species)**

a) Dhufish ..... _____ fish
b) Pink Snapper ..... _____ fish
c) Baldchin groper ..... _____ fish
d) Other species ..... _____ fish

Q 9 **How did you find out what places were likely to be the best for bottom fishing of such species as dhufish, pink snapper or baldchin groper? (Accept multiples) (Do not read out) (Do not prompt)**

I don't find out - just take pot luck 1
Word of mouth 2
Always go there / I just know / habit 3
Newspapers, magazines and publications 4
Angling/Fishing Club 5
Other **(specify)** _____ ..... ( )

Q 10 **I am going to read out factors about bottom fishing for such species as dhufish, pink snapper or baldchin groper offshore between Augusta and Kalbarri. As I read out each one, please tell me how important a role it plays in a successful fishing trip, and how satisfied you are with each factor. (Read out each statement.) (One importance rating and one satisfaction rating per statement.)**

	Not at all important	Not very	Quite	Very important	Very dissatisfied		Neutral		Very satisfied	NA
a. No congestion at the boat ramp.....	1	2	3	4	1	2	3	4	5	9
b. Catching as many fish as you expect to ..	1	2	3	4	1	2	3	4	5	9
c. The number of fish you catch and keep..	1	2	3	4	1	2	3	4	5	9
d. The size of the fish you catch and keep ..	1	2	3	4	1	2	3	4	5	9
e. The species of the fish you catch and keep.....	1	2	3	4	1	2	3	4	5	9
f. The time it takes to catch the number of fish you expected to.....	1	2	3	4	1	2	3	4	5	9
g. The time it takes to catch the number of fish you want to keep.....	1	2	3	4	1	2	3	4	5	9
h. Catching enough fish for a decent feed ..	1	2	3	4	1	2	3	4	5	9
i. Enjoying the fishing experience, regardless of the number of fish caught and kept ...	1	2	3	4	1	2	3	4	5	9
j. Having an enjoyable time out on the ocean.....	1	2	3	4	1	2	3	4	5	9

Most Recent Offshore Bottom Fishing Trip in the West Coast Wetline Fishery Offshore Between Augusta and Kalbarri for Such Species as Dhufish, Pink Snapper and Baldchin Groper

Q 11 **When was the last time you went bottom fishing offshore in the West Coast Wetline fishery between Augusta and Kalbarri for such species as dhufish, pink snapper or baldchin groper?**

_____ (date/month or # weeks ago)

Q 12 **Where was the boat launched? (Probe for boat ramp, pen or mooring) (One only)**

_____ .... ( )

Q 13 **Roughly how far did you go offshore? (Probe for rough location or distance)**

_____ .... ( )

Q 14 **How long did it take you travel (on the ocean from the boat ramp to the fishing spot back to the boat ramp) on the fishing trip?**

_____ hours

Q 15 **How long did you spend actually bottom fishing offshore between Augusta and Kalbarri trying to catch such species as dhufish, pink snapper or baldchin groper?**

_____ hours

Q 16 **How far did you travel (from home to the boat ramp and back again) to go on the offshore bottom fishing trip? (Include any side trips related to the fishing trip, eg getting petrol for boat, getting bait, picking up mates, etc. Exclude travel in the boat on the water.)**

_____ kms

Q 17 **And how long did it take you to travel that far?**

_____ hours or _____ days

Q 18 **How long were you away from home on your fishing trip?**

_____ hours or _____ days

Q 19 **What percentage of the time on the ocean did you spend: (Read out each statement first, then record percentage against each)**

a) Fishing (either from the boat or diving from the boat) ..... ____ %

b) Recreational diving..... ____ %

c) Cruising (excluding travelling to fishing spot) ..... ____ %

d) Other **(specify)** _____... ____ %

TOTAL **(check)** 100 %

Q 20 What species did you target to catch on that offshore bottom fishing trip? (Accept multiples)

- Dhufish 1
- Pink snapper 2
- Baldchin groper 3
- No species in particular 4
- Other **(specify)** _____.. ( )

Q 21 Including yourself, how many people were in the fishing group on that trip?

