THE UNIVERSITY OF WESTERN AUSTRALIA
Achieve International Excellence

A CENTURY OF ACHIEVEMENT
1913 - 2013

THE UWA OCEANS INSTITUTE

Annual Report 2012

ACHIEVE INTERNATIONAL EXCELLENCE

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IMAGE/ JOAN COSTA

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Ocean Solutions
for humanity's grand challenges

Advancing knowledge to safely and sustainability deliver water, food, energy and bioresources from our oceans

Strategy

The UWA Oceans Institute is focusing on the sustainable and innovative management of ocean resources to create wealth.

We aim to develop untapped opportunities to generate ocean based solutions to safely and sustainably provide critical resources for human development, including water, food, energy and bioresources. At the same time, we are committed to reconcile the delivery of wealth from the oceans with the conservation of the biodiversity and ecosystems that support these resources.

Underpinned by excellence in research, the deliberate exploration of ocean solutions can generate great opportunities for innovation, providing a competitive advantage to the industry partners collaborating with us to deliver this vision.

A maritime nation

Australia is a maritime nation with more territory in the ocean than on land and an economy that heavily relies on its oceans, through fisheries, oil and gas and tourism.

Australia has the potential to lead the world in the development of safe and sustainable uses of our ocean resources, opening a pathway of wealth and well-being through what is, in effect, our last frontier. Advancing knowledge to safely and sustainably deliver water, food, energy and bioresources from our oceans

IMAGE/ JOAN COSTA

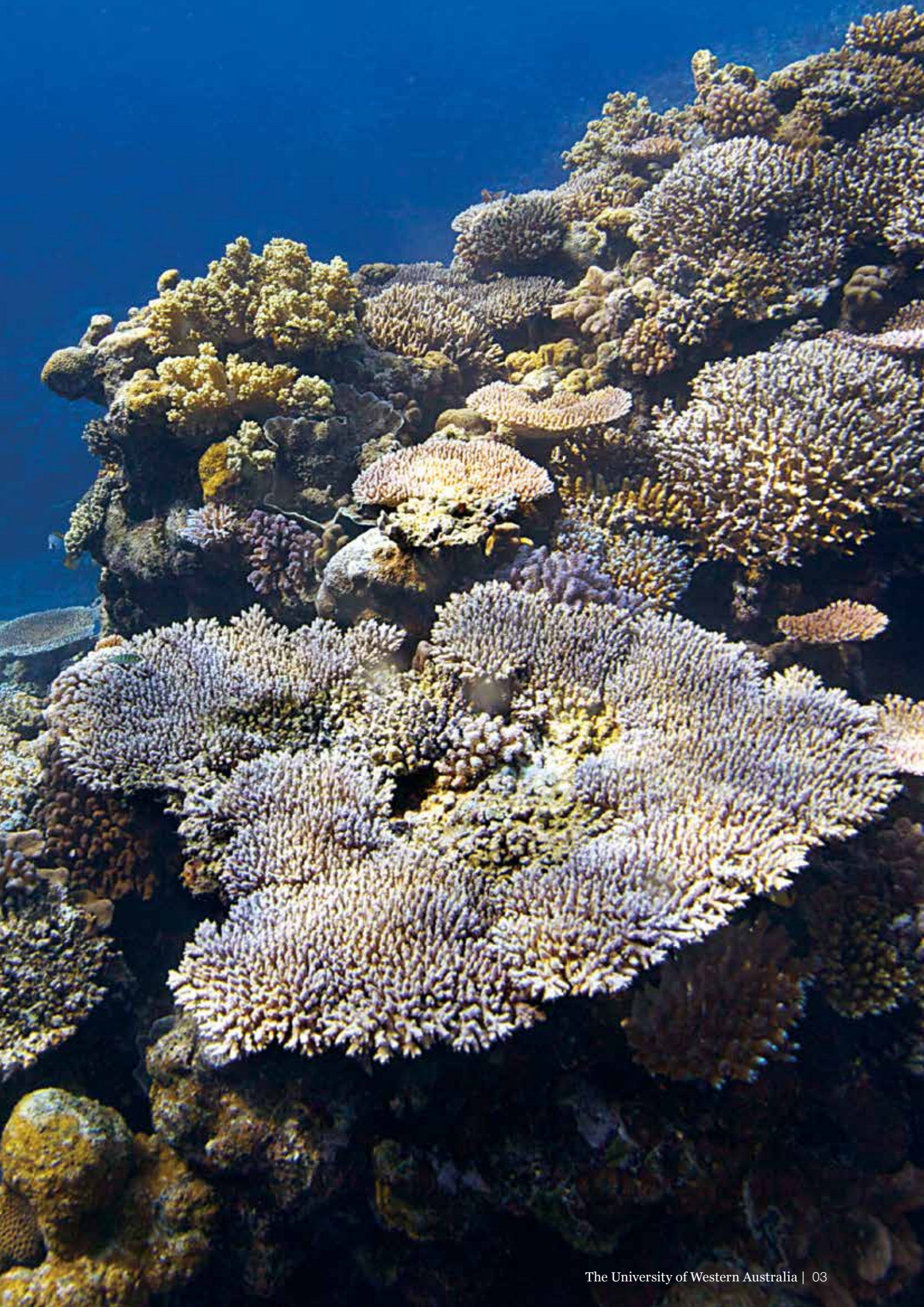


IMAGE / RED SEA CORALS
(PHOTO: XABIER IRIGOYEN)

Director's executive summary

Committed to Solution Science

The overview of the research conducted during 2012 highlights two key aspects of the work conducted at The UWA Oceans Institute; firstly the continuous progression to advance our understanding of the oceans and secondly the commitment to solution science.

The improvement in the quantity and quality of the scientific publications reported here provides evidence of our contribution to advancing our understanding of the oceans. These achievements were validated by three independent indicators: (1) the inclusion, in 2012, of The University of Western Australia within the top 100 universities in the world according to the Shanghai Jiao Tong University's Academic Ranking of World Universities, towards which the high performance of marine sciences certainly contributes; (2) the ERA rankings that places The University of Western Australia within the top in the country in the three areas of assessment to which the UWA Oceans Institute contributes to; and (3) the presence of UWA Oceans Institute scientists in the updated list of Highly Cited scientists – including the top 250 most cited scientists in each of 10 broad areas encompassing all sciences – released by the Institute for Scientific Information (ISI) of Philadelphia.

Winthrop Professor Carlos Duarte
Director, The UWA Oceans Institute

The ERA assessment, ranking Australian universities against world benchmarks, released in 2012 included good news for UWA. Specifically, the three areas to which The UWA Oceans Institute contributes were ranked 5 (Ecology and Environmental Management, 5 means "well above world average") and 4 (Oceanography, 4 means above world average). UWA has increased from 3 (World average) to 4 in Oceanography, rising from the 8th ranked university in Australia in Oceanography to the 2nd Australian University in this assessment category. In Environmental Sciences and Management, UWA has climbed from a 3 to a 5, and has become the leading Australian University in this field (ranked number 1). In Ecology, UWA maintains a 5 from the 2010 ERA assessment, but has risen from being ranked 8th to occupy number 1 of Australian Universities.

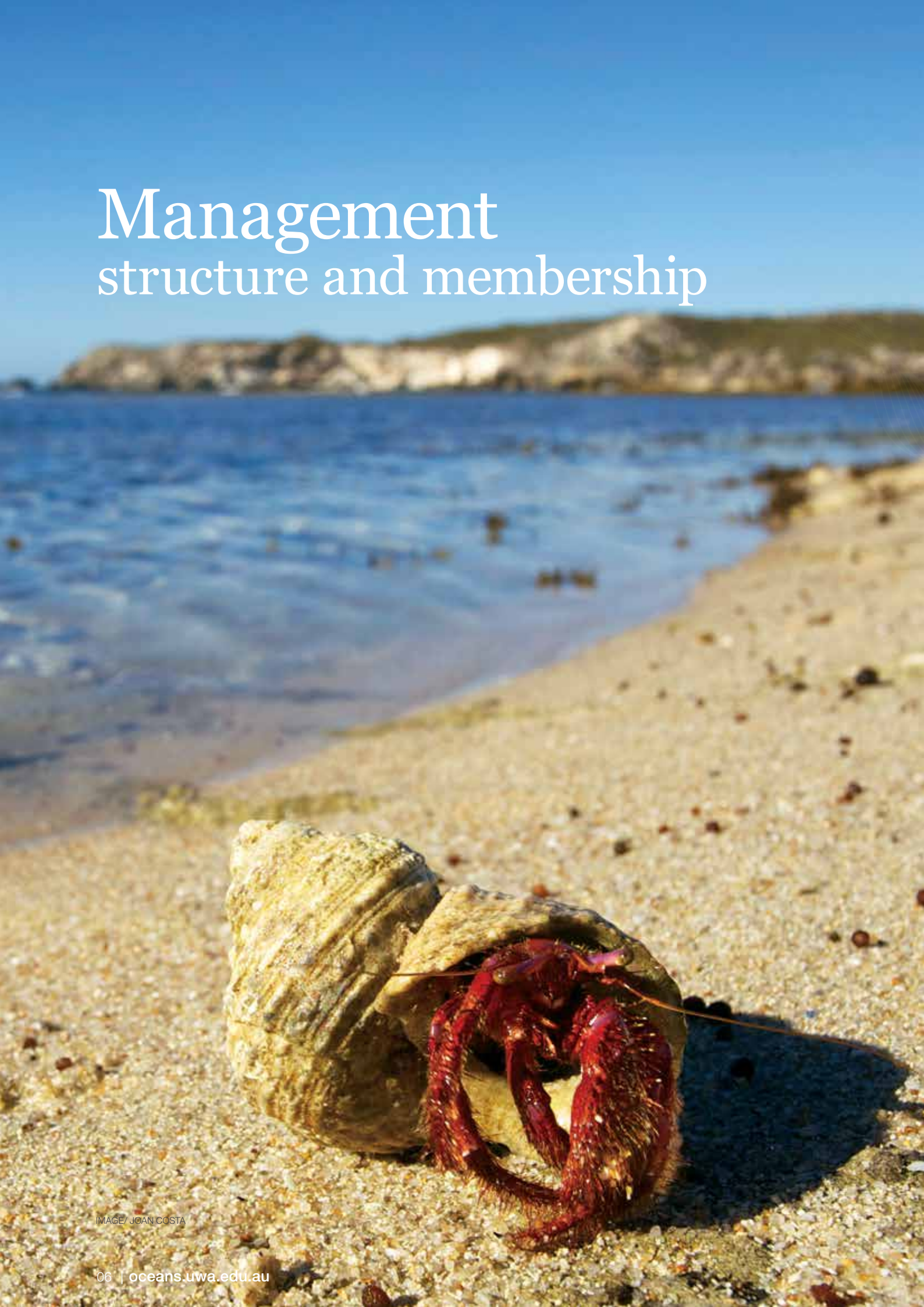
The ISI list includes two UWA Oceans Institute Scientists, Professor Michael Burton, resource economics, and myself. In addition to this accolade Winthrop Professor Malcolm McCulloch was awarded a prestigious Laureate Fellowship to explore how corals cope with Ocean Acidification.

Our vision to achieve excellence in marine science to deliver ocean-based solutions to address Humanity's Grand Challenges is progressing and gaining traction within the UWA Oceans Institute, The University of Western Australia, and Western Australia society in general. Two elements have contributed to this. First the launching of the Ocean Solution Dialogue Series with two workshops conducted in 2012, the first on the role of science in responding to disasters in the marine environment and the second on spatial planning for the safe and sustainable use of the marine environment (see page 45). The second element involves the launching of projects aimed at providing solutions for relevant problems. These include a package of State-funded research projects aimed at mitigating the risks of Shark attacks by users of the marine environment (see page 22) and the successful submission of a proposal to form a national research Cluster led by CSIRO on carbon sinks in the marine environment, which will be initiated in 2013. A series of public lectures on the topic of Ocean Solutions, organised jointly with the UWA Institute of Advanced Studies, presented the public with research on how understanding of neuroecology of marine life can help deliver solutions to address human needs, the role of the ocean in the evolution of humans and the role of the oceans as a source of energy.

To better achieve its goals, the UWA Oceans Institute has continued to broaden its interdisciplinary base, particularly incorporating social scientists, and has strengthen its research collaboration with its partners in the Indian Ocean Marine Research Center, AIMS, CSIRO and the WA Department of Fisheries. The first joint appointment, that of Dr Tim Langlois, between the WA Department of Fisheries and the UWA Oceans Institute has provided a new model to enhance this partnership.

The establishment in 2012 of The UWA Oceans Institute Advisory Board, chaired by Dr Ian Poiner, provided key guidance to ensure that the UWA Oceans Institute is on track to achieve its ambitious vision.

Management
structure and membership



IMAGE/ JOAN COSTA

Governance Structure

ADVISORY BOARD

INSTITUTE BOARD

- CHAIR
  PRO VICE CHANCELLOR RESEARCH Professor Alistar Robertson (January-November)
  DEPUTY VICE CHANCELLOR RESEARCH
  Professor Robyn Owens (December)
- OI DIRECTOR
  W/Professor Carlos Duarte
- DEAN OF SCIENCES
  W/Professor Tony O'Donnell
- DEAN OF ENGINEERING, COMPUTING AND MATHEMATICS
  W/Professor John Dell
- DEAN OF LAW
  W/Professor Stuart Kaye
- OI GENERAL MANAGER
  Ms Tracy Parker (January–June)
  Ms Tara McLaren (Acting July–December)
- PHD STUDENT REP
  Ms Janelle Braithwaite

BUSINESS TEAM

- OI DIRECTOR
  W/Professor Carlos Duarte
- OI DEPUTY DIRECTOR
  W/Professor Mark Cassidy
- OI GENERAL MANAGER
  Ms Tracy Parker (January-June)
  Ms Tara McLaren (Acting July-December)
- OI EXECUTIVE ASSISTANT
  Ms Lauren White
- OI ACCOUNTS OFFICER
  Ms Marian Riddell
- OI COMMUNICATIONS OFFICER
  Mr Beau Gamble (January-April)
  Ms Guiomar Duarte Agusti (December)
- DIVING AND BOATING SAFETY OFFICER
  Mr Warren Starr

PROGRAM LEADERS

- W/Professor
  Shaun P. Collin
- W/Professor
  Mark Cassidy
- W/Professor
  Carlos M. Duarte
- W/Professor
  Gary Kendrick
- Professor
  Euan Harvey
- W/Professor
  Greg Ivey
- W/Professor
  Malcolm McCulloch
- Professor
  Jessica Meeuwig
- W/Professor
  Anya Waite

Oceans Institute Early Career Mentor

In late 2012, Professor Alistar Robertson was recruited to the role of Oceans Institute Early Career Mentor.

Professor Robertson, UWA Pro Vice-Chancellor (Research), has played an important role in the Oceans Institute since its inception in 2009 and continues to be actively involved as a member of the senior leadership team.

The UWA Oceans Institute recognises the importance of providing ongoing support to postdoctoral researchers and early career researchers to enable them to contribute to the vision of the Institute and to develop their research careers. To enable this support to be provided at a high-level, Professor Robertson has been appointed as Early Career Mentor. His passion and enthusiasm for research and his commitment to Solutions Science will provide outstanding leadership to Institute researchers.

From mid-2013, a number of workshops and mentoring sessions will be held exploring topics including securing funding to undertake research, strategies for effective publication and collaborative group dynamics.

IMAGE ABOVE / PROFESSOR ALISTAR ROBERTSON. (PHOTO: JOAN COSTA)

IMAGE OPPOSITE/ JOAN COSTA

Research Program Leaders

Our Program Leaders include members leading or representing the Institute in significant state, national and international research programs and forums. Program Leaders form the Institute's scientific committee and help to strengthen and expand its capacity in marine research. The leaders are (in alphabetical order):

Winthrop Professor Mark Cassidy is Deputy Director of The UWA Oceans Institute and Director of The UWA Centre for Offshore Foundations. His research interests are in offshore geotechnics and engineering, predominantly developing wave-structure-soli interaction models for the analysis of oil and gas platforms, mobile drillings and pipe lines. Professor Cassidy is a fellow of both the Australian Academy of Technological Sciences and Engineering and the Institution of Engineers Australia, holds The Lloyd's Register Educational Trust Chair of Offshore Foundations and is Deputy Director of the ARC Centre of Excellence for Geotechnical Science and Engineering.

Winthrop Professor Shaun P. Collin is a WA Premier's Research Fellow and heads the Neuroecology Group at The UWA Oceans Institute and School of Animal Biology. His team investigates the neural basis of behaviour in both Invertebrates and vertebrates – with a strong focus on sharks - and with special emphasis on sensory systems and vision. He uses a range of neurobiological and ecological methods to understand the environmental pressures on aquatic biodiversity. Professor Collin is a member of the Technology and Innovation Advisory Council (TIAC) for the WA State Government and oversees a number of large research Programs.

Winthrop Professor Carlos M. Duarte is Director of The UWA Oceans Institute and a Research Professor with the Spanish National Research Council (CSIC) at the Mediterranean Institute for Advanced Studies (IMEDEA). His research focuses on the effects of global change in marine ecosystems. Professor Duarte is a member of the Scientific Council of the European Scientific Council, the highest-level scientific committee in the EU, and presently leads research projects in the Mediterranean, Europe, the Arctic and global projects.

Professor Euan Harvey is a marine ecologist at The UWA Oceans Institute and School of Plant Biology. His research focuses on the demography and population dynamics of fish; in particular how fish assemblages respond to human impacts. He has been developing fishery independent, non-destructive sampling techniques using stereo-video systems-such as baited remote underwater stereo-video stations (Stereo BRUVs) and Diver Operated stereo-video (Stereo-DOVs) and leads research aiming to incrementally automate the recognition and measurement of fish in stereo-video imagery. Professor Harvey is the coordinator for years 1-5 for the marine science program at UWA.

