

TCEPR data and depth zone

Tables and plots showing the estimated swept areas for each species overlain on the depth bands (0–400 m; 400–800 m; 800–1200 m and deeper than 1200 m) are in Appendix 3 (tables are in files <species id>_footprint_stats.pdf and <species id>_footprint_stats.xls, e.g., barracouta data are in BAR_footprint_stats.pdf and BAR_footprint_stats.xls; plots are in files <species id>_fig_part<number>.pdf, e.g. BAR_fig_part1.pdf. See file README.doc for more information). Results are provided for each species for each fishing year and for the period 1989/90 to 2009/10.

Analysis of the edited records provides statistics about the distribution of bottom trawling effort relative to the physical characteristics of the EEZ. Table 7 lists the estimated areas of sea floor contacted by bottom trawling as a function of water depth. Figure 20 shows the spatial distribution of the swept area in relation to the depth zones. The swept area for all species peaked in 2002/03 but declined again to 1989/90 levels by 2009/10. The depth zone with the largest swept area is 0–400 m, representing 178 340 km² or 46% of the total swept area (Table 7). This is an underestimate of the total bottom trawling effort in this depth zone because it is also fished by smaller boats that record their catches on CELR or TCER forms (see Appendix 2).

The swept area in the 0–400 m zone started at just over 25 000 km² in 1989/90 and rose to just over 40 000 km² in 1997/98. A period of relative stability followed, before a decline back to 25 000 km² between 2002/03 and 2009/10. In the 400–800 m zone it increased from just under 18 000 km² in 1989/90 to nearly 59 000 km² in 2002/03 and then declined to 20 000 km² in 2009/10. The estimated annual swept area in the 800–1200 m depth zone nearly doubled from around 5000 km² in 1989/90 to about 9000 km² in 1998/99, but had declined to about 3000 km² by 2009/10 (Figure 21).

The group of minor stocks contributes most of the swept area in the 0–400m zone (30%), followed by BAR (16%), JMA (15%), HOK (13%) and SQU (11%) (Figure 22). The estimated swept area in the 400–800 m depth zone is 146 922 km² or 31% of the total. This depth zone is dominated by trawling for HOK (64%). The remaining fisheries in this zone comprise fairly small swept areas; HAK (8%), SBW (6%), LIN (4%), SCI (4%), minor stocks (4%), SWA (3%) and SQU (3%). The 800–1200 m depth zone has a trawl footprint of 47 272 km² or 12% of the total swept area. This depth zone is dominated by ORH (51%), followed by OEO (22%), HOK (19%) and minor stocks (4%). The depth zone deeper than 1200 m has a total swept area of 12 473 km², which is around 0.4% of the total swept area. Dominant stocks in this zone are ORH (63%), OEO (15%), HOK (8%) and minor stocks (8%).

For the most recent five-year period, fishing effort as determined by the percentage of 5 × 5 km cells contacted by trawl for all species combined, showed a steady decline from 27.2% to 22.6% for the fishable area. This decline was most pronounced in the 0–400 m depth zone where the percentage of cells contacted reduced from 51% in 2005/06 to 40.6% in 2009/10. The decline in the 400–800 m depth zone was slight, from 24.2% to 20.6%, while in the 800–1200 m and 1200–1600 m depth zones the trend was flat (Figure 23).

Figures 24 and 25 provide examples, using squid and hoki, of how the database can be used to characterise fishing grounds. The data illustrate that while hoki is fished mainly in the 400–800 m depth range, squid is trawled primarily in depths of less than 400 m.

Table 7: Estimated total area of sea floor contacted by bottom trawling for all species for the period 1989/90 to 2009/10 as a function of depth (m).

Depth Range	0-400 m	400-800 m	800-1200 m	> 1200 m
Area (km ²)	407 963	473 433	386 530	2 853 205
Swept Area (km ²)	178 340	146 922	47 272	12 473
Swept Area (%)	44	31	12	0.4

