The 11th International Abalone Symposium

Poua te mana o Pāua ki te tai, kia whakaika te moana!

Affirm the mana of Pāua to the sea!

27 February – 2 March 2023

DELEGATE GUIDE
KAITAKAWAENGA KAIARAHI

Tāmaki Makaurau • Auckland
Aotearoa • New Zealand

TABLE OF CONTENTS

NAU MAI, HAERE MAI - WELCOME

E ngā maunga
E ngā waka
E ngā reo
Koutou nō ngā pito o te ao
Tēnei te karanga
Kia tata mai, kia rata mai
Tēnā koutou, tēnā koutou,
tēnā koutou katoa!

To the descendants of mountains
To the descendants of explorers and navigators
To the descendants with many different languages
People of the world

Here is our call – gather and join with us.

We welcome you once, we welcome you twice, we welcome you thrice, we welcome you, your ancestors, and your descendants yet to be born!

Welcome to all from across the globe to the land of the long white cloud, Aotearoa, and welcome to our friends and colleagues at home.

NEW ZEALAND QUICK FACTS

Māori name:	Aotearoa, meaning “land of the long white cloud”.
Official languages:	English, Māori, NZ Sign Language
Population:	Around 5.2 million
Largest city:	Auckland – population 1.6 million
Capital City:	Wellington
Climate:	Daytime temperatures in Auckland range from an average of 24°C (75°F) in summer (December to March) to 16°C (60°F) in winter (June to August)
Area:	268,021 km²
Currency:	New Zealand dollar

WELCOME – LOCAL ORGANISERS

Nau mai, haere mai! (Welcome)

On behalf of the organising committee, I welcome you to the 11th International Abalone Symposium in Auckland. New Zealand is home to Black-foot Abalone (*Haliotis iris*) also known as “pāua” by indigenous Māori. Pāua is a recognised taonga (sacred species) both as kaimoana (seafood) and as a valued resource for traditional and contemporary arts and crafts. Pāua are frequently used to represent the eyes in Māori carvings and is traditionally associated with the stars or whetū, the symbolic eyes of ancestors that gaze down from the night sky. The New Zealand abalone industry includes wild-catch and aquaculture. Pāua aquaculture is a growing sector in New Zealand with exports expected to increase exponentially in the next few years.

We are grateful to the Abalone Society for having given us the opportunity to host the 11th International Abalone Symposium at the Auckland University of Technology. We have worked hard to put together an exciting program, which will focus on fisheries management, physiology and ecology, aquaculture technology, processing, and marketing of abalone. Cultural, scientific, industrial, and networking sessions have been carefully developed to present to you a special and memorable conference in Aotearoa, New Zealand.

We hope you make the most of your time with us, share knowledge and experiences, meet old friends and new people, and above all, enjoy our kiwi hospitality!

Andrea C. Alfaro
IAS 2023 Organising Chair

WELCOME – IAS PRESIDENT

Dear abalone community. Kia ora! On behalf of the International Abalone Society, please receive a warm welcome to the XI International Abalone Symposium. We have been through very difficult times due to the pandemic which postponed this symposium for two years, so we are very excited to meet in person again. We express our deep gratitude to the New Zealand Organising Committee that has made this possible, especially to Andrea Alfaro and Leonie Venter.

The last symposium was held in China in 2018, so I am confident that there will be a lot of new information to exchange among international leaders in abalone research and production, that will certainly expand the collaboration between countries. The organising committee has set up a very interesting program that includes not only every topic on fisheries, aquaculture, biology, indigenous knowledge, and marketing of abalone, but also the possibility of visiting some of their most important production regions and facilities.

New Zealand is important not only for its abalone production (locally known as pāua) but it is a very beautiful country with unique cultural richness and long indigenous knowledge, traditions, and values that form the rich fabric of Aotearoa New Zealand. Please enjoy the symposium and make as many new friends as you can.

Ricardo Searcy-Bernal
President
International Abalone Society

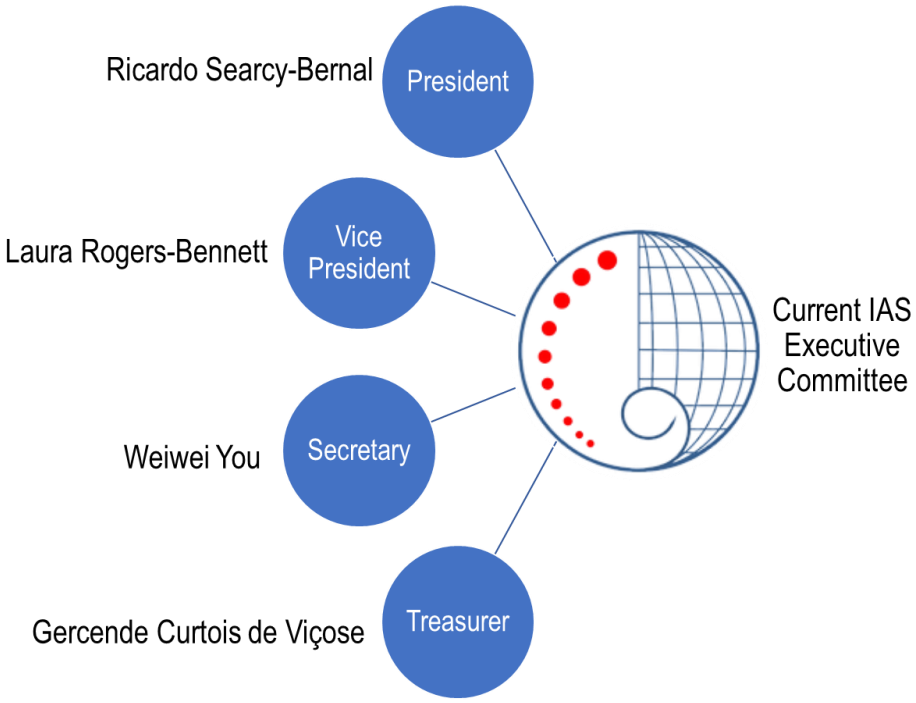
INTERNATIONAL ABALONE SOCIETY

The International Abalone Society (IAS) is an international forum, intended to promote research on abalone; facilitate the distribution of information on abalone; promote cooperation between abalone researchers and members of the abalone industry; and to recognise the achievements of individuals and organisations by the award of IAS International awards.

International Abalone Symposiums are held about every three years. The first symposium was held 34 years ago and keep on growing and diversifying with each new meeting.

Past symposia:

1989: Mexico
1994: Australia
1997: United States of America
2000: South Africa
2003: China
2006: Chile
2009: Thailand
2012: Tasmania, Australia
2015: Korea
2018: China
2023: New Zealand



Visit the website for all Abalone Society news:
https://www.internationalabalonesociety.net/

VENUE & GENERAL INFORMATION

Venue

The venue for this conference is AUT City Campus – Sir Pual Reeves (WG) Building. The conference sessions are being held within the WG building. Please see room numbers here:
Registration: WG201 (open forum /exhibition space)
Mains Sessions: WG308
Concurrent Sessions: WG308, WG224a, WG224b
Daily Catering: WG201
Social Functions: WG201

Information Desk

The registration and information desk are located on Level 2 of the WG Building and will remain open daily during the symposium days. AUT Events are the organisers and will be able to assist with any enquires. Lost property will be held at the registration desk until the end of the symposium.

Name badges

These should always be worn for entry to the symposium sessions, morning and afternoon teas, lunches, and the social events. This will also serve as your entry ticket to the symposium dinner.

Wi-Fi

SSID: IAS 2023
Username: Abalone2023
Password: Symposium2023

Emergency

In any urgent situation, Emergency Services should be called on 111. On campus, our security team are available to assist and can be contacted on 09 921 9999 ext. 9997 or 0800 AUT SAFE (0800 288 7233). When a building needs to be evacuated an alarm will sound, please use the stairs, and make your way to the gathering point following instructions of the emergency wardens.

Exhibition space

The exhibition space will house all the sponsors, poster presentations, hui (meeting) points and other interactive activities. Here please visit our sponsors, support the students at the poster session and embrace all the social activities planned. You are also encouraged to meet up with old friends and make new ones in this space. To facilitate encounters, we have designed some fun activities strategically placed around the symposium space. Have fun!

Catering

All morning and afternoon teas, lunches, and social functions will be set out at the catering station across WG Level 2 in the forum (exhibition space). If you have any dietary requirements pleas make yourself known to the catering staff and they will point you in the right direction. Please ensure that your name badge is visible during these times.

Dinner

The symposium dinner and awards ceremony will be held on Thursday 2 March at the New Zealand Maritime Museum (Address: Corner of Quay and Hobson Street, Auckland 1140). This is a 20-min walk from AUT downtown to the Auckland Viaduct area. Be sure to have your name badge! Dress code: Smart casual.

