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# The distribution of juvenile snapper within the Auckland Fishery Management Area

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**Auckland**
**1993**



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## 1. INTRODUCTION

In 1989, MAF Fisheries North proposed a Fisheries Management Plan (FMP) for the Auckland Fishery Management Area (AFMA). This document recognised the importance of minimising fishing mortality on juvenile fish as a mechanism for improved yield from the fishery (Anon. 1989). The FMP developed three management strategies to minimise the mortality on juvenile fish:
1. Closure of important juvenile habitats.
2. Use of appropriate net mesh size.
3. Use of minimum fish size.

Bulk fishing methods, such as trawling, Danish seining and drag netting, are generally unselective and have the potential to catch large numbers of juvenile fish. Currently, many embayments and inshore areas within the AFMA are closed to these fishing practices (see the proposed FMP for details). These areas are generally recognised as important nursery grounds for snapper but much of the information on juvenile snapper abundance is anecdotal.

Juvenile snapper are known to congregate around shallow and sheltered bays, harbours and river mouths (Haddon 1990). The Hauraki Gulf has been recognised as an important habitat for juvenile fish. Paul (1976) conducted an extensive survey of the Hauraki Gulf and described the seasonal distribution and movement of juvenile snapper. An important snapper nursery area in the North Taranaki Bight was also defined by Horn (1986).

Since 1982, the R.V. *Kaharoa* has regularly conducted trawl surveys within the AFMA. A primary objective of the trawl survey programme has been to determine the relative abundance of juvenile snapper. The *Kaharoa* programme has facilitated the collection of an extensive database of snapper catch rates and spatial distributions of snapper. The objective of this report is to summarise the data in order to quantify the distribution of juvenile snapper and identify snapper nursery grounds within the AFMA. For the purpose of this review, juvenile snapper are defined as pre-recruit fish, below the minimum legal size of 25 cm fork length (F.L.).

## 2. METHODS

The AFMA is currently divided into four management areas: the Hauraki Gulf, the Bay of Plenty, East Northland and the west coast of the North Island. Trawl surveys have been conducted in all management areas and their boundaries generally define the survey areas (Drury and McKenzie 1992a, 1992b, 1992c, 1992d). Most of the trawl surveys have been carried out during spring or summer, depending on the area surveyed. Additional surveys have also been conducted outside the normal sampling period to examine seasonal distributions of snapper. Table 1 summarises the frequency and the timing of the trawl surveys used in the subsequent analysis.

Trawl surveys within the AFMA have employed a random stratified design. Each survey area was divided into depth and area strata based on the catch rate of snapper. Within each stratum, trawls were conducted at randomly selected station positions.

All trawling was carried out using a high opening bottom trawl (HOBT) with a codend

constructed of 40 mm mesh. The gear was rigged to attain an average headline height of 5 metres and an estimated doorspread of 79.0 metres. Towing speed was between 3.0 and 3.5 knots and standard procedures were employed to determine tow direction. The distance trawled was generally constant for a given survey at between 0.7 and 1.5 n. miles depending on the study area (Drury and McKenzie 1992a, 1992b, 1992c, 1992d).

For each trawl station, the date, time, position, and bottom depth were recorded at the start and end of the trawl. The ship's speed, heading and distance towed were recorded from the GPS, gyro compass, and doppler log. Observations of environmental variables including air and sea surface temperature, wind speed, sea state, turbidity and bottom substrate were also recorded.

The catch from each trawl was sorted and weighed by species. Most snapper caught were measured, to the centimetre below the fork length, but for large catches only random subsamples of fish were measured.

The snapper length frequency data were summarised into four categories. For each trawl station, the number of snapper caught in the two youngest age classes and the total number of juvenile and legal snapper were calculated. The two youngest age classes are clearly discernable from the survey length frequency distributions and occupy relatively discrete length ranges. The size range of the two cohorts varied between survey areas but generally corresponded to length ranges of 7-13 cm and 14-19 cm (see Drury and McKenzie 1992a, 1992b, 1992c and 1992d). Each cohort was assigned to a given age class based on the nomenclature of Paul (1976) whereby 1 January is defined as the theoretical birthday. Consequently, the age assigned to a given length cohort is dependent on the timing of the trawl survey. For example, snapper spawned during the preceding spring-summer will be defined as 0+ age fish during a survey carried out in November, but will be aged 1+ fish in the new year. Generally, two juvenile cohorts could be described in each area, and depending upon when the survey was carried out these will either be 0+ and 1+ or 1+ and 2+.

To standardise the catch from tows of various distances, the number of snapper in each length category was scaled by the distance trawled. The catch rate (number per nautical mile trawled) was then used to express the relative abundance of snapper at each station. The percentage of legal snapper in each snapper catch was also determined.

The relative abundance of snapper in each length category was plotted against the station start position. For each survey area, the distribution of legal snapper catches and the percentage of legal fish in the snapper catch was examined against the depth of station position.

## 3. RESULTS

The distribution of trawl positions included in this analysis is presented in Figure 1. Trawl surveys of the Hauraki Gulf were conducted frequently and a large number of stations have been occupied in this area. Conversely, only one survey of East Northland has been carried out and limited data are available for this area. The most recent survey of the west coast extended the study area further south, outside the boundaries of the AFMA.

### 3.1 West Coast

Figures 2 and 3 present the relative abundance of the 0+ and 1+ snapper cohorts on the west coast. Catches of 0+ fish are generally numerically smaller and less frequent than 1+ snapper, however, both cohorts appear to follow a similar distribution. Significant catches of fish in these cohorts were taken at Ninety Mile Beach, Baylys Beach and adjacent to the entrances of the Whangape, Kaipara, Manukau and Raglan Harbours in depths less than 30 metres (Figures 2 and 3). The 1991 survey, extended to encompass the southwest coast of the North Island, also caught juvenile fish within the North Taranaki Bight.

The distribution of all juvenile snapper does not differ significantly from the distribution of both the 0+ and 1+ cohorts (Figure 4). However, the catch of juvenile fish within the above areas is highly variable. Consecutive surveys did not consistently catch juvenile snapper in all the areas identified and many trawls in these areas caught no juvenile snapper.

Legal snapper appear relatively evenly distributed through the west coast survey area (Figure 5). The largest catches of legal fish were taken off Ninety Mile Beach, Hokianga Harbour, Kaipara Harbour and the North Taranaki Bight. The surveys extended to the east of North Cape also caught significant numbers of legal snapper within Rangaunu Bay and Doubtless Bay. The largest snapper catches were generally taken from stations in depths of less than 50 metres but reasonable catch rates of legal snapper were still maintained between 50-100 metres (Figure 6a). In the deeper stations, fish of legal size dominated the snapper catch. The proportion of legal fish gradually declined in shallower water (Figure 6b), although the mean number of juvenile snapper in the catch did not exceed 20% for any depth interval.