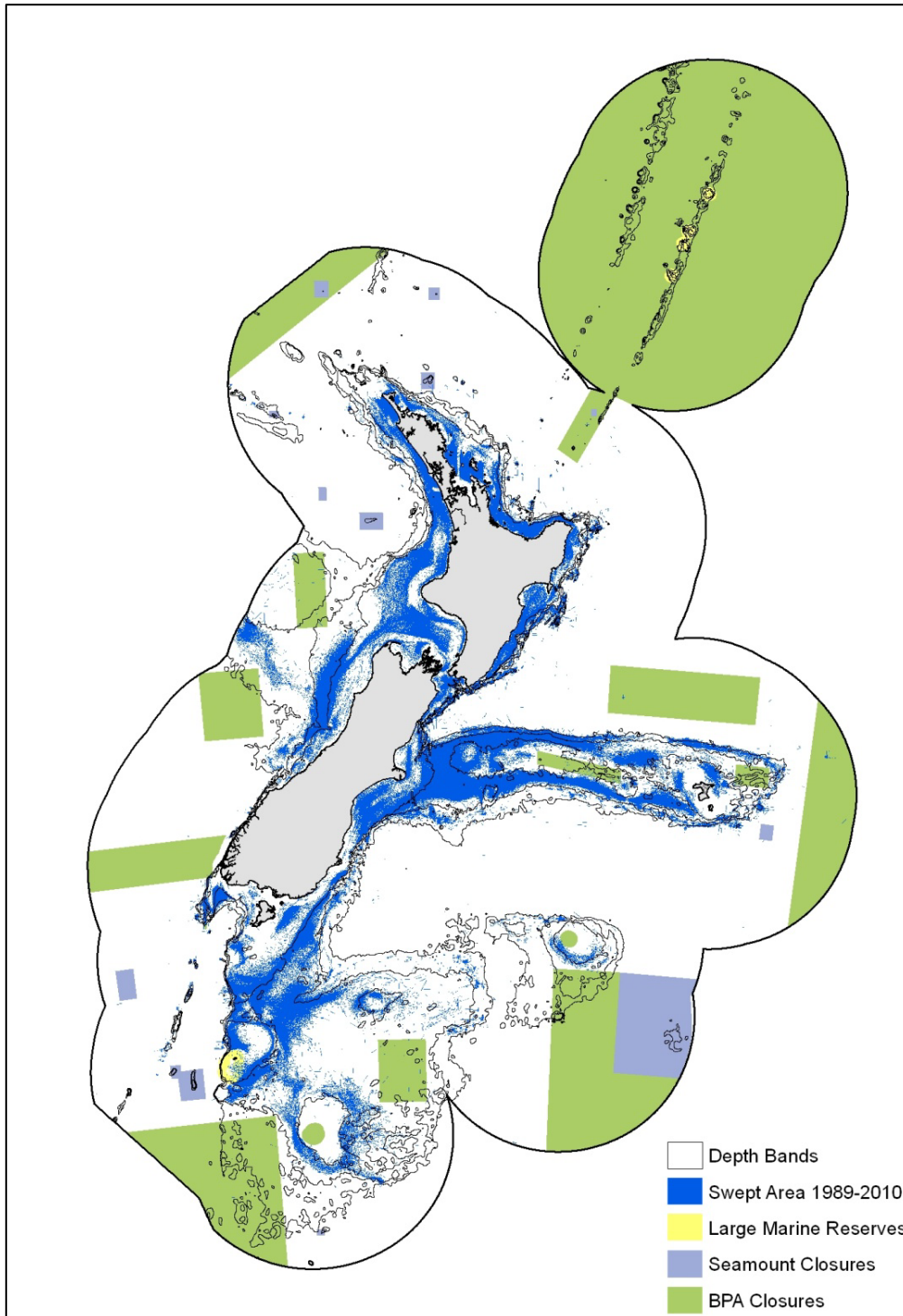


Figure 20: Total trawl footprint distributed by depth zone (200, 400, 800 and 1200 m contours are shown).

