

Te Aroturuki Kōura o Ngā Rāhui Tapu o Te Taitokerau | Northland rāhui tapu spiny lobster monitoring

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Northland Rāhui Tapu Spiny Lobster Monitoring, 2025

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Mixed den of kōura *Jasus edwardsii* and pawharu *Sagmariasus verreauxi* within the Mimiwhangata Rāhui Tapu. Photo: Evan Brown

Summary

Established in 2023, the Rakaumangamanga and Mimiwhangata Rāhui Tapu (hapū/iwi-led marine protected areas in Northland, Aotearoa New Zealand) prohibit all fishing and extraction except for kina (sea urchin) and customary harvest. Northland rocky reef environments are home to two important species of spiny lobster: kōura (*Jasus edwardsii*), or crayfish (red rock lobster), and pawharu (*Sagmariasus verreauxi*), or packhorse lobster. The 2025 lobster surveys aimed to gather baseline data on the density and size of both species inside and outside these Rāhui Tapu and assess any initial effects of the protection.

The survey revealed a concerning picture at Rakaumangamanga, where densities of both lobster species were extremely low, suggesting population declines. In contrast, Mimiwhangata had higher densities overall. At the Mimiwhangata Rāhui Tapu, kōura and sub-legal pawharu densities were marginally higher than in adjacent fished areas. However, due to high variability in kōura densities between sites, the analysis could not confirm a clear 'protection effect' after less than two years of closure.

Long-term monitoring sites at Mimiwhangata, dating back to 1976, showed diverging trends with evidence kōura have declined over the long term, while pawharu numbers have increased. This may be linked to warming water temperatures that benefit the warm-water pawharu but hinder recruitment of the cool-water associated kōura.

Overall, the 2025 survey showed limited evidence of recovery so far. This aligns with findings from other protected areas in Aotearoa where recovery can be slow and heavily dependent on recruitment. Evidence of slightly higher mean densities within the Mimiwhangata Rāhui Tapu are however promising, but ongoing annual monitoring will be essential to track the recovery of these important species.

Executive summary

The Rakaumangamanga and Mimiwhangata Rāhui Tapu are hapū/iwi-led marine protected areas which prohibit all fishing and extraction, except for kina and customary harvest, in Northland, Aotearoa New Zealand. These Rāhui Tapu were established November 2023 but not actively enforced until September 2024. The period between 2023-2024 included an education phase, signage, on-water education, boat ramp advocacy, and media and social media communication. Two species of spiny lobster occupy rocky reef throughout the region: kōura (crayfish or red rock lobster) *Jasus edwardsii* and pawharu (packhorse lobster) *Sagmariasus verreauxi*.

The 2025 Rakaumangamanga and Mimiwhangata lobster surveys aimed to establish baseline density and size information for these species within and outside of Rāhui Tapu, assess initial effects of Rāhui Tapu protection and continue the long-term monitoring of permanent sites at Mimiwhangata established by Dr Roger Grace in 1976. Using an under visual census method on SCUBA, six sites were surveyed within and outside of both Rāhui Tapu. At each site six 50 x 10 m transects were surveyed.

Densities of both species were extremely low within and outside the Rakaumangamanga Rāhui Tapu, contrasting an earlier report and suggesting population reductions. Comparatively, densities of both species were greater at Mimiwhangata both within and outside of the Rāhui Tapu. Legal and sub-legal densities of *J. edwardsii* were marginally higher in the Mimiwhangata Rāhui Tapu than adjacent fished areas (2.5 and 3 times higher, respectively) but analyses could not confidently identify a ‘protection’ effect due to high site level variability. Densities of *S. verreauxi* also tended to be higher in the Mimiwhangata Rāhui Tapu than adjacent fished areas. The long-term permanent transects revealed divergent trajectories for the two lobster species, showing long-term declines in *J. edwardsii*, while *S. verreauxi* have increased. It is possible warmer water temperatures in recent decades maybe benefiting *S. verreauxi*, which has warm water affinities, while simultaneously hindering population recruitment of *J. edwardsii*.

Overall, the 2025 surveys reveal limited evidence of recovery of rock lobster in the Rāhui Tapu areas after ~1 year of active protection. This is consistent with patterns of lobster recovery seen in other protected areas in Aotearoa, which is highly variable and dependent on recruitment levels. Evidence of slightly higher mean densities within the Mimiwhangata Rāhui Tapu are therefore promising, but ongoing annual monitoring is recommended to better understand recruitment and recovery patterns in these newly protected areas.

Introduction

Spiny lobsters (family: Palinuridae) densities, biomass, and individual sizes have widely been shown to increase following protection from fishing in marine protected areas (reviewed in Spanier, 2024). Two species of spiny rock lobster occupy rocky reef throughout the Northland region: kōura (red rock lobster), *Jasus edwardsii* and pawharu (packhorse lobster), *Sagmariasus verreauxi*. Both species have significant economic and cultural value and are integral to the functioning and health of Northland's rocky reef ecosystems (Booth, 2017, Booth, 2011, Kerr et al., 2025). These species are important predators in coastal environments and in north-eastern New Zealand, *J. edwardsii* are one of the primary predators of the sea urchin (kina) *Evechinus chloroticus* (Andrew and MacDiarmid, 1991). Consequently, overfishing of *J. edwardsii* is one of the primary drivers of trophic cascades leading to the loss of kelp forests and expansion of kina barrens in northern New Zealand (Shears and Babcock, 2002).

The poor state of *J. edwardsii* on Northland's east coast was recently recognised in a New Zealand High Court ruling which confirmed that the widespread loss of kelp forests in the northernmost region of New Zealand is linked to fishing. The government was found to have acted illegally in setting fishing quota for lobster without considering the ecological and cultural impacts of fishing on kelp forest ecosystems as required under the Fisheries Act 1996. Kerr et al. (2025) ultimately characterised lobster populations on Northland's east-coast as heavily overfished, ecologically degraded and failing to support healthy kelp-dominated reef ecosystems.

The Mimiwhangata and Rakaumangamanga (Maunganui Bay–Oke Bay, Cape Brett) Rāhui Tapu are hapū/iwi-led marine protected areas given formal legal effect in November 2023 through the Northland Regional Plan under the Resource Management Act, following Environment Court proceedings (Northland Regional Council., 2024). Originally under customary management by Ngātiwai and resident hapū Te Uri o Hīkiahiki (Mimiwhangata), and declared as customary rāhui by Te Rawhiti hapū Ngāti Kuta and Patukeha (Rakaumangamanga) to address serious depletion of kaimoana and reef species, they now prohibit all fishing and extraction, with exceptions for kina and customary take under Fisheries New Zealand regulations. Their primary objectives are to restore degraded reef ecosystems (including kelp forests, crayfish and reef fish), uphold kaitiakitanga and mātauranga Māori over traditional fishing grounds and ultimately enhance adjacent customary and recreational fisheries through spillover and larval export (i.e., Kelly et al., 2002, Le Port et al., 2017). As hapū-driven Rāhui

Tapu embedded in regional planning law, these sites also serve as important exemplars for co-governed marine protection that better reflects Māori customary management than conventional marine reserve tools.

