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Characterisation of recreational fishing activity for snapper and estimating release mortality for SNA 1

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J.Q. Maggs, J.C. Holdsworth, S. Curtis, O.E. Evans, C.E.H. Bodie, B.K. Madden

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Fisheries New Zealand
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PLAIN LANGUAGE SUMMARY

Snapper catch data were collected from the private and charter boat recreational fishing sectors in the SNA 1 Quota Management Area, which includes East Northland, the Hauraki Gulf and the Bay of Plenty.

From January 2024 to January 2025, 1746 private boat outings were sampled with records of 16 912 captured snapper. At the same time, 240 charter boat fishing events were sampled with records of 7092 captured snapper.

More than 60% of snapper were released after capture in both the private (62%) and charter boat (69%) sectors.

This data was combined with results of other fisheries research, including experimental results on the survival of snapper after release as well as estimates of the annual snapper harvest.

The combined results provided estimates of the weight and numbers of snapper that are expected to die after release, known as release mortality.

The annual release mortality for SNA 1 was estimated at 200 t (477 000 fish) in the private boat fishery and 48 t (105 000 fish) in the charter boat fishery.

These estimates help describe the selectivity of recreational fishing methods and allow for a more informed allowance for snapper release mortality.

Maggs, J. Q., J. C. Holdsworth, S. Curtis, O. E. Evans, C. E. H. Bodie, and B. K. Madden. 2026. "Estimating Total Post-Release Mortality in a Boat-Based Recreational Fishery." *Fisheries Management and Ecology*1–11. **https://doi.org/10.1111/fme.70088**.

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EXECUTIVE SUMMARY

Maggs, J.Q.[1]; Holdsworth, J.C.[2]; Curtis, S.; Evans, O.E.; Bodie, C.E.H.; Madden, B.K. (2026).
Characterisation of recreational fishing activity for snapper and estimating release mortality for SNA 1.

***New Zealand Fisheries Assessment Report 2026/20.* 53 p.**

Since the 1990s, snapper catch in SNA 1 has increased. In the recreational fishery, stricter catch regulations have led to increased size limits and higher release rates. Snapper are sensitive to capture depth and anatomical hooking location meaning that some released fish do not survive, contributing to release mortality. The current Total Allowable Catch (TAC) for SNA 1 is 8050 t annually, which includes a recreational landed harvest allowance of 3050 t and a further allowance of 450 t for other mortality, such as illegal fishing and mortality of fish returned to the sea. The current allowance for other sources of mortality is somewhat arbitrary, and the actual level of release mortality that can be attributed to recreational fishing is unknown.

This study investigated release mortality in SNA 1 by characterising the boat-based recreational snapper catch, which included that of released fish. Data on the size and condition of released fish were collected at sea by private fishers recruited at boat ramps and by trained observers on amateur fishing charter boats throughout the SNA 1 quota management area from 1 January 2024 to 31 January 2025. On both private and charter vessels, details were recorded for each snapper caught, including fish fork length, capture depth, anatomical hooking location and whether the fish was kept (landed) or released. Sampling was spatially stratified according to the regional definitions used by the latest SNA 1 stock assessment (East Northland, Hauraki Gulf, Bay of Plenty).

In the private boat fishery, 1746 fishing outings were recorded with 16 921 individual snapper catch records. Fish lengths ranged from 5–87 cm fork length (FL) and 53% of the fish were under the minimum legal size. Most (87%) fish were caught in 1–40 m water depth and 88% were lip-hooked. Overall, 62% of the snapper caught by private boat fishers, mostly undersize fish, were released. In the charter boat fishery, 240 fishing events were recorded with 7092 individual snapper records. Fish length ranged from 14–79 cm FL and 60% of the fish were under the minimum legal size. Most (79%) fish were caught in 1–40 m and 95% were lip-hooked. Overall, 69% of the snapper caught by charter boat fishers, also mostly undersize fish, were released.

These catch characteristics were combined with results from other research to derive absolute estimates of release mortality. Harvest estimates provided by the 2022–23 National Panel Survey and the Amateur Charter Vessel (ACV) database were combined with the fishery characterisation data to estimate the total number of fish caught (kept + released) in the fishery. Thereafter, the length-specific numbers of fish could be estimated separately for kept and for released fish in the fishery. This was converted to weights using a published length-weight regression. A probability of death was then assigned to each fish in the sample, based on the capture depth and hook location, from previous experimental data.

It was estimated that the annual release mortality, or the volume of released snapper that were expected to die, in SNA 1 during 2024 was 200 t (477 000 fish) for private boats and 48 t (105 000 fish) for charter boats. An alternative, less conservative scenario, was explored and is presented for completeness. However, this research did not consider all sources of post-release mortality, such as predation by other fish immediately after release. Potential mitigation measures are discussed.

[1] National Institute of Water and Atmospheric Research Ltd (NIWA)
[2] Blue Water Marine Research Ltd

1. INTRODUCTION

Recreational fisheries are managed using a variety of regulations, which often includes the use of a minimum legal size (MLS) to constrain recreational harvest and improve the yield-per-recruit in a fishery. Daily bag limits (DBL) are commonly used alongside an MLS so that an angler may take a maximum number of fish all of which have to be at or above the MLS. These regulations are examples of output controls, which do not regulate the fishing effort, only the retained or landed catch. The process is thus selective, resulting in catch being returned to the water if in violation of the regulations.

In New Zealand, there is a large recreational fishery for snapper *Chrysophrys auratus* on the upper east coast of the North Island. This snapper stock is managed under the SNA 1 Quota Management Area (QMA) and employs both an MLS and a DBL for recreational fishing. The National Panel Survey (NPS) estimated that, in 2022–23, private boat recreational fishers harvested more than 1.3 million snapper, weighing 1514 t. The Amateur Charter Vessel (ACV) database recorded a further 237 141 snapper caught by the charter vessel sector during the same fishing year. Snapper catch in SNA 1 has increased since the 1990s, as the stock size has increased, and in 2014 the SNA 1 MLS was increased from 27 cm to 30 cm fork length and the DBL reduced from 10 to seven fish per person. The increased availability of snapper combined with more restrictive catch limit regulations have resulted in a steadily increasing release rate (Hartill et al. 2020). The current biomass of released fish as a proportion of the overall catch is unknown but may be considerable.

Released fish may not survive. The mortality rate of released snapper has been investigated using controlled field experiments (Maggs et al. 2024b, c). It was found that, among line-caught snapper, the probability of death in released individuals was strongly associated with capture depth and anatomical hooking location. Depending on the biomass of released fish and the characteristics of the recreational fishery, in terms of depths fished and hooking location, the total biomass of release mortalities could be substantial.

Snapper is a quota managed species with an annual Total Allowable Catch (TAC) of 8050 t. This is allocated across four sources of mortality, including a Total Allowable Commercial Catch (TACC) of 4500 t, a recreational allowance (3050 t), a customary allowance (50 t) and an allowance (450 t) for other sources of mortality. The recreational allowance provides for recreational harvest, the magnitude of which is estimated by periodic National Panel Surveys (Heinemann & Gray 2024) and annual boat ramp creel surveys (Maggs et al. 2024a). Release mortality is covered under other sources of mortality but is not well informed.

Previous surveys to determine the selectivity of recreational catches of New Zealand snapper and their size and condition on release were conducted from 2004 to 2007. Data collection required sampling at sea and methods were developed and tested in a 2004–05 pilot survey and a year-long survey in 2005–06 (Holdsworth & Boyd 2008a). Sampling was limited to the recreational hook and line fishery from boats because most of the recreational snapper catch is taken using this method and because sampling other methods is logistically difficult. Private fishers were recruited on boat ramps prior to fishing and observers were placed on selected charter boats.

More than 19 000 recreationally caught snapper were measured at sea in SNA 1 in 2004–05 and 2005–06. There were regional and annual differences in recreational snapper length frequency. Released snapper contributed 59% of the total catch. Most of the released snapper were smaller than the MLS, which was 27 cm fork length at the time. In 2006–07, 9449 recreationally caught snapper were measured at sea in SNA 1. Released snapper contributed 54% of the catch recorded by private trailer boat fishers and 60% of the catch recorded by observers on charter boats (Holdsworth & Boyd 2008b).

Data on fish condition, hook type, hook size, where the fish was hooked on the body, and water depth were also collected. Of the snapper recorded as released by observers on charter boats, 92% were

reported as swimming away and not bleeding and a further 6% swam away but showed signs of bleeding from a wound other than that caused by a hook in the jaw. Just 1.8% of released snapper observed on charter boats were reported as either floating or dying; however, 24% showed some sign of barotrauma or hook damage.

The overall objective of this study for Fisheries New Zealand research project MAF2023-01 was to characterise recreational fishing activity within SNA 1 and use the results of MAF2020-06 (Maggs et al. (2024c) to estimate total annual recreational release mortality for this fish stock. There were four specific objectives:

1. Characterise recreational fishing activity within SNA 1 on the basis of previous surveys to describe the temporal and spatial patterns of fishing and inform the design of a survey of recreational fishing activity (Objective 2).

2. Design and implement a survey of recreational fishing activity within SNA 1 to characterise the number, size, capture depth, hooking location, and condition of released snapper.

3. Use the estimates generated by Objective 2 in conjunction with results from MAF2020-06 to estimate annual recreational release mortality from SNA 1.

4. Broader Outcomes

To address these objectives, we conducted a fishery characterisation, which informed the design of a survey to collect release mortality data from the SNA 1 recreational fishery. Both characterisation and the resulting survey design was approved by the Marine Amateur Fisheries Working Group on 20 November 2023. We then collected snapper catch data (size, capture depth, hook location, fish condition) from the fishery and used these data in combination with experimental data on snapper release mortality rates (Maggs et al. 2024b,c) as well as harvest estimates provided by the 2022–23 National Panel Survey (Heinemann & Gray 2024) and Fisheries New Zealand's ACV database to estimate total release mortality in SNA 1.

2. METHODS

This study covered both the private boat and charter boat sectors of the New Zealand recreational fishery. Although both recreational fisheries, these sectors operate very differently and are thus treated separately in this report. Note that the SNA 1 fishing year is from 1 October – 30 September. In this report, a given fishing year may be represented by the second of the two consecutive calendar years. That is, 1 October 2023 – 30 September 2024 may be simplified to 2024.

2.1 Fishery characterisation

A fishery characterisation was undertaken to inform the design for the release mortality data collection. For the private boat recreational fishery, boat ramp creel data was extracted from Fisheries New Zealand's *rec_data* database (Fisher & Dick 2020) on the 9 November 2023. The extract specification was all trailer boat outings at all monitored boat ramps throughout the SNA 1 Quota Management Area (QMA) from 1 October 2017 to 30 September 2023. However, at the time of data extraction, the data entry was incomplete for the 2023 fishing year. Using the available data, the spatio-temporal distribution of snapper-directed effort and catch as well as snapper size were summarised graphically.

For the characterisation of the charter vessel recreational fishery, a data extract was requested from Fisheries New Zealand's Amateur Charter Vessel (ACV) database on 9 November 2023 under replog 15278. The extract specification was all charter vessel fishing outings at all localities throughout the

SNA 1 QMA from 01 October 2017 to 30 September 2023. However, at the time of data extraction, the data entry on the ACV database was incomplete for the 2023 fishing year. Charter vessel operators were not required to record snapper catches until 2020, so a subset of the available data was used to summarise the spatial and temporal distribution of charter fishing snapper catch in a tabular format.

2.2 Study area

This investigation covered the SNA1 QMA on the upper east coast of New Zealand's North Island covering both the private (Figure 1) and charter (Figure 2) vessel fisheries. The western coastal boundary of this QMA is North Cape at the northern tip of New Zealand, while the eastern coastal boundary is Cape Runaway at the eastern end of the Bay of Plenty.

The proposed data collection and analytical methods were closely based on those described by Holdsworth & Boyd (2008a, b), who investigated release mortality in the SNA 1 recreational fishery in the mid-2000s.

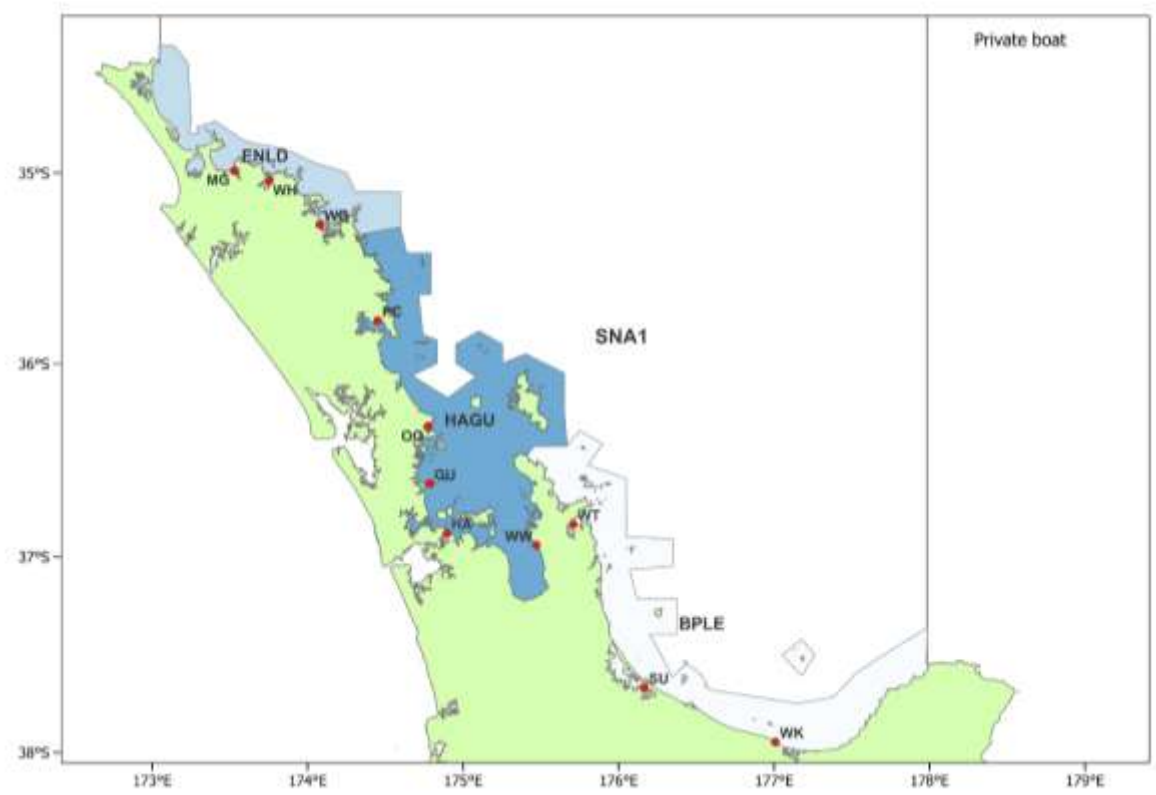

Figure 1: Boat ramps covered in the SNA 1 release mortality survey of the private boat recreational fishery. Regions indicated for East Northland (ENLD), Hauraki Gulf (HAGU) and Bay of Plenty (BPLE). Boat ramps - MG: Mangōnui, WH: Whangaroa, WG: Waitangi, PC: Parua Boat Club, OO: Omaha, GU: Gulf Harbour, HA: Half Moon Bay, WW: Waikawau, WT: Whitianga, SU: Sulphur Point, WK: Whakatāne.

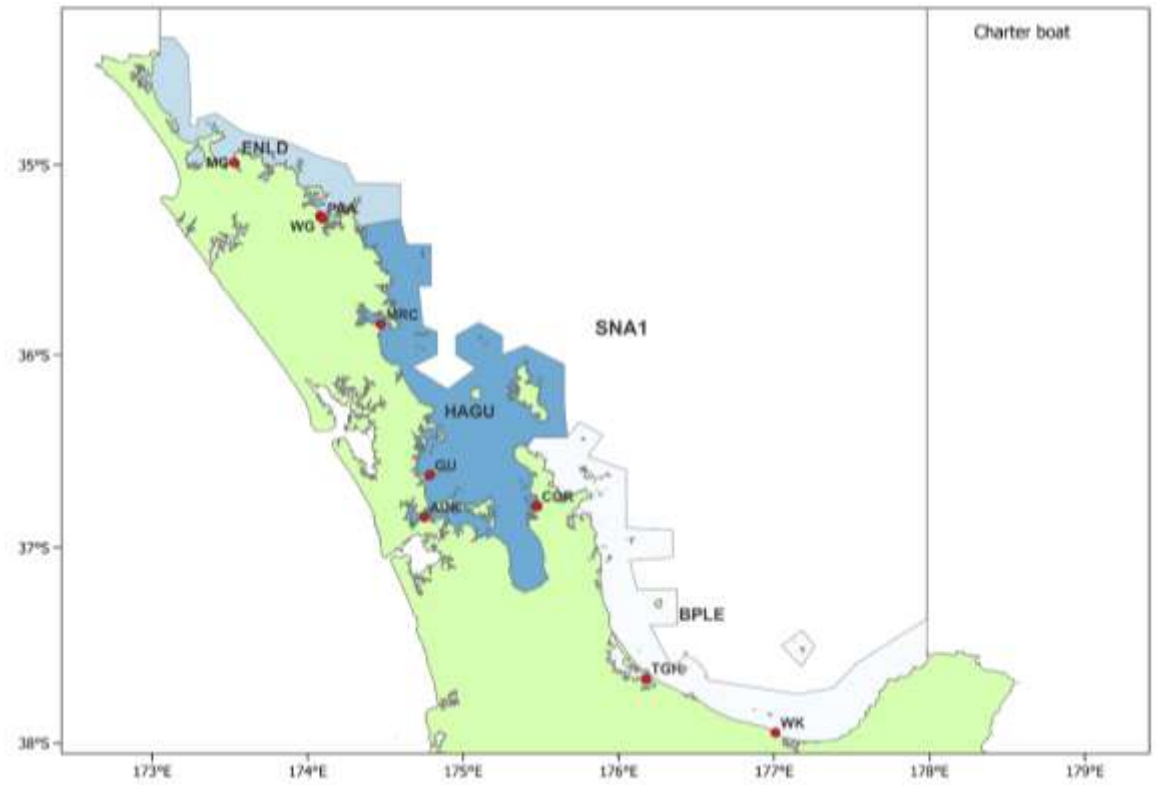

Figure 2: Ports and marinas covered in the SNA 1 release mortality survey of the charter boat recreational fishery. Regions indicated for East Northland (ENLD), Hauraki Gulf (HAGU) and Bay of Plenty (BPLE). Localities - MG: Mangōnui, WG: Waitangi, PAA: Paihia, MRC: Marsden Cove, GU: Gulf Harbour, AUK: Auckland, COR: Coromandel, TGH: Tauranga Harbour Bridge Marina, WK: Whakatāne.

To align with the most recent SNA 1 stock assessment boundaries (Fisheries New Zealand 2024), the survey design was spatially stratified into three regions, namely East Northland (ENLD) from North Cape to Home Point, Hauraki Gulf (HAGU) from Home Point to Port Jackson, and Bay of Plenty (BPLE) from Port Jackson to Cape Runaway. Release mortality data were collected at multiple locations within each of the three regions, covering key boat ramps and ports/marinas used in the private and charter boat fishery.

2.3 Data collection

Private boat recreational fishery

Data were collected for the private boat recreational fishery in tandem with the National Boat Ramp Creel Survey (NBRCS) conducted under Fisheries New Zealand project MAF201901 (Maggs et al. 2024a). Besides the fishery characterisation described earlier, the choice of ramps was also influenced by logistic considerations, which have been highlighted during NIWA's experience with ongoing creel surveys. For example, it has been difficult to find suitable interview staff at certain ramps and some of the high-traffic club ramps are difficult to access.

