



Australian Government
Department of Agriculture
ABARES

Spatial analysis of Australian and New Zealand historical bottom trawl fishing effort in the SPRFMO Area



SC-01-20

Andrew Penney

October 2013



SPRFMO Bottom Fishing Effort Mapping

- The original motivation for mapping bottom fishing effort was to provide some way of defining ‘currently fished’ areas so that fishing could be limited to within such areas under the SPRFMO interim measures.
- Science working group subsequently recommended that bottom fishing effort maps *“be expressed as grid blocks of 20 minute resolution, with a ‘fished’ block being defined as any grid block partially crossed by at least one trawl track. The period 2002 to 2006 is to be used as the reference period for developing this joint trawl footprint map.”* (SWG4 2007)
- The mapping resolution of 20-minute blocks has been criticised in an international scientific review of implementation of UNGA Resolution 61/105 as including substantial unfished areas within maps of supposedly fished areas (Weaver et al. 2011).
- The choice of reference period of 2002–2006 has also been questioned by fishing industry representatives, as not representing the full history of the fishery.

The purpose of this analysis is therefore to provide further scientific advice on the effect on fishing footprint maps and fished area estimates of using different mapping resolutions and time periods.



Bottom Fishing Impact Assessment Standard

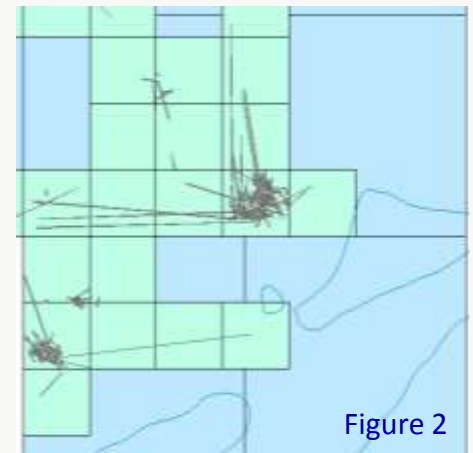
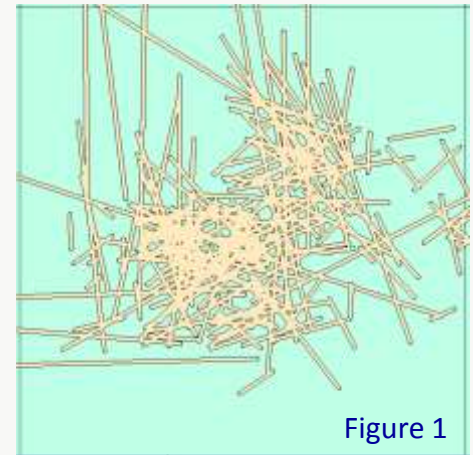
The question of resolution of fishing effort maps was therefore further addressed by the scientific working group during development of the *SPRFMO Bottom Fishing Impact Assessment Standard*, which was adopted at the 3rd session of the Preparatory Conference (SPRFMO 2012) and requires that:

- *Participants are to provide bottom fishing effort distribution maps of areas that will be fished and areas that have been fished throughout the history of the fishery.*
- *These maps will be prepared at 0.1 degree (6 minute) grid resolution, noting SPRFMO confidentiality provisions.*
- *Areas below fishable depth (currently about 1500m depth for bottom trawl fishing in the SPRFMO Area) should be excluded in maps of fishing effort distribution.*
- *Maps of the fishing effort distribution should also be prepared for different periods of years, so that the SWG can evaluate the cumulative duration of fishing impacts in various areas, and also the recovery time for areas fished in the past.*