### 3.2 East Northland

During the 1990 East Northland trawl survey, significant catches of 0+ (Figure 7) and 1+ (Figure 8) snapper were taken from Waikuku Beach, Doubless Bay, the Bay of Islands and Whangaruru Harbour. At these locations, catches of 1+ snapper were numerically greater than for the 0+ cohort. In addition, 1+ snapper were also caught in Whangaroa Bay, Sandy Bay, Ngunguru Bay and Ocean Beach (Figure 8). The abundance of all juvenile snapper generally followed the areal distribution of 1+ snapper but were also more abundant in deeper water (25-50 m) and adjacent to Houhora Harbour (Figure 9). Legal snapper were caught throughout the survey area, with the largest catches taken from the localities where juvenile snapper were prevalent. Significant numbers of legal snapper were also taken from deeper water, where fish of legal size dominated the catch (Figure 10).

### 3.3 Hauraki Gulf

Large catches of both the 0+ and 1+ cohorts have been taken within the inner Hauraki Gulf (Figures 11 and 12). Both cohorts were most abundant in the shallower reaches of the Gulf, around Kawau Island, the Whangaparoa Peninsula, Waiheke Island, Firth of Thames and western Coromandel. Catch rates of the 1+ fish were generally larger and more widespread within the central Hauraki Gulf and significant numbers were also taken in Kennedy Bay and adjacent Mangawhai Harbour. The distribution of all juvenile snapper generally follows the distribution of the 1+ cohort but are more abundant in the outer Hauraki Gulf to the boundaries of the survey area (Figure 13). The juvenile snapper caught in these areas are generally within the 20-24 cm (F.L.) length range.

Legal size snapper have been caught throughout the survey area (Figure 14) with the largest

catches taken within the inner Gulf in water shallower than 30 metres (Figure 15a). In this area, the legal fish represented 20-30% of the numeric snapper catch. However, the mean percentage of legal snapper in the catch increased in depths exceeding 50 metres (Figure 15b).

Trawl surveys conducted during autumn and winter indicate juvenile snapper are prevalent in the Hauraki Gulf throughout the year. However, changes in the seasonal distribution of snapper in the Hauraki Gulf are apparent. During winter, juvenile snapper were abundant within the Kawau Island, Whangaparoa Peninsula and Waiheke Island areas but were no longer prevalent in the Firth of Thames. The abundance of legal snapper in the Hauraki Gulf was lower during the autumn and winter period, especially within the central and outer Gulf and the Firth of Thames.

### 3.4 Bay of Plenty

Major catches of 1+ and 2+ snapper in the Bay of Plenty were taken at inshore stations around Hikuwai Beach, adjacent to the Tauranga and Whangamata Harbours and off the Rangitaki and Motu River mouths (Figures 16 and 17). 1+ fish were most abundant in the eastern Bay of Plenty, particularly around the Motu River, whereas 2+ snapper were more evenly distributed throughout these areas. The relative abundance of all juvenile snapper generally followed the distribution of 2+ fish but were also more abundant in deeper water (Figure 18).

Legal snapper were most prevalent in the inshore areas associated with catches of juveniles (Figure 19). However, significant numbers of legal snapper were also caught in deeper water and dominated the snapper catch at stations exceeding 50 m depth (Figure 20b). Juvenile snapper accounted for the greatest proportion of the snapper catch (by numbers) in the 25-30 metre depth range. In shallower water, where catch rates were high, there was a general increase in the percentage of legal fish taken. These large catches of legal fish were not restricted to a localised area but occurred throughout the Bay of Plenty.

A trawl survey of the Bay of Plenty during late autumn 1987 provides a seasonal comparison of the snapper distribution. The areal distribution of all size categories of snapper appeared to be consistent with the distribution observed from the summer surveys. However, catch rates of juvenile snapper were slightly below average and legal snapper were much less abundant, especially in the deeper strata.

### 3.5 Summary

A comparison of relative catch rates between the AFMA study areas indicates that juvenile snapper are most abundant within the inner Hauraki Gulf. Large catches of juvenile snapper were also relatively frequent in localised areas of the Bay of Plenty and East Northland. On the west coast, juvenile snapper comprised a small proportion of all snapper caught during trawl surveys. The distribution of juvenile snapper on the west coast also appears more variable, with a high proportion of inshore stations yielding no juvenile fish.

Snapper of legal size were most abundant within the eastern survey areas, particularly in the Hauraki Gulf during spring and summer. Large catches of legal snapper were generally taken throughout the inshore areas sampled. However, on the west coast legal snapper were more evenly dispersed over the survey depth range.

## 4. DISCUSSION

Trawl surveys consistently caught juvenile fish within shallow bays and harbours and adjacent to river mouths and harbour entrances. Snapper belonging to the youngest cohort were most abundant in shallow water, particularly in areas associated with major snapper spawning. These areas include the Kaipara and Manukau Harbour entrances, the Motu River mouth, Great Exhibition Bay, the Bay of Islands, Doubtless Bay and the Hauraki Gulf. With increasing age and length, the distribution of juvenile snapper progressively spreads from these localities into deeper water and more exposed areas of coast. Legal sized fish dominated the snapper catch in water deeper than 50 metres. This distribution pattern is consistent with observations by Paul (1976) of snapper in the Hauraki Gulf.

Comparisons between the length frequency distribution of snapper catches from the R.V. *Kaharoa* and the commercial longline fleet indicate that the trawl surveys do not adequately sample the population for fish over 28-30 cm in length (K.J. Sullivan, pers. comm.). Consequently, the distributions of legal snapper presented in this document can only be considered relative between areas and not relative to the distribution of juvenile snapper. In all survey areas, legal sized snapper were most abundant in inshore areas where juvenile fish were prevalent. However, significant catches of legal fish were taken to depths of 50 metres.

During autumn and winter, the number of juvenile snapper within the Hauraki Gulf and Bay of Plenty appeared to decline possibly due to fish retreating from shallow localised areas, such as the Firth of Thames. Paul (1976) observed a similar change in distribution and related the movement of juvenile fish to declining inshore sea surface temperatures. The catches of legal fish also dramatically decreased within the survey areas, particularly in deeper water. This observed change in the abundance may correspond to seasonal movements of legal snapper and/or an increased vulnerability of these fish to trawl gear during the spring-summer spawning period.

In 1990, juvenile fish constituted 40% of the total estimated snapper biomass (by weight) within the Hauraki Gulf (Drury and McKenzie 1992c). By comparison, juvenile snapper accounted for only 3% and 8% of the total biomass from the 1989 (Drury and McKenzie 1992a) and 1991 west coast trawl surveys respectively. The low abundance of juvenile snapper on the west coast indicates that the current trawl survey design does not adequately sample this portion of the population. Significant catches of 0+ and 1+ age snapper have been taken in areas adjacent to the entrances of west coast harbours. However, the shifting sand bars and strong currents in these areas make trawling difficult and these localities were not adequately surveyed. The harbour interiors may also be important nursery areas for snapper. Paul (1976) recorded the presence of very small snapper within the Manukau Harbour. However, the distribution of juvenile snapper within the harbours has not been quantified.

The observed distribution of juvenile snapper on the west coast is consistent with the results of other research programmes. A summary of data collected from trawl surveys conducted by R.V. *James Cook* recorded juvenile snapper catches from shallow trawls (< 50 m) in the Ninety Mile Beach, Kaipara, Manukau and North Taranaki Bight areas (Paul 1985). Catch rates of juvenile snapper in the North Taranaki Bight by R.V. *Kaharoa* were similar to those obtained by Horn (1986) using comparable trawl gear.