_____ people **(If = 1, SKIP to Q23)**

Q 22 What was the relationship of the other people to you? (Accept multiples)

- Friend(s)..... 1
- Spouse, partner or 'significant other' 2
- Parent(s) 3
- Children 4
- Extended family..... 5
- Other **(specify)** _____..... ( )

Q 23 On that trip, how many dhufish did you personally: (Read out)

a) catch and release? _____ dhufish

b) catch and keep? _____ dhufish

Q 24 (On that trip) how many pink snapper did you personally: (Read out)

a) catch and release? _____ pink snapper

b) catch and keep? _____ pink snapper

Q 25 (On that trip) how many baldchin groper did you personally: (Read out)

a) catch and release? _____ baldchin groper

b) catch and keep? _____ baldchin groper

Q 26 (On that trip) how many other species of fish did you personally: (Read out)

a) catch and release? _____ other species

b) catch and keep? _____ other species

Q 27 On that trip, did you personally: (Read out) (One only)

- Catch and keep the limit of dhufish, pink snapper or baldchin groper? 1
- Catch as many of these fish as you wanted within the limit? 2
- Not catch as many of these fish as you wanted?..... 3
- (None of these)..... 4

Q 28 Were you happy with the number of fish you personally caught (and not necessarily kept) that trip? (One only)

- Yes 1
- No 2

Q 29 Were you happy with the number of fish you personally kept that trip? (One only)

- Yes 1
- No 2

Q 30 Were you happy with the size of fish you personally caught (and not necessarily kept) that trip? (One only)

- Yes 1
- No 2

Q 31 Were you happy with the type of fish you personally caught (and not necessarily kept) that trip? (One only)

- Yes 1
- No 2

Q 32 Were you happy with the type of fish you personally kept that trip? (One only)

- Yes 1
- No 2

Q 33 Did you catch as many fish as you thought you would? (One only) (If no, ask if they thought they'd catch more or less)

- No, thought I'd catch more 1
- No, thought I'd catch less..... 2
- Yes, caught as many as I thought I would 3

Q 34 Did you keep as many fish as you thought you would? (One only) (If no, ask if they thought they'd catch more or less)

- No, thought I'd keep more 1
- No, thought I'd keep less..... 2
- Yes, kept as many as I thought I would 3

Costs of Fishing

Q 35 **Do you still own your registered boat?**

Yes 1

No **(SKIP to Q39)** 2

Q 36 **How long is your boat?**

_____ feet or _____ metres

Q 37 **What is the current market value of your boat including the motor?** *(round to the nearest $10)*

$ _____

Q 38 **In the last twelve months, how much money did you spend on:** *(round to the nearest $1)* **(Read out.)**

a. Boat and trailer licence fees? $_____

b. New equipment such as GPS or sounder or motor? $_____

c. Parts for the boat, motor or trailer? $_____

d. Boat, motor or trailer maintenance? $_____

e. Insurance for boat, motor or trailer? $_____

f. Boat club membership and pen fees? $_____

Q 39 **In the last twelve months, how much money did you spend on:** *(round to the nearest $1)* **(Read out)**

a. Fishing-related equipment for a motor vehicle such as roof racks or a tow bar? $_____

b. Life jackets and safety gear? $_____

c. Recreational fishing club membership? $_____

d. Rods, reels or other fishing equipment? $_____

e. Books, magazines, videos etc on boat fishing, locations, fishing gear, etc to help you find and catch fish $_____

f. Angling Club membership fees $_____

Q 40 **On a typical offshore bottom fishing trip for such species as dhufish, pink snapper or baldchin groper between Augusta and Kalbarri, how much did you spend on the following?** *(round to the nearest $1)* **(Read out)**

a. Accommodation? $_____

b. Food, drink and refreshments? $_____

c. Transport - petrol for vehicle? $_____

d. Petrol for boat? $_____

e. Parking and boat launching fees? $_____

f. Special clothing, hats, footwear or sunglasses for fishing? $_____

g. Bait and ice? $_____

Q 41 **A recent fisheries survey shows that many people on recreational fishing trips in the West Coast Wetline fishery for species such as dhufish, pink snapper and baldchin groper return without any of these fish. When people return with a catch, it is usually with less than 3 of these species, whilst 6 is exceptional.**

A fishing management strategy could be considered for the West Coast Wetline fishery to sustain the fishery and increase the chances of more reliable recreational catches of these prized species. The strategy would be funded by an annual recreational licence fee, which would entitle you to fish in the West Coast Wetline fishery and to catch and keep these and other species within daily catch and size limits.