Data Filtering and Preparation

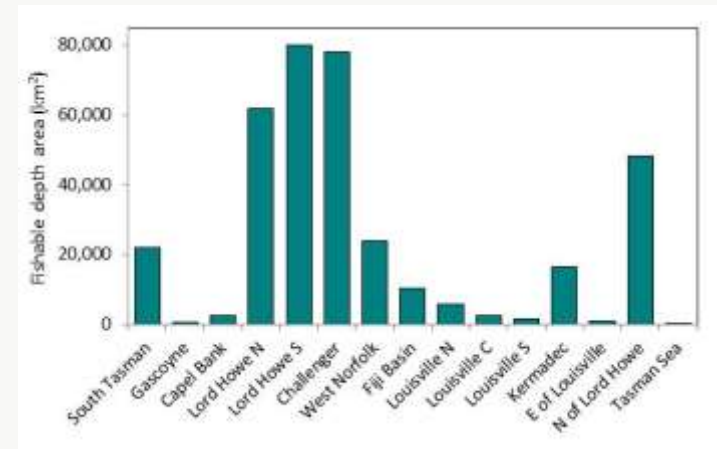
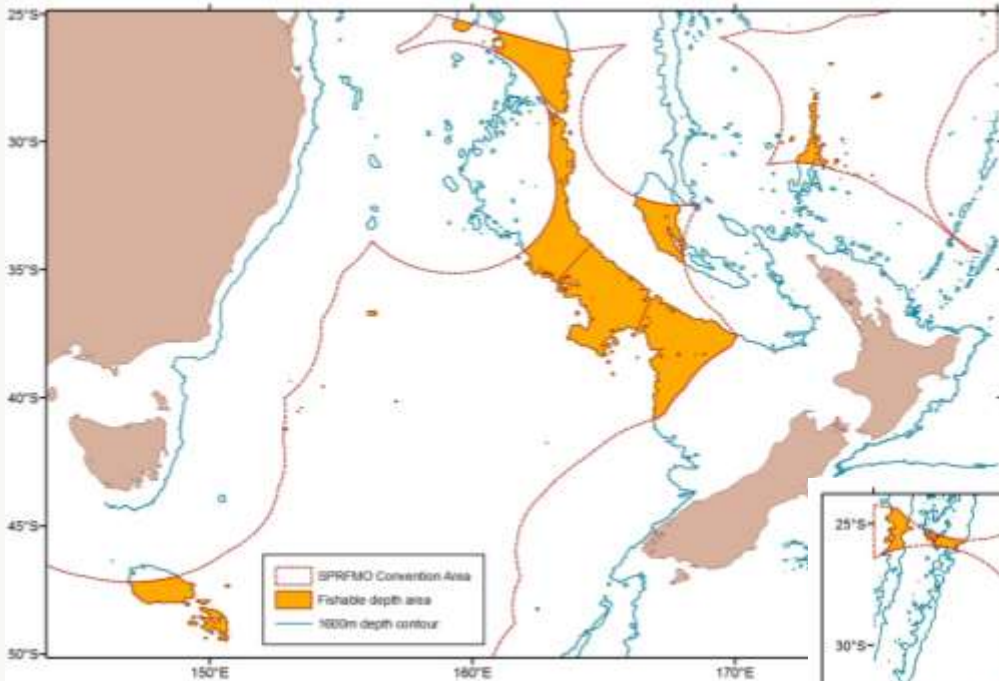
Bottom fishing effort data over the period 1990–2006 were extracted from the AFMA fishing logbook and NZ MPI CELR databases. Trawl data were filtered and prepared using the methods described in Penney (2011):

- Trawl tows with the same start and end positions or missing end position were allocated an end position by adding 0.001 deg to the start latitude and longitude.
- All tow start and end points were jittered by addition of a random offset of ± 0.5 minutes to compensate for rounding of reported positions.
- All tows longer than 40km were excluded and remaining tows were truncated to the 1600m depth contour.
- Actual seabed swept areas were estimated by generating a 50m buffer either side of each trawl tow (100m swept width), merging these and calculating the merged area (Figure 1).
- Footprint maps were generated for 5-year periods by generating 20-minute and 6-minute blocks touched by any tows over the periods concerned (Figure 2).
- Areas of the resulting 20-minute and 6-minute block footprints were calculated. Areas excluding blocks containing only 1 tow were also calculated.