Catches of juvenile snapper from successive trawl surveys can be highly variable within areas recognised as important juvenile habitats. This may reflect annual variability in the distribution of juvenile snapper and/or be an artefact of the random trawl survey design. The distribution of juvenile fish appears to be patchy and may correspond to localised micro-habitats. Juvenile snapper are also known to congregate in schools (Paul 1976, Horn 1986). Both factors could contribute to the inconsistency observed in relative abundance between trawl stations. Combining the data collected from trawl surveys conducted in different years also contributes to the true variability. Snapper recruitment is highly variable (Paul 1976, Horn 1986) and the estimated year class strength of the 1+ cohort in the Hauraki Gulf varied 17-fold during the study period (Francis, in prep.). Estimates of total snapper biomass derived from the Hauraki Gulf trawl surveys were also positively correlated with the sea surface temperature at the time of the survey (Gilbert and Sullivan, in prep.). Consequently, annual variation in the relative abundance of snapper in each length category would be expected.

Many of the areas identified in this report as important juvenile snapper habitats are currently provided protection by area closures. On the west coast, waters within 1 n. mile offshore between Scott Point and the south end of Muriwai Beach are closed to all trawling and Danish seining. The 1 n. mile line generally corresponds to the 20 metre depth contour along this stretch of coast. This coastal zone includes most of the areas identified as important juvenile habitats, although significant catches of juvenile snapper did extend to depths of 30 metres and were taken further offshore, outside the entrance to the Kaipara Harbour. Consistent catches of juvenile snapper have also been taken in trawls off the entrance to Raglan Harbour. Currently, no restrictions are imposed on fishing practices within these areas.

The areas identified as principal juvenile habitats on the east coast of Northland were generally within large bays and harbours. These regions are currently afforded protection from trawling and Danish seining and a partial closure to drag netting exists within the Whangarei Harbour. Outside the closed areas, significant catches of juvenile snapper were also taken off Ocean Beach, Ngunguru Bay, Sandy Bay and Waikuku Beach. Conclusions on the distribution of juvenile snapper in this area are based on the results from one trawl survey and should be considered tentative. Subsequent surveys, planned by MAF Fisheries North, will enable a more detailed definition of juvenile abundance.

Historically, commercial fishing within the Hauraki Gulf has been highly regulated. All trawling and Danish seining is currently excluded from the inner Gulf and western Coromandel areas and trawling is also restricted from the central Gulf. Outside the Gulf, trawling and Danish seining are excluded from Kennedy Bay and a seasonal closure operates along Pakiri Beach. These areas encompass the regions identified as major juvenile nursery grounds. However, the distribution of juvenile fish is variable and large catches have also been taken outside these areas.

Within the Bay of Plenty, all trawling and Danish seining is currently excluded from around the Whangamata Harbour, from the coastal waters within 2 n. miles of the shore between Homunga Bay to Haurere Point, and from Orete Point to Cape Runaway. In this area, the 2 n.mile line generally corresponds to the 20-25 m depth contour. A seasonal closure also excludes all commercial fishing from around the Motu River area during summer. These closures include the areas identified in this report as important juvenile nursery grounds. The seasonal closure of the Motu region recognises the importance of this area as a snapper

spawning ground. However, it also appears to be an important nursery ground, particularly for very small snapper, which may be vulnerable to fishing outside the period of closure.

The *Kaharoa* trawl survey programme has adequately defined the distribution of juvenile snapper in the AFMA. Currently, most of the important snapper nursery grounds are protected from bulk fishing practises by their inclusion within closed areas. However, the overlapping distribution of juvenile and legal snapper make such regulations inappropriate for the protection of all juvenile fish. Juvenile snapper are afforded additional protection by the adoption of a minimum mesh size and minimum legal fish size. Further research is required to quantify the effectiveness of these mechanisms in reducing juvenile mortality and increasing the potential yield from the snapper fishery.

**Acknowledgements**

This report summarises a dataset collected from nineteen trawl surveys conducted between 1982 and 1992. I would like to collectively thank the many people responsible for the design and implementation of these surveys.

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Table 1: Seasonal and annual periodicity of trawl surveys conducted by the R.V. *Kaharoa* within the sub-regions of the AFMA.

| | **Summer** | **Autumn** | **Winter** | **Spring** |
|---|---|---|---|---|
| West coast | | | | 1986, 1987, 1989, 1991. |
| East Northland | | | | 1990 |
| Hauraki Gulf | | 1986, 1987 | 1982 | 1984, 1985, 1986, 1987, 1988, 1989, 1990 |
| Bay of Plenty | 1983, 1990, 1992 | 1985, 1987 | | |