Data were collected along the East Northland coast at the Mangōnui (MG), Waitangi (WG) and Whangaroa (WG) boat ramps (Figure 1). In the Hauraki Gulf, data were collected at the Parua Bay Club (PC), Omaha (OO), Gulf Harbour (GU), Half Moon Bay (HA) and Waikawau (WW) boat ramps. In the Bay of Plenty region, data were collected at the Whitianga (WT), Sulphur Point (SU), and Whakatāne (WK) boat ramps. The ENLD region as defined in this survey had insufficient coverage by the NBRCS, which included only the Waitangi ramp. Therefore, Mangōnui and Whangaroa were added as ramps dedicated to the collection of release mortality data.

As the survey was conducted in tandem with the NBRCS, the data collection naturally followed a temporally stratified design, which matched sampling intensity to the annual distribution of fishing effort and multispecies catch. Although the SNA 1 recreational fishery is focused around the summer months, from October – April (Maggs et al. 2024a), some snapper are still caught throughout the year. Additionally, the mean length of recreationally caught snapper varies during the year, which affects the selectivity by fishers and therefore the number of released fish due to the minimum legal size (30 cm FL). However, as the release mortality sampling did not require a probabilistic design like the NBRCS, some sampling effort was opportunistically redirected towards good weather days to get a larger sample of recreational snapper catch.

On survey days, interviewers were required to be present at the selected boat ramps for two hours in the morning during peak times when most fishers were heading out to sea. Willing fishers were recruited to participate in the data collection. Fishers were asked to record details about their fishing trip and about the catch (Appendix 1). Trip data included date, hours fished, number of people fishing, length of boat in metres, and boat name. Catch data included fishing location, fish fork length (rounded down to nearest centimetre), capture depth in metres, hook site (lip/foul/swallowed), fish fate (kept/released), bleeding (yes/no), floating on release (yes/no), and any other comments. Capture depth and hook site was used in the data analysis to match released fish to mortality probabilities reported in the release mortality experiments (Maggs et al. 2024c). Participating fishers were supplied with vinyl measuring mats, paper datasheets, clipboards, and pencils, and received a short explanation of the data collection protocol.

Datasheets and sampling equipment were returned later that day to the interviewer either directly by the returning fisher or using a drop box installed at the boat ramp. Periodically, returning fishers were not intercepted by the interviewer and data were not returned to a drop box. At the time of recruiting fishers, the interviewer recorded the fisher details, including a telephone number. This allowed follow-up communication with the fisher if data had not been submitted. In some cases, paper datasheets were then photographed by the fisher and submitted to NIWA electronically.

Charter boat recreational fishery

Trained observers joined charter fishing trips to collect data on the size and condition of snapper in a similar way to that described above for private fishers. Based on the fishery characterisation, suitable charter vessel operators were enrolled at selected ports. On suitable days, where possible, observers were present on a charter vessel and collected trip and data for all snapper caught by charter boat client fishers for the duration of the outing.

The charter boat sampling design followed the spatial stratification described above for the boat ramp sampling, covering the three SNA 1 regions (East Northland, Hauraki Gulf and Bay of Plenty; Figure 2). Data were collected on eight charter vessels operating out of nine ports along SNA 1. Criteria for appropriate vessels and ports included vessel size, enough space for an observer and gear, and spatial coverage of the recreational fishery. In East Northland, data were collected from Mangōnui (MG), Waitangi (WG) and Paihia (PAA). In the Hauraki Gulf, data were collected from Marsden Cove (MRC), Gulf Harbour (GU), Auckland (AUK) and Coromandel (COR). In Bay of Plenty, data were collected from Tauranga (TGH) and Whakatāne (WK). Charter vessels operating out of Whitianga (WT) were trailer boats with limited passenger numbers and limited space for observers to work.

Like the private boat component, the data collection followed a temporally stratified design, which aligned sampling intensity to the annual distribution of fishing effort and multispecies catch. Charter vessels targeting snapper are more active around the summer months, from October – April when snapper fishing peaks (Maggs et al. 2024a) and target other species in the low periods. However, some charter operators target snapper year-round, particularly in Hauraki Gulf. Sampling effort was targeted at fishing trips where snapper was the target species and where there were five or more client fishers onboard.

Observers were supplied with vinyl measuring mats, waterproof datasheets, clipboards and pencils. Survey days were planned fortnightly and were dependent on weather, bookings, space availability on the boat and observer availability. On survey days, observers would provide client fishers with an explanation of the survey and what data was being collected. Observers were set up in an accessible location on the boat where snapper could be easily passed to them for data collection and caused minimal disruption to crew operations. Observers collected details about each fishing event and about the catch (Appendix 2). Fishing event data included boat name, date, hours fished, latitude and longitude, fishing location code, number of people fishing and sea conditions. For each trip, fishing event data was collected at each separate fishing location. The catch data included snapper fork lengths (rounded down to nearest centimetre), capture depth in metres, hook site (lip/foul/swallowed), fish fate (kept/released), hook type (lure, j-hook, circle, kale), barotrauma condition (none, stomach, intestine, extreme) and condition on release (swam not bleeding, swam bleeding, floated not bleeding, floated bleeding, dying). If any snapper were not measured a tally was recorded.

Trained observers were able to record more detail on level of barotrauma and fish condition on release compared to the private boat sector. Barotrauma was recorded as 'stomach' when a distended stomach was seen in the mouth forward of the eyes, including when the gut popped while being handled. Barotrauma was recorded as 'intestine' when the intestine was extended out of the cloaca but there was no stomach showing and 'extreme' was recorded when both were extended or the fish showed signs of bulging eyes.

The Marine Amateur Fishing Working Group (MAFWG) asked for data to be collected on seabird interactions. Observers recorded whether a fish was returned to the water because it was suspected as being skinny or having milky white flesh. Any seabird captures were collected following the standard NIWA boat ramp survey classifications. Observers recorded species and whether the bird was hooked or tangled. The condition on release was not collected for birds.

2.4 Data analysis

The methods used for developing estimates of annual snapper release mortality closely follow those of Holdsworth & Boyd (2008a, b). Survey data collected in this study were combined with the results of the snapper release mortality experiments conducted by Maggs et al. (2024c) and estimates of total harvest numbers for the SNA 1 region. For the private boat fishery, 2022–23 National Panel Survey estimates of the number of snapper harvested (NPS [Heinemann & Gray 2024]) was used, while for the charter boat fishery, harvest data were extracted from the ACV system under replog 16560 to provide a total annual release mortality estimate for the SNA 1 region. The methods described below were conducted separately for the private and charter datasets.

Estimating the total number of snapper caught in the fishery (kept + released)

Firstly, for each region, the number of snapper caught in the recreational fishery over the duration of a year was estimated by

$$N = N_k/\hat{p}_k$$

where $N_k$was the total number of kept (landed) fish taken from the 2023 NPS for private boats and from the 2023 ACV system for charter boats and $\hat{p}_k$ is the kept number of fish as a proportion of all snapper caught in the sample. The analyses assumed that the actual harvest during the survey period is the same as the NPS or ACV estimated harvests for 2023 but allows for a survey derived mean weight.

Length-specific proportions of kept and released snapper in the sample

Length frequencies were compiled separately for kept fish and for released fish. Length-specific numbers of kept snapper were converted to proportions of all sampled catch (kept and released) in the respective region by

$$\hat{p}_{i,k} = \frac{k_i}{\sum(k_i + r_i)}$$

where i is the centimetre length class index, k_i is the length-specific number of kept snapper and r_i is the length-specific number of released snapper. The sum of $\hat{p}_{i,k}$ is then equal to the overall proportion of kept fish $\hat{p}_k$. Similarly, the length-specific proportion of released snapper was calculated by

$$\hat{p}_{i,r} = \frac{r_i}{\sum(k_i + r_i)}$$

Estimating the length-specific numbers of kept and released snapper in the fishery

The total numbers of fish caught (kept + released) in the fishery N was then combined first with the length-specific proportions of kept fish in the sample $\hat{p}_{i,k}$ to establish the length-specific numbers of fish kept in the fishery by

$$N_{i,k} = \hat{p}_{i,k} \cdot N$$

and then with length-specific proportions of released fish in the sample $\hat{p}_{i,r}$ to establish the length-specific numbers of fish released in the fishery by

$$N_{i,r} = \hat{p}_{i,r} \cdot N$$

Estimating the length-specific weight of kept and released snapper in the fishery

Weight in kilograms for a given length class in the sample was estimated by

$$w_i = a l_i^b$$

where a and b are length-weight regression parameters (Walsh et al. 2022) and l_i is the sampled length class in centimetres. Length-specific total weights in the fishery were then calculated for released fish by

$$W_{i,r} = N_{i,r} \cdot w_i$$

and for kept fish by

$$W_{i,k} = N_{i,k} \cdot w_i$$

with $\sum W_{i,r}$ giving the total weight of released snapper in the fishery, $\sum W_{i,k}$ giving the total weight of kept snapper in the fishery and the sum of $\sum W_{i,r}$ and $\sum W_{i,k}$ giving the total weight of snapper caught overall.

Estimating release mortality

Having established the length-specific number and weight of fish being released by the fishery, the next step was to apply a probability of death to each fish. This was achieved by assigning a randomly selected fish fate (0 = lived, 1 = died) from the 2022 release mortality experiments, matched by water depth category (shallow: < 15 m, medium: 15–25 m, deep: 26–40 m) and hook location (lip, foul, swallowed). Some fish in this study were caught deeper than the depth range covered by the experiments and were simply assigned a probability of death from the deep category. This procedure was embedded in an overall bootstrapping procedure described below and thus contributed to the overall uncertainty.

Probabilities of death were then summed for each sampled length class to estimate the length-specific numbers of dead fish, which was in turn converted to a proportion of the number of fish released in the respective length class. These length-specific sampled proportions were matched to the fishery scale estimates of fish released $N_{i,r}$. A length-specific estimate of number of released fish that were expected to die could then be estimated for the fishery and converted to a length-specific weight of fish released dead. Summing the length-specific numbers or weights of fish released dead provided the overall fishery scale release mortality.

In the charter boat fishery, the observers recorded multiple fish condition outcomes (swim – no bleeding; swim – bleeding; floated – no bleeding; floated – bleeding; dying). A "worst-case" scenario ("dying") was thus evaluated where all snapper that were recorded as either floating, bleeding or dying, were assumed certain to die. Under this assumption, the probability of death of all such snapper was updated from that predicted by the experiments to a value of one.

Incorporating uncertainty

The procedure described above was nested in the R bootstrap resampling function *boot* (Canty & Ripley 2022) and the input dataset resampled 1000 times with replacement. The input dataset was stratified by region during the bootstrapping process so that the proportional representation of the region was unchanged between resampling draws. This represented a non-parametric bootstrapping procedure.

Regional mean weights

The overall regional mean weight of released fish was obtained by calculating the weighted mean of the weight classes in each region,

$$\overline{W}_r = \frac{\sum(\tilde{\hat{p}}_{i,r} \cdot w_i)}{\sum \tilde{\hat{p}}_{i,r}}$$

with the weighting $\tilde{\hat{p}}_{i,r}$ obtained by

$$\tilde{\hat{p}}_{i,r} = \hat{p}_{i,r} / \sum \hat{p}_{i,r}$$

so that the proportions of the released group sum to one.

All analyses were performed using R v4.3.0 (R Core Team 2023). The maps were produced using QGIS 3.42.0 (QGIS Development Team 2024).

3. RESULTS

3.1 Characterisation of the SNA 1 recreational fishery

Private boat fishery

In the characterisation of the private boat recreational fishery, which covered fishing years 2018–2023 it was evident that not all ramps were monitored each year (Figure 3). Where data was available, it was evident that the number of outings and snapper catch were not evenly distributed throughout the SNA 1 region. The coverage of the SNA 1 boat ramps has been driven by the coverage of the long-standing National Boat Ramp Creel Survey (NBRCS), which itself has focussed on high traffic boat ramps. Figure 3 thus confirmed that conducting the release mortality in tandem with the NBRCS would be productive for collecting snapper release mortality data. Although effort was focussed more in the summer (October–April), the snapper catch rate was more consistent throughout the year (Figure 4). The fork length of snapper was variable through the year with larger fish accounting for a higher proportion of the landed catch during early summer (October and November; Figure 5).

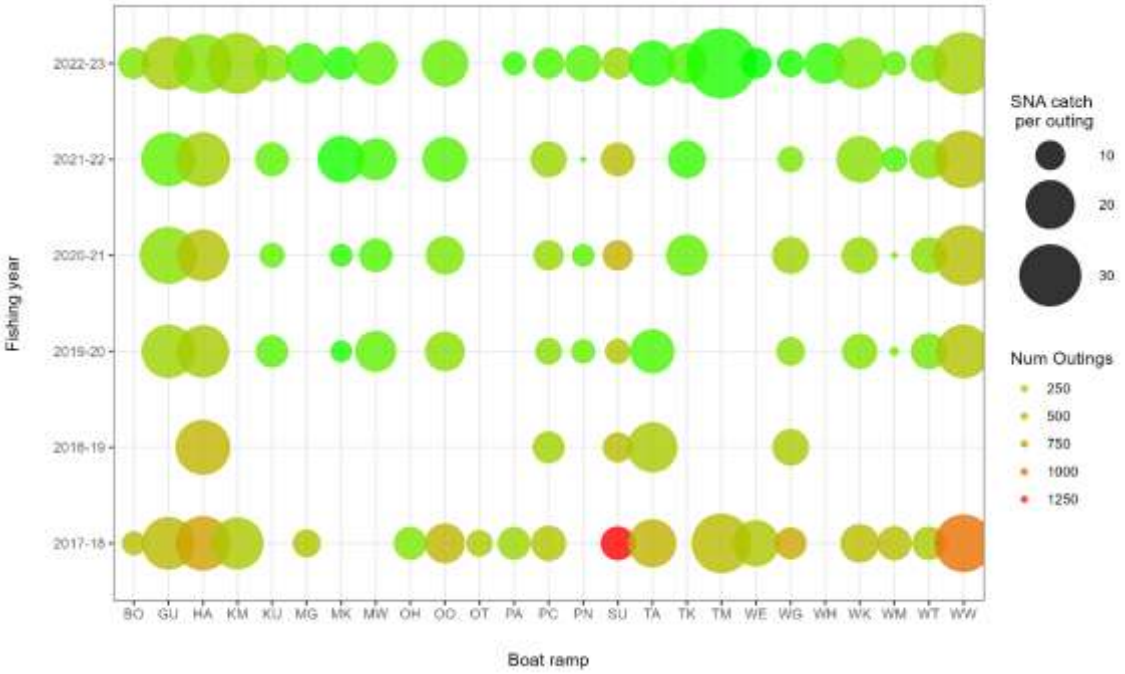

Figure 3: Distribution of private boat recreational fishing outings (data point colour) and landed snapper catch rate (data point size) in the SNA 1 Quota Management Area by monitored boat ramp and fishing year from 2018–2023. No data point indicates no creel sampling. Boat ramps – BO: Bowentown, GU: Gulf Harbour, HA: Half Moon Bay, KM: Kawakawa Bay, KU: Kūaotunu, MG: Mangōnui, MK: Maketu, MW: Mangawhai, OH: Ōhope, OT: Opito Bay, PA: Parua Bay, PC: Parua Bay Club, PN: Pauanui, SU: Sulphur Point, TA: Takapuna, TK: Te Kaha, TM: Te Kouma, WE: Westhaven, WG: Waitangi, WH: Whangaroa, WK: Whakatāne, WM: Whangamata, WT: Whitianga, WW: Waikawau. Source data: *rec_data* database.

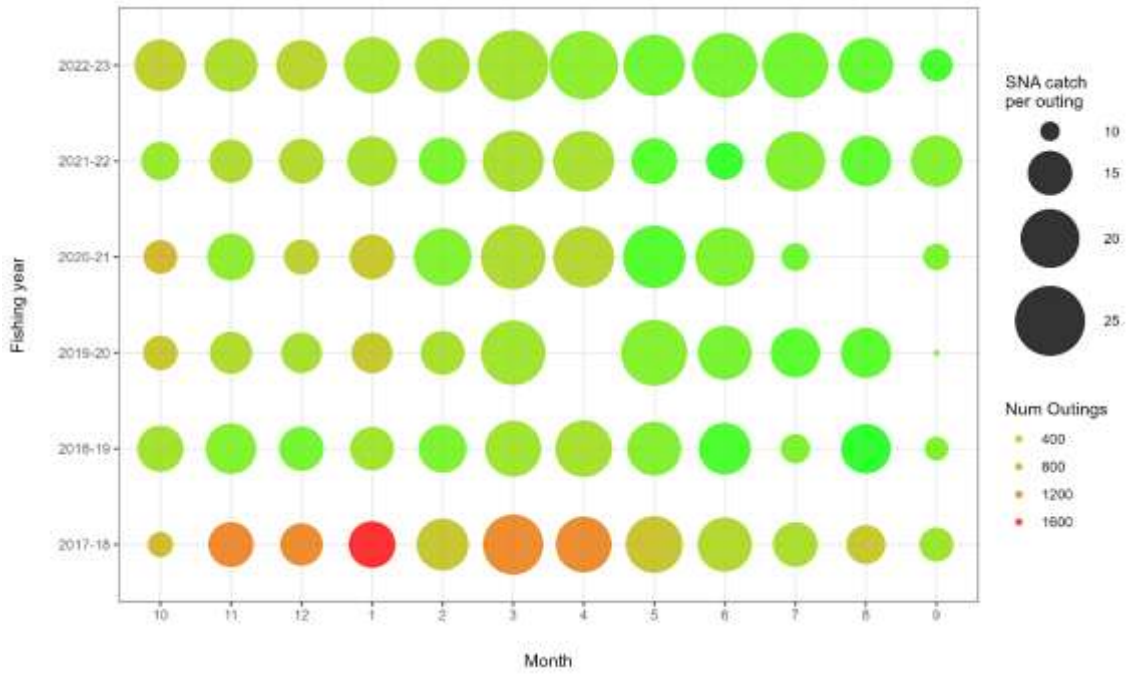

Figure 4: Distribution of private boat recreational fishing outings (data point colour) and landed snapper catch rate (data point size) in the SNA 1 Quota Management Area by month and fishing year from 2018 to 2023. No data point indicates no creel sampling. Source data: *rec_data* database.

