# Net parameter analysis for Jersey's Bass (*Dicentrarchus labrax*) Fishery


The F/V Saucy Sue off the East coast of Jersey during gill netting trials in December 2020.

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## Introduction

The European Sea Bass (*Dicentrarchus labrax)* is one of Jersey's most prolific and commercially important fish species. Data suggests that Bass will grow to >90cm total length (TL) and reach maturity between 4 and 7 years of age (35 cm for males and 42cm for females) (Pawson & Pickett, 1987). Bass have historically been heavily targeted during their winter spawning season by mobile fishing gear and continue to be targeted through many different commercial metiers such as gillnet and rod and line fisheries. Bass are also a sought-after species for the recreational sector for both catch and release fishing and harvesting to a bag limit of two fish per person in Jersey.

This study focuses on the gillnet and rod and line fishery in Jersey as these are the most used metiers for targeting Bass. The current Minimum Landing Size (MLS) for bass in Jersey is 42cm Total Length (TL). Gillnet fisheries can be made generally selective through the use of different mesh sizes. Bass below the gill net's optimum (modal) length will avoid entanglement and larger bass above this modal length are less likely to become trapped as the gillnet will not be the correct size to entrap their body parts (Revill *et al*.2009). The exact length range of fish that become entangled depends on the gillnet geometry such a mesh size, monofilament gauge and hanging ratio (Revill *et al*., 2009) as well as fish morphology and behaviour. This allows a select size of bass to be caught with the appropriate mesh size. Data in relation to reliable size selection in gillnets is limited to a study conducted by CEFAS in 2009 which was in offshore areas (approximately 12 miles offshore). Considering the importance of gillnetting as a metier for the commercial fishery, the interest in bass from recreational stakeholders and lack of data regarding mesh size selectivity, a study was formed to assist local marine managers in selecting an appropriate mesh size for Jersey's Bass fishery.

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## Aim

- To understand how catches will differ according to target species and by-catch when using varying mesh sizes in the coastal waters of Jersey, Channel Islands.
- To gain an understanding of post-release mortality of caught fish species.
- To identify and document changes in fish morphology and length to weight relationships between seasons to better understand catchability.

# Methodology

## Study Site

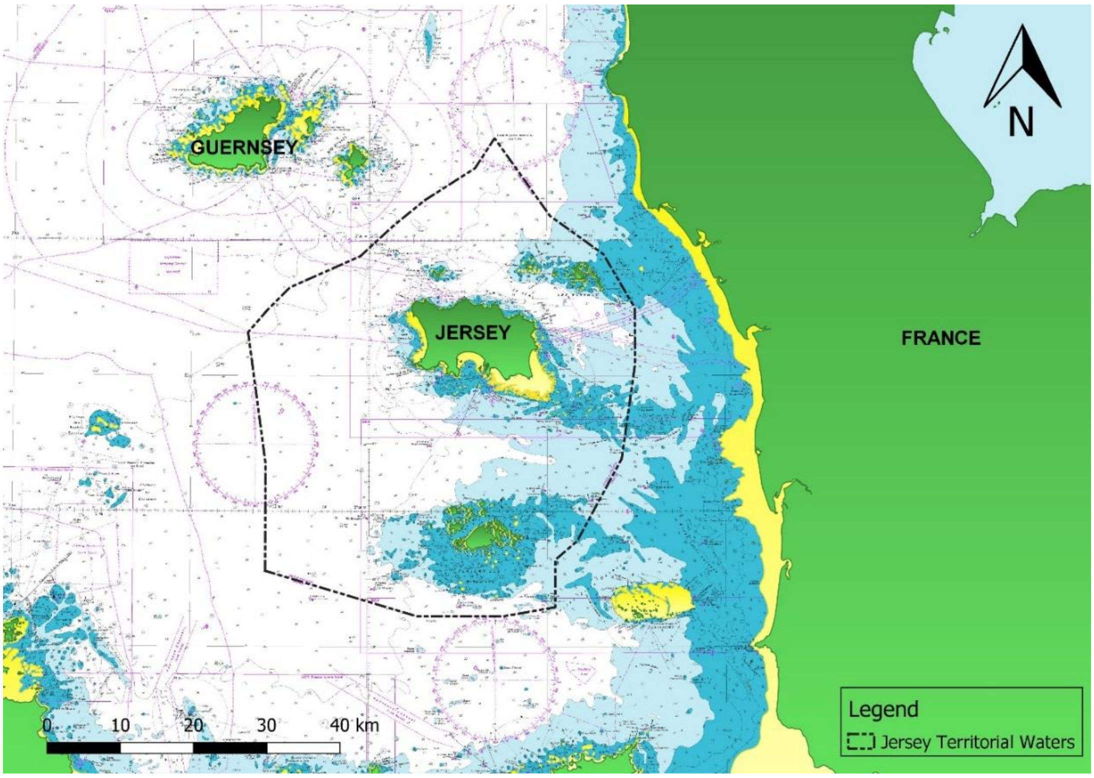


*Figure 1. The island of Jersey based within the Normano-Breton Gulf and surrounding Channel Islands and offshore reef systems.*

This study was conducted around the inshore waters of Jersey, the largest and southernmost of the Channel Islands in the Normano-Breton Gulf (49°12'N, 2°01W) which has a tidal range of 12m during spring tides. Jersey has a high tidal flow, clear water and rocky reefs making it a productive area for different bass fishing metiers. Vessels were chosen from the local commercial fishing fleet with the study being undertaken aboard FV *Saucy Sue*, FV *Mackerel Sky* and FV *Skye*. All gillnetting was aboard FV *Saucy Sue*. All three vessels are designed to fish mixed metiers including netting, and all hold current Jersey bass fishing permits. Fishing sites were decided on each sampling day by the fishing vessel's skipper. This was to represent their usual fishing patterns over similar weather, seasonal and tidal conditions.

Gill net soak locations were based around the east coast of Jersey due to the netting vessel *Saucy Sue* operating out of Gorey harbour on the east coast of the island. Precise locations have been masked in this report to protect fishing locations (Figure 2).