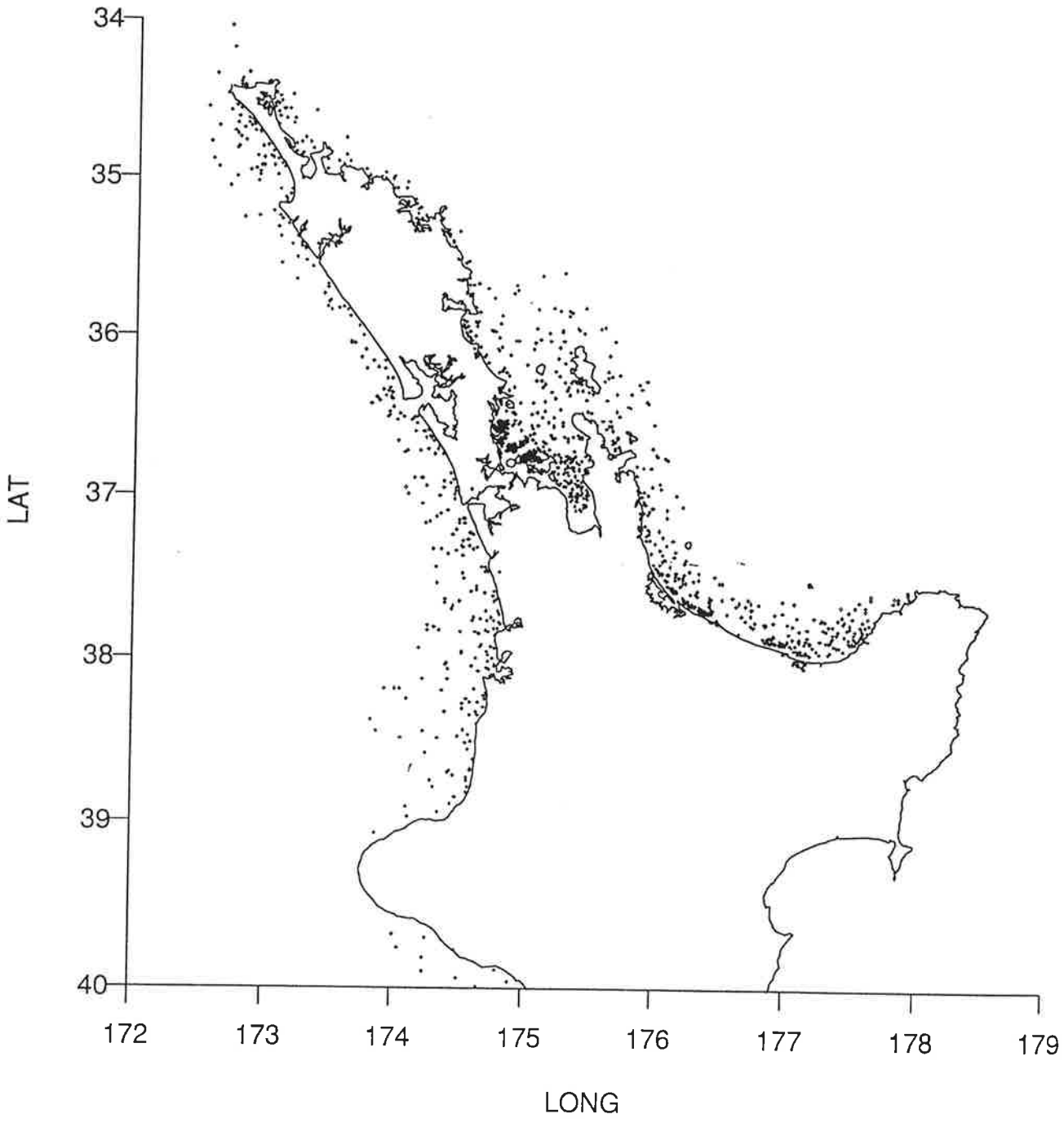


Figure 1. Tow start positions from R.V. *Kaharoa* trawl surveys conducted within the AFMA.

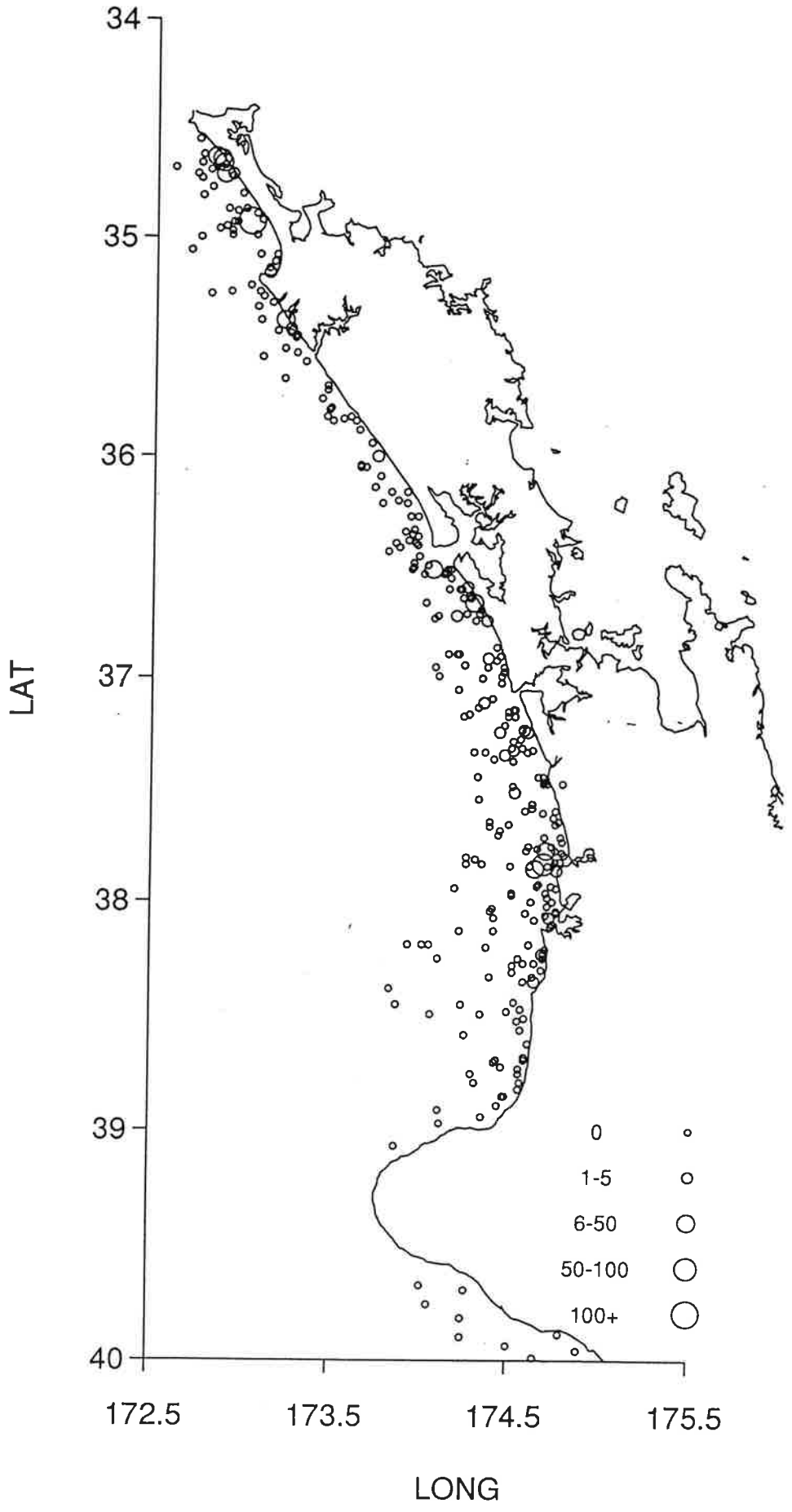


Figure 2. Distribution and relative abundance (number per n. mile) of 0+ cohort snapper from R.V. *Kaharoa* trawl surveys of the west coast North Island.