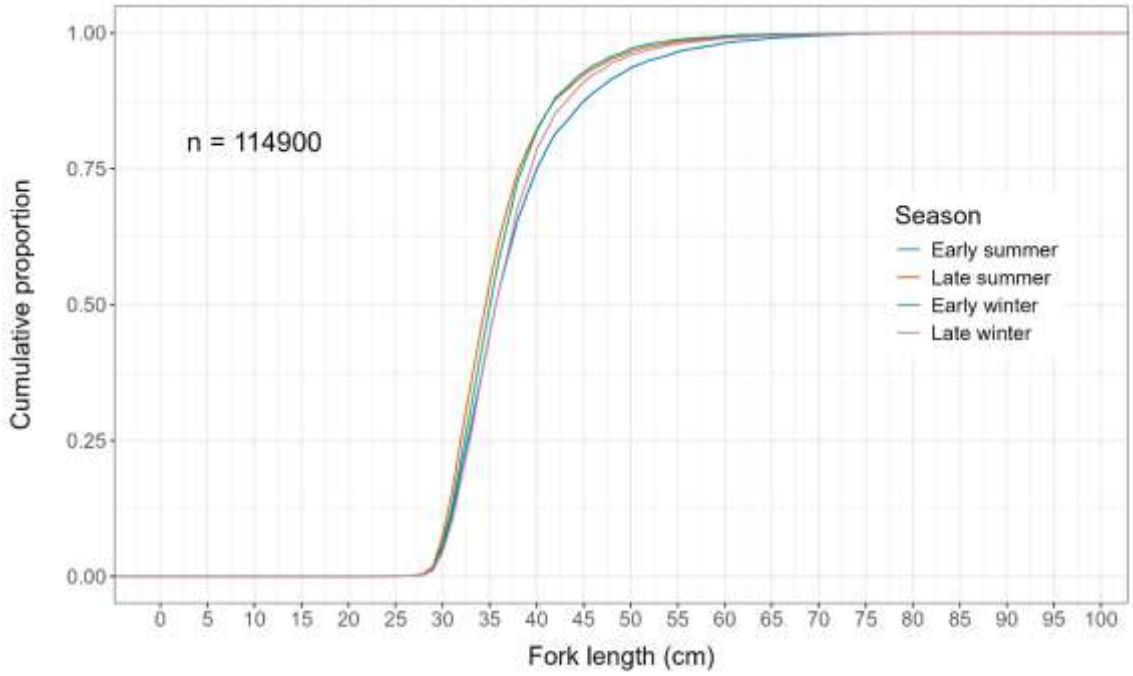

Figure 5: Empirical cumulative distribution function plot comparing length frequency of snapper by season (Early summer: October–December, Late summer: January–March, Early Winter: April–June, Later winter: July –September) from 2018 to 2023. Source data: *rec_data* database.

Charter boat fishery

Amateur fishing charter vessels cater to a range of recreational fishers from individuals, groups or domestic and international tourists. Charter operators have been required to record fishing effort for all paid trips on their vessel(s) with a date, location, target species, total catch and kept catch by

species since 2010. Snapper was not included in the list of species that required catch recording until 2020, though some charter operators voluntarily added snapper to their ACV catch reporting forms.

Data from the charter vessel catch returns for the 2022 calendar year were used to characterise the distribution of reported snapper catch on charter vessels by region and month. The Covid-19 pandemic and associated restrictions affected charter businesses, and several vessels had stopped operating. Data was also used to identify the most active ports or locations and charter operators in the current snapper fishery (Table 1). Minor ports and locations are not listed in Table 1 and port or location was not consistently reported in the ACV database.

Table 1: The number of snapper recorded by charter boats in the 2022 calendar year and the proportion of snapper from the listed locations. Source data: Amateur Charter Vessel database.

Region	Location	Number of snapper	Proportion
East Northland		33 351	
	Paihia	14 062	0.04
	Mangōnui	7 693	0.02
	Opua	7 273	0.02
	Russell	3 438	0.01
	Whangaroa	885	0.00
Hauraki Gulf		313 324	
	Auckland	165 745	0.42
	Te Kouma	46 206	0.12
	Tapu	27 221	0.07
	Gulf Harbour	21 652	0.06
	Waiomu	17 835	0.05
	Leigh	6 651	0.02
	Whangarei	5 660	0.01
	Marsden Cove	4 944	0.01
	Great Barrier	4 759	0.01
	Sandspit	3 579	0.01
	Tipoint	3 536	0.01
	Mangawhai	3 154	0.01
	Parua Bay	2 382	0.01
Bay of Plenty		43 555	
	Whitianga	13 413	0.03
	Whakatāne	9 805	0.03
	Tauranga	7 141	0.02
	Ohope	6 644	0.02
	Whangamata	6 552	0.02
Total		390 230	

3.2 Survey of the private boat recreational fishery

Based on the characterisation, 11 boat ramps were selected for targeted sampling (Table 2). Snapper release mortality data was collected at these boat ramps throughout the 2024 calendar year and in January 2025. The number of sampling days was varied through the year to reflect the anticipated level of fishing effort determined from the characterisation. Initially, the survey was meant to cover the 2024 calendar year only, but during the survey period it was decided to continue the sampling till the end of January 2025 to compensate for a poor start in January 2024. Very few fishers were encountered during August 2024, resulting in very little data being collected in that month.

Table 2: Planned temporal allocation of sampling effort and actual sampling days achieved in the private boat recreational fishery in the SNA 1 Quota Management Area and subregions for the snapper release mortality survey. Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. The planned allocation of sampling effort was based on the fishery characterisation presented in this report as well as consideration of other logistical constraints. Note that sampling in January 2025, although unplanned, was conducted due to a late start to the sampling in January 2024.

		ENLD		HAGU		BPLE		SNA 1			
Year	Month	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Planned prop.	Actual	Actual prop.
2024	1	27	11	45	31	27	14	99	0.12	56	0.07
	2	27	22	45	34	27	22	99	0.12	78	0.10
	3	27	15	45	36	27	25	99	0.12	76	0.10
	4	21	9	35	22	21	17	77	0.09	48	0.06
	5	15	15	25	19	15	15	55	0.07	49	0.06
	6	9	10	15	16	9	9	33	0.04	35	0.05
	7	6	10	10	12	6	11	22	0.03	33	0.04
	8	9	9	15	12	9	7	33	0.04	28	0.04
	9	9	16	15	23	9	14	33	0.04	53	0.07
	10	24	27	40	23	24	26	88	0.11	76	0.10
	11	24	25	40	29	24	26	88	0.11	80	0.10
	12	24	22	40	27	24	33	88	0.11	82	0.11
2025	1	0	19	0	31	0	24	0	0.00	74	0.10
	Total	222	210	370	315	222	243	814	1	768	1

Overall, snapper release mortality data were collected from 1746 private recreational fishing outings (Table 3, Figure 6). This included release mortality data on 16 921 individual snapper (Figure 7, Table 4).

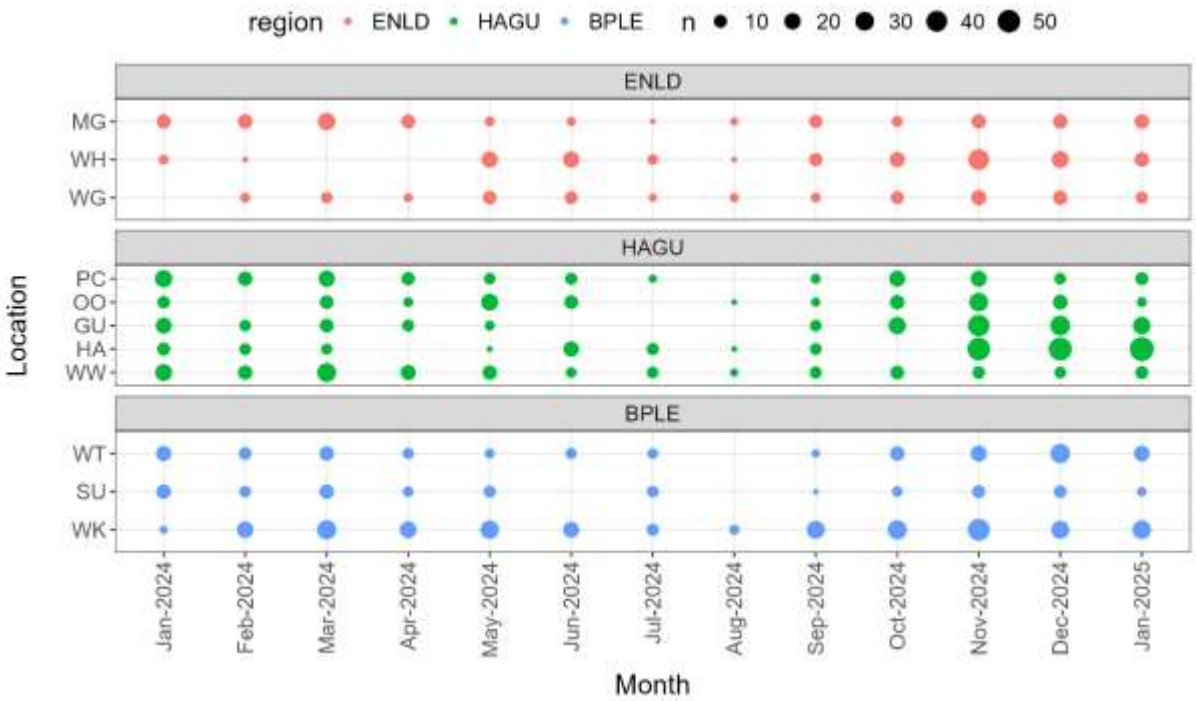

Figure 6: The number of sampled boat outings (bubble size) by private recreational fishers in the SNA 1 regions by location and month during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Boat ramps MG: Mangōnui, WH: Whangaroa, WG: Waitangi, PC: Parua Bay Club, OO: Omaha, GU: Gulf Harbour, HA: Half Moon Bay, WW: Waikawau, WT: Whitianga, SU: Sulphur Point, WK: Whakatāne.

Table 3: The number of sampled boat outings by private recreational fishers in the SNA 1 regions by location and month during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Boat ramps MG: Mangōnui, WH: Whangaroa, WG: Waitangi, PC: Parua Bay Club, OO: Omaha, GU: Gulf Harbour, HA: Half Moon Bay, WW: Waikawau, WT: Whitianga, SU: Sulphur Point, WK: Whakatāne.

		2024												2025	
Region	Boat ramp	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
ENLD	MG	13	14	24	13	4	3	1	2	11	6	14	14	14	133
	WH	4	1	0	0	20	20	5	1	11	17	40	23	14	156
	WG	0	4	7	3	12	10	2	3	4	10	16	14	8	93
HAGU	PC	24	14	20	11	7	8	2	0	4	19	19	7	10	145
	OO	9	0	12	4	23	12	0	1	3	14	30	15	4	127
	GU	19	7	12	8	4	0	0	0	7	24	44	35	25	185
	HA	10	7	6	0	1	17	8	1	7	0	51	53	59	220
	WW	22	14	31	16	14	5	7	2	8	12	9	7	10	157
BPLE	WT	17	9	14	6	4	6	5	0	2	14	19	34	18	148
	SU	14	7	14	5	8	0	7	0	1	5	10	9	3	83
	WK	2	21	32	22	29	19	8	4	27	32	46	27	30	299
SNA 1		134	98	172	88	126	100	45	14	85	153	298	238	195	1 746

Table 4: The number of snapper (kept + released) recorded in private boat recreational fishing outings in the SNA 1 regions by location and month during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Boat ramps MG: Mangōnui, WH: Whangaroa, WG: Waitangi, PC: Parua Bay Club, OO: Omaha, GU: Gulf Harbour, HA: Half Moon Bay, WW: Waikawau, WT: Whitianga, SU: Sulphur Point, WK: Whakatāne. Dash indicates no sampling.

		2024												2025	
Region	Boat ramp	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
ENLD	MG	146	115	191	130	43	15	7	4	34	11	89	70	66	921
	WH	28	6	-	-	143	169	53	0	57	115	288	161	117	1 137
	WG	-	83	128	32	128	74	11	47	9	95	107	139	79	932
HAGU	PC	221	201	242	142	83	84	11	-	30	81	162	18	48	1 323
	OO	154	-	160	52	199	140	-	13	32	82	381	114	0	1 327
	GU	313	157	216	106	103	-	-	-	83	217	547	307	194	2 243
	HA	134	89	82	-	6	243	97	3	97	-	630	674	677	2 732
	WW	406	177	560	275	227	66	93	14	50	156	126	193	107	2 450
BPLE	WT	200	95	134	47	33	23	35	-	27	38	103	176	133	1 044
	SU	119	82	102	37	57	-	75	-	5	19	50	39	28	613
	WK	8	233	372	208	353	164	44	7	86	185	265	150	124	2 199
SNA 1		1 729	1 238	2 187	1 029	1 375	978	426	88	510	999	2 748	2 041	1 573	16 921

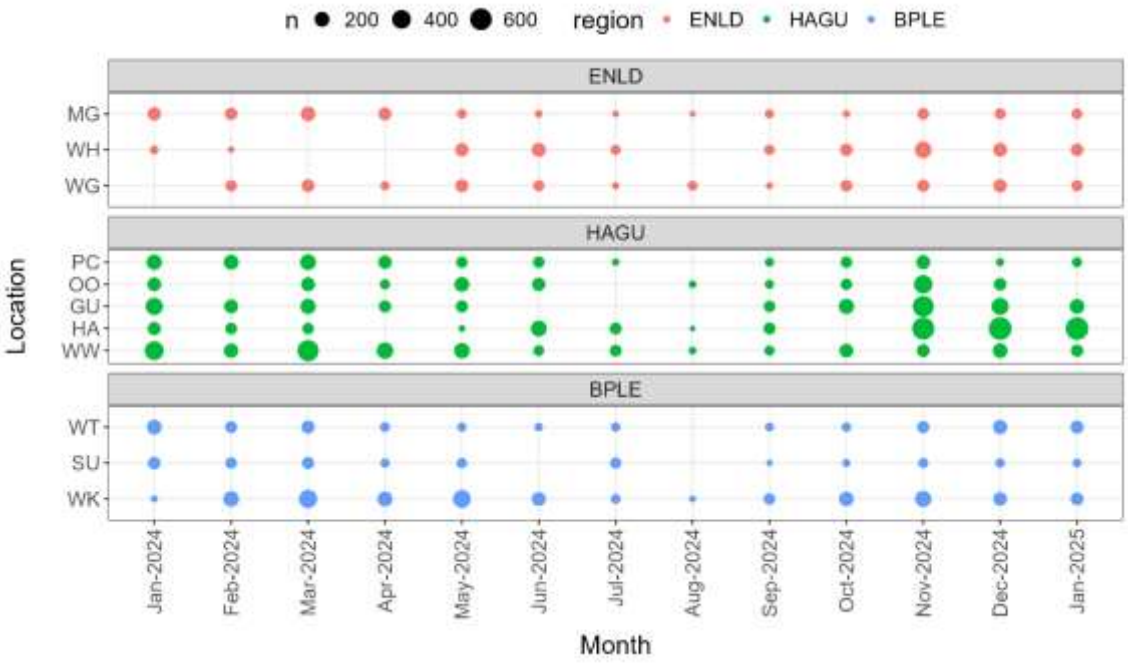

Figure 7: The number of snapper (kept + released) recorded in private boat recreational fishing outings in the SNA 1 regions by location and month during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Boat ramps MG: Mangōnui, WH: Whangaroa, WG: Waitangi, PC: Parua Bay Club, OO: Omaha, GU: Gulf Harbour, HA: Half Moon Bay, WW: Waikawau, WT: Whitianga, SU: Sulphur Point, WK: Whakatāne.

Snapper catch characteristics

Of the 16 921 snapper recorded as being caught, 10 547 (62%) were released (Figure 8). The proportion of released snapper remained relatively consistent throughout the year in East Northland but declined during the winter months in the Hauraki Gulf and Bay of Plenty. Bay of Plenty data from August 2024 indicated that no fish were kept, but this data point was limited to only seven fish.

The lengths of snapper in the private boat dataset ranged from 5–87 cm FL, with 53% of the snapper being smaller than the SNA 1 minimum legal size of 30 cm FL. A very few snapper smaller than 5 cm FL or larger than 100 cm FL were recorded by fishers, but these were deemed unrealistic measurements and removed from the dataset prior to analyses. The length structure of snapper did not appear to be related to region (Figure 9). However, snapper length appeared to vary during the year (Figure 10). Some measurement rounding was evident at the 15 cm and 20 cm length classes. Released snapper were also smaller than kept snapper in all three regions, reflecting the selectivity of the fishery and the minimum legal size (Figure 11). Of the 10 547 released snapper, 8903 (84%) were undersize.

Most of the snapper that were caught in all three regions were lip-hooked, similar to the experiments conducted by Maggs et al. (2024c) (Figure 12). Of the 16 314 snapper records for which hook locations were specified, 14 307 (88%) were lip hooked, 606 (4%) were foul-hooked, and 1401 (9%) were gut hooked. These proportions did not change appreciably through the year. Seemingly anomalous results in August may be reflective of very low sample sizes due to very low levels of fishing. Of the 10 547 snapper released from private boats, only 3% were recorded as floating.

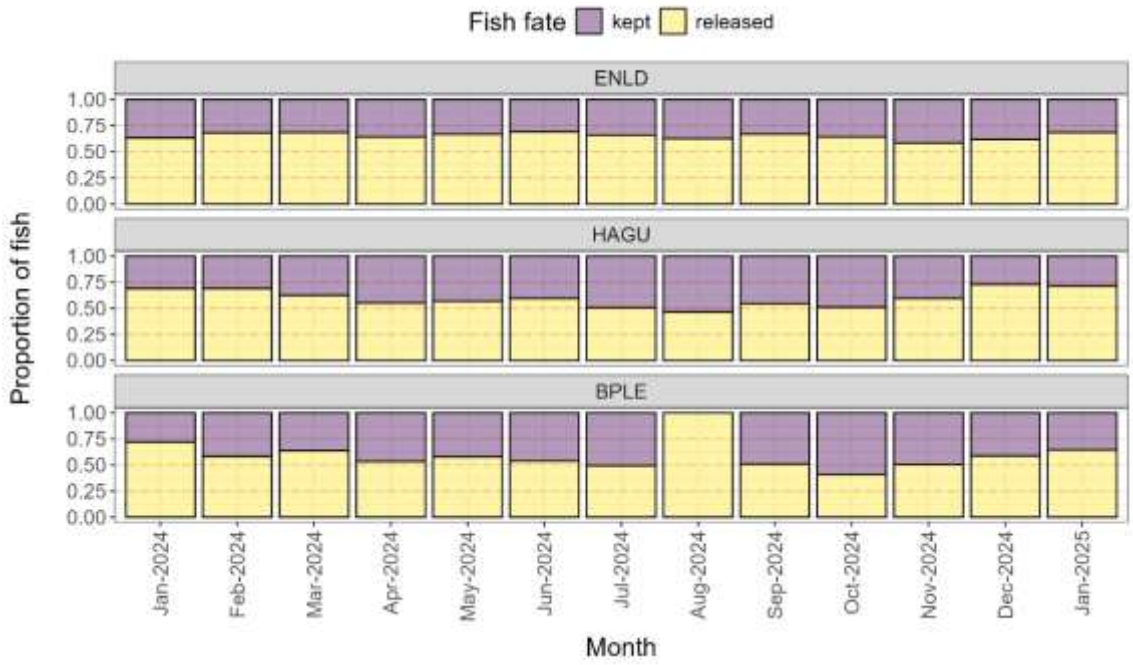

Figure 8: The proportion of kept and released snapper recorded in private boat recreational fishing outings in the SNA 1 regions by month during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty.