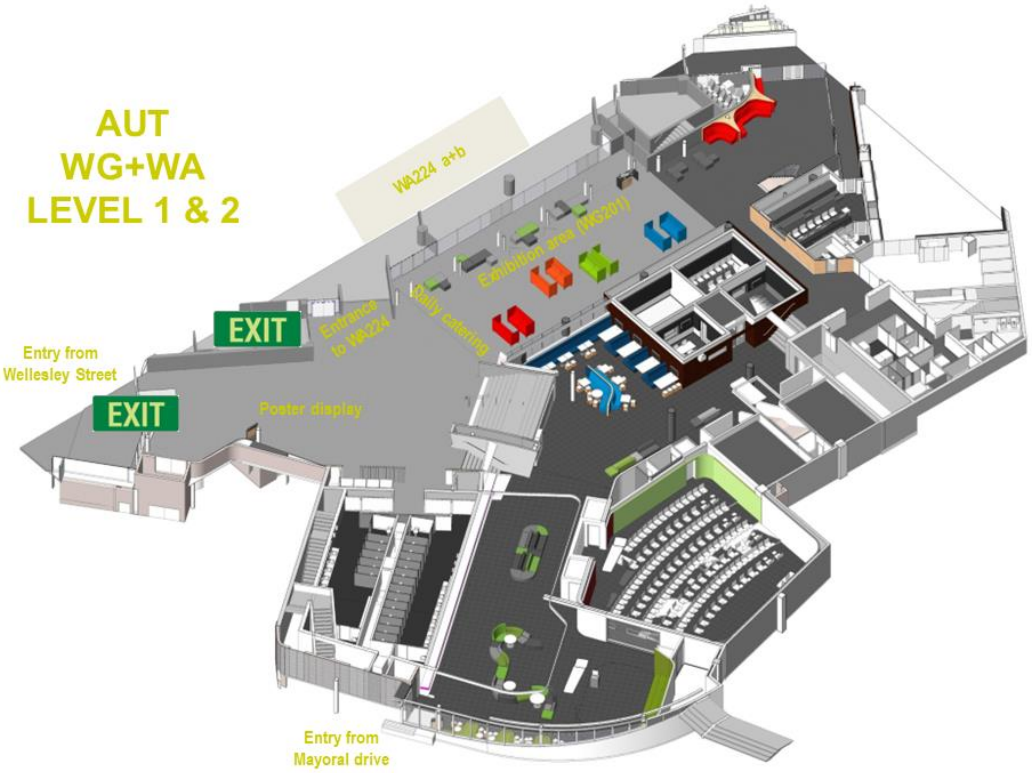
Presentations

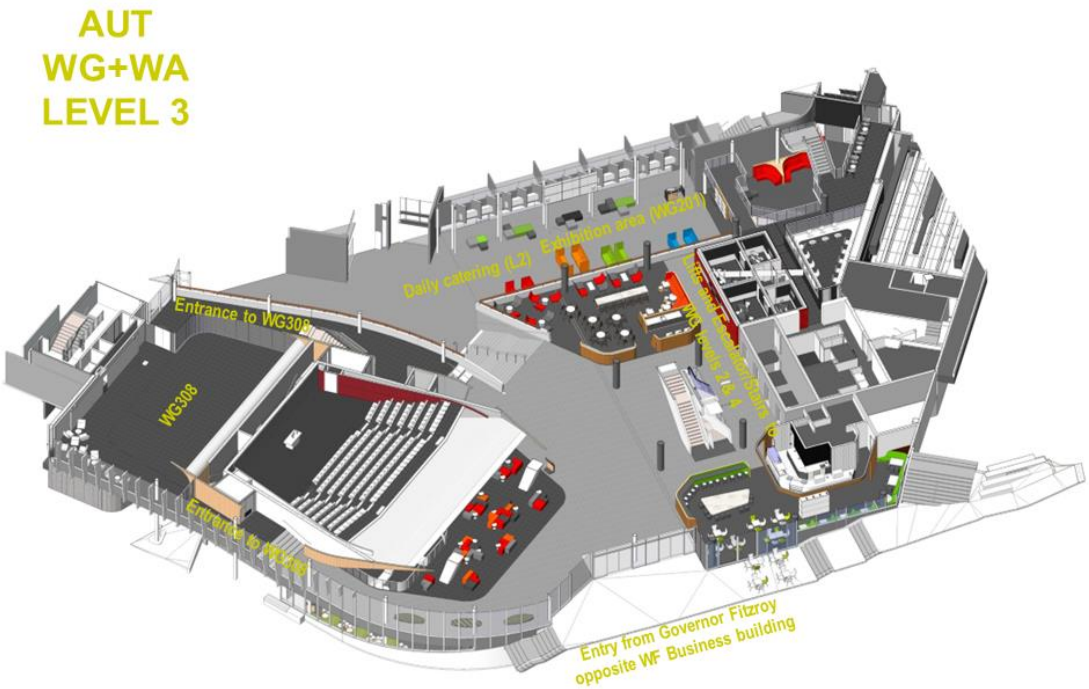
Please ensure you have your presentation loaded in the room you are scheduled to present in either at the start of the day or during the catering break ahead of your allocated speaking slot. Our AV staff will be onsite to assist you with the loading of your presentation.

Posters

Please aim to have your poster in place on the provided boards by the end of symposium on Monday 27 February 2023 (Velcro dots will be provided). Posters should remain up until the end of the symposium, Thursday (2 March) 14:00. Please ensure that you stand next to your poster during the poster presentation session on Wednesday 1 March (17h15).

FLOOR PLAN


AUT
WG+WA
LEVEL 1 & 2
WA224 a+b
Exhibition area (WG201)
Entrance to WA224
Daily catering
EXIT
Entry from Wellesley Street
EXIT
Poster display
Entry from Mayoral drive


AUT
WG+WA
LEVEL 3
Daily catering (L2)
Exhibition area (WG201)
Entrance to WG308
WG308
Entry from Governor Fitzroy opposite WF Business building

Nau mai, Haere mai
Monday 27 February 2023

Time	Venue	Activity
09:00-16:00	WG201	Registration open
09:45-10:00	WA224	Greetings
10:00-12:00	WA224	Workshop 1 - Hosted by **Te Rerekohu Tuterangiwhiu** A 'Pāuaful' conversation - A collective of indigenous world views of Pāua (abalone)
12:00-13:00	WG201	Lunch
13:00-15:00	WA224	Workshop 2: Hosted by **Norman Ragg** Abalone research in a changing world - What are the opportunities and what are our responsibilities?
15:00-16:00	WG808	Student Session
16:00-17:00	WG	Pōwhiri (Official Welcome)
17:00	WG201	True South Seafood Partnership Acknowledgement
17:00-19:00	WG201	Welcoming Social Event

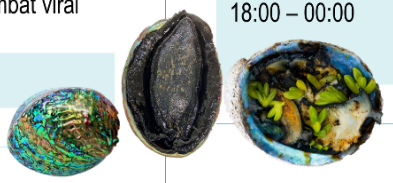
Tahi
Tuesday 28 February 2023

Time	Venue	Activity
08:30-09:00	WG308	Official Opening
09:00-09:45	WG308	Keynote speaker: **Dr Kristin Aquilino** Saving a species, saving ourselves: The importance of community- and relationship-building in species restoration
09:45-10:20	WG308	Featured speaker: **Graeme Sinclair** New Zealand Pāua in its natural element
10:20-10:25	WG308	Marifeed Partnership Acknowledgement
10:30-11:00	WG201	Morning tea
11:00-13:00	WG308	Country update session: Hosted by **Peter Cook**
13:00-14:00	WG201	Lunch
14:00-15:30		Delegate oral presentation sessions
		Cultural and Indigenous Knowledge (WA224a)
		Resource Productivity & Enhancement (WA224b)
15:30-16:00	WG201	Afternoon tea
16:00-16:45	WG308	Plenary speaker: **Te Rerekohu Tuterangiwhiu** The Pāua is in your hands" Māori knowledge and the marine environment
16:45-16:55	WG308	**Mark Jones** – Shell Showcase Introduction
16:55-17:00	WG308	Closing
17:00-19:00	WG201	Mix and Mingle Event

Rua

Wednesday 1 March 2023

Time	Venue	Activity
08:45-09:00	WG308	Morning Greeting
09:00-09:45	WG308	Keynote speaker: **Dr Sylvain Huchette** Using seaweed culture to make abalone farming more sustainable: Wishful thinking or true economic potential?
09:45-10:20	WG308	Featured speaker: **Sir Mark Solomon** Māori perspectives and natural resources
10:20-10:25	WG308	Moana New Zealand Partnership Acknowledgement
10:30-11:00	WG201	Morning tea
11:00-13:00		Delegate oral presentation sessions
		Resource Threats (WG308)
		Genetics & Genome (WA224a)
		Biology & Physiology (WA224b)
13:00-14:00	WG201	Lunch
14:00-15:45		Delegate oral presentation sessions
		Resource Assessment & Data gathering (WG308)
		Restoration Ecology & Biodiversity (WA224a)
		Nutrition & Feed (WA224b)
15:45-16:15	WG201	Afternoon tea
16:15-17:00	WG308	Plenary speaker: **Professor Karla Helbig** Immune priming as an approach to combat viral infection in abalone
17:00-17:10	WG308	Closing
17:10-19:00	WG201	Pub and Poster Event



Toru

Thursday 2 March 2023

Time	Venue	Activity
08:45-09:00	WG308	Morning Greeting
09:00-09:45	WG308	Keynote speaker: **Professor Katherina Brokordt** Challenges for the farming of abalone in Chile and the potential contribution of genetic improvement programmes
09:45-10:45	WG308	**Delegate speakers: Processing and production**
10:45-11:15	WG201	Morning tea
11:15-13:00	WG308	AquaVitae IMTA - Special session (open for all)
11:15-13:00		Delegate oral presentation sessions
		Climate Change (WA224a)
		Resource Management & Protection (WA224b)
13:00-14:00	WG201	Lunch
14:00-14:45	WG308	Plenary speaker: **Professor David R. Schiel** Ecosystem resilience, recovery, and the rise and demise of inshore abalone populations after the devastating Kaikōura earthquake
14:45-15:00	WG308	Closing
15:00-16:30	WG308	General IAS meeting
15:00		Scientific program ends for delegates
17:00		Maritime Museum open for visitors
18:00 – 00:00		Symposium dinner at New Zealand Maritime Museum *Corner of Quay and Hobson Street, Viaduct Harbour, Auckland*
		Tasmanian Seafood Partnership Acknowledgement


Welcome

WELCOME – MONDAY, 27 FEBUARY 2023

09:00-16:00	**Registration Open (WG201)**
09:30-10:00	**Welcome (WG224)**
10:00-12:00	**Workshop 1 (WG224)** **Te Rerekohu Tuterangiwhiu** A 'Pāuaful' conversation - A collective of indigenous world views of Pāua (abalone)
12:00-13:00	**Lunch (WG201)**
13:00-15:00	**Workshop 2 (WG224)** **Norman Ragg** Abalone research in a changing world - What are the opportunities and what are our responsibilities?
15:00-16:00	**Student Session (WG808)** **Jessica Ericson** Get to know your fellow students in a flash format
16:00-17:00	**Pōwhiri - Official Welcoming (WG308)**
17:00-19:00	**Welcoming continued (WG201)**

Pōwhiri: Welcome Ceremony

A pōwhiri is a Māori welcoming ceremony, which involves whaikōrero (formal speech) , waiata (singing) and kai (food). The Tangata whenua (the people of the land) welcome the Manuhiri (the guests) onto their land.

WORKSHOPS

Tēnā koutou katoa!

Greetings and welcome to all of you united by a passion for abalone (Pāua)
We would like to extend a warm and sincere invitation to attend our pre-symposium workshops on Monday, 27 February 2023. In a provocative and thought-provoking journey, we will explore the ways in which indigenous knowledge and modern science can combine to provide a richer understanding of abalone and their needs in a challenging world.
We look forward to sharing this journey with you all.
Ngā mihi nui
Te Rerekohu Tuterangiwhiu & Norman Ragg

A 'Pāuaful' conversation - A collective of indigenous world views of Pāua (abalone	Abalone research in a changing world - What are the opportunities and what are our responsibilities?
Too often, the opportunities to engage the world view of our indigenous peoples are missed, and their contribution is often muffled or mis-used. This first workshop offers a safe space for indigenous expression and will focus on the fundamental and inclusive approach to the Kurahuna or 'hidden wisdoms' of Pāua. The question that we will unapologetically ask all indigenous whanaunga (relatives) who attend this workshop having witnessed local abalone population declines, is "how would you approach this Pāua problem"? The workshop will include: • Exploring ancestral wisdoms and cultural narratives of Pāua (Abalone) • Tikanga: the ethics and morals of Pāua • Practices, and expressions of epistemology and ontology • The state of Pāua from an indigenous world view • Integrating indigenous cultures and Science: has/can it worked? • How could we help the Pāua?	Abalone are paradoxically both resilient and vulnerable. Their ancient body plan resembles a 'living fossil', reflecting successful biological architecture that has resisted evolutionary pressure. This looks like resilience. In a rapidly changing world full of anthropogenic stressors, this conservative biology may be the abalone's downfall, with insufficient plasticity to adapt rapidly. This vulnerability was reflected in the recent UN COP15 Biodiversity conference, where it was stated that "20 of the world's 54 abalone species are threatened with extinction". As abalone stakeholders, we have a responsibility to understand these vulnerabilities and to support abalone population success. The workshop will consider success case studies, where research and restoration are bringing hope. Participants will be encouraged to share their own stories: successes, concerns, and key strategies for maintaining this genus. Key questions will include: • How can indigenous knowledge, notably the wisdom of te ao Māori introduced in the previous workshop, guide protection and restoration? • Which approaches to abalone protection are proving successful and why? • What are the key knowledge gaps critical for success? Delegates will be asked to consider how best to capitalise on the multi-national collaboration opportunities presented by the IAS meeting. If there is sufficient interest, we will also consider compiling a review or opinion piece for publication.


