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Research mortality allowance

Proposed allowance for 2016 and 2015 usage report

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Contents

Summary

Australia requests research mortality allowances (RMA) for four projects on southern bluefin tuna (SBT) in 2016. Most of the projects aim to avoid SBT mortality and are requesting RMA to cover any incidental mortality. The RMA amounts requested are relatively small and appropriate for the individual projects. The four projects requesting RMA are:

1) A 1 t RMA is requested to continue initiatives focused on investigating: (a) the spatial dynamics and mortality rates of SBT utilising electronic tagging techniques; (b) the impacts of noise associated with oil and gas exploration on SBT in the Great Australian Bight. Note that RMA has been granted previously for this project and is to cover incidental mortalities only. No RMA for this project has been used in recent years.

2) A 0.5 t RMA is requested for a study examining the molecular basis for endothermy using SBT as a novel model. This project will involve the capture of small SBT off southern Western Australia. Larger fish will be purchased from Port Lincoln aquaculture farms. Note that RMA has been granted previously for this project and is to cover incidental mortalities only. No RMA for this project has been used in 2015.

3) A 1.2 t RMA is requested for a project examining the health of wild SBT. Note that RMA has been granted previously for this project. A total of 392 kg of the 1.2 t RMA was used for this project in 2015.

4) Finally, a 4 t RMA is requested for the proposed gene tagging field trial in the Scientific Research Program, which may potentially begin in 2016. If this trial is not conducted the RMA will not be required. The request is based on the RMA requests in the early 2000s for the CCSBT conventional tagging program conducted by CSIRO. A similar amount will be requested for the following years if the CCSBT continues ongoing monitoring of juvenile SBT via a gene-tagging program. Note, that this RMA request is to cover any incidental mortality associated with taking a tissue sample from wild fish and releasing them alive.

The overall RMA requested by Australia is small (6.7 t) and primarily for incidental mortalities and is for projects that will enhance our understanding of the biology and ecology of SBT.

In 2015, Australia was granted 5.95 t of RMA for four projects. Three of those projects are also requesting RMA for 2016. As of 1 July 2015, a total of 400 kg, from two projects, had been used.

1 Proposals for 2016

i) Electronic tagging and effect of seismic exploration

The major aim of this project is to continue previous tagging initiatives aimed at examining spatial dynamics (movements, mixing, residency, regional fidelity and spawning frequency) of wild SBT. This study involves the tagging of SBT across a range of sizes (25–100 kg) with archival and pop-up satellite archival tags throughout the south-eastern Australian region in 2015. It will also conduct controlled exposure experiments investigating the impacts of seismic exploration on SBT behaviour and anatomy.

Tagging efforts to date have been critical in improving our understanding of the spatial dynamics and habitat use of SBT and are fundamental to the ongoing spatial management of the domestic fishery. Use of similar, and newer technology (mini-PATs) to that used previously, in this next phase of research will allow us to add to current understanding of the spatial dynamics of juvenile and adult SBT and better understand the spatial dynamics of medium size ranges of SBT (30+ kg), data which are currently lacking. Continued tagging of larger size classes will allow for better understanding and characterization of spawning migrations, data which are relevant to the parameterisation of spawning stock biomass (SSB) in the operating model. Success of tagging initiatives to date suggests that releases of electronic tags on SBT are feasible and cost effective.

The aim of this project, undertaken by scientists at the Commonwealth Scientific and Industrial Research Organisation (CSIRO), is to continue tagging initiatives. This study is proposing to release in the order of 150–200 tags on SBT ranging in size from 20 kg to 100+ kg. The majority of fish are planned to be tagged in 2014–15, with any tags not deployed in 2014–15, deployed the following year 2015–16. Approval for 2014 was applied for under CCSBT-ESC/1309/21 and approved (see agenda item 14(153) of Anon (2013)).

The study will also investigate the impacts of noise associated with oil and gas exploration on SBT in the Great Australian Bight (GAB). The GAB is particularly important for young SBT (1–4 years), with large numbers migrating into the warm, shelf waters each summer to feed on abundant prey species. Scientific aerial surveys for juvenile SBT in the GAB collect data on surface schools of SBT observed from light planes that fly designated line transects according to established and consistent protocols. These data are used to estimate an annual index of relative abundance of 2–4 year olds in the GAB between December and March (Eveson et al. 2012). This index forms one of two relative abundance series used directly as an input data series for the Management Procedure used by the CCSBT to recommend the global TAC (Anon 2013).