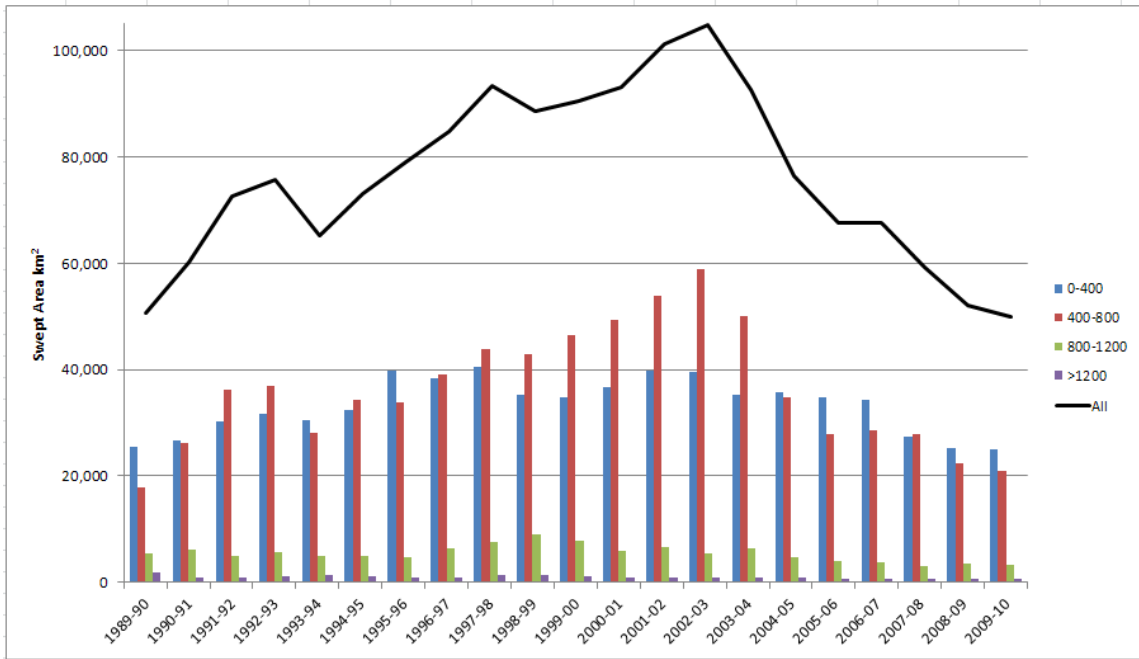


Figure 21: Swept area (km²) for all species as a function of depth zone (m) for each fishing year.

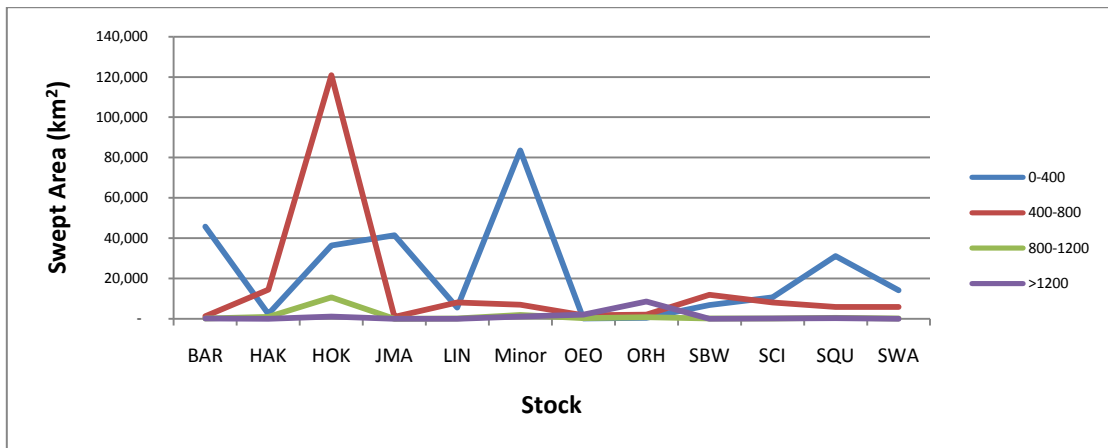


Figure 22: Swept area by species and depth zone for the period 1989/90 to 2009/10.

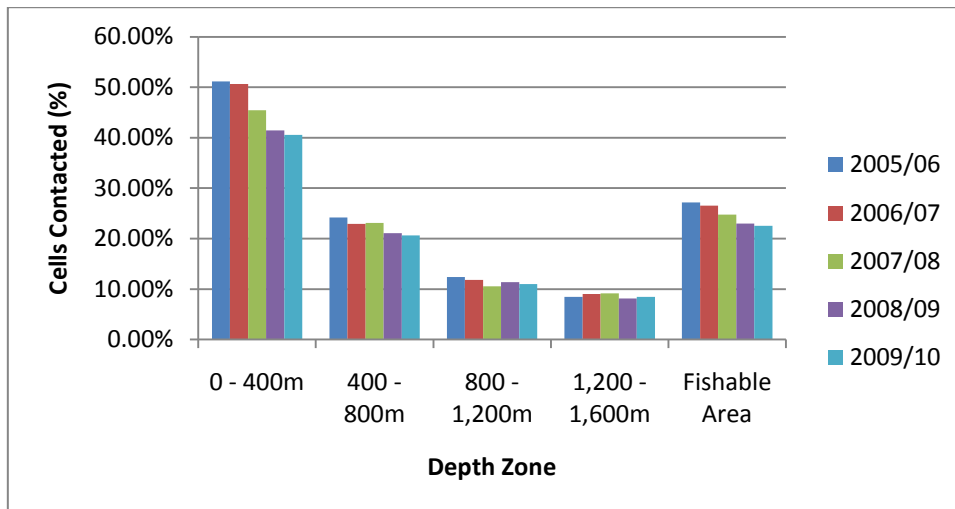


Figure 23: Percentage of cells contacted by tows during the period 2005/06 to 2009/10, for all species combined, in the fishable area and by depth zone.

