

Table 2: The ecological issues discussed in the text for the demersal hake fishery, and corresponding indicators and research approaches that may be useful in addressing each issue. Issues are those in the category 'Ecological Well-being', identified and prioritised (see methods) by stakeholders attending the Pelagic Fishery Risk Assessment for Sustainable Fishery (see Nel 2005a). Research approaches or monitoring studies currently underway are given, and those proposed for the future are also indicated. For each issue, technical management measures are proposed and, where possible and applicable, ways in which their performance could be evaluated, and South Africa's ability to manage each issue is rated using asterisks

Issues	Indicators	Research approaches and proposed studies	Technical management measures and evaluation	Implementation ¹
Extreme risk category				
Removal of large <i>M. capensis</i> by fishing (larger females targeted in longline and trawl fishery are likely to produce more eggs than smaller females, and the eggs are probably more viable) (SINGLE SPECIES)	Relative abundance of large females in the hake population; length distributions and abundances (disaggregated by sex and fishing fleet); size structure/size spectra	Continue current observer programme to collect data on species ratio and size structure of the hake catch on trawlers and longliners. Sex-specific length data available for longliners Future: develop length/sex/fecundity keys for demersal trawl catch to decompose catch-length data into catch per species per sex; update hake fecundity study; regularly assess variation in length at maturity; develop sex-disaggregated and age-based population models to determine limits and performance measures to gauge success of management strategies; up-date assessment of the effects of fishing in terms of altered size structure in hake; extend minimum realistic models	Limit the removal of large, fecund females to enhance potential recruitment; consider time/area closures to protect spawning <i>M. capensis</i> (establish open ocean MPAs)	*
High risk category				
Threatened, protected species of seabirds caught/injured/killed by trawling and longlining (and sometimes caught for human consumption using handlines) (ECOSYSTEM)	Recorded mortality of seabirds in trawl and longline fisheries	<u>Longline</u> : determine most effective tori line design and weighting regime; implement adequate observer programme in place <u>Trawl</u> : quantify and monitor seabird mortality and devise most effective or appropriate bird mitigation devices for trawl	Longline fishery permits already require mitigation measures (observers, line weighting, tori lines, offal discharge control, dead birds to be landed, time restrictions for line setting); compliance to be improved. Test and put in place mitigation measures for trawl fishery (offal management, Brady baffle being tested, tori lines). Consider seabird mortality when determining proportion of TAC allocated to longline and trawl; improve compliance with mitigation measures	**
Bycatch of linefish (e.g. silver and dusky kob) protected in MLRA on soft ground available to the inshore trawling and operating in nursery grounds of linefish; bycatch of linefish on hard ground; bycatch of wreckfish in waters deeper than 200m (ECOSYSTEM)	Stock status of linefish species (cpue in trawl and in linefishery); linefish catch (trawl and total for all fisheries); market availability of juvenile linefish; spatial overlap of trawls and linefish distribution	Improve coverage of current observer programme; include bycatch declarations in commercial catch records; further investigate mitigation measures Future: improve linefish assessments (poor assessments at present due to uncertainties and lack of data and effort monitoring); use data on spatial overlap between trawl and linefish distribution to site effective time/area closures	Some measures are already in place (most bays on the South-East Coast closed to trawling; move-on rule for kob catches; bycatch limit for kob), but further measures need to be implemented. These could include setting a per trip linefish bycatch, time/area closures, and use of escape panels or selector grids	**

Table 2: cont.

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Physical impact of trawls on the benthic biota and habitat (ECOSYSTEM)	Species composition and diversity in MPAs compared with trawled areas	Incorporate available data collated for the Marine Stewardship Council certification process into a GIS Future: identify areas which have not been extensively damaged or allowed to recover, to create MPAs for use as reference sites – identify areas suitable for MPAs representative of offshore benthic habitats; map habitat type data and systematic benthic distributions; comparative studies of areas subjected to range of trawling pressure	Eliminate use of certain destructive gear (e.g. types of bobbins and trawl doors); aim for WSSD target of protecting 20% of representative habitat (also offshore); currently no offshore trawling grounds formally protected	***
Moderate risk category				
Trophic effects of removing hake (removal of a high level predator with no obvious replacement species; effects on abundance of hake prey; smaller pelagic species and mesopelagics) (ECOSYSTEM)	Size structure of hake in research surveys; diet composition of both hake species (pelagic prey and proportion of small <i>M. paradoxus</i> eaten by large <i>M. capensis</i>); abundance estimates of small pelagics and mesopelagics; trophic level of the catch and in the community	Continue to collect catch-at-size data; expand collection of catch-at-size data to more species; continue to monitor biomass of hakes and their prey (swept-area demersal surveys, acoustic pelagic surveys); trophic models of the role of hake in the ecosystem; investigate prey switching (data analyses and modelling). Future: collection of species-specific catch data; detailed, updated hake diet study; explore effects of fishing on large hake on inter-species predation, which may alter hake stock size and distribution; quantify hake in the diet of marine mammals and other top predators (seals, swordfish – possible, snoek)	A basis for species-specific management that does not require species-specific catch limits has been proposed, but needs further exploration; consider ways to achieve size-specific annual catches through, for example, implementation of zone and/or depth specific catch limits; discourage/prevent filling the quota with catches of small hake at times when larger fish are less available; consider trade-offs between pelagic/mesopelagic fisheries and hake fisheries depending on sufficient prey available for hake	*

¹ Ease of implementation of management response/ability to manage

* Limited

** Fair

*** Good potential