These Rāhui Tapu were built upon a history of smaller and alternative protection measures. In 1984 a ‘Marine Park’ was implemented in the waters surrounding the Mimiwhangata Peninsula, which established special fisheries regulations within its boundaries in the form of recreational fishing method and species restrictions. However, these regulations were effectively unenforceable and recreational fishing continued in the Marine Park in accordance with normal recreational fishing regulations, while commercial longlining and lobster potting continued until 1994. From 1994 commercial fishing was excluded from the Marine Park, but recreational fishing was permitted until 2023 when the area became protected as a Rāhui Tapu. At Rakaumangamanga, the Maunganui Bay (Deep Water Cove) area has been designated a ‘no-take’ Rāhui since 2010. The 2023 Environmental Court decision extended the Rāhui area from Maunganui Bay (Deep Water Cove) to Opourua (Oke Bay). While both Rāhui Tapu came into effect in November 2023, with signage installed late 2023 and active enforcement commencing in September 2024.

Dr Roger Grace established the Mimiwhangata monitoring programme in 1976 to provide long-term information on rocky-reef ecology across the Mimiwhangata coastline. This programme employed a permanent transect methodology whereby the same patch of reef (50 x 10 m in area) is surveyed for spiny lobster and reef fish during each survey. While this monitoring methodology is antiquated and inconsistent with modern statistical techniques, Shears et al. (2006) emphasized the importance such long-term data to evaluate different protection strategies. Analysis of the long-term data ultimately showed that allowing recreational fishing in Mimiwhangata Marine Park effectively erased any conservation benefit for *J. edwardsii*, where the park had no measurable impact on the species (Shears et al., 2006).

Lobster populations at the Mimiwhangata permanent transect sites were last surveyed in 2011, while a survey of lobster within and outside of the Maunganui Bay (Deep Water Cove) was undertaken in 2016 (Sutton, 2016). The 2025 Rakaumangamanga and Mimiwhangata lobster surveys aimed to establish baseline density information for both lobster species within and outside of Rāhui Tapu, assess the initial impact of Rāhui Tapu protection ~2 years after implantation, and add to the Mimiwhangata long-term time series.

Methods

Surveys were undertaken at sites spanning the Rakaumangamanga and Mimiwhangata Rāhui Tapu areas and adjacent unprotected control (fished) areas (Fig. 1). Rakaumangamanga was surveyed in June 2025, while Mimiwhangata was surveyed over September and early October 2025. North-eastern New Zealand lobster surveys typically take place over winter between May and July to coincide with *J. edwardsii* mating when male and female lobster are concentrated on shallow reefs (Kelly and MacDiarmid, 2003, MacDiarmid, 1991). While this may result in seasonally elevated densities on shallow reefs, this effect is assumed to be constant between reserve and fished areas, and therefore a good indicator of overall population status, minimising the influence of seasonal movements on inshore abundances (MacDiarmid 1991; Kelly & MacDiarmid 2003). Due to a prolonged period of unsettled weather, the Mimiwhangata survey was delayed beyond the ideal window for *J. edwardsii* surveys. Surveying over this period was expected to result in lower densities than if surveys were carried out over the usual surveying period, particularly on reef shallower than 10 m (Hanns et al., 2025).

At Rakaumangamanga site selection used a combination of available multibeam data, satellite imagery and existing benthic monitoring locations, and also included sites surveyed during an independent survey in 2016 (see Sutton, 2016). Site selections aimed to include areas with continuous rocky reef habitat extending from 0 to 20m of depth and provide a representative spatial spread across the coastal margins of the Rāhui Tapu and fished areas either side of the Rāhui Tapu longshore boundaries. Six sites were selected within the Rāhui Tapu and six across adjacent fished reef (Fig. 1, Table 1). Rāhui Tapu sites included four sites within the long-standing Maunganui Bay (Deep Water Cove) Rāhui area, and two across the 2023 Opourua (Oke Bay) extension. At each site six 50 x 10 m transects (sampling 500 m² of reef per transect) were surveyed. Where possible sampling within sites was stratified by depth, with three shallow (0-10 m) transects and three deep (10-20 m) transects. These surveys used underwater visual census methods developed in MacDiarmid (1991) and refined in Kelly et al. (2000), where transects are haphazardly placed across rocky reef habitat.

At Mimiwhangata the historic permanent transects sites established by Dr Roger Grace in 1976 and recently located by Kerr (2024) were used as site centroids. Here, each permanent transect was surveyed using the site specific reference information provided by Kerr (2024). Permanent transects typically ran perpendicular to the shoreline from the low-tide mark to a maximum depth of between 5 and 10 m, with the low-tide mark identified using a combination of site

photographs, gps coordinates and sub-tidal habitat maps. Either side of each permanent transect, five haphazardly placed transects were also surveyed to provide site level replication comparable to Rakaumangamanga survey and to permit a more detailed assessment of potential Rāhui Tapu protection effects. Depth stratified surveying was only possible at the Motutara Island (fished) and Awash rock (Rāhui Tapu) sites. At all other sites the rocky reef habitat rarely exceeded 10 m depth. Kerr (2024) provided spatial information for six permanent transect sites within the Rāhui Tapu area and five across adjacent fished reef. To balance sampling between protection ‘Status’ areas an additional fished site was added at Titi Island ~0.575 km south of the Rāhui Tapu’s southern longshore boundary and ~2.2 km north of Otamure fished site. The Mimiwhangata surveys provided two sets of data; 1) the permanent transect data (at all sites except for Titi Island), and 2) haphazard sampling data where each permanent transect was included as one of six transect replicates at each site (excluding Titi Island).

On all transects, the species (*J. edwardsii* or *S. verreauxi*), size (carapace length), and sex were determined for all lobster by visual estimation. Carapace lengths (CL) were measured between the antennal platform to the dorsal posterior margin of the carapace along the midline. A builder’s ruler was used to provide direct measurements where possible or guide visual estimations. The sex of each lobster was determined using sexually dimorphic features such as the 5th periopod and pleopod anatomy (MacDiarmid, 1991).