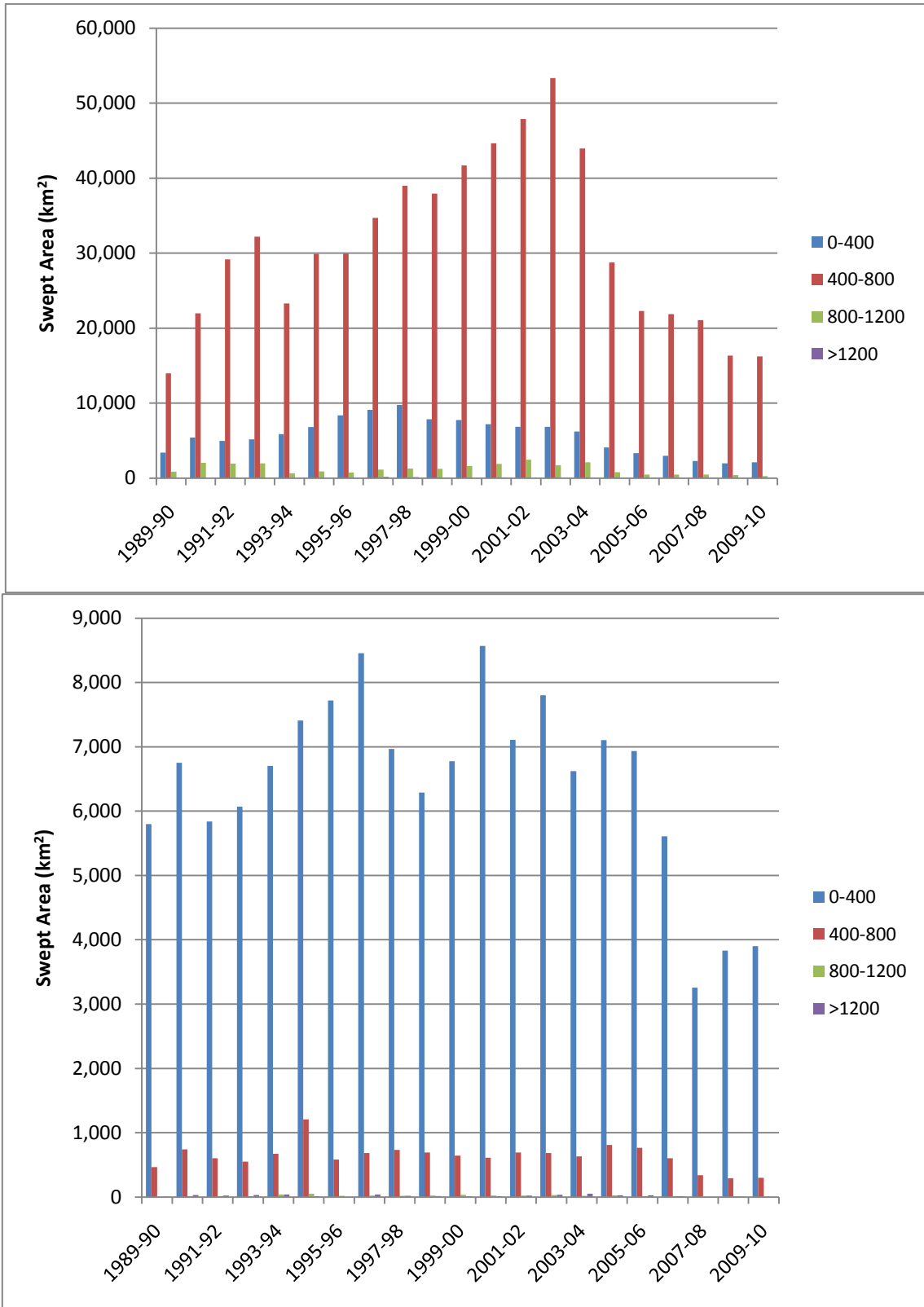


Figure 24: Swept area (km²) for bottom trawls targeting hoki (top) and squid (bottom) as a function of depth (m) for each fishing year.