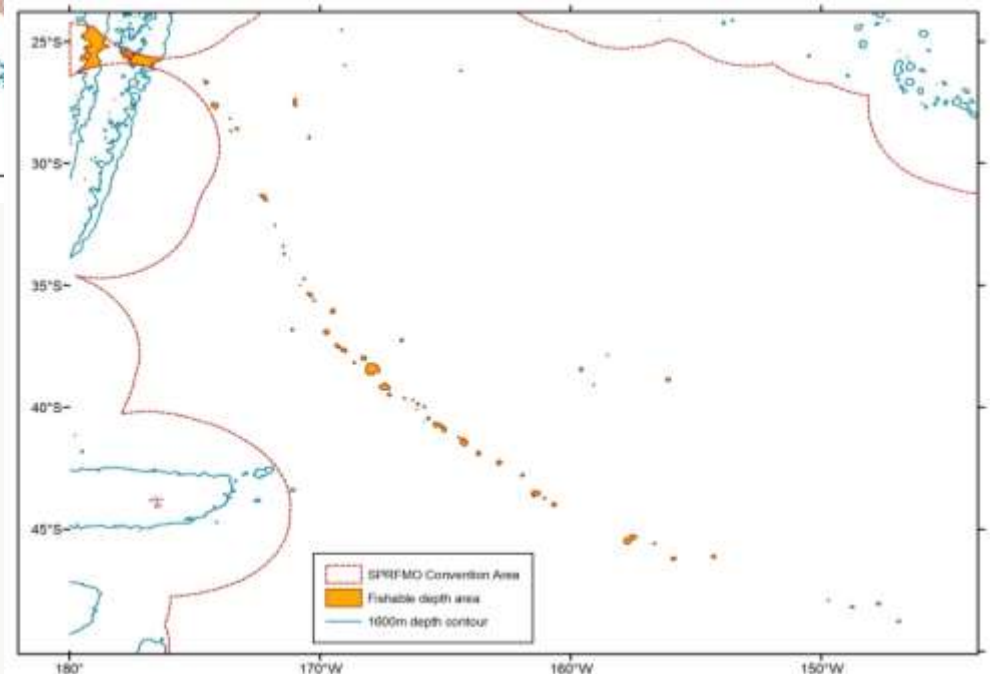




Western SPRFMO Convention Area Fishable Depth Areas by Fishing Area



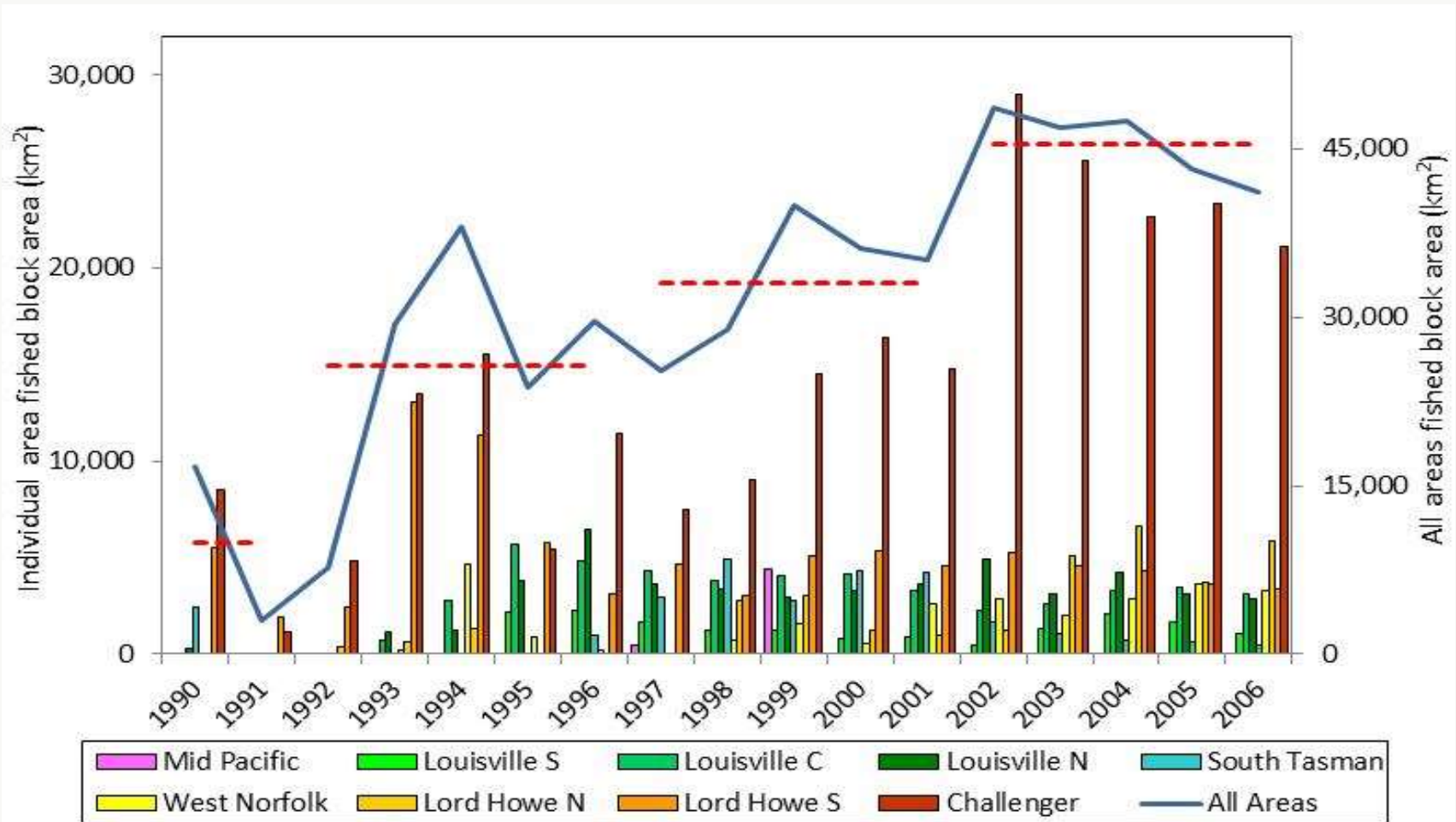
The 1600m depth contour was used to define the limits of fishable depth area, which was calculated for all fishing areas in the western SPRFMO Area. There are substantial differences east and west of New Zealand, with large fishable depth plateau areas in the Tasman Sea region and isolated seamounts with little fishable depth in the Louisville Ridge region.