For *J. edwardsii* the minimum legal size (MLS) applies to tail width (TW) and differs by sex, being 54 mm for male and 60 mm for females, which is equivalent to 95 mm CL for both sexes (see Hanns et al., 2022). For *S. verreauxi* the MLS is a TW of measures of 84 mm for males and 90 mm for females (formally 216 mm tail length, or ~155 mm CL, Booth, 1986, Booth, 1979). Lobster above the MLS were classed ‘Legal’, while those below the MLW were classed ‘Sub-legal’.

Data analysis:

The following analyses were performed in R (R Core Team, 2024) using the *brms* package (Bürkner, 2017). These analyses used four Markov chain Monte Carlo (MCMC) chains with a thinning parameter of 1 for 2000 iterations, with the first 1000 iterations discarded as burn-ins for a total of 4000 posterior samples.

Assessment of lobster densities by protection ‘Status’ (Rāhui Tapu vs adjacent control/fished areas) were made using zero-inflated negative binomial models to account for over-dispersed count data and excess zeros (Model 1). Data analyses were separated by species (*J. edwardsii*

and *S. verreauxi*), then by total density, legal density (density of lobster above the MLS), and sub-legal density (density of lobster below the MLS). In each model, the random intercept (1|Site) was included to accommodate for unexplained variability among sites, where each site had its own baseline density level. All models were ran using the uninformative default priors for the zero-inflated negative binomial family. Analyses were only undertaken if sufficient non-zero data was available across both ‘Status’ groups.

Model 1: Density $\sim$ Status + (1|Site)

Patterns of lobster densities across the Mimiwhangata permanent transect through time (i.e., ‘Year’) were investigated using zero-inflated negative binomial Bayesian Generalised Additive Mixed Model (GAMM, Model 2). The model was designed with an interaction between time and ‘Status’, where sites were designated as Rāhui Tapu or fished based on their position relative to the 2023 Rāhui Tapu boundaries. Site was included as a random intercept, where replication at the site level occurred across years rather than within years.

Model 1: Density $\sim$ s(Year, by = Status) + (1 | Site)

Results

Rakaumangamanga:

Densities of *J. edwardsii* and *S. verreauxi* were extremely low across all fished sites, including sites within the long-standing Rāhui Tapu area (Maunganui Bay/Deep Water Cove) and sites within the Rāhui Tapu extension area (Fig. 2). In general, the survey data were characterised by an extremely high proportion of transects where zero lobster were recorded. Of the 72 transects surveyed (totalling 36,000 m² of rocky reef), 16 *J. edwardsii* were recorded across 10 transects (absent from 86% of transects surveyed) and 14 *S. verreauxi* across 2 transects (absent from 97% of transects surveyed).

Most *J. edwardsii* recorded were above the minimum legal-size limit (13 or 81.3%, Fig. 3). In contrast, only one legal *S. verreauxi* was recorded, with the remaining 13 sub-legal *S. verreauxi* observed within a single den. No *S. verreauxi* or sub-legal *J. edwardsii* were recorded at Rāhui Tapu sites, and analyses of total or legal *J. edwardsii* densities found no evidence of meaningful differences in between Rāhui Tapu and fished areas (95% credible intervals overlapped zero, Table 2). Mean estimated total *J. edwardsii* densities within the Rāhui Tapu were 0.1 individuals per 500 m² and 0.25 individuals per 500 m² across fished sites. For *J. edwardsii*,

distribution by sex was relatively even (5 females, 7 males) with 4 individuals unable to be sexed, while none of the 14 *S. verreauxi* could be accurately sexed.

Mimiwhangata:

Both lobster species were more abundant at fished and Rāhui Tapu sites at Mimiwhangata than Rakaumangamanga sites. However, the survey data were still characterised by a high proportion of transects where zero lobster were recorded. Of the 72 transects surveyed, a total of 172 *J. edwardsii* were recorded on 34 transects (absent from 50% of transects), and 126 *S. verreauxi* were recorded on 31 transects (absent from 56% of transects). Sub-legal *J. edwardsii* made up 47% of the total surveyed Mimiwhangata population, including 12% below 50 mm carapace length (Fig. 4). Legal *J. edwardsii* made up a slightly higher percentage of lobster recorded within the Rāhui Tapu (55.5%) compared to fished sites (45.5%). Only three female *J. edwardsii* were recorded across all Mimiwhangata sites, compared to 53 males, while 116 individuals could not be sexed.

Total, legal and sub-legal *J. edwardsii* densities (Fig. 4) appeared marginally higher within the Rāhui Tapu (1.65 total individuals per 500 m²) compared to the adjacent fished area (0.65 total individuals per 500 m²), but analyses for all *J. edwardsii* density metrics indicated wide 95% credible intervals overlapping zero for the ‘Status’ effect (Rāhui Tapu vs. fished) reflecting high variability among transects and sites (Table 2). This site level variability was highlighted by the anomalously high densities of *J. edwardsii* recorded at the Taukawau Point Rāhui Tapu site (36 legals, 15 sub-legals on a single transect) and the absence of lobster at the Awash Rock Rāhui Tapu site.

Overall, *S. verreauxi* made up 34% of all lobster recorded across fished sites and 44.6% within the Rāhui Tapu. Only 6% of *S. verreauxi* at Mimiwhangata were above the MLS (5 total). Of these four were recorded at Rāhui Tapu sites. Sub-legal *S. verreauxi* were also more abundant within the Rāhui Tapu (99 total) compared to fished sites (22 total). Analyses indicated a strong likelihood total and sub-legal *S. verreauxi* densities (individuals per 500 m²) were ~4.5 time greater at Rāhui Tapu sites than at adjacent fished sites (estimated density with Rāhui Tapu ~ 2.2 *S. verreauxi* per m²), with only moderate site level variation.

Long-term monitoring of permanent transect sites at Mimiwhangata illustrates large reductions in *J. edwardsii* densities between early surveys (pre-1985) and those undertaken in the early 2000s (Fig. 5). From the early 2000s onwards, legal densities remained largely static, although variability between sites increased, while sub-legal densities continued to decline. In contrast,

densities of sub-legal *S. verreauxi* increased, with 2025 marking the first time this species has been recorded at these sites since the mid-1980s. Although it is noted these sites were surveyed intermittently, with the last survey in 2011. Lastly, sub-legal *S. verreauxi* densities were marginally higher at sites now within the Rāhui Tapu across the time series, independent of protection implementation (i.e., during period of full fishing, partial protection, and full Rāhui Tapu protection), suggesting ‘Site’ rather than ‘Status’ maybe a better predictor sub-legal *S. verreauxi* densities.