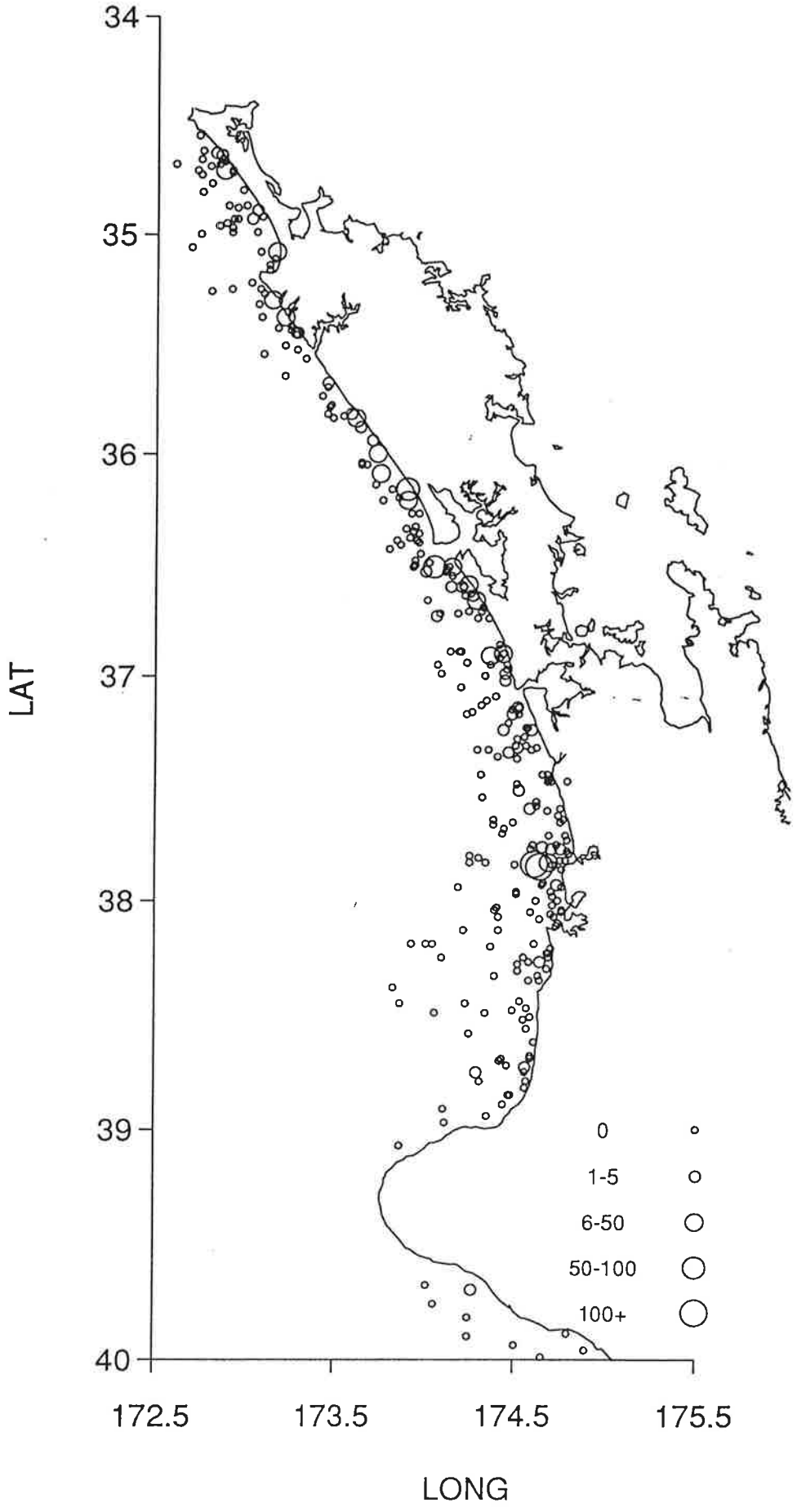


Figure 3. Distribution and relative abundance (number per n. mile) of 1+ cohort snapper from R.V. *Kaharoa* trawl surveys of the west coast North Island.

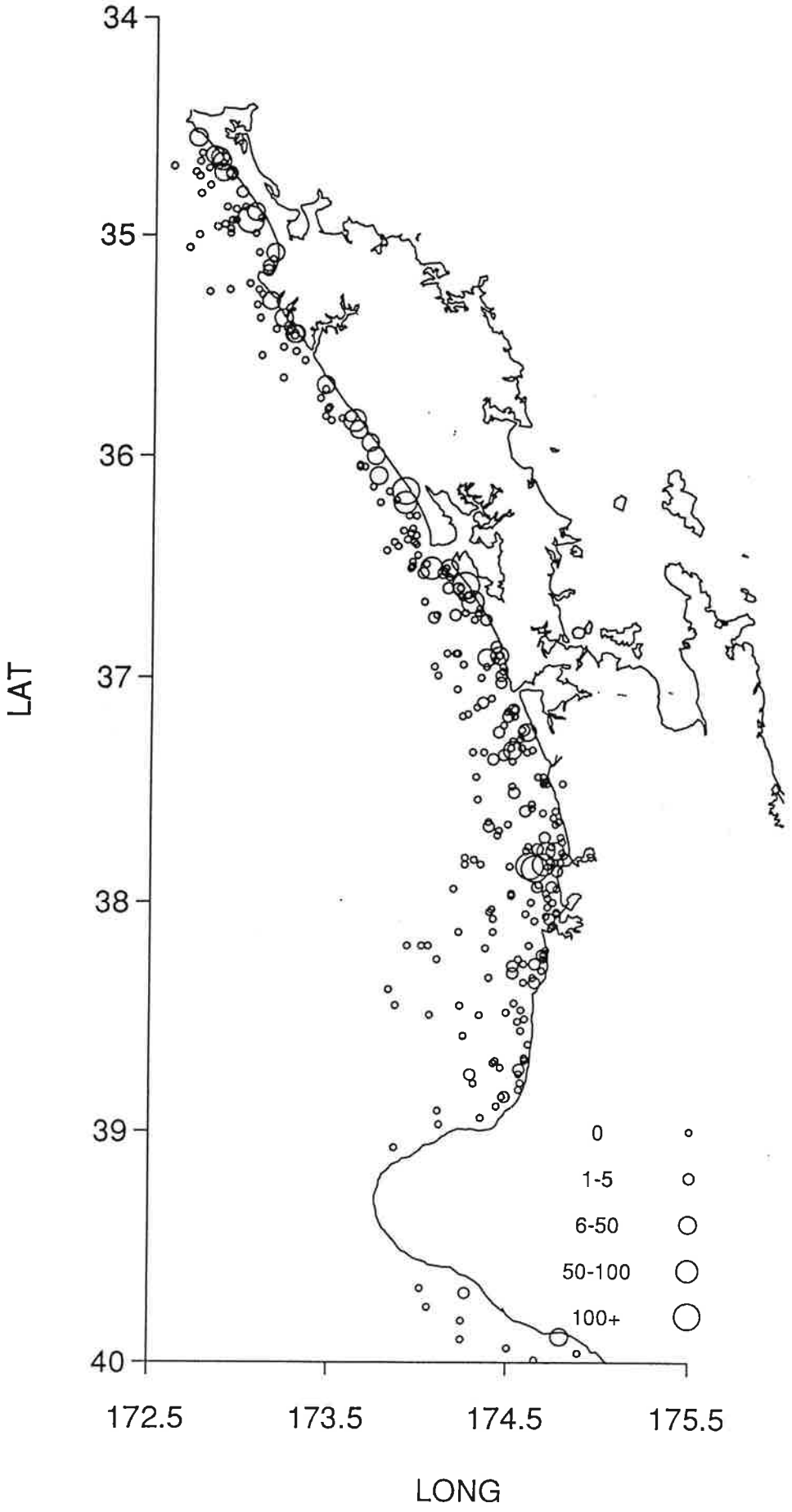


Figure 4. Distribution and relative abundance (number per n. mile) of juvenile snapper from R.V. *Kaharoa* trawl surveys of the west coast North Island.