All money collected would be paid into a dedicated fund to be used to improve coastal recreational fishing.

The alternative to the strategy is to leave things as they are. However, the locations, number and size conditions applying to these species may still need to be tightened to sustain the fishery.

Are you willing to buy an annual recreational fishing licence for $* that entitles you to go fishing in the West Coast Wetline fishery and to catch and keep up to x dhufish, y baldchin groper and z pink snapper per trip within existing size limits, and any other species within the existing catch and size limits? (One only)

Yes (**Skip to Q42**) 1

No (**Skip to Q43**) 2

*10.1.1.1.1.1 * Randomly assigned fees of $20, $30, $40, $50 and $60.*

x, y, z: Assign values from a look up table of fish baskets (see end of questionnaire).

Q 42 **(If 'yes' to Q41) Are you willing to buy an annual recreational fishing licence for $**?**
(Increase the start price by using the $5 intervals below and ask until a 'no' response is received. Record the price given for the last 'yes' response.)

** *$25 $30 $35 $40 $45 $50 $55 $60 $65 $70 $75 $80 $85 $90 …*

Last 'Yes' Price $_____

Q 43 **(If 'no' to Q41) Are you willing to buy an annual recreational fishing licence for $***?**
(Decrease the start price by using the $5 intervals below and ask until a 'yes' response is received. Record the price given for the 'yes' response.)

*** ***$55 $50 $45 $40 $35 $30 $25 $20 $15 $10 $5 $0***

'Yes' Price $_____

Demographics

Q 44 **Gender (record automatically)**

Male	1
Female	2

Q 45 **Which of these age categories do you belong to? (One only) (Read out)**

15 to 19 years	1
20 to 29 years	2
30 to 39 years	3
40 to 49 years	4
50 to 59 years	5
60 to 69 years	6
70 years or older	7
(Refused)	99

Q 46 **Which of the following best describes your situation? (One only) (Read out)**

Full time employment	1
Full-time student (not in paid employ)	2
Part time or casual employment	3
Unemployed	4
Home duties	5
Retired	6
Pensioner (disability, illness, age, etc)	7
Other **(specify)** _____	( )
(Don't know)	98
(Refused)	99

Q 47 **What is your personal weekly income before tax?** *(annual income indicated in brackets)*
(One only) (Read out)

Negative income	01
Nil income	02
$1–$79 ($1–$4,159)	03
$80–$159 ($4,160–$8,319)	04
$160–$299 ($8,320–$15,599)	05
$300–$499 ($15,600–$25,999)	06
$500–$699 ($26,000–$36,399)	07
$700–$999 ($36,400–$51,999)	08
$1,000–$1,499 ($52,000–$77,999)	09
$1,500 or more ($78,000 or more)	10
(Don't know)	98
(Refused)	99

That concludes the interview. Thank you for your time. (Standard Interview Closing Spiel.)

Fish Baskets

The baskets are the numbers of dhufish, pink snapper and baldchin groper that people can catch on each fishing trip. Use the answers to Q6 and Q20 (prized species targeted when bottom fishing in the West Coast Wetline Fishery) to make sure that the basket offered to the respondent includes a minimum of one fish for each of the species they target.

For example:

If they target dhufish only (of the three prized species), randomly select a proposed basket with at least 1 dhufish.

If they target pink snapper and dhufish, randomly select a basket with at least 1 dhufish, at least 1 pink snapper.

If they target all three of the prized species, randomly select a proposed basket with at least 1 dhufish, at least 1 pink snapper and at least 1 baldchin groper.

If they don't target any of the prized species, randomly select any of proposed baskets.