DAY 1

DAY 1 – TUESDAY, 28 FEBUARY 2023

08:30-09:00	**Official Opening (WG308)** Prof Andrea C. Alfaro (Organising Chair) Dr Damon Salesa (AUT Vice-Chancellor) Hon Stuart Nash (NZ Minister of Forestry, Minister for Oceans and Fisheries) Dr Ricardo Searcy-Bernal (President International Abalone Society)
09:00-09:45	**Keynote Address (WG308)** **Dr Kristin Aquilino** Saving a species, saving ourselves: The importance of community- and relationship-building in species restoration
09:45-10:20	**Featured Speaker (WG308)** **Graeme Sinclair** New Zealand Pāua in its natural element
10:20-10:25	Marifeed Partnership Acknowledgement
10:30-11:00	Morning Tea (WG201)
11:00-13:00	**Country Updates (WG308)** **Peter Cook** South Africa: Rowan Yearsley & Peter Britz Australia: Nick Savva New Zealand: Tom McCowan Mexico: Ricardo Searcy-Bernal Europe: Gercende Curtois de Viçose USA: Laura Rogers-Bennett China: Weiwei You
13:00-14:00	Lunch
14:00-15:30	**Symposia Sessions 1** **Cultural and Indigenous Knowledge (WA224a)** **Resource Productivity & Enhancement (WA224b)**

15:30-16:00		Afternoon Tea (WG201)
16:00-16:45		**Plenary Address (WG308)** **Te Rerekohu Tuterangiwhiu** The Pāua is in your hands" Māori knowledge & marine environment
16:45-16:50		**Mark Jones** Shell Showcase Introduction
16:50-17:00		**Closing**
17:00-19:00		**Mix and Mingle Event**

PLENARY SPEAKER

Dr Kristin Aquilino

Associate Director, Bodega Marine Laboratory, University of California, Davis, USA.

Dr Kristin Aquilino has championed abalone restoration aquaculture for the past decade, directing a captive breeding program for endangered white abalone, *Haliotis sorenseni*, on the west coast of North America. She is an advocate for enhancing community engagement around restoration aquaculture efforts, forging strong partnerships among state and federal agencies, Indigenous peoples, commercial aquaculture growers, aquariums, and other stakeholders. Her research focuses on the reproductive conditioning and husbandry of endangered white abalone, as well as the effects of climate change and disease on their captive and wild populations. She received a Species in the Spotlight Hero Award from the US National Oceanic and Atmospheric Administration in recognition of her exceptional efforts related to white abalone conservation and recovery. She has a penchant for science communication, and her work has been featured by dozens of media outlets including The New York Times, Los Angeles Times, and NPR. Among the things that bring her the most joy is showing someone an abalone's beady, black eyes and hearing the exclamation, "Oh! It has a face!"

Saving a species, saving ourselves: The importance of community- and relationship-building in species restoration

How do you save a species? There are as many answers to this question as there are drops of water in the ocean. These numerous perspectives, like the water droplets that compose the sea, are so much more powerful when they connect and interact. When I first began working with endangered white abalone (*Haliotis sorenseni*) in 2011, there were only a few thousand, mostly solitary, individuals left in the wild, there had been no captive reproduction of the species in nearly a decade, and few people outside of a handful of research- and conservation-related organizations knew of the animal's plight. In the decade that followed, captive production increased by three orders of magnitude, thousands of captive-bred white abalone were out planted into the ocean, and the species was receiving national and international press. What energized this transformation? It took flowing grant money and scientific advancement, and it also required the intentional fostering of community and investment in personal relationships – curating a bountiful collection of "water droplets" to create an ocean of support and progress. Saving this species is as much about the abalone as it is about who we are as humans.

https://kristinaquilino.weebly.com/

KEYNOTE SPEAKER

Te Rerekohu Tuterangiwhiu

Kairangahau researchers at Cawthron Institute, New Zealand who are passionate about bringing te reo o ngā hapū and a wider Te Ao Māori perspective to change the way we interact with our natural environment.

Te Rerekohu is currently a Kaiārahi Rangahau Kaimōana at Cawthron Institute in Nelson and holds formal qualifications in Mātauranga Māori, Teaching, Marine Biology and Aquaculture. He is involved in several projects at Cawthron that span Shellfish and Finfish Aquaculture, Aquatic Animal Health, Biosecurity and Seafood Safety, and he believes there is a place for te reo o ngā hapū and a wider Te Ao Māori to be heard in these kaupapa.

The Pāua is in your hands" Māori knowledge & marine environment

Pāua is a recognised taonga (sacred species) both as kaimoana (seafood) and as a valued resource for traditional and contemporary arts and crafts. Pāua are frequently used to represent the eyes in Māori carvings and is traditionally associated with the stars or whetū, the symbolic eyes of ancestors that gaze down from the night sky. One of the concluding processes of whakairo (carving) is Tiwhaia, which involves placing the pāua shells onto the carving to imbue the mouri (life force) of the ancestor and brings the carving to life. Tiwhaia offers us a context around Pāua of spiritual and wellbeing importance, of imbuing mouri (life force) into living things and maintaining the culture, memory, and history of the wellness of our moana (sea), our tupuna (ancestors) and narratives. Tangaroa is the atua (ancestor or god) of the sea. Te whatukura o Tangaroa (The storm of Tangaroa) has traditional meaning around the intricate balance that needs to be maintained between the ability to harvest and cultivate the ocean so that the balance is kept. The Pāua is a tohu or key indicator that fits in kaitiakitanga (guardianship), which tells us about the quality of the water and the environment through its special relationship with the rimurimu (seaweed), which also shares a relationship to the land through the freshwater flows that bring nutrients from the mountains to the sea.

https://www.royalsociety.org.nz/early-career-researcher-forum/turama/heni-unwin-and-te-rerekohu-tuterangiwhiu/

FEATURED SPEAKER

Graeme Sinclair

New Zealand's favourite fisherman, wearing multiple hats as TV personality, celebrity, professional keynote business speaker, inspirational and motivational speaker, and much more.

He is the managing Director of Frontier Television (NZ) Ltd, producing 26 seasons of the very popular NZ TV series “Gone Fishin” (https://gonefishin.co.nz/). Now his focus is on a documentary style series “Ocean Bounty”. Due to his services towards television, he was appointed by Her Majesty the Queen and awarded as a member of the New Zealand Order of Merit (MNZM). He has written and published many books, spoke at many events, and produced several documentaries. He is nationally involved in attending “Kids Gone Fishin”; a charitable event, in conjunction with Police Blue Light, involving a fun day of fishing for children, some who are picking up a rod for the first time. He served as a Trustee for the Southern Seabird Solutions Trust and member of a technical advisory group focusing on the future of fishing in New Zealand. He is a fascinating storyteller sharing his passion for life despite debilitating illness. In the words of Graeme: “Life is what you make of it and as long as I’m around to draw breath I will make the most of life’s opportunities and get through the challenges”.

Mark Jones

Aquaculture lover, business owner,

Abalone shell expert and collector

Published Of Sea and Shore

From an early age, Mark was a keen diver, and took an interest in all marine life, particularly interested in abalone. Being located to Japan for military service in 1967/68, the opportunity to learn more on Ama Divers on the islands off the Noto Peninsular occurred. At this stage Mark started collecting abalone shells, where he obtained many of the large shells he has to this day. He has an ever-growing abalone shell collection; many say one of the largest personal collections in the world. Subsections of this collection will be on display at the 11th International Abalone Symposium, in Auckland.

COUNTRY UPDATES

Peter Cook

Lifetime IAS member

Country update session chair

After receiving his PhD from the University of Wales, Peter moved to the Zoology Department at the University of Cape Town, in South Africa, where he was employed as a lecturer in animal physiology. After receiving several personal promotions, he was appointed as Full Professor and Head of Department in 2000. Peter's main research interests have involved various aspects of the biology of mariculture species such as mussels, oysters, and abalone. He headed an extremely active Abalone Research Group in Cape Town and he, and his research team, have published widely on many aspects of abalone biology and aquaculture. His research work on this species was recognised internationally when, in 2000, he was elected President of the International Abalone Society. Peter is author, or co-author, of over 200 research papers, book chapters, and scientific reports. He has also been editor of several recent Special Issues of the Journal of Shellfish Research that have been dedicated to publication of papers resulting from several International Abalone Symposia. He has given well over 100 papers at local and international symposia, often as keynote speaker. He resigned as Head of Department of Zoology at UCT in 2001 and took up an adjunct appointment at the University of Western Australia in the Centre of Excellence in Natural Resource Management in Albany. Peter has had a long and active association with the international Aquaculture Stewardship Council, a body charged with encouraging the rapidly growing aquaculture industry to become more sustainable and socially responsible. In 2015, Peter was elected as Chairman of the Board of Directors of the ASC.

South Africa:

Rowan Yearsley & Peter Britz

Australia:

Nick Savva

Europe:

Gercende Curtois de Viçose

USA:

Laura Rogers-Bennett

New Zealand:

Tom McCowan

Mexico:

Ricardo Searcy-Bernal

China:

Weiwei You

Other:

Peter Cook

Symposia Sessions (1)

Theme	Cultural and Indigenous Knowledge	Resource Productivity & Enhancement
Room	WA224a	WA224b
Session chair	Gaya Gnanalingam	Laura Rogers-Bennett
14:00-14:15	**Bryan Denny** Indigenous abalone harvesting 40 thousand years of history, and still going	**Jeremie Bauer** Black Abalone translocation as a strategy for population recovery in Baja California, Mexico
14:15-14:30	**Gaya Gnanalingam** Pāua - Restoring a cultural icon	**David Witting** Movement patterns of a Southern California Abalone species, *Haliotis kamtschatkana*, with implications to management and recovery of abalone in the eastern Pacific
14:30-14:45	**Louise Bennett-Jones** Customary management of a customary fishery: Time to try something old	**Katie Sowul** Comparing survival of hatchery-reared pinto abalone (*Haliotis kamtschatkana*) released in mixed-age cohorts in Washington State
14:45-15:00	**Severino Gomes** A tribal-scientific alliance to produce and restore the red abalone (*Haliotis rufescens*) in Northern California's kelp forest ecosystem	**Niall Vine** From the hatchery to the sea: Optimising transportation methods for South African abalone (*Haliotis midae*) larvae
15:00-15:15	**Taylor White** What ever happened to Alaskan abalone? Current insights and historical comparisons of pinto abalone populations in Southeast Alaska	**Jeremy Prince** Shellogy – Reading the shells to inform and motivate reef-scale management
15:15-15:30	**Jeremie Bauer** Positive effects of community-led marine reserves on the green abalone	**Laura Rogers-Bennett** Rise in purple sea urchin recruitment and kelp forest collapse precipitates red abalone recruitment failure


DAY 2

DAY 2 – WEDNESDAY, 1 MARCH 2023

08:45-09:00		**Greetings (WG308)**
09:00-09:45		**Keynote Address (WG308)** **Dr Sylvain Huchette** Using seaweed culture to make abalone farming more sustainable: Wishful thinking or true economic potential?
09:45-10:20		**Featured Speaker (WG308)** **Sir Mark Solomon** Māori perspectives and natural resources
10:20-10:25		Moana New Zealand Partnership Acknowledgement
10:30-11:00		**Morning Tea (WG201)**
11:00-13:00		**Symposia Sessions (2)** **Resource Threats (WG308)** **Genetics & Genome (WG224a)** **Biology & Physiology (WG224b)**
13:00-14:00		**Lunch (WG201)**
14:00-15:45		**Symposia Sessions (3)** **Resource Assessment & Data gathering (WG308)** **Restoration Ecology, Biodiversity (WG224a)** **Nutrition & Feed (WG224b)**
15:45-16:15		**Afternoon Tea (WG201)**
16:15-17:00		**Plenary Address (WG308)** **Professor Karla Helbig** Immune priming as an approach to combat viral infection in abalone
17:00-17:15		**Closing (WG308)**
17:15-19:00		**Pub and Poster Event (WG201)**

PLENARY SPEAKER

Dr Sylvain Huchette

Founder and general manager of France Haliotis, Poligeenan, France.