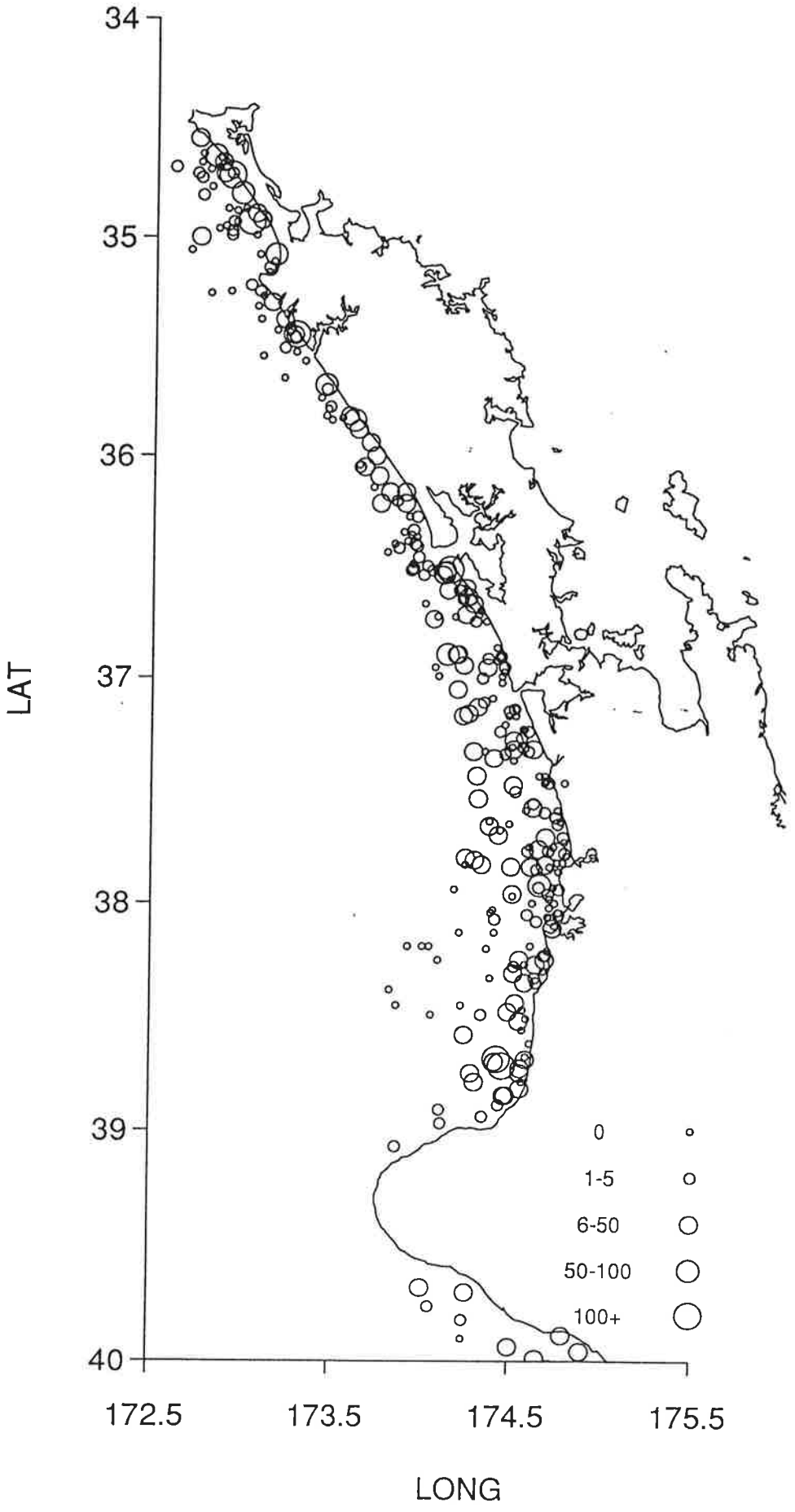


Figure 5. Distribution and relative abundance (number per n. mile) of legal snapper from R.V. *Kaharoa* trawl surveys of the west coast North Island.

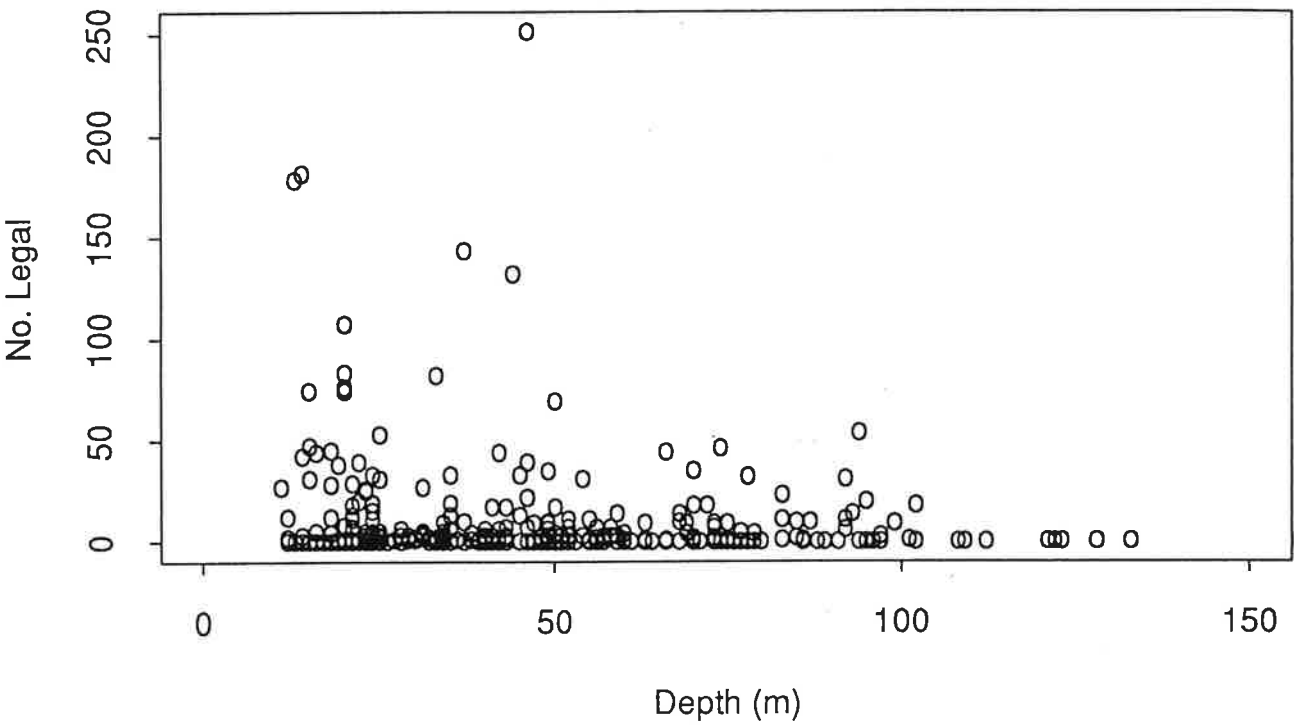


Figure 6a. Relative abundance (number per n. mile) of legal snapper against depth of trawl station from R.V. *Kaharoa* trawl surveys of the west coast North Island.

