IIOE-2 endorsement

Project: *Mesoscale variability in nitrogen sources and food-web dynamics supporting larval southern bluefin tuna in the eastern Indian Ocean,* OCE-1851247, US National Science Foundation

Acronym: **BLOOFINZ-IO** (**B**luefin **L**arvae in **O**ligotrophic **O**cean **F**oodwebs, **I**nvestigations of **N**utrients to **Z**ooplankton)

Lead-P.I.: Michael Landry, Scripps Instn. Oceanogr

Some History:

Initially developed as part of EIOURI (2013, 2014 meetings, 2016 Science Plan)

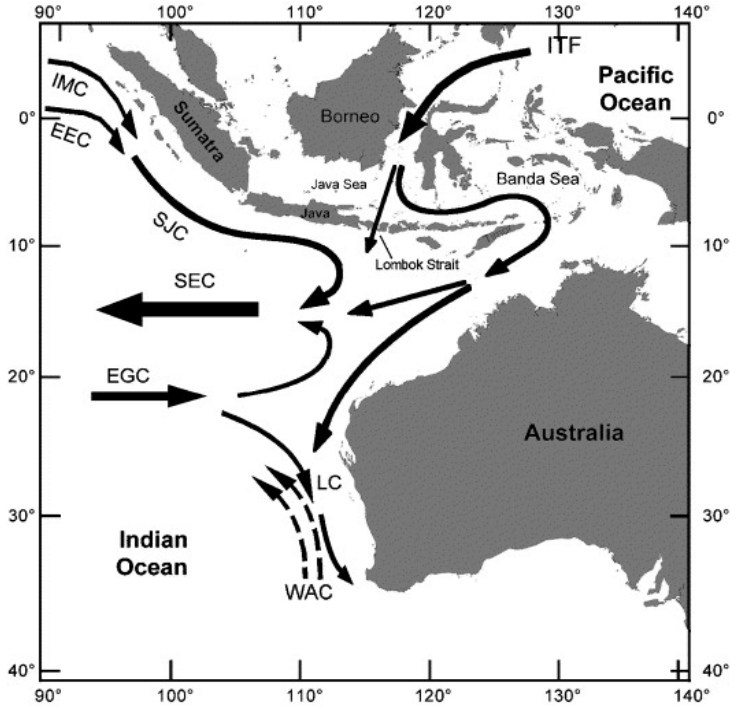
Presented as an IIOE-2 Initiative, *Overview for an Australian/US component of EIOURI* (M. Landry, L. Beckley), IOP-IOGOOS-SIBER, Goa, Dec. 2015

IIOE-2 US National Committee Rpts – 2018 (Jakarta), 2019 (Port Elizabeth)