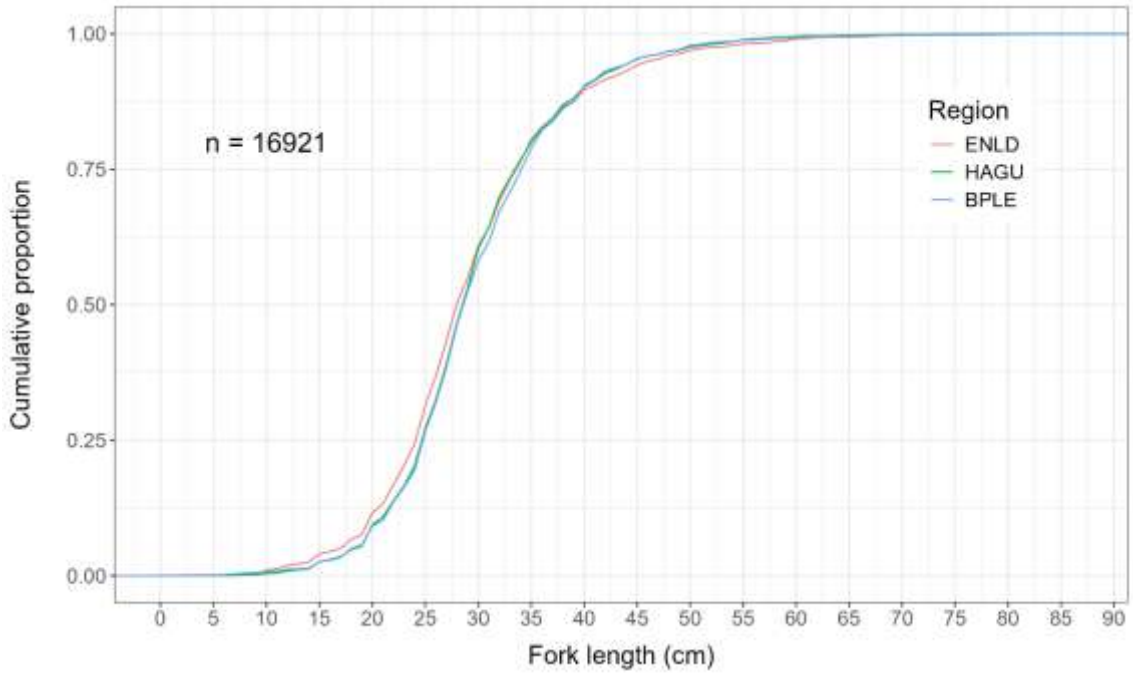

Figure 9: Empirical cumulative distribution function plot of length frequency for all snapper recorded in private boat recreational fishing outings in SNA 1 by region during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty.

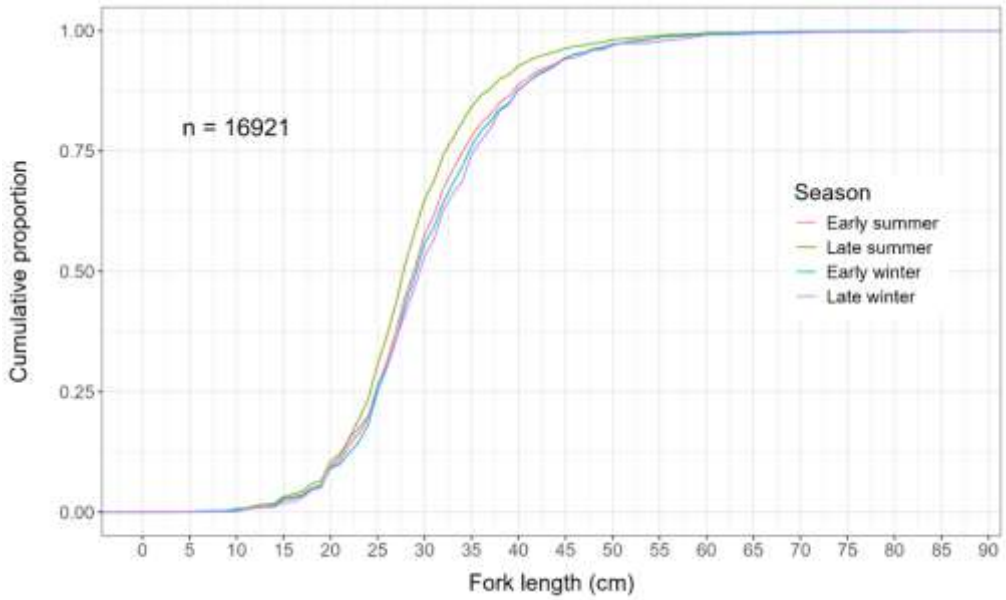

Figure 10: Empirical cumulative distribution function plot of length frequency for all snapper (released and retained combined) recorded during private boat recreational fishing outings in SNA 1 by season (Early summer: October–December, Late summer: January–March, Early winter: April–June, Late winter: July–September) during the SNA 1 release mortality characterisation (January 2024 to January 2025).

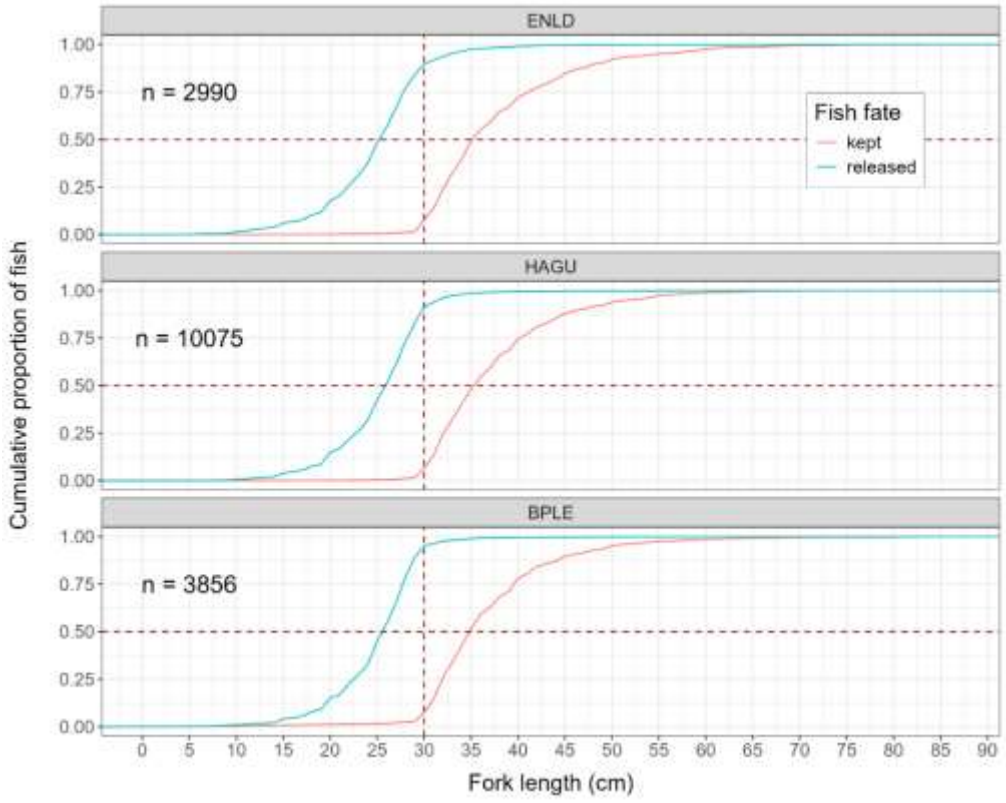

Figure 11: Empirical cumulative distribution function plot of snapper length frequency recorded in private boat recreational fishing outings in SNA 1 by region and fish fate during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Dashed vertical line is 30 cm minimum legal size for snapper in SNA 1. Dashed horizontal line is 50% accumulation of recorded sizes.

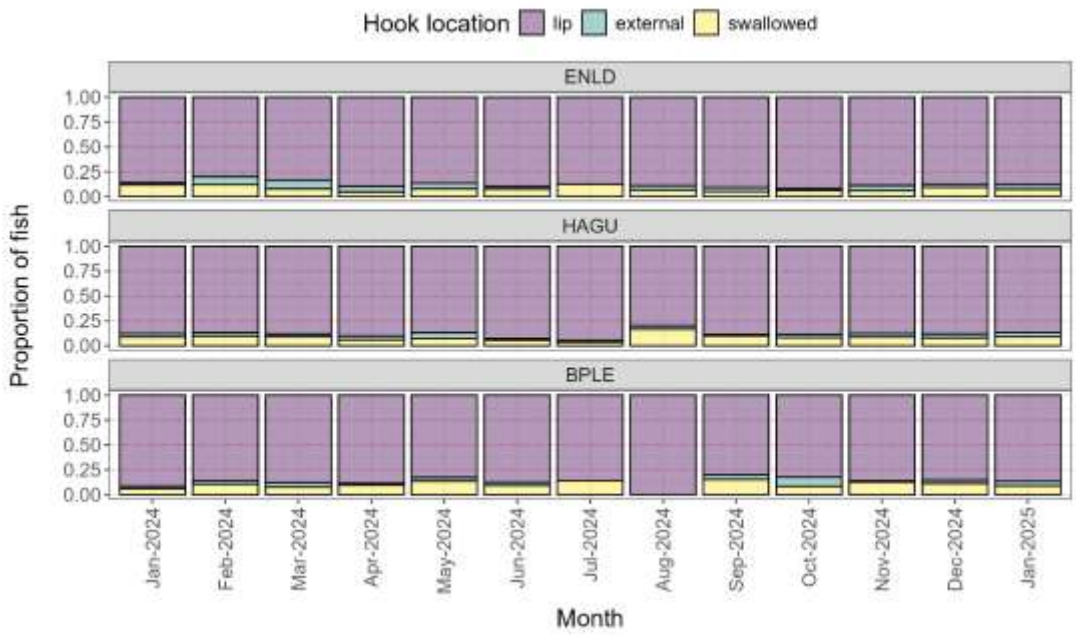

Figure 12: The proportion of lip-hooked, external-hooked and gut-hooked (hook swallowed) snapper recorded in private boat recreational fishing outings in SNA 1 by region and month during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty.

Water depth of captured snapper ranged from 1–124 m but did not differ much by region for all fish caught or for just released fish (Figure 13, Figure 14). Of the 16 165 records with water depth specified, 14 052 (87%) were caught in 1–40 m. The remainder, caught deeper than 40 m, were beyond the model predictions of probability of death provided by the experiments in Maggs et al. (2024c). Water depth of captured snapper also did not vary much during the year for all fish caught or for just released fish (Figure 15, Figure 16). August had the shallowest median depth, but this is also likely to be an artefact of the low sample size.

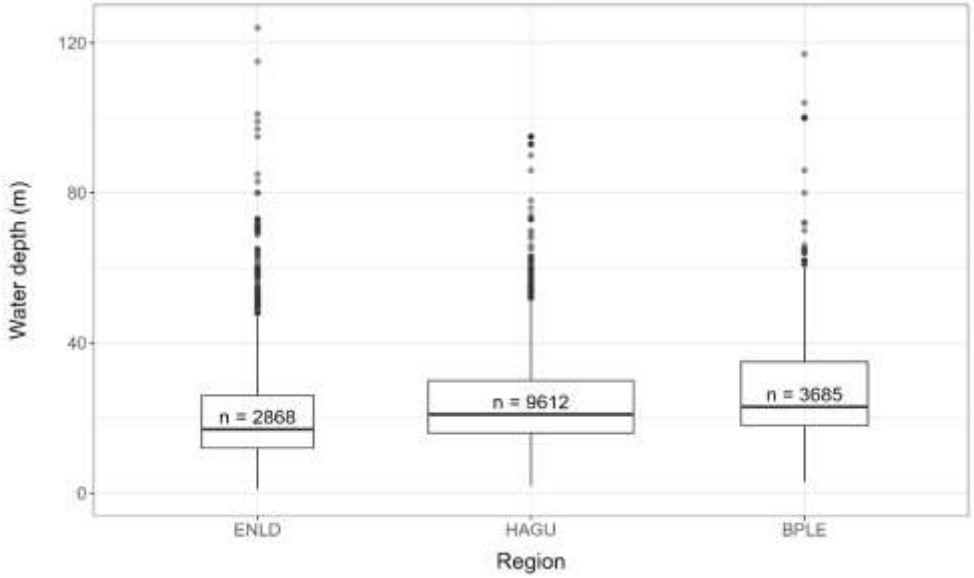

Figure 13: Median water depth of captured snapper (released and retained combined) recorded in private boat recreational fishing outings in SNA 1 by region during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Box indicates interquartile range (IQR), whiskers indicate largest/smallest value up to 1.5 × IQR and points indicate outliers beyond the whisker range.

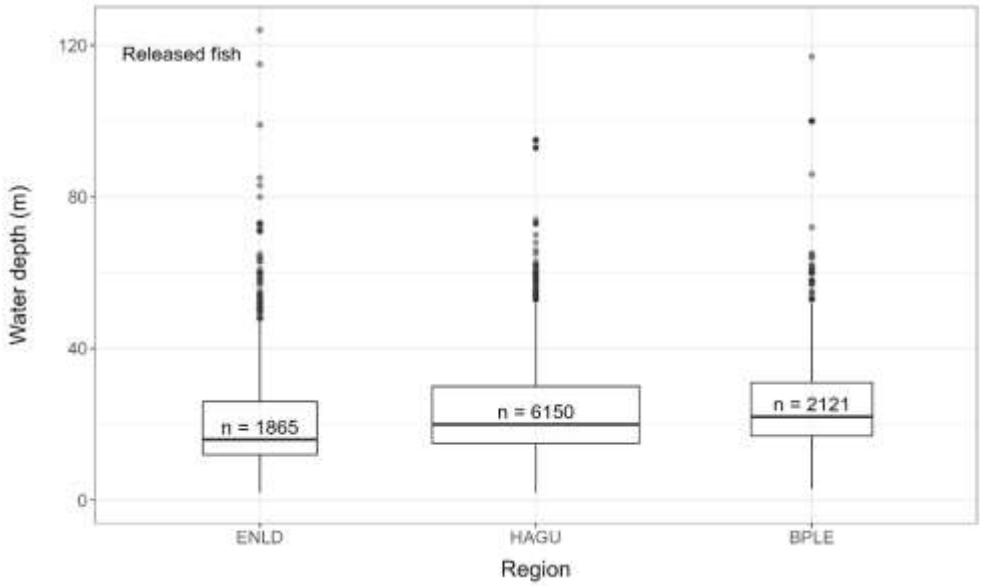

Figure 14: Median water depth of released snapper recorded in private boat recreational fishing outings in SNA 1 by region during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Box indicates interquartile range (IQR), whiskers indicate largest/smallest value up to 1.5 × the inter quartile range and points indicate outliers beyond that range.

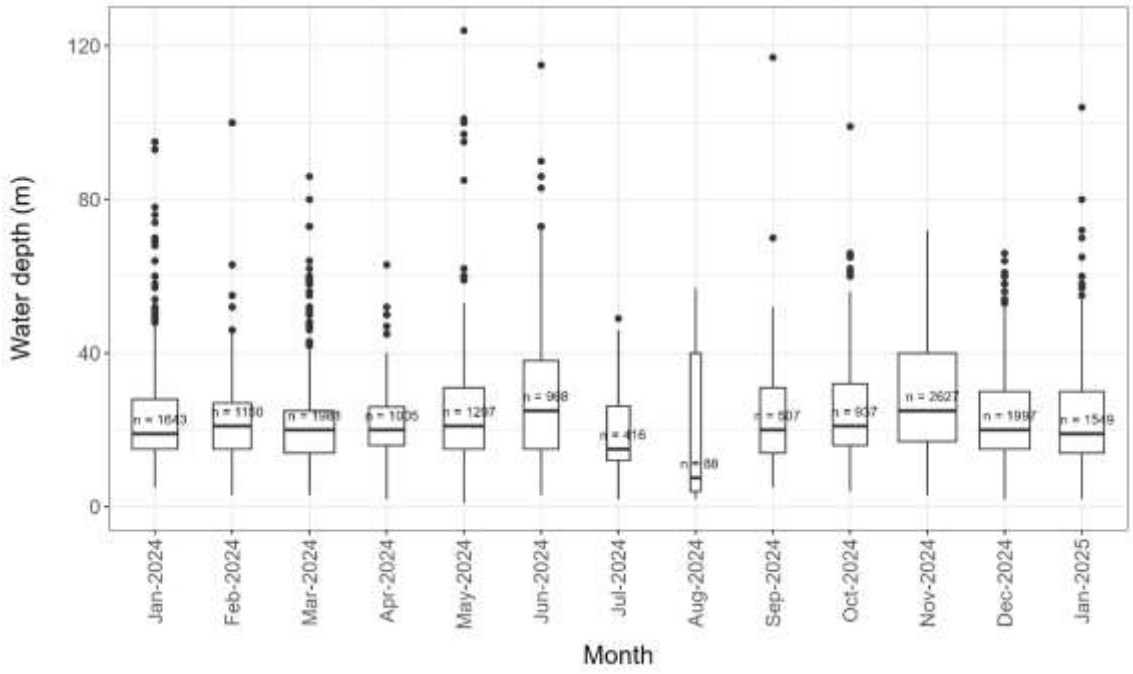

Figure 15: Median water depth of captured snapper recorded in private boat recreational fishing outings in SNA 1 by month during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Box indicates interquartile range (IQR), whiskers indicate largest/smallest value up to 1.5 × the inter quartile range and points indicate outliers beyond that range.

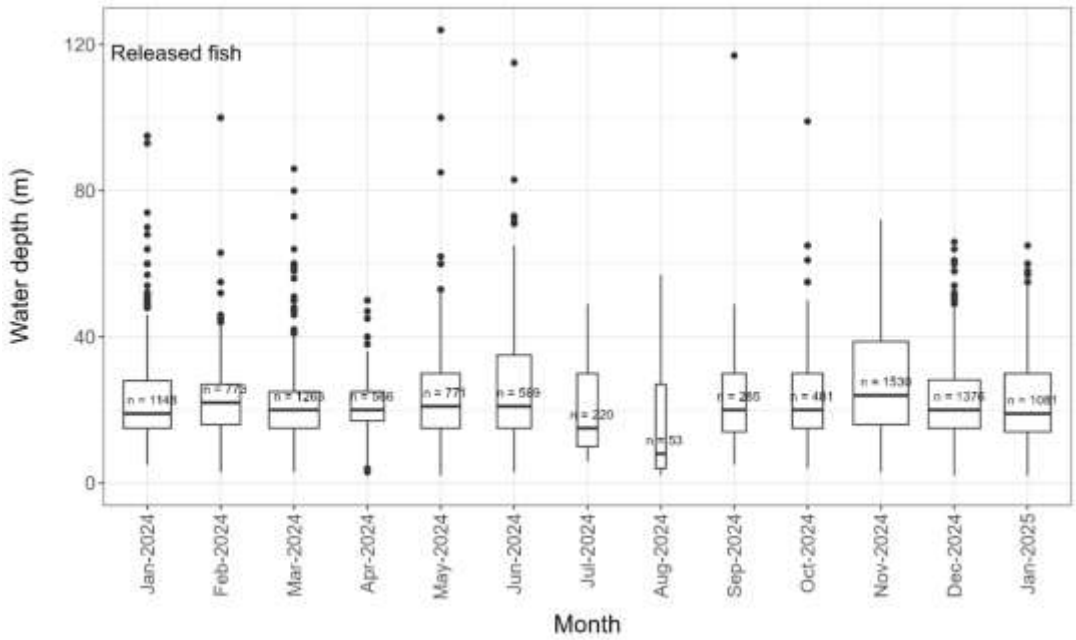

Figure 16: Median water depth of released snapper recorded in private boat recreational fishing outings in SNA 1 by month during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Box indicates interquartile range (IQR), whiskers indicate largest/smallest value up to 1.5 × the inter quartile range and points indicate outliers beyond that range.

In all regions of the private boat fishery, the proportion of released snapper expected to die because of their capture depth and hook location was greatest in the medium (15–25 m) and deep (>25 m) depth category (Figure 17). The expectation of death was substantially lower in the shallow (< 15 m) category.

