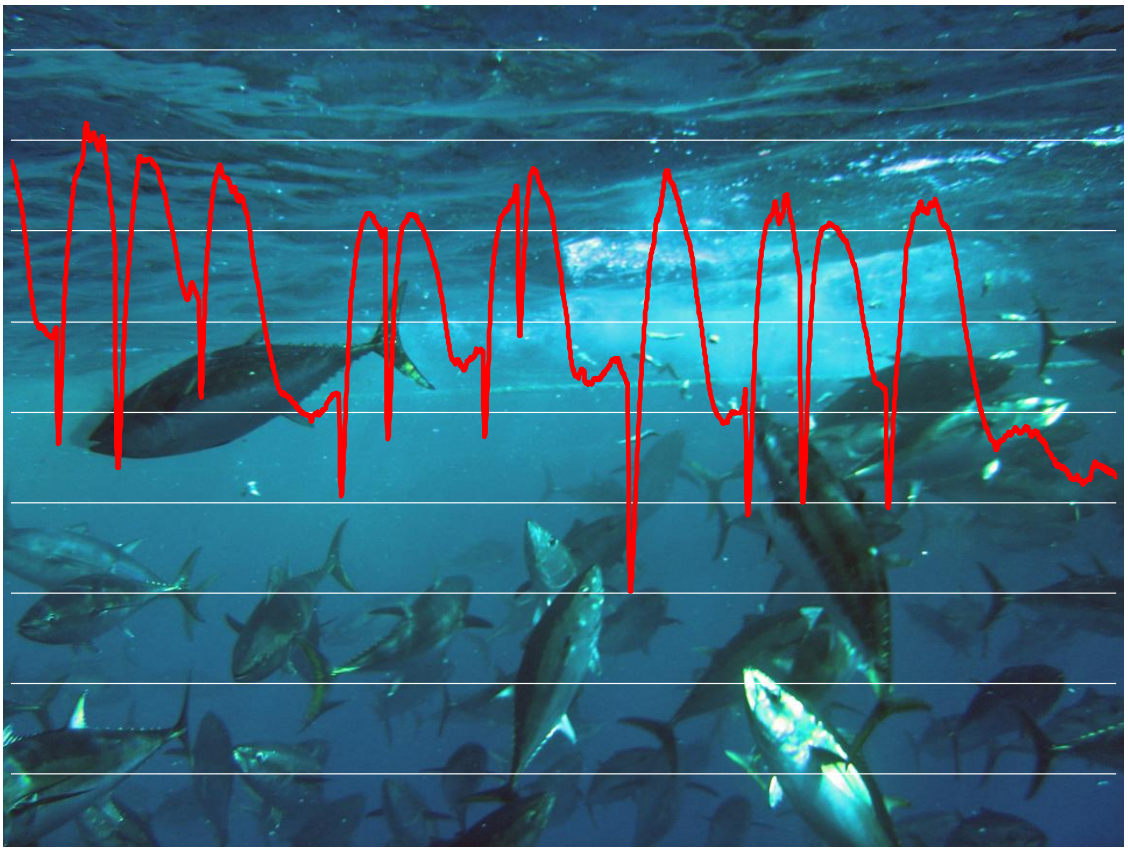
The measurement of visceral temperature patterns and implications for feeding practices in ranched southern bluefin tuna *Thunnus maccoyii*



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Submitted in fulfillment for the degree of Master of Applied Science

National Centre for Marine Conservation and Resource Sustainability

AMC, University of Tasmania

Declaration of Originality

This thesis contains no material which has been accepted for a degree or diploma by the University or any other institution, except by way of background information and duly acknowledged in the thesis, and to the best of the my knowledge and belief no material previously published or written by another person except where due acknowledgement is made in the text of the thesis, nor does the thesis contain any material that infringes copyright.

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Statement of Ethical Conduct

The research associated with this thesis abides by the international and Australian codes on human and animal experimentation, the guidelines by the Australian Government's Office of the Gene Technology Regulator and the rulings of the Safety, Ethics and Institutional Biosafety Committees of the University. The research methodology received clearance from the University of Tasmania Experimentation Ethics Review Committee (Approval number A0008195)

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Statement of the contribution of other parties

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Supervision

- Assoc Prof John Purser, University of Tasmania
- Prof Chris Carter, Tasmanian Fisheries Institute
- Prof Rob van Barneveld, Barneveld Nutrition

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To close friends and family, I sincerely appreciate your help, support and understanding.

For inspiration -

Look, if you had one shot, or one opportunity

To seize everything you ever wanted in one moment

Would you capture it or just let it slip?

Opening song lyrics from "Lose Yourself" by American hip-hop artist Eminem, released as the first single from the original soundtrack to the movie *8 Mile* on October 22, 2002

Dedication

This thesis is dedicated to

Ross Guerin and Albert Ellis

These blokes taught me many things and the older I get I recognise the real value of grandfathers. I only wish that they were still around to catch up with and share their life experiences.

Abstract

Southern bluefin tuna (*Thunnus maccoyii*) warm their viscera when digesting food. Through surgical implantation of archival tags, this thesis explores visceral warming patterns in southern bluefin tuna (SBT) with the aim of identifying relationships between visceral heat, nutrient supply, feed frequency and efficiency in SBT.

Based on six trials with different but related objectives, it was found that dietary energy influences visceral warming, time taken to reach peak visceral temperature and duration of visceral warming when SBT receive one meal per day. When SBT are fed more than one meal per day, feed intake may be measured when dietary energy is known and water temperatures are cool. Different industry feeding practices were shown to have no impact on visceral warming patterns when SBT were regularly fed two times per day with a high energy diet compared with six times per day using a low energy diet emphasising the importance of providing an appropriate protein and lipid balanced diet. SBT visceral warming patterns in this trial altered when regular meals were missed.

An 18 week trial involving four baitfish feeding treatments with different protein to lipid ratios fed in 3 x 6 week time periods demonstrated that maintaining a consistent feed profile of approximately 7 % lipid especially in the first 6 weeks of culture will optimise SBT performance in respect to growth, food conversion and body condition. Specific growth rates from all treatments were significantly better than Atlantic bluefin (*Thunnus thynnus*) of the same size and age. An analysis of dietary energy with regard to visceral warming showed that dietary energy is not a reliable measure of feed intake and that visceral warming is more influenced by water temperature and feeding behaviour. In cooler water temperatures SBT feed less, increase visceral warming and conserve heat. In warmer water temperatures SBT feed more and expend visceral heat suggesting that SBT have a physiology response to body temperature that is not directly related to dietary energy intake.

A trial investigating visceral and tissue temperature profiles showed that at water temperatures of 20^{o}C or less, SBT maintain basal and maximum visceral temperatures between 4^{o}C and 10^{o}C above ambient water temperature and that visceral temperatures can be predicted with confidence. At water temperatures above 20^{o}C the relationship

between basal and maximum visceral temperatures and water temperature may be predicted with less certainty. SBT maintain red muscle temperature at approximately 30^{o}C irrespective of feeding regime or water temperature, white muscle temperature at approximately 6^{o}C above water temperature irrespective of water temperature and feeding regime, but visceral cavity temperature of SBT is influenced by both water temperature and feeding regimes in water temperatures up to approximately 20^{o}C. Temperature profiles developed through this research suggest that water temperatures above 20^{o}C lead to heat stress in SBT.