Basket	Dhufish (x)	Baldchin Groper (y)	Pink Snapper (z)
1	1	0	0
2	0	1	0
3	0	0	1
4	0	0	2
5	2	0	0
6	0	2	0
7	1	1	0
8	0	1	1
9	1	0	1
10	1	1	1
11	3	0	0
12	0	3	0
13	0	0	3
14	2	1	0
15	0	2	1
16	1	0	2
17	4	0	0
18	0	4	0
19	0	0	4
20	2	2	1
21	1	2	1
22	1	1	2
23	3	1	0
24	0	3	1
25	1	0	3
26	2	2	0
27	0	2	2
28	2	0	2
29	4	1	0

Basket	Dhufish (x)	Baldchin Groper (y)	Pink Snapper (z)
40	1	2	2
41	4	2	0
42	0	4	2
43	2	0	4
44	2	2	2
45	3	1	2
46	2	3	1
47	1	2	3
48	4	1	1
49	1	4	1
50	1	1	4
51	3	3	0
52	0	3	3
53	3	0	3
54	4	3	0
55	0	4	3
56	3	0	4
57	4	1	2
58	2	4	1
59	1	2	4
60	2	2	3
61	3	2	2
62	2	3	2
63	3	3	1
64	1	3	3
65	3	1	3
66	4	4	0
67	0	4	4
68	4	0	4

30	0	4	1
31	1	0	4
32	3	2	0
33	0	3	2
34	2	0	3
35	3	1	1
36	1	1	3
37	1	3	1
38	2	1	2
39	2	2	1

69	2	2	4
70	4	2	2
71	2	4	2
72	3	2	3
73	3	3	2
74	2	3	3
75	1	3	4
76	4	1	3
77	3	4	1

10.2 2010 Survey

Introduction

*Hello, I'm _____ from West Coast Field Services. We have been asked by the Department of Fisheries to conduct research into recreational fishing. Can I please speak to _____? **Reintroduce if necessary, then:***

You recently purchased a new Fishing From Boat License and I would like to ask you some questions about your fishing activities, particularly if you fish in the recreational offshore bottom fishery off the West Coast between Augusta and Kalbarri. This survey will take about 15 minutes and all responses will be held in the strictest confidence. Do you have the time to do it now or would you prefer I called back at a more convenient time? Two prizes of A200 each will be drawn from those people who take part in the survey.

Federal Privacy laws protect the confidentiality of any comments you make in relation to this survey. Your responses will be used solely for research purposes and while we prefer you to answer all the questions in the survey, you do not have to.

Part I: Bottom Fishing Offshore in the West Coast Wetline Fishery Between Augusta and Kalbarri in the last 12 months

Q 48 To start with, do you go fishing from a boat between Augusta and Kalbarri for species such as dhufish, baldchin groper, pink snapper and other bottom fish?

Yes..... 1

No **(Terminate interview)** 2

Don't know **(Terminate interview)** 3

Q 2 In the past 12 months, how much of your boat-based fishing was offshore between Augusta and Kalbarri bottom fishing for species such as dhufish, baldchin groper and pink snapper? (Probe)

0 (None) **(If '0%', terminate interview)**
1-25% A Quarter or less
26-50% More than a Quarter but less than Half
51-75% More than Half but Less Than Three Quarters
76-99% (More Than Three-quarters)
100% (All)
Don't know **(Terminate interview)**

Q 3 In the last 12 months, how many times did you go bottom fishing from a boat between Augusta and Kalbarri? (Probe)

0 times **(If '0 times', terminate interview)**

1-2 (rarely)

3-6 (a few times)

7-12 (once a month)

13-24 (twice a month)

25-50 (weekly)

>50 (more than weekly)

Don't know **(Terminate interview)**

Q 4 In this same 12 month period, how much of your boat-based fishing was spent fishing elsewhere in the state?

0 (None)
1-25% A Quarter or less
26-50% More than a Quarter but less than Half
51-75% More than Half but Less Than Three Quarters
76-99% (More Than Three-quarters)
100% (All)
Don't know

Q 5 Again, in the past 12 months, how many times did you fish from the shore between Augusta and Kalbarri? (Probe)

0 (none)

1-2 (rarely)

3-6 (a few times)

7-12 (once a month)

13-24 (twice a month)

25-50 (weekly)

>50 (more than weekly)

Don't know

Q 6 In the last twelve months, ON AVERAGE PER TRIP, how many of the following species did you catch and keep when you went bottom fishing offshore between Augusta and Kalbarri? (Read out) (One answer for each species)

a) Dhufish..... _____ fish
b) Pink Snapper..... _____ fish
c) Baldchin groper..... _____ fish
d) Other high risk
bottom species ..... _____ fish
d) Other species..... _____ fish
Don't know

Q 7 **In the last twelve months, ON AVERAGE PER TRIP, how many of the following species did you catch and release when you went bottom fishing offshore between Augusta and Kalbarri? (Read out) (One answer for each species)**

a) Dhufish..... _____ fish

b) Pink Snapper..... _____ fish

c) Baldchin groper..... _____ fish

d) Other high risk

bottom species ..... _____ fish

d) Other species..... _____ fish

Don't know

Q 8 **I am now going to ask you about THE LAST TIME you went bottom fishing for dhufish, pink snapper between Augusta and Kalbarri. How long did it take you to travel from home or the place you were staying to the boat ramp/marina?**

_____ hours _____ mins Don't know

How far did you travel to this boat ramp/marina?