French Agriculture Engineer, Sylvain Huchette has been working with abalone for over 20 years. After a PhD on abalone ecology and aquaculture at the University of Melbourne, Sylvain founded France Haliotis in Brittany in 2004 where he and his team developed original farming techniques for the European species, *Haliotis tuberculata*. France Haliotis was the first abalone farm certified organic in 2012 and has contributed to facilitating many key research works on abalone on topics such as domestication, stress and behaviour, nutrition, shell mineralization, ocean acidification and global warming. Convinced that abalone farming can play a role in the production of more sustainable seafood, he now investigates the production of several species of macroalgae to use in co-culture on his farm. Passionate about seafood and gastronomy, he has developed unique collaborations with many world-famous chefs - Alain Ducasse, Olivier Roellinger, Sebastien Bras, Anne Sophie Pic. His abalone and seaweeds are served in top French restaurants like Le Meurice or George V in Paris.

Using seaweed culture to make abalone farming more sustainable: Wishful thinking or true economic potential?

Haliotis tuberculata, also known as ormer, is the only abalone species living in European waters. It has been consumed traditionally in French coastal areas for a long time. Commercial fishing activities and first regulations to protect the stocks appeared in the 1960's. First aquaculture experiments were conducted in the 1970's by CNEXO - with the contribution of Pr Yasuyuki Koike. However, the first abalone farms really emerged in the 2000's.

France Haliotis was established in 2004 and developed unique farming techniques adapted to the species and its local environment. With the local constraints for space on the densely populated shores of Brittany, the farm chose to develop an original sea-based grow-out with low energy requirements using benthic cages and fresh seaweed collected by hand during low tides.

With climate changes and increasing interest for seaweeds from the French food industry in recent years, the pressure on the local resources have never been so high. France Haliotis's team and associated research laboratories have initiated work on macroalgae farming both at sea (integrated multitrophic Aquaculture/IMTA) and on land. Although farming cost were felt prohibitive at first, recent progresses showed unexpected profitable impacts on our abalone farm. Improved technical results included faster growth, reduced mortality, and healthier animals. This new production provides new commercial opportunities and open interesting perspectives for mitigation of Ocean Acidification on the farm.

https://www.francehaliotis.com/

KEYNOTE SPEAKER

Professor Karla Helbig

Head of Microbiology Discipline and The Antiviral Innate Immunity and Viral Genomics Laboratory, Department of Microbiology, Anatomy Physiology and Pharmacology, La Trobe University, Melbourne, Australia.

Karla has over 20 years' experience working with viruses and studying the early innate antiviral immune response in both humans and animals. She is currently a professor in molecular virology at La Trobe University (Melbourne, Australia), where her research team works towards the development of novel antiviral solutions to combat many significant viral threats. Her more recent work revolves around the use of immune priming technologies to control infection of Molluscs with Herpesviruses, and her team is currently involved in a large-scale industry project to develop novel antiviral solutions to assist in control of Herpesvirus infection in Australian abalone species. Karla's research is highly interdisciplinary and collaborative in nature, and she is a passionate advocate for educating the next generation of Women in STEM.

Immune priming as an approach to combat viral infection in abalone

Immune priming generally refers to the ability of an organism to better protect itself against a viral or bacterial infection following an initial exposure. Although we do not fully understand the mechanisms involved in immune priming, recent research in aquacultural settings has demonstrated it can offer some protection to marine animals against various pathogenic infections. Most notably, direct immune priming has been successful in reducing the susceptibility of oysters against OsHV-1, a related virus to the main viral pathogen of Australian abalone, HaHV-1 (Haliotid herpesvirus); and this protection has been shown to be passed onto the progeny of immune primed parents.

Our team has recently shown that immune priming via specific routes upregulates a favourable immune response to successfully protect 100% of Australian hybrid (*Haliotis rubra x H. laevigata*) adult abalone against a lethal dose of HaHV-1 in laboratory aquaria. We can demonstrate that this protection lasts for up to 4 months post priming, with the upregulation of transcripts from known antiviral genes remaining in the haemolymph of primed animals. To determine if this protection is transgenerational, and able to be passed from primed mothers to their offspring we are currently running a large scale on-farm trial across three locations to assess whether immune primed female *H. rubra* or *H. laevigata* broodstock produce progeny that have an enhanced resistance to HaHV-1 challenge. Juvenile hybrid and *H. laevigata* (6-7 months) were found to be highly resistant to HaHV-1, therefore no viral susceptibility differences were observed between offspring from control or immune primed parents at the first time point of this trial. Additionally, immune primed females produced progeny of a similar weight and size to that of their control counterparts, indicating that immune priming does not negatively affect the growth rate of juvenile abalone.

https://scholars.latrobe.edu.au/khelbig

FEATURED SPEAKER

Sir Mark Solomon

New Zealand Māori leader from the Ngāi Tahu and Ngāti Kurī (Kaikōura) iwi. Known for his mana, honesty, integrity, and effective leadership.

Sir Mark Wiremu Solomon KNZM is a New Zealand Māori leader from the Ngāi Tahu and Ngāti Kurī (Kaikōura) iwi. He served as kaiwhakahaere (chairperson) of Te Rūnanga o Ngāi Tahu, the tribal council of Ngāi Tahu, for approximately 18 years. He served as deputy chair of the Canterbury District Health Board. He served as a board member of the Museum of New Zealand Te Papa Tongarewa. He holds an Honorary Doctorate from Lincoln University as a Doctor of Natural Resources, recognising his enduring interest and concern for the natural environment. He spent a couple of seasons as a commercial pāua diver where he had a lot of good experiences and stories he shares to this day. In this direct memoir, Sir Mark reflects on his life, on the people who influenced him, on what it means to lead, and on the future for both Ngāi Tahu and Aotearoa New Zealand. He is known for his mana, honesty, integrity, and effective leadership. Be inspired and read Sir Mark's story: Mana whakatipu: Ngai Tahu leader Mark Solomon on leadership and life by Mark Solomon with Mark Revington.

Hui (Meeting) Points'

Kia ora whānau (family)!

Welcome to Aotearoa New Zealand! We hope you have a productive and enjoyable symposium. We encourage you to meet up with old friends and make new ones. To facilitate these encounters, we have designed some fun activities which involve the items in this kete (bag) and some hui (meeting or gathering) points strategically placed around the symposium areas.

Puzzle Piece (Hui Points A-D)

Find the 'Hui Point' corresponding to the letter behind your puzzle piece. See if you can connect your piece with the others. If not, come back later or leave your piece for someone else to have a go. Make sure to circle back to see the picture emerging.

String (Hui Point E)

Your string needs to connect with another item, which you can find in 'Hui Point E'. Find this place and make your new poroporo!

Coin (Hui Point F)

The New Zealand 10 cent coin features a Māori carved head or 'koruru'. On the back of your coin, there is a Māori word. Find another person with the same word and go together to 'Hui Point F' to find out what you have in common.

Pāua Shell (Hui Point G)

The small shell in your kete is a juvenile farmed Pāua. Take it to 'Hui Point G', and use it as an ornament in your flax flower.

Symposia Sessions (2)

Theme	Resource Threats	Genetics & Genome	Biology & Physiology
Room	WG308	WA224b	WA224b
Session chair	Adam Miller	Weiwei You	Norman Ragg
11:00-11:15	**Adam Miller** Using genomics to inform the management of fisheries facing new environmental challenges: blacklip abalone as a case study	**Weiwei You** Development of a 40K multiple-SNP array for Pacific abalone and its application in genomic selection for feed efficiency	**Sabine Roussel** Starvation and transport before seeding: Implications for stock enhancement programs in the European abalone *Haliotis tuberculata*
11:15-11:30	**Finn Ryder** Re-assessment of a blackfoot abalone population in Peraki Bay, New Zealand, after 45 years, and its response to environmental change	**Casandra Delgadillo-Anguiano** Evaluation *of Candidatus Xenohaliotis californiensis* (CXc) and its associated phage pCXc in black abalone of Baja California	**Leonie Venter** Specialised abalone metabolites: Transport of *Haliotis iris* as case study
11:30-11:45	**Owen Holland** Size-dependent maximum thermal limits in Australian farmed hybrid abalone: Implications for productivity shifts with ocean warming	**Fucun Wu** Genotype by environment interaction for growth and survival related traits in Pacific abalone	**Gercende Courtois de Viços** Sensory characterisation and physical properties of abalone, *Haliotis tuberculata coccinea* reared under different conditions
11:45-12:00	**Sharna Rainer** Managing range-extending urchins to protect Tasmanian abalone stocks	**James Dimond** Population genomics of wild and hatchery-raised pinto abalone (*Haliotis kamtschatkana*)	**Ziping Zhang** Immune regulatory of *Haliotis discus hannai* haemocytes in response to Vibrio parahaemolyticus reinfection
12:00-12:15	**John Keane** Sustainable overfishing of longspined sea urchins to protect key abalone habitat	**Nur Syahirah Mamat** Preliminary DNA barcoding of abalone, Haliotis spp. from Sabah, Malaysia	**Justine Fouassier** Physiological and behavioural responses of the European abalone *Haliotis tuberculata* to thermal stress
12:15-12:30	**Shawn Gerrity** Cataclysmic mortality, recovery, and reopening of an iconic New Zealand abalone fishery	**Xuan Luo** Chemical induced autotriploid and allotriploid abalone and performance grown in sea-based systems in southern China	**Jun Hayakawa** Comparisons of amount of movement and degree of aggregation by adult *Haliotis discus hannai* between spawning and non-spawning seasons

12:30-12:45	**Ben Stobart** The impact and implication of *Perkinsus olseni* on Australian abalone fisheries	**Nick Robinson** Genomic selection of greenlip abalone for improved growth rate, limiting inbreeding and maintaining genetic diversity	**Eileen Bates** Can settlement on coralline algae ameliorate negative effects of ocean acidification and temperature increase on pinto abalone early life stages?
12:45-13:00	**Wendy Bragg** Post-fire debris flows: a newly realised threat to endangered black abalone and the rocky intertidal zone in California, USA	**Ya Zhang** Characterisation of the molecular mechanisms of sexual maturation in the greenlip abalone, *Haliotis laevigata*	**Norman Ragg** The constant volume heart: an old hypothesis finally confirmed in a very old mollusc