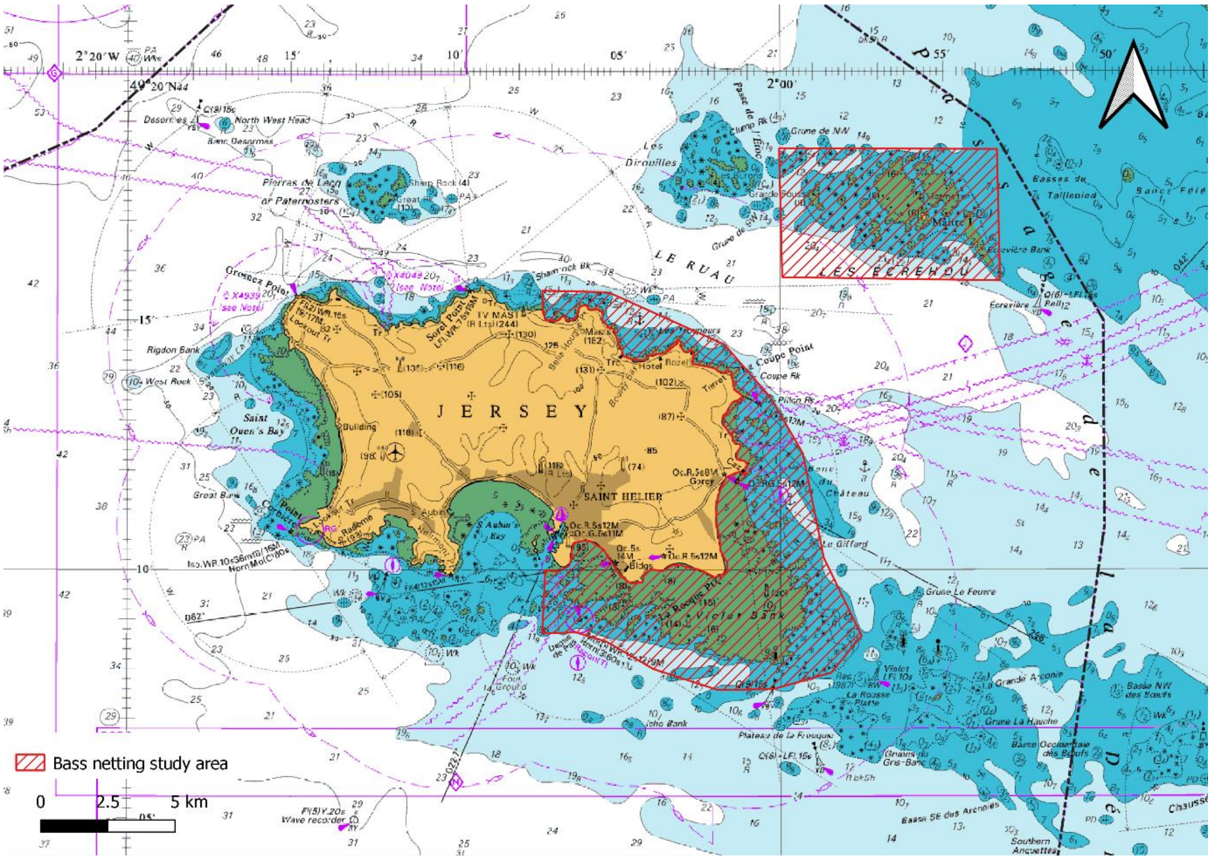


*Figure 2. Total area fished during netting trials.*

## Gear Selection

Gill net mesh sizes of 100 mm, 108 mm, 110 mm and 112 mm were trialled. These sizes had been discussed and agreed at a meeting with local industry experts with the object of finding a modal length of Bass which suited the current MLS and size abundance of fish around Jersey's inshore waters. Each net was measured for accuracy with an Omega mesh gauge (Table 1). Twenty different meshes were measured throughout the length of each net. This was repeated at the end of the study.

*Table 1. Mesh size differences between advertised measurements and measurements taken using omega gauge.*

| Mesh Size as Advertised (mm) (October 2020) | Omega gauge size (mm) | Difference (mm) from advertised | After trials (April 2022) | Difference (mm) after study |
|---|---|---|---|---|
| 100 | 99 | 1 | 102 | 3 |
| 108 | 105 | 3 | 109 | 4 |
| 110 | 108 | 2 | 111 | 3 |
| 112 | 112 | 0 | 117 | 5 |

Each gill net was 90 metres in length and three metres high (27 to 30 meshes deep). All gillnets were manufactured to be as close to three metres height as possible, and the same gill nets were used throughout the study apart from the 108 mm net which was replaced in April 2021.


*Figure 3. All four net bins with associated gill nets and anchors.*

All nets were maintained and cleaned after each deployment. Netting took place between 8th October 2020 and 5th April 2022. Soak times varied throughout the study due to tidal restrictions in both the outlying harbours where the study operated from and due to depth ranges during certain states of tide dropping below safe operating levels. All gillnets used during the trials were identical in construction (aside from the mesh sizes) and rigged individually. The gillnets were placed in marked net bins allowing officers to identify different mesh sizes during fishing operations (Figure 3).

## Experimental Design

Each deployment of a net was in close proximity (<200 metres) to another to allow for similar soak times. Nets were hauled either by hand or with the use of a net hauler. On retrieval of the nets, all fish were removed from the mesh as quickly as possible with the capture position of the bass in the net recorded. This was marked down as either gilled (meshed immediately behind the gill cover), entangled (wrapped into the netting), or wedged (meshed around the body behind the gill cover). At this point, any damage to the fish would also be noted down (Table 2). By-catch species were sorted into fish trays and separated by mesh size caught. All fish were identified and measured by a fisheries officer on board. All Bass (*Dicentrarchus labrax*) and by-catch species that were enmeshed including undersize individuals were measured for total length (cm) with the weight (kg) of each animal being recorded. Three girth measurements were taken on all Bass (*Dicentrarchus labrax*) to identify morphometric differences. Girth measurements were taken on the edge of the gill cover, the anterior of the first dorsal (D1) and posterior of the first dorsal (D2) (Figure 4). All gill nets were set in shallow, mixed ground areas with high tidal flow.

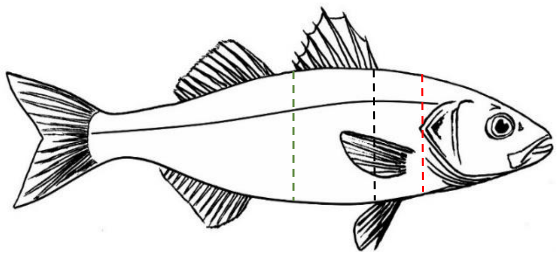

*Figure 4. Girth measurement locations starting from head to caudal fin. Gill cover (red), anterior of first dorsal (black) and posterior of first dorsal (green).*

Post-release mortality of bass was measured with the use of a large 'live well' onboard the research vessel. The aerator for the live well was powered by an external 12v battery to ensure the vessels power supply would not be drained. Undersize Bass and by-catch species were assessed and released into the live well once caught and observed for between 5 and 90 minutes before being released (Figure 5). Not all by-catch species were assessed for post release mortality.

Hook and line fishing techniques were used abord FV Skye and FV Mackerel Sky to obtain Bass measurements during the summer months when gill netting is not viable due to environmental conditions such as floating seaweed and large levels of Spider crabs (*Maja squinado*).

*Table 2. Damage of all fish was grouped into 12 different categories* (*Revill* et al.*2009*).

| Damage | Description |
|---|---|
| Abrasion | Haemorrhaging red area from abrasion |
| Bleeding | Obvious bleeding from any location |
| Bruising Body | A body injury to underlying tissues in which the skin is not broken, often characterised by ruptured blood vessels and discolouration's. |
| Bruising Fin | A fin injury to underlying tissues in which the skin is not broken, often characterised by ruptured blood vessels and discolouration's. |
| Fin Fraying | Fins damaged possibly, with slight bleeding |
| Internal organs exposed | Internal organs exposed with wounds |
| Net marks | Any type of clearly visible net marks on body from trawl, gillnet etc. |
| Scale loss | Obvious area of scale loss |
| Scratches | Thin shallow cut or mark on a surface. |
| Partial bloating | Abdomen swollen, due to inflated swim bladder, tight to touch, fish floats to surface of tank when not swimming. |
| Full bloating | Abdomen swollen, due to inflated swim bladder, tight to touch, fish floats at surface of tank and cannot dive |
| Wounding | Nicks or cuts on body |

*Figure 5. Bass live well with 7 juvenile Bass in.*

## Statistical data analysis and modelling

Data manipulation and visualisation were carried out in the statistical program R (R Core Team 2018) using the packages in the tidyverse (Wickham *et al.* 2019). To assess the selectivity of mesh size for length of bass, Generalised Linear Mixed Effects Models (GLMMs) were used in R (Wickham *et al.*, 2019). Optimal models were determined using the Akaike Information Criterions (AIC) in which an iterative process was used to determine variable contribution to model fit. The response variable of total length was modelled as a function of Mesh Size (100, 105, 110, and 112 mm) with soak time as a random effect. Total length was modelled using a Gamma distribution with a log link.

To assess correlations between bass total length and girth measurements, scatter plots were created with linear regression lines. This was repeated for all three girth measurements.

Bar charts were used to show frequency of length distributions for each mesh size; the vitality (number of live and dead) of bass caught using the various mesh sizes and fishing methods (nets or hook and line), standardised by hour fished; the number of each bycatch species, and the vitality (number alive and dead), standardised by trip.

# Results

## Gill net catch

During the study, 22 successful netting trips took place aboard F/V *Saucy Sue* with each haul providing catch data from all four mesh sizes. During the netting trial, 294 bass were caught ranging in size from 28 to 69 cm including 21 by-catch species (Table 3).