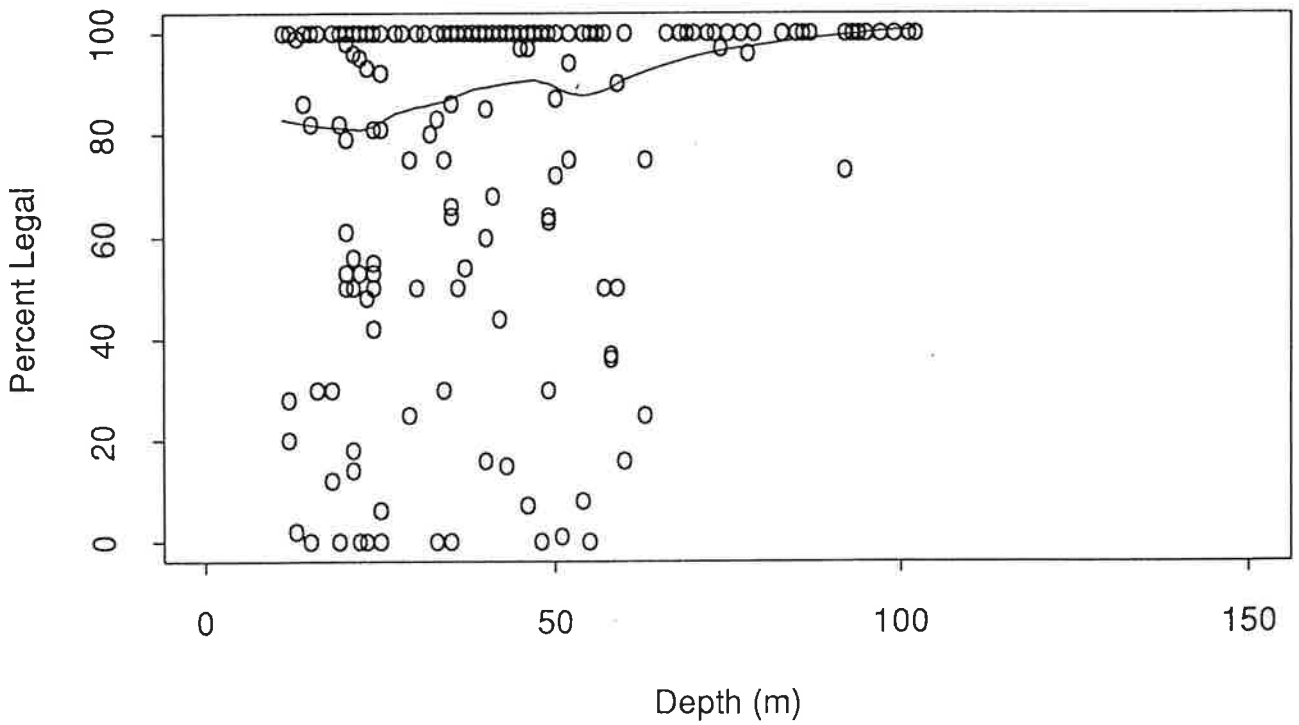


Figure 6b. Percentage of legal fish in snapper catch, against depth of trawl station from R.V. *Kaharoa* trawl surveys of the west coast North Island. The plotted line represents the trend in the data produced using a lowess smoothing function (see Cleveland 1979).

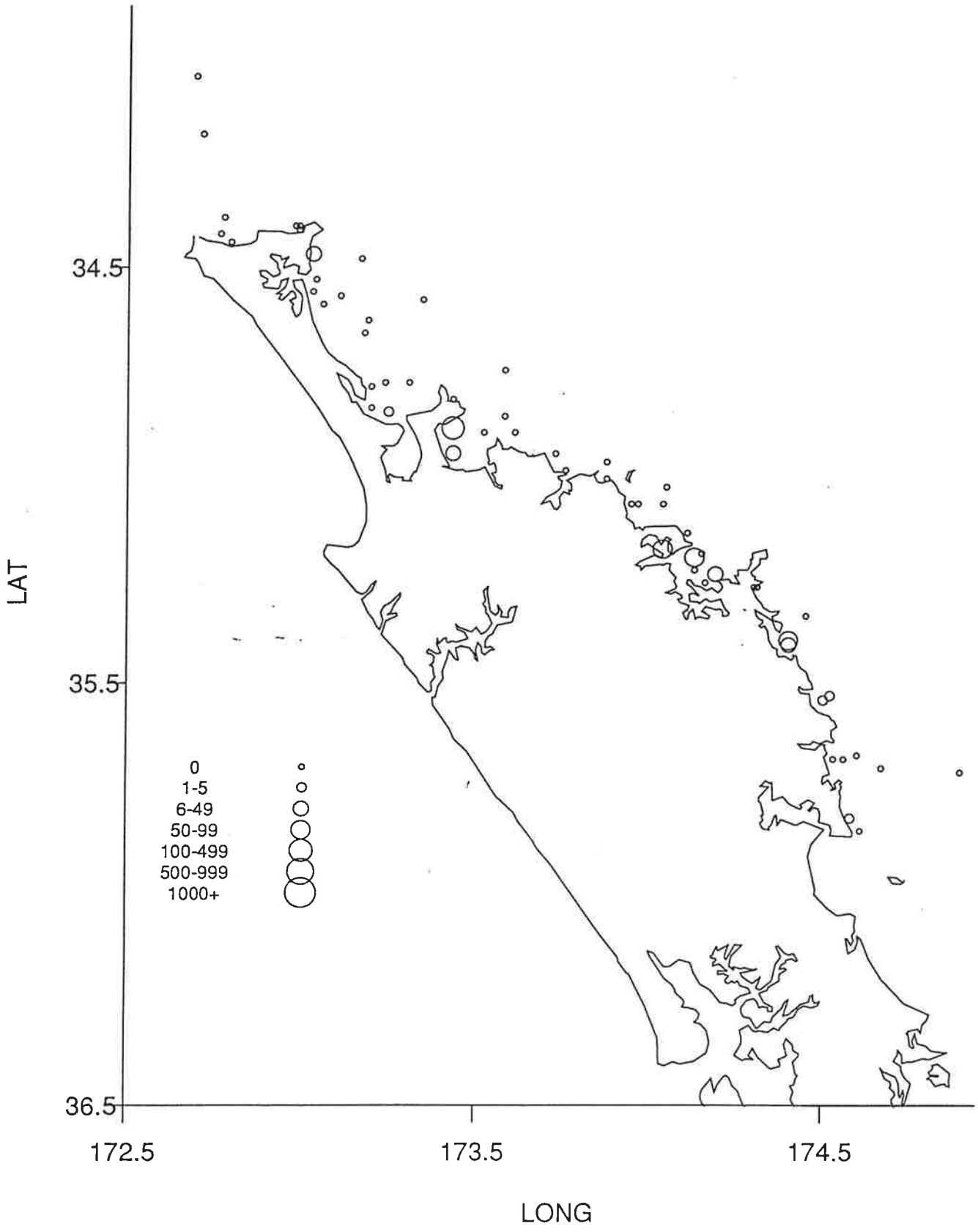


Figure 7. Distribution and relative abundance (number per n. mile) of 0+ cohort snapper from *the R V Kaharoa* trawl survey of East Northland.