Areas Fished per Fishing Area and Year

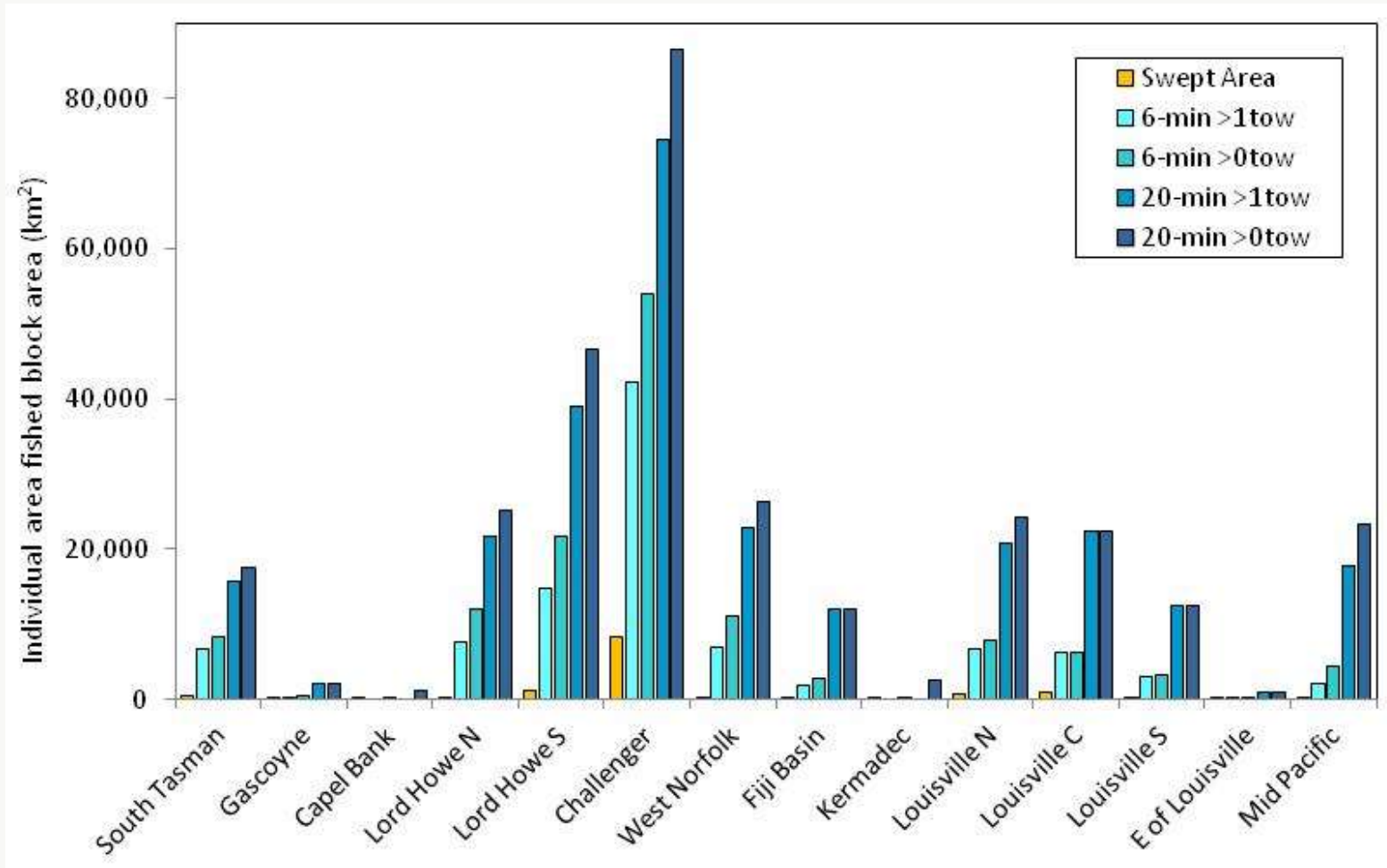
6-Minute Blocks with > 0 tows: 1990 - 2006



