Albacore tuna fisheries and megafauna bycatch: comparing driftnets and pair trawling using Productivity Susceptibility Analysis

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Introduction

Ecological Risk Assessment for the Effects of Fishing (ERAEF) is a hierarchical, precautionary approach used to assess ecological risk in an Ecosystem-based Fishery Management (EBFM) context (Hobday *et al.* 2011). It has been applied to many fisheries including those in Australia, where the process was developed, and is also applied as part of the certification process of the Marine Stewardship Council. The process has 3 key stages: scoping; scale intensity consequence analysis (SICA) and productivity susceptibility analysis (PSA). PSA, from a species perspective, scores each unit of analysis in terms of its intrinsic productivity and susceptibility to fishing. Whilst PSA has been widely applied to fish species its application to bycatch species, such as cetaceans, has been limited. Here we apply a generic PSA, as detailed below, to two fisheries, known, through observer programmes, to differ in degree of cetacean bycatch, to assess the utility of PSA in terms of assessing cetacean bycatch. We aim to further refine the PSA approach, by incorporating bycatch rates, to facilitate rapid screening of cetaceans, alongside fish bycatch, in the ERAEF process.

Aims

- Apply PSA to Albacore driftnet fisheries and pair trawl fisheries
- Combine PSA results and bycatch rates to produce a "likelihood risk score" for cetacean species exposed to each fishery

Method

- Species caught during onboard observer programmes were included in the PSA
- Data were taken from peer reviewed and grey literature of observer programmes from Irish, UK and French Albacore boats from the NE Atlantic
- Productivity attributes (Table 1) and susceptibility attributes (Table 2) were scored using a default set of scores developed for Australian fisheries (Hobday *et al.* 2007)
- Productivity and susceptibility scores plotted on axis and Euclidean distance used as the PSA risk score
- PSA risk score for each species multiplied by the bycatch rate, determined in the observer programme, as a measure of the likelihood of being caught – the "likelihood risk score"
- The scores for each species were compared between the two fisheries

NB. These are generic tables designed for rapid screening of all species potentially at risk from fishing including fish, mammals, birds and reptiles. Attribute tables specific for cetaceans are being developed as part of this project

Table 1. Productivity cut-off scores for species attributes taken from Hobday *et al* (2007). Productivity determined from the mean of these scores.

Attribute	High Risk (Score 3)	Medium Risk (Score 2)	Low risk (Score 1)
Average age at maturity	>15 years	5-15 years	<5 years
Average size at maturity	>200cm	40-200 cm	<40 cm
Average maximum age	>25 years	10-25 years	<10 years
Average maximum size	>300cm	100-300cm	<100cm
Fecundity	<100 egg/year	100-20,000 egg/year	>20,000 egg/year
Reproductive strategy	Live bearer/bird	Demersal egg layer	Broadcast spawner
Trophic level	>3.25	2.75-3.25	<2.75

Table 2. Susceptibility attributes taken from Hobday *et al* (2007). Susceptibility is determined from the product of these scores and is gear type specific.

Attribute	
Availability	Overlap of fishing effort with species distribution
Encounterability	Likelihood that species will encounter fishing gear
Selectivity	Potential of gear to capture and retain species
Post capture mortality	Condition and survival of species that are captured then released

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References

Hobday *et al* (2011) Ecological Risk Assessment for the Effects of Fishing. *Fisheries Research* 108, 372-384

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Results

Data recorded by onboard observers indicated that, in addition to albacore, 50 species were caught by gillnets and 13 species were caught by pair trawling. In the case of driftnets the additional species included fish, seabirds, turtles and 10 cetacean species. In pair trawling additional species caught included 2 cetacean species (common dolphin *Delphinus delphinus* and bottlenose dolphin *Tursiops truncatus*) and 11 fish species. Common dolphin and bottlenose dolphin occurred as bycatch in both fisheries and were scored as being at high risk from both fisheries (Figure 1 and Figure 2).