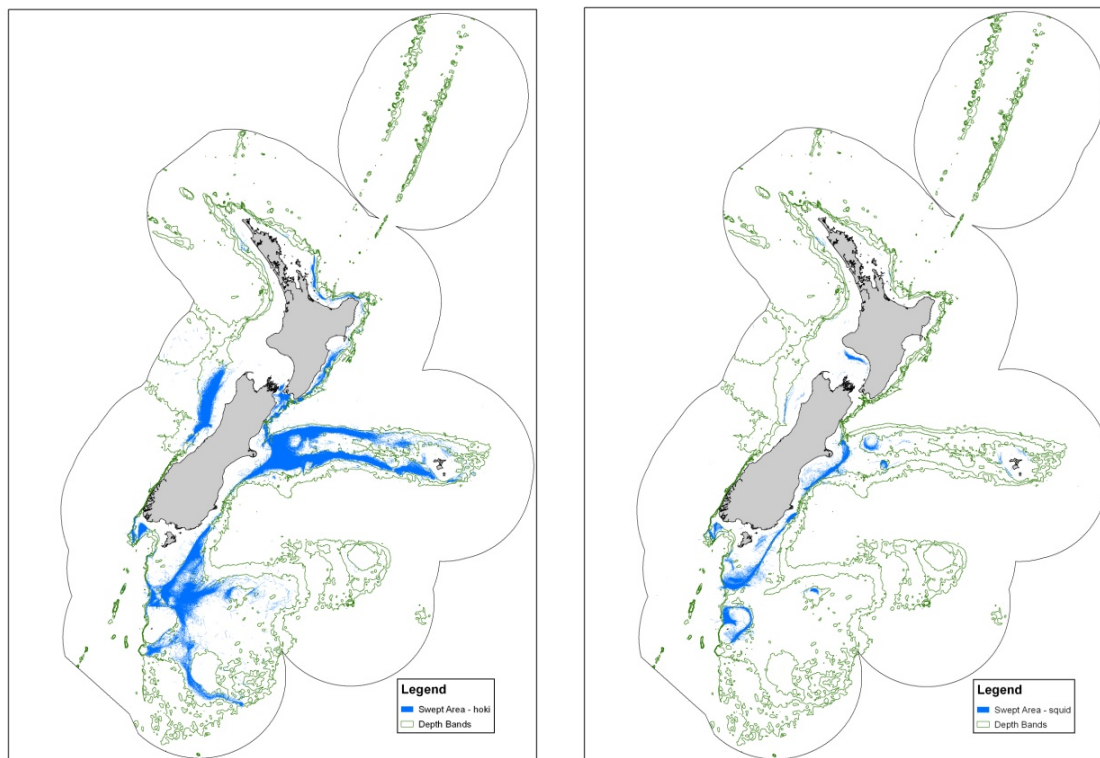


Figure 25: The swept area for bottom trawls targeting hoki (left) and squid (right), for 1989/90 to 2009/10.

TCEPR data and fishable area

Tables and plots showing the estimated swept areas for each species overlain on the fishable area are provided in Appendix 3 (tables are in files <species id>_footprint_stats.pdf and <species id>_footprint_stats.xls, e.g., barracouta data are in BAR_footprint_stats.pdf and BAR_footprint_stats.xls; plots are in files <species id>_fig_part<number>.pdf, e.g. BAR_fig_part1.pdf. See file README.doc for more information). Results are provided for each species for each fishing year and for the period 1989/90 to 2009/10.

For this analysis the fishable area is defined as that part of the TS and EEZ that is shallower than 1600 m and outside all Benthic Protection Areas (BPAs), Seamount Closure and Marine Reserve areas (Figure 26). The fishable area in the TS and EEZ is 1 408 210 km², which amounts to 34% of the total area of seabed in the TS and EEZ. An analysis of TCEPR data revealed that the estimated total area contacted by bottom trawling for all species is 385 032 km², of which 4 849 km² (1% of the total swept area) occurred in areas outside the fishable area (i.e. in BPAs, Seamount Closures and large MPAs or in depths deeper than 1600 m) (Table 8). There are some trawls inside closed areas (Table 9). These trawls may have occurred before the areas were closed, Seamount Closures were implemented in 2001, and BPAs in 2007. The total area swept within the fishable area is 380 183 km², or about 27% of the fishable area (Table 8).

Table 8: Estimated area of total sea floor contacted by trawling for all species as a function of Fishable Area, 1989/90 to 2009/10.

	Area (km ²)	Swept Area (km ²)	Swept Area (%)
EEZ and TS	4 121 131	385 032	9.34%
Fishable Area	1 408 210	380 183	27.00%

Table 9: Estimated area of total sea floor contacted by trawling for all species outside of the Fishable Area, 1989/90 to 2009/10. There is some spatial overlap between the area deeper than 1600m, the BPAs and the Seamount Closures, and between the different types of closures.