*Table 3. Raw catch data from 14 deployments of four different mesh size gillnets.*

| Species caught (Scientific name) | Common name | Gillnet mesh size (mm) | | | | Number of fish caught |
|---|---|---|---|---|---|---|
| | | 99 | 105 | 110 | 112 | |
| *Alosa alosa* | Allis Shad | 1 | 0 | 0 | 0 | 1 |
| *Cancer pagarus* | Chancre Crab | 0 | 0 | 0 | 1 | 1 |
| *Chelon aurata* | Golden Grey Mullet | 1 | 0 | 0 | 0 | 1 |
| *Chelon labrosus* | Thick Lipped Mullet | 24 | 32 | 2 | 12 | 70 |
| *Chelon ramada* | Thin Lipped Mullet | 2 | 1 | 0 | 1 | 4 |
| *Dicentrarchus labrax* | Bass | 121 | 109 | 33 | 31 | 294 |
| *Homarus gammarus* | Lobster | 3 | 1 | 4 | 0 | 8 |
| *Labrus bergylta* | Ballan Wrasse | 21 | 12 | 5 | 15 | 53 |
| *Maja squinado* | Spider Crab | 1 | 1 | 1 | 1 | 4 |
| *Mullus surmuletus* | Red Mullet | 1 | 1 | 0 | 0 | 2 |
| *Mustelus asterias* | Starry Smoothound | 9 | 1 | 9 | 4 | 23 |
| *Pleuronectes platessa* | European Plaice | 0 | 0 | 1 | 0 | 1 |
| *Pollachius pollachius* | Pollack | 7 | 4 | 3 | 5 | 19 |
| *Scomber scombrus* | Mackerel | 2 | 1 | 2 | 1 | 6 |
| *Scyliorhinus canicula* | Lesser Spotted Catshark | 192 | 30 | 22 | 15 | 259 |
| *Scyliorhinus stellaris* | Bull Huss | 1 | 0 | 1 | 1 | 3 |
| *Solea solea* | Dover Sole | 1 | 1 | 2 | 3 | 7 |
| *Sparus aurata* | Gilthead Bream | 12 | 3 | 0 | 0 | 15 |
| *Spondyliosoma cantharu* | Black Bream | 31 | 15 | 6 | 2 | 54 |
| *Trisopterus minutus* | Pouting | 3 | 0 | 1 | 0 | 4 |
| *Zeugopterus punctatus* | Topknot | 0 | 0 | 0 | 1 | 1 |

## Net Selectivity

Selectivity is high when using netting as a metier to target bass (Figure 6). The most frequently caught size class is 42 to 52 cm when using nets with meshes between 100 and 112 mm.

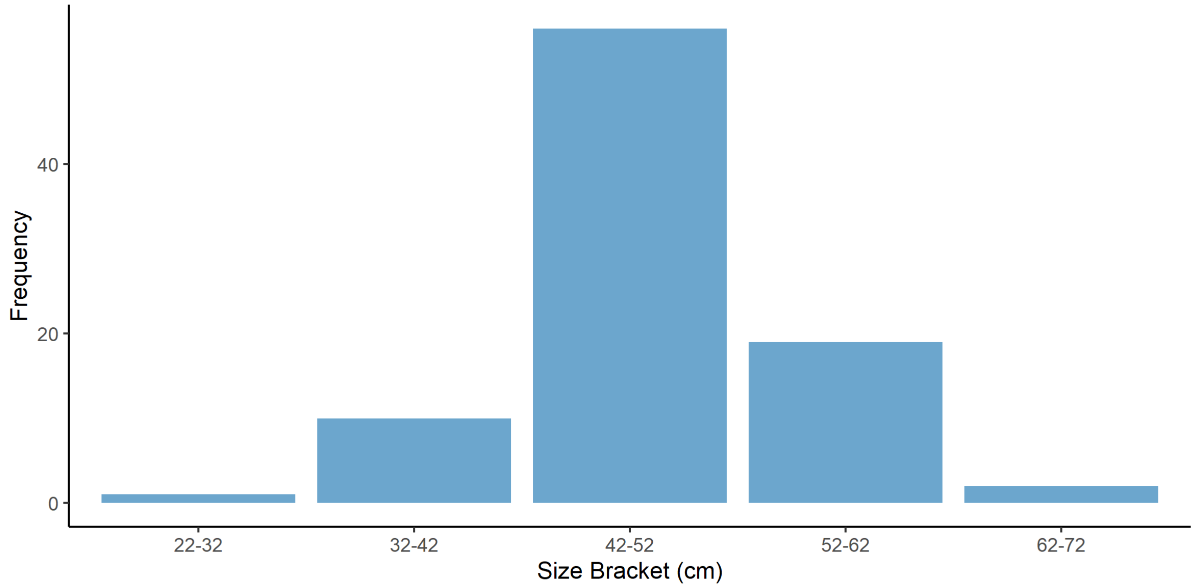


*Figure 6. Size selectivity of bass caught during gill net trials using meshes ranging from 100-112mm.*

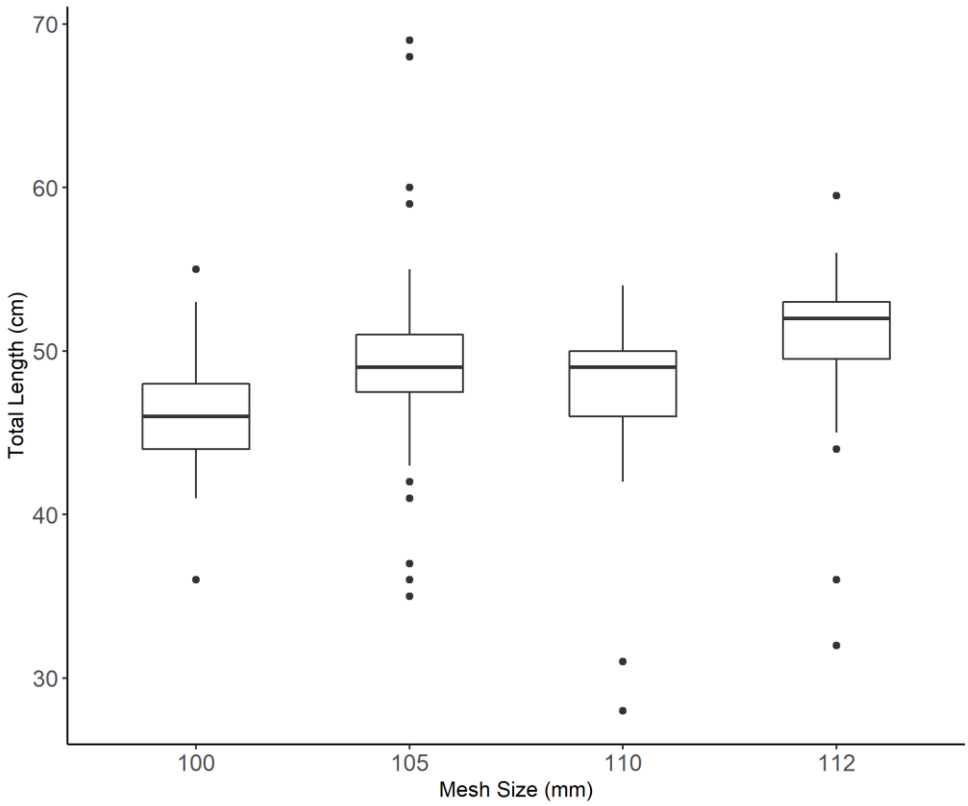


*Figure 7. Total length (cm) of bass caught per mesh size (mm). Outliers are shown as filled circles.*

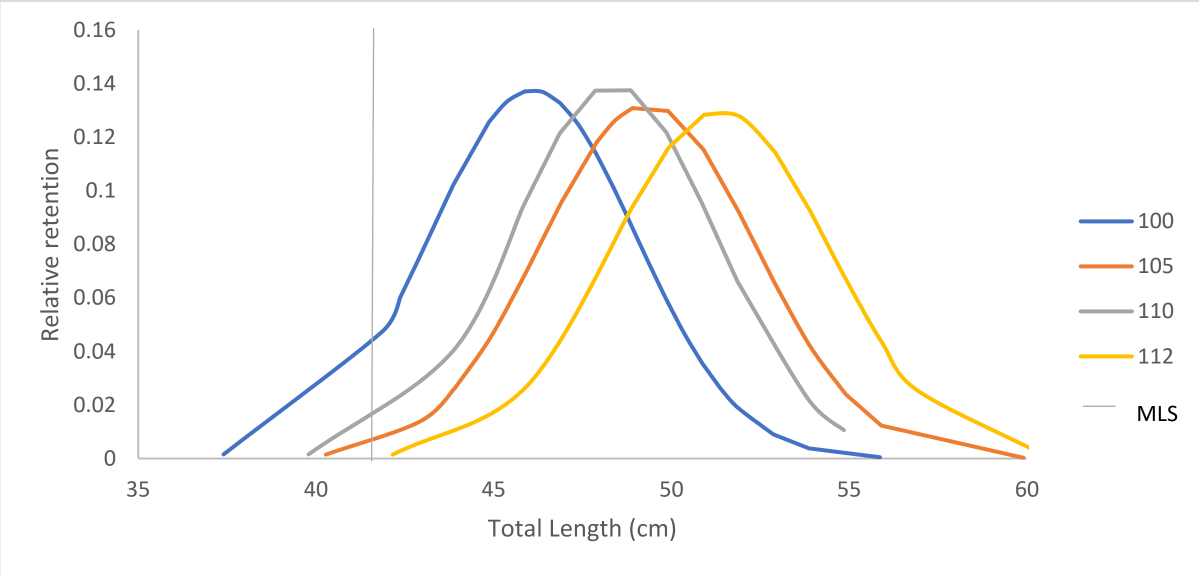


*Figure 8. Selectivity curves derived for bass from the catch data. Bass which were not 'gilled' have been excluded from the results.*

*Table 4. Modal length in relation to bass caught using different gillnet mesh sizes.*

| Gillnet mesh size (mm) | 100 | 105 | 110 | 112 |
|---|---|---|---|---|
| Modal Length | 46 | 49 | 47 | 50 |

The mean (± Standard deviation) total length of bass caught varied between mesh sizes (Figure 7, Table 3). The largest mesh size of 112 mm caught the largest size of bass (50.3 ± 5.3 cm) but this was only significant when compared to mesh sizes 100 mm (46.0 ± 3.06 cm) and 110 mm (47.4 ± 5.5 cm). The mesh size of 105 mm caught the greatest range of bass lengths (35 to 69 cm), with a mean of 49.4 ± 4.6 cm, resulting in no significant difference from the two largest mesh sizes (110 and 112 cm).