Figure 1: Gillnet PSA

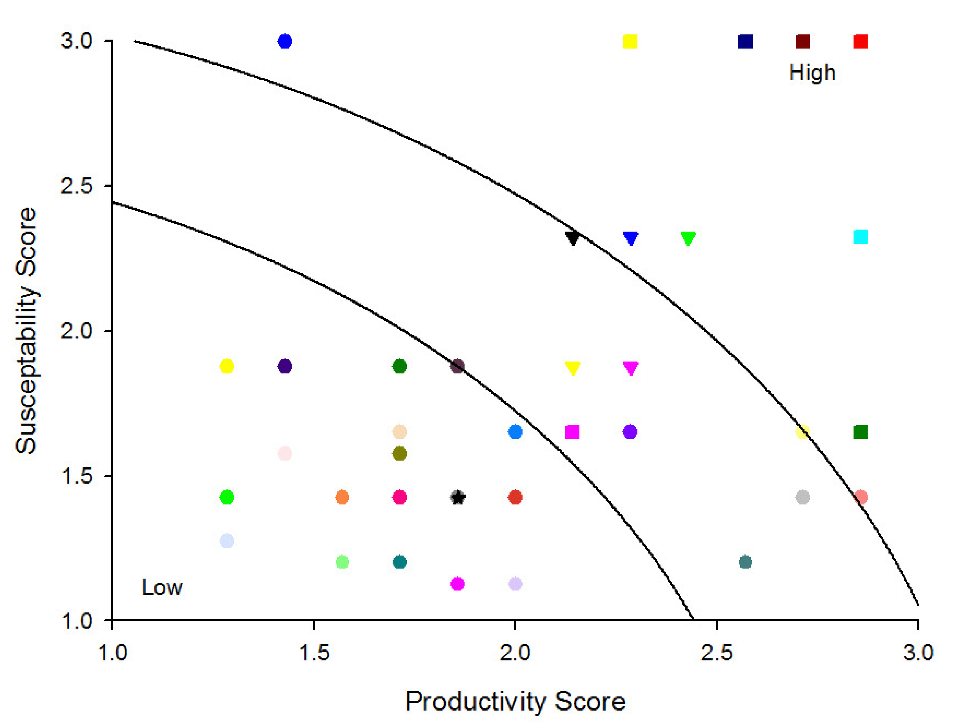


Figure 2: Pelagic trawl PSA

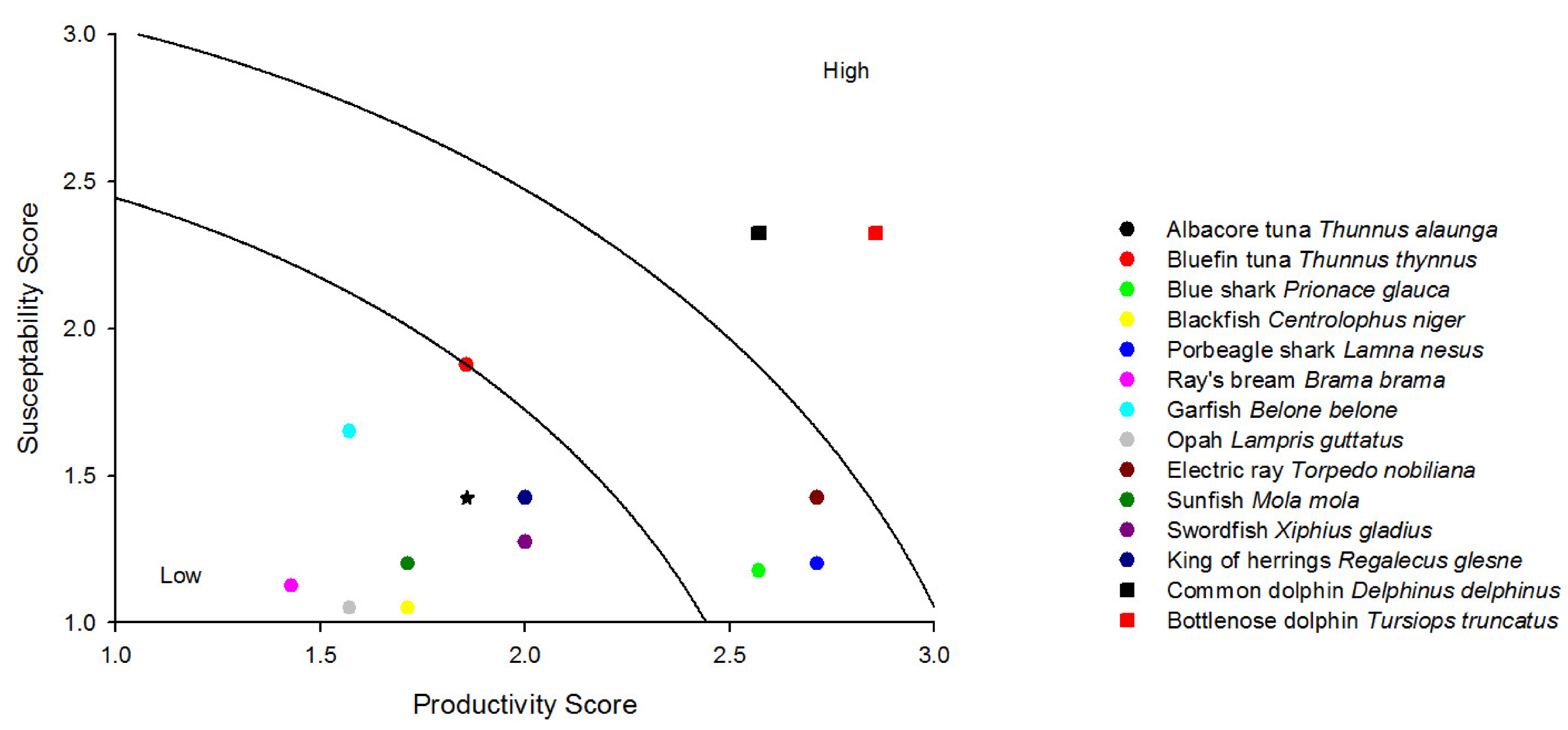
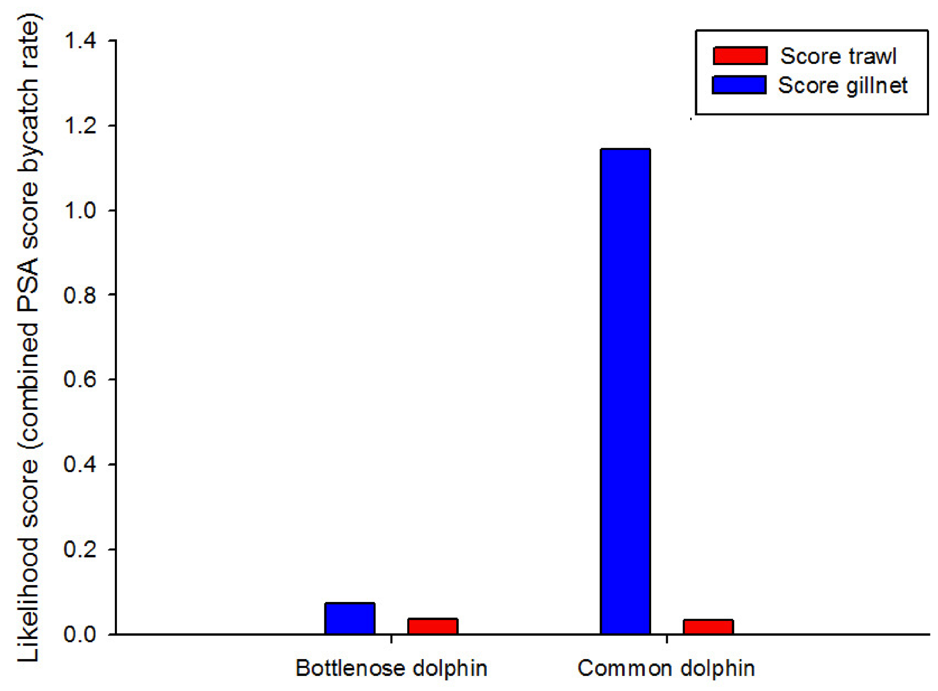


Figure 3: Cetacean likelihood



However bycatch rates, based on observer days at sea were lower in pelagic trawling and therefore the likelihood risk score was lower in pelagic trawls than in drriftnets for both cetacean species (Figure 3). When bycatch rates were combined with PSA scores for the 12 bycatch species occurring in both fisheries likelihood risk scores were significantly lower in the pair trawl than in driftnet fishery ($Z=-2.98$, $p=0.003$).

Discussion and Further work

The above example indicates that, although bycatch rates are lower in pair trawls than driftnets, the potential risk to bottlenose and common dolphins was high for both fisheries. This illustrates that PSA scores alone may not be sufficient in determining risk from a fishery and could potentially be considered misleading by stakeholders. Stakeholder support is crucial to the successful implementation of ERAEF and the inclusion of a likelihood risk score may encourage stakeholder "buy-in" to the process. Bycatch rate, estimated from observer programmes, can be used to further refine risk scores but will require the co-operation of stakeholders in observer programmes. Further work is required to determine appropriate cut-off points for likelihood risk scores to make these scores meaningful. To refine the PSA process work is currently underway to incorporate productivity attributes which are relevant for mammal, bird and reptile bycatch species, such as inter-birth/brood interval and/or gestation period. Work is also in progress to develop selectivity attributes for different gear types, for fish, mammal, bird and reptile species, to produce gear specific susceptibility scores.

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