Planar area of fished 6-minute blocks (any block with > 0 tows) by year and fishing area (columns, left hand axis) and total planar area of all fished 6-minute blocks in all areas (line, right-hand axis). Dashed lines show the average annual planar area of fished 6-minute blocks over 5-year historical time periods, back from the interim SPRFMO bottom fishing reference period of 2002-2006.



Effect of Spatial Resolution on Fished Area By Fishing Area: 1990-2006

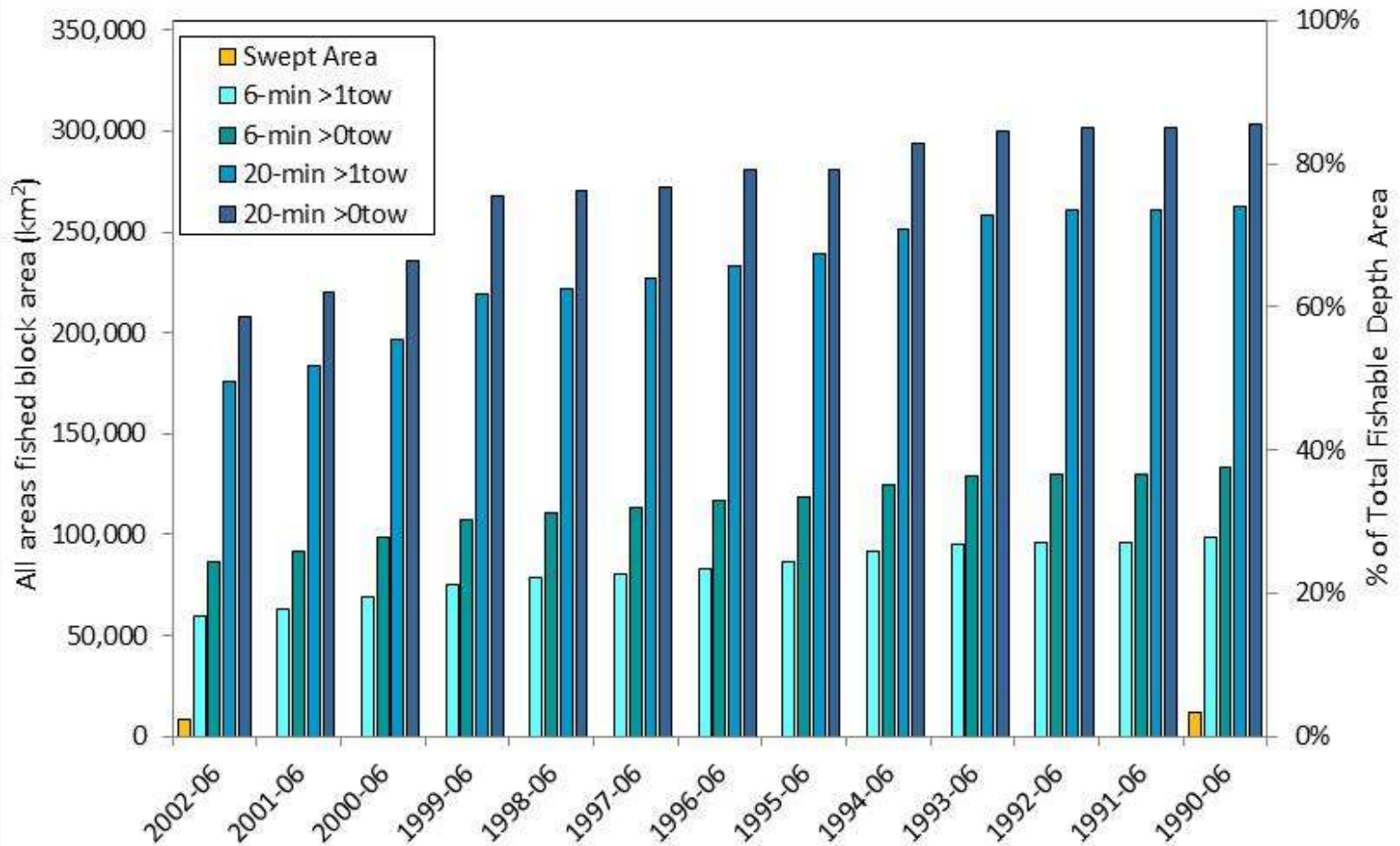


Total planar areas fished (km²) by fishing area over the entire period 1990 – 2006 at different spatial mapping resolutions. Mapping resolutions used are estimated swept area, 6-minute blocks with either more than one or more than zero tows and 20-minute blocks with either more than one or more than zero tows.



Total Area Fished per Time Period

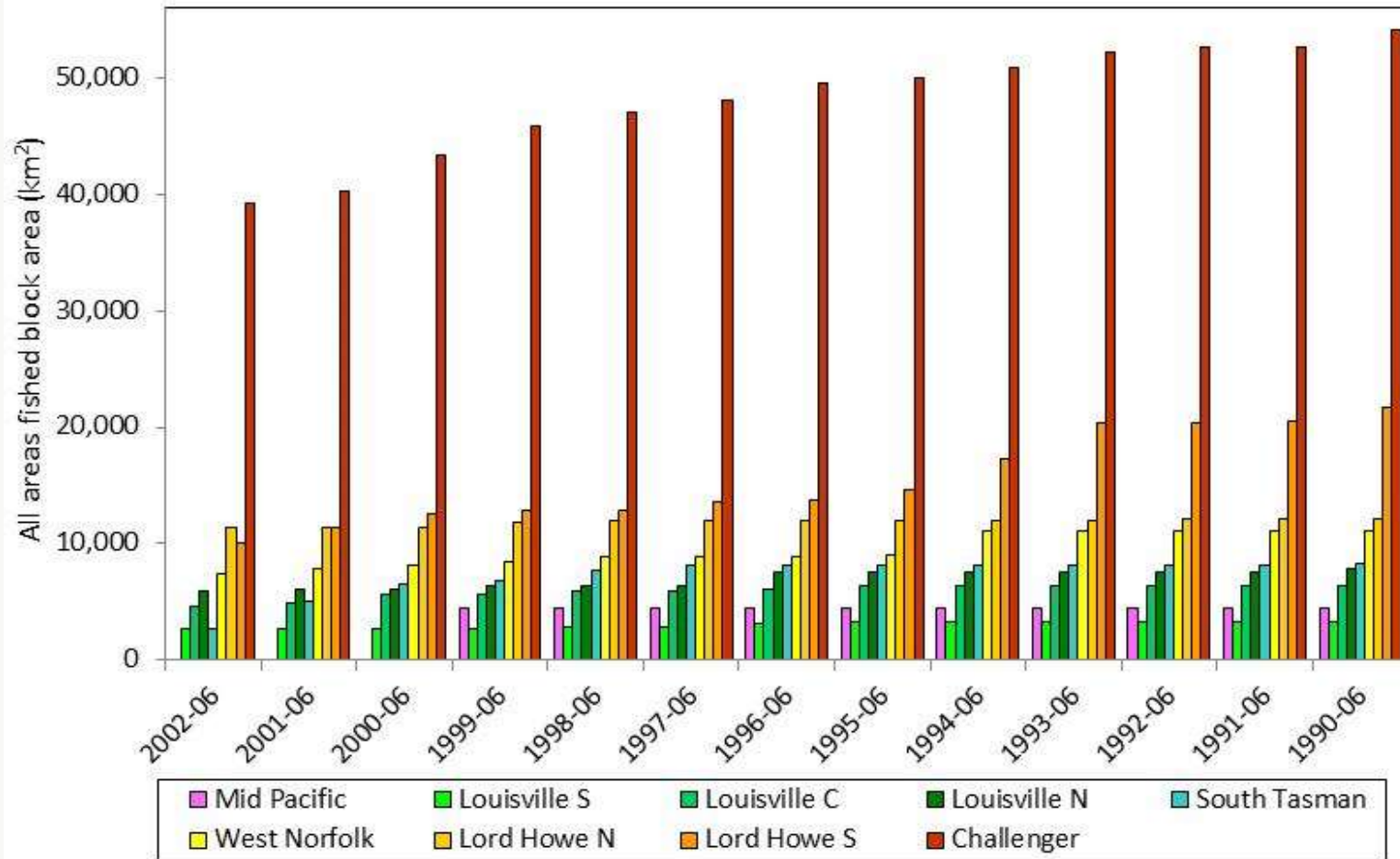
Alternative resolutions: 2002-2006 to 1990-2006