Winthrop Professor Greg Ivey is Deputy Dean and Deputy Dean Research in the Faculty of Engineering, Computing and Mathematics, and is Professor of Geophysical Fluid Dynamics in the School of Environmental Systems Engineering and the UWA Oceans Institute. His research is in the area of physical oceanography, focusing on ocean mixing, internal waves and cyclonic forcing in the shelf and coastal regions. Professor Ivey is a program leader in the WAMSI Kimberley Marine Research Program (KMRP).

Winthrop Professor Gary Kendrick is a marine ecologist at the UWA Oceans Institute and school of Plant Biology whose research focuses on diversity and function in species-rich algal assemblages and species-poor seagrass landscapes with the goal to understand the linkages between species distributions, their genetics and biology, species interactions and the physical environment. Present research focusses on stressors to shallow phytobenthos and system thresholds with an emphasis on effects of desalination outfalls, dredging plumes, and nutrient enrichment.

Winthrop Professor Malcolm McCulloch is a WA Premier's Research Fellow at The UWA Oceans Institute and School of Earth and Environment and is one of two Deputy Directors at the ARC Centre of Excellence in Coral Reef Studies. His research addresses the impacts of climate change and direct human activities on coral reefs. Professor McCulloch is a Fellow of The Royal Society (London) and the Australian Academy of Science, among other societies, and was awarded the Jaeger Medal for career excellence in the earth sciences from the Australian Academy of Sciences, and an Honorary Doctorate from Curtin University. He was also recently awarded an ARC Laureate Fellowship (mid 2012) which will commence in 2013.

Professor Jessica Meeuwig is the Director of the Centre for Marine Futures at The UWA Oceans Institute and School of Animal Biology. Her team documents the structure of reef and open water fish communities using innovative video techniques to understand how these communities respond to human impacts, including fishing, oil spills protection afforded via marine reserves. Professor Meeuwig is aConservation Fellow of the Zoological Society of London and adjunct Professor at the University of British Columbia's Fisheries Research Centre.

Winthrop Professor Charitha Pattiaratchi is head of School at UWA's School of Environmental Systems Engineering. His research interests are in coastal physical oceanography and coastal sediment transport, with emphasis on field experiments and numerical modelling. He has a particular interest in ocean observation systems using ocean gliders, and is facility leader at the Australian national facility for Ocean Gliders (ANFOG). Professor Pattiaratchi is the node leader for the WA Integrated Marine Observing System (WAIMOS) and Project leader for the SEA-SERPENT project.

Winthrop Professor Anya Waite is a biological oceanographer at the UWA Oceans Institute and School of Environmental Systems Engineering. Her research interests include the biogeochemistry of ocean eddies, particle dynamics and aggregation. Her field work has targeted oceanography and food web structure of Ningaloo Reef, and the feeding habits of Western Rock Lobster larvae and Whale sharks. Professor Waite is a member of the Board of Directors of the Association for the Sciences of limnology and Oceanography (ASLO).

Members
across Schools and Centres

Oceans Institute Members

Prof Susana Agusti
School of Plant Biology

Asst/Prof Bryan Boruff
School of Earth and Environment

Dr Anne Brearley
School of Plant Biology

Dr Marion Cambridge
School of Plant Biology

W/Prof Mark Cassidy
Centre for Offshore Foundation Systems

Asst/Prof Julian Clifton
School of Earth and Environment

Assoc/Prof Peta Clode
Centre for Microscopy, Characterisation & Analysis

W/Prof Shaun Collin
School of Animal Biology

Assoc/Prof Wayne Davies
School of Animal Biology

Asst/Prof Scott Draper
Centre for Offshore Foundation Systems

W/Prof Carlos Duarte
UWA Oceans Institute

Prof Christophe Gaudin
Centre for Offshore Foundation Systems

Assoc/Prof Anas Ghadounai
School of Environmental Systems Engineering

Assoc/Prof Atakelty Hailu
School of Agriculture and Resource Economics

Assoc/Prof Nathan Hart
School of Animal Biology

Prof Euan Harvey
School of Plant Biology

Assoc/Prof Jan Hemmi
School of Animal Biology

Assoc/Prof Matthew Hipsey
School of Earth and Environment

Assoc/Prof Muhammad Hossain
Centre for Offshore Foundation Systems

W/Prof David Hunt
School of Animal Biology

W/Prof Greg Ivey
School of Environmental Systems Engineering

Asst/Prof Nicole Jones
School of Environmental Systems Engineering

W/Prof Gary Kendrick
School of Plant Biology

Prof Ryan Lowe
School of Earth and Environment

W/Prof Malcolm McCulloch
School of Earth and Environment

Prof Jessica Meeuwig
Centre for Marine Futures

Asst/Prof Nicola Mitchell
School of Animal Biology

W/Prof David Pannell
School of Agriculture and Resource Economics

W/Prof Chari Pattiaratchi
School of Environmental Systems Engineering

Asst/Prof Natasha Pauli
School of Earth and Environment

Assoc/Prof David Sutton
School of Chemistry and Biochemistry

Prof Erika Techera
Law School

Asst/Prof Julie Trotter
School of Earth and Environment

Assoc/Prof Kimberly van Niel
School of Earth and Environment

W/Prof Anya Waite
School of Environmental Systems Engineering

Assoc/Prof Thomas Wernberg
School of Plant Biology

Ms Barbara Wueringer
School of Animal Biology

Dr Kara Yopak
School of Animal Biology

Assoc/Prof Elizabeth Sinclair
School of Plant Biology

Associate Members

Dr Pauline Grierson
School of Plant Biology

Prof Alistair Paterson
School of Social Sciences – Archaeology

Asst/Prof Petra Buergelt
Centre for Social Impact

Post Doctoral / Research Associate

Dr Peter Coulsen
Centre for Marine Futures

Asst/Prof Jim Falter
School of Earth and Environment

Dr Monica Gagliano
Centre for Microscopy, Characterisation & Analysis

Dr Ivan Haigh
School of Environmental Systems Engineering

Asst/Prof Christine Hanson
School of Environmental Systems Engineering

Dr Jean-Paul Hobbs
School of Plant Biology

Mr Ben Hollings
School of Environmental Systems Engineering

Dr Renee Hovey
School of Earth and Environment

Asst/Prof Flo Kaempf
School of Environmental Systems Engineering

Mr Samuel Kelly
School of Environmental Systems Engineering

Dr Timothy Langlois
UWA Oceans Institute

Ms Bonnie Laverock
School of Plant Biology

Asst/Prof Tom Letessier
Centre for Marine Futures

Dr Cordelia Moore
School of Earth and Environment

Asst/Prof Adam Rountrey
Centre for Marine Futures

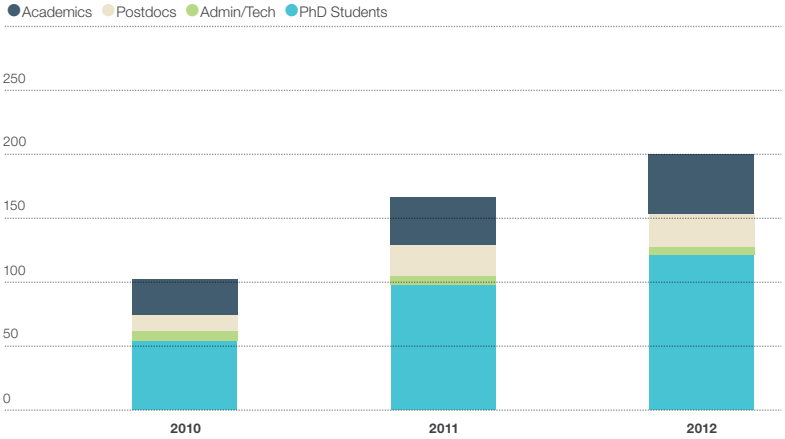
Dr Oscar Serrano Gras
UWA Oceans Institute /
School of Plant Biology

Mr Dennis Stanley
School of Environmental Systems Engineering

Asst/Prof Michael Stat
Centre for Microscopy, Characterisation & Analysis

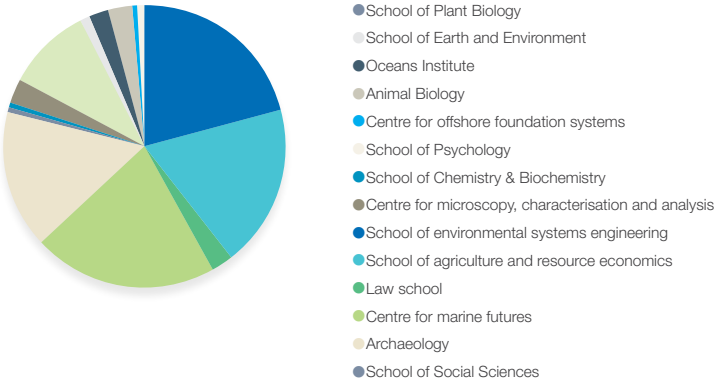
Mr John Statton
School of Plant Biology

Members Growth



Total number of members and students in 2010, 2011 and 2012

Distribution of members across Schools and Centres



Dr Paul Thomson
School of Environmental Systems Engineering

Dr Michele Thums
School of Environmental Systems Engineering

Dr Sarath Wijeratne
School of Environmental Systems Engineering

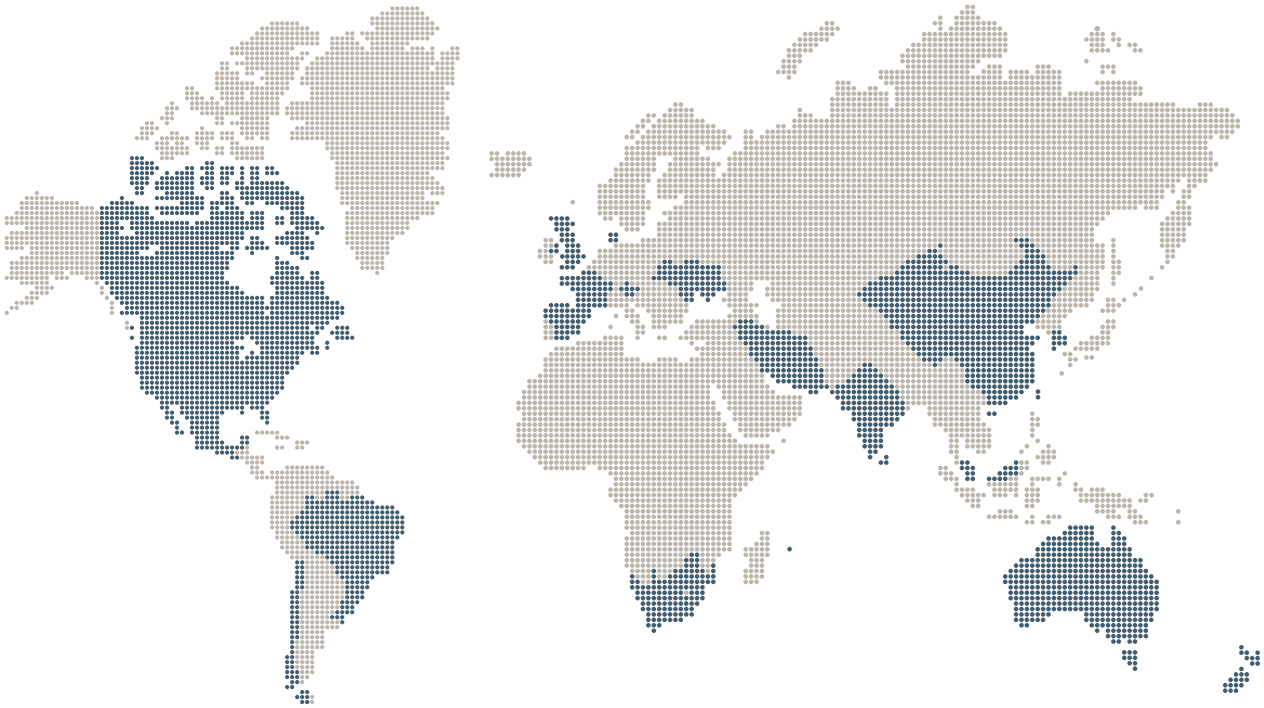
Asst/Prof Jens Zinke
School of Earth and Environment

Adjunct Appointments

Dr Tim Cooper BHP Billiton
Dr Martial Depczynski AIMS
Dr Paul Erftemiejer SKM
Dr Stuart Field DEC
Dr Rebecca Fisher AIMS
Dr Kim Friedman DEC
Dr James Gilmour AIMS
Dr Ivan Haigh
University of Southampton
Dr Nick Hardman-Mountford
CSIRO
Dr Andrew Heyward AIMS
Dr Ross Jones AIMS
Dr Mark Meekan AIMS
Dr Jamie Oliver AIMS
Dr Ben Radford AIMS
Dr Tyrone Ridgeway Oceanica
Dr Michael Rule DEC
Dr Christine Schoenberg AIMS
Dr Oscar Serrano Gras ECU
Dr Jim Underwood AIMS
Dr Fred Wells Consultant
Dr Shaun Wilson DEC

PhD Students

Shanta Barley	JC
Luciana Cerqueira Ferreira	JM
Beverly Oh	JM
Phil Bouchet	JM
James Hehre	JM
Janelle Braithwaite	JM
Issam Rasadi	JM
Jamie Tedeschi	NM
Gabriel Vianna	JM
Leia Howes	NM
Audrey Appudurai	SC
Lucille Chapuis	SC
Joao Coimbra	NH
Fanny de Busserolles	SC
Eduardo Garza Gisholt	SC
Ryan Kempster	SC
Anton Kuhar	SC
Nicolas Nagloo	NH
Amy Newman	SC
Stephanie Marjanovich	SC
Carlos Salas	SC
Rachael Warrington	SC
Laura Ryan	NH
Santiram Chatterjee	DW
Steven Cheng	MC
Indranil Guha	DW
Omid Kohan	MC
Pan Hu	MC
Vickie Kong	MC
Chengcai Lu	LC
Jiajia Ma	MR
Jalal Mirzadehniasa	MK
Lucile Queau	MK
Amin Rismanchian	DW
Fauzan Sahdi	DW
Divya S.K.Mana	SG
Hamed Poornaki	NB
Yue Yan	DW
Bassem Youssef	MC
Zack Westgate	DW
Beau Whitney	DW
Youhu Zhang	BB
Ehssan Zargar	MK
Jake Asher	EH
Scott Bennett	TW
Samantha Childs	GK
Adrian Ferguson	EH
Ben Ford	EH
Matthew Fraser	GK
Steve Lindfield	EH
Margie Mohring	TW
Jillian Ooi	GK
Julia Santana Garcon	EH
David Rivers	GK
Luke Thomas	GK
Katherine Cure	EH
Bijo Arackal	TW
Jordan Goetze	EH
Tiffany Simpson	TW
Jean-Philippe Dumas	TW
Jessie Short	MM
Napo Cayabyab	RL
Sana Dandan	MM
Taryn Foster	MM
Alice Gedaria	MH
Gayan Gunaratne	MH
Jung Ok Kang	MM
Yu Li	MH
Ana Ruibal	MH
Leonardo Ruiz Montoya	RL
Zhenlin Zhang	RL
Liza Roger	MM
Lucy Georgiou	MM
Mark Buckley	RL
Andrew Pomeroy	RL
Renee Gruber	RL
Jiangtao Xu	GI



Danielle Barrington	GI
Cynthia Bluteau	GI
Olga Bondarenko	CP
Cyprien Bosserelle	CP
Paul Branson	GI
Eloise Brown	CO
Asha de Vos	CP
Alexis Espinosa-Gayosso	GI
Shari Gallop	CP
Yasha Hetzel	CP
Saskia Hinrichs	AW
Shabab Hosseini	GI
Conor Mines	GI
Matthew Rayson	GI
Julia Reisser	CP
Darshani Thotagamuwage	CP
Lei Tien	GI
Jennifer Penton	CP
Thisara Welhena	CP
Eric Raes	AW
Martin James McLaughlin	CP
Sarik Salim	CP
Taj Sarker	MG
Wandres Moritz	CP
Kim Lema	PC
Caroline Coombs	SK
Damna Alzahrani	ET
Polzer Mark	AP

KEY

AP Alistair Paterson	MC Mark Cassidy
AW Anya Waite	MR Mark Randolph
BB Britta Bienen	MH Matthew Hipsey
CO Carolyn Oldham	MK Mehrdad Kimiaei
CP Chari Pattiaratchi	NH Nathan Hart
DW Dave White	NM Nicola Mitchell
ET Erika Techera	NB Noel Boyland
EH Euan Harvey	PC Peta Clode
GK Gary Kendrick	RL Ryan Lowe
GI Greg Ivey	SC Shaun Collin
JM Jessica Meeuwig	SK Stuart Kaye
LC Liang Cheng	SG Susie Gourvenec
MM Malcolm McCulloch	TW Thomas Wernberg
MG Marco Ghisalberti	TL Timothy Langlois

Highlights

IMAGE/JOAN COSTA

ARC funding awarded for innovative coral research

One of the UWA Oceans Institute's most senior scientists, Winthrop Professor Malcolm McCulloch, was awarded an Australia Research Council Laureate Fellowship that will allow him to extend his trailblazing work on the effects of climate change on corals.

The Fellowship – worth $3.2 million over five years – will help Professor McCulloch investigate the future of coral reefs and marine calcifiers in response to rising carbon dioxide and ocean acidification.

The research will be undertaken along Western Australia's coast but will apply world-wide.

Professor McCulloch is a WA Premier's Fellow and also works at the School of Earth and Environment. He is associate director of the ARC Centre of Excellence in Coral Reef Studies based at the UWA campus.

The Laureate Fellowship scheme aims to attract world-class researchers who can play a significant leadership and mentoring role in building Australia's internationally competitive research capacity.

Professor McCulloch's Laureate Fellowship follows earlier successes in securing ARC funding.