Gillnet selectivity curves were used and are assessed on a relative scale. For smaller bass, the greater the number of individuals which avoid entanglement, the lower the relative retention rate. This retention rate for larger bass is also decreased as the larger fish are not entrapped in the net. This creates a 'bell-shaped' curve graph where the peak of the graph is the apex of the size selectivity (Figure 8).

The effect of mesh size on the average total length of bass caught is displayed in figure 7. This model compares the four mesh sizes, taking monthly variation into account. Outliers (fish which were not gilled) have pulled down the 110 mm category due to multiple juveniles being entangled in the mesh. These outliers were removed from Figure 8 and it shows that the 110mm mesh still has a lower modal length compared to the 105mm mesh. It would be expected that the larger the mesh, the larger the modal length of bass caught. This indicates a larger sample size is needed.

100 mm mesh caught the highest number of bass (n=121) and the 112 mm mesh caught the least (n=31) (Table 3). The 100 mm mesh predominantly caught bass around 46 cm TL compared to the 105 mm mesh catching larger bass averaging 49 cm TL (Table 4). The 112 mm mesh had the highest modal length at 50 cm TL.

*Figure 9. A bass of 44cm TL enmeshed during a fishing trip.*

## Capture process

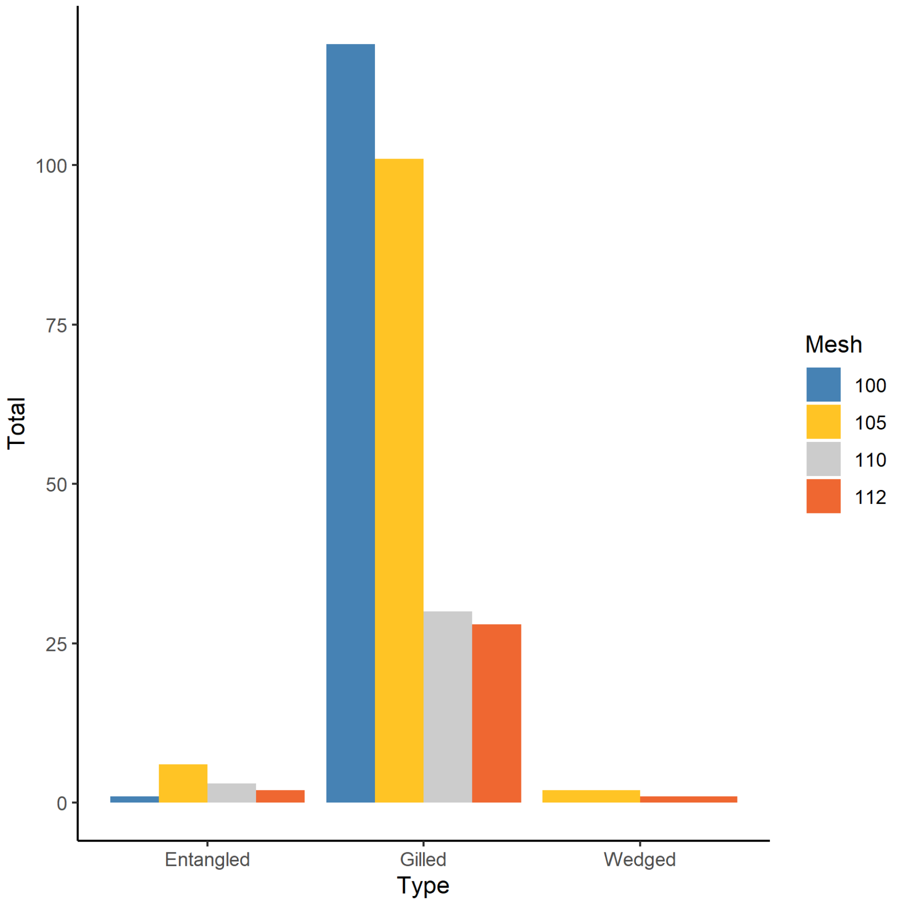


*Figure 10. Capture process of all bass caught using mesh sizes 100-112mm.*

The capture process of all bass was assessed whilst bass were being landed. Of all bass landed with the use of nets, 97% were classified as 'gilled' where the bass was meshed immediately behind the gill cover (Figure 10).