Discussion

The 2025 kōura (*Jasus edwardsii*) and pawharu (*Sagmariasus verreauxi*) surveys within and adjacent to the Rakaumangamanga and Mimiwhangata Rāhui Tapu provide baseline data for evaluating the ecological outcomes of these marine protection initiatives. Overall, the results highlight differences in lobster abundances between the Rakaumangamanga and Mimiwhangata locations. Densities of both species were higher at Mimiwhangata compared to Rakaumangamanga, where only 36 individuals were recorded across 72 transects (36,000 m² of reef). Despite these differences, Mimiwhangata data were still characterised by a high proportion of transects with zero lobsters, and long-term trends from the permanent transect sites indicate current *J. edwardsii* populations are very low relative to historical levels. Collectively, these findings reinforce the characterisation of *J. edwardsii* populations presented in Kerr et al. (2025) as heavily degraded, and ultimately highlight the pertinence and importance of conservation measures such as Rāhui Tapu.

Evidence of recovery attributable to Rāhui Tapu protection was mixed, varying between species and locations. No ‘protection effect’ was evident at Rakaumangamanga, reflecting overall extremely low lobster densities. The Rakaumangamanga Rāhui Tapu under its current geometry has only been in-place since 2023, while the Maunganui Bay (Deep Water Cove) area has had no-take Rāhui designation since 2010. The extremely low densities recorded across sites within Maunganui Bay (Deep Water Cove) are at odds with the 2016 survey which was carried out over the same seasonal period (June – early July) and estimated mean densities of 21 *J. edwardsii* per 500 m² (± 15.1 95% confidence interval) across four single transect sites within the then Maunganui Bay (Deep Water Cove) Rāhui area and mean densities of 8.5 (± 8.7 95% confidence interval) across four single transect fished sites. Although direct comparisons between these surveys are constrained by methodological differences, the 2016 survey nonetheless provides important context and suggests that lobster densities across both

Rāhui Tapu and fished sites have declined. The 2025 survey sites were positioned to largely cover the same areas as the 2016 surveys. At no point were densities across any transect in 2025 at levels comparable to that reported in the 2016 survey. As it is difficult to infer trends for one-off surveys, annual surveys should be continued to better understand extent of possible population reductions.

At most Rakaumangamanga sites the depth-stratified survey design meant that the full extent of reef habitat was surveyed, from the deep reef edge (rocky reef/sand interface) to just below the intertidal. We are confident this methodology provided an accurate evaluation of *J. edwardsii* across the reef at both the fished and Rāhui Tapu sites. However, anecdotal reports of extremely high densities of *S. verreauxi* around and inside the Canterbury wreck in Deep Water Cove/Maunganui Bay during the survey period suggest that this species may be aggregating in deeper habitats that were not captured by our transects. These aggregations are known to occur over winter potentially for moulting and mating, but limited information is known on these aggregations and packhorse movement in general - in particular where these lobster are coming from and where they go. Due to the timing of the surveys coinciding with these deep-water aggregations, our estimates may have underestimated local *S. verreauxi* density on shallow reefs. Future monitoring may need to explore seasonal surveys to determine the best period to most accurately survey this species.

At Mimiwhangata, *J. edwardsii* densities were marginally higher in the Rāhui Tapu than adjacent fished areas but the analyses could not identify a certain ‘protection’ effect due to high site level variability, even within the Rāhui Tapu. In their assessment of recovery of *J. edwardsii* in New Zealand marine reserves, Kelly et al. (2000) reported populations increased by 3.9 and 9.5% in shallow (<10 m depth) and deep sites (>10 m depth), respectively, for each year in which the reserves were established. Although the overall ‘Status’ effect was not statistically disguisable, estimated mean densities of legal *J. edwardsii* were 2.5 times greater within the Rāhui Tapu than on adjacent fished reef, and legal *J. edwardsii* were proportionally more prevalent within Rāhui Tapu lobster (Fished = 35% legal, Rāhui Tapu = 45% legal) after less than two years of full protection.

The even distribution of size classes, including a notable proportion of individuals below 50 mm carapace length, are indicative of recent and ongoing recruitment and is suggestive of potential future population growth and the development of stronger protection effects (i.e., Freeman et al., 2012). Adult *J. edwardsii* are highly resident (Kelly, 2001, Kelly and

MacDiarmid, 2003), so the grow-through of sub-legal cohorts into the legal size class should largely occur and remain within the bounds of the Rāhui Tapu. Freeman et al. (2012) describe recovery of *J. edwardsii* within New Zealand marine reserves as correlated with local larval settlement. Here, marine reserves set against a background of high larval settlement and high initial juvenile densities may experience rapid recovery, while recovery under low settlement may take decades. Continued collection and assessment of individual size information will be key to understanding and evaluating recovery within these Rāhui Tapu.

The near absence of female *J. edwardsii* from the Mimiwhangata survey data (only three recorded) is likely attributable to the timing of the survey and associated seasonal movements, rather than being indicative of population instability. Due to a prolonged period of easterly winds and swell, fieldwork was delayed until late September–early October. During this period, reproductively active female *J. edwardsii* are expected to move to deeper reef or reef-edge habitats to release fertilised eggs into the plankton (MacDiarmid, 1989, MacDiarmid, 1991). These areas were not captured by our surveys which were restricted to reef <20 m deep. Protection effects on *J. edwardsii* spawning stock biomass (biomass of all reproductive females) have been found to be proportional to total biomass in the Hauraki Gulf (Hanns et al., 2022). However, the implications of reproductively active females occupying deep habitats beyond the limits of the survey at the time of sampling on our assessment, and our estimates of the overall Rāhui Tapu protection effects remain unclear. Ongoing monitoring should ensure that surveys are carried out during mating season to limit the influence of seasonal movements and help clarify impact movements on the present survey's population estimates.

The strong protection effect observed for sub-legal *S. verreauxi* at Mimiwhangata was unexpected. Analyses indicated that total and sub-legal densities were approximately 4.5 times higher within the Mimiwhangata Rāhui Tapu than at fished sites, with only moderate site-level variation. Given that these lobsters are not expected to be vulnerable to fishing (below the MLS limit) and, due to their highly transient ecology, are not expected to benefit from spatially static marine protected areas (Booth, 2011), this pattern is difficult to explain solely as a protection effect. The long-term permanent transect time series provides important context as sub-legal *S. verreauxi* were generally more abundant at the sites now within the Rāhui Tapu before protections were implemented. The apparent positive protection effect may therefore partly reflect underlying habitat differences or unaccounted for ecological phenomena, operating at a site-level, rather than protection alone.