_____ km Don't know

Q 9 **Approximately how long was the trip at sea? (Probe)**

____hours _____ mins Don't know

What proportion of the time on the boat did you spend fishing for bottom fish?

_____ hours _____ mins or _____ % Don't know

What proportion of the time on the boat did you spend fishing for other species?

_____ hours _____ mins or _____ % Don't know

Q 10 **Was your time spent fishing for bottom fish cut short or limited in any of the following ways?**

1. Ran out of time - other commitments ……..1

2. Couldn't catch preferred species ……..2

3. Caught the bag limit……. ……..3

4. Weather 4

10.2.1.1.1 5. Other **……(Specify**)……5

6. No 6

If Yes to more than one, which was the main reason (**One only**) ....

Q 11 Where was the boat launched from on this bottom fishing trip?

_____ **(Refer Checklist for Name) Include Don't know**

Q 12 Including yourself, how many people joined you on your last bottom fishing trip?

_____ people Don't know

Q 13 On this fishing trip, how many of the following species did you catch and keep and catch and release? (Read out) (One answer for each species)

1) Catch and Keep

a) Dhufish ……_____fish

b) Other high risk bottom fish species
such as pink snapper, baldcin groper,
breaksea cod, emperors, red snapper
…….._____fish

c) Other species……_____fish

Don't know = 98

2) Catch and Release

a) Dhufish ……_____fish

b) Other high risk bottom fish species
such as pink snapper, baldcin groper,
breaksea cod, emperors, red snapper
…….._____fish

c) Other species……_____fish

Don't know = 98

Q 14 Depending upon season, do you ever fish for any of the following? (Read out) (Accept multiples)

	Target 1= Yes, 2= No

a) Nearshore species such as Trevally ('Skippy'), King George whiting	
b) Pelagic species such as Samson fish	
c) Western rock lobster	
d) Crabs	

Q15 **I am going to read out some factors about fishing offshore between Augusta and Kalbarri. As I read out each one, please tell me how satisfied you are with each of these factors. (Read out each statement.) (One satisfaction rating per statement.)**

Now on a scale of 1 to 5, where 1 is Very Dissatisfied, 2 is (interviewer reads list)…How satisfied are you with:

		Very Dissatisfied	Moderately Dissatisfied	Neutral	Moderately Satisfied	Very Satisfied	NA
Level of congestion at the boat ramp		1	2	3	4	5	9
The number of fish you catch		1	2	3	4	5	9
The number of fish you keep		1	2	3	4	5	9
The size of the fish you catch		1	2	3	4	5	9
The species of fish you catch		1	2	3	4	5	9
The species of fish you keep		1	2	3	4	5	9
The time it takes to catch the number of							
fish you expected to		1	2	3	4	5	9
Catching enough fish for a decent feed		1	2	3	4	5	9
Enjoying the fishing experience, regardless							
of the number of fish caught and kept		1	2	3	4	5	9
Having an enjoyable time out on the							
Ocean		1	2	3	4	5	9

Part 2: Fishing Trips Anywhere in the State for a Range of Target Species between October 15 and December 15, 2009. (New behaviours due to new regs – closure, etc)

Q 16 **The first closure for a number of high-risk offshore bottom fish species occurred between October 15 and December 15, 2009 in the West Coast Bioregion (Between Kalbarri and Augusta). During this two month period before Christmas, was your fishing behaviour DIFFERENT IN ANY WAY to your usual fishing behaviour?**

Yes

No

Q 17 **Did you go fishing for species such as dhufish, pink snapper or baldchin groper OUTSIDE OF THIS BIOREGION during this two month period?**

Yes

No (**Go to Q 20**)

Don't know (**Go to Q 20**)

Q 18 How many times did you go bottom fishing for species such as dhufish, pink snapper or baldchin groper OUTSIDE OF THIS BIOREGION during this period?