Symposia Sessions (3)

Theme	Resource Assessment & Data gathering	Restoration Ecology, Biodiversity	Nutrition & Feed
Room	WG308	WA224b	WA224b
Session chair	Tom McCowan	Jessica Ericson	Gercende Courtois de Viçose
14:00-14:15	**Jaime McAllister** Monitoring the Tasmanian East Coast blacklip abalone (*Haliotis rubra*) stock rebuild; Fishery-independent time swim survey program	**Alyssa Frederick** Tools for saving a species: Using ecophysiology to improve endangered white abalone production	**Gercende Courtois de Viçose** Evaluation of low-trophic species inclusion in aquafeeds: effect on abalone *Haliotis tuberculata coccinea* grow-out performance
14:15-14:30	**Tom McCowan** The Kaikoura earthquake and the pāua fishery: The road to re-opening and management of a new fishery	**Erin Herder** Status of the endangered Northern Abalone, *Haliotis kamtschatkana,* on the Pacific coast of Canada	**Natalia Bullon** Beyond the fishmeal trap: The potential of insect meal and grape marc to feed the New Zealand farmed abalone
14:30-14:45	**Craig Mundy** Quantifying hyperstability in abalone fishery catch rates	**Jeremie Bauer** Abalone Mariculture in Baja California: a conservation aquaculture project	**James Harris** Colour change kinetics of greenlip abalone, *Haliotis laevigata* Donovan, fed dried macroalgae meals

14:45-15:00	**Malcolm Haddon** When are commercial abalone catch rates informative?	**Jessica Ericson** Taking the lab to the field: Physiology of NZ pāua at the Chatham Islands	**María del Pino Viera** Assessment of various seaweed-based diets and formulated feed on growth, body composition and colour of abalone (*Haliotis tuberculata* coccinea)
15:00-15:15	**Marine Pomarède** New Zealand pāua fishery research programme	**Joshua Bouma** Recovering Pinto abalone: use of conservation aquaculture to give Washington State's largest rocky-reef grazing snail a population boost	**Thao van Nguyen** Multiple omics approach to evaluate the effect of encapsulated feeds on blacklip abalone (*Haliotis rubra*) during the holding period before live exporting
15:15-15:30	**Ben Stobart** Critical reproduction density and resilience in abalone: A South Australian case study	**Laura Rogers-Bennett** Red abalone egg production estimates as indicators for fisheries and restoration in a warming ocean: Climate ready management	**Clifford L W Jones** Recent advances in abalone IMTA in South Africa – the AquaVitae story
15:30-15:45	**Peter Britz** Territorial user rights fishery (turf) restoration of a wild *Haliotis midae* population to sustainable harvest using cultured seed	**Melissa Neuman** Restoring the iconic white abalone (*Haliotis sorenseni*) to the kelp forests of Southern California, USA	**Gercende Courtois de Viçose** Optimising abalone settlement and metamorphosis: a red macroalgae candidate as an alternative to existing algal substrates.

Abstracts: Poster Presentations

Abstracts are ordered alphabetically by first name of presenter.

Presenter	Title
Andrea C. Alfaro	Investigation of Bluff's farmed abalone's gut microbiome under various formulated feed pellets
Andrea C. Alfaro	Preliminary results of Tasmanian abalone gut microbiome analysis from a feeding experiment
Andrea C. Alfaro	*Perkinsus olseni* and other parasites in New Zealand pāua, or black-footed abalone (*Haliotis iris*)
Caihuan Ke	Role of Bmal1 in mediating the cholinergic system to regulate the behavioural rhythm of abalone
Caihuan Ke	Genomic prediction and genome-wide association for heat tolerance trait in Pacific abalone
Corentin de Charnacé	How to estimate zoosanitary status of abalone?
David Witting	A flexible, sustainable data management system for abalone restoration
Dean Barber	Mana o te Pāua
Gercende Courtois de Viçose	*Haliotis tuberculata* coccinea grow out performances according to diet and production systems
Jacinta Agius	Investigating the Immune Control of Herpesvirus Infection in Marine Molluscs
Joanna Copedo	Histopathological investigation of four populations of abalone (*Haliotis iris*) exhibiting divergent growth performance.
Joshua Percy	Two Shells and Seven Arms: Assessing interactions between three key invertebrate species in East Otago, Southern New Zealand.
Justine Fouassier	Predation is the key component to explain high mortality during stock enhancement program
Leonie Venter	Metabolite profiling of abalone (*Haliotis iris*) energy metabolism: a Chatham Islands case study
María del Pino Viera	Does the on-growing diet influences consumer acceptance of cultured abalone?
María del Pino Viera	*Haliotis tuberculata* coccinea grow-out under two different feeding regimes: Evaluating potential strategies for abalone culture in the Canary Islands

Melissa Neuman	Combining a novel outplant module with metareplication to further abalone restoration capacity in California
Natalia Bullon	A pilot study testing sustainable aquafeed formulations for farmed New Zealand abalone
Ronan Le Gall	Effect of domestication on the response of European abalone to natural environmental variations and global change: a common garden experiment
Sabine Roussel	Stock-enhancement of the European abalone: transdisciplinary approach of the OURMEL project to evaluate the practical feasibility of the program
Sara Masoomi	Encapsulated bioactives for Increased Growth of Farmed Abalone (*Haliotis iris*)
Soniya Mohammadi	Extraction and characterisation of bioactive compounds from New Zealand black-footed abalone
Taylor White	What you can count on: data limitations and short monitoring periods; research made robust and inclusive when paired with local and Indigenous Knowledge
Thao V. Nguyen	Spatial Variation in Metabolomic Profiling of Black-foot Abalone in the Chatham Islands of New Zealand
Wendy Bragg	Black abalone, newly realised threats, and efforts to support recovery of this endangered species in California, USA
Xuan Luo	The effects of temperature and diets on nutritional value, flavour and sensory quality in abalone
Xuan Luo	Three-way cross hybrids trail on abalone and heterosis in growth performance, thermal tolerance, and hypoxia tolerance


DAY 3

DAY 3 – THURSDAY, 2 MARCH 2023

08:45-09:00	**Greeting (WG308)** **Professor Pare Keiha (AUT Pro Vice Chancellor for Māori Advancement)**
09:00-09:45	**Keynote Address (WG308)** **Professor Katherina Brokordt** Challenges for the farming of abalone in Chile and the potential contribution of genetic improvement programmes
09:45-10:45	**Delegate Speakers (WG308)** **Processing and production** **Sabine Daume** - Credible international standards and certification schemes for the abalone industry **Rowan Yearsley** - One company's experiences and learnings on the way to commercialising abalone ranching in South Africa **Irene Zhai** - New technologies, new products, and new trends in Chinese abalone processing industry **Brad Adams** - From the seed of an idea to an MSC certified fishery. The Rare Foods Australia story
10:45-11:15	**Morning Tea (WG201)**
11:15-13:00	**Symposia Sessions (4)** **Climate change (WA224a)** **Resource Management & Protection (WG224b)** **AquaVitae IMTA - Special session (open for all) (WG308)**
13:00-14:00	**Lunch (WG201)**
14:00-14:45	**Plenary Address (WG308)** **Professor David R. Schiel** Ecosystem resilience, recovery, and the rise and demise of inshore abalone populations after the devastating Kaikōura earthquake

14:45-15:00		**Closing**
15:00-16:30		**IAS General Meeting**
17:00		**Maritime Museum open for visitors (free with your dinner ticket)**
18:00-24:00		**Symposium Dinner**

NZJMFR Call for papers: Special issue on "**Abalone research in a changing world: A powerful conversation on opportunities and responsibilities**"

Dear Abalone Enthusiast,

A special issue of the New Zealand Journal of Marine and Freshwater Research (NZJMFR) will be dedicated to manuscripts showcased as oral and / or poster presentations at the 11th International Abalone Symposium 2023 (Abalone 2023).

Abalone are long-lived, slow-growing, slow-moving marine gastropods from the genus Haliotis with multiple species established as successful fishery and aquaculture producers. Apart from economic gain abalone is regarded as a sacred species in various cultures as valued resource for traditional and contemporary arts and crafts. Unfortunately, the abalone industry is under threat due to challenges and problems such as changing oceans, climate driven events, diseases, shortage of natural seaweed, costs of formulated feeds, land-based space availability, catch limitations, genetic diversity, changing oceans, lack of knowledge in some areas, and much more.

As abalone stakeholders, we have a responsibility to understand the needs of abalone in a challenging world to support abalone population success. Building on the theme of the symposium: "Poua te mana o Pāua ki te tai, kia whakaika te moana!" Affirm the 'mana' of Pāua to the sea, make the oceans plentiful!", this issue welcomes original abalone research linked to aquaculture and wild harvest production and cultural and indigenous case studies, presented at the 11th International Abalone Symposium, held in Auckland in 2023.

In support of this special issue, I would like to invite you to submit a manuscript via the online portal of NZJMFR (https://www.tandfonline.com/journals/tnzm20) for peer review as potential publication towards this special issue. Please select 'Special Issue' when submitting your manuscript.

If you have any questions, feel free to let me know.

Ngā mihi nui,
Professor Andrea C. Alfaro (Associate editor)
andrea.alfaro@aut.ac.nz

PLENARY SPEAKER

Professor Katherina Brokordt

Professor at the Aquaculture Department, Marine Science Faculty, Universidad Católica del Norte, Chile.

Marine Biologist (Universidad Católica del Norte - UCN, Chile) and Ph.D. in Biology (Laval University, Canada). Currently, Professor at the Aquaculture Department, Marine Science Faculty at the UCN. Her broad scientific interests are the physiology and genetics applied to the aquaculture of shellfish, where abalone has been central. Her research focuses on understanding marine organisms' responses to changes in their environment from their physiology and genetics. Specifically, she studies how physiological capacities are modulated by external and internal factors, such as the environment, ontogeny, reproductive, nutritional, stress, and immune statuses, as well as their genotype. She looks for these responses at different levels of biological organization, from main effect genes, proteins, organelles, the complete cell, tissues, the whole animal, and population level. For this, her work is characterised by an interdisciplinary approach, which has been possible due to the permanent collaboration with several other researchers.

Challenges for the farming of abalone in Chile and the potential contribution of genetic improvement programmes

Globally, abalone has transitioned from being a captured to a farmed mollusc in the last decade. While abalone is not native to Chile, this country became the fourth-largest producer worldwide during this period. Recently, this production has declined, and a ten-year agenda has been raised by the industry. The main lines of action identified are: (1) improve the associativity between farmers; 2) promote the relationship with the communities; (3) generate a country image; (4) improve productive diversification and technological development; and (5) establish a genetic programme. Among genetic improvement strategies, hybridisation has generated interesting benefits for the industry, and selective breeding is considered an appealing approach because improvement can be cumulative and permanent. The prerequisite for family-based selection is the accurate estimation of genetic parameters including heritability and genetic correlation for the target traits. This talk will cover our advances in estimating the potential response to selection of some of the main traits of interest for abalone farming, centred on *Haliotis rufescens*, the main farmed abalone species worldwide. Economically important traits such as growth and disease resistance (focussed on withering syndrome) will be addressed, but also less studied traits, such as those associated with energy intake and allocation, flesh quality, susceptibility to lighting conditions, and expression of molecules associated with the immune response capacity. Interestingly, high potential responses to selection were estimated for most of these traits, and several are also genetically correlated. Thus, the potential contribution of selective breeding to improve abalone production, in synergy with other new biotechnology-based strategies, is here highlighted.

https://www.researchgate.net/profile/Katherina-Brokordt

KEYNOTE SPEAKER

Professor David R. Schiel

Distinguished Professor, Marine Science, Canterbury University,

Christchurch New Zealand.