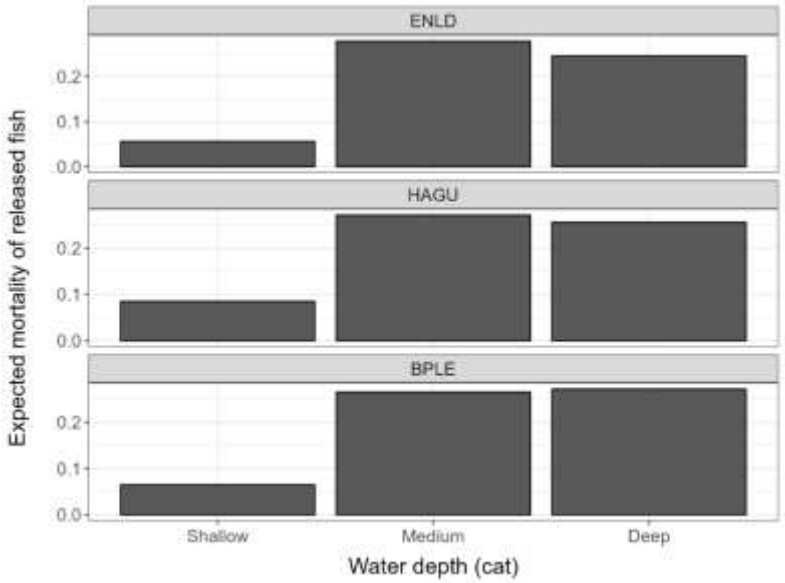

Figure 17: Number of snapper expected to die as a proportion of snapper released in each depth category by private boat recreational fishers during the SNA 1 release mortality characterisation (January 2024 to January 2025). Expected mortality based on the capture depth and hook location of snapper matched to experimental results obtained by Maggs et al. (2024). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Depth categories are Shallow: <15 m, Medium: 15–25 m, Deep: >25 m). The probability of mortality (0 or 1) for fish caught deeper than 40 m was based on experimental results obtained by Maggs et al. (2024b, c) for the 26–40 m depth category as the experiments did not cover depths greater than 40 m.

The mean weight of released snapper estimated for this study was 0.42 kg for SNA 1, whereas the mean weight of kept snapper was 1.26 kg (Table 5). Mean weight was lowest in the Bay of Plenty region for both released and kept snapper. East Northland had the highest mean weight of kept snapper, while the Hauraki Gulf and East Northland had similarly high mean weights for released snapper.

Table 5: Mean weight of released and kept snapper recorded in private boat recreational fishing outings in SNA 1 by region during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty.

	Mean weight (kg)	
Region	Released	Retained
ENLD	0.425	1.332
HAGU	0.428	1.236
BPLE	0.408	1.201

3.3 Snapper release mortality in the private boat recreational fishery

It was estimated that 903 t of snapper (2.1 million individual fish), were released in SNA 1 by private boat recreational fishers over a 12-month period (Table 6, Appendix 4). Released tonnage was highest in the Hauraki Gulf at 551 t (1.3 million fish), followed by Bay of Plenty at 210 t (516 000 fish) and East Northland at 142 t (333 000 fish) (Figure 18). The annual estimated release mortality, defined as released snapper expected to die, was estimated to be 200 t (477 000 fish) for the entire SNA 1 region. Release mortality was highest in the Hauraki Gulf at 124 t (293 000 fish), followed by the Bay of Plenty at 49 t (122 000 fish) and East Northland at 27 t (62 000 fish).

Combining release mortality with kept fish indicated a total mortality in the SNA 1 fishery of 1700 t or 1.8 million fish over this 12-month period. Overall, 22% of released snapper in SNA 1 were expected to die. The biomass of expected deaths was 13% of the SNA 1 landed (kept) catch, whereas the number of expected deaths was 37% of the landed catch.

Table 6: The estimated annual biomass and number of individual fish in the SNA 1 private boat recreational fishery (base case). Mean volume of released fish, which were expected to die was estimated by non-parametric bootstrapping, SE: standard error, LCI: lower 95% confidence interval, UCI: upper 95% confidence interval. Note that retained (kept) catch was taken from the 2023 National Panel Survey (Heinemann & Gray 2024) estimates for SNA 1. Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty.

					Estimated fish dying							
Metric	Region	Retained catch (NPS)	Estimated total catch	Released fish	Mean	Bias	SE	CV	LCI	UCI	% of released fish dying	Deaths as % of retained catch
Biomass (t)	ENLD	236.7	383	142	27	0.2	2.1	0.08	24	32	19%	11%
	HAGU	807.5	1471	551	124	2.6	4.5	0.04	118	136	22%	15%
	BPLE	469.9	664	210	49	1.6	2.9	0.06	45	57	23%	10%
	SNA 1	1514.1	2518	903	200	4.5	5.7	0.03	194	216	22%	13%
Numbers	ENLD	180 950	514 297	333 347	62 154	2 768	3 983	0.06	57 324	73 201	19%	34%
	HAGU	744 122	2 031 165	1 287 043	292 987	1 651	9 294	0.03	277 018	314 067	23%	39%
	BPLE	378 070	893 831	515 761	121 655	3 751	6 454	0.05	112 588	138 494	24%	32%
	SNA 1	1 303 142	3 439 293	2 136 151	476 796	8 170	12 030	0.03	460 170	507 997	22%	37%

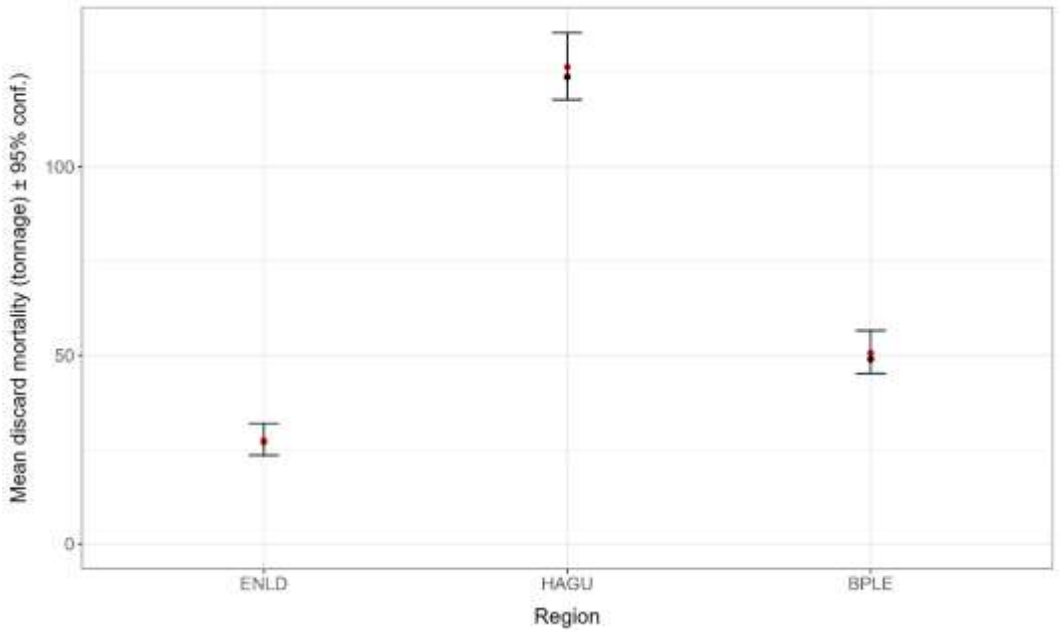

Figure 18: Estimated annual release mortality (t) of released snapper (base case) during the SNA 1 release mortality characterisation (January 2024 to January 2025) by region. ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Red points indicate bootstrap bias as it deviates from the mean (underlying black points).

3.4 Survey of the charter boat recreational fishery

Based on the characterisation, snapper catch data were collected at fishing ports throughout the 2024 calendar year and in January 2025 (Table 7). The number of sampling days was varied through the year to reflect the anticipated level of fishing effort determined from the characterisation. Initially, the survey was meant to cover the 2024 calendar year only, but during the survey period it was decided to continue the sampling till the end of January 2025 to compensate for a poor start in January 2024. August and September 2024 had little data collected due to limited charter trip bookings or other constraints (i.e., mechanical issues with vessels).

Overall, 240 charter boat fishing events were sampled from nine fishing ports, which were identified with suitable charter vessels for placement of observers for collecting snapper catch data (Figure 19, Table 8). These were Mangōnui (MG), Waitangi (WG) and Paihia (PAA) in East Northland; Marsden Cove (MRC), Gulf Harbour (GU), Coromandel (COR) and Auckland (AUK) in the Hauraki Gulf; Tauranga Harbour Bridge Marina (TGH) and Whakatāne (WK) in the Bay of Plenty. The location and depth of each location fished on a charter trip was recorded as a separate fishing event.

Catch data were collected for 7092 individual snapper, including fish kept and released (Figure 20, Table 9). Over half (54%) of the catch data was collected from Hauraki Gulf (3840 fish) followed by Bay of Plenty (2005 fish) and East Northland (1247 fish). In Gulf Harbour, over 600 individual fish were recorded in March and November compared to other regions and months where around 400 or less fish were recorded. The charter boats in Gulf Harbour usually had larger groups of 10 or more people and fishing trips were of a longer duration.

Table 7: Planned temporal allocation of sampling effort and actual sampling days achieved in the charter boat recreational fishery in the SNA 1 Quota Management Area and subregions for the snapper release mortality survey. Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. The planned allocation of sampling effort was based on the fishery characterisation presented in this report as well as consideration of other logistical constraints. Note that sampling in January 2025, although unplanned, was conducted due to a late start to the sampling in January 2024.

		ENLD		HAGU		BPLE		SNA 1			
Year	Month	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Planned prop.	Actual	Actual prop.
2024	1	3	1	4	0	4	0	11	0.12	1	0.01
	2	2	1	5	3	3	3	10	0.12	7	0.09
	3	3	2	5	4	4	3	12	0.12	9	0.12
	4	2	0	4	3	3	4	9	0.09	7	0.09
	5	1	3	3	1	2	3	6	0.07	7	0.09
	6	1	2	2	3	1	2	4	0.04	7	0.09
	7	1	3	2	1	1	1	4	0.03	5	0.06
	8	1	1	2	1	1	0	4	0.04	2	0.03
	9	1	0	3	0	1	2	5	0.04	2	0.03
	10	2	4	4	1	2	1	8	0.11	6	0.08
	11	2	1	5	5	3	0	10	0.11	6	0.08
	12	3	2	5	3	3	3	11	0.11	8	0.10
2025	1	0	3	0	6	0	2	0	0	11	0.14
	Total	22	23	44	31	28	24	94	1	78	1.00

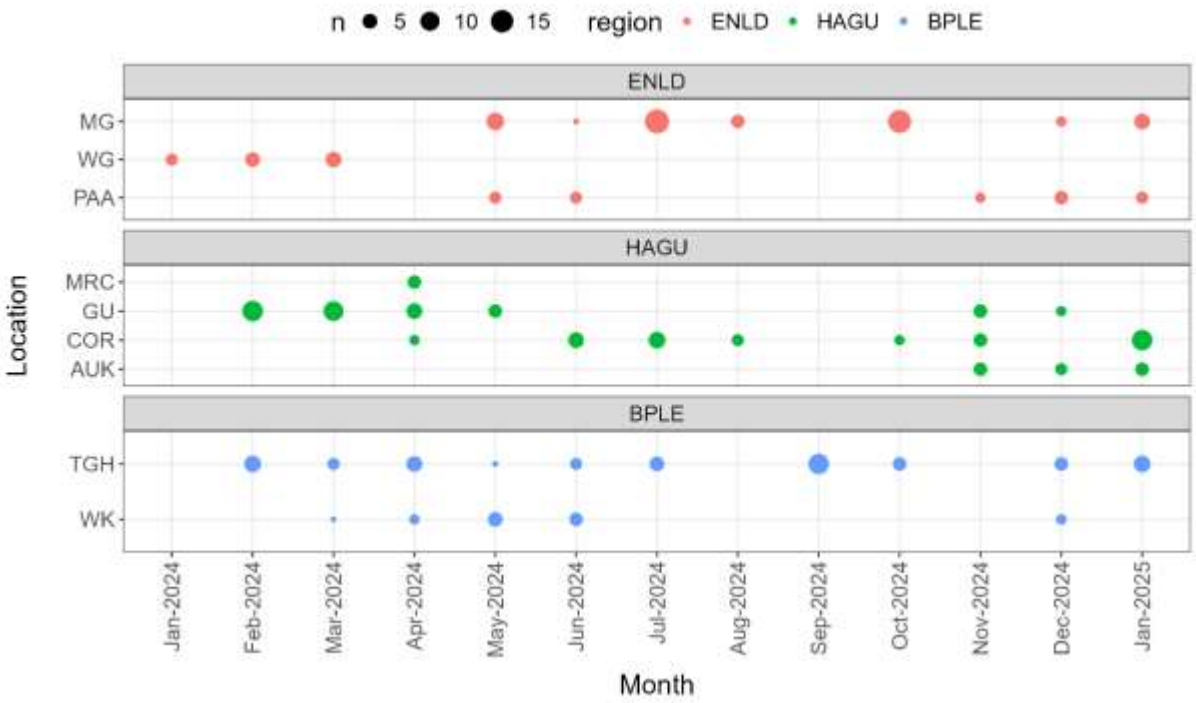

Figure 19: The number of sampled fishing events by charter boat recreational fishers in the SNA 1 regions by locality and month during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Localities - MG: Mangōnui, WG: Waitangi, PAA: Paihia, MRC: Marsden Cove, GU: Gulf Harbour, COR: Coromandel, TGH: Tauranga Harbour Bridge Marina, WK: Whakatāne.

Table 8: The number of sampled fishing events by charter boat recreational fishers in the SNA 1 regions by locality and month during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions - ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Localities - MG: Mangōnui, WG: Waitangi, PAA: Paihia, MRC: Marsden Cove, GU: Gulf Harbour, COR: Coromandel, TGH: Tauranga Harbour Bridge Marina, WK: Whakatāne.

		2024												2025	
Region	Locality	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
ENLD	MG	0	0	0	0	8	1	18	4	0	16	0	2	6	55
	WG	3	5	6	0	0	0	0	0	0	0	0	0	0	14
	PAA	0	0	0	0	3	3	0	0	0	0	2	4	3	15
HAGU	MRC	0	0	0	4	0	0	0	0	0	0	0	0	0	4
	GU	0	12	11	6	4	0	0	0	0	0	4	2	0	39
	COR	0	0	0	2	0	6	7	3	0	2	4	0	12	36
	AUK	0	0	0	0	0	0	0	0	0	0	4	3	4	11
BPLE	TGH	0	7	3	6	1	3	5	0	12	4	0	4	7	52
	WK	0	0	1	2	5	4	0	0	0	0	0	2	0	14
SNA 1		3	24	21	20	21	17	30	7	12	22	14	17	32	240

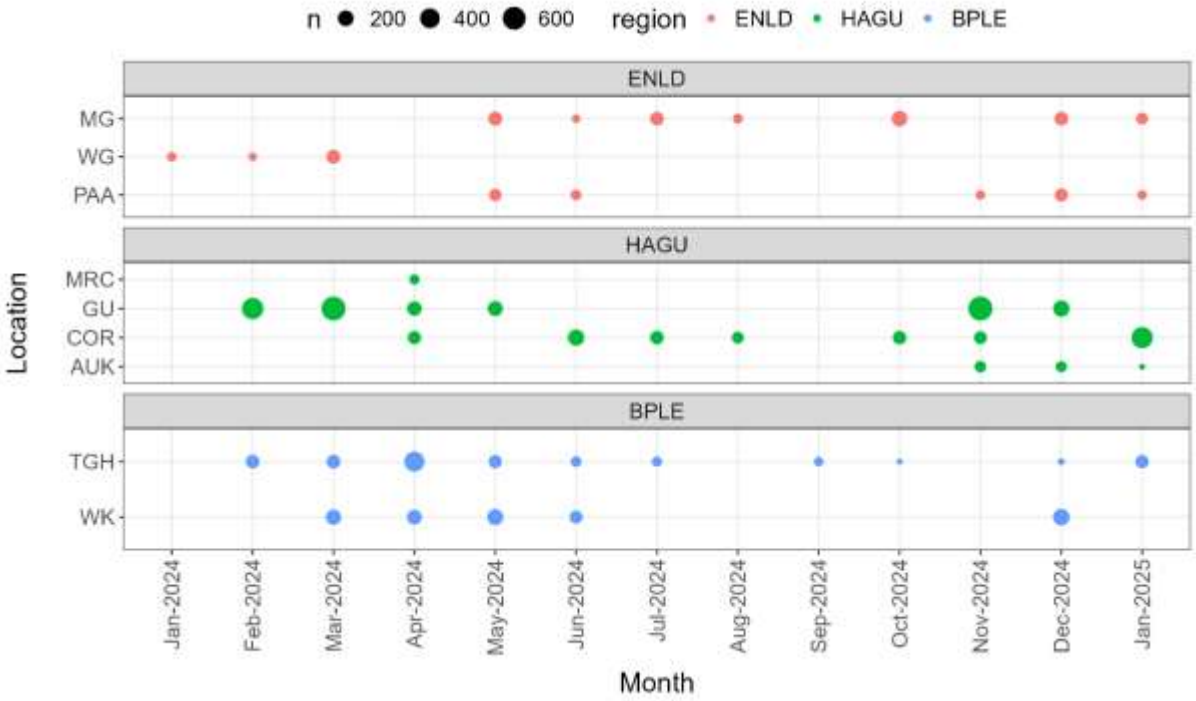

Figure 20: The number of snapper (kept + released) recorded in charter boat recreational fishing outings in the SNA 1 regions by location and month during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Localities MG: Mangōnui, WG: Waitangi, PAA: Paihia, MRC: Marsden Cove, GU: Gulf Harbour, COR: Coromandel, TGH: Tauranga Harbour Bridge Marina, WK: Whakatāne. Bubble size is proportional number of snapper.

Table 9: The number of snapper (kept + released) recorded in charter boat recreational fishing outings in the SNA 1 regions by locality and month during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Localities - MG: Mangōnui, WG: Waitangi, PAA: Paihia, MRC: Marsden Cove, GU: Gulf Harbour, COR: Coromandel, TGH: Tauranga Harbour Bridge Marina, WK: Whakatāne. Dash indicates no sampling conducted.

		2024												2025	
Region	Locality	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
ENLD	MG	-	-	-	-	142	21	131	38	-	200	-	129	76	737
	WG	33	20	139	-	-	-	-	-	-	-	-	-	-	192
	PAA	-	-	-	-	92	51	-	-	-	-	32	110	33	318
HAGU	MRC	-	-	-	45	-	-	-	-	-	-	-	-	-	45
	GU	-	499	682	156	177	-	-	-	-	-	688	225	-	2 427
	COR	-	-	-	114	-	226	124	80	-	123	108	-	491	1 266
	AUK	-	-	-	-	-	-	-	-	-	-	71	60	6	137
BPLE	TGH	-	129	132	421	115	51	43	-	30	6	-	8	115	1 050
	WK	-	-	185	169	216	112	-	-	-	-	-	238	-	920
SNA 1		33	648	1 138	905	742	461	298	118	30	329	899	770	721	7 092

Snapper catch characteristics

Of the 7092 snapper recorded, 4912 (69%) were released (Figure 21). The proportion of released snapper varied between months, indicative of the availability of fish at or above the minimum legal size and a small sample size in some months. More fish were kept over winter and spring across all regions. East Northland data from January to March 2024 indicated low numbers of kept fish. Limited survey days were available and when data collection did occur there was a high proportion of sub-legal snapper.