2018 NSF proposal funded in 2019 for 2020 cruise; delayed 2 years by ship issue & Covid

Successfully completed cruise, *R/V Revelle* RR2201, January-March 2022

The study region

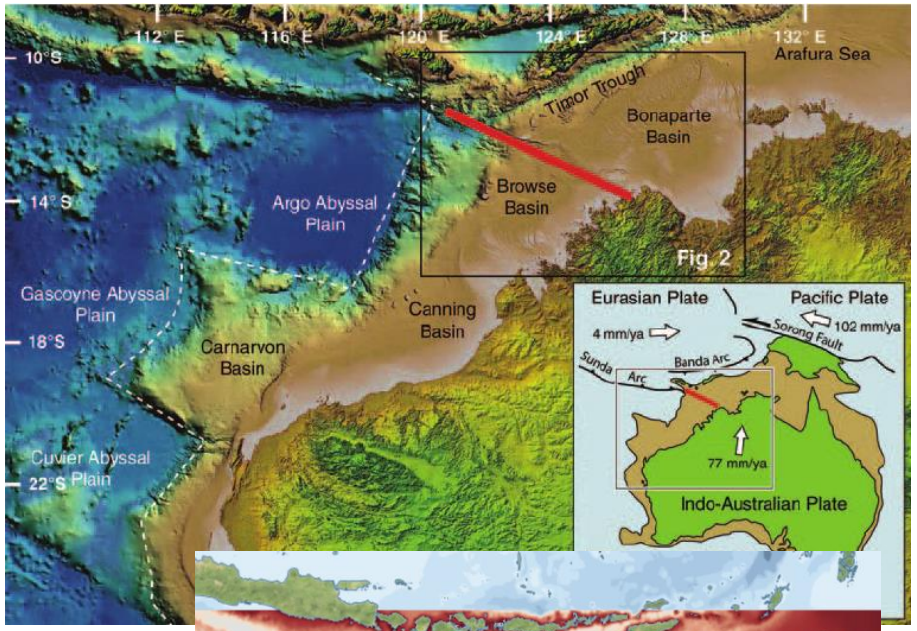


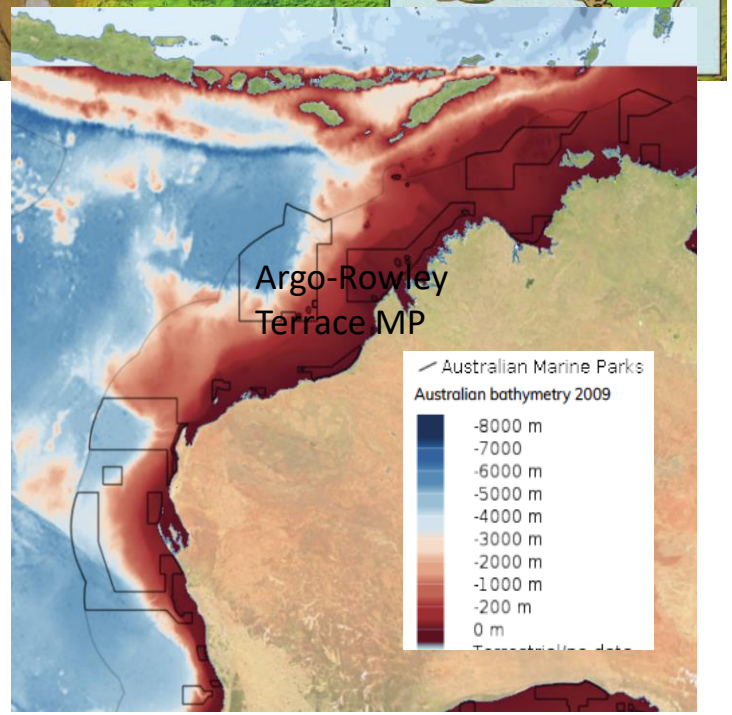
Map of Eastern IO with Indonesian Throughflow (ITF), South Equatorial (SEC), South Java (SJC), East Gyral (EGC) and Leeuwin (LC) Currents (Murgese & De Deckker 2005). SBT spawing region is red highlighted (from Matsuura et al. 1997).

Only global spawning area for Southern bluefin tuna (SBT)

<u>Poorly studied area</u>:

Production
Biogeochemistry
Plankton ecology
Trophic interactions





Broad shelf
Argo deep basin
A-RT Marine Park
Australian EEZ

Study goals/elements

End-to-end food web study (IMBER) – nutrients to fish
Integrated physical circulation, biogeochemistry and trophic ecology

Climate vulnerabilities of SBT recruitment -- factors underlying success of larval feeding, growth, survival

Biogeochemical controls of productivity – N sources, iron limitation

Full nitrogen (N) budget – new prod (nitrate uptake, N_2 fixation), denitrification, export

Plankton community biomass and structure – bacteria, protists, mesozooplankton, fish

Trophic flows (process rates) – phytoplankton growth, micro- & mesozoo grazing, mixotrophy, larval diet & selectivity, trophic positions (CSIA-AA)

Mesoscale variability – eddies, fronts, currents

Genetic/molecular – microbial metagenomics, nif gene, larval diet, taxon-specific rates of phytoplankton growth and grazing, e-DNA deep microbes to fishes

Approach

Lagrangian Experiments: 4-5 days, marked water parcels with satellite tracked drifters, repeat integrated sampling/incubations over full EZ

plankton structure – flow cytometry, pigments, microscopy, genetics, nets

measured rates – ^{14}C-primary production, $^{15}NO_3$, $^{15}NH_4$ uptake, $^{15}N_2$ fixation, mixotrophy, phyto growth and microzoo grazing (dilution), mesozoo grazing, export (thorium, sediment traps, UVP),

larval trophic ecology – feeding selectivity, daily growth (otoliths), survival, trophic position (^{13}C, ^{15}N isotopes, CSIA-AA)

Mesoscale & Regional Variability: emphasis on larval habitat (0-25m; ML)

net sampling & continuous flow-through measurements – populations (Imaging FlowCytobot, FlowCam), photophysiology (FRRF, FiRE), taxon-specific pigments (ALPHA), net primary production (EIMS), N_2 fixation (FARACAS), Continuous Plankton Recorder (CPR)

Contributors

US institutions: SIO, Florida State, Miami, Hawaii, Duke, Columbia, Alaska
Countries: Australia, EU (Spain, France, Italy), New Zealand, China, Korea, Nigeria