Four other members of the UWA Oceans Institute took up their ARC Future Fellowship appointments in 2012, with funding totalling:

- Associate Professor Thomas Wernberg being awarded $697,000 for his research involving seaweeds;
- Professor Ryan Lowe being awarded $681,000 for his work on waves, currents and water levels around coastal reef environments;
- Dr Wayne Davies being awarded $714,000 to investigate the molecular mechanisms underlying non-visual photoreception and their implications in the treatment of human neurological disease; and
- Dr Jan Hemmi being awarded $712,000 for his neuroecology research looking at how the brain processes information under natural conditions.

IMAGE ABOVE / WINTHROP PROFESSOR MALCOLM MCCULLOCH (PHOTO: JOAN COSTA)

Biodiversity Hotspot: extreme climatic events alters marine ecosystem structure

Researchers at the UWA Oceans Institute have examined the ecological impacts of a record-breaking ocean heatwave, which swept along the WA coast in early 2011.

IMAGES/ THOMAS WERNBERG

The extreme warming event decimated habitat-forming seaweeds, with one species being eliminated from about 100km of coastline in the Jurien Bay region. These seaweeds provide vital habitat for an interdependent web of marine plants and animals, and the ensuring shifts in local biodiversity patterns could have far-reaching implications for the shallow water ecosystem.

In contrast, some warm water fish species increased in abundance at the Jurien Bay study sites, 250km north of Perth, resulting in a relative 'tropicalisation' of the fish fauna. Further north at the Abrolhos Islands, the heatwave caused widespread bleaching of some corals and abnormal levels of 'biofouling' on kelps.

The ecological impacts of the warming event were published in the journals Nature Climate Change, Proceedings of the Royal Society B and Coral Reefs. The lead authors, Dr Dan Smale and ARC Future Fellow, Associate Professor Thomas Wernberg, are from the UWA Oceans Institute and School of Plant Biology, the Australian Institute of Marine Science and the Marine Biological Association of the UK.

The studies examine the impact of the region's most extreme warming event which began in December 2010 and peaked in March 2011. At its worst, ocean temperatures at Jurien Bay were five degrees higher than normal and for many weeks sea temperatures along more than 2000km of the WA coastline were two to four degrees higher than normal.

"We've surveyed this coastline at three locations – Hamelin Bay, Marmion Lagoon and Jurien Bay – almost every year since 2006," Dr Smale said. "Following the heatwave we found that the seaweed Scytothalia dorycarpa – a prominent habitat-forming species along the temperate coastline – retracted its range some 100km because the extreme temperatures exceeded its physiological threshold. The dominant kelp Ecklonia radiata was also severely impacted."

Dr Wernberg, who leads the research program, said "We were surprised by the magnitude of ecological effects that we observed, and especially by how quickly the large, habitat-forming seaweeds were impacted. These seaweeds form the basis of the marine food web and provide habitat for a myriad of other organisms. Over time, continued surveys along the coastline will ascertain whether the ecosystem will eventually return to 'normal'. The heatwave may have far-reaching implications for the structure and functioning of the marine ecosystem in the region, which is a global biodiversity hotspot." The authors comment that, "extreme climate events are increasing in frequency and magnitude as a consequence of human activities, and in the last 30 years, the number of days of anomalously high seawater temperatures has increased along 38 per cent of the world's coastlines. Understanding ecological thresholds and how these discrete disturbances drive abrupt ecological change is of fundamental importance to climate change mitigation and adaption."

Wernberg T, Smale, DA, Tuya F, Thomsen MS, **Langlois TJ**, de Bettignies T, **Bennett S** and Rousseaux CS (2012). An extreme climatic event alters marine ecosystem structure in a global biodiversity hotspot. Nature Climate Change, 3: 78-82, DOI: 10.1038/NCLIMATE1627

Smale, DA and Wernberg, T. (2013) Extreme climatic event drives range contraction of a habitat-forming species Proceedings of the Royal Society B, 280: 1754 20122829; doi:10.1098/rspb.2012.2829 1471-2954

Smale, DA, Wernberg, T., 2012. Ecological observations associated with an anomalous warming event at the Houtman Abrolhos Islands, Western Australia. Coral Reefs 31, 441; 10.1007/s00338-012-0873-4

IMAGE/ TWIN SISTER OF THE 10 M DIAMETER CENTRIFUGE TO BE INSTALLED IN THE NEW IOMRC BUILDING (PHOTO COURTESY OF THE KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY).

COFS further cements its international standing

The Centre for Offshore Foundation Systems (COFS) further cemented its international reputation in 2012 with a series of appointments, events and research awards. These include the following highlights:

Shell EMI Chair

Professor David White was appointed as the inaugural Shell EMI (Energy and Minerals Institute) Professorial Chair in Offshore Engineering. Professor White is an Australian Research Council Future Fellow who joined COFS seven years ago, and in 2011 he was named WA Early Career Scientist of the Year. As Shell EMI Chair, he will lead an enhanced research and education program focusing on offshore engineering, building on UWA's capabilities and serving the needs of local and international industry.

Lloyd's oration

Winthrop Professor Mark Randolph attracted an international audience to UWA when he delivered the first Lloyd's Educational Trust oration on Geotechnical Engineering on and off the North-West Shelf of Australia. Professor Randolph, an internationally renowned engineer and founder of COFS, outlined how COFS came about and the innovative technologies it has helped develop in order to serve the offshore oil and gas sector. The event was attended by Michael Franklin, the Director of The Lloyd's Educational Trust (renamed Lloyd's Register Foundation as of 1 March 2013), who flew out especially from London for the event.The educational charity provides some $2.4 million to COFS to help fund The Lloyd's Register Educational Trust Centre of Excellence and the LRET Chair of Offshore Foundation Systems.

International medal winners

Three COFS researchers – Professor Christophe Gaudin, Winthrop Professor Mark Cassidy and Associate Professor Britta Bienen – were awarded the international Geotechnical Research Medal in 2012, which was presented at an awards ceremony in London. The medal was awarded by the Institution of Civil Engineers (UK) for the trio's paper: Investigation of the Potential of Bottom Water Jetting to Ease Spudcan Extraction in Soft Clay.

Centrifuge planning gathers momentum

Planning is underway for the COFS's new $1.58 million centrifuge to be built in the proposed Indian Ocean Marine Research Centre at UWA. The 10-metre diameter centrifuge will be capable of spinning 2.4 tonnes of soil at up to 100 times the force of Earth's gravity, and will be the third centrifuge to be based at COFS, making its facilities among the best in the world. The funding is being provided by the Australian Research Council, UWA and partner organisations.

Conservation and Management of Sharks: Law and Legal Governance

Professor Erika Techera's research explores the role of law in shark conservation and management and ways to improve legal frameworks.

Global shark populations are under a growing threat from human activity but only two of the international legal instruments that protect sharks are legally binding: Convention on Migratory Species (CMS) and the Convention on International Trade in Endangered Species (CITES). CMS signatories have signed up to a Memorandum of Understanding and a Conservation Plan for sharks.

In 2012 the parties agreed that involvement in CMS should go beyond States and that greater participation of NGOs, scientists and fishing industry representatives is needed. The meeting also recommended that sharks be landed with their fins naturally attached, aimed at reducing the practice of live finning. Ultimately, however, the CMS Memorandum is not legally binding and only 50 States have signed the document and by extension committed to the Conservation Plan.

The other legally binding international instrument is CITES which regulates international trade in species listed under the treaty. Three sharks are currently listed and in preparation for the next CITES meeting, seven further species of sharks and manta rays have been submitted for listing. However even if these listings are successful, the vast majority of more than 1000 species of shark (including at least 95 migratory species) will remain unprotected and unregulated at the global level.

Professor Techera argues that "the overall legal framework is not comprehensive, the result is that international law offers at best only a limited level of protection for sharks."

She has recently been awarded an ARC Discovery grant to improve the international governance of sharks. "This three year project will enhance international laws and institutions for shark conservation and management by confronting obstacles that prevent existing laws working better, identifying best practice global governance options and highlighting opportunities for legal reform," Professor Techera said.

There are other non-binding global agreements aimed at addressing shark conservation and management, such as the FAO International Plan of Action on Sharks, which calls on countries to adopt National Plans of Action for Sharks. Although Australia has done so, the majority of nations have not, and where Plans have been developed they are inconsistent.

Nevertheless, there has been important progress around the world and in a study published in the *International Journal of Marine and Coastal Law* Professor Techera has focused on legal developments in the Pacific region. "Another approach to improving the conservation status of sharks is to educate and engage the public through eco-tourism," Professor Techera said. "Marine-based tourism may provide economic, educational and environmental benefits but is not without risks to people, animals and the environment. If the benefits of this sector are to be harnessed an increasing focus upon law and policy governing the industry is essential. Australia has a longstanding history of tourism involving whale sharks and great white sharks and an examination of Australian law and policy in shark eco-tourism provides a powerful case study."

Professor Techera's most recent article in Marine Policy addresses this topic as a first step towards identification of best practice legal strategies that both support the industry and ensure environmental integrity.

Techera EJ, 'Fishing, Finning and Tourism: Trends in Pacific shark conservation and management' (2012) 27(3) International Journal of Marine and Coastal Law 1-25.

Techera EJ and Klein N (2012). The role of law in shark-based eco-tourism: lessons from Australia. Marine Policy 39: 21–28.

ARC Discovery Project (DP13) – N Klein & **E Techera** – Improving the Global Governance of Sharks: Obstacles, Options and Opportunities

IMAGE/ ANDREW HEYWARD AND ANDREW NEGRI (AIMS).

Coral Clones: The secret lives of corals on dark and stormy nights

A study published in the prestigious international journal *Science* revealed for the first time that coral offspring have the unique ability to form genetic clones of themselves before they settle and develop into adult corals.

Coral 'offspring' are usually the result of sexual reproduction – eggs are fertilised either before or after being released by the parent coral into the surrounding water. These fertilised eggs are carried by ocean currents before settling at new locations. Coral "clones", on the other hand, are genetic replicas of the parent coral, for example, if waves generated in a storm break up a coral colony, the remnant parts may continue to survive as independent but genetically identical individuals; a faculty that most animals do not possess.

The Australian Institute of Marine Science's Dr Andrew Heyward (also an Adjunct Professor with the Oceans Institute) and Dr Andrew Negri suspected that fertilised coral eggs (embryos) might also break up because unlike most animal embryos, coral embryos lack a protective outer-layer or membrane; they are so called 'naked' embryos.

The scientists were able to create turbulent conditions in the laboratory by pouring embryos floating in seawater over a vertical distance of 30cm. "This effectively mimics the kind of wave height generated by moderate wind speeds where small breaking waves, commonly called whitecaps, occur. That sort of weather is often encountered during a night of coral spawning on the Great Barrier Reef," Dr Negri said. "So it's highly likely that this fragmentation occurs regularly on nights when corals release their eggs. Almost half of all these naked embryos fragmented in our experiments, suggesting that this has long been part of the corals' repertoire for maximising the impact of their reproductive efforts. This mixed breeding system means colonising corals benefit simultaneously from the advantages of both sexual and asexual reproduction," Dr Heyward said.

"Much like humans, it's important that the offspring of corals have genetically distinct parents, but these embryos also readily clone to form multiple versions of themselves, and helps to explain how coral maximise their chances of finding a suitable habitat in which to settle and survive. "In human terms this is the equivalent of giving birth to identical twins, triplets, quadruplets and so on. This is another example of the complexity of these incredible animals and suggests that there may be more to learn about the lives of corals and their interaction with the environment," Dr Heyward said.

Heyward AJ and **Negri AP** (2012). Turbulence, cleavage and the naked embryo: a case for coral clones. Science 335(6072): 1064, doi: 10.1126/science.1216055.

IMAGE/ JOAN COSTA

Corals: Coping with the acidification of the world's oceans

Corals may be better placed to cope with the gradual acidification of the world's oceans than previously thought – giving rise to hopes that coral reefs might escape climatic devastation.

Two research projects, led by Premier's Research Fellow Winthrop Professor Malcolm McCulloch and published in the journals Nature Climate Change and Geochimica et Cosmochimica Acta, identified a powerful internal mechanism that could enable some corals and their symbiotic algae to counter the adverse impact of a more acidic ocean. As humans release ever-larger amounts of carbon dioxide into the atmosphere, besides warming the planet, the gas is also turning the world's oceans more acidic, at rates thought to far exceed those seen during past major extinctions of life.

In the ground-breaking research, international teams including scientists from Australia's ARC Centre of Excellence for Coral Reef Studies, at The University of Western Australia have shown that some marine organisms that form calcium carbonate skeletons have an in-built mechanism to cope with ocean acidification - which others appear to lack. "The good news is that most corals appear to have this internal ability to buffer rising acidity of seawater and still form good, solid skeletons," Professor Malcolm McCulloch said. "Marine organisms that form calcium carbonate skeletons generally produce it in one of two forms, known as aragonite and calcite. Our research broadly suggests that those with skeletons made of aragonite have the coping mechanism – while those that follow the calcite pathway generally do less well under more acidic conditions. But the picture for coral reefs as a whole isn't quite so straightforward, as the 'glue' that holds coral reefs together – coralline algae - appear to be vulnerable to rising acidity," Professor McCulloch explained.

The researchers conclude "Although our results indicate that up-regulation of pH at the site of calcification provides corals with enhanced resilience to the effects of ocean acidification, the overall health of coral reef systems is still largely dependent on the compounding effects of increasing thermal stress from global warming and local environmental impacts, such as terrestrial runoff, pollution and overfishing."

McCulloch M, **Falter J, Trotter J** and Montagna P (2012). Coral resilience to ocean acidification and global warming through pH up-regulation. Nature Climate Change 2(8): 623–627.

McCulloch M, **Trotter J**, Montagna P, **Falter J**, Dunbar R, Freiwald A, Försterra G, López Correa M, Maier C, Rüggeberg A and Taviani M (2012). Resilience of cold-water scleractinian corals to ocean acidification: boron isotopic systematics of pH and saturation state up-regulation. Geochimica et Cosmochimica Acta 87: 21–34.

Expanding capabilities

The UWA Oceans Institute is committed to expanding the interdisciplinary membership of researchers to better position the Institute to find solutions to Humanity's Grand Challenges.

To enable the delivery of Ocean Solutions we increasingly require the collaboration of researchers from a diverse range of disciplines to undertake research which is truly interdisciplinary in nature.

The Oceans Institute provides a mechanism for researchers from science, engineering, law, social sciences and economics to come together to engage in effective interdisciplinary research collaborations. In 2012, the Institute recruited new members from the disciplines of Law, Archaeology and Social Science to further strengthen our capabilities.

Law

Professor Erika Techera from the UWA Faculty of Law joined the Oceans Institute in January 2012. She is an environmental lawyer whose research interests focus on international and comparative environmental law. She has researched and published in a number of different areas focusing on the governance of marine protected areas and marine species protection, including regulatory aspects of shark fishing, finning and tourism. Her other research interests include cultural heritage law (in particular the safeguarding of intangible and underwater cultural heritage) and indigenous peoples and the law (focusing on the Pacific Island states). Professor Techera further strengthens the Institute's ability to consider issues of marine law and governance in diverse research areas including shark attack mitigation and marine spatial planning.

Archaeology

Professor Alistair Paterson is an archaeologist whose research and teaching covers culture contact, historical archaeology in maritime and terrestrial settings, and archaeological and historical methodology. Professor Paterson, who joined the Oceans Institute in January 2012, undertakes much of his research in northern Western Australia, an area of focus for the Institute.

Professor Paterson is involved in a partnership between the Western Australian (WA) Museum and the British Museum. This partnership focuses on an international collaboration on exhibition and research projects, and it will re-evaluate collections related to Western Australia, the Indian Ocean, and the wider world. Expertise in marine archaeology will better position the Institute to address issues of historical and cultural preservation within large multidisciplinary research projects.

Social Science

Assistant Professor Petra Beurgelt from UWA's Centre of Social Impact joined the Oceans Institute in March 2012. She is a social, community and environmental psychologist with an interdisciplinary (horticulture, anthropology, sociology, and communication), intersectional (academia, business, NGO, government) and intersocietal background. Using an ecological framework, Assistant Professor Beurgelt has extensive expertise in cross-disciplinary, mixed-methods and qualitative research that focuses on capturing complexity and processes across time and space/place. Petra is experienced in conducting a wide variety of qualitative data collection methods (in-depth interviews, participant observation, diaries, focus groups) and in the systematic qualitative analysis of social-ecological influences on adaptation to risk, major change and crisis (especially natural hazards and migration).

Research is increasingly evaluated on contributions to social impact. The quality and degree to which research is able make a real difference for people, communities and societies is determined by the ability to both understand human behaviour and communities and to work effectively together with communities. Developing an understanding of human behaviour, and the valuable methods social scientists can provide for collaborating, is one crucial pathway in which the social scientists are enabling the Oceans Institute to provide Solutions Science.

The Shark Challenge: Mitigation versus Protection and Conservation

Community concerns and the impact of a burgeoning oil and gas industry in Western Australia are among the driving forces behind Oceans Institute researchers who are leading world research into better understanding the behaviour of sharks.

Shark Mitigation

The Neuroecology Group at UWA's Oceans Institute and the School of Animal Biology is spearheading new research into the biology and behavior of sharks in a race to protect these apex predators amid mounting community concerns about their seemingly increasing presence at popular swimming beaches.

The Western Australia government announced $2 million in funding for shark hazard-reduction research in response to one of the worst years for shark attacks in the State's history, resulting in five fatalities.

The grants for research are being spread over the next three years, with $646,000 over two years allocated to fund three major Oceans Institute studies into shark detection and deterrents.

WA Premier's Fellow and Winthrop Professor Shaun Collin, who leads the Neuroecology Group, is a world leader in shark sensory biology. He is testing the effectiveness of the existing "shark shield" and other electric devices, which emit an electronic pulse said to repel sharks. However, he is also interested in testing acoustic deterrents.

There are only a few scientific studies about the hearing abilities of sharks and Professor Collin's group is believed to be the only group worldwide currently working to translate this basic research into developing non-lethal means of repelling sharks.

"What we're interested in is what frequency and intensity range sharks of various species can hear," Professor Collin said. "We cannot begin to understand how to develop deterrents under different conditions without a basic understanding of these senses and the sensitivity thresholds under which they operate in the shark's natural environment".