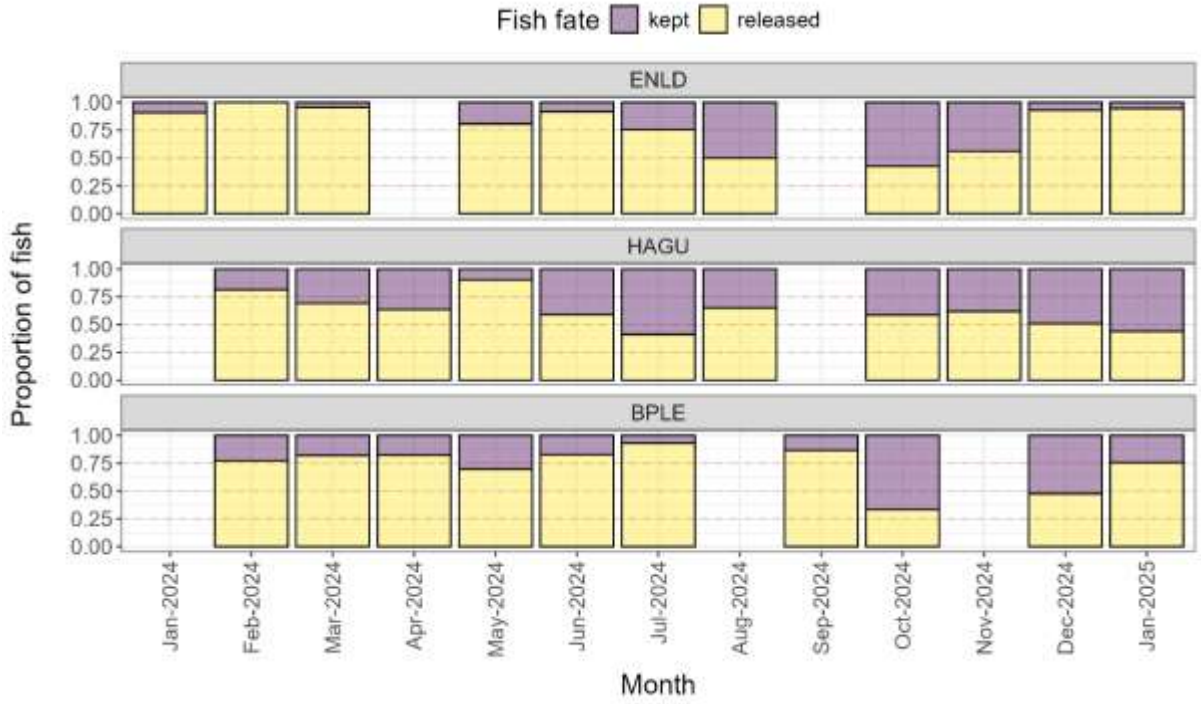

Figure 21: The proportion of kept and released snapper recorded in charter boat recreational fishing outings in the SNA 1 regions by month during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty.

The snapper length distribution showed fewer small snapper caught in the Hauraki Gulf, while the length distribution in East Northland and Bay of Plenty was similar (Figure 22). However, there were more snapper larger than 40 cm in East Northland. Length structure also changed during the year in SNA 1 with a higher proportion of larger snapper in spring and smaller fish in summer (Figure 23). Released snapper were also notably smaller than kept snapper, reflecting the selectivity of the fishery and the minimum legal size of 30 cm. Most legal-sized fish were kept, and in the Hauraki Gulf, the Coromandel charter boat had a voluntary minimum legal size of 35 cm except on days where fishing was harder (Figure 24).

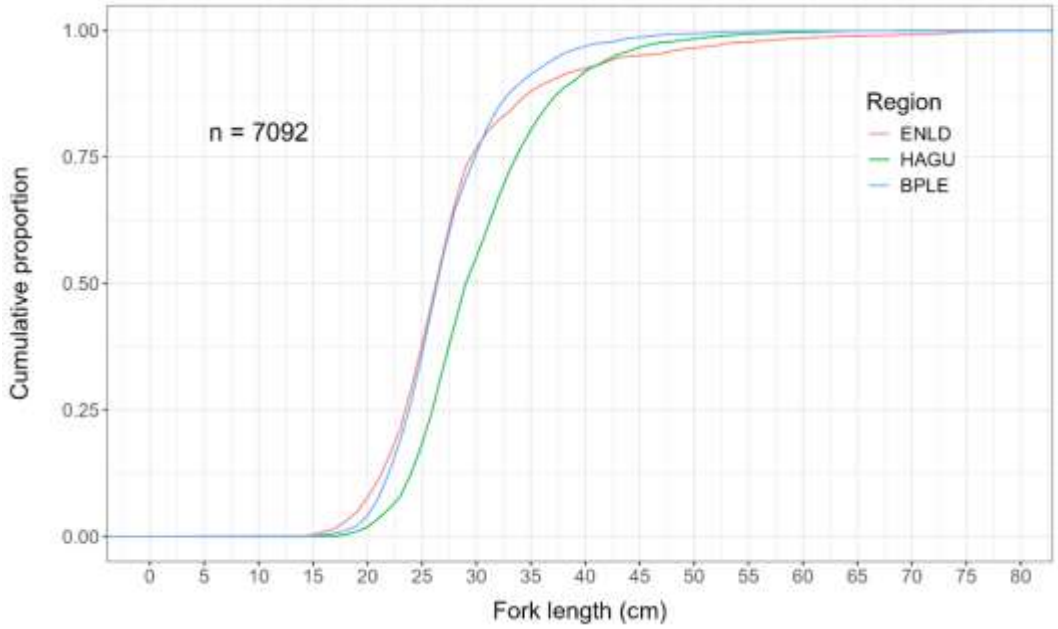

Figure 22: Empirical cumulative distribution function plot of length frequency for all snapper recorded in charter boat recreational fishing outings in SNA 1 by region during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty.

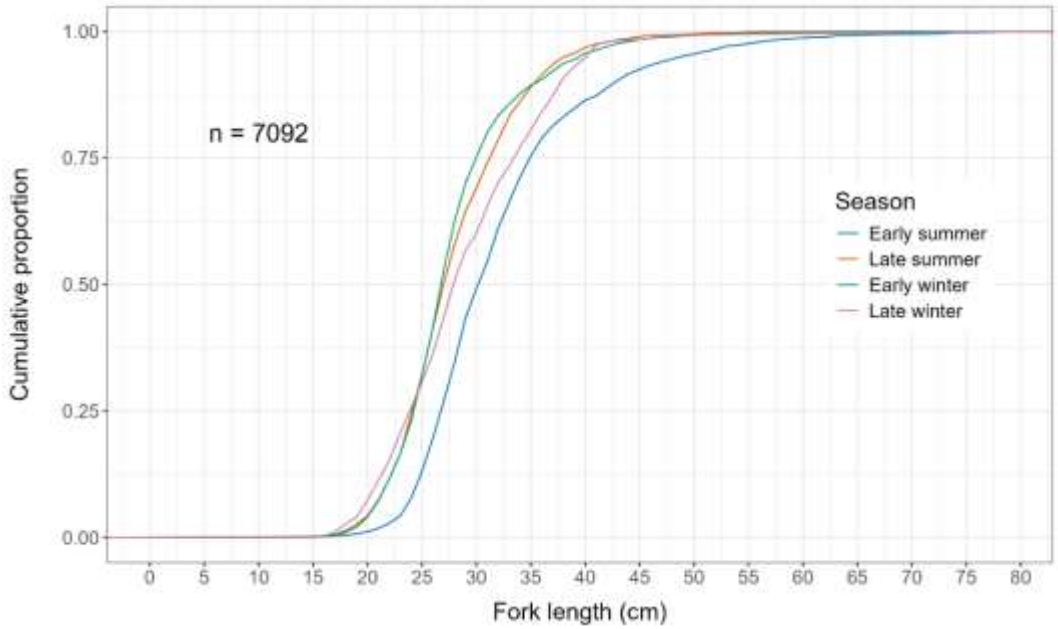

Figure 23: Empirical cumulative distribution function plot of length frequency for all snapper recorded in charter boat recreational fishing outings in SNA 1 by season (Early summer: October–December, Late summer: January–March, Early winter: April–June, Late winter: July–September) during the SNA 1 release mortality characterisation (January 2024 to January 2025).

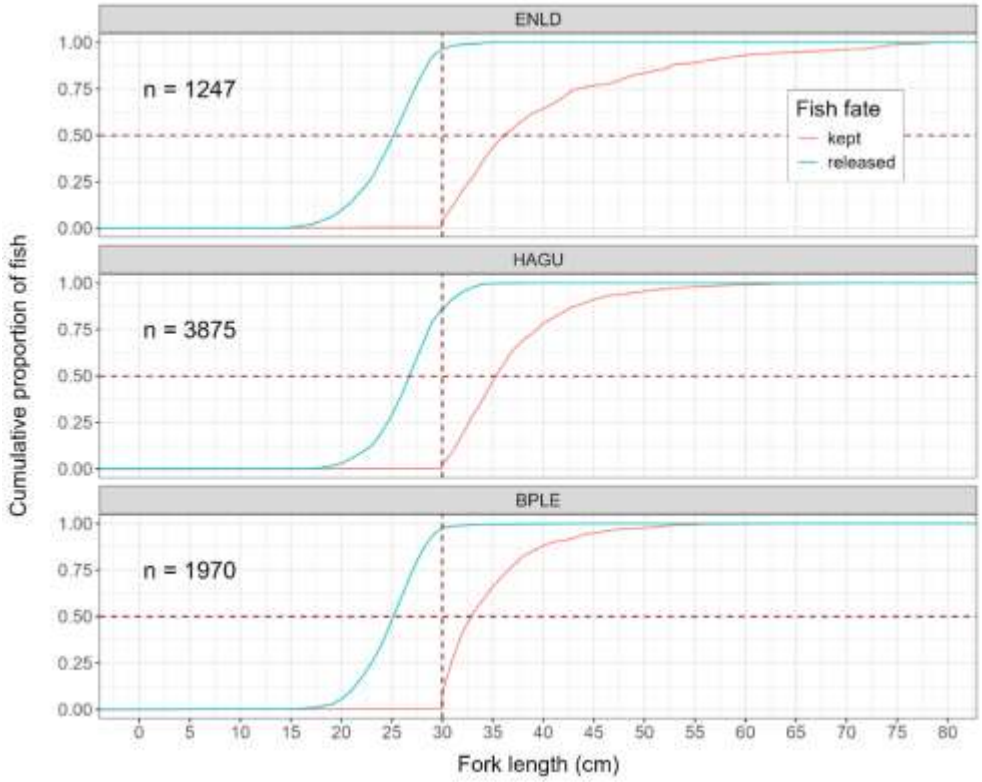

Figure 24: Empirical cumulative distribution function plot of snapper length frequency recorded in charter boat recreational fishing outings in SNA 1 by region and fish fate during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Dashed vertical line indicates 30 cm minimum legal size for snapper in SNA 1. Dashed horizontal line indicates 50% accumulation of recorded sizes.

Most snapper were lip-hooked in all three regions, similar to the experiments conducted by Maggs et al. (2024c) (Figure 25). Of the 7092 snapper recorded, 6769 (95%) were lip hooked. A much smaller proportion of snapper had been foul-hooked (201 fish, 3%) and 122 (2%) snapper were hooked in the throat or gut. These proportions did not change much through the year. East Northland data in February and November 2024 indicated a jump in foul-hooked snapper; however, there was a smaller sample size with only three fish recorded as foul-hooked in February and six in November. Of the 4905 snapper released from charter boats, only 1.7% were recorded as floating.

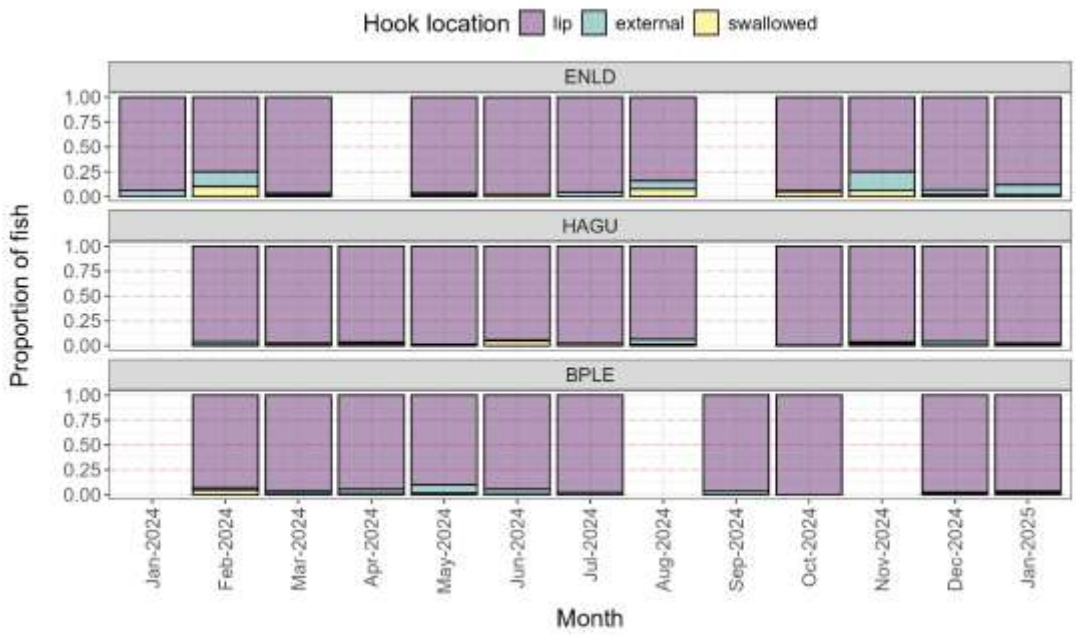

Figure 25: The proportion of lip-hooked, external-hooked and gut-hooked snapper recorded in charter boat recreational fishing outings in SNA 1 by region and month during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty.

Median water depth of all captured snapper ranged from 5–60 m but did not differ much by region (Figure 26). Although the majority (79%) of snapper were caught in 20–40 m, some were caught deeper than 40 m, which is beyond the model predictions of probability of death provided by the experiments in Maggs et al. (2024c). The median capture depth of released snapper followed a similar pattern to that of all fish (Figure 27). Fishing was deeper in the Hauraki Gulf in the summer months. Water depth of all captured snapper was greatest in February and March 2024 (Figure 28). The monthly median water depth of released snapper showed a similar pattern (Figure 29).

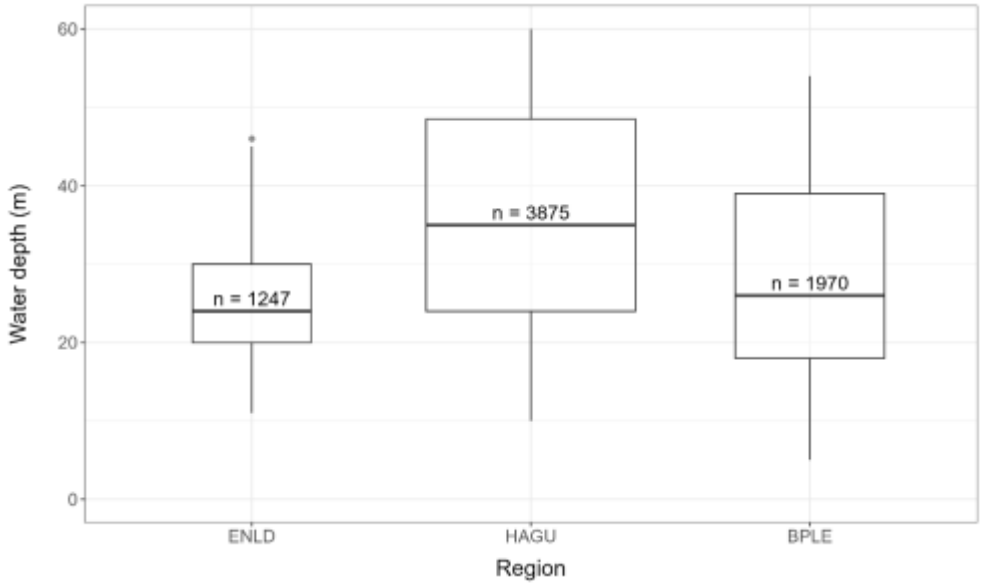

Figure 26: Median water depth of captured snapper recorded in charter boat recreational fishing outings in SNA 1 by region during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Box indicates interquartile range (IQR), whiskers indicate largest/smallest value up to 1.5 × IQR and points indicate outliers beyond the whisker range.

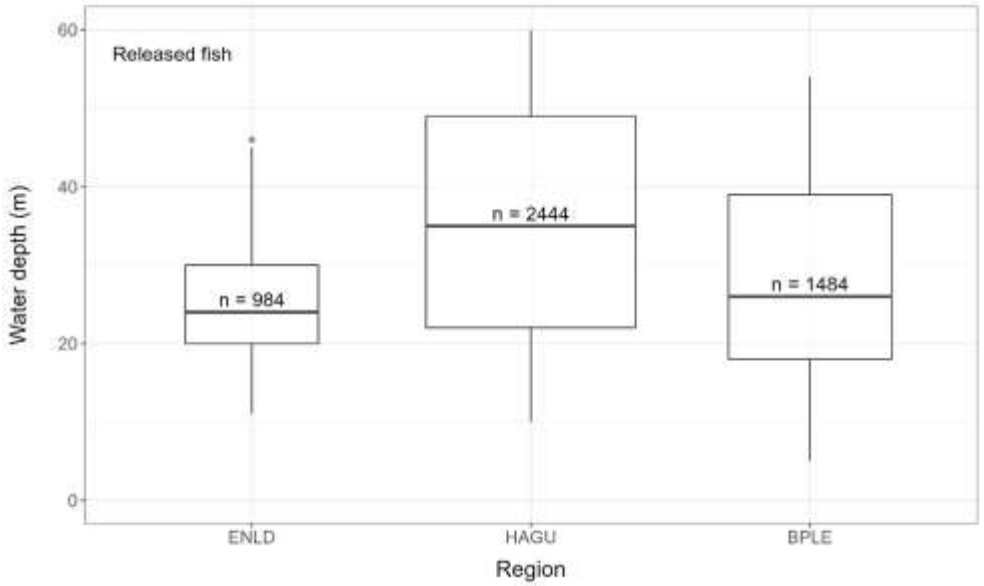

Figure 27: Median water depth of released snapper recorded in charter boat recreational fishing outings in SNA 1 by region during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Box indicates interquartile range (IQR), whiskers indicate largest/smallest value up to 1.5 × IQR and points indicate outliers beyond the whisker range.