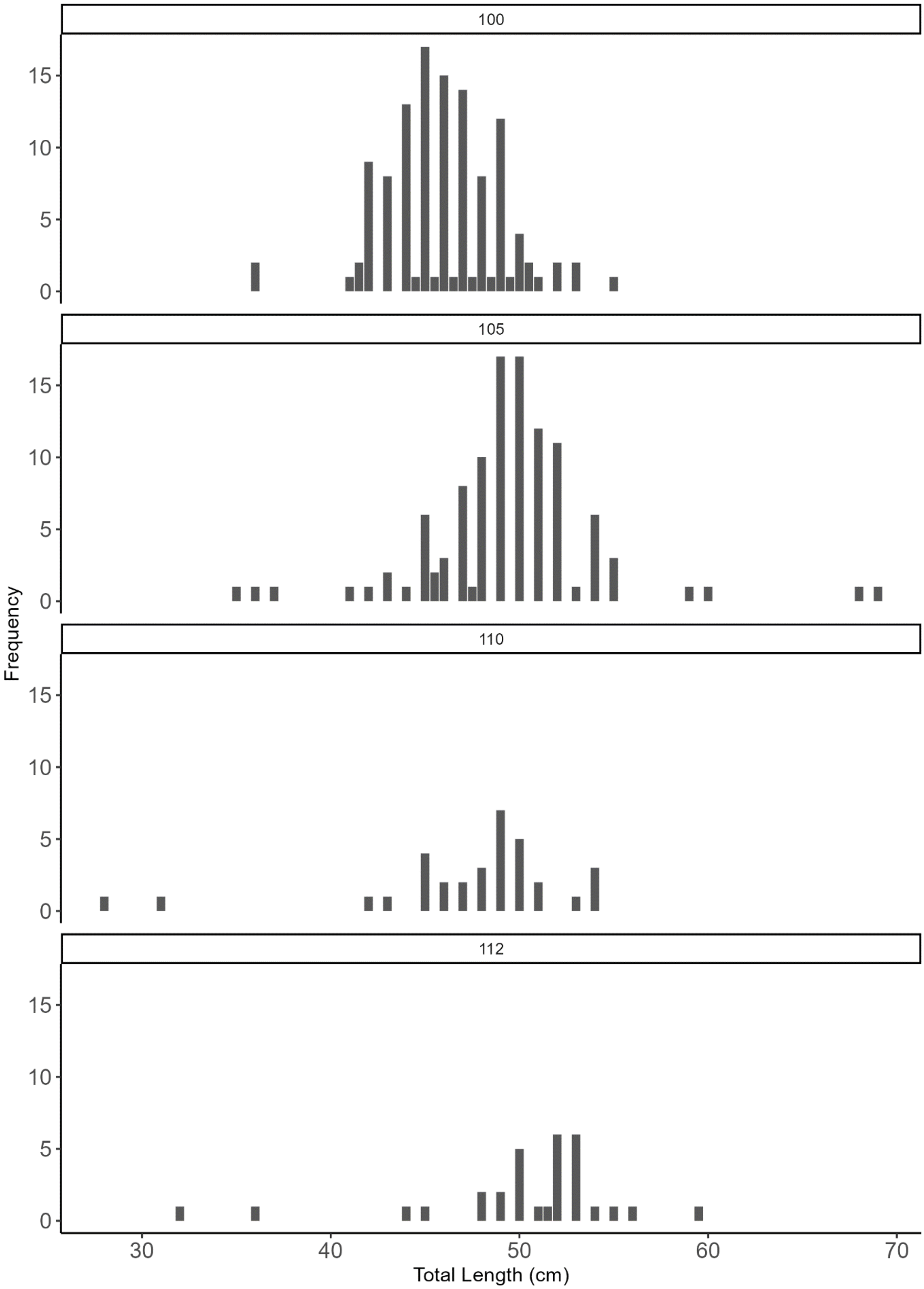


*Figure 11. Length distribution of bass caught by different mesh size.*

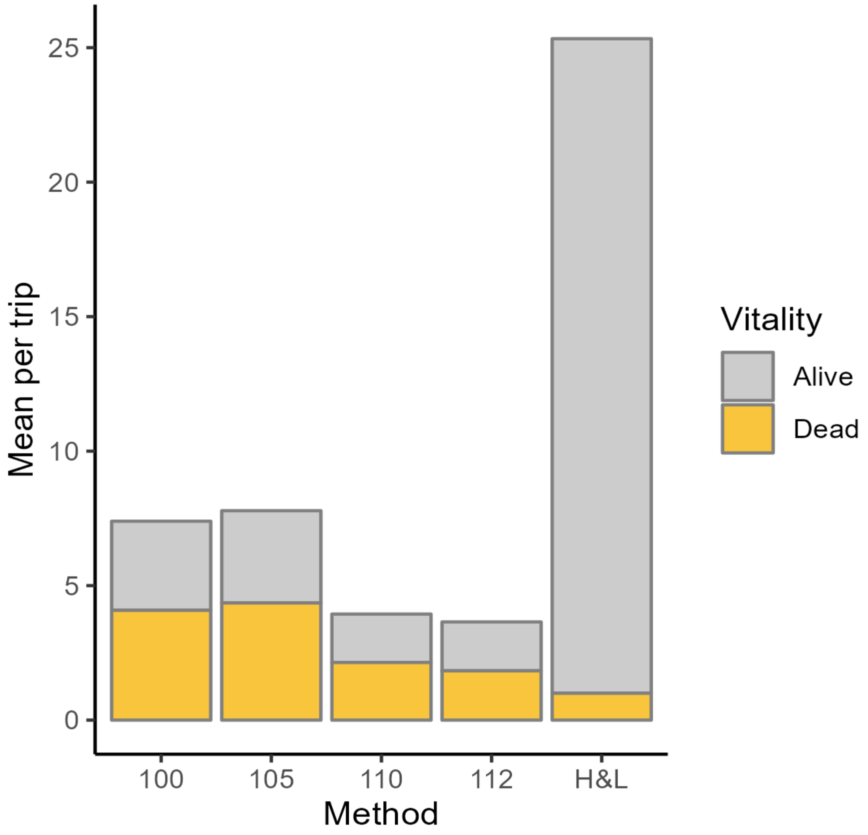


*Figure 12. Vitality assessment of bass caught using both hook and line fishing and net fishing.*

Vitality and catch rates have been assessed comparing soak time for net caught fish and hours fished for hook and line caught fish (Figure 12). Hook and line fishing caught the highest number of bass per trip averaging 25 and the lowest point of landing mortality rate of one per trip. The 100mm mesh caught the most bass averaging eight bass per trip and showed the second highest mortality levels of four fish per trip. The 112 mm mesh showed the lowest catch rate of three bass per trip and lowest mortality rate of the four mesh sizes.

*Figure 13. An example of a bass which had been 'wedged' and has left net marks underneath the dorsal fin.*

*Table 5. General linear mixed effects model outputs for total length (cm) of bass as a response of mesh size with soak time as a random factor.*

| Terms | Estimate | Std. Error | t value | P |
|---|---|---|---|---|
| Mesh 100-105 | -0.001 | 0 | -4.38 | <0.0001 |
| Mesh 100-110 | -0.001 | 0 | -1.92 | 0.055 |
| Mesh 100-112 | -0.002 | 0 | -4.65 | <0.0001 |
| Mesh 105-110 | -0.001 | 0 | 1.31 | 0.19 |
| Mesh 105-112 | -0.001 | 0 | -1.37 | 0.17 |
| Mesh 110-112 | -0.001 | 0 | -2.22 | 0.027 |

## Post Release Mortality

Post release mortality was assessed for 95 bass, 65 of which were caught using rod and line and 30 caught using nets. Time in the live well varied from 5 to 90 minutes with a 36-minute average. Of the 65 rod and line caught bass, one individual showed bleeding from the gills and was in poor condition. This fish did release successfully but mortality is likely for this individual. Of the 30 net caught bass assessed for post release mortality in the live well, five suffered from mortality with three mortalities within two minutes of being placed in the live well. It is noted both under and over MLS bass were assessed in the live well.

## Rod and line caught Bass

Six rod and line sampling days took place between 03/06/2021 and 15/07/2021 on F/V *Skye* and F/V *Mackerel Sky*. 149 bass were caught ranging in size from 29 to 67cm with no other species caught during rod and line sampling.

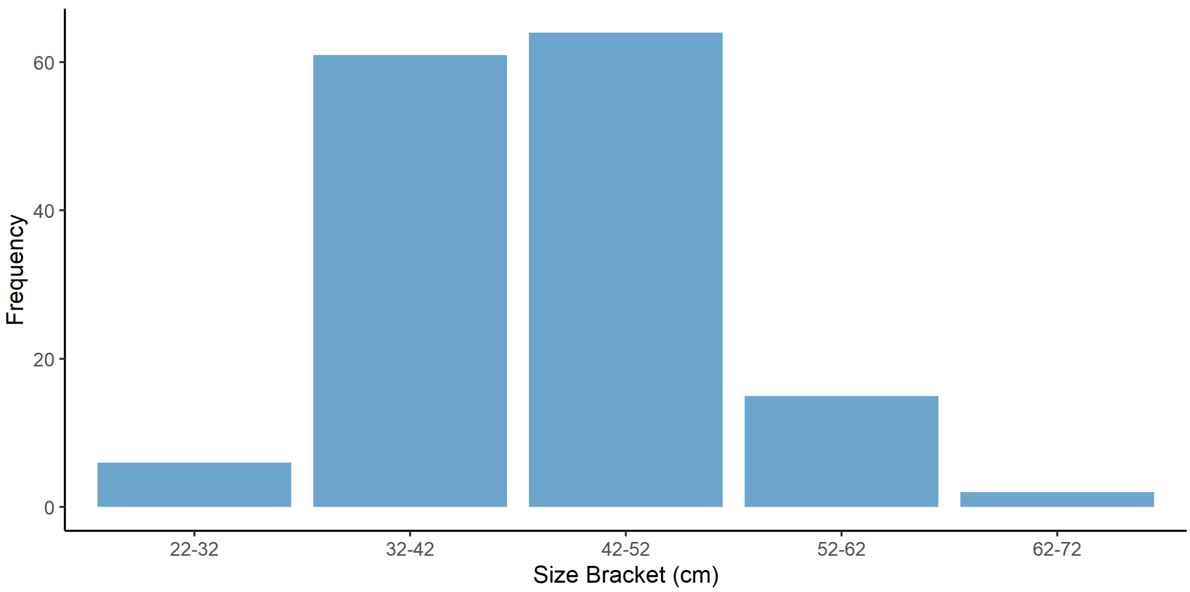


*Figure 14. Size selectivity of bass caught during hook and line sampling using artificial lures.*

Compared to net caught bass (Figure 6), the 32 to 42 cm class has a similar catch level to the 42 to 52 cm bracket when rod and line fishing (Figure 14). Four percent of bass caught during netting were in the size bracket 32 to 42cm compared to 41% for hook and line caught fish.