	Area (km ²)	Swept Area (km ²)	Proportion of Swept Area (%)
Outside Fishable Area	2 712 921	4 848	1.26%
Deeper than 1600m	2 490 100	3 151	0.82%
Inside BPAs	1 138 465	935	0.24%
Inside Seamount Closures	78 466	93	0.02%
Inside large MPAs	9 433	736	0.19%

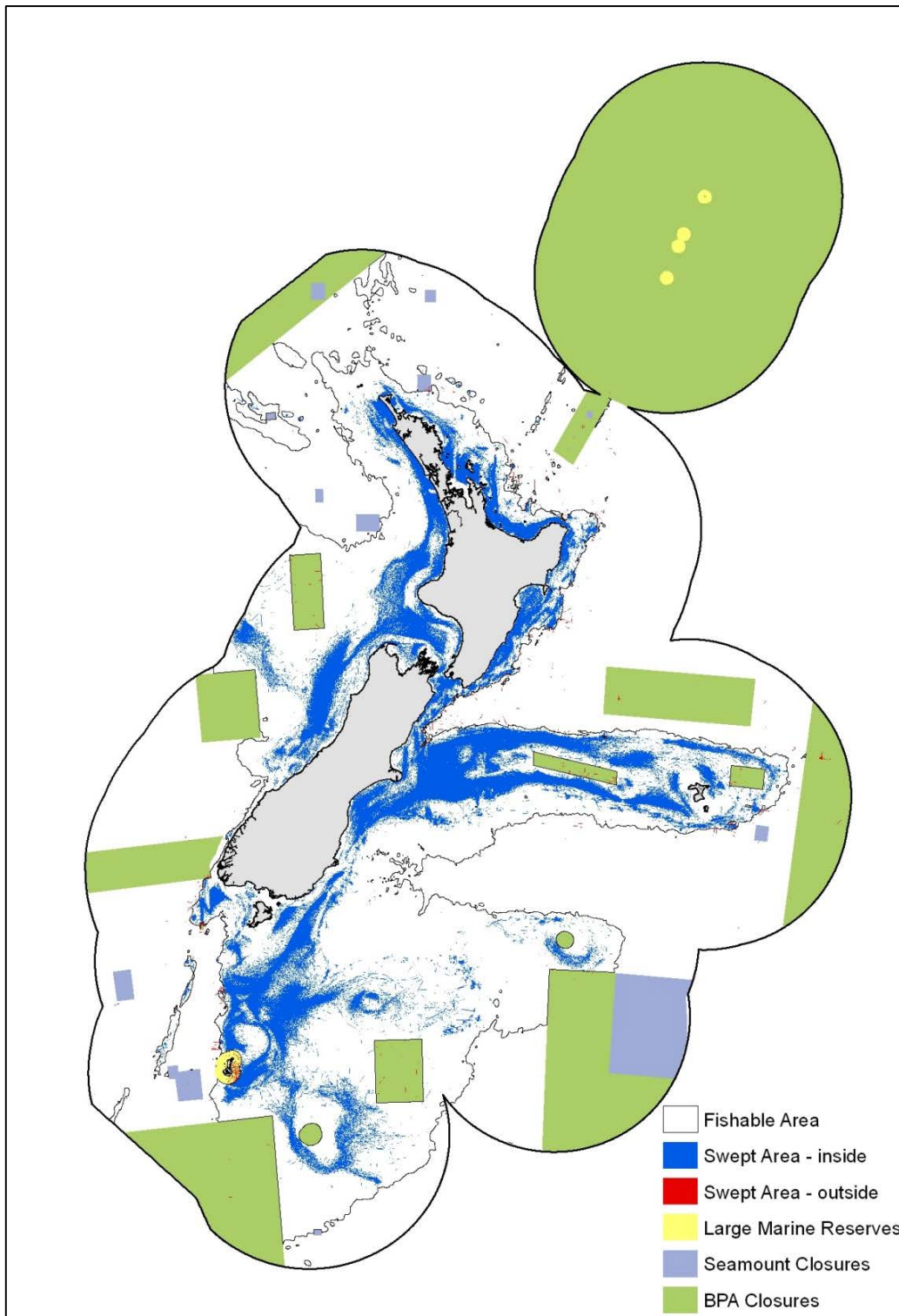


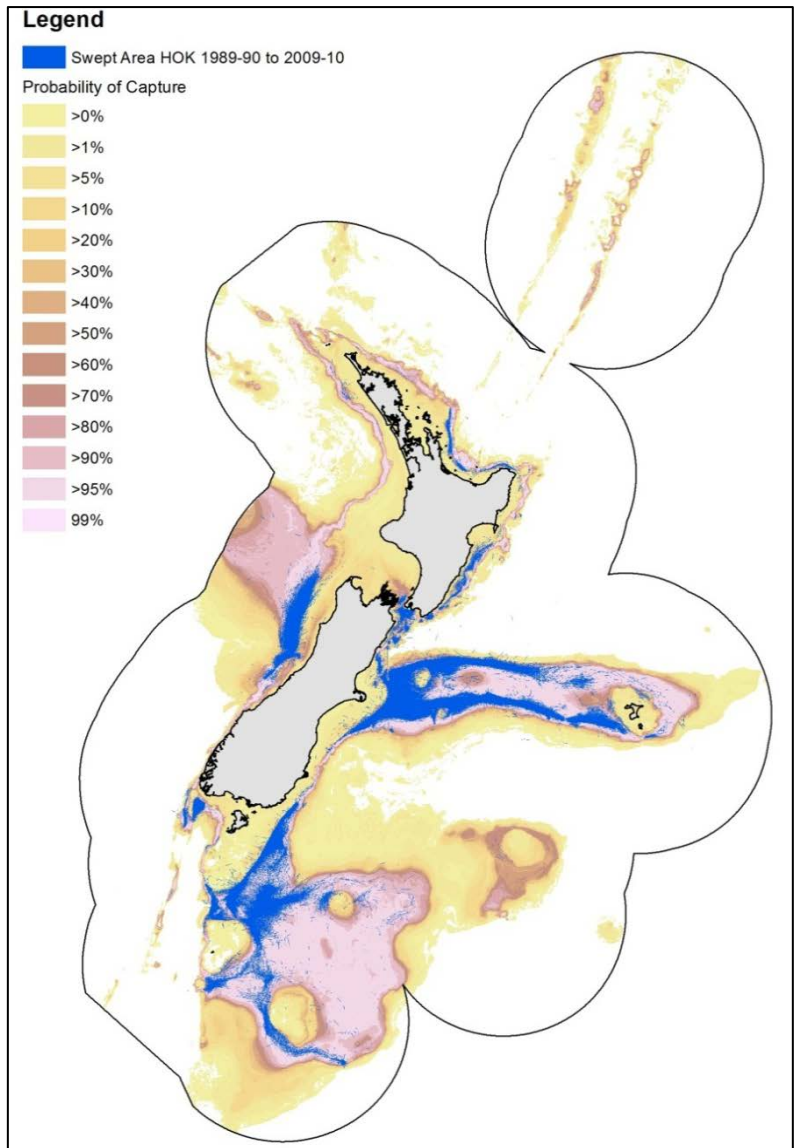
Figure 26: Trawl footprint for all species in relation to the fishable area for the period 1989/90 to 2009/10.

TCEPR data and preferred habitat

Tables and plots showing the estimated swept areas for each species overlain on the preferred habitat, represented by the probability of capture, are provided in Appendix 3 (tables are in files <species id>_footprint_stats.pdf and <species id>_footprint_stats.xls, e.g., barracouta data are in BAR_footprint_stats.pdf and BAR_footprint_stats.xls; plots are in files <species

id>_fig_part<number>.pdf, e.g. BAR_fig_part1.pdf. See file README.doc for more information). Results are provided for each species for each fishing year and for the period 1989/90 to 2009/10.

TCEPR data were used to map fishing effort for key target species against preferred habitat. An example is shown in Figure 27 for hoki, which illustrates that the swept area for the period 1989/90 to 2009/10 comprises a little over 10% of the total preferred habitat (i.e. in the over 0% probability of capture area). As the hoki fishing grounds occur in fairly well-established, discrete areas within the preferred habitat range there is