Total planar fished area (km²) in the western SPRFMO Area calculated using various spatial mapping resolutions (ranging from estimated swept area to 20-minute blocks with >0 tows) over progressively longer historical time periods from 2002 – 2006 to 1990 – 2006. (Swept area was only calculated for 2002-2006 and 1990-2006 due to computational time.)



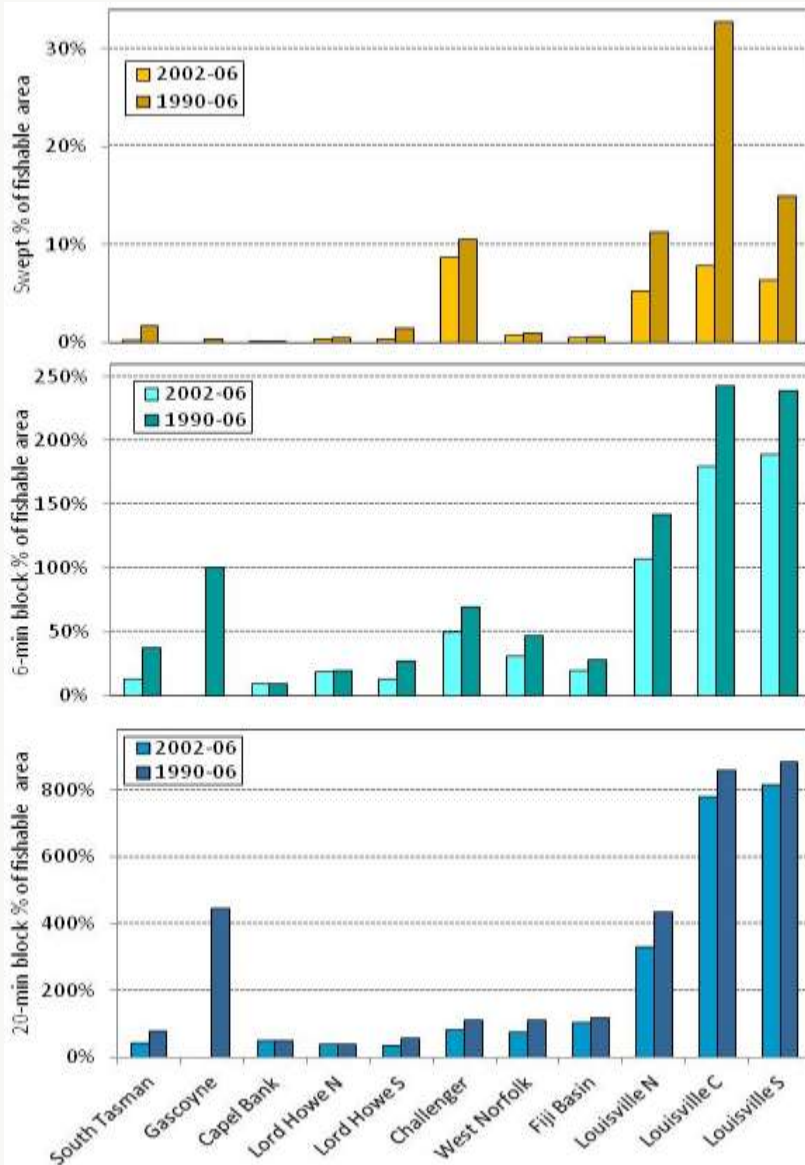
Areas Fished by Fishing Area and Time Period 6-minute blocks > 0 tows: 2002-2006 to 1990-2006