The long-term permanent transects revealed divergent trajectories for the two lobster species. Between early surveys (pre-1985) and the early 2000s *J. edwardsii* densities declined sharply, after which legal densities remained largely static while sub-legal densities continued to fall. In contrast, sub-legal *S. verreauxi* increased, with 2025 marking the first record of this species at these sites since the mid-1980s (noting gap in sampling between 2011 and 2025). While early trends in legal *J. edwardsii* may reflect fishing impacts, continued reductions in sub-legals and concomitant increases in sub-legal *S. verreauxi* populations may also suggest more broader climatic processes. North-eastern has experienced a period of unprecedented warming over the last two decades (Shears et al., 2025). It is possible this warming has benefited the warm water associated *S. verreauxi* while also hindered population recruitment of *J. edwardsii*.

These survey data paint both a promising and concerning picture for the future of spiny lobster on north-eastern New Zealand rocky reefs. Although not statistically ‘significant’, the marginally higher densities of *J. edwardsii* within the Mimiwhangata Rāhui Tapu and evidence of recent recruitment are encouraging and suggest these populations should continue to build. However, the time series provides important context, showing that any rebuilding is occurring from historically depleted levels and remains slow and spatially patchy. While warming temperatures may explain declining numbers of juvenile *J. edwardsii*, the extremely low numbers of large legal sized *J. edwardsii* at Rakaumangamanga, particularly within Maunganui Bay (Deep Water Cove), is concerning and warrants further investigation. Active regular enforcement of these protected areas only began in September 2024, so we may expect recovery to be gradual, emerging over a multi-year time frame. We therefore recommend continuing the current surveys annually for at least 5 years to better understand impacts of these protected areas. Increasing densities of *S. verreauxi* suggest that this species may be emerging as an important component of Northland’s rocky reef ecology. To support effective monitoring and management, seasonal surveys should also be considered to better characterise its habitat use and temporal dynamics.

Table 1: Site information. * Denotes Mimiwhangata sites with historic permanent transect.

Rakaumangamanga		
Site	Depth range (m)	Status
LOB9C	4.5 - 15	Fished
LOB10C	5.5 - 19	Fished
LOB11C	3 - 17.5	Fished
LOB12C	3 - 17	Fished
LOB16C	6.5 - 17	Fished
LOB17C	5.5 - 16	Fished
LOB1R	4 - 16	Rāhui Tapu
LOB2R	4 - 18	Rāhui Tapu
LOB5R	5 - 18.5	Rāhui Tapu
LOB6R	5 - 16	Rāhui Tapu
LOB7R	5 - 20	Rāhui Tapu
LOB8R	4.5 - 17	Rāhui Tapu
Mimiwhangata		
Site	Depth range (m)	Status
Awash Rock*	1.5 - 14	Rāhui Tapu
Barron's North*	0.5 - 12	Fished
Barron's South*	0.5 - 9.5	Fished
Grey Rock*	2.5 - 10	Rāhui Tapu
Lunch Bay*	0.5 - 9.5	Rāhui Tapu
Motutara*	0.5 - 10	Fished
Otamure*	0.3 - 8.6	Fished
Pa Point*	1 - 6.5	Rāhui Tapu
Porae Point*	0.5 - 9.2	Rāhui Tapu
Suicide Cove*	0.5 - 9.8	Fished
Taukawau Point*	0.5 - 9.8	Rāhui Tapu
Titi Island	5.5 - 10	Fished

Information identifying the specific location of monitoring sites has been redacted from this table to protect targeting of the species.

Table 2: Summary output for analyses evaluating differences in lobster densities between Rāhui Tapu and adjacent fished areas. Model coefficients reported on the log link scale; positive values indicate higher predicted densities relative to the reference (fished) level. Fixed effect estimates shown with associated 95% low and high credible intervals (CI). Random-effects output (*sd__*(Intercept)) shows the standard deviation of the site-level random intercept, representing among-site variability in baseline densities.

Rakaumangamanga						
Species	Metric	effect	term	estimate	CI low	CI high
<i>J. edwardsii</i>	Total	fixed	(Intercept)	-0.69048	-2.38376	0.668626
		fixed	Status	-1.03431	-3.63463	0.895411
		ran_pars	sd__(Intercept)	0.939272	0.036841	2.833649
	Legal	fixed	(Intercept)	-1.56212	-3.80065	0.235869
		fixed	Status	-0.65102	-3.98784	2.14736
		ran_pars	sd__(Intercept)	1.47228	0.104641	3.878122
Mimiwhangata						
<i>J. edwardsii</i>	Total	fixed	(Intercept)	-0.36971	-2.15891	1.106008
		fixed	Status	0.938965	-1.55126	3.328815
		ran_pars	sd__(Intercept)	1.66535	0.659901	3.324272
	Legal	fixed	(Intercept)	-0.64058	-2.47418	0.904508
		fixed	Status	0.906888	-1.43369	3.106978
		ran_pars	sd__(Intercept)	1.369632	0.128139	2.99541
	Sub-legal	fixed	(Intercept)	-1.04616	-2.93724	0.466126
		fixed	Status	1.124965	-0.96609	3.429092
		ran_pars	sd__(Intercept)	1.537997	0.526862	3.254579
<i>S. verreauxi</i>	Total	fixed	(Intercept)	-0.53	-1.84579	0.603337
		fixed	Status	1.498998	0.036457	3.07447
		ran_pars	sd__(Intercept)	0.900292	0.074035	2.037244
	Sub-legal	fixed	(Intercept)	-0.62303	-2.08979	0.494515
		fixed	Status	1.533836	-0.00763	3.185091
		ran_pars	sd__(Intercept)	0.972173	0.08192	2.248874