There is concern that activities associated with oil and gas exploration, specifically seismic surveys and noise associated with exploratory drilling activities, may impact on the migration and behaviour of SBT in the GAB. A pilot controlled exposure experiment developed in consultation with industry in Port Lincoln, and done in collaboration with Curtin University and research staff of the Australian Southern Bluefin Tuna Industry Association is proposed. A small number of juvenile SBT in experimental cages will be exposed to a range of levels of seismic noise representative of that used in oil and gas exploration in the GAB and compared with SBT in "control" cages (i.e. not exposed to direct seismic noise). A range of technologies including stomach temperature sensors and acoustic tags will be used to monitor the feeding and swimming behaviour of individuals. Weights and lengths of individuals, along with amount of feed provided will be monitored, to determine if growth rates and feed conversion ratios at the

end of the trial deviated from expected rates of growth. Necropsies of caged fish will be conducted to assess any immediate post-exposure organ damage and also later in the trial to examine rates of recovery.

This proposal extends the 3 t RMA request granted for 2015, to cover SBT tagging in 2015, noting that none of the RMA requested for 2014 has been used as yet (as of July 2015), due to delays in funding arrangements. Only 1 t is requested for 2016.

Results of earlier initiatives investigating the spatial dynamics of SBT are provided in Gunn and Patterson (2003), Patterson et al. (2005), Gunn et al. (2006), Evans and Patterson (2007), Patterson et al. (2008), Evans et al. (2012) and Basson et al. (2012). Data from these projects are integral in spatial management procedures of the Australian Fishery implemented by the Australian Fisheries Management Authority. Use of these data in spatial management is detailed in Hobday and Hartmann (2006), Hobday et al. (2011) and Hartog et al. (2011).

ii) Does the "membrane pacemaker" theory hold true for endothermic fish?

This project, undertaken by CSIRO, will use SBT as a model to test prevailing theories of the evolution of endothermy (warm-bloodedness). Bluefin tunas are top predators whose removal or displacement due to over-fishing or climate change could destabilize marine ecosystems. Captive breeding is a possible solution but its success is limited by our inadequate understanding of tuna thermal biology. This project will rectify this.

This project will investigate the molecular basis of endothermy using a novel model, SBT. Endotherms maintain their internal body temperature by conserving metabolically generated heat, whereas ectotherms depend on heat from the environment. Despite its evolutionary significance, the molecular basis of endothermy is still not well understood. Tunas provide unique models to investigate this because their bodies consist of both endothermic and ectothermic organs and they only develop the capacity for endothermy during the first year of their lives. The outcome of this project will be a greater understanding of vertebrate thermal biology leading to better predictions of the effects of climate change on ecosystem stability.

Recently it was suggested that the limited success of bluefin tuna captive breeding may be due to under-developed capacity for endothermy when the young fish are transferred from the warm water of the hatchery to the cooler water of the sea cages. This was based on observations of Pacific bluefin tuna but it may also be true for SBT. The growth of the bluefin tuna aquaculture industry is limited by high rates of cold-induced mortalities in captive bred fish proposed to be due to underdeveloped endothermy. Small (incipiently endothermic) southern bluefin tuna are found in Australian coastal waters from Western Australia to the GAB.

We will compare small (40 to 60 cm fork length) SBT with similarly sized Australian bonito, a close ectothermic relative. These species, in this size range, are found in waters off southern Western Australia during the period November to February each year.

The specific aims of this project are:

1) To investigate the ontogeny of red muscle endothermy in small (incipiently endothermic) SBT.

2) To compare mitochondrial respiration rate, proton leak rate and membrane lipid unsaturation in endothermic versus ectothermic organs/tissues of large (fully endothermic) SBT and similarly-sized Australian bonito.

3) To determine the effects of varying membrane unsaturation on mitochondrial respiration rate and proton leak rate in a recently established SBT cell line.

4) To explore the transcriptional regulation of mitochondrial biogenesis and its role in the ontogeny of red muscle endothermy in fish.

We seek to capture small SBT in waters between Albany and Fremantle from around 50 young-of-the-year SBT with body sizes ranging from 20 to 80 cm fork length (i.e. encompassing the size of 55 cm fork length where we expect the onset of significant red muscle warming). The maximum weight expected for this size range is less than 10 kg. We estimate the maximum take as 50 x 10 kg = 500 kg. These fish are not available from the commercial fishery in the Great Australia Bight.

Larger SBT with body sizes ranging from 100 to 150 cm fork length (i.e. in the range where we expect well-developed red muscle warming) will be obtained during normal commercial harvests from tuna farms located near Port Lincoln, South Australia, and are not included in the request for RMA.