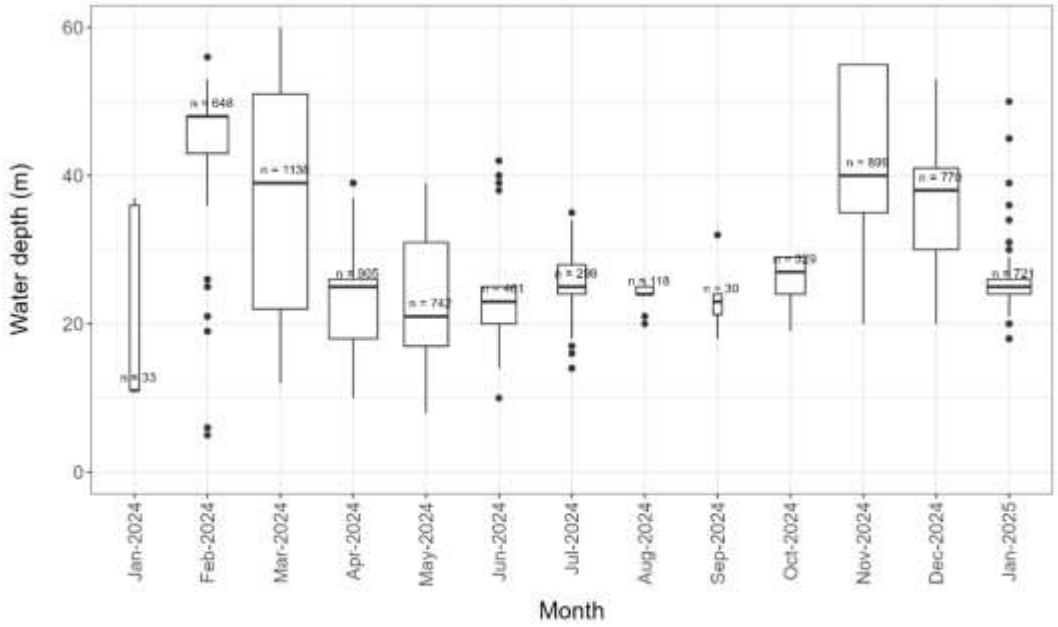

Figure 28: Median water depth of captured snapper recorded in charter boat recreational fishing outings in SNA 1 by month during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Box indicates interquartile range (IQR), whiskers indicate largest/smallest value up to 1.5 × IQR and points indicate outliers beyond the whisker range.

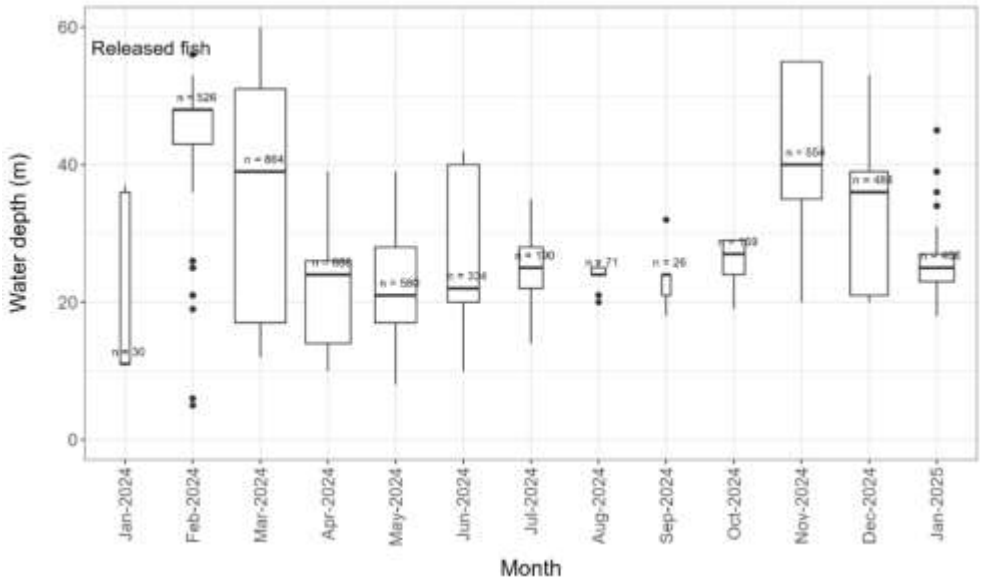

Figure 29: Median water depth of released snapper recorded in charter boat recreational fishing outings in SNA 1 by month during the SNA 1 release mortality characterisation (January 2024 to January 2025). Box indicates interquartile range (IQR), whiskers indicate largest/smallest value up to 1.5 × IQR and points indicate outliers beyond the whisker range.

In the charter boat fishery, the proportion of released snapper expected to die because of their capture depth and hook location was more variable than in the private boat fishery (Figure 30). In East Northland the proportion of expected mortalities was greatest in the deep (26–40 m) water depth category, followed by the very deep (> 40 m), the medium (15–25 m) and then the shallow (<15 m) depth categories. By contrast, in the Hauraki Gulf and the Bay of Plenty, expected mortality was greatest in the medium depth category, followed by the deep, the very deep and then the shallow depth categories.

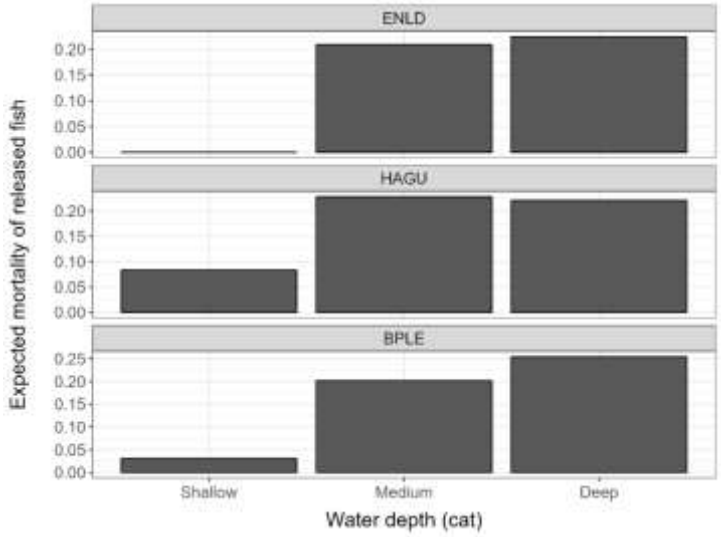

Figure 30: Number of snapper expected to die as a proportion of snapper released in each depth category by charter boat recreational fishers during the SNA 1 release mortality characterisation (January 2024 to January 2025). Expected mortality based on the capture depth and hook location of snapper matched to experimental results obtained by Maggs et al. (2024c). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Depth categories are Shallow: <15 m, Medium: 15–25 m, Deep: >25 m). The probability of mortality (0 or 1) for fish caught deeper than 40 m was based on experimental results obtained by Maggs et al. (2024b, c) for the 26–40 m depth category as the experiments did not cover depths greater than 40 m.

The mean weight of released snapper estimated for this study (charter boats) was 0.416 kg for SNA 1, whereas the mean weight of kept snapper was 1.280 kg (Table 10). Mean weight was lowest in the Bay of Plenty region for both released and kept snapper. East Northland had the highest mean weight of kept snapper, while the Hauraki Gulf had the highest mean weight for released snapper.

Table 10: Mean weight of released and kept snapper recorded in charter boat recreational fishing outings in SNA 1 by region during the SNA 1 release mortality characterisation (January 2024 to January 2025). Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty.

	Mean weight (kg)	
Region	Released	Retained
ENLD	0.388	1.687
HAGU	0.466	1.181
BPLE	0.395	0.973

3.5 Snapper release mortality in the charter boat recreational fishery

It was estimated that 207 t of snapper (462 000 individual fish), were released in SNA 1 by charter boat recreational fishers over a 12-month period (Table 11). The estimated tonnage of fish released was highest in the Hauraki Gulf at 160 t (344 000 fish), followed by the Bay of Plenty at 28 t (72 000 fish) and East Northland at 18 t (46 000 fish).

The overall SNA 1 annual release mortality, defined as snapper released and expected to die, for the recreational charter boat fishery was estimated at 48 t (CV: 0.04, 95% CI: 42.8–50.9 t). The estimated release mortality was highest in the Hauraki Gulf at 38 t (CV: 0.05, 95% CI: 33.3–41.1 t) (Figure 31). This was followed by Bay of Plenty at 6 t (CV: 0.07, 95% CI: 4.8–6.5 t) and East Northland at 4 t (CV: 0.10, 95% CI: 3.3–4.8 t).

The 48 tonne release mortality estimate for SNA 1 increased the 2022–23 charter boat removals by 17% from 281 t up to 329 t when this additional source of mortality was taken into account. In numbers, additional mortality estimates for SNA 1 were 105 000 fish, which increased the 2022–23 removals estimate by 44% from 237 000 fish to 342 000 fish. See Appendix 4 for full model output.

Table 11: The estimated annual biomass and number of individual fish in the SNA 1 charter boat recreational fishery (base case). Mean volume of released fish, which were expected to die was estimated by non-parametric bootstrapping, SE: standard error, LCI: lower 95% confidence interval, UCI: upper 95% confidence interval. Note that retained (kept) catch numbers was taken from the 2023 Amateur Charter Vessel (ACV) database. Retained catch biomass was taken as retained catch numbers multiplied by mean weights estimated in this study. Regions ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty.

					Estimated fish dying							
Metric	Region	Retained catch (ACV)	Estimated total catch	Released fish	Mean	Bias	SE	CV	LCI	UCI	% of released fish dying	Deaths as % of retained catch
Biomass (t)	ENLD	21	39	18	4	0.1	0.4	0.10	3	5	22%	19%
	HAGU	238	398	160	38	-1.1	2.0	0.05	33	41	24%	16%
	BPLE	23	51	28	5	0.1	0.4	0.07	5	7	19%	24%
	SNA1	281	488	207	48	-0.9	2.0	0.04	43	51	23%	17%
Numbers	ENLD	12 314	58 386	46 072	10 207	342	961	0.09	8 784	12 518	22%	83%
	HAGU	201 391	545 346	343 955	81 345	-1 940	4 044	0.05	71 814	87 893	24%	40%
	BPLE	23 436	94 998	71 562	13 792	201	983	0.07	12 063	16 068	19%	59%
	SNA1	237 141	698 730	461 589	105 343	-1 397	4 284	0.04	95 713	112 865	23%	44%

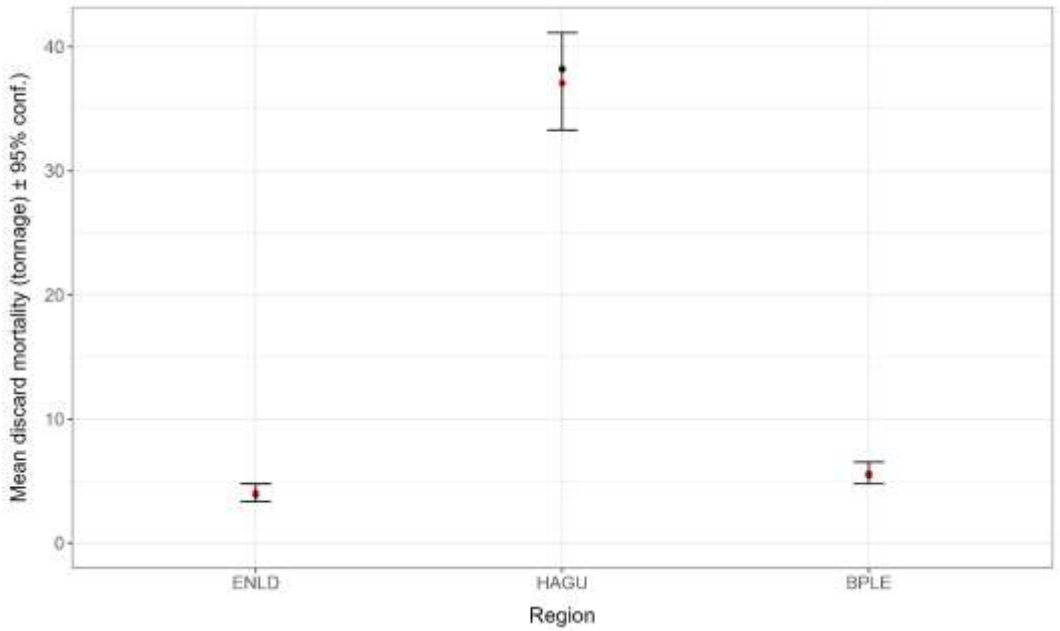

Figure 31: Estimated annual release mortality (t) of released snapper during the SNA 1 release mortality characterisation (January 2024 to January 2025) by region. ENLD: East Northland, HAGU: Hauraki Gulf, BPLE: Bay of Plenty. Red points indicate bootstrap bias as it deviates from the mean (underlying black points).

Under the assumption that all snapper that were recorded as floating, bleeding or dying after release were certain to die, the overall SNA 1 release mortality in the charter boat fishery was estimated at 52 t (SE: 2.2, CV: 0.04, 95% confidence interval: 47–56 t) or 116 000 fish (SE: 4722, CV: 0.04, 95% confidence interval: 105 000–124 000). See Appendix 4 for full model output.

3.6 Seabird interactions recorded by observers on charter fishing vessels

Observers recorded the type of interaction (tangled, hooked or net) and species group. Overall, 14 seabird interactions were observed on seven fishing trips from a total of 79 trips. Seabird interactions included 11 petrels or shearwaters, eight of which were tangled and three were hooked. Of the birds that were hooked, two were hooked in the beak and one was hooked in the wing. Interactions with three shags were recorded all on one trip, two were tangled and one shag was hooked in the foot. All birds were released alive. The average interaction rate for petrels or shearwaters was one per 7.2 trips and for shags was one per 26.3 trips. While the charter boats included in this survey typically had more fishers than on private boats, the observers noted that that ledger rigs and heavy sinkers were often used to avoid tangling lines. Most lines were straight down, and baits were fished close to the bottom reducing the likelihood of seabird interactions.

4. DISCUSSION

The combined release mortality estimated here for SNA 1 in the private and charter boat recreational fisheries, under the base case scenario, was 248 t, which accounts for 55% of the current allowance (450 t) made for other mortality under the SNA 1 Total Allowable Catch (Fisheries New Zealand 2024), which should also account for other sources of mortality associated with the much larger commercial fishery.

The mortality probabilities used in this study were provided by Maggs et al. (2024c), who acknowledged certain caveats to their results. Their experiments were based on a short-term post-release observation period of up to seven days, during which snapper were held captive in large at-sea

nets. This meant that post-release snapper were protected from predation while they recovered from the capture event. Furthermore, the relatively short observation period was not long enough to detect longer term sub-lethal effects of capture (Arlinghaus et al. 2007, Cooke et al. 2013). In laboratory trials, McArley & Herbert (2014) reported reflex impairment among snapper subjected to simulated angling with extended fight times and air exposure. Reflex impairment may yield a released fish vulnerable to predation over a longer term than was covered in the experiments (Cooke & Philipp 2004, Raby et al. 2018). The level of SNA 1 release mortality may therefore be higher than what we have presented for our base case scenario. Under a less conservative scenario that used data from charter boat observers on the condition of released snapper we estimated that the release mortality could have been at least 8% higher if we assumed all fish recorded as floating, bleeding or dying were certain to die (raising our total release mortality estimate for SNA 1 to 252 t). However, it is reasonable to expect that at least some of these fish would survive. Furthermore, this scenario only considered a change to the expectation of mortality in the charter vessel data.

The estimates provided in this report incorporated various sources of uncertainty. One source of uncertainty that was not included was in the estimates of retained catch (harvest) provided by the National Panel Survey (NPS). However, the uncertainty in SNA 1 harvest estimates provided by the NPS is low and is unlikely to have increased the uncertainty estimates presented in this study appreciably.

Very few snapper were recorded as floating after release. In the release mortality experiment, 10% of the lip hooked snapper were recovered floating and dead from the holding nets. Some of these may have initially swum down 15 m to the bottom of the net and died later and some may have been exhausted already by the time they transported to the holding nets. Experiments using a hyperbaric chamber to simulate pressure changes experienced by snapper during capture from depths of 30 and 70 m have shown them to be a relatively robust species to the effects of barotrauma if the fish can quickly (~ 2 minutes) repressurise (Hughes & Stewart 2013). Snapper left at the surface from a simulated capture depth of 30 m were dead in about 15 minutes if they were unable to self-vent by expelling gas from the body cavity (Hughes & Stewart 2013). Most recreational fishers and charter operators try to avoid releasing snapper that will float away and try to mitigate the risk of this by their immediate release after captureor by venting fish which have their everted stomach in their mouth. If these mitigation measures are effective for lip hooked fish, this would reduce actual mortality rates in the fishery.

In the release mortality experiments by Maggs et al. (2024c), snapper were found to be particularly vulnerable to dying if gill or gut-hooked, which appeared to override the effect of capture depth. Despite using only standard 4/0 J hooks, the incidence of gut-hooking was still lower than expected in the experiments. It is understood that the use of artificial baits or lures has increased in the New Zealand recreational fishery and that these methods further reduce the incidence of gut-hooking. However, it must be noted that release mortality estimates provided in this study are based directly on the recorded incidence of the three anatomical hooking locations (lip, foul, swallowed) by all the methods currently used by the public. This aspect is therefore not relevant to any uncertainty that there may be in the release mortality estimates.

Most snapper caught by recreational fishers in SNA 1 are smaller than the minimum legal size (MLS) and are consequently released while anglers target snapper larger than the MLS. This is mainly because the fishery generally operates close to the shore and in areas where small fish are more abundant. The large quantity of released snapper provides the foundation for release mortality, which is a significant waste of a valuable resource – 22% of the released fish biomass in this study. However, reducing this source of mortality in a recreational fishery is complex. One potential avenue to reduce release mortality would be to reduce or remove the MLS. However, this may not be desirable or effective. The MLS has been used to constrain total recreational harvest and may also serve to improve the yield-per-recruit if release mortality is not too high. Further, even if the mandatory MLS was reduced or removed, recreational fishers tend to be selective and retain larger fish, returning smaller fish to the water. They could be allowed to retain damaged or gut hooked fish

that were likely to die. It would be impractical to legally prohibit releasing any snapper in the recreational fishery as compliance is very difficult to enforce in such a diffuse fishery especially as infringements would take place at sea.

A more pragmatic approach would be to encourage steps to improve the survival of released fish through ongoing education on good handling and release practices. A range of mitigation methods are discussed in Maggs et al. (2024c).

5. POTENTIAL RESEARCH

Considering the results presented in this report, a simulation study may be warranted to explore scenarios associated with different mitigation methods. For example, what would the expected release mortality be if the incidence of gut-hooking was reduced through education programmes or if descender devices were used to quickly return released fish to their capture depth?

The MAFWG (meeting on the 28 April 2025) indicated that it may be useful to apply the experimental results obtained by Maggs et al. (2024b, c) to the fishery characterisations conducted by Holdsworth & Boyd (2008a, b) in the same way that they were applied to the current fishery characterisation.

6. FULFILMENT OF BROADER OUTCOMES

Boat ramp interviewers and observers were employed from local communities. In this way, members of the community got to play a part in monitoring resource use and contribute to informed management of the SNA 1 stock. This work contributes to a better understanding of the impacts of catch and release of snapper and behavioural changes that may reduce incidental mortality. We printed and distributed fish measuring mats to fishers taking part in this study. These mats featured useful information about recreational fisheries, including QR codes that link to websites with further information.

Blue Water Marine Research subcontracted Sydney Curtis to assist with logistics, data management and analysis for this project. Sydney completed a BSc in Environmental Science at AUT in 2022 and will be assisting on other Blue Water Marine Research projects. Sydney Curtis is Māori from Ngāti Hine.