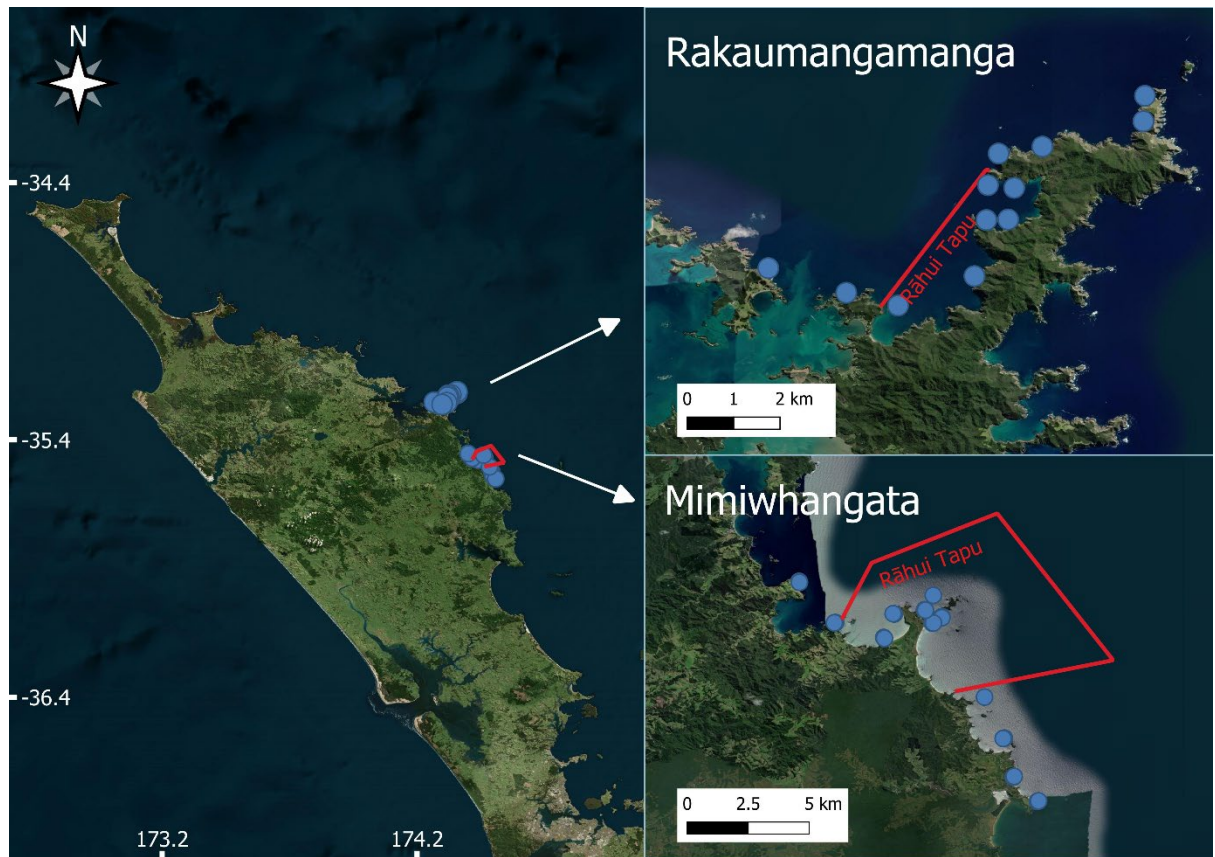


Figure 1: Spiny lobster survey sites inside and outside the Rakaumangamanga and Mimiwhangata Rāhui Tapu, Northland, Aotearoa New Zealand. Red lines show the Rāhui Tapu boundaries and blue points show site positions.

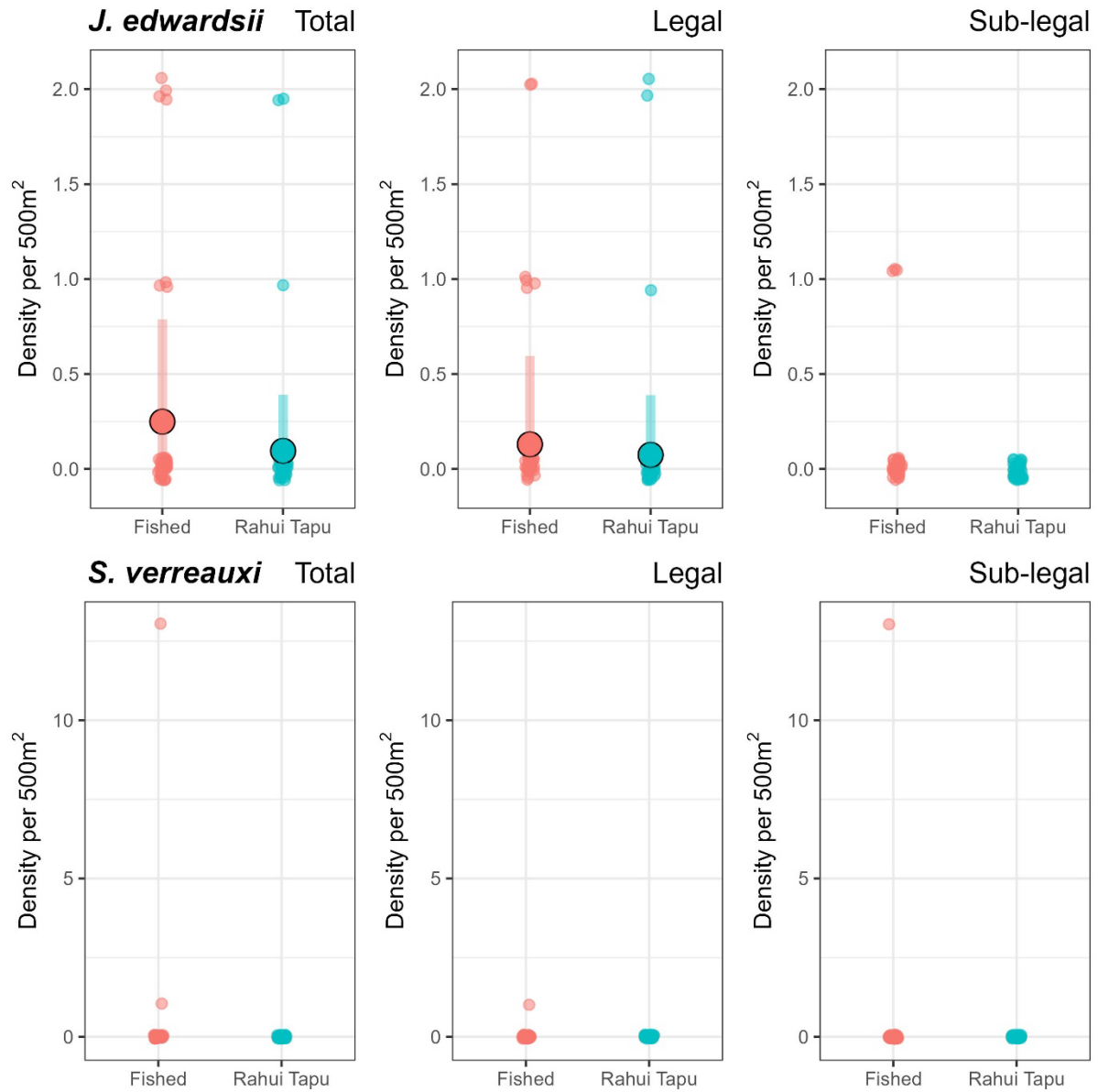


Figure 2: *Jasus edwardsii* (top) and *Sagmariasus verreauxi* (bottom) densities across Rakaumangamanga fished and Rāhui Tapu sites, shown as total, legal-sized ($\geq$ MLS), and sub-legal ($<$ MLS) lobsters. Small points represent transect-level counts, and large points show model-estimated mean densities with 95% credible intervals. Model estimates are presented only where there were sufficient non-zero observations in both status areas.