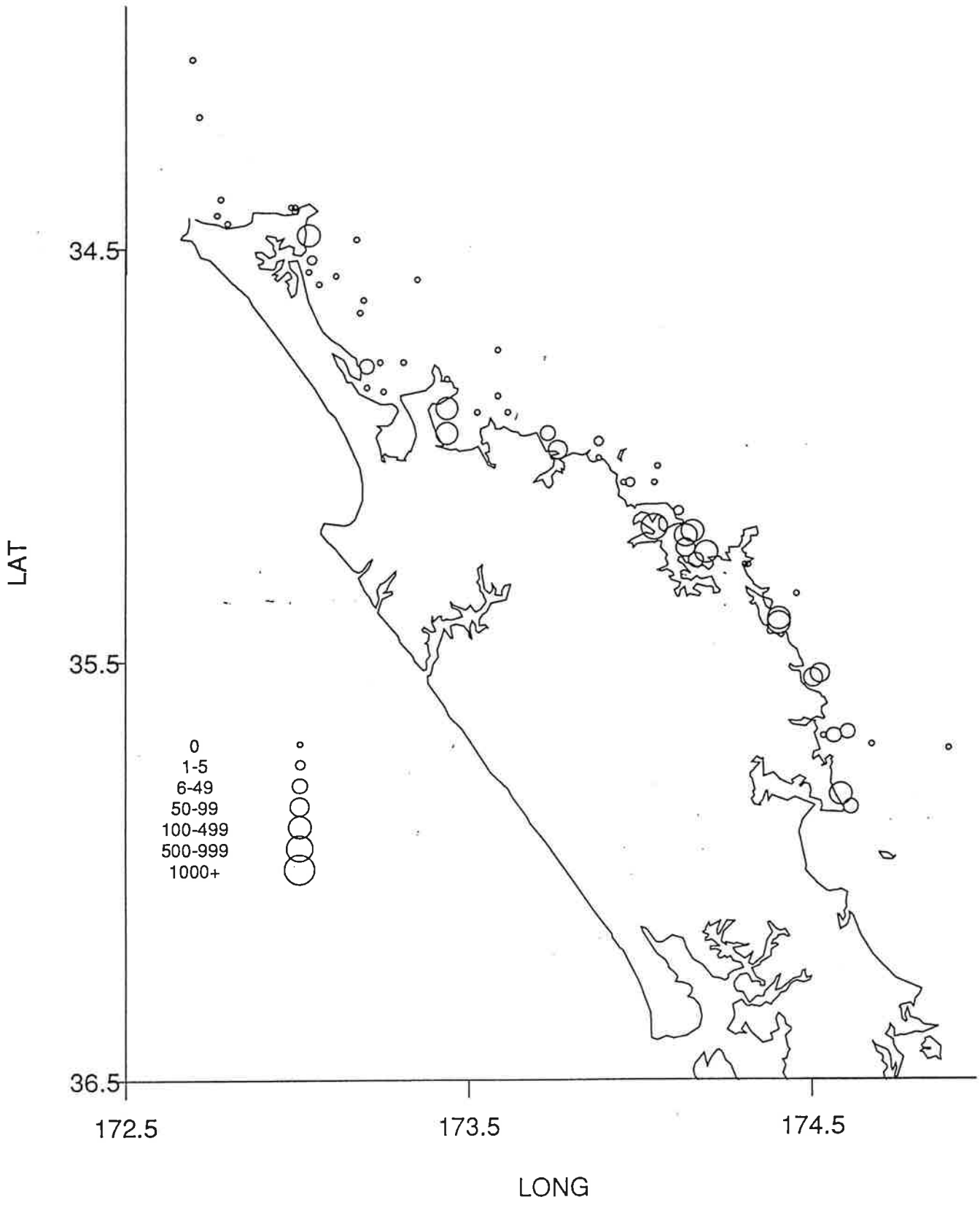


Figure 8. Distribution and relative abundance (number per n. mile) of 1+ cohort snapper from the R.V. *Kaharoa* trawl survey of East Northland.

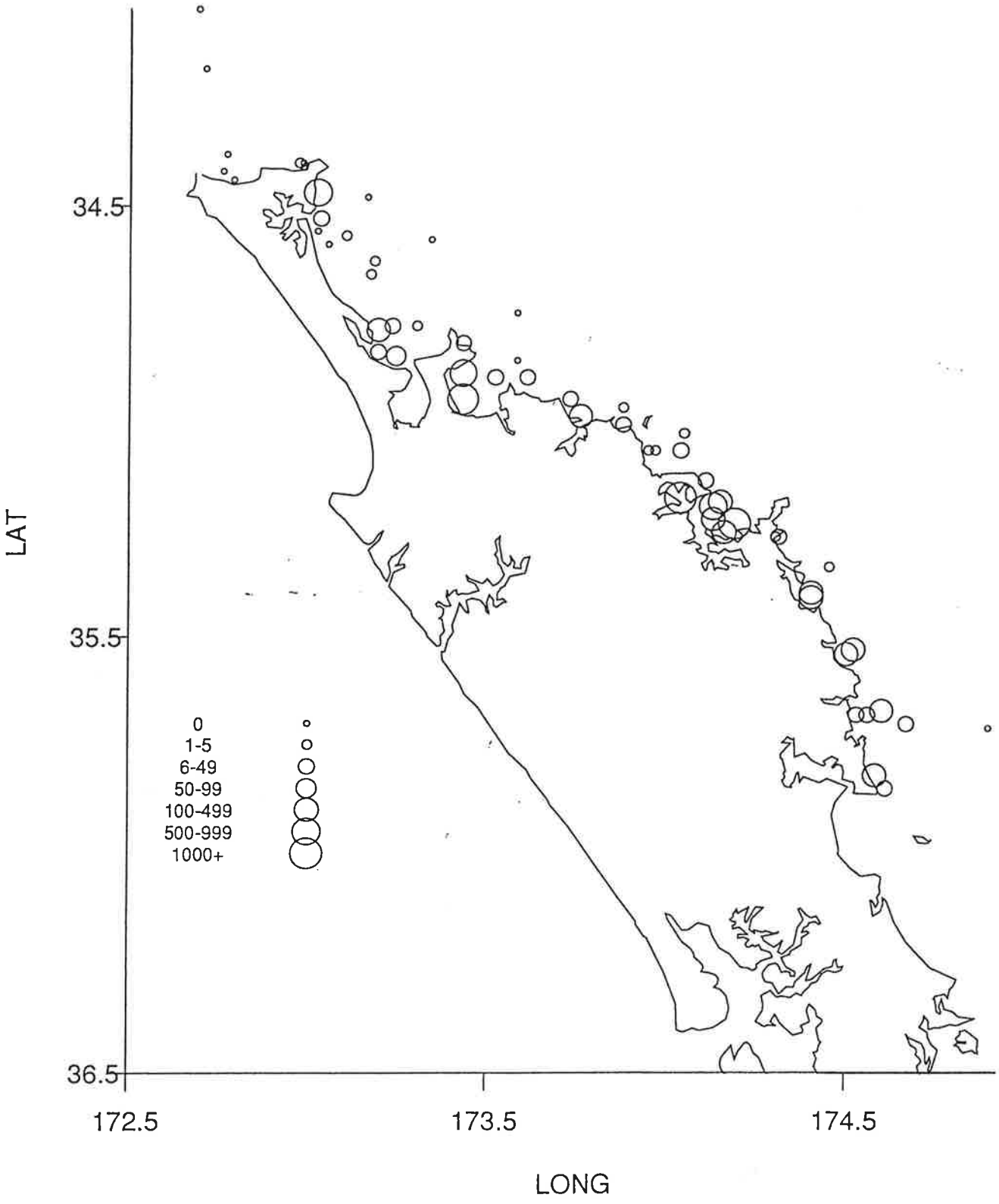


Figure 9. Distribution and relative abundance (number per n. mile) of juvenile snapper from the R.V. *Kaharoa* trawl survey of East Northland.