David Schiel is head of the Marine Ecology Research Group at Canterbury University in Christchurch, New Zealand. He and his group have worked on a wide range of topics in marine science, with significant contributions in aquaculture, fisheries, kelp forest ecology and the functioning of nearshore ecosystems. Much of their current research underpins new management and rehabilitation efforts in pāua, scallop and algal populations. In particular, he and his group have monitored the recovery of the Kaikoura coastal ecosystem after the 7.8Mw earthquake in 2016, including the recovery dynamics of NZ abalone populations, which were greatly affected by the massive coastal uplift caused by the earthquake. It's a story of population resilience and habitat recovery. His first 'real' job was as a fisheries scientist working on NZ pāua populations. He is a Fellow of the Royal Society of New Zealand, a Fellow of the Marine Biological Association (UK), and a former NZ Science Communicator of the year. With over 200 scientific publications, he is one of New Zealand's top-cited marine scientists.

Ecosystem resilience, recovery, and the rise and demise of inshore abalone populations after the devastating Kaikōura earthquake

The Mw 7.8 Kaikōura Earthquake of November 2016 caused substantial uplift of the nearshore ecosystem and extensive mortality of NZ pāua, *Haliotis iris*. This included loss of juvenile pāua habitat and devastation of algal communities that had been lifted by up to 6m. The fishery was closed until there was convincing evidence of recovery of algal and pāua populations. Detailed coastal sampling for 6 years showed major shifts in algal communities compared to pre-earthquake conditions, with very poor recovery of the large habitat-forming fucoid alga Durvillaea spp. It is clear that the coastal community is still under flux, especially given the repeated heat waves, gravel inundation and sedimentation events that have had differential effects on major taxa. Nevertheless, inshore pāua populations recovered to a state generally unseen in recent times, with large numbers of adult pāua exposed at low tide over the 130km of coastline. We considered these would be particularly vulnerable to shore-based recreational fishing. After 5 years of closure the fishery opened for 3 months over summer 2021-22 to enormous recreational fishing pressure, resulting in a 74% decline of legal pāua biomass of 'wade-able' populations (which are generally not fished commercially). The 5t recreational allocation was exceeded by a factor of 9. This was, in effect, the Tragedy of the Commons in action, with no recreational fishing licence required, no catch reporting and no effective way to enforce accumulation limits. We contend with ever-increasing numbers of recreational fishers, and the particular vulnerability of abalone populations, that managers need to invoke and trial new methods of ensuring that an 'allocation' or catch limit is actually that. In the end, there is only one pāua fishery, and it cannot be managed unless all sectors participate sustainably.

https://www.researchgate.net/profile/David_Schiel

Symposia Sessions (4)

Theme	Climate Change	Resource Management & Protection
Room	WA224a	WA224b
Session chair	Andrea C. Alfaro	Craig Mundy
11:15-11:30	**Daniel Swezey** Will the endangered white abalone (*Haliotis sorenseni*) survive the climate crisis?	**Craig Mundy** Standardising wild abalone fishery catch rates: Partitioning weather effects from biomass changes
11:30-11:45	**Joanna Copedo** Influence of summer heatwaves on slow- and fast-growing populations of pāua.	**Katherine Farag-Page** Stakeholder engagement: A key element of harvest strategy development
11:45-12:00	**Sabine Roussel** Ocean acidification: What consequences for larvae, juveniles, and adult abalone *H. tuberculata?*	**Lachlan Strain** From sustainability to safety: a new age recreational abalone fishery
12:00-12:15	**Yilei Wang** Response of *Haliotis discus hannai* to thermal, hypoxic stress, and Vibrio parahaemolyticus infection based on multi-omics analysis	**Laura Rogers-Bennett** Ongoing mass mortalities of red abalone, *Haliotis rufescens*, in Northern California threaten population viability and species recovery
12:15-12:30	**Sarah Carroll** Validation of candidate biomarkers of abiotic stress in *Haliotis midae*	**Philipp Neubauer** Evaluating management options for pāua fisheries in Aotearoa/New Zealand: Towards fine scale management of a priced natural resource
12:30-12:45	**Weiwei You** The cross-tolerance and metabolic coordination in abalone under long-term thermal acclimation and hypoxia stress	**Ronan Le Gall** Population genetic structure of natural and hatchery-raised populations of European abalone *Haliotis tuberculata tuberculata*: Lessons for future restocking and stock-enhancement
12:45-13:00	**Andrea C. Alfaro** Capturing abalone stress signals and building resilience	**Nicole Hancox** Partners in sustainability: The abalone industry association of South Australia's successful self-management arrangement

ORAL PRESENTATION ABSTRACTS

Abstracts are ordered alphabetically by last name of presenter and include those provided to the committee for publishing at the time of printing.

From the seed of an idea to an MSC certified fishery: The rare foods Australia story

Brad Adams

Rare Foods Australia, 8 Simmons Court, Augusta, WA 6290 Australia

Bio: Brad is the founder and innovator of Ocean Grown Abalone (now Rare Foods Australia) an abalone ocean ranching company listed on the Australian Stock Exchange. He is a fisherman, scientist, entrepreneur. abalone diver, abalone farmer, abalone rancher, and current the president of Australasian Abalone Association. His passion and interest are working with the incredible power of the marine environment.

Keywords: Abalone, Innovation, MSC, Ranching

The development of the Rare Foods Australia abalone ranching business from concept to ASX listed seafood company that has innovation at its core. The past, present & future.

Capturing abalone stress signals and building resilience

Andrea C. Alfaro[1], Leonie Venter[1], Thao V. Nguyen[1,2], Tim Young[1]

[1]Aquaculture Biotechnology Research Group, Department of Environmental Science, School of Science, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand
[2]NTT Hi-Tech Institute, Nguyen Tat Thanh University, Ho Chi Minh City, Vietnam

Bio: Andrea is a leading marine scientist with inter-disciplinary research interests in Aquaculture Biotechnology. Her research centres on understanding the complex interactions between organisms and their environments, in both natural (field ecology) and controlled (aquaculture) settings. Andrea leads the Aquaculture Biotechnology Research Group at AUT (Auckland, New Zealand), which applies innovative approaches (e.g., metabolomics, integrated omics) to understand complex research questions, such as host-pathogen-environment interactions, resilience in a changing environment, and eco-physiological trade-offs and balances throughout life stages.

Keywords: Multi-omics, Stress, Resilience

Cutting-edge biotechnological innovations and transdisciplinary approaches have opened the door for deep understanding of physiological activities within marine organisms. These tools and approaches facilitate integrated studies of complex endogenous processes, such as immunological responses, metabolic pathway perturbations, and mechanisms that underpin survival and resilience in the face of unprecedented global change effects. Multi-omics approaches are now being used routinely to investigate genotype to phenotype research questions in organisms exposed to a range of environmental conditions, such as increasing ocean temperatures and pathogen loads. Of particular importance is the area of biomarker discovery for early diagnostics of health, nutritional improvements, growth enhancement and production success in fisheries and aquaculture. Integrating these new advances with ground-truthed traditional techniques may give us the best chance to understand and respond to current and future global environmental challenges:

~How does an organism respond to stressors (e.g., diseases, pollutants, temperature, acidification) and their cumulative effects?
~What are the tipping points for populations facing increased stress frequencies and magnitudes? Can these be predicted?
~Can we add resilience and future-proof our commercially important marine populations and preserve those which are ecologically sensitive?

As scientists, we have much to do…!

Can settlement on coralline algae ameliorate negative effects of ocean acidification and temperature increase on pinto abalone early life stages?

Eileen Bates[1], Ryan Crim[2], Josh Bouma[2], Caitlin O'Brien[2], Jodie Toft[2], Jacqueline Padilla-Gamino[1]

[1]University of Washington School of Aquatic and Fishery Sciences, Seattle, WA 98105 United States
[2]Puget Sound Restoration Fund

Bio: Eileen Bates is a PhD candidate at the University of Washington's School of Aquatic and Fishery Sciences in Seattle, USA. Her dissertation work is focused on the restoration of endangered pinto abalone. She works closely with Puget Sound Restoration fund on hatchery-based experiments to assess impacts of climate change on early abalone life stages and to study microbiome of hatchery tanks to better optimise the hatchery rearing process. She also works closely with Washington Department of Fish and Wildlife to compare the oceanographic conditions at different pinto abalone restoration sites in the San Juan Islands (Washington, USA) with abalone survival at those sites through long term monitoring studies. She aims to combine the knowledge from these hatchery and field experiments to better understand optimal habitat and oceanographic conditions for abalone in Washington State as climate change continues.

Keywords: Climate change, Coralline algae, restoration, Pinto abalone, Restoration

Since 1994, Washington State (USA) has seen a 97% drop in the native pinto abalone population. Since 2007, restoration aquaculture efforts have been underway to return the wild population to a self-sustaining density. Restoration groups spawn pinto abalone in hatcheries and rear them for 1-2 years before releasing them to subtidal sites. However, the success of abalone not only depends on restoration efforts but also on the capacity of abalone to survive and reproduce as threats of ocean acidification and warming increase. In a preliminary hatchery study, we found that pH and temperature influence larval survival, but pH has a stronger effect on settlement success. Crustose coralline algae can play an important role in the success of restoration efforts by serving as a natural settlement inducer and creating a pH refuge for juvenile abalone. In this study we examined settlement of pinto abalone under different environmental conditions (7.95 pH, 14°C (control); 7.95 pH, 18°C; 7.6 pH 14°C; and 7.6 pH, 18°C) using two substrates: clean fiberglass with GABA (a neurotransmitter typically used to induce larval settlement) and CCA covered fiberglass. If presence of CCA can improve settlement and mitigate effects of ocean acidification on larval and juvenile abalone, we may be able to improve the efficacy of abalone restoration efforts in Washington. We tracked settlement rate and then survival, growth, and substrate microbial composition for the first three months of juvenile growth. Our findings will unblock bottlenecks in the hatchery rearing process and provide insights into ideal wild abalone habitat as climate change continues.

Abalone mariculture in Baja California: A conservation aquaculture project

Jeremie Bauer[1], Julio Lorda[2], Rodrigo Beas[3], Luis Malpica-Cruz[4], Laura Rogers-Bennett[5], Fiorenza Micheli[6], Alicia Abadía-Cardoso[7], Ricardo Searcy-Bernal[8]

[1]Universidad Autónoma de Baja California (UABC), Facultad de Ciencias Marinas
[2]UABC, Facultad de Ciencias
[3]UABC, Facultad de Ciencias Marinas
[4]UABC, Instituto de Investigaciones Oceanológicas (IIO)
[5]California Department of Fish and Wildlife, Karen C. Drayer Wildlife Health Center
[6]Stanford University, Hopkins Marine Station
[7]UABC, Facultad de Ciencias Marinas
[8]International Abalone Society

Bio: As a scientist from Mexico, Jeremie's research interests are in social-ecological projects to integrate community-led marine reserves with ecosystem restoration strategies and sustainable aquaculture. His bachelor's, master's, and doctoral theses focused on management and conservation strategies to help Mexico's abalone populations recover. In his group they focus specifically on multitrophic aquaculture and mariculture systems, restoration initiatives through restocking and translocations, and the establishment of marine reserves to improve various abalone species populations in Mexico.