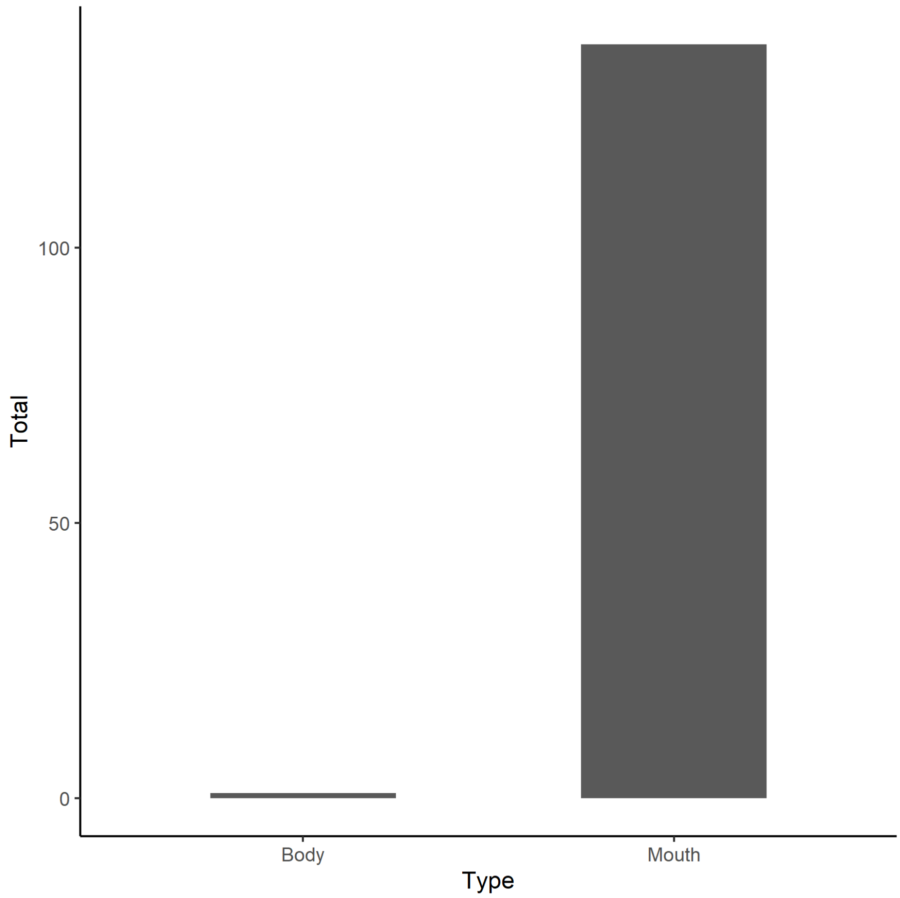


*Figure 15. Hook placement for all bass caught during rod and line fishing.*

Hook placement was noted for all bass caught during rod and line fishing. 0.8% of bass (n=1) were hooked in the body (foul hooked). Lures ranged from single hooks on soft plastic lures to treble hooks on surface and shallow diving lures. Lure type was not distinguished in the results.

All three girth measurements show a positive linear relationship when compared to total length (Figure 15)(Figure 16) Data includes bass caught using netting and rod and line fishing techniques.

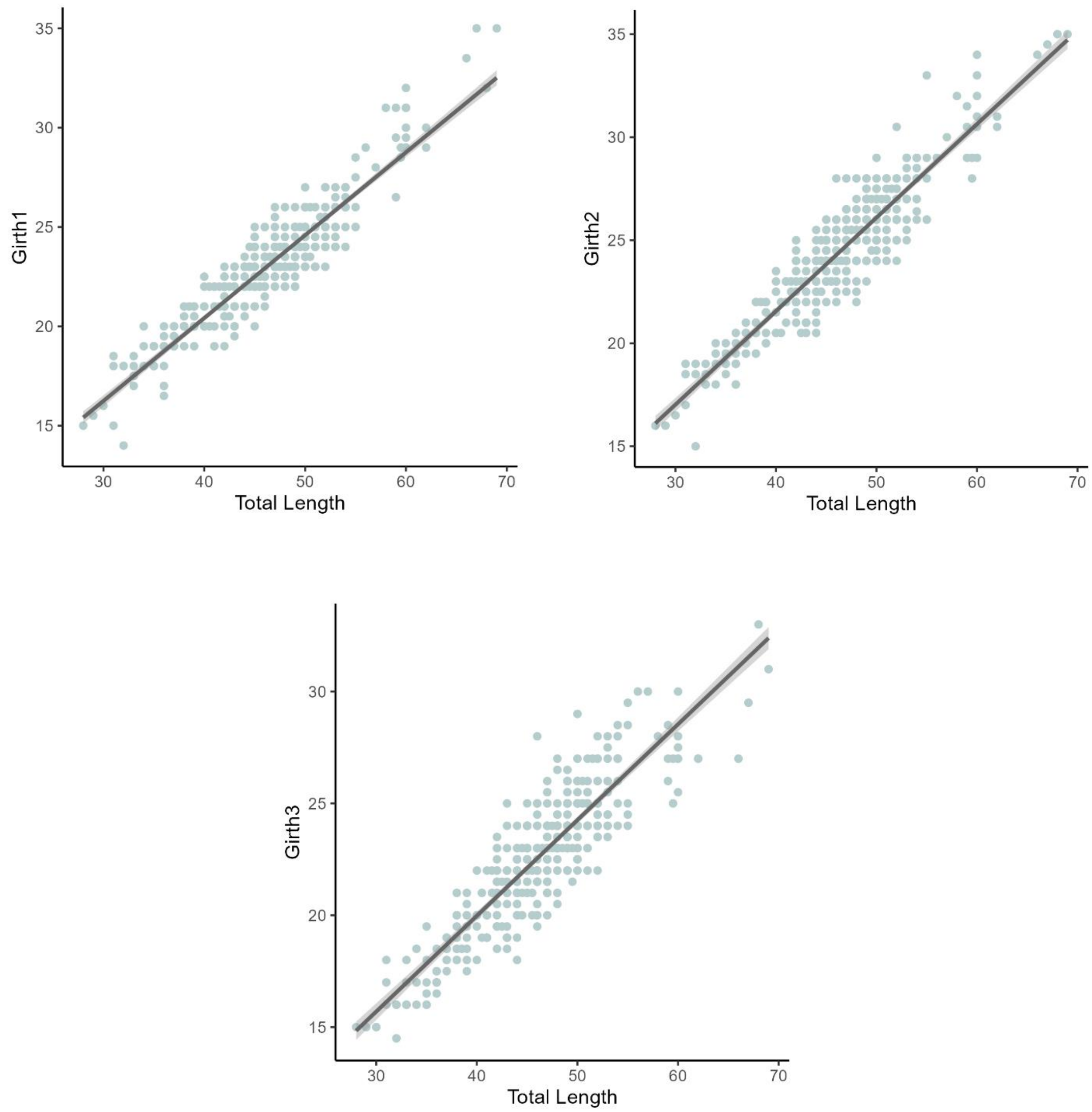


*Figure 16. Three girth measurements of bass compared to total length.*

# By-Catch

There was no by-catch during hook and line sampling with 100% of species recorded being bass. The most common by-catch species during netting were the Lesser Spotted Catshark which accounted for 47% of all by-catch species (n=259). This was followed by Thick Lipped Mullet (n=70) (Figure 17). Twenty-one by-catch species were caught during the 22 netting trips totalling 551 individual animals (Table 3).

Selectivity can also be seen between varying mesh sizes for by-catch. The 100 mm showed high selectivity for Dogfish, catching 70% of all dogfish in this study. A 105 mm mesh was most effective at catching Thick Lipped Mullet (50%) (n=32) compared to the 110 mm mesh accounting for 3% (n=2).