M. Landry, M. Décima, R. Swalethorp, G. Cawley (SIO) – plankton food webs, microbial growth & grazing, zooplankton, CSIA-AA

D. Die, E. Malca, J. Lamkin (Miami); R. Laiz & J. Quintanilla (Málaga, Spain); L. Beckley (Murdoch); A. Jeffs (Auckland) – larval abundance, feeding, growth (otoliths), survival

S. Kranz, M. Stukel (FSU) – nutrients, primary productivity, nitrate uptake, N_2 fixation, denitrification, POC/PON, export (Th, sed traps), ecosystem & individual-based models

K. Selph (Hawaii) – flow cytometry

C. Traboni (CSIC, Spain) – mixotrophy

P. Morton (FSU), T. Kelly (UAF) – trace metals, aerosols

R. Lampe, A. Allen (SIO) – IFCB, Fe limitation, microbial genetics

T. Biard, M. Laget (Littoral, France) – UVP profiles, export/imaging sediment traps

C. Davies (CSIRO) – CPR, zooplankton

N. Cassar, S. Gu, A. Desouza – flow-through/continuous N_2-fixation (FARACAS)

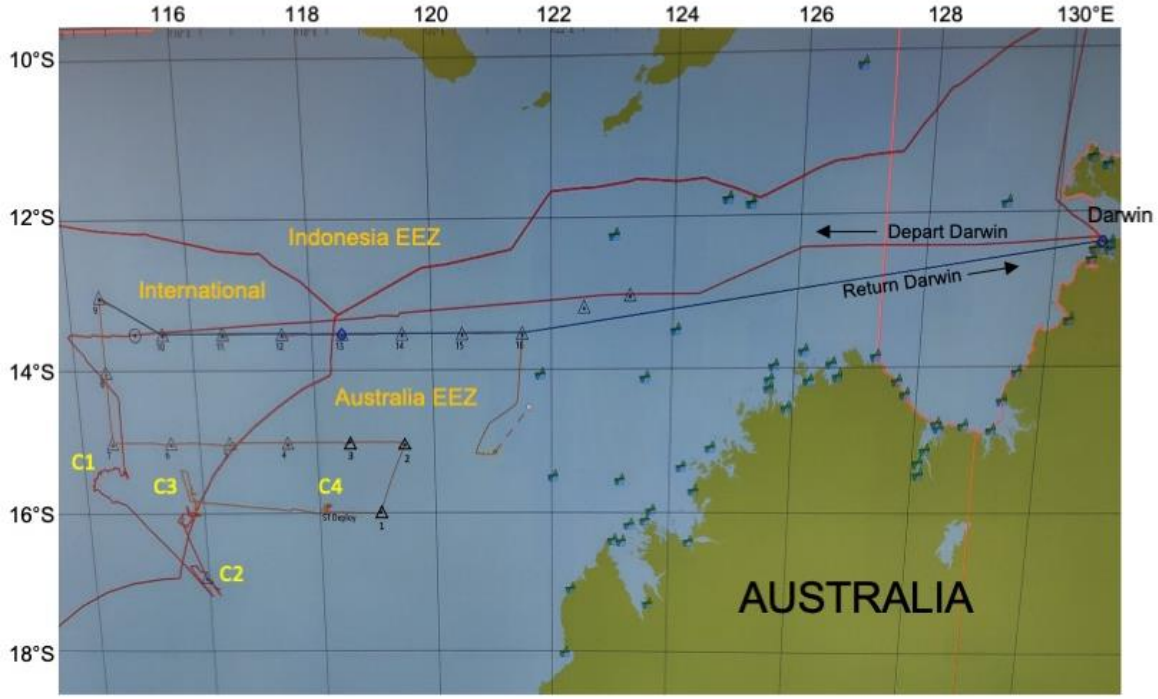
J. Goes – FlowCam phytoplankton structure, photophysiology & production