Keywords: Climate change, Diets, Red abalone, Restocking

Landings of fished abalone have significantly decreased in the last decades and global production has drastically changed from fishing to farming. In particular, multiple stressors related to climate change and overfishing are threatening these resources in California, USA, and Baja California, Mexico. Aquaculture and subsequent restocking efforts may support sustainable harvesting of abalone. To test, inform, and promote innovative sustainable seafood production strategies in the North-eastern Pacific, we designed an experimental mariculture system at San Jeronimo Island, Baja California, Mexico, in collaboration with the local fishing cooperative. Specifically, this pilot experiment aimed to explore the feasibility of rearing red abalone, *Haliotis rufescens*, during its early stages to a larger size for a future local restocking program. We also tested the effects of two different depths, surface, and bottom (6 m) and three different macroalgae diets on the survival and growth of juvenile red abalone (30 ± 8 mm), using a long line system. Our results show a 7.22 ± 0.27 mm mean increase in shell length after three months of experimentation, which appears to be greater than for red abalone raised in the lab. We did not find any effect of depth or macroalgae diet treatments. High growth rates suggest mariculture might allow abalone to attain size refuge and increase its survival when restocked in its natural habitat. If scaled successfully, these conservation aquaculture strategies could contribute to sustainable abalone populations and landings in North America.

Black Abalone translocation as a strategy for population recovery in Baja California, Mexico

Jeremie Bauer[1], Alicia Abadía-Cardoso[1], Julio Lorda[1], Rodrigo Beas[1], Luis Malpica-Cruz[2], Ricardo Searcy-Bernal[3], Miguel Bracamontes-Peralta[4]

[1]Universidad Autónoma de Baja California (UABC), Facultad de Ciencias Marinas
[2]Universidad Autónoma de Baja California, Instituto de Investigaciones Oceanológicas (IIO)
[3]International Abalone Society
[4]Sociedad Cooperativa Pesquera "Ensenada"

Keywords: Conservation, Endangered, *Haliotis cracherodii*, Restoration

Black abalone was once an abundant macroinvertebrate in the North-eastern Pacific. Due to a combination of factors, such as disease, overfishing, and environmental impacts, black abalone numbers declined dramatically in the late 1980s and early 1990s. Today, black abalone populations have not recovered, and restoration programs are being proposed as an alternative to improve recovery. One potentially successful strategy involves translocations, where wild adults are aggregated in high-density areas that may boost reproduction and recruitment. Here, we present the results of a black abalone translocation experiment in Baja California. First, we characterised potential sources and translocation sites. Then, we collected 125 black abalones from a high abundance area and measured, tagged, and acclimated prior to release on Isla San Jeronimo and Punta Baja, two historically abundant black abalone reefs. Finally, we surveyed the translocated abalones after nine months (274 days) and recorded survival, aggregations, and growth rates. We recorded 33.33% of the translocated black abalones at Isla San Jeronimo and 30.65% at Punta Baja. Our results suggest translocation may be a promising restoration strategy to recover depleted black abalone populations. This study demonstrates the importance of co-management between academia and local communities for the development of restoration programs.

Positive effects of community-led marine reserves on the green abalone

Jeremie Bauer[1], Jaime Segovia-Rendón[2], Julio Lorda[1], Rodrigo Beas[1], Alicia Abadía-Cardoso[1], Luis Malpica-Cruz[3], Ricardo Searcy-Bernal[4]

[1]Universidad Autónoma de Baja California (UABC), Facultad de Ciencias Marinas
[2]Proyectos y Servicios Marinos (PROSEMAR)
[3]Universidad Autónoma de Baja California, Instituto de Investigaciones Oceanológicas (IIO)
[4]International Abalone Society

Keywords: Conservation, Guadalupe Island, *Haliotis fulgens*, Mexico, MPA

Marine reserves are implemented worldwide to protect, restore, and manage marine ecosystems and species. The green abalone, *Haliotis fulgens*, is a marine gastropod of high economic value, extracted for over 35 years at Guadalupe Island, Mexico. In this work, we assessed the effects of recent marine reserves established and managed by the local fishing cooperative. We evaluated the population status of the green abalone by conducting 1) an assessment of the green abalone population around Guadalupe Island through subtidal monitoring; and 2) an evaluation of the effect of newly established marine reserves (Plancha and Gaviota), on abundance, size, aggregation, and potential egg production. To assess the population structure around Guadalupe Island, we surveyed during 2020 and 2021 a total of 11,160 m^2. We recorded and measured 2,327 green abalones. All variables were higher at the marine reserves, except the shell length. For example, the green abalone densities inside the marine reserves in 2020 (Plancha = 0.70 ± 0.06 SE), and 2021 (Plancha = 0.66 ± 0.06; Gaviota = 0.66 ± 0.26 SE individuals m^{-2}) were in average three times higher compared to fished sites in 2020 (0.19 ± 0.02 SE individuals $^{m-2}$), and 2021 (0.21 ± 0.02 SE individuals $^{m-2}$). In this work, we report a positive biological response to community-led marine reserves on a green abalone population. This study shows that marine reserves can support sustainable fishing practices and enhance ecosystem resilience.

Customary management of a customary fishery: Time to try something old

Louise Bennett-Jones[1], Gaya Gnanalingam[1,2], Brendan Flack[1,3], Nigel Scott[4], Christopher Hepburn[1,2]

[1]Coastal People Southern Skies Centre of Research Excellence, Dunedin NZ
[2]Department of Marine Science, University of Otago, Dunedin NZ
[3]Kāti Huirapa Rūnaka ki Puketeraki, Karitāne NZ
[4]Strategy and Influence, Te Rūnanga o Ngāi Tahu, Christchurch NZ

Bio: Originally from the British Channel Island of Jersey, Louise undertook an undergraduate degree in Marine Biology & Coastal Ecology at Plymouth University before returning to the island to work as a Marine & Fisheries Officer for the local Environment Department. Wishing to gain further fisheries management knowledge and experience, she moved to New Zealand in 2019 to pursue postgraduate study at the University of Otago. Presently, she is working alongside Tangata Tiaki for Kāti Huirapa Rūnaka ki Puketeraki to conduct her PhD thesis on the assessment, restoration, and management of pāua (blackfoot abalone, *Haliotis iris*) in the East Otago Taiāpure.

Keywords: Local management, Maramataka, Wading fishery

Centralisation of fisheries management within governing bodies removes management rights of Indigenous communities. Management of pāua (blackfoot abalone, *Haliotis iris*) in Aotearoa exemplified this transition, from small-scale fisheries management by tangata whenua (Indigenous people with historical claim to the land, Māori) to central government regulation. Co-management strategies have the potential to address degradation of biological and cultural diversity by returning management to local scales and authority to local people. Aotearoa's customary fisheries management legislation aims to facilitate such a devolution of management though the establishment of Taiāpure Local Fisheries and Mātaitai Reserves. The East Otago Taiāpure, established in 1999 by Kāti Huirapa Rūnaka ki Puketeraki, is one such area. These customary fisheries management areas are said to allow tangata whenua to conduct management in ways that best fit local practices. As such, a key objective of the East Otago Taiāpure Management Committee is to "promote the use of traditional tikanga (customs) and kawa (protocols) through the management regulations for the taiāpure". Accordingly, the Committee has proposed returning pāua gathering to wading only methods, and realigning harvest frequency with the maramataka – the Māori lunar calendar. However, numerous constraints have been experienced by the Committee as they endeavour to operate within the confines of a centralised legal framework. Here, an overview of these management proposals is given, and constraints to their implementation are discussed. Insights are then drawn from another abalone fishery in the British Channel Islands, where a wading fishery for ormers (*Haliotis tuberculata*), regulated via the lunar cycle, exists.

Recovering Pinto abalone: use of conservation aquaculture to give Washington State's largest rocky-reef grazing snail a population boost

Joshua Bouma[1], Eileen Bates2, Henry Carson[3], James Dimond[4], Caitlin O'Brien[1], Katie Sowul[3]

[1]Puget Sound Restoration Fund, Bainbridge Island, WA 98110 USA
[2]University of Washington
[3]Washington Department of Fish & Wildlife
[4]Western Washington University

Bio: Josh Bouma is a shellfish biologist, scientific diver, and Abalone Recovery Program Director at Puget Sound Restoration Fund. He leads Pinto abalone conservation aquaculture efforts and conducts research and field programs aimed at recovery of this charismatic and unique, but severely threatened native mollusc. Josh also manages the Port Madison Community Shellfish Farm for PSRF. Josh has been with PSRF for twelve years following five years as a biologist with the Washington Department of Fish & Wildlife. He earned an MS in Aquatic & Fishery Sciences from the University of Washington.

Keywords: Conservation aquaculture, Juvenile outplants, Restoration

Pinto abalone (*Haliotis kamtschatkana*) in Washington State, USA, are currently at an extreme low abundance and facing potential collapse due to long-term population declines. In 2019, the Washington Department of Fish & Wildlife (WDFW) listed this ecologically important rocky-reef grazer as a state endangered species. The WDFW Pinto Abalone Recovery Plan was published in 2022, recognising the importance of an active supplementation program as key to rebuilding self-sustaining population densities. Anticipating this need for human intervention, a diverse collaboration of state, federal, university, tribal

and NGO partners have worked on applied research and pilot scale restoration efforts to support recovery in Washington State since 2003. Puget Sound Restoration Fund (PSRF) has managed the state's conservation aquaculture program to responsibly produce hatchery cultured juveniles for release into the wild. Only wild singletons are collected and used as broodstock and outplant efforts rely solely on first generation hatchery cohorts. Over the past decade, partners have carefully released more than 45,000 genetically diverse, healthy Pinto abalone to 27 restoration sites in the San Juan Archipelago and surrounding waters. Annual diver surveys monitoring growth, survival, and movement have revealed site selection as a significant driver in seeding success. Currently, two-thirds of established sites are considered successful based on relative percentage of out planted abalone observed during diver surveys. Efforts to date have set the stage for expanded abalone recovery efforts across its range in Washington State.

Post-fire debris flows: a newly-realised threat to endangered black abalone and the rocky intertidal zone in California, USA

Wendy Bragg[1] and Steve I. Lonhart[2]

[1]University of California, Santa Cruz
[2]Monterey Bay National Marine Sanctuary, NOAA, California, USA

Bio: Wendy Bragg is a Ph.D. student at University of California, Santa Cruz where she examines the impacts of fire and rain on California's rocky intertidal habitat and the endangered black abalone (*Haliotis cracherodii*). This research pivoted to rescue/relocation operations when post-fire debris flows buried distant stretches of rocky coastline containing large populations of black abalone. Bragg is calculating losses to the species and its critical habitat and developing techniques to better predict, respond, and monitor similar impacts, in part through drone and other aerial imagery. Recently, Bragg has been exploring methods to culture black abalone to support recovery.