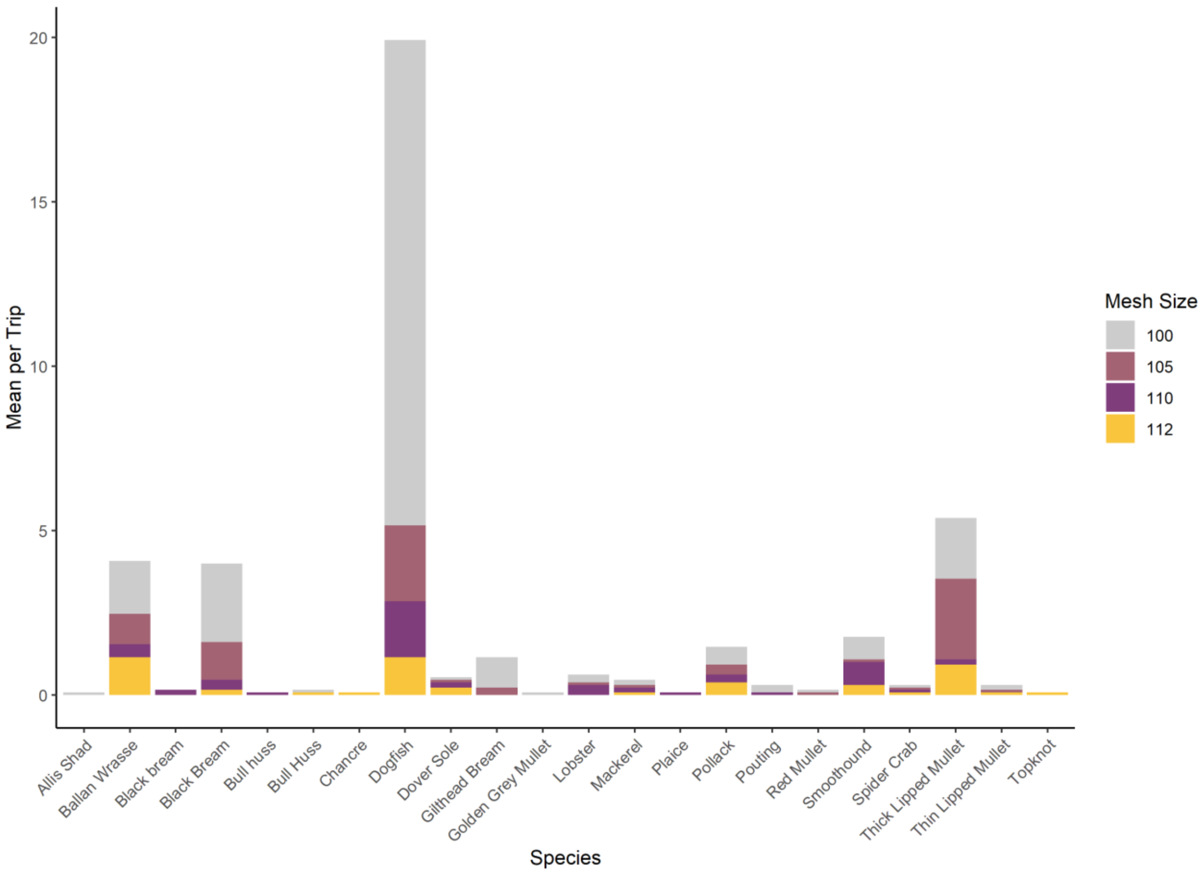


*Figure 17. Bycatch of all species caught during netting trials displaying the mean bycatch caught per fishing trip (n=13).*

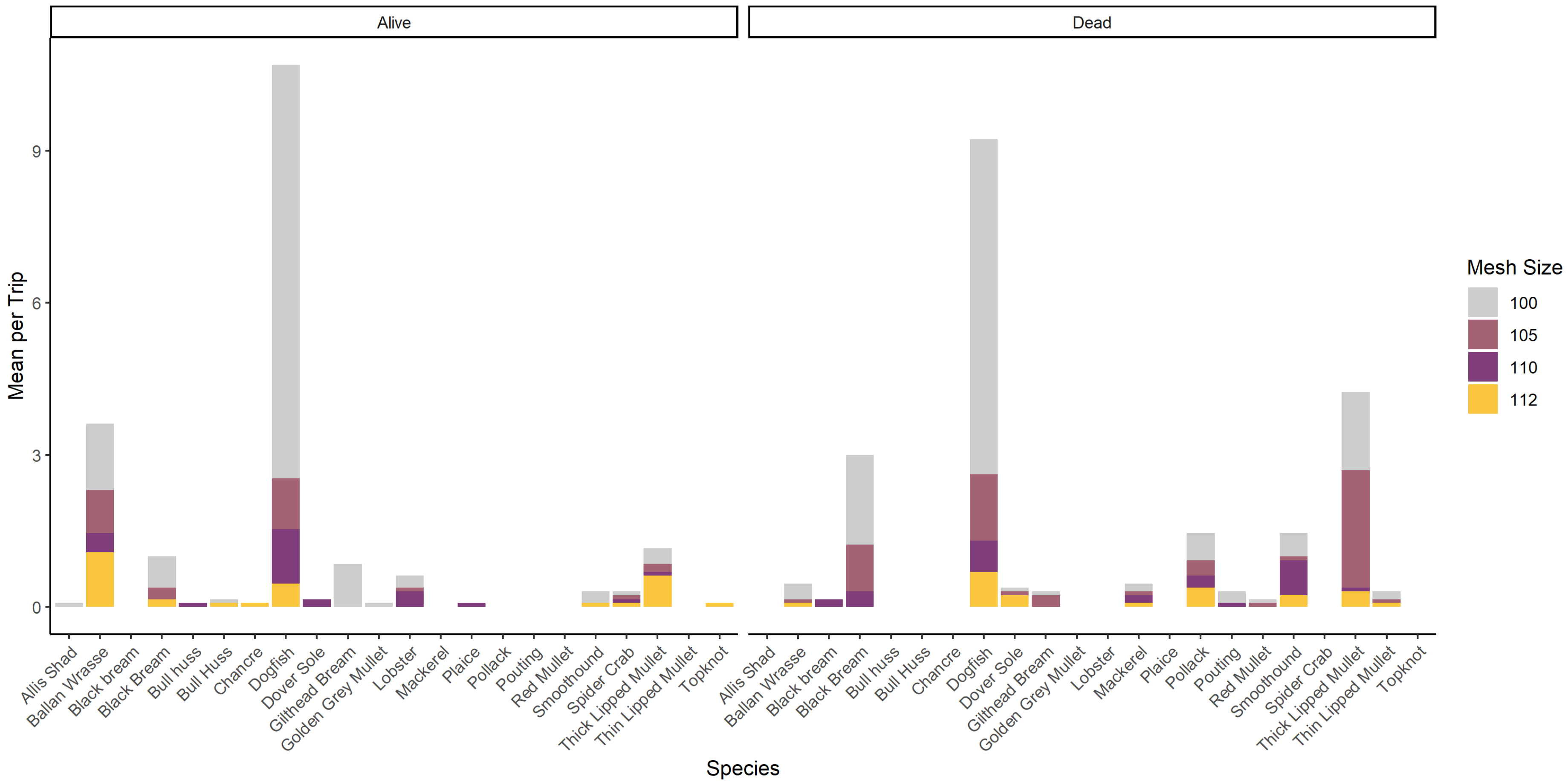


*Figure 18. Bycatch of all species caught during netting trials separated into alive/dead on arrival.*

## By-Catch Mortality

Hook and line sampling had a mortality rate for bass of zero whereas netting had mortality rate of 47% for bass across all four mesh sizes. Thick-lipped Mullet showed high levels of mortality during netting trials with 79% being dead on arrival to the vessel. Dogfish had a lower mortality rate of 47% across all mesh sizes surveyed (Figure 18 & Table 6). Due to low sample sizes other species had mortality rates of either 100% or 0%. Out of the 22 netting days, one bird by-catch was recorded and showed mortality in the net. This was identified as a Cormorant (*Phalacrocorax carbo*).

*Table 6. Mortality percentage for all species caught during netting trials.*

| Species caught (Scientific name) | Common name | Mortality rate (%) | Number of fish caught |
|---|---|---|---|
| *Alosa alosa* | Allis Shad | 100 | 1 |
| *Chelon ramada* | Thin Lipped Mullet | 100 | 4 |
| *Mullus surmuletus* | Red Mullet | 100 | 2 |
| *Pollachius pollachius* | Pollack | 100 | 19 |
| *Scomber scombrus* | Mackerel | 100 | 6 |
| *Trisopterus minutus* | Pouting | 100 | 4 |
| *Chelon labrosus* | Thick Lipped Mullet | 83 | 79 |
| *Mustelus asterias* | Starry Smoothound | 83 | 23 |
| *Spondyliosoma cantharu* | Black Bream | 75 | 55 |
| *Solea solea* | Dover Sole | 71 | 7 |
| *Scyliorhinus canicula* | Lesser Spotted Catshark | 47 | 259 |
| *Dicentrarchus labrax* | Bass | 47 | 294 |
| *Sparus aurata* | Gilthead Bream | 27 | 15 |
| *Labrus bergylta* | Ballan Wrasse | 11 | 53 |
| *Cancer pagarus* | Chancre Crab | 0 | 1 |
| *Chelon aurata* | Golden Grey Mullet | 0 | 1 |
| *Homarus gammarus* | Lobster | 0 | 8 |
| *Maja squinado* | Spider Crab | 0 | 4 |
| *Pleuronectes platessa* | European Plaice | 0 | 1 |
| *Scyliorhinus stellaris* | Bull Huss | 0 | 3 |
| *Zeugopterus punctatus* | Topknot | 0 | 1 |

## Discussion

### Net Selectivity

The results showed that gill netting was a selective fishery for bass if the correct mesh size was used. Both the smallest (22-32cm) and largest (62-72cm) bass made up a small minority (four bass) of total catch, accounting for 0.7%. In all circumstances the four fish caught in these size classes were not gilled but had become entangled in the nets mesh. In one instance, a large bass was pinned against the mesh by the tide as the net was being hauled. As a result of this, the size range of possible catch using gill nets was shown to be large, but these size classes are seen in low numbers and do not follow the general trend of the modal length.