"Based on this knowledge, we can then produce sounds of the right intensity and frequency that we know the sharks will respond to but will be uncomfortable to them and subsequently change their behaviour. We do know that the sensory abilities of every species is different ,so we need to focus our attention on specific species", he said.

Another project is lead by Associate Professor Nathan Hart, who is developing and testing new shark deterrents, including the innovative use of bubble curtains, strobe lights and sub aquatic sounds.

Winthrop Professor Mohammed Bennamoun, from the School of Computer Science and Software Engineering, is also collaborating with the Oceans Institute researchers to develop advanced vision systems for automatic shark detection.

"These animals form a very important part of the food chain and they are being decimated worldwide," Professor Collin said. "If we start culling because of these attacks, which are still extremely rare, we are also going to upset the fine balance of our aquatic ecosystems."

IMAGE/ JOAN COSTA
IMAGE OPPOSITE/ JACQUI McGHIE

Exploring the possibilities

Associate Professor Hart is already working with Professor Collin to develop shark attack deterrent wetsuits in a project co-funded by the WA company Dunbar Harper and the WA Government.

Dr Kara Yopak, of the Neuroecology Group, also looked at the visual systems of sharks and found that with great white sharks, the area of the brain that receives visual input is quite large, suggesting the relative importance of vision in these animals is quite high.

"This information may direct researchers' efforts towards targeting the visual system when developing repellents for this species," Dr Yopak said.

Although sharks were previously thought to have relatively simple brains, the Oceans Institute researchers have shown that sharks and other cartilaginous fishes have a battery of highly developed sensory systems and relatively large brains.

Other papers produced by the researchers in the year focused on using body scarring to identify and tag whale sharks in Mexico for better management programs; the mating and reproduction habits of sharks and rays; and a study of Spain's blue shark catch and policy implications for enforcing a European Union ban on shark finning.

Whale Shark Conservation

Oceans Institute and Australian Institute of Marine Science researchers have been collaborating on research that is delivering new insights into the little-known behaviour of whale sharks.

Research undertaken by Dr Michele Thums and Dr Mark Meekan (AIMS) found that the world's biggest fish can dive to chilly waters hundreds of metres deep but they need to return to the surface to warm up. "When we looked at our data, we found that the whale sharks spent regular intervals at the surface between diving bouts. This pattern of returning to the surface looked similar to the patterns seen in air-breathing marine animals, so we were curious as to why fish that do not breathe air would do it," Dr Thums said.

The study involved four whale sharks: three at Ningaloo Reef off the north west coast of Western Australia and one at Christmas Island. The sharks were tagged with time-depth recorders that also recorded water temperatures. The researchers found that after the deepest and coldest dives - an average 340 metres deep with temperatures of about 14 degrees Celsius – the sharks spent the longest time at the surface, an average of 145 minutes.

Dr Thums concluded that they need to do so to regulate their body temperature - in effect, to warm up after spending time in the deeper, colder parts of the sea. "Whale sharks, like many other fish are ectothermic, which means that their body temperature is similar to the surrounding water temperature and they can't regulate their body temperature through internal physiological processes."

This important research was published online on October 2012 in the Journal of Royal Society Interface. The researchers are continuing to work on better understanding the whale sharks' behaviour in an effort to develop effective conservation and management strategies, as well as predicting responses to environmental changes.

Whale sharks were also the focus of research looking into the effects of ecotourism on whale sharks. This research was undertaken by Dr Mark Meekan and Mr Rob Sanzogni and was funded by Apache Energy Ltd and supported by the Western Australian Department of Environment and Conservation).

The research which was carried out over a 5-year period at Ningaloo Reef in Western Australia suggested that ecotourism – when well-regulated – does not affect whale sharks. Results indicated that sharks that frequently encounter tourists are just as likely to return to the reef as sharks that rarely interact with tourists.

"Our research shows that the code of conduct used by the Department of Environment and Conservation to protect whale sharks is very effective with no detectable impacts of tourists on their aggregation behaviour at Ningaloo across years," says lead author Rob Sanzogni.

Into the Future

Through partnerships with government research organisations and industry, the UWA Oceans Institute continues to provide valuable scientific information to decision making bodies as well as focusing on delivering solutions for the State in their goal to address risk.

Jellyfish Blooms: Questioning the rise in the world's oceans

New research put speculation about a global increase in jellyfish blooms to the test and established an important body of evidence on which to base reliable scientific assessments of global trends.

In three separate papers, published over the course of 2012, teams of international marine scientists, including UWA Oceans Institute Director, Winthrop Professor Carlos Duarte, sought to better understand jellyfish behaviour.

In the paper, "Questioning the rise of gelatinous zooplankton in the world's oceans", published in *BioScience*, researchers assembled more than 500,000 records dating back to 1750 to form a community-based Jellyfish Database Initiative (JEDI). The team of 30 experts from the international Global Jellyfish Group found that jellyfish numbers had risen in some places such as Japan but decreased or fluctuated elsewhere, there was no evidence of an overall increase.

The second paper, "Is Global Ocean Sprawl a Trojan Horse for Jellyfish Blooms?" found an increase in man-made structures such as harbours, tourist facilities, oil rigs and aquaculture farms is providing ideal sanctuaries for jellyfish polyps to flourish. The study examined the tiny polyp phase of jellyfish and found they congregate at densities of more than 10,000 individuals per square metre, and sometimes up to 100,000 per square metre, on the underside of man-made structures. "We call this new proposition the 'Trojan Horse' hypothesis," Professor Duarte said.

The third international study found no real evidence of a global increase in jellyfish over the past two centuries. The results of the study, "Recurrent Jellyfish Blooms are a Consequence of Global Oscillations", appeared in the *Proceedings of the National Academy of Science*. The research was led by Dr Rob Condon of the Dauphin Island Sea Lab in Alabama, US with experts from the Global Jellyfish Group, including lead co-author Professor Duarte. Key finding of the study shows global jellyfish populations undergo concurrent oscillations with successive decadal periods of rise and fall, including a rising phase in the 1990s and early 2000s that has contributed to the current perception of a global increase in jellyfish.

"There are major consequences for getting the answer correct for tourism, fisheries and management decisions as they relate to climate change and changing ocean environments," Professor Duarte said. "The important aspect about our work is that we have provided the long-term baseline backed with all data available to science, which will enable scientists to build on and eventually repeat these analyses in a decade or two from now so to determine whether there has been a real increase in jellyfish. The more we know, the better we can manage oceanic ecosystems or respond accurately to future effects of climate change."

IMAGE RIGHT/ *CRAMBIONE MASTIGOPHORA* BROOME, AUSTRALIA (PHOTO: JAMES BROWN)

Condon RH, Graham WM, **Duarte CM**, Pitt KA, Lucas CH, Haddock SHD, Sutherland KR, Robinson KL, Dawson MN, Decker MB, Mills CE, Purcell JE, Malej A, Mianzan H, Uye S, Gelcich S, Madin LP (2012). Questioning the rise of gelatinous zooplankton in the world's oceans. Bioscience 62(2): 160–169.

Duarte CM, Pitt K, Lucas C, Purcell J, S.-I. Uye, Robinson K, Brotz L, Decker MB, sutherlandKR, Malek A, Madin LP, Mianzan H, J.- M. Gili, Fuentes V, Atienza D, Pagés F, Breitburg D, Malek J, Graham WM, condon RH. Is Global ocean sprawl a trojan Horse for jellyfish Blooms? Frontiers in Ecology and the Environment, doi: 10.1890/110246.

Condon RH, **Duarte CM**, Pitt KA, Robinson KL, Lucas CH, sutherland KR, Mianzan HW, Bogeberg M, Purcell JE, Decker MB, S.-I. Uye, Madin LP, Brodeur RD, Haddockn SHD, Malejo A, Parryp GD, Eriksen E, Quiñones J, Acha M, Harvey M, Arthur JM, Graham WM. 2012. Recurrent jellyfish Blooms are a consequence of Global oscillations. Proceedings of the national Academy of science of the Us, doi: 10.1073/1210920110

Sawfish: New research breaks the myth about their Saw

Scientists thought that sawfish used their saw to probe the seabed for food, however a UWA Oceans Institute researcher found that these large and endangered fish actually use the saw to locate and dismember free-swimming fish.

In an international collaboration for an aquarium fish collector based in Cairns, researchers led by Ms Barbara Wueringer uncovered that, contrary to previous assumptions, a sawfish's saw can actually sense electric fields to locate and attack prey. The discovery disproves the assumption that sawfish are purely bottom feeders that use their saw to rake the sandy bottom, and it provides evidence that the fish who develop in freshwater river systems also feed closer to the surface. The discovery, published in the journal *Current Biology*, could help save the sawfish from extinction by providing vital information for captive breeding programs and strategies to save them from falling victim to commercial fishing nets.

IMAGE ABOVE/ BARBARA WUERINGER (PHOTO: TROY LECHNER).
IMAGE RIGHT/ DAVID WACHENFELD.

Sawfish share a common ancestry with shovelnose rays and it's believed they evolved their saw-like rostrum with teeth on the outside to extend their niche in the underwater world. Once common in tropical and subtropical regions, freshwater sawfish spend their young life in river systems until they reach adulthood (about age 10 and at least three metres long) when they move into the ocean. Sawfish feed on catfish, mullet and freshwater prawns, four species, which are protected in Australia, and are found in the northern half of the country.

"Despite their worldwide decline, there is an indication the population in Australia is still in good condition," Ms Wueringer said. "Officially they have never been targeted and so they are caught only as by-catch. The more we know about them the better we can protect them. The first step might be to develop by-catch diversion strategies, and for captive sawfish, we can make sure they get the right stimuli to survive and reproduce."

Wueringer BE, Squire Jr L, Kajiura SM, **Hart NS** and **Collin SP** (2012). The function of the sawfish's saw. *Current Biology* 22(5): 150–151.

IMAGES/ JOAN COSTA

Seagrass Ecosystems: A significant global carbon stock

Researchers at the UWA Oceans Institute contributed to the first global analysis of carbon stored in seagrasses, which shows they can hold as much carbon as the world's temperate and tropical forests.

The study 'Seagrass Ecosystems as a Globally Significant Carbon Stock,' published in the journal Nature Geoscience provides further evidence of the important role the world's declining seagrass meadows have to play in mitigating climate change. Results gathered from 3640 observations of 946 distinct seagrass meadows across the globe revealed that coastal seagrass beds store up to 83,000 metric tons of carbon per square kilometre, mostly in the soils below them. In comparison, a typical land forest stores around 30,000 metric tons per square kilometre.

The research also estimates that, although seagrass meadows occupy less than 0.2 per cent of the world's oceans, they are responsible for more than 10 per cent of all 'blue carbon' stores buried annually in the ocean and rival carbon stores in the extensive peat deposits of mangroves. Data sets as deep as one metre were concentrated in Florida Bay, USA; the Spanish coast of the Western Mediterranean; and Shark Bay, Western Australia.

The greatest concentration of carbon found was in the Mediterranean where seagrass meadows stored carbon many metres deep. According to the study, seagrass meadows store ninety per cent of their carbon in the soil and continue to build on this indefinitely. Winthrop Professors Gary Kendrick and Carlos Duarte contributed to the study led by Professor James Fourqurean, a professor of biology at Florida International University. "These results show that seagrass meadows are key sites for carbon storage and probably are far more important as carbon dioxide sinks than we realised," Professor Kendrick said.

Seagrasses are among the world's most threatened ecosystems. Around 29 per cent of all historic seagrass meadows have been destroyed, mainly due to dredging and degradation of water quality and a further 1.5 per cent of seagrass meadows are lost each year. The study estimates that emissions from destruction of seagrass meadows can potentially emit up to 25 per cent as much carbon as deforestation on land. "The good news is if seagrass meadows are restored they can effectively and rapidly reestablish lost carbon sinks and stores as well as providing a range of other valuable ecosystem benefits, including water quality protection, and as an important biodiversity habitat," Professor Kendrick said.

Fourqurean JW, **Duarte CM**, Kennedy H, Marbà N, Holmer M, Mateo MA, Apostolaki ET, **Kendrick GA**, Krause-Jensen D, McGlathery KJ, Serrano O, 2012. Seagrass ecosystems as a significant global carbon stock. nature Geosciences 5: 505-509

Research Areas

IMAGE/ JOAN COSTA

IMAGE/ JOAN COSTA

Blue Water oceanography

The UWA Oceans Institute is a significant research provider in oceanography, with a focus on observations in biological, biogeochemical and physical oceanography, as well as the numerical modelling of coupled ocean physical-biological processes.

Biological oceanography: We are investigating the drivers of productivity and carbon flow in plankton food webs, including the regulation of settling fluxes; the role of environmental conditions in driving plankton dynamics, and the impact of global change (such as persistent organic pollutants, enhanced UV radiation, ocean warming and ocean acidification) on oceanic plankton communities. This includes coupling between physical ocean dynamics and meroplankton dynamics.

Megafauna oceanography: This emerging field uses megafauna, such as sea lions or turtles, to sample the oceans. Instrumenting megafauna with small CTD and other oceanography sensors allows us a new opportunity to sample the oceans in the way megafauna do. Because these animals are engaged in very long-range migrations, they provide data of the oceanographic structures they encounter and also sample the oceans in a deliberate way, searching the structures that conform to their requirements (feeding, reproduction, etc.).

Ocean biogeochemistry: Our research is focused on carbon and nutrient fluxes in the ocean ecosystem (ranging from local to global scales), the role of micronutrients and trace elements in driving ocean production, and the exchanges of carbon and biogenic elements between the atmosphere and the mixed layer, as well as between the mixed layer and the ocean interior.

Physical oceanography: We focus on the field and numerical modeling of the physical properties of the ocean (such as ocean circulation and temperature variability). These are based on principles of fluid mechanics that can be transferred across regions, as well as on coupled physical-biological models. In addition, this research examines ocean optics, particularly UV penetration and absorption in the ocean ecosystems, and the dynamics of ocean systems forced by tidal stirring.

IMAGE/ JOAN COSTA

Coastal Processes

The UWA Oceans Institute conducts research on coastal processes, including observations, modelling and forecasts of tidal forcing of coastal environments, wave dynamics, sea level rise and sediment transport, interactions between organisms and flows, as well as transport processes across the continental shelf.

This research is complemented with an intense activity in the development and operation of coastal observing systems and remote vehicles, particularly gliders.

This research component is essential to determine risks and threats to WA coastal areas, and includes the leadership of the Australian node of the Indian Ocean tsunami alert system.

Continental Shelf Processes: The broad continental shelf around Australia represents the world's third largest economic exclusive zone, and delivers much of the wealth driving Australia's prosperity, including oil and gas, mineral and fisheries resources. Understanding continental shelf processes, ranging from physical transport and exchanges with the open-ocean, deep-water formation, biogeochemical processes and biological productivity is essential to resolve the drivers of biodiversity in Australia's Continental Shelf and ensure that resources and wealth can be derived from the continent shelf while maintaining healthy coastal ecosystems. This research assesses the coupled physical, chemical and biological dynamics of the continental shelf and its interactions with the adjacent boundaries, open ocean, coast and atmosphere.

Estuarine Processes: Estuaries are sites on unique biodiversity and intense biogeochemical cycles, affected by both open-ocean and river and watershed processes. Estuaries are highly vulnerable to human impacts in their watershed and climate change, which may affect ecosystem structure and the value of the ecosystem services estuaries deliver to society. Estuaries are sandwiched between impacts derived from human activities in the watershed and those derived from human impacts on coastal processes. As a consequence, the health of estuaries is often compromised, with a proliferation of eutrophication, hypoxia and contamination issues. This research focuses on understanding the drivers of estuarine health and formulating ecological, managerial and engineering solutions to improve their status and resilience.

Nearshore processes: The shore line is the most valuable and yet most vulnerable component of the ocean. Near-shore processes affect sediment transport, beach stability and erosion, and the stability and performance of key infrastructure located nearshore. This research processes assesses, in an interdisciplinary manner, the processes affecting the stability and dynamics of the nearshore environment.

Marine Ecology

The UWA Oceans Institute conducts research on the dynamics and structure of a broad range of marine ecosystems, communities and populations, with particular emphasis of those ecosystems most important in the Indian Ocean.

Coral reef ecology: We use quantitative, process-based methods to gain an understanding of present and past reef growth, metabolism, and calcification rates in relation to environmental factors. The research addresses the functioning of the entire reef ecosystem, from the individual components, including reef fauna and symbiotic zooxanthella, to whole-system processes, such as metabolic rates.

Fish ecology: We study the demography and population dynamics of fish, habitat requirements and the evolutionary ecology of fish. Over the past 15 years, we have developed an ongoing range of non-destructive sampling techniques using stereo-video cameras to achieve this.

IMAGE/ JOAN COSTA

Marine biomineralisation: We are investigating the formation of complex natural structures, such as teeth, shells and skeletons. Using a range of cutting-edge imaging and characterisation techniques, our researchers investigate cellular structure-function relationships, crystal formation and growth, structure and properties of organic scaffolds, elemental uptake pathways and distributions, and the immunological properties of biomineralised tissues.

Microbial ecology: Our research aims to improve understanding of the diversity, roles and relationships of marine micro-organisms. We address the biodiversity, interactions and ecology of free-living, epiphytic and symbiotic marine bacteria.

Marine neurobiology: Our researchers use innovative neurobiological techniques to investigate the neural basis of behaviour in marine organisms. Such techniques include molecular genetics, microspectrophotometry, bioimaging, electrophysiology and anatomy to trace the evolution of light detection and image formation, and to explore the impacts of light on biodiversity, sustainability and environmental health.

In addition to both basic and applied studies of the influences of light on animal behaviour, other sensory modalities are now being investigated, including the detection of chemosensory signals, electric fields, water borne sound and hydrodynamic disturbances.

Marine Plant ecology: This research area centres on the production and population dynamics of seagrass ecosystems, including understanding their responses and recovery from pressures, their role in carbon cycling in the coastal zone, and the dynamics of seagrass landscapes.