Keywords: Black abalone, Climate change, Fire; Sediment, Threat

The black abalone (*Haliotis cracherodii*) is a critically endangered species found on the west coast of North America from roughly San Francisco, California to Baja California, Mexico. While overfishing contributed to its decline, withering syndrome decimated populations, especially in central and southern California, beginning in the 1980's. Many areas south of the Big Sur coast have experienced declines of 90% or more. Since a levelling off withering syndrome deaths, scientists hoped the species would recover by expanding from its last remaining stronghold populations in central California. However, in 2020/2021, a fire + flood event precipitated numerous debris flows that buried distant stretches of Big Sur's rocky intertidal habitat and healthy black abalone populations. Our team surveyed black abalone populations and rocky habitat before and after debris flows and recorded impacts severe enough to prompt NOAA to grant emergency authorisation for rescue/relocation operations, which we conducted in 2021. We have since been working to quantify the initial and ongoing impacts of this natural disaster through on-site surveys and the use of drone imagery. It is likely that California will experience more frequent and intense impacts to the coastline from similar post-fire debris flows and landslides given climate change predictions including: (1) increasing fire intensity and frequency, in part due to historic fire suppression; (2) increasing drought conditions that reduce vegetative cover; and (3) increasing risk of severe flooding from extreme storms, such as atmospheric rivers. For black abalone, this adds another regional threat to the recovery of the species.

Territorial user rights fishery (turf) restoration of a wild *Haliotis midae* population to sustainable harvest using cultured seed

Peter Britz and Andrew Witte

Department of Ichthyology and Fisheries Science, Rhodes University, Grahamstown, South Africa

Bio: Peter Britz is a professor in the Department of Ichthyology and Fisheries Science at Rhodes University. His research focus is the biology, aquaculture, and fisheries of the South Africa abalone. He was Chairman of the International Abalone Society (IAS) from 2009-2014 and received the IAS Distinguished Research Medal. His research team has played a key role in the development the commercial abalone farming technology in South Africa. His research is currently focused on abalone ranching and the restoration of depleted fishery populations.

Keywords: Enhancement, Restoration, Seeding, Stock, TURF

The abalone aquaculture industry in South Africa has made it possible to restore wild abalone populations using hatchery reared seed. We present results of an abalone ranching and stock enhancement pilot project which conducted to restore an abalone (*Haliotis midae*) population which was depleted by poaching. The South African fisheries authority granted a right to a private company to reseed an 18 km ranching zone at Port Elizabeth, South Africa. Approximately 3 million seed abalone were stocked to between 2014 and 2019, with resource protection provided by private security. A research survey conducted in January 2018 indicated that on commercially seeded sites the average density increased from 0.3 abalone per m^2 in 2014 to 1.0 abalone per m^2, with the hatchery seed contributed more than 50% of the abalone found on seeded sites. Poaching fishing effort was significantly reduced by the presence of the private security and successful prosecutions of syndicates by the state. Based on a stock assessment of the resource, an initial harvest of 33 tons was granted by the fisheries authority in 2021 and 55t for 2022. The key to the success of the project is the TURF (Territorial User Rights Fishery) rights system which incentivizes private sector investment in stock rebuilding by means of exclusive and secure long-term rights. The success of the model has profound implications for the management and restoration of abalone resources in South Africa.

Beyond the fishmeal trap: The potential of insect meal and grape marc to feed the New Zealand farmed abalone

Natalia Bullon[1,2], Ali Seyfoddin[2], Nazimah Hamid[3], Andrea C. Alfaro[1]

[1]Aquaculture Biotechnology Research Group, Department of Environmental Science, School of Science, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand
[2]Drug Delivery Research Group, Science, School of Science, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand
[3]Department of Food Science, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand

Bio: Natalia Bullon is a PhD student in the School of Science, at the Auckland University of Technology, Auckland, New Zealand. Her research focusses on aquatic nutrition, sustainable aquafeeds, aquafeed delivery design, alternative ingredients with potential for aquaculture feeds and food science for aquaculture nutrition. In this regard she is using *Haliotis iris* as model organism to test and formulate alternative abalone feeds. Additionally, she is passionate about merging art and science and methods to effectively communicate findings through interaction, play awareness, cultivating an ethical awareness.

Keywords: Abalone, Aquafeed, Encapsulated feed, Grape marc, Insect meal

Abalone, locally called pāua in New Zealand, is a valuable export product for the country worth about NZD $50-60 million annually. One of the most significant bottlenecks of land-based abalone aquaculture is the high cost of the feed, which can be up to 50% of the production cost. The high price has been attributed to fish meal (FM), which use has been questioned due to the exacerbation of overfishing marine resources. Alternative ingredients, such as insect meal (IM) and grape marc (GM) are potential candidates for FM replacement due to their suitable nutritional profile and sustainable production methods. This study focused on the development of four formulated feeds in support of creating a diet for New Zealand abalone (*Haliotis iris*) using IM and GM. In addition, novel techniques in delivery methods (using a polymer matrix) were also investigated. Both short- and long-term feeding trials were performed, supplying the formulated diets to *Haliotis iris* in both farm and laboratory conditions. To this end, abalone growth parameters, feed utilisation and selected gastrointestinal tract enzymes were measured. Additionally, physico-chemical properties of the feeds were assessed. Results show that the formulated diets showed greater water stability than the commercial diet (control), potentially aiding tank cleaning activities and reducing solid losses. The inclusion of IM and GM did not compromise abalone weight gain; however, shell length, feed conversion ratio, protein percentage and enzyme activity were significantly different amongst diets. In conclusion insect meal and grape marc are effective ingredients for abalone feed formulations, supporting growth and favourable physicochemical characteristics, showing promise for use in a farm environment.

Validation of candidate biomarkers of abiotic stress in *Haliotis midae*

Sarah Carroll and Vernon Coyne

University of Cape Town, 12 College Road, Rondebosch, Cape Town, Western Cape 7700 South Africa

Bio: Sarah received gher PhD in molecular biology at the University of Cape Town in 2020, where her research was focused on elucidating the proteomic stress response of *Haliotis midae* to ocean acidification and elevated temperature. They made use of high-throughput proteomics and bioinformatics to functionally characterise the abalone proteome and identify candidate biomarkers of stress that could be incorporated in a health monitoring program for farmed abalone. Currently, she is cofounding a marine biotech start-up, MariHealth Solutions, in South Africa that aims to commercialise this, and other, research for farmed fish and shellfish. Ultimately, their pipeline of technology seeks to improve animal health management on aquaculture farms such that farming practices can be optimised and production costs decreased.

Keywords: Biomarkers, Proteomics, Stress

Haliotis midae is an economically important marine invertebrate that contributes more than half of the total revenue generated by the aquaculture industry in South Africa. However, the feasibility of farming this understudied invertebrate in the long-term remains unclear as few studies have been conducted on the effects of climate change on *H. midae*. The aim of this study was to validate candidate stress-induced biomarkers using label-free protein quantification (LFQ) tandem mass spectrometry. Aquarium-based stress trials were conducted where four abalone were sampled from treatment tanks (either pH 7.15, 25°C or both) after exposure for 12, 24 and 72 h and compared to animals sampled from the control tank (pH 7.9, 17°C). Five candidate biomarkers of ocean acidification (OA) stress were validated, while 10 candidates of acute temperature stress were detected and validated. Seven potential biomarkers were identified from abalone simultaneously exposed to elevated water temperature and decreased water pH. Candidate biomarkers of OA stress were found to be predominantly associated with the innate immune system, while those responding to temperature stress were associated with energetics and oxidative stress. Potential biomarkers of the combined stressors were associated with signal transduction and intracellular trafficking. This research demonstrates the usefulness of an LFQ-proteomics approach for biomarker validation, particularly with regard to non-model organisms. Ultimately, this research produced a solid foundation for further investigation of the functional stress response of a non-model organism and highlighted the complex dynamics and interplay that occurs between the stress and immune response systems of *H. midae*.

Influence of summer heatwaves on slow- and fast-growing populations of pāua

Joanna Copedo[1,2], Stephen C. Webb[2], Norman L. C. Ragg[2], Leonie Venter[1], Andrea C. Alfaro[1]

[1]Aquaculture Biotechnology Research Group, Department of Environmental Science, School of Science, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand
[2]Cawthron Institute, Nelson 7042, New Zealand

Bio: Joanna Copedo is an early career aquatic health scientist at Cawthron institute, and a PhD candidate within the Aquaculture Biotechnology Research Group at the Auckland University of Technology. Her research focuses on using histopathology to understand the complex host-pathogen-environment relationship in marine molluscs. Joanna's research interests include environmental stressors, particularly the effect of climate change and pathogens on the host, in valuable New Zealand aquatic species.

Keywords: Abalone, Growth divergence, Heat wave, Nutrition, Parasites

The black-foot abalone, *Haliotis iris*, locally known as pāua, is one of three haliotid species commonly found around New Zealand. Pāua are marine gastropods that can display a high level of variation in growth performance. The pāua inhabit subtidal, coastal habitats which vary from bare rocky shores to kelp forests. These environments are potentially exposed to fluctuating and adverse conditions. Three questions have been identified from a previous study which have guided this research: 1) Does the tissue health, as assessed by histopathology, change in response to heatwave stressors and are the slow-growing populations disproportionately affected? 2) What is the cause and composition of previously undescribed birefringent kidney concretions in these populations? and 3) Is the Haplosporidian-like parasite found in recent samples the same species as the potentially harmful parasite identified in commercial *H. iris* in the early 2000s and, if so, what are the future implications for the wild populations? This histological investigation focused on not only identifying factors associated with growth performance, but also on how summer heatwaves might influence the overall tissue health of the pāua. In addition, factors identified in a previous study, such as the mineral concretions and parasites observed in the right kidney are quantified to provide further information beyond prevalence. Preliminary results indicate potential nutritional deficiencies, as well as differences in kidney concretion and parasite prevalence between the slow-growing and fast-growing population. These findings will be discussed in the context of potential vulnerability to marine heatwave stress.

Integration of the sea cucumber *Holothuria sanctori* in Haliotis tuberculata grow-out processes: evaluation of a low trophic species IMTA system

Gercende Courtois de Viçose, Mohamad Magdy, Juan Manuel Afonso

[1]Institute of Sustainable Aquaculture and Marine Ecosystems (IU-ECOAQUA), Aquaculture Research Group (GIA), University of Las Palmas de Gran Canaria (ULPGC), Las Palmas de Gran Canaria, Spain.

Bio: Aquaculture researcher with a PhD in Biology and 25 years' experience in aquaculture, marine biology and ecology focusing on molluscs and invertebrates related themes. Her main research areas are larval development and settlement, hatchery, and nursery technologies as well as sustainable aquaculture techniques. Her research encompasses physiological processes, larval and post-larval production techniques, micro and macroalgal production, grow-out techniques, and nutrition. Author and co-author of peer-refereed scientific publications, conference presentations and acting as a referee in various aquatic science journals as well as evaluator of scientific projects. She is the European representative and treasurer of the International Abalone Society.

Keywords: Feed, *Holothuria sanctori, Haliotis tuberculata*