Mean total length of bass (figure 7) was greatest in the 112 mm mesh but this was only significant when compared to 100 mm mesh (Table 5). The 105 mm mesh size has a marginally lower modal length compared to the 105 mm mesh but this may be down to a small sample size (n=33). The reduction in catch when using both the 105 and 110 mm mesh sizes are concerning as this has shown a lack of larger fish with areas being dominated by 32-52 cm fish. The catch of the 32-42 cm size class by rod and line fishing was high (figure 14) and 42-52 cm bass was high with the use of nets (figure 6). This drop in fish >52 cm is concerning for the fishery as larger bass have a greater reproductive output with increased fecundity than smaller, less mature individuals (Barneche et al., 2018). All fish were caught inshore (within Jersey's six mile limit) and therefore catch composition of fish <62cm may be due to the inshore sampling area. Commercial fishers were asked for their thoughts and advice on whether larger fish were present further offshore and out of the sampling area for this study. It was noted by all fishers (n=3) contacted that larger fish are also not present in quantities worth targeting further offshore.

Although bass sizes have shown to increase with increasing mesh sizes and therefore each fish increases in value, the catch rate and efficiency dropped for larger mesh sizes. For example, the

105mm mesh caught 109 bass compared to the 110mm catching 33(Table 3). With the current stock dynamics of bass around Jersey, these larger mesh sizes would not be economically viable to fish with whilst targeting bass for a commercial vessel.

## Capture process

The capture process during netting showed a high proportion of bass caught to be 'gilled' (97%). This is the method for how gill nets are designed to work and shows high selectivity of bass size when 'gilled'. Bass which were furthest from the modal length (smallest and largest caught) tended to be enmeshed in the net with the mesh size not being a defining factor in the size of those bass caught. The bass had become tangled in the monofilament by tails, fins and their head. These 'enmeshed' fish lowered the modal length of the 110mm mesh size especially although only two were caught. The110mm mesh still showed a lower modal length than the 105mm net when the analysis removed all fish which had not been gilled. The high percentage of 'gilled' fish displays appropriate mesh size selection for this study.

## Vitality

Fishing efficiencies varied dramatically between the four mesh sizes used and when compared to hook and line fishing (Figure 14). Mortality levels showed slight variations but averaged approximately 50% for all mesh sizes. This mortality level however did not result in high levels of unnecessary death of bass due to the selectivity of net fishing paired with an MLS of 42 cm. Large differences are seen in hook and line fishing with a dramatic increase in catch rates and decrease in mortality however, over 41% of the catch is within the 32-42cm size bracket and needs to be returned. This increase in undersize individuals causes delays and an extra workload for commercial fishers through fight times and unhooking. This metier is most used in the summer months in Jersey when net fishing is not practical due to drifting seaweed and spider crabs (*Maja brachydactyla*) fouling the nets (MR Commercial Fishery Review report, 2022). It is noted that hook and line fishing took place in one offshore reef location around

Jersey in the summer months (June-August). This has the potential to favour a certain size class of bass being prevalent in the area at that time of year which was seen as the 32-52 cm size class (Figure 14). Further research is needed to understand how the size dynamics change of hook and line caught bass throughout the year and in different habitats and environmental conditions.

## Post release mortality

Post release mortality was assessed opportunistically with a small sample being taken from both net and rod and line caught fish. Observations were made with many bass showing signs of recovery within the live well and released in good condition. Bass which were not entered into the live well showed initial signs of disorientation when being released but this was only assessed with an observation. Higher mortality levels were seen in the live well with net caught fish and is likely to be due to long periods of time being enmeshed. Three bass were caught looking in a live state but quickly showed mortality within the live well. Longer term data is needed to further understand post release mortality for bass and could be obtained with the use of acoustic tags to detect these released fish.

Hooking injury is considered the primary cause of angling-related mortality (Muoneke and Childress, 1994). The degree of hooking related injury in this study was minimal with only one of the 149 bass being foul hooked. This study does not focus on practices for catch and release fishing and was used as a mechanism to gain bass measurements throughout the calendar year. A limitation of this study is that lure and hook type was not recorded which can influence foul hooking ratios.

## Length to weight relationship

Girth measurement analysis showed a positive linear relationship when compared to total length but month was dropped from the model, suggesting that this variable did not have a significant effect on the girth/length relationship. Initially it was believed a difference would be seen in girth measurements throughout the spawning season (February to March) with girths being larger around spawning times. This would therefore reduce the modal length for each mesh size as the fish would have larger girths at certain times of year. As only one fishing trip took place within the spawning season, the sample size was not great enough to understand if a difference is noticeable in girth measurements throughout a bass's spawning cycle.

## By-Catch

By-catch was seen to be high during netting trials with 21 by-catch species being caught ranging from crustaceans to elasmobranchs to pelagic fish such as mackerel. By-catch was often higher than bass catch in kg per fishing trip although bass were the target species. The levels of by-catch were consistent throughout the study and were dominated by lesser spotted catsharks (dogfish). Commercially valuable species such as gilthead bream and thick lipped mullet were also caught during the netting trials with approximately five of each caught during each fishing trip. It is noted that all by-catch species caught during the netting trials were sold, this varied between use for human consumption and for the bait industry (dogfish and ballan wrasse). All lobsters landed as by-catch showed no mortality and were either returned if below the MLS or retained for sale. Predation from shore crabs (*Carcinus maenas*) was present on bass and other fish by-catch species in certain inter tidal areas. This was particularly present during longer soak times. Presence of this species was not fully quantified in this study but mortality was seen when removing shore crabs from the gill nets. The predation on bass on two occasions made the fish unharvastable.

Mesh sizes showed large catch differences for by-catch species (figure 17). For the 294 bass caught, 536 by-catch individuals were caught. The 100 mm mesh size caught the most by-catch per weight and species richness. Dramatic reductions of lesser spotted catsharks are seen with the 105 mm mesh and has shown to be a way of avoiding unwanted by-catch species. This study shows that certain species are more susceptible to be caught with different mesh sizes and can be tactically used to catch target species if they are in similar areas to by-catch species. For example, an area with bass and large levels of lesser spotted catsharks, a 105 mm mesh shows promising results in reducing by-catch but keeping high levels of target species catch.

Mortality in by-catch species was also evaluated (table 6). This displayed which species are susceptible to high levels of mortality using nets. These include species such as pollack, thick lipped mullet, black bream and smoothounds. Species with lower mortality levels were gilthead bream and ballan wrasse (27% and 11% mortality respectively). Predation on bass was seen on one occasion by seals during the one net fishing trip at an offshore reef site. This predation is increasing throughout the Jersey bass fishing fleet with some fishers moving to shorter soak times to reduce predation levels. There are low sample sizes of certain by-catch species such as thin lipped and red mullet. Further sampling would be required to show an accurate mortality representation.

## Gill net parameter change

Gill nets were ordered in sizes 100-112mm. These advertised sizes were measured with an omega gauge and were found to be different for all mesh sizes apart from the 112mm mesh. The largest difference was seen in the 108mm mesh which measured 105mm. After the trials, measurements were taken again and found all mesh sizes to have changed by up to 5mm (112mm mesh) (Table 1). With all mesh sizes increasing over the 22 deployments this shows a need for annual monitoring of mesh sizes used in Jersey's bass fishery to understand which size nets are being used. This information is key for fishers to update their logbooks accurately and in terms of meeting target catch composition requirements under Jersey and UK regulations.

## Conclusion

Net fishing for bass is one of Jersey's most used metier amongst bass permit holders. This study shows the impact different mesh sizes have when targeting both bass and by-catch species. For example, the 105mm net is shown to considerably drop by-catch levels but retain similar catch levels of bass compared to the 100mm mesh size. This enables fishers to alter their tactics depending on the prevalent fish species in the area as well as the size of those target fish. Worrying trends are seen in this dataset with the lack of larger, mature bass not being present suggesting management measures are needed to protect larger size class fish from being harvested and allow smaller fish to grow to these larger size classes. Bass are important to the livelihoods of commercial fishers as well as for recreational fishers with any new measures needing to be proportionate to all sectors to allow livelihoods to continue and angling communities to continue enjoying the sport and productive fishing.

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