Based on the above, an RMA of 0.5 t is requested for this study.

iii) Health assessment of wild southern bluefin tuna

The major aim of this project is to assess the health of wild SBT. As well as traditional health assessments including histology, microbiology, immunology and haematology, this project will aim to further develop and apply new molecular methods, including those for pathogen detection and associated pathology in wild SBT. New molecular methods will be developed which could help to identify specific blood borne biomarkers for various pathogens (disease agents) and ultimately could lead to non lethal health assessment for these animals.

This project, undertaken by researchers from the University of Tasmania, will have significant scientific and ethical benefits. The results of this project will greatly contribute to the current lack of knowledge of the health of wild SBT populations including pathogen prevalence and/or intensities. Identification of suitable health biomarkers could also negate the need for destructive sampling of animals. This project could therefore have implications for future SBT research.

Most health assessments for SBT have been conducted using ranched animals. Comparatively, the health status of non-ranched wild SBT has received little attention. Some wild SBT sampling has previously been conducted with participation of SBT industry as part of Aquafin Cooperative Research Centre and Fisheries Research and Development Corporation projects. This research was based on frozen and formalin fixed samples that were collected by the industry from tuna schools captured for ranching so for example the samples for pathogen detection (particularly some species of parasites) were limited. All SBT were from GAB, further limiting interpretation of the results. Some of the results from this work with wild tuna have been published (please see Rough et al. 2005, Aiken et al. 2007, Aiken et al. 2008, Aiken et al. 2009, Kirchoff et al. 2014).

This proposal extends the 1.2 t RMA request granted for 2015, to cover further work in 2016. This request is based on an estimate of 20 SBT with a maximum weight of 60 kg each. In 2015, a total of 16 SBT have been caught for this project, amounting to an estimated 392 kg.

To date, publications from this research have not yet been completed. The first papers are anticipated to be submitted for publication later this year. The papers will be provided to the ESC for information once available.

iv) Gene tagging

A pilot gene-tagging project has been incorporated into the current CCSBT Scientific Research Program (Anon. 2014, Preece et al. 2014; Anon. 2). Subject to CCSBT resourcing, it may commence in late 2015. The project aims to provide an estimate of absolute abundance of juvenile SBT for use in the SBT operating model and potentially in future management procedures. The pilot project would test the logistics and feasibility of gene-tagging SBT. Gene-tagging operates in a similar way to conventional tagging programs, however genetic matching of tissue samples is used to match a tagged fish with itself upon recapture rather than a physical tag. This resolves the problem of non-reporting of tags, which led to the cessation of the CCSBT Scientific Research Tagging Program in 2007. Gene-tagging may also provide an alternative method to the scientific aerial survey for monitoring SBT recruitment. The SBT scientific aerial survey provides an index of recruitment for use in the SBT operating models and management procedure, but was not run in 2015 due to budgetary constraints.

A gene-tagging design study is currently underway to refine the experimental design and costs, and will report to the 2015 CCSBT Scientific Committee meeting. The 2014 SBTMAC recommended a pilot gene-tagging project as a high priority (i.e. rank 1 research program). The design study builds on preliminary work presented to the CCSBT in 2013 (Preece et al. 2013) and CSIRO's history and experience in tagging fish. If the pilot gene-tagging project is funded, the anticipated sampling design is for approximately 5000 fish to be tagged by taking a small tissue sample. The fish is then released alive at sea. Recapture tissue samples would be taken from fish at time of harvest.

The RMA request of 4 t is to cover any incidental mortalities associated with tagging fish and is based on the RMA requests of previous, conventional tagging studies.

2 Summary of 2015 RMA usage

A total of 5.95 t of RMA was granted in 2014 for Australian research projects undertaken in 2015. To date (1 July 2015), 400 kg of RMA has been utilised in 2015, well below the amount granted, although the possibility remains that tagging will commence in the first project listed below in December 2015.

1) A 3 t RMA was approved to continue initiatives focused on investigating: (a) the spatial dynamics and mortality rates of SBT utilising electronic tagging techniques; (b) the impacts of noise associated with oil and gas exploration on SBT in the Great Australian Bight. No RMA for this project has been used in recent years.

2) A 0.5 t RMA was approved to use SBT as a model to test prevailing theories of the evolution of endothermy (warm-bloodedness). However, as the funding proposal for this work was not approved, no RMA was used in 2015.

3) A 1.25 t RMA was approved for a project examining iconic and apex predator species in the Great Australian Bight as part of a larger ecosystem project. A single, small (8 kg) SBT was taken as part of this project in 2015.

4) An RMA of 1.2 t was approved for a project examining the health of wild SBT. A total of 392 kg of SBT was used for this project in 2015.

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