only a gradual increase in the percentage of the habitat range swept, from 10% to 32%, between the over 0% and over 95% probability of capture areas, but then a steep escalation to 71% in the 99% probability of capture area. Figure 28 shows how the percentage swept area in the habitat range for hoki, by probability of capture areas, varies as a function of year, and how the total swept area for hoki varies by the probability of capture areas.



	Area (km ²)	Swept Area (km ²)	Swept Area (%)
EEZ and TS	4 121 131	168 975	4.10%
Probability of Capture >0%	1 667 848	168 603	10.11%
Probability of Capture >1%	1 336 861	167 988	12.57%
Probability of Capture >5%	1 045 235	165 715	15.85%
Probability of Capture >10%	933 803	162 820	17.44%
Probability of Capture >20%	798 645	158 988	19.91%
Probability of Capture >30%	739 548	156 359	21.14%
Probability of Capture >40%	697 444	153 870	22.06%
Probability of Capture >50%	663 634	151 231	22.79%
Probability of Capture >60%	630 881	148 437	23.53%
Probability of Capture >70%	595 105	145 693	24.48%
Probability of Capture >80%	556 199	141 886	25.51%
Probability of Capture >90%	492 106	135 315	27.50%
Probability of Capture >95%	353 805	114 477	32.36%
Probability of Capture 99%	6 504	4 632	71.22%

Figure 27: The trawl footprint of tows targeting hoki in 1989/90 to 2009/10 overlain on the probability of capture zones (top). Statistics for the range of probability of capture areas and swept areas within the preferred habitat for hoki (bottom).