Total planar fished area (km²) of fished 6-minute blocks with >0 tows by fishing area over progressively longer historical time periods from 2002 – 2006 to 1990 – 2006.



Effect of Time Period and Resolution on Area Fished By Fishing Area: 2002-2006 & 1990-2006



Swept Area: Less than 10% of available fishable depth area in all areas was actually swept over 2002-2006. Swept area increases to >10% of fishable depth area for the Challenger, Louisville North and Louisville South areas, and to above 30% for the Louisville Central Area, over the full period 1990-2006.

6-Minute Blocks: Use of 6-minute blocks >0 tows increases estimates of “fished” area to around 50% of fishable depth area for the Challenger area, 100% on the Gascoyne Seamount and to between 100% and 250% for the Louisville Ridge area.

20-Minute Blocks: Use of 20-minute blocks >0 tows increases the estimates of “fished” area to around 100% of fishable depth area on the Challenger, West Norfolk and Fiji Basin areas, over 400% of the Gascoyne Seamount and between 400% and 800% on the Louisville Ridge.

Use of coarser mapping resolution results in increasing unfished areas being included in effort maps:

Spatial resolution	Unfished area included
Swept area	0%
6-minute blocks >1 tow	87%
6-minute blocks all tows	91%
20-minute blocks >1 tow	95%
20-minute blocks all tows	96%

Key Conclusions

- Alternative time periods and mapping resolutions both have a substantial effect on effort maps and fished area estimates for bottom trawl fisheries in the western SPRFMO Convention Area.
 - Use of longer historical reference periods extending back in time from the current SPRFMO reference period of 2002–2006 results in a fairly steady increase in estimates of ‘fished area’.
 - Compared to 2002–2006, extending the analysis back in time using 6-minute blocks adds about 5% to the estimated ‘fished area’ with each additional year, with the 1990–2006 estimated fished area being about 60% larger than over 2002–2006.
 - Extending the analysis back in time using 20-minute blocks adds about 4% to the estimated ‘fished area’ with each additional year, with the 1990–2006 estimated fished area being about 48% larger than over 2002–2006.
 - Estimates of ‘fished area’ generated using any mapping resolution other than actual trawl tracks substantially exaggerate the areas within the footprints that have actually been impacted.
 - The actual impacted areas are small compared to the footprint maps, with 86% to 91% of a footprint mapped using 6-minute blocks being unfished, and 95% to 96% of a footprint mapped using 20-minute blocks being unfished.
-



Key Conclusions

- Global predictive habitat modelling studies predict that there would be a high probability of occurrence of vulnerable scleractinian corals (Davies & Guinotte 2011) and octocorals (Yesson et al. 2012) in unfished areas within 'fished footprint' areas mapped at coarse resolutions.
 - There are expectations under UNGA 61/105 and 64/72 that vulnerable marine ecosystems (VMEs) occurring within 'previously fished' areas will be protected from significant adverse impacts. Other approaches are therefore required to protect these VMEs, irrespective of whether they occur within or outside 'previously fished areas'.
 - The SWG has previously noted that effective protection of benthic VMEs in the Pacific Ocean high seas will probably require the establishment of spatial closures designed to protect adequate and representative areas of vulnerable habitats and ecosystems (SWG4 2007).
-



Australian Government
Department of Agriculture
ABARES

Questions?



Andrew Penney

October 2013