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APPENDIX 1: DATASHEET FOR PRIVATE BOAT RECREATIONAL FISHERY

RECREATIONAL FISHERIES RESEARCH
SNAPPER RELEASE MORTALITY (ver. 2023)

Trip data

Name: _____

Contact number: _____

Boat ramp: _____

Date (YYYY-mm-dd): _____

Hours fished: _____

Number of people fishing: _____

Instructions and fish state definitions

1. Please complete both sections - "Trip data" and "Snapper capture details".
2. Record all snapper caught whether kept or released.
3. Measure from nose (with mouth closed) to inner fork of tail.
4. Record length in whole centimetres and round down to nearest cm.
5. Record depth in metres (from depth sounder) where fish was caught.
6. Circle how fish was hooked (swallowed = hooked in throat, gills, gut)
7. Circle whether the fish was kept or released.
8. Was barotrauma evident (internal organs protruding from gut or anus).
9. For released fish, circle whether the fish swam away or floated.

Snapper capture details

Fish No.	Fish length (cm)	Water depth (m)	Hook location circle one	Fish was... circle one	Barotrauma evident	If released, the fish... circle one	Comment (optional)
Example	*27*	*31*	lip / swallowed/ external	kept / released	yes / no	swam away / floated	*Line cut, hook left in throat*
1			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
2			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
3			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
4			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
5			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
6			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
7			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
8			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
9			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
10			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
11			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
12			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
13			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
14			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
15			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
16			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
17			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
18			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
19			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
20			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
21			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
22			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
23			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
24			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
25			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
26			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
27			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
28			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
29			lip / swallowed/ external	kept / released	yes / no	swam away / floated	
30			lip / swallowed/ external	kept / released	yes / no	swam away / floated	

Please hand this datasheet back to the NIWA data collector, who will be waiting at the boat ramp at the end of the day. Alternativley, you can post it to NIWA, Private Bag 99940, Newmarket, Auckland 1149 or email a photo of the datasheet to helena.armiger@niwa.co.nz.

Measure the fork length of snapper

APPENDIX 2: DATASHEET FOR CHARTER BOAT RECREATIONAL FISHERY

STATION DATA **Observer name** _____

Date	**Start Time**	**Finish Time**		**Page ….. of ……**
Boat				
Station number		**Swell Height**	**Cloud Cover %**	**Seabird**
Lat Long				**Hooked H / Tangled T**
Location code		**Wind Strength**	**Wind Direction**	**Species**
Time fished				
Number of people fishing		**Hook L / lure**	**Condition eg. Swam Bleeding SB /**	
Number SNA not measured		**J / C Circle / K Kale**	**Floated no bleed FN / Dying D**	
Hk Loc Code: Lip L /Deep D /External E.		**Gut Out Code: None 0 / Mouth 1 / Anus 2 / 3 Extreme.**		

Fish #	Fish lgth (cm)	Water dpth (m)	Hk loc L/ D / E	Kpt Rel K / R	Hook L/J/C/K	Gut Out 0/ 1/ 2/ 3	Fish Condition SN, SB, FN, FB, D		Comments
NA	32	31	D	R	J	1	FN	Skinny ✓	
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									

APPENDIX 3: PROBABILITY OF DEATH IN RELEASED SNAPPER

	Lip		External		Swallowed	
Capture depth (m)	Probability of death	Standard error	Probability of death	Standard error	Probability of death	Standard error
1	0.001	0.001	0.020	0.073	0.997	0.023
2	0.001	0.001	0.024	0.081	0.995	0.032
3	0.001	0.002	0.030	0.087	0.992	0.044
4	0.002	0.003	0.037	0.093	0.987	0.060
5	0.003	0.004	0.046	0.096	0.980	0.078
6	0.005	0.005	0.057	0.096	0.970	0.098
7	0.007	0.006	0.069	0.093	0.954	0.116
8	0.011	0.007	0.084	0.085	0.933	0.128
9	0.017	0.008	0.102	0.076	0.904	0.128
10	0.025	0.009	0.121	0.069	0.871	0.115
11	0.036	0.010	0.142	0.071	0.834	0.103
12	0.050	0.012	0.163	0.082	0.799	0.113
13	0.068	0.015	0.185	0.097	0.771	0.140
14	0.090	0.019	0.206	0.107	0.754	0.163
15	0.114	0.023	0.227	0.111	0.748	0.174
16	0.140	0.026	0.245	0.109	0.752	0.170
17	0.167	0.027	0.263	0.101	0.763	0.156
18	0.194	0.027	0.280	0.091	0.778	0.135
19	0.219	0.026	0.295	0.086	0.796	0.116
20	0.243	0.026	0.310	0.090	0.814	0.101
21	0.263	0.028	0.324	0.103	0.830	0.095
22	0.280	0.032	0.338	0.121	0.843	0.094
23	0.293	0.036	0.353	0.139	0.852	0.097
24	0.301	0.040	0.368	0.153	0.857	0.101
25	0.306	0.042	0.384	0.161	0.858	0.103
26	0.306	0.042	0.400	0.164	0.856	0.106
27	0.303	0.041	0.417	0.162	0.851	0.107
28	0.297	0.038	0.434	0.155	0.842	0.106
29	0.288	0.035	0.452	0.144	0.830	0.104
30	0.277	0.032	0.470	0.131	0.815	0.100
31	0.264	0.029	0.489	0.118	0.796	0.093
32	0.249	0.028	0.508	0.111	0.774	0.086
33	0.234	0.028	0.526	0.113	0.747	0.079
34	0.218	0.031	0.545	0.125	0.716	0.079
35	0.203	0.034	0.564	0.147	0.682	0.091
36	0.188	0.038	0.583	0.174	0.645	0.117
37	0.173	0.042	0.601	0.204	0.605	0.153
38	0.159	0.045	0.619	0.235	0.564	0.193
39	0.146	0.048	0.637	0.266	0.521	0.235
40	0.134	0.051	0.655	0.295	0.479	0.275

Capture depth (m)	Lip		External		Swallowed	
	Probability of death	Standard error	Probability of death	Standard error	Probability of death	Standard error
41	0.134	0.051	0.655	0.295	0.479	0.275
42	0.134	0.051	0.655	0.295	0.479	0.275
43	0.134	0.051	0.655	0.295	0.479	0.275
44	0.134	0.051	0.655	0.295	0.479	0.275
45	0.134	0.051	0.655	0.295	0.479	0.275
46	0.134	0.051	0.655	0.295	0.479	0.275
47	0.134	0.051	0.655	0.295	0.479	0.275
48	0.134	0.051	0.655	0.295	0.479	0.275
49	0.134	0.051	0.655	0.295	0.479	0.275
50	0.134	0.051	0.655	0.295	0.479	0.275
51	0.134	0.051	0.655	0.295	0.479	0.275
52	0.134	0.051	0.655	0.295	0.479	0.275
53	0.134	0.051	0.655	0.295	0.479	0.275
54	0.134	0.051	0.655	0.295	0.479	0.275
55	0.134	0.051	0.655	0.295	0.479	0.275
56	0.134	0.051	0.655	0.295	0.479	0.275
57	0.134	0.051	0.655	0.295	0.479	0.275
58	0.134	0.051	0.655	0.295	0.479	0.275
59	0.134	0.051	0.655	0.295	0.479	0.275
60	0.134	0.051	0.655	0.295	0.479	0.275
61	0.134	0.051	0.655	0.295	0.479	0.275
62	0.134	0.051	0.655	0.295	0.479	0.275
63	0.134	0.051	0.655	0.295	0.479	0.275
64	0.134	0.051	0.655	0.295	0.479	0.275
65	0.134	0.051	0.655	0.295	0.479	0.275
66	0.134	0.051	0.655	0.295	0.479	0.275
67	0.134	0.051	0.655	0.295	0.479	0.275
68	0.134	0.051	0.655	0.295	0.479	0.275
69	0.134	0.051	0.655	0.295	0.479	0.275
70	0.134	0.051	0.655	0.295	0.479	0.275
71	0.134	0.051	0.655	0.295	0.479	0.275
72	0.134	0.051	0.655	0.295	0.479	0.275
73	0.134	0.051	0.655	0.295	0.479	0.275
74	0.134	0.051	0.655	0.295	0.479	0.275
75	0.134	0.051	0.655	0.295	0.479	0.275
76	0.134	0.051	0.655	0.295	0.479	0.275
77	0.134	0.051	0.655	0.295	0.479	0.275
78	0.134	0.051	0.655	0.295	0.479	0.275
79	0.134	0.051	0.655	0.295	0.479	0.275
80	0.134	0.051	0.655	0.295	0.479	0.275
81	0.134	0.051	0.655	0.295	0.479	0.275
82	0.134	0.051	0.655	0.295	0.479	0.275

Capture depth (m)	Lip		External		Swallowed	
	Probability of death	Standard error	Probability of death	Standard error	Probability of death	Standard error
83	0.134	0.051	0.655	0.295	0.479	0.275
84	0.134	0.051	0.655	0.295	0.479	0.275
85	0.134	0.051	0.655	0.295	0.479	0.275
86	0.134	0.051	0.655	0.295	0.479	0.275
87	0.134	0.051	0.655	0.295	0.479	0.275
88	0.134	0.051	0.655	0.295	0.479	0.275
89	0.134	0.051	0.655	0.295	0.479	0.275
90	0.134	0.051	0.655	0.295	0.479	0.275
91	0.134	0.051	0.655	0.295	0.479	0.275
92	0.134	0.051	0.655	0.295	0.479	0.275
93	0.134	0.051	0.655	0.295	0.479	0.275
94	0.134	0.051	0.655	0.295	0.479	0.275
95	0.134	0.051	0.655	0.295	0.479	0.275
96	0.134	0.051	0.655	0.295	0.479	0.275
97	0.134	0.051	0.655	0.295	0.479	0.275
98	0.134	0.051	0.655	0.295	0.479	0.275
99	0.134	0.051	0.655	0.295	0.479	0.275
100	0.134	0.051	0.655	0.295	0.479	0.275
101	0.134	0.051	0.655	0.295	0.479	0.275
102	0.134	0.051	0.655	0.295	0.479	0.275
103	0.134	0.051	0.655	0.295	0.479	0.275
104	0.134	0.051	0.655	0.295	0.479	0.275
105	0.134	0.051	0.655	0.295	0.479	0.275
106	0.134	0.051	0.655	0.295	0.479	0.275
107	0.134	0.051	0.655	0.295	0.479	0.275
108	0.134	0.051	0.655	0.295	0.479	0.275
109	0.134	0.051	0.655	0.295	0.479	0.275
110	0.134	0.051	0.655	0.295	0.479	0.275
111	0.134	0.051	0.655	0.295	0.479	0.275
112	0.134	0.051	0.655	0.295	0.479	0.275
113	0.134	0.051	0.655	0.295	0.479	0.275
114	0.134	0.051	0.655	0.295	0.479	0.275
115	0.134	0.051	0.655	0.295	0.479	0.275
116	0.134	0.051	0.655	0.295	0.479	0.275
117	0.134	0.051	0.655	0.295	0.479	0.275
118	0.134	0.051	0.655	0.295	0.479	0.275
119	0.134	0.051	0.655	0.295	0.479	0.275
120	0.134	0.051	0.655	0.295	0.479	0.275
121	0.134	0.051	0.655	0.295	0.479	0.275
122	0.134	0.051	0.655	0.295	0.479	0.275
123	0.134	0.051	0.655	0.295	0.479	0.275
124	0.134	0.051	0.655	0.295	0.479	0.275

Capture depth (m)	Lip		External		Swallowed	
	Probability of death	Standard error	Probability of death	Standard error	Probability of death	Standard error
125	0.134	0.051	0.655	0.295	0.479	0.275
126	0.134	0.051	0.655	0.295	0.479	0.275
127	0.134	0.051	0.655	0.295	0.479	0.275
128	0.134	0.051	0.655	0.295	0.479	0.275
129	0.134	0.051	0.655	0.295	0.479	0.275
130	0.134	0.051	0.655	0.295	0.479	0.275
131	0.134	0.051	0.655	0.295	0.479	0.275
132	0.134	0.051	0.655	0.295	0.479	0.275
133	0.134	0.051	0.655	0.295	0.479	0.275
134	0.134	0.051	0.655	0.295	0.479	0.275
135	0.134	0.051	0.655	0.295	0.479	0.275
136	0.134	0.051	0.655	0.295	0.479	0.275
137	0.134	0.051	0.655	0.295	0.479	0.275
138	0.134	0.051	0.655	0.295	0.479	0.275
139	0.134	0.051	0.655	0.295	0.479	0.275
140	0.134	0.051	0.655	0.295	0.479	0.275
141	0.134	0.051	0.655	0.295	0.479	0.275
142	0.134	0.051	0.655	0.295	0.479	0.275
143	0.134	0.051	0.655	0.295	0.479	0.275
144	0.134	0.051	0.655	0.295	0.479	0.275
145	0.134	0.051	0.655	0.295	0.479	0.275
146	0.134	0.051	0.655	0.295	0.479	0.275
147	0.134	0.051	0.655	0.295	0.479	0.275
148	0.134	0.051	0.655	0.295	0.479	0.275
149	0.134	0.051	0.655	0.295	0.479	0.275
150	0.134	0.051	0.655	0.295	0.479	0.275

APPENDIX 4: MODEL OUTPUT FOR RELEASE MORTALITY

Private boat fishery – base case

Metric	Result	Region	Mean	Bias	SE	LCI	UCI
Tonnage	Caught	ENLD	382.8	0.4	8.5	367.7	401.4
Tonnage	Caught	HAGU	1 470.7	1.3	15.2	1 442.1	1 502.3
Tonnage	Caught	BPLE	664.2	0.2	11.4	643.9	688.8
Tonnage	Caught	SNA1	2 517.7	1.9	20.5	2 481.4	2 562.6
Tonnage	Released	ENLD	141.8	0.5	6.2	130.8	154.7
Tonnage	Released	HAGU	551.3	0.9	12.3	529.8	577.7
Tonnage	Released	BPLE	210.3	0.1	7.4	196.8	225.2
Tonnage	Released	SNA1	903.3	1.4	15.3	874.5	933.1
Tonnage	Release_Mortality	ENLD	27.1	0.2	2.1	23.5	31.9
Tonnage	Release_Mortality	HAGU	123.9	2.6	4.5	117.8	135.6
Tonnage	Release_Mortality	BPLE	49.0	1.6	2.9	45.3	56.6
Tonnage	Release_Mortality	SNA1	200.0	4.5	5.7	193.8	215.5
Numbers	Caught	ENLD	514 297	1 200	12 222	492 751	539 961
Numbers	Caught	HAGU	2 031 165	1 422	25 990	1 984 404	2 086 521
Numbers	Caught	BPLE	893 831	221	17 193	860 589	929 151
Numbers	Caught	SNA1	3 439 293	2 844	33 286	3 377 588	3 507 650
Numbers	Released	ENLD	333 347	1 200	12 222	311 801	359 011
Numbers	Released	HAGU	1 287 043	1 422	25 990	1 240 282	1 342 399
Numbers	Released	BPLE	515 761	221	17 193	482 519	551 081
Numbers	Released	SNA1	2 136 151	2 844	33 286	2 074 446	2 204 508
Numbers	Release_Mortality	ENLD	62 154	2 768	3 983	57 324	73 201
Numbers	Release_Mortality	HAGU	292 987	1 651	9 294	277 018	314 067
Numbers	Release_Mortality	BPLE	121 655	3 751	6 454	112 588	138 494
Numbers	Release_Mortality	SNA1	476 796	8 170	12 030	460 170	507 997

Charter boat fishery – base case

Metric	Result	Region	Mean	Bias	SE	LCI	UCI
Tonnage	Caught	ENLD	38.6	0.1	1.8	35.5	42.7
Tonnage	Caught	HAGU	398.1	0.2	6.8	385.4	411.5
Tonnage	Caught	BPLE	51.1	0.0	1.5	48.3	54.4
Tonnage	Caught	SNA1	487.8	0.3	7.1	474.2	501.9
Tonnage	Released	ENLD	17.9	0.1	1.3	15.6	20.4
Tonnage	Released	HAGU	160.4	0.0	5.6	150.3	171.8
Tonnage	Released	BPLE	28.2	0.0	1.5	25.7	31.3
Tonnage	Released	SNA1	206.5	0.1	5.9	195.5	218.6
Tonnage	Release_Mortality	ENLD	3.9	0.1	0.4	3.3	4.8
Tonnage	Release_Mortality	HAGU	38.2	-1.1	2.0	33.3	41.1
Tonnage	Release_Mortality	BPLE	5.5	0.1	0.4	4.8	6.5
Tonnage	Release_Mortality	SNA1	47.6	-0.9	2.0	42.8	50.9
Numbers	Caught	ENLD	58 386	166	3 254	52 408	65 059
Numbers	Caught	HAGU	545 346	109	11 724	524 104	569 212
Numbers	Caught	BPLE	94 998	-7	3 613	88 616	102 144
Numbers	Caught	SNA1	698 730	268	12 668	675 513	724 474
Numbers	Released	ENLD	46 072	166	3 254	40 094	52 745
Numbers	Released	HAGU	343 955	109	11 724	322 713	367 821
Numbers	Released	BPLE	71 562	-7	3 613	65 180	78 708
Numbers	Released	SNA1	461 589	268	12 668	438 372	487 333
Numbers	Release_Mortality	ENLD	10 207	342	961	8 784	12 518
Numbers	Release_Mortality	HAGU	81 345	-1 940	4 044	71 814	87 893
Numbers	Release_Mortality	BPLE	13 792	201	983	12 063	16 068
Numbers	Release_Mortality	SNA1	105 343	-1 397	4 284	95 713	112 865

Charter boat fishery – dying case

Metric	Result	Region	Mean	Bias	SE	LCI	UCI
Tonnage	Caught	ENLD	38.6	0.1	1.8	35.5	42.7
Tonnage	Caught	HAGU	398.1	0.2	6.8	385.4	411.5
Tonnage	Caught	BPLE	51.1	0.0	1.5	48.3	54.4
Tonnage	Caught	SNA1	487.8	0.3	7.1	474.2	501.9
Tonnage	Released	ENLD	17.9	0.1	1.3	15.6	20.4
Tonnage	Released	HAGU	160.4	0.0	5.6	150.3	171.8
Tonnage	Released	BPLE	28.2	0.0	1.5	25.7	31.3
Tonnage	Released	SNA1	206.5	0.1	5.9	195.5	218.6
Tonnage	Release_Mortality	ENLD	4.6	0.0	0.4	3.8	5.4
Tonnage	Release_Mortality	HAGU	41.5	-0.7	2.1	36.7	45.4
Tonnage	Release_Mortality	BPLE	5.7	0.0	0.4	4.9	6.6
Tonnage	Release_Mortality	SNA1	51.8	-0.7	2.2	46.8	55.9
Numbers	Caught	ENLD	58 386	166	3 254	52 408	65 059
Numbers	Caught	HAGU	545 346	109	11 724	524 104	569 212
Numbers	Caught	BPLE	94 998	-7	3 613	88 616	102 144
Numbers	Caught	SNA1	698 730	268	12 668	675 513	724 474
Numbers	Released	ENLD	46 072	166	3 254	40 094	52 745
Numbers	Released	HAGU	343 955	109	11 724	322 713	367 821
Numbers	Released	BPLE	71 562	-7	3 613	65 180	78 708
Numbers	Released	SNA1	461 589	268	12 668	438 372	487 333
Numbers	Release_Mortality	ENLD	11 921	-91	1 059	9 812	13 965
Numbers	Release_Mortality	HAGU	89 661	-1 615	4 416	79 118	97 495
Numbers	Release_Mortality	BPLE	14 106	271	1 037	12 518	16 443
Numbers	Release_Mortality	SNA1	115 688	-1 434	4 722	105 211	124 272