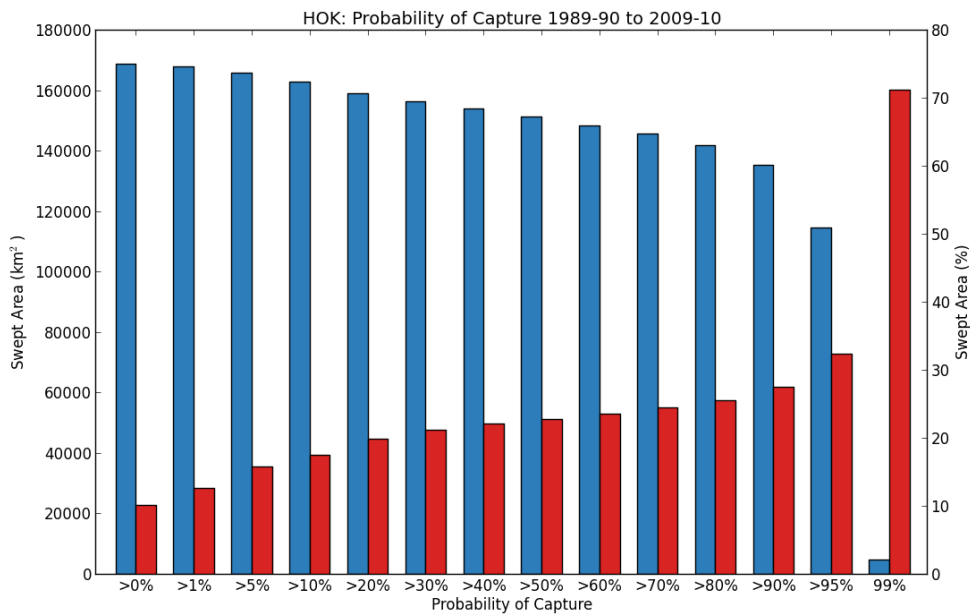
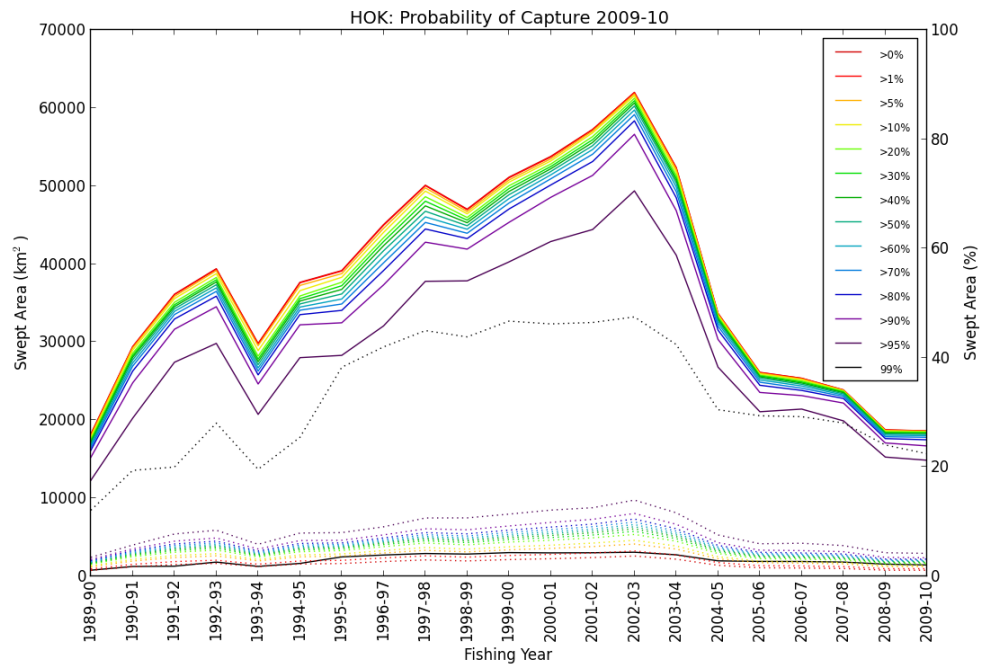


Figure 28: Swept area in square kilometres (solid) and as a percentage (dashed) for hoki for each probability of capture area per year (top); and for all years (bottom) showing the swept area in square kilometres (blue) and as a percentage (red).