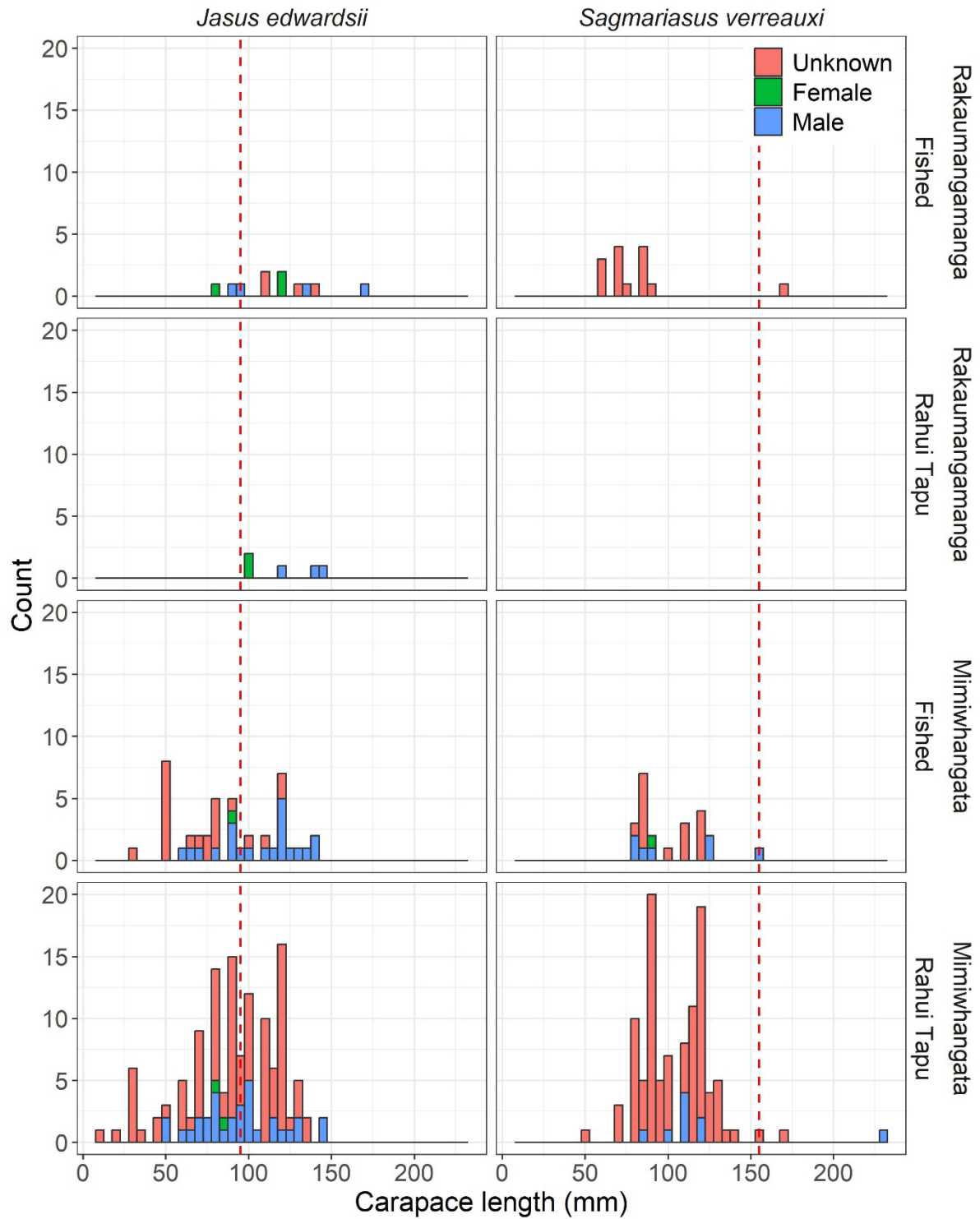


Figure 3: Distribution of lobster carapace lengths recorded during Mimiwhangata and Rakaumangamanga surveys. Carapace length distributions (5 mm bins) specified by sex. ‘Unknown’ specifies individuals where sex was unable to be accurately determined.