0 times (**Go to Q 20**)

1 (once)

2 (once a month)

3-4 (twice a month)

5-9 (weekly)

>10 (more than weekly)

Don't know

Q19 What was the main reason for fishing OUTSIDE of the area between Augusta to Kalbarri? (One only)

10.2.1.1.2 On holidays ……..……..1

Working in the area……..2

10.2.1.1.3 Fishing is better ……..…….…….....3

Due to the closure in the West Coast Bioregion……4

Other**……(specify)……**5

Don't know 6

Q20 How many times did you go fishing from a boat between Augusta and Kalbarri during the 2 months from October 15th to December 15th, 2009?

0 times (**Go to Q 24**)

1 (once)

2 (once a month)

3-4 (twice a month)

5-9 (weekly)

>10 (more than weekly)

Don't know

Q21 During the two months between October 15th and December 15th 2009, which species group did you target?

	Target 1= Yes, 2= No
a) Bottom species	
b) Nearshore species such as Trevally (Skippy), King George whiting	
c) Pelagic species such as Samson fish	
d) Western rock lobster	
e) Crabs	

* Don't know = 98

Q 22 Again on this your last trip during this two month period, were you satisfied with the number of fish you caught? (One only)

Yes, caught at least as many as I thought I would 1

No, thought I'd catch more……..... 2

Q 23 Where was the boat launched from on you last boat-based trip in this period? (Probe for boat ramp/marina/town or suburb) (One only)

_____ **(Refer Checklist for Name) Include Outside the region, Don't know**

Q 24 How many times did you go fishing from the shore between Augusta and Kalbarri during this 2 month period?

0 times **(Go to Q 26)**

1 (once)

2 (once a month)

3-4 (twice a month)

5-9 (weekly)

>10 (more than weekly)

Don't know

Q 25 Where were you fishing from the shore? (Probe for town or suburb) (One only)

_____ **(Refer Checklist for Name) Include Don't know (Go to Q27)**

Q 26 What was your primary reason for NOT going fishing from a boat and/or the shore in the West Coast Bioregion during this period? (Read out Options) (Accept One only)

Other commitments (no time) 1

Couldn't catch preferred species due to the closure.....2

Not a regular fisher 3

10.2.1.1.4 General cost of fishing 4

10.2.1.1.5 Other **……(Specify)**…….....5

Don't know 6

Part 3: Fishing in the West Coast Bioregion Between Augusta and Kalbarri in the months after December 15, 2009.

On December 15, the closed season ended and you could resume fishing for offshore bottom fish in the region between Kalbarri and Augusta. I am now going to ask you some questions about your fishing activities over the four month period since December 15, 2009.

Q 27 Have your fishing activities changed in the period since December 15th 2009 in comparison to your typical fishing behaviour IN PREVIOUS YEARS?

Yes

No **(Go to Q29)**

Q28 How have your fishing activities changed? Do you (Accept multiple answers)

1. Fish more frequently (Yes=1 No=2)
2. Fish in a different location (Yes=1 No=2)
3. Fish for a longer period of time on each trip (Yes=1 No=2)
4. Target different species (Yes=1 No=2).

If Yes, which of the following do you target more often now?

	Target 1= Yes, 2= No
a) High risk demersal species such as dhufish, pink snapper, baldchin groper, breaksea cod, emperors and queen snapper	
b) Other bottom species	
c) Nearshore species such as Trevally (Skippy), King George whiting	
d) Pelagic species, such as Samson fish	
e) Western rock lobster	

f) Crabs	

* Don't know = 98

5. Other (Yes=1 No=2)**.....(Specify).....**

Costs of Fishing

Q 29 **Approximately how much did you personally spend in the last 12 months on the following items of fishing gear?**

	$
1. Rods, reels, pots, etc	_____
2. Special clothing, incl hats, footwear, for fishing	_____
3. Diving gear (incl. hire)	_____
4. Boat and other equipment hire	_____
5. Fishing club membership fees	_____
6. Other (specify) – (not ice & bait)	_____

Q 30 **Do you or anyone in your household own a registered boat which is used for fishing?**

No (**Go to Q 37**) 1

Yes 2

If Yes, Can I ask you a few details about the boat ?