E. Raes, M. Heydenrych (Minderoo) – e-DNA

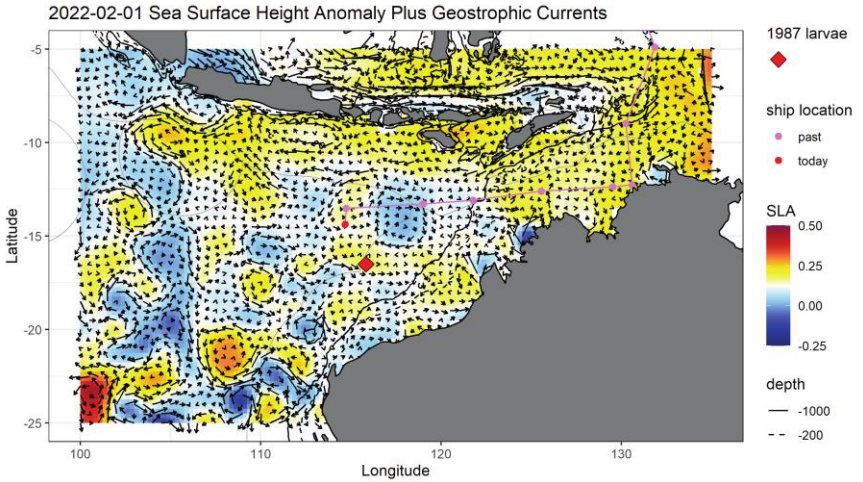
H. Liu, Y. Li (HKUST) – microbial metagenomics, clade-specific phyto growth & grazing

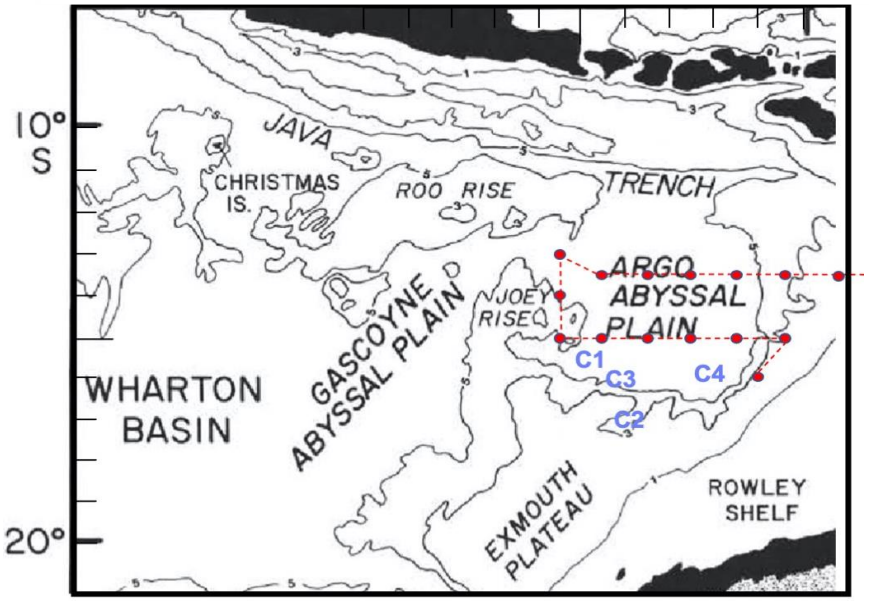
B. Muhling (UCSC) – satellite products, larval habitat modeling

R/V Roger Revelle cruise **RR2201**
20 Jan-14 Mar 2022



Screen photo of cruise track on ship monitor. C1-C4 are locations of experimental cycles. Triangles are transect sampling stations.





Seafloor bathymetry with Cycle 1-4 locations superimposed in blue and survey transect stations in red.

From IIOE-2 SCIENCE PLAN, A Basin-Wide Research Program (2015-2020):

P57-58: *Planning for an Eastern Indian Ocean Upwelling Research Initiative (EIOURI) is already in an advanced stage. …. The biogeochemical and ecological science drivers for EIOURI include the need to understand the impact of the unique regional physical forcing in the eastern Indian Ocean upwelling regions on* ***nutrient concentrations and stoichiometry*** *related, for example, to the influence of the ITF,* ***atmospheric inputs, nitrogen fixation and denitrification, and also how phytoplankton productivity and community composition responds to these nutrient inputs****.*

From EIOURI SCIENCE PLAN (2016) -- KEY QUESTIONS (addressed by BLOOFINZ):

P22: *What are the roles of mesoscale and sub-mesoscale features and advective processes on* ***biogeochemistry, food-web dynamics and habitat quality in the SBT spawning area****?*

P24: *What influence does* ***Fe-stimulated nitrogen fixation*** *have on nutrient concentrations and ratios in upwelled waters off of NW Australia? Does nitrogen fixation have a significant impact on N:P ratios and therefore the* ***species composition of the phytoplankton blooms, and how might this, in turn, influence higher trophic levels****?*

P30: *How does temporal and spatial variability in the* ***N sources for primary productivity*** *in the eastern IO relate to* ***variability in food web structure and trophic transfer efficiency*** *to higher level consumers?*

P35: *What is the* ***variability in primary productivity and trophic transfer efficiency*** *that determine the* ***food resources for larvae and juvenile SBT****? What are their* ***relations with physical and biogeochemical conditions*** *in order to achieve better management of SBT?*