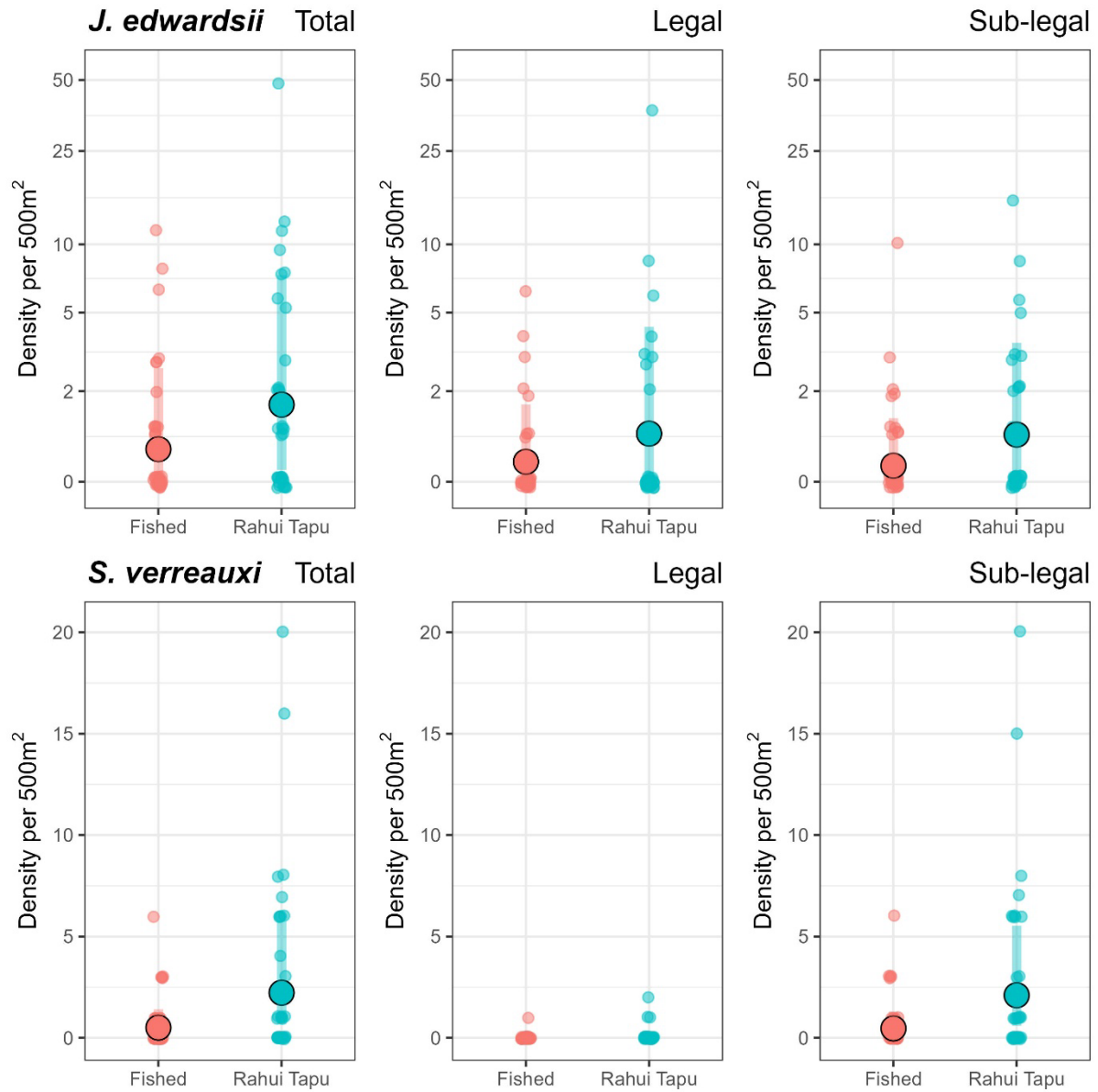


Figure 4: *Jasus edwardsii* (top) and *Sagmariasus verreauxi* (bottom) densities across Mimiwhangata fished and Rāhui Tapu sites, shown as total, legal-sized ($\geq$ MLS), and sub-legal ($<$ MLS) lobsters. Small points represent transect-level counts, and large points show model-estimated mean densities with 95% credible intervals. Model estimates are presented only where there were sufficient non-zero observations in both status areas. *J. edwardsii* densities are plotted on a pseudo-log scale to reduce the visual separation driven by transects with very high densities.

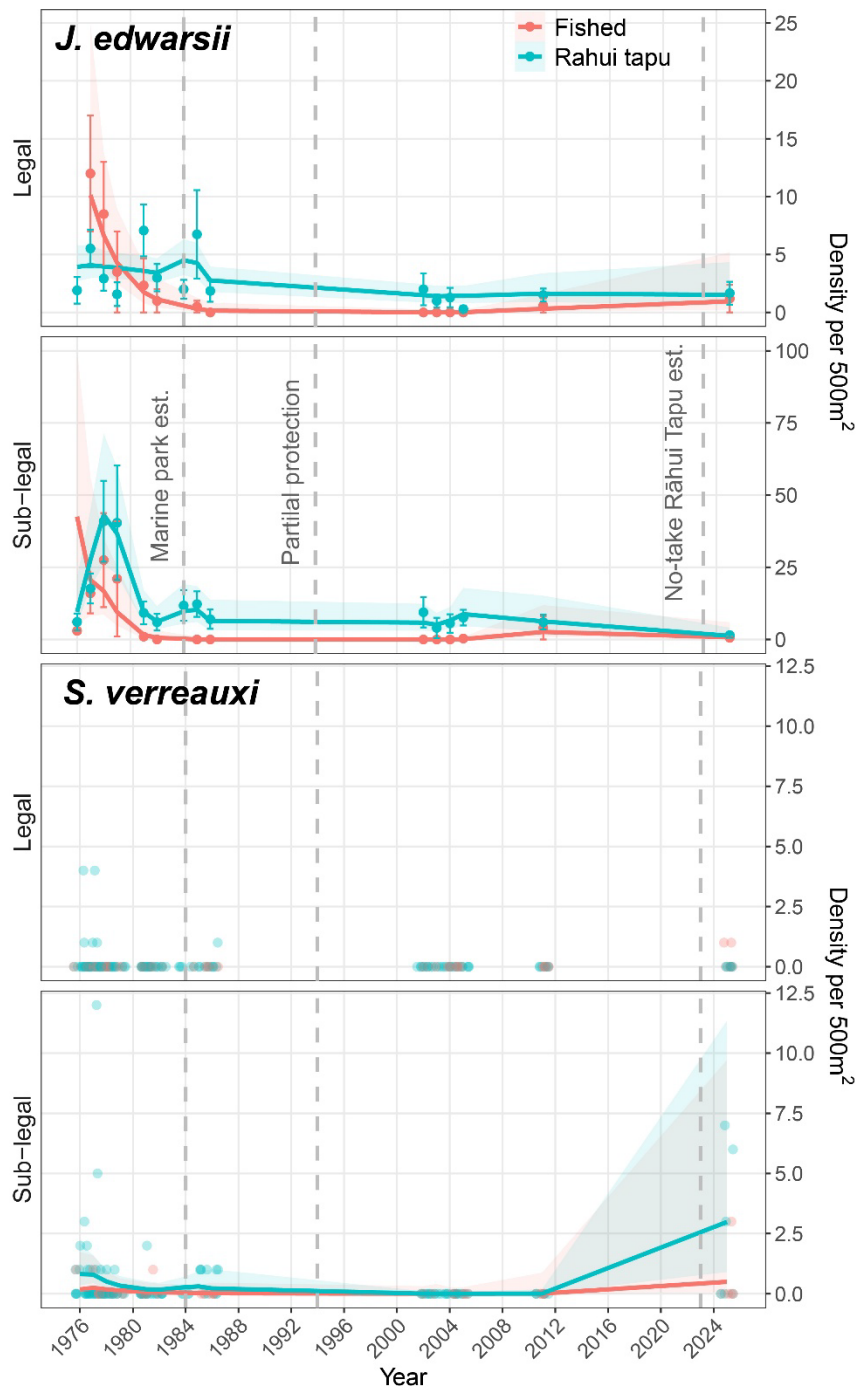


Figure 5: Long-term density trends across permanent transect sites currently positioned within the Mimiwhangata Rāhui Tapu boundaries and permanent transect sites currently open to fishing. Line depicts mean densities estimated by the GAMM. Large points for *J. edwardsii* show yearly means and associated standard errors. Small points in the *S. verreauxi* plots indicate transect level counts. Vertical dashed grey lines indicate the years when the Mimiwhangata marine park was established, partial protection was implemented (i.e., commercial fishing closure) and the implementation of the ‘no-take’ Rāhui Tapu.

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