Yes = 3,

No = 4 **(Go to 37)**

Q 31 **What type of boat is it?**

Powerboat – moored or penned 1

Powerboat – transported on trailer 2

Sailboat – moored or penned 3

Sailboat – transported on trailer 4

Other (**Specify**) 5

Don't know 6

Q 32 **On average, how many times has this boat been used for any purpose during the past twelve months?**

Don't know **(Go to Q 34)**

0 **(Go to Q 34)**

1-2 (rarely)

3-6 (a few times)

7-12 (once a month)

13-24 (twice a month)

25-50 (weekly)

>50 (more than weekly)

Q 33 **Of the total time that the boat was in use over the past 12 months, approximately what percentage of the time was the boat used for each of the following purposes? (Probe)**

1. Recreation/entertaining _____
2. Diving (not fishing) /swimming _____
3. Fishing _____
4. Racing _____
5. Other (specify) _____

_____

100%
6. Don't know

Q 34 **Are you the person responsible for the boat's expenses?**

Yes..... 1
No (**Go to Q 37**)..... 2

Q 35 **What is the current market value of your boat including the motor?** *(round to the nearest $1000)* **(Probe)**

$ _____

Don't Know = 98

Q 36 **In the last twelve months, how much money did you spend on:** *(round to the nearest $10)* **(Read out.) (Probe)**

g. New boat or equipment such motor, GPS or sonar? $_____
h. Parts for the boat, motor or trailer? $_____
i. Maintenance for boat, motor or trailer? $_____
j. Insurance for boat, motor or trailer? $_____
k. Boat and trailer licence fees? $_____
l. Boat club membership and pen fees? $_____
g. Other $_____

Q 37 **On a typical offshore fishing trip for such species as dhufish, pink snapper or baldchin groper between Augusta and Kalbarri, how much did you spend on the following?** *(round to the nearest $1)* **(Read out) (Probe)**

h. Accommodation? $_____
i. Food, drink and refreshments? $_____
j. Fuel for boat? $_____
k. Parking and boat launching fees? $_____
l. Bait and ice? $_____
f. Other $_____

Licenses

Q 38 You recently purchased a new Recreational Fishing From Boat License. Have you been fishing since?

Yes

No **(Go to Q41)**

Q39 Since obtaining the new license, do you think your fishing activities have or will change in any of the following ways? Do you/will you (Accept multiple answers, except for No Change)

- Fish more often…… 1
- Fish less often…… 2
- Fish from the shore…… 3
- Fish for rock lobster or abalone from a boat …… 4
- Other**……[specify]** …… 5
- No Change ……6

Q 40 Since purchasing your new Fishing From Boat License, how many people including yourself were fishing under your license on your last boat trip?

……..people

Q 41 Which of the following recreational licences do you currently hold?

- Umbrella licence ……1 (**Got to Q 42**)
- Rock lobster …… 2
- Abalone …… 3
- Marron…… 4
- South West freshwater angling …… 5
- Net fishing …… 6
- None ……7

Demographics

Q 42 Gender (record automatically)

Male…… 1

Female …… 2

Q 43 Which of the following best describes your situation? (One only) (Read out)

Full time employment	1
Full-time student (not in paid employ)	2
Part time or casual employment	3
Unemployed	4
Home duties	5
Retired	6
Pensioner (disability, illness, age, etc)	7
Other (**specify**) _____	( )
(Don't know)	98
(Refused)	99

Q 44 What is your personal weekly income before tax? *(annual income indicated in brackets)* **(One only) (Read out)**

Nil or Negative income	01
$1–$499 ($1–$25,999)	02
$500–$999 ($26,000–$33,799)	03
$1,000–$1,699 ($52,000–$88,399)	04
$1,700–$1,999 ($88,400–$103,999)	05
$2,000–$2,499 ($104,000–$129,999)	06
$2,500–$2,999 ($130,000–$155,999)	07
$3,000–$3,999 ($156,000–$207,999)	08
$4,000 or more ($208,000 or more)	09
(Don't know)	98
(Refused)	99

Thank you for your time. That completes the actual survey. You may be called back in case my supervisor needs to check my work. Apart from the checking process, you will not be contacted again after this survey, nor will your name be recorded on a separate database. Etc to be provided by WCFS.