Spatial ecology: We focus on the description and understanding of the drivers and patterns of both species and assemblage distribution. Some of the techniques used are continuous coverage mapping, specialising in waters too deep for spectral remote sensing, and distribution modelling.

Ocean Engineering

The UWA Oceans Institute conducts research to advance the safe extraction of resources in the marine environment to derive energy, food and water from the oceans and the sea floor and transport it safely to land.

Because of the growth of these activities in Western Australia, the Oceans Institute is perfectly located to build strong relationships with industry and other organisations.

The challenge of ocean engineers is to design, build and maintain the structures used to extract and transport marine resources so that they run effectively, safely and with minimal damage to the environment.

Ocean engineers not only need a combination of skills derived from the disciplines of civil, mechanical and electrical engineering; they also require a thorough understanding of other oceanographic disciplines such as marine biology, chemical and physical oceanography, marine geology and geophysics.

Offshore foundation systems: For more than twelve years the Centre for Offshore Foundation Systems (COFS) has been researching the mechanics of seabed sediments, offshore foundation systems, the stability of offshore platforms, pipeline and deep water offshore engineering and marine geohazards.

The Centre consistently produces research findings of international standard and recognition. World-class facilities have allowed UWA to service the offshore oil and gas industry at a national and international level.

COFS has one of the largest teams of internationally recognised researchers and engineers in offshore geomechanics in the world. COFS also maintains world-leading geotechnical centrifuge and soils testing equipment.

Marine Energy Deep sea environments can be very harsh and pose many challenges to both fixed and floating structures such as offshore oil rigs.

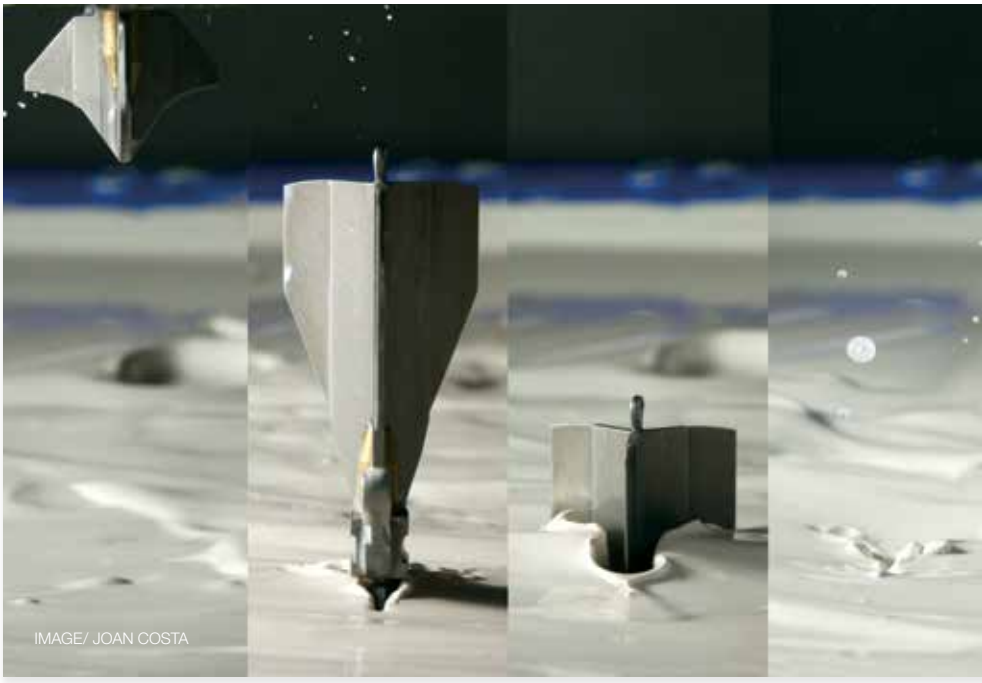
One of the greatest challenges in building structures that can survive these conditions is the different loads that the structures experience during installation as they are lowered to the sea floor.

UWA researchers are investigating dynamic lifting factors to determine safer practices for subsea installations and the development of installation vessels. We also study the structural fatigue from ocean currents, called vortex-induced motions, to improve designs.

Floating structures used for oil and gas production, such as large tankers moored to the sea floor, behave in an unpredictable manner when sea states get complex.

For example, the research team is studying the motion response of one of these floating structures in seas where the long-period swells and short-term seas approach from different directions, as is common in north-west WA.

In the near-shore area, we have investigated the behaviour of concrete gravity structures when in close proximity to the seabed during tow-out from casting basins, and have researched wave-breaking and run-up in coastal structures.



IMAGE/ JOAN COSTA

Marine Biological Resources, Management, Governance and Conservation

Research at the UWA Oceans Institute provides a basis to inform effective policies and management frameworks, while conserving functional and diverse marine ecosystems.

This is a challenge that requires the integration of expertise — now possible under the broad collaborative and interdisciplinary platform that the Institute provides to align and articulate research capabilities in natural and social sciences and technologies.

Integrated coastal management: Integrated coastal management is a dynamic, multidisciplinary and iterative process to promote sustainable management of our coasts. The UWA Oceans Institute brings together researchers who have a wealth of experience in their particular fields. The synergies of this research will provide ocean solutions that maintain the balance between resources for human development and protecting the underlying biodiversity and ecosystems that support these resources.

Maritime Archaeology: This area covers culture contact, historical archaeology in maritime and terrestrial settings, sheep and cattle pastoralism, European colonization, historical rock art, and archaeological and historical methodology. Most of this is in Western Australia, particularly in the Pilbara and Kimberly.

Marine biotechnology: Unlocking the genome of marine organisms has opened the door to new opportunities across a range of industries, including food, cosmetic, biomedical and energy. A key focus of the Institute is the use of living marine resources — from entire organisms to molecules to genes — to solve problems and deliver key innovations.

Marine conservation: By combining natural and social sciences, we can translate existing science into policy outcomes. The Oceans Institute helps to break down barriers to effective management of the marine environment, leading to the conservation of biodiversity and cultural heritage.

Maritime law, management and governance: This area involves spatial planning in the marine environment, national and international regulatory frameworks for biodiversity conservation, the governance of economic exclusive zones and areas beyond national jurisdiction in the Indian Ocean, and the governance of new and emerging maritime sectors and activities.

Marine resource economics: We focus on the valuation of marine ecosystem resources and services in support of policy and management, and aim to shape positive public perception and attitudes toward the marine environment.

Marine spatial planning: Our research provides the basis for safe and sustainable human operation in the marine environment. We evaluate the risks and synergies, both positive and negative, involved in the interactions between human activities – from fishing and boating to offshore exploration and drilling — and the sensitive biological and cultural elements therein. We consider the social and psychological drivers of perceived conflicts and reluctance towards innovation; and provide governance frameworks that adequately address the complexity inherent to the continuity and connectivity of the marine environment.

IMAGE/ JOAN COSTA

IMAGE/ JOAN COSTA

Impacts of Climate Change in the Marine Environment

The UWA Oceans Institute is focusing its research strengths and capacities to understand, forecast and mitigate the impacts of climate change on the marine environment.

Climate change is arguably one of the greatest challenges affecting the functionality and health of our oceans, as well as the safety of our operations at, or near, the marine environment. Since the trajectories and impacts of climate change are strongly dependent on societal and technological factors, the Institute's strong interdisciplinary capacity positions us as a key resource to provide knowledge to guide society and policy to address this important problem.

Adaptation and mitigation of climate change: The deep understanding of the marine environment, delivered through an interdisciplinary approach, offers multiple opportunities to deploy strategies to mitigate climate change. We can achieve this by increasing the supply of energy from marine renewable sources or enhancing natural marine carbon sinks. We can also adapt to climate change through the use of ecosystems to dissipate energy, reduce coastal flooding and erosion, and by adaptively managing marine resources to accommodate their trajectories with climate change.

Carbon pools, cycling and sequestration in the marine environment: The capacity of the oceans to remove CO2 from the atmosphere is one of the key buffers to climate change. We are researching and quantifying the capacity of marine ecosystems to act as carbon sinks, which is of fundamental importance to forecast future climate trajectories. Similarly, the increased CO2 in seawater is causing ocean acidification, which may adversely affect marine organisms such as calcifiers — the essential components of our valuable coral reefs.

Impacts of climate change on marine ecosystems: We are building an understanding of the responses of marine organisms, communities and ecosystems to climate change. The goal is to forecast trajectories in biodiversity conservation and ecosystem function, and to intervene through management strategies and policies aimed at maintaining healthy ecosystems.

Multiple stressors in the marine environment: Climate change trajectories occur in parallel to major changes in other important components of the Earth System. We are investigating the compounding effects of changes in UV radiation; changes in the cycles of nitrogen, phosphorus, water and other key elements; and changes in the loads and range of pollutants reaching the marine environment.

Sea level rise, coastal flooding and surges: Climate change is forecast to accelerate sea level rise, but the impact of this rise will vary greatly along the world's coasts. Rising water levels are compounded by long-term cycles and a range of other factors — such as changes in precipitation patterns, land use and coastal erosion — that need be considered in predictions of regional sea level rise and to assess the risk of coastal floods.

IMAGE/ JOAN COSTA

Marine Observation, Monitoring & Risk Management

The UWA Oceans Institute is committed to the need to observe and monitor the marine environment. Our researchers deliver the knowledge and data required to detect changes, identify their drivers, and manage the risks associated with natural changes or those resulting from the increased scale of human operation in the marine environment.

Marine forecast: We focus on generating capabilities in operational oceanography and the development of models able to forecast changes in the marine environment and the response of the marine ecosystem.

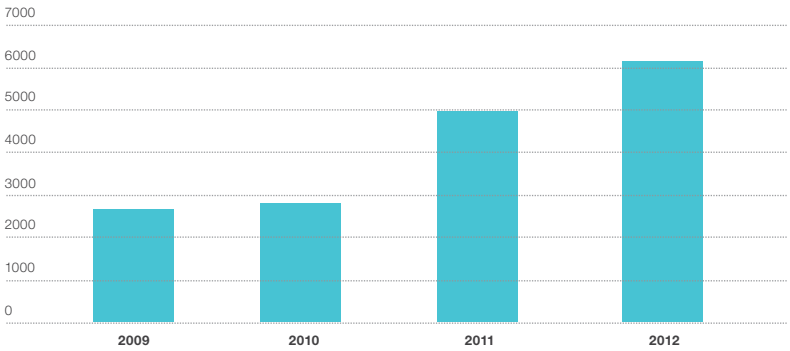
Marine observation: Observing the oceans is critical for all of the Institute's goals. We observe the oceans through an array of technologies, including advanced gliders — hosting the National Glider Facility, part of the Australian Integrated Marine Observing System (IMOS) — mooring systems, surveys using towed videos, baited video arrays, investigating changes in the carbon chemistry of our coastal and marine systems, and the reconstruction of past conditions through records extracted from corals and other biological structures.

Risk management: We study the impacts — both individuals and communities — of extreme natural events, human-induced hazards and changes to our climate, and use our expertise to inform policies and strategies to minimise the impacts from these risks. Our goal is to help build resilience and the adaptive capacity of coastal populations despite increased interactions between societies and the oceans.

Tsunami alert systems: Oceans Institute researchers are leading participants in the Coordinating Group for the Indian Ocean Tsunami Warning and Mitigation System, and are active in modelling tsunamis to better assess risks and defence strategies.

Impact

Total citations❶

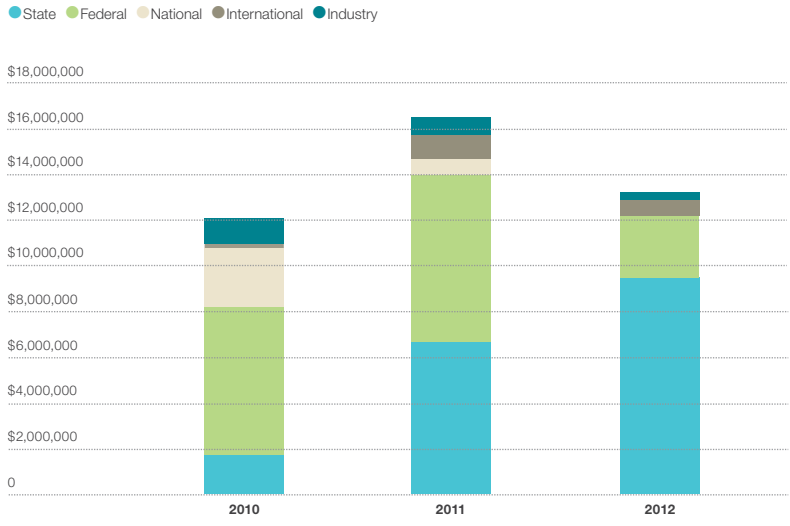


❶ Total citations for peer-reviewed journal articles by Oceans Institute members

Citations

The number of cites received by UWA Oceans Institute members continue to grow, at rates much faster than the growth in members. This provides evidence of the growing impacts of the research conducted the UWA Oceans Institute.

Funding sources❷



❷ Sources of funding for the Oceans Institute over 2010, 2011 and 2012 and total funding for that year.

Funding Sources

The funding received from Federal sources has declined somewhat, largely due to the cycling of ARC calls as well as delays in the timing of some of the calls in 2012. However, research funding from State sources has shown a healthy growth, now becoming, for the first time, the top source of research income at the UWA Oceans Institute.

Collaborations

IMAGE/ JOAN COSTA

Industry and Government collaborations

Industry and Government connection is vital to the UWA Oceans Institute. It provides a mechanism for many outreach activities and further proves the relevance and impact of our research and initiatives such as the Ocean Solutions Dialogue Series.

KEY

- S Sponsoring Organisation
- F Source of Research Founding
- O Participants in Dialogues & Other Activities
- A Advisory work with Oceans Institute

The UWA Oceans Institute continues to focus on growth and development of their collaborations with industry and government, leading to many multi-dimensional relationships.

Organisation

- Antarctic Climate & Ecosystems CRC — O
- Aquaculture Council Western Australia — O
- Australian Fisheries Management Authority — O
- Australian Government Department of Foreign Affairs and Trade (DFAT) — A
- Australian Government Oceans Policy Advisory Group (OSPAG) — A
- Australian Institute of Marine Science (AIMS) — S F O A
- Australian National Environmental Research Program (NERP) — F
- Australian National Network in Marine Science — F O
- Australian Petroleum Production and Exploration Association Ltd (APPEA) — O A
- Australian Research Council (ARC) — F
- Carnegie Wave Energy Ltd. — F O
- Chevron — O
- Cocks Macnish — O
- Commonwealth Department of Climate Change — O
- Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) — O
- Conservation Council of Western Australia — O
- Conservation International — A
- Fisheries Research and Development Corporation (FRDC) — F
- Integrated Ocean Observing System — F
- Ocean Nourishment Corporation — F
- Parsons Brickehoff — O
- Pew Environment Group — O
- Rio Tinto Iron Ore — O
- Shell Australia — S F O
- Shire Exmouth — A
- Sinclair Knight Merz — O
- South West Catchment Corporation — O
- Southseas Abalone Ltd. — O
- The Aquarium of Western Australia (AQWA) — A
- The Commonwealth Scientific and Industrial Research Organisation (CSIRO) — S F O A
- The Water Corporation — O
- UNESCO Intergovernmental Oceanographic Commission — O
- WA Department of Commerce — F
- WA Department of Environment and Conservation — F O A
- WA Department of Fire and Emergency Services — O
- WA Department of Fisheries — S F O A
- WA Department of Indigenous Affairs — O
- WA Department of State Development — A
- WA Department of Transport — F O
- West Australian Integrated Marine Observation System — O
- Western Australia Energy Research Alliance (WA:ERA) — F O
- Western Australian Fishing Industry Council Inc. (WAFIC) — A
- Western Australian Marine Science Initiative (WAMSI) — F O
- Woodside — O
- Worley Parsons — O
- WWF — O

International and National collaborations

The UWA Oceans Institute was conceived as a platform for collaborative research, delivering the critical mass and interdisciplinary capability required to address key questions around the oceans. Collaborative research both within the University and with our national and international partners is a key tenet of the Oceans Institute.

In a world where no single person or even organization boasts the sum of knowledge in a given research field, collaboration has become more crucial than ever, and by strengthening and expanding our collaborative network we are addressing gaps in our own research capacities, increasing the quality and impact of research outcomes, and setting the Institute on a path of future growth.

In 2012 our members published scientific papers in collaboration with 227 institutions (up from 113 institutions in 2011) – around the state, the nation, and internationally, doubling the number of research partners we had in 2011. Of all scientific publications, more than half involved international collaboration – in total with 37 different countries (up from 23 countries in 2011). USA, the United Kingdom, Spain and Germany represented the Oceans Institute's strongest international links.

The Ocean Institute's collaborative partners include:

ARGENTINA
- CONICET
- Instituto Nacional de Investigación y Desarrollo Pesquero
- Museo Argentino de Ciencias Naturales
- Universidad Nacional de Mar del Plata

AUSTRALIA
- Australian Commonwealth Scientific Industrial and Research Organisation (CSIRO)
- Australian Institute of Marine Science (AIMS)
- Australian National University
- Botanic Gardens and Parks Authority
- Cairns Marine
- Centre for Environment and Life Sciences (CSIRO)
- Centre for Marine Ecosystems Research
- Curtin University
- Deakin University
- WA Department of Environment and Conservation
- WA Department of Fisheries
- Edith Cowan University
- Griffith University
- James Cook University
- Kings Park and Botanic Garden
- Lions Eye Institute
- Macquarie University
- Mindabbie Marine Consulting
- Monash University
- Murdoch University
- Museum of Tropical Queensland
- Queensland Department of Environment and Heritage Protection
- Reef Channel
- South Australian Research and Development Institute
- The University of Adelaide
- The University of Queensland
- University of New South Wales
- University of Sydney
- University of Tasmania
- Western Australian Fisheries and Marine Research Laboratories

BELGIUM
- Ghent University

BERMUDA
- Bermuda Institute of Ocean Sciences

BRAZIL
- Núcleo de Educação e Monitoramento Ambiental (NEMA)
- Universidade Federal do Rio Grande

CANADA
- Queen's University
- University of Alberta
- University of British Columbia
- Institut Maurice-Lamontagne
- University of Saskatchewan
- University of Vancouver

CHILE
- Catholic University of Santiago
- Huinay Scientific Field Station
- Pontificia Universidad Católica de Valparaíso

CHINA
- Ocean University of China
- Northeast Dalian University
- Jiangsu Institute of Parasitic Diseases

CROATIA
- Institute of Oceanography and Fisheries

DENMARK
- Aarhus University
- Technical University of Denmark
- University of Southern Denmark

FRANCE
- IFREMER
- Institut de Recherche pour le développement
- Laboratoire des Sciences du Climat et de l'Environnement
- Laboratoire d'Océanographie de Villefranche-sur-Mer
- Muséum National d'Histoire Naturelle
- Universite Paris-Diderot
- Université de la Réunion

GERMANY
- Helmholtz-Zentrum fur Ozeanforschung Kiel (GEOMAR)
- Humboldt University
- Leibniz Center for Tropical Marine Ecology
- Max-Planck-Institut für Chemie
- Senckenberg am Meer
- Universität Erlangen-Nürnberg
- University of Bonn
- University of Applied Sciences
- Carl von Ossietzky University

GREECE
- Helenic Centre for Marine Research

INDONESIA
- Universitas Nusa Cendana

IRELAND
- University of Dublin

ISRAEL
- Israel Oceanographic and Limnological Research

ITALY
- Institute of Marine Sciences
- ISMAR – CNR

JAPAN
- The University of Tokyo
- Hiroshima University

MADAGASCAR
- Institut Halieutique et des Sciences Marines

MALAYSIA
- University of Malaya

MEXICO
- Centro de Investigaciones Biológicas del Noroeste
- Tiburón Ballena México proyecto de Conciencia México
- Proyecto Domino
- Comisión Nacional de Áreas Naturales Protegidas
- Universidad Nacional de Áreas Naturales Protegidas
- Universidad Nacional Autonoma de Mexico

MONACO
- Centre Scientifique de Monaco

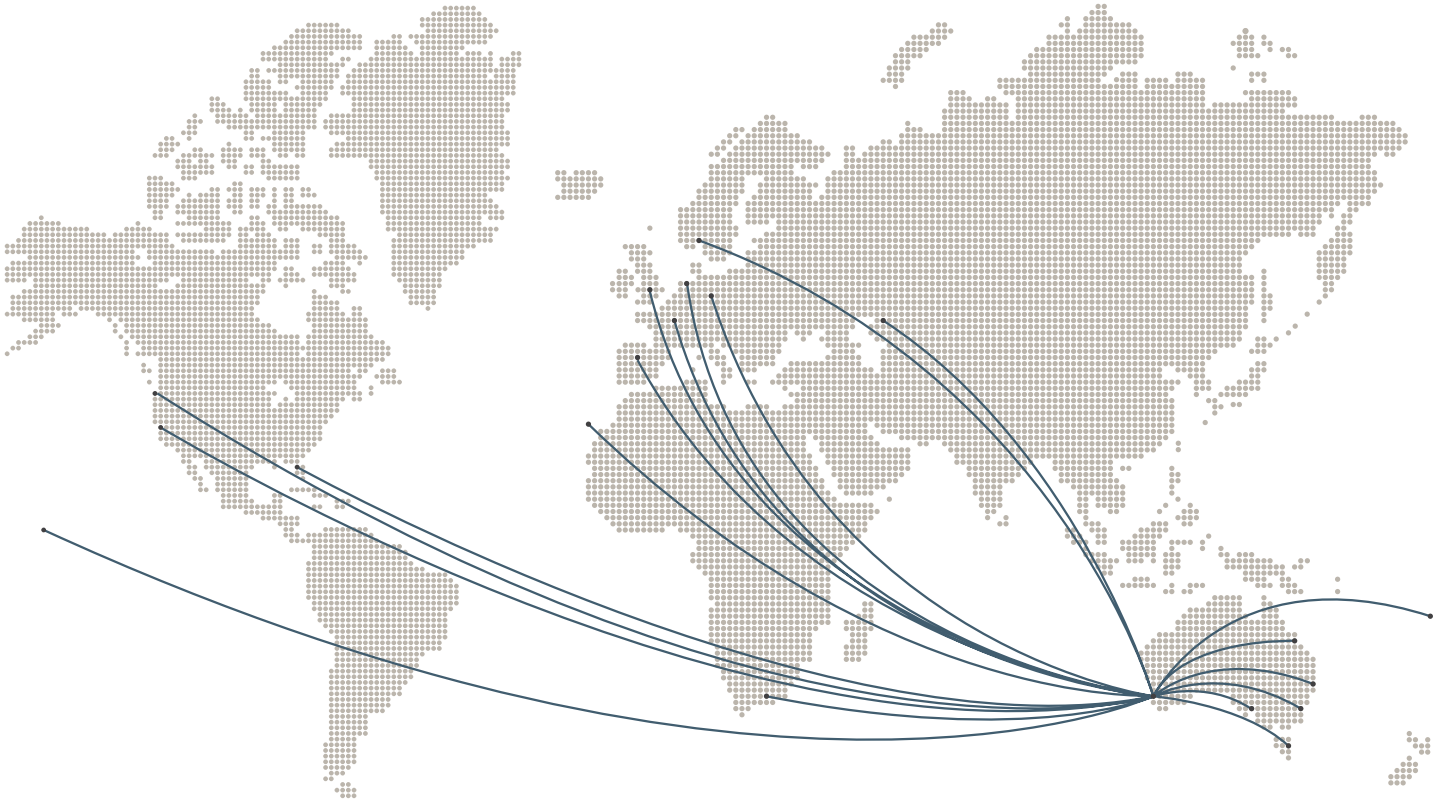
NEW ZEALAND
- Museum of New Zealand Te Papa Tongarewa
- New Zealand Institute for Advanced Study
- The Cawthron Institute
- University of Auckland
- University of Canterbury
- University of Otago

NORTHERN IRELAND
- University of Ulster

NORWAY
- University of Tromso
- Institut of Marine Research

PERU
- Instituto del Mar del Peru

PORTUGAL
- CIIMAR
- Universidad do Algarve



- Universidade de Évora
- Universidade de Lisboa
- University of Fernando Pessoa

SAMOA
- Secretariat of the Pacific Regional Environment Programme

SAUDI ARABIA
- Kind Abdullah University of Science and Technology

SEYCHELLES
- UNDP

SINGAPORE
- Keppel Offshore & Marine Technology Centre
- Institute of Mollecular and Cell Biology
- National University of Singapore

SLOVENIA
- National Institute of Biology

SOUTH AFRICA
- Nelson Mandela Metropolitan University
- University of Witwatersrand

SPAIN
- CRAM Foundation
- CSIC, CEAB
- CSIC, ICM
- CSIC, IDAEA
- CSIC, IFISC
- CSIC, IMEDEA
- Universidad de las Palmas de Gran Canaria
- University of Barcelona

SWEDEN
- Lund University

THAILAND
- Burapha University

THE NETHERLANDS
- Delft University of Technology
- Department ZKS and Department HYE
- NIOZ Royal Netherlands Institute for Sea Research
- Royal Netherlands Institute of Marine Science
- University of Amsterdam
- Vrije Universiteit Amsterdam
- VU University

UK
- Aberystwyth University
- Bangor University
- Bristol University
- Marine Biological Association of the UK
- Moorfields Eye Hospital
- National Oceanography Centre
- Natural Environment Research Council
- Nature Boureau
- Plymouth Marine Laboratory
- Scottish Marine Institute
- Southampton University
- University College of London
- University of Cambridge
- University of Essex
- University of Exeter
- University of Hull
- University of Oxford
- University of Plymouth
- University of Southampton
- University of York
- University of St Andrews
- British Antarctic Survey
- Scottish Universities Environmental Research Centre
- University of Wales
- Newcastle University
- Central Manchester Foundation Trust

USA
- American Museum of Natural History
- Berkeley Geochronology Centre
- California Institute of Technology
- Columbia University
- Dauphin Island Sea Lab (DISL)
- Duke University Medical Center
- Farallon Institute for Advanced Ecosystem Research
- Florida Atlantic University
- Florida International University
- Gettysbourgh College
- Hawaii Institute of Marine Biology
- Institute of Ecosystem Studies
- Marquette University
- Monterey Bay Aquarium Research Institute
- NASA
- National Oceanic and Atmospheric Administration Fisheries Service
- NOAA National Marine Fisheries Service
- Ocean Alliance
- Oregon State University
- Purdue University
- Shannon Point Marine Center
- The Citadel (The Military College of South Carolina)
- The Ocean Foundation
- UC Santa Barbara
- Universities Space Research Association/ Global Modeling and Assimilation Office
- University of Arizona
- University of California
- University of California Santa Barbara
- University of Connecticut
- University of Georgia
- University of Hawaii
- University of Illinois
- University of Maryland
- University of Miami
- University of North Carolina at Chapel Hill
- University of Rochester
- University of South Alabama
- University of Southern Mississippi
- University of Texas
- University of Washington
- Wildlife Conservation Society (WCS)
- Woods Hole Oceanographic Institution
- Yale University
- University of Oregon
- Northwest Fisheries Science Center
- Midwestern University
- Dartmouth College
- Cornell University
- University of Iowa
- The University of California
- The Smithsonian Institute
- University of Virginia
- University of Alabama
- Stanford University

IMAGE/ ARTIST IMPRESSION, CRAWLEY FACILITY

Indian Ocean Marine Research Centre

Throughout the year, the UWA Oceans Institute worked closely with partners involved with the largest marine research partnership in the Southern Hemisphere – the Indian Ocean Marine Research Centre.

Consisting of four collaborating organisations, the Indian Ocean Marine Research Centre will lead scientific research into one of the world's least explored marine environments.

Participating partners are:

- Australian Institute of Marine Science (AIMS)
- Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- Department of Fisheries, Western Australia
- The University of Western Australia

With the vision to drive global knowledge of the Indian Ocean marine environment and its sustainable management, the Indian Ocean Marine Research Centre will be the largest marine science partnership in the Southern Hemisphere and have the largest marine research capability in the Indian Ocean Rim.

The Indian Ocean Marine Research Centre aims to deliver the capacity to take advantage of the Commonwealth's investments in Super Science; Marine and Climate. Also importantly the Indian Ocean Marine Research Centre will speed the development of research and development solutions for the complex issues facing the sustainable management of marine habitats and resources in the coastal and offshore regions of northwest Australia.

Investing in New Research Facilities

As part of the collaboration the partners are investing in new facilities, development of these new research facilities is being made possible with a $34 million grant from the Australian Government through the Education Investment Fund, and contributions from the four collaborative partners.

This major investment consists of two projects, with the University appointed as the lead partner for the planning, design and delivery of the $73m new marine research and teaching facilities. A new $62 million facility will be constructed within the grounds of UWA's Crawley campus and an $11 million upgrade to the Department of Fisheries Watermans Bay Marine Centre. Collectively, both of the buildings will be known as the Indian Ocean Marine Research Centre. A key milestone for the project has now been achieved with the University attaining the required Development Approvals for both facilities.

Indian Ocean Marine Research Centre, Crawley

The University of Western Australia will become the home for a new, purpose-built marine research facility and will bring together more than 240 researchers working across a broad range of subjects, extending from oceanography to marine ecology, to fisheries, geochemistry, governance, marine technologies and engineering.

The facility will include offices and workstations for researchers, technicians and post-graduate students; flexible wet and dry laboratories with PC2 capability; flexible collaborative spaces; and a ground level multi-purpose lecture theatre linked to a large interaction space with an external courtyard. Other external areas include undercover field staging, loading bays, technical areas and boat storage.

A unique inclusion within the facility will be the Centre for Offshore Foundation Systems. The Centre will install a new centrifuge and operate as the National Geotechnical Centrifuge facility.

The six-storey purpose-built marine research facility will be designed to target a Five Star Green Star rating, a benchmark in sustainable development.

This new facility is anticipated to be operational and ready for occupancy in 2015.

Indian Ocean Marine Research Centre, Watermans Bay

The site of the existing Watermans Bay Marine Centre, located approximately 24kms from Crawley, on the WA coast, will undergo significant refurbishment including upgrades to the internal laboratories, offices and marine cultural facilities with direct access to quality sea water.

The upgrade and refurbishment of this facility is expected to be completed and ready for occupancy in 2014. Upon completion of these new facilities, the Indian Ocean Marine Research Centre will be set to lead the way in scientific exploration of the Indian Ocean.

Learn more about these projects at **uwa.edu.au/iomrc**

IMAGE/ JOAN COSTA

Partners

The Australian Institute of Marine Science (AIMS) is committed to the protection and sustainable use of Australia's tropical marine resources. The Indian Ocean Marine Research component of the Institute's work focuses on the pristine Ningaloo Marine Park and the resource-rich waters of the Kimberley coast and northwest shelf. **aims.gov.au**

CSIRO is Australia's national science agency. CSIRO manages the Marine National Facility – Southern Surveyor, and a number of marine and atmospheric collections. The research effort at CSIRO Marine and Atmospheric Research is delivered largely through CSIRO's Wealth from Oceans Flagship, and with the Bureau of Meteorology through The Centre for Australian Weather and Climate Research. The Wealth from Oceans Flagship focuses on understanding Australia's oceans and their biodiversity, resources and relationships with the climate system and provides CSIRO's contribution towards national challenges where oceans play a central role. **csiro.au/oceans**

The University of Western Australia's Oceans Institute brings together the strength of marine researchers at UWA into a multi-disciplinary integrated research focus, with an emphasis on solutions science. The goal is to capitalise on the existing research strengths of the University, in areas such as oceanography, ecology, engineering, resource management and governance – to deliver Ocean Solutions for Humanity's Grand Challenges. **oceans.uwa.edu.au**

The Department of Fisheries in Western Australia manages the State's fish, marine and aquatic resources to world-class standards to conserve, develop and share the fish and other living aquatic resources of WA – for the benefit of present and future generations. **fish.wa.gov.au**

WAIMOS

Early in 2012, the Western Australian node of the Integrated Marine Observing System (WAIMOS) extended the geographical range of IMOS observations into the Pilbara and Kimberley.

With co-investment from the WA State Government of $6m over three years, WAIMOS deployments of ocean gliders, moorings and acoustic listening stations close a large gap in the national research infrastructure portfolio. The state-of-the-art equipment is operated by a group of institutions, with UWA hosting the Australian National Facility for Ocean Gliders (ANFOG) at the School of Environmental Systems Engineering.

Seven Slocum gliders (4x Kimberley and 3x Pilbara) were piloted through the tidal extremes of the Pilbara and Kimberley by the ANFOG. The missions of up to one month at a time continuously observe temperature, pressure, salinity, conductivity, biological productivity and turbidity. Together with the moorings, the data will contribute to an understanding of major boundary currents and continental shelf processes. Acoustic listening stations deployed at the end of 2012 will provide new information on fish movement and megafauna connectivity in the two largest coral atoll groups in the Kimberley region.

The WAIMOS Annual Science Meeting held on the UWA campus welcomed over 80 participants in a full day of presentations covering details of the Leeuwin Current heatwave; multi-decadal physical and biogeochemical time series off Rottnest; the Holloway current; tracking megafauna; monitoring benthic reference sites; plankton recordings, wind and wave effects; through to vocal and behavioural characteristics of blue whales in WA.

Dr Agi Gedeon has been appointed as the Manager of WAIMOS to encourage opportunities for networking and discovering interdisciplinary prospects leveraging from IMOS and AODN data streams.

More information can be found at: **imos.org.au**

WAMSI

OI researchers part of Kimberley project

Scientists from UWA Oceans Institute are playing a key role in undertaking research to better understand and manage the unique marine environment of the Kimberley region and its proposed network of marine parks and reserves.

The Kimberley Marine Research Program is being managed by the WA Marine Science Institution (WAMSI). It involves scientists from seven research organisations including CSIRO, AIMS, the Department of Environment and Conservation, Fisheries WA, Murdoch University, Curtin University and Edith Cowan University.

The Institute is also heavily involved in assessing the impacts of large scale dredging on sea life, including corals, seagrass, seaweed, fish and sponges. This WAMSI co-ordinated program is funded in part by industry offsets from existing dredging programs in the Pilbara, and has a focus in the Pilbara marine flora and fauna.

The State is presently undergoing some of the largest dredging programs in the Southern Hemisphere, with the growth of natural gas production offshore in the Pilbara. These studies are timely in that they will influence environmental policy and management of these activities.

UWA Oceans Institute researchers will specifically focus on the following collaborative areas of research:

- The present and future impacts of climate change on calcification of coral reefs and crustose coralline algae (Winthrop Professor Malcolm McCulloch).
- Physical oceanographic dynamics in the Kimberley (Winthrop Professor Greg Ivey).
- Bio-geochemical processes supporting productivity of Kimberley coastal waters (Winthrop Professor Anya Waite).
- Benthic community production and response to environmental forcing (Professor Ryan Lowe)
- Dynamics of near bed particle movement (Professor Ryan Lowe and Associate Professor Marco Ghisalberti)
- Benthic primary productivity: production and herbivory of seagrasses, macroalgae and microalgae, Defining thresholds and indicators of primary producer response to dredging related pressures, and Effects of dredging- related pressures on critical ecological processes for other organisms (Winthrop Professor Gary Kendrick) , and;
- Effects of dredging- related pressures on demersal fish (Professor Euan Harvey)
- Integrated assessment of benthic primary productivity in the Kimberley region (Associate Professor Kimberley Van Niel).

Developing a partnership with the Red Sea Research Centre

The Oceans Institute continues to strengthen its ties with the Red Sea Research Centre establishing joint research and personnel exchanges between The University of Western Australia the King Abdulla University of Science and Technology (KAUST), Saudi Arabia.

Oceans Institute Director Winthrop Professor Carlos Duarte and Professorial Fellow Susana Agustí visited Saudi in March 2012 with a reciprocal visit to UWA by the Red Sea Centre Director Professor Xabier Irigoyen in October 2012 discussed exciting new projects that will commence towards the end of the year. “The Western Australian coastline and the Red Sea share many similarities and by combining our skills and research efforts the Oceans Institute hopes to establish a long-term working relationship with KAUST that will advance knowledge and research in both institutions,” Professor Duarte said.

IMAGE/ OI PROF. PETA CLODE RED SEA RESEARCH CENTRE (KAUST) AND DIRECTOR PROF. XABIER IRIGOYEN (PHOTO: GUIOMAR DUARTE AUGUSTI)

Ongoing joint projects will continue to gather information on the ecology of mesopelagic fish; biodiversity of coral reef fish; the diversity of coral symbionts and its significance for their resistance to stress; and the development and operation of ocean observation systems based on gliders.

Looking to the future;

- Premier’s Research Fellow Winthrop Professor Malcolm McCulloch, ARC Research Fellow Assistant Professor Julie Trotter and Assistant Professor Jens Zinke will be involved in coral coring and processing in the Red Sea as part of a project to understand Red Sea coral reef paleoreconstruction;
- Premier’s Fellow Professor Shaun Collin and KAUST’s Professor Stein Kaartvedt will develop a program to study vision systems of Red Sea lantern fish and use advanced video techniques to examine the fish assemblages of the mesopelagic ocean;
- Professor Euan Harvey and Dr Jean Paul Hobbs will collaborate with KAUST colleagues to develop stereo-cameras in different areas of the Red Sea to research deep fish communities; and
- Oceans Institute seagrass experts Winthrop Professor Gary Kendrick and Dr John Statton will work with KAUST toward restoration of Red Sea seagrass and mangrove ecosystems.

UWA and KAUST scientists are also developing a course on ocean processes and ecosystems for mid-level oil and gas operators. It is anticipated that the Saudi Arabian Oil Company (ARAMCO) sponsored course will run in 2013. ARAMCO is also supporting international workshops led by the Oceans Institute that will draw on experts’ experiences in responding to oil spills around the world to develop guidelines and actions.

Technical and management experience from within UWA will contribute to programs being established to develop a Red Sea Glider-based observation program and the operation of a microscope and visualisation facility at KAUST.

Joint research projects are also to be established that will compare oceanographic and ecosystem dynamics off the coast of Western Australia with the Red Sea to better understand their circulation and biogeochemistry.

Outreach

IMAGE/ JOAN COSTA

Dialogue Series

To realise the Institute's vision of ocean-based solutions to meet society's challenges requires the engagement of government, industry and society at large.

To articulate a dialogue between researchers, government, industry and community stakeholders, the UWA Oceans Institute developed the Ocean Solution Dialogue series.

In 2012, the inaugural workshops were held along with associated public events.

The first event held in March discussed The role of Science in the Response to Disasters in the Marine Environment. One of the major outcomes of the workshop was the proposal to develop a code of best practice to help guide scientists in responding to marine disasters.

The topic for discussion at the second event held in November explored Marine Spatial Planning for a Safe and Sustainable Operation in the Marine Environment. The group looked at the barriers to spatial planning and management in the marine environment, and why law and policy in marine areas is more difficult to work with than on land.

The topics covered in 2012 were broad and designed to demonstrate the complexity when dealing with serious issues facing our oceans and communities.

The workshops are designed to generate initiatives, resources and potential projects to be developed to deliver the solutions as well as identifying those who will lead them.

In 2013, the Institute will be hosting two Ocean Solutions Dialogues to discuss:

- Efficient Marine Monitoring; and
- The Oceans as a Source of Food

More information can be found at: **oceans.uwa.edu.au/strategy/dialogue/workshops**

IMAGE/ JOAN COSTA

IMAGE / JOAN COSTA

Oceans Solutions public lecture series 2012

The 2012 'Oceans Solutions for Humanity's Grand Challenges' lecture series was co-hosted by the UWA Oceans Institute and UWA's Institute of Advanced Studies. This series of lectures explored the ways in which safe and sustainable uses of our oceans can open a pathway of wealth and well-being through what is, in effect, our last frontier.

The first lecture of 2012 'Light and the sea: an ocean of opportunities to understand the eye and brain' was presented by Winthrop Professor Shaun Collin. In this lecture Professor Collin examined what constitutes an 'eye' and the range of functions it has in image formation and setting circadian rhythms in animals that inhabit the ocean and compared these to the eyes of terrestrial animals, including humans. He described examples about how light is used for survival and how many of these models are informing us of new light detection mechanisms that can be useful for understanding not only the evolution of the eye but also how important it is in maintaining optimal human health.

In the second lecture of the series 'The role of the ocean in human evolution, history and future', Winthrop Professor Carlos Duarte developed a case for the existence of a long relationship, at the deepest possible level, between humans and the ocean. During this lecture, Professor Duarte explored the relationship between major deviations in morphology, anatomy and physiology between humans and other terrestrial mammals, and the close dependence of human health on a marine input to the human diet. Professor Duarte used examples of these relationships to support the hypothesis that humans evolved in coastal environments.

The final 'Oceans Solutions' lecture for 2012 'Energy from the Ocean in Western Australia' was presented by Dr Scott Draper from the UWA Oceans Institute and the Centre for Offshore Foundation Systems. Western Australia is bordered by substantial resources of marine energy - waves generated from storms in the Southern and Indian Oceans provide and the Kimberley tides in the North which offer some of the largest tidal fluctuations in the world. Dr Draper discussed the renewable energy potential of these resources were compared to other well-known forms of renewable energy. He also outlined the key challenges facing marine energy device developers in the race to become an economical form of energy supply.

The Institute of Advanced Studies serves as a gateway for research at UWA by showcasing some of the world's most dynamic scholars, artists and public intellectuals. Each year, the IAS presents a rich and vibrant lecture program, many of which are free and open to the public. More information can be found at: **ias.uwa.edu.au**

Oceans Community Supports Shark Forum

Following the submission of a package of five research proposals to the State Government in mid September addressing the issue of shark attacks in WA, a very successful invitation only Shark Attack Mitigation Forum co-hosted by the UWA Oceans Institute and Liza Harvey's electorate was held in September in Scarborough.

The initial forum was a well-attended event with guests from a range of Government Departments and community user groups including Sport and Recreation, Department of Commerce, Water Police, Department of Fisheries, Indian Ocean Paddlers group, Surf Life Saving WA and WAFIC. The meeting was also attended by Mr Jock Clough, Chair of the Institute's Oceans Community group.

During the forum, Oceans Institute members Winthrop Professor Shaun Collin, Professor Nathan Hart, Professor Erika Techera, Assistant Professor Petra Buergelt and Winthrop Professor David Pannell outlined the research capabilities of UWA across science, economics, social sciences and law. Professors Collin and Hart then presented a summary of the shark mitigation strategies and related issues, which the Institute is positioned to address. The Oceans Institute also acknowledged the importance of including anecdotal evidence in the research program and that this type of community consultation provides valuable input into the research agenda.

Excellent feedback was received from the attendees of this initial forum concerning the role that science and the UWA Oceans Institute has to play in addressing this issue.

This event was followed up with a shark research breakfast meeting held at Sorrento Surf Lifesaving Club and hosted by the Mayor of Joondalup, Mr Troy Pickard. UWA Oceans Institute Director Winthrop Professor Carlos Duarte spoke of the role and the interest of the Institute in undertaking this proposed research and in working with community groups to address issues of public safety.

Attendees expressed an interest in the proposed research by the UWA Oceans Institute including information provided about the responses of different shark species to various stimuli and possible attractants and repellents. There was also an acknowledgement that the proposed research will have value and impact in the medium and longer term.

The Oceans Institute's Oceans Community is committed to addressing the concerns of the local community and plans to hold further community forums in 2013 and beyond.

IMAGE / JOAN COSTA

Visiting Scholars

In 2012, the UWA Oceans Institute launched the Oceans Institute Visitors Program to enhance opportunities for members to bring highly regarded researchers to the Institute to provide mentoring, develop collaborations and share knowledge.

Four UWA Oceans Institute visitors grants were awarded in 2012; Dr Paolo Montagna, Dr Dolors Vaqué, Dr Tim McClanahan and Dr Alexandra Campbell, with Dr Vaque and Dr Montagna visiting the Oceans Institute in November and December respectively.

Visitor profile: Dr Dolors Vaqué

Dr Dolors Vaqué from the Marine Science Institute at the Spanish Council for Scientific Research in Barcelona has an interest in aquatic microbial ecology including the role of viruses within the microbial food webs. She researches the carbon fluxes between bacteria and protists and the effect of the viral shunt, how protists and viruses will control bacterial biomass, production and promote changes in bacterial diversity. She also works in virus identification, isolation and virus host-range specificity of marine microorganisms.

During her visit, hosted by Professor Susana Agusti, Dr Vaqué presented a seminar titled “Role of virus in the Ocean” and a workshop “A Tool Box for Microbial Oceanography”. She also had the opportunity to interact with Oceans Institute staff and students to discuss scientific issues relating to marine microbial ecology. She looks forward to developing ongoing collaborations with the Institute.

IMAGE/ DOLORS VAQUE

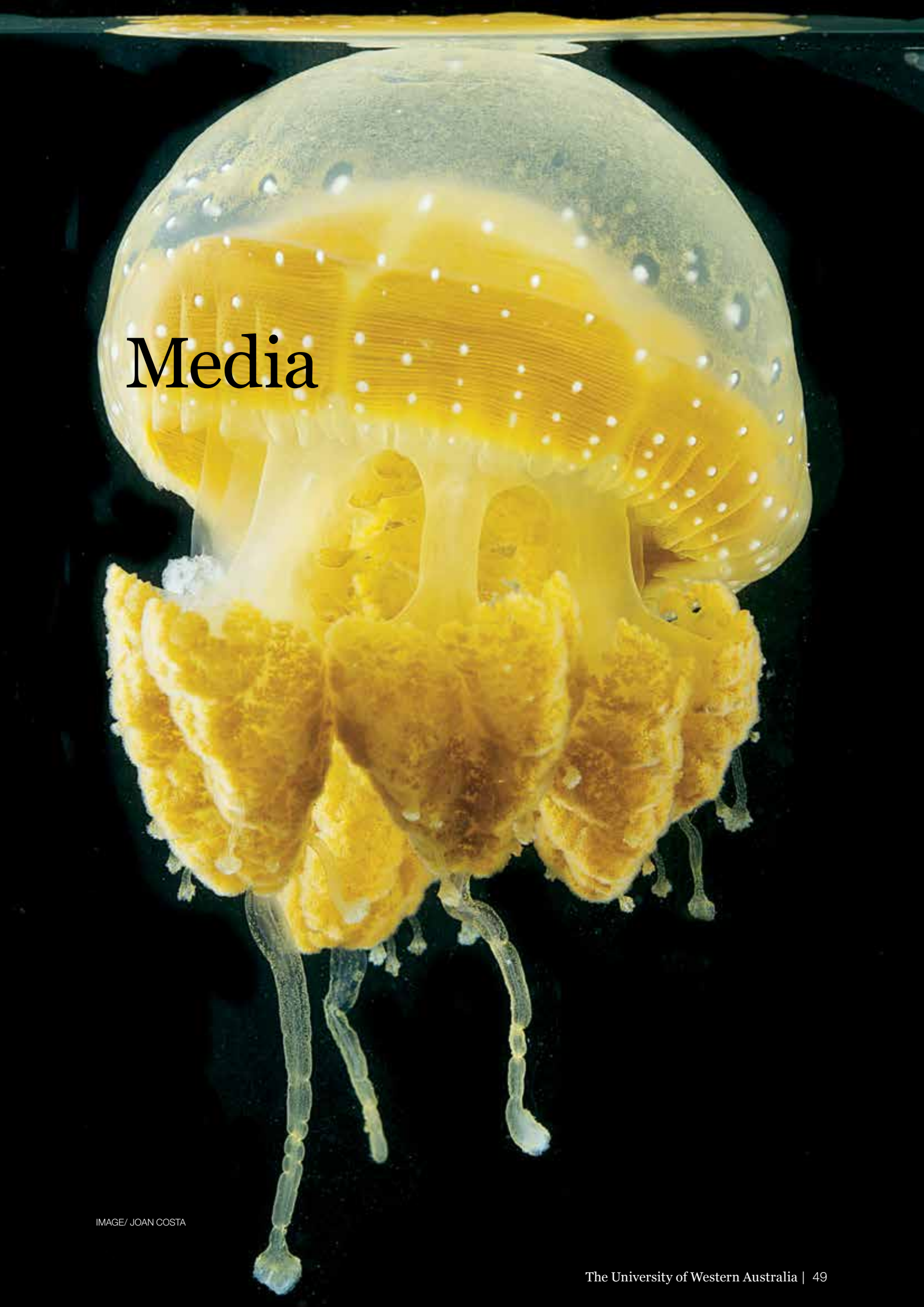
Visitor profile: Dr Paolo Montagna

Paolo Montagna from the Institute of Marine Science at the National Research Council (ISMAR-CNR) in Bologna focuses his research on the development and application of geochemical proxies to address fundamental problems in palaeoceanography and palaeoclimatology.

His visit to the Oceans Institute focused on an investigation of the geochemistry of long-lived coral samples from the North Atlantic and the Mediterranean Sea, in collaboration with Professor Malcolm McCulloch and Assistant Professor Julie Trotter. His research in oceans chemistry is complimentary to the research that will be undertaken by Professor McCulloch’s team at the new Indian Ocean Marine Research Centre Waterman’s Bay facility due to open in late 2014 and aims to lead to important international collaborative research.

IMAGE/ UNDERTAKING FIELDWORK ON THE NINGALOO REEF AT CORAL BAY. (PHOTO: PAOLO MONTAGNA).

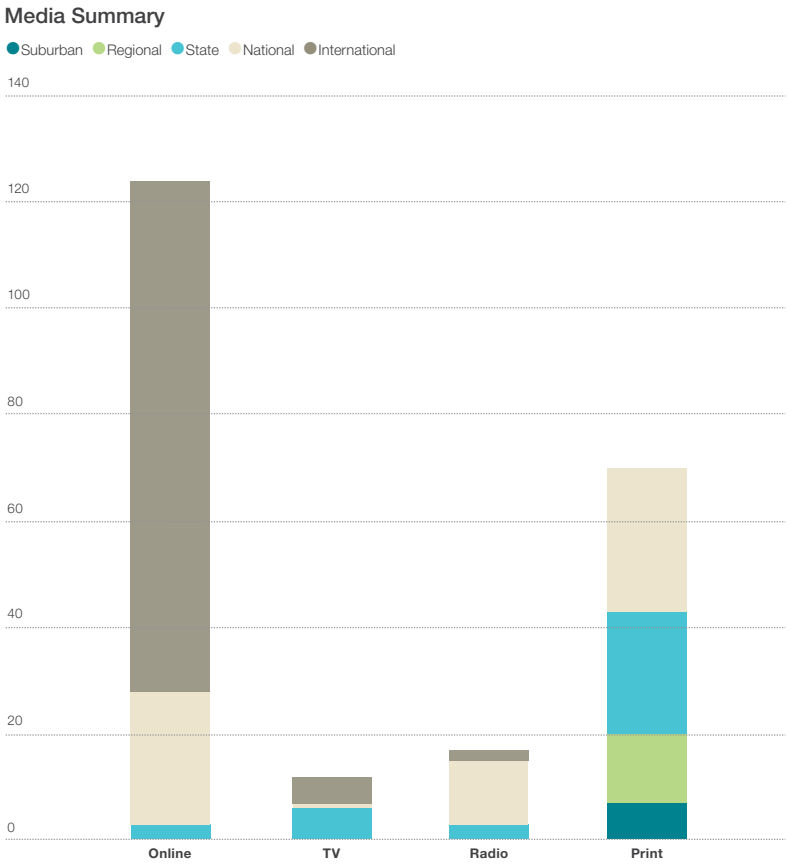
Media



IMAGE/ JOAN COSTA

2012 Summary

The Oceans Institute appeared in more than 200 media stories as a result of 23 media releases focussed on Oceans Institute members. There was a rboad range of coverage in international, national, state and local news media, including stories on the BBC, CNN and in *The Australian*. The Institute also published three newsletters and 41 articles in the Oceans Institute Online Newsroom.



Online
International: 70
National: 25
State: 3

Television
International: 5
National: 1
State: 6

Press
National: 27
State: 23
Regional: 13
Suburban: 7

Radio
International: 2
National: 12
State: 3

(international print and radio coverage is not recorded)

Research Funding

IMAGE/ JOAN COSTA

UWA Ocean's Institute research grants awarded in 2012

Project Title	Funding Period	Funding Body	Amount	Researchers
Shark attack mitigation wetsuit design (zebra suit)	2012	Department of Commerce, Industry, Science and Innovation, Government of Western Australia Innovation Vouchers Program Grant	$25,000	Hart, N.S. Collin, S.P.
Towards an integrated Indian Ocean wide coral reef research program	2012-2013	OI Visitors Grant	$4,000	Stat, M Zinke, J Thums, M Moore, C Hobbs, JP Laverock, B
Managing the conservation significance of coral reef ecosystems in the Pilbara/ Ningaloo region: the Pilbara Marine Conservation Partnership	2012-2013-2016-2017	Gorgon Barrow Island Net Conservation Benefits Program Grant	$7,224,356	Babcock, R. Collin, S.P.
Ocean-shelf exchange with an emphasis on the roles of waves, tides, eddies and cross-shelf flows on carbon exchange	2012–2013	Australian National Network in Marine Science Springboard	$284,523	Pattiaratchi, C.B.
Multiple approaches for understanding earth environmental changes using biogenetic carbonates	2012-2014	JSPS Japan G2301 JSPS program name: Strategic Young Researcher Overseas Visits Program for Accelerating Brain Circulation	$150,000	Watanabe, T. Zinke, J.
Reconstruction of mesoscale meteorological phenomenon from microanalysis of coral skeleton	2012-2013	JSPS program: 12034011-000302	$100,000	Shirai, K. Clode, P. Zinke, J.
Temperature tolerances and assisted rehabilitation of temperate seaweed populations	2012	National Climate Change Adaptation Research Facility, Marine Adaptation Network Honours and Masters Research Support Grant	$7,000	Andrews, S. Bennett, S. Wernberg, T.
Community interactions of seaweed canopies in response to temperature gradients: intercontinental patterns and insights for a warmer future	2012-2013	Convocation, the UWA Graduates Association - Postgraduate Research Travel Award	$2,500	Bennett, S.
Assessing and mitigating environmental impacts of SWRO outfalls on key benthic marine organisms (seagrass)	2012-2015	National Centre of Excellence in Desalination	$207,840	Cambridge, M.L. Kendrick, G.A.
Coupled physical and biogeochemical dynamics on the Australian North West Shelf	2012-2014	Australian Research Council Discovery Project	$520,000	Ivey, G. Lowe, R. Strutton, P. Jones, N. Furnas, M. Brinkman, R.
Quantitative measures of brain evolution in early vertebrates	2012-2014	ARC Discovery Project	$360,000	Collin, S. P. Northcutt, R. G.
Auditory abilities of sharks and their relatives	2012	Australian Geographic Society	$3,000	Chapuis, L. Collin, S.P. McCauley, R.
The role of potassium channels in photoreceptor function.	2012-2014	NH&MRC Project Grant	$349,338	Hunt, D.M. Key, B. Hart, N.S. Collin, S.P.
Ecological responses to native fishes to dynamic water flows to northwest arid Australia	2012-2015	ARC Linkage Grant	$400,000	Grierson, P.F. Collin, S.P. Davies, P.M.

Project Title	Funding Period	Funding Body	Amount	Researchers
IMOS—West Australian Integrated Marine Observing System (gliders)	2012-14	University of Tasmania ex WA State Government	$1,344,000	Pattiaratchi, C.B.
Augusta boat harbour: coastal sediment transport and seagrass wrack movement assessment	2012	WA Department of Transport	$52,000	Pattiaratchi, C.B.
New insights into blue whales, the Sri Lankan enigma: Linking oceanography and blue whale distribution in an ecological cul-de-sac	2012-2013	Ocean Park Conservation Foundation, Hong Kong	$14,000 (HKD 110,000)	de Vos , A.
New insights into blue whales, the Sri Lankan enigma: Linking oceanography and blue whale distribution in an ecological-cul-de-sac	2012-2013	Duke University Global Fellows Minigrant	$2,000	de Vos, A.
Physical oceanographic dynamics in the Kimberley	2012-2015	Kimberley Marine Research Program, West Australian Marine Science Institute	$744,911	Ivey, G. Brinkman, R. Lowe, R. Jones, N. Symonds, G.
The Murujuga (Dampier) Rock-art Recording Project, Pilbara Region, Northwestern Western Australia	2012	WA Royalties for Regions Pilbara Development Commission	$150,000	Balme, J. McDonald, J. Paterson, A.
From Fire Stick Farming to the Friendly Frontier - Landscape Change at Albany WA	2012-2014	Department of Industry Innovation Science Research Tertiary Education Science Inspiring Australia IA	$35,000	Dortch, J. Ward, I. Paterson, A.
Building an Indian Ocean Archaeology Network	2011	World University Network	$23,000	Paterson, A.
Determining the suitability of Anion Exchange Membranes for monitoring phosphorus concentrations in the Swan River	2013	Hodgkin Trust Scholarship	$5,000	Fraser, M.W.
Phosphorus dynamics in seagrasses of Shark Bay, Western Australia	2012	2011/2012 Australian Geographic Bayerboost Scholarship	$6,000	Fraser, M.W.
Vulnerability of coral reef-protected coastlines in a changing environment	2012	UWA Research Collaboration Award	$12,400	Lowe, R. Pomeroy, A. Buckley, M. Dongeren, A. Roelvink, D.
Key biological indices required to understand and manage nesting sea turtles along the Kimberley coast.	2012-2016	WAMSI II	$300,000	Whiting, S. Mitchell, N. Berry, O.
Stress, Disease and Extreme Events	2012-2013	OI visitors grant	$4,000	Campbell, A. Wernberg, T.
The evolution of light detection and its impacts on early vertebrate evolution.	2011-2013	ARC Discovery Grant	$375,000	Collin, S.P. Lamb, T. Hunt, D. Potter, I.C. Hart, N.S.
The evolution of light detection: eco-physiological impacts on biodiversity, sustainability and health. West Australian Premier's Fellowship. WA State Government and UWA.	2010-2013	WA Premiers Fellowship (WA State Government	$2,100,000	Collin, S.P.
Development and Testing of Novel Shark Deterrents. WA State Government Applied Research Program - Shark Hazard Mitigation Round 1 2012	2012-2014	WA State Government Applied Research Program – Shark Hazard Mitigation Round 1	$220,000	Hart, N.S. Collin, S.P.
Collin SP and Hart, NS. Testing and enhancement of existing shark deterrents. 2012	2012-2014	WA State Government Applied Research Program – Shark Hazard Mitigation Round 1	$200,500	Collin, S.P. Hart, N.S.

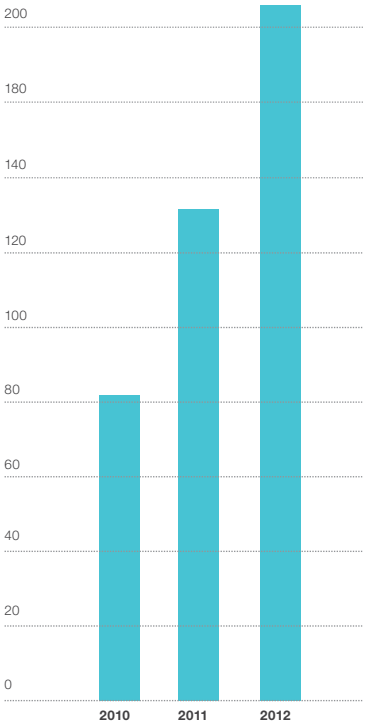
Project Title	Funding Period	Funding Body	Amount	Researchers
In search of a magnetoreceptor in the shark CNS	2012-2013	National Imaging Facility for Subsidised Access. The University of Queensland. 2012	$14,800	Yopak, K.E. Collin, S.P.
In search of a magnetoreceptor in the shark CNS	2012-2013	National Imaging Facility for Subsidised Access. The University of Queensland.	$3,300	Yopak, K.E. Collin, S.P.
The zebrafish as a model organism for the study of visual processes and associated inherited disorders in humans	2012-2013	UWA-UQ Bilateral Research Collaboration Award.	$11,000	Hunt, D.M. Key, B. Collin, S.P. Hart, N.S. Gaudin A.
The Connectivity of the Australian North West Shelf with the Leeuwin Current	2012-2013	Office of Naval Research, Naval International Cooperative Opportunities in Science & Technology Program, N62909-11-1-7058.	$440,000	Ivey, G. Jones, N. Lowe, R. Kelly, S. Brinkman, R. Book, J. Steinberg, C. Burrage, D.
The Influence of Nonlinear Internal Waves on Mixing and Transport in the Ocean	2012	UWA Research Development Award	$21,000	Jones, N.
Structure and Propagation of an Internal Tide Beam in the Tasman Sea	2012	UWA Research Collaboration Award.	$15,000	Kelly, S. Jones, N. Ivey, G. Simmons, H. Klymack, J. Nash, J.
Expanding capability in Western Australian flow cytometry for earth, oceans, environmental and biomedical sciences: state-of-the-art four laser and 12 colour analysis	2012	ARC Linkage Infrastructure, Equipment and Facilities Grant	$446,000	Collin, S.P. Duarte, C.M. Erskine, W. Marshall, B.J. Heel, K.A. Ziman, M. Sharman, M.J. Gray, E.S. Thompson, R.C. Ryan, U.M. Stumbles, P.A.
IMOS National Working Group on Bio-optical Instrumentation and Observing: Phase II.	2012-2014	Integrated Marine Observing System (IMOS)	$41,000	Hanson, C E. Doblin, M.A.

Publications

IMAGE/ JOAN COSTA

Collaborative research both within the University and with our national and international partners is a key tenet of the Oceans Institute.

Peer-reviewed journal articles❶



❶ Total number of peer-reviewed journal articles published by The UWA Oceans Institute members.

Refereed Journals

1. Aires T, Marbà N, Serrao E, **Duarte CM** and Arnaud-Haond S (2012). Selective elimination of chloroplastidial DNA for metagenomics of bacteria associated with the green algae *Caulerpa taxifolia* (bryopsidophyceae). *Journal of Phycology* **48**(2): 483–490.

2. Aparicio-González A, **Duarte CM**, and Tovar-Sánchez A (2012). Trace Metals in Deep Ocean: A Review. *Journal of Marine Systems* doi: 10.1016/j.jmarsys.2012.03.008.

3. Arnaud-Haond S, **Duarte CM**, Diaz-Almela E, Marbà N, Sintes T and Serrão EA (2012). Implications of extreme life span in clonal organisms: millenary clones in meadows of the threatened seagrass *Posidonia oceanica*. PLoS One **7**(2): e30454, doi: 10.1371/journal.pone.0030454.

4. Atkinson CJL and **Collin SP** (2012). Structure and topographic distribution of oral denticles in elasmobranch fishes. *The Biological Bulletin* **222**(1): 26–34.

5. Bellwood DR, Baird AH, **Depczynski M**, et al (2012). Coral recovery may not herald the return of fishes on damaged coral reefs. *OECOLOGIA* **170**: 567-573. doi: 10.1007/s00442-012-2306-z.

6. Berquist RM, Gledhill K, Peterson MW, Doan AH, Baxter G, **Yopak KE**, Kang N, Walker HJ, Hastings PA, and Frank LR (2012). The Digital Fish Library: Digitizing, databasing, and documenting the morphological diversity of fishes with MRI. *PLoS One* **7**: e34499.

7. Bienen B, **Gaudin C**, **Cassidy MJ**, Rausch L, Purwana OA and Krisdani H (2012). Numerical modelling of a hybrid skirted foundation under combined loads. *Computers and Geotechnics* **45**: 127-139.

8. Bienen B, **Gaudin C**, **Cassidy MJ**, Rausch L and Purwana O (2012). Numerical modelling of undrained capacity of hybrid skirted foundation under combined loading. *International Journal of Offshore and Polar Engineering* **22**(3): 1-7.

9. Birt MJ, **Harvey ES** and **Langlois TJ** (2012). Within and between day variability in temperate reef fish assemblages: learned response to baited video. *Journal of Experimental Marine Biology and Ecology* **416–417**: 92–100.

10. Boegman L and **Ivey GN** (2012). The dynamics of internal wave resonance in periodically forced narrow basins. *Journal of Geophysical Research—Oceans* **117**(C11002), doi: 10.1029/2012JC008134.

11. **Bosserelle C**, **Pattiaratchi CB** and **Haigh ID** (2012). Inter-annual variability and longer-term changes in the wave climate of Western Australia between 1970 and 2009. *Ocean Dynamics* **62**(1): 63–76.

12. **Braithwaite JE**, **Meeuwig**, **JJ** and Jenner CS (2012). Estimating cetacean carrying capacity based on spacing behavior. *PLoS One* 7(12): e51347. doi:10.1371/journal.pone.0051347.

13. Brewer TD, Cinner JE, **Fisher R**, Green A and **Wilson SK** (2012). Market access, population density, and socioeconomic development explain diversity and functional group biomass of coral reef fish assemblages. *Global Environmental Change* **22**: 399-406.

14. Bruggemann H, Rodier M, Guillaume M, Andréfouët S, Arfi R, Cinner J, Pichon M, Ramahatratra F, Rasoamanendrika F, **Zinke J** and McClanahan T (2012). Social-ecological problems forcing unprecedented change on the latitudinal margins of coral reefs: the case of southwest Madagascar. *Ecology and Society* **17**(4): 47. http://dx.doi.org/10.5751/ES-05300-170447.

15. Burrows MT, Schoeman DS, **Duarte CM**, O'Connor MI, Buckley LB, Kappel CV, Parmesan C, Halpern BS, Brown C, Brander KM, Bruno JF, Pandolfi JM, Sydeman WJ, Moore P, Kiessling W, Richardson AJ and Poloczanska ES (2012). Invasive species unchecked by climate change—response. *Science* **335**(6068): 537–538.

16. **Cambridge ML**, **Fraser MW**, Holmer M, Kuo J and **Kendrick GA** (2012). Hydrogen sulfide intrusion in seagrasses from Shark Bay, Western Australia. *Marine and Freshwater Research* **63**(11): 1027–1038.

17. Carroll J, Dubra A, Garner JC, Mizrahi-Meissonnier L, Cooper RF, Dubis AM, Nordgren R, Genead M, Connor TB Jr, Stepien KE, **Hunt DM**, Banin E, Hardcastle AJ, Moore AT, Williams DR, Fishman G, Neitz J, Neitz M and Michaelides M (2012). The effect of cone opsin mutations on retinal structure and the integrity of the photoreceptor mosaic. *Investigative*

Ophthalmology and Visual Research **53**: 8006-8015.

18. Carvalho LS, Davies WL, Robinson PR and **Hunt DM** (2012). Spectral tuning and evolution of primate short wavelength-sensitive visual pigments. **Proceedings of the Royal Society B** doi: 10.1098/rspb.2011.0782.

19. Carvalho LS, Davies WL, Robinson PR and **Hunt DM** (2012). Anion sensitivity and spectal tuning of middle- and long wavelength-sensitive (MWS/LWS) visual pigments. *Cellular and Molecular Life Sciences* **69**: 2455-2464.

20. **Cassidy MJ**, **Gaudin C**, Randolph MF, Wong PC, Wang D and Tian Y (2012). A plasticity model to assess the keying behaviour and performance of plate anchors. *Géotechnique* **62**(9): 825-836.

21. **Cassidy MJ** and Tian Y (2012). Development and application of models for the stability analysis of Australia's offshore pipelines. *Australian Geomechanics* **47**(2): 61-78.

22. **Cassidy MJ** (2012). Experimental observations of the penetration of spudcan footings in silt. *Géotechnique* **62**(8): 727-732.

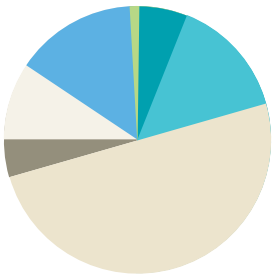
23. Cerutti-Pereyra F, **Meekan MG**, Wei NWV, O'Shea O, Bradshaw CJA and Austin C (2012). Identification of rays through DNA barcoding: an application for ecologists *PLoS One* 7:e36479. doi:10.1371/journal.pone.0036479

24. Chen R, **Gaudin C** and **Cassidy MJ** (2012). An investigation of the vertical uplift capacity of deep water mudmats in clay. *Canadian Geotechnical Journal* **49**(7): 853-865.

25. Cheung WWL, **Meeuwig JJ**, **Feng M**, **Harvey ES**, Lam VWY, **Langolis T**, Slawinski D, Sun C and Pauly D (2012). Climate-change induced tropicalisation of marine communities in Western Australia. *Marine and Freshwater Research* **63**(5): 415–427.

26. **Clifton J**, Etienne M, Barnes DKA, Barnes RSK, Suggett DJ and Smith DJ (2012). Marine conservation policy in Seychelles: current constraints and prospects for improvement. *Marine Policy* **36**(3): 823–831.

Publications by research area



	Total
Ocean engineering	25
Marine resources and governance❶	38
Climate impacts❷	28
Marine biology and ecology	111
Marine observation❸	3
Blue water oceanography	6
Coastal processes	12
	223

❶ Marine biological resources, management, governance and conservation
❷ Impacts of climate change in the marine environment
❸ Marine observation, monitoring and risk management

27. **Clifton J** and Majors C (2012). Culture, conservation and conflict: perspectives on marine protection amongst the Bajau of south-east Asia. *Society and Natural Resources* **25**(7): 716–725.

28. **Coimbre JP**, Nolan PM, **Collin SP** and **Hart NS** (2012). Retinal ganglion cell topography and spatial resolving power in penguins. *Brain, Behavior and Evolution* **80**(4): 254–268.

29. **Coimbra JP**, **Hart NS**, **Collin SP** and Manger PR (2012). Scene from above: Retinal ganglion cell topography and spatial resolving power in the giraffe (*Giraffa camelopardalis*). *Journal of Comparative Neurology* doi: 10.1002/cne.23271.

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31. **Collin SP** (2012). The neuroecology of cartilaginous fishes: sensory strategies for survival. *Brain, Behavior and Evolution* **80**(2): 80–96.

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35. Coyle BJ, **Hart NS**, Carleton KL and Borgia G (2012). Limited variation in visual sensitivity among bowerbird species suggests that there is no link between spectral tuning and variation in display colouration. *Journal of Experimental Biology* **215**(7): 1090–1105. doi: 10.1242/jeb.062224.

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IMAGE/ JOAN COSTA

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Future directions
2013 and beyond

2010

- The UWA Oceans Institute is formally launched

2011

- IOMRC collaboration formed with AIMS, CSIRO and the Department of Fisheries
- Memorandum of Understanding signed with Consejo Superior de Investigaciones Cientificas (CSIC)

2012

- Ocean Solutions strategic focus strengthened
- Ocean Solutions Dialogue Series launched

IMAGE/ JOAN COSTA

2013

- Expanding network of international collaborations
- Launch of the Oceans Community outreach program
- Launch of on-line courses

2014

- Opening of IOMRC Watermans facility
- Oceans Horizons 2020 conference hosted by the UWA Oceans Institute

2015

- First intake of students in the Ocean Solutions Masters program
- IOMRC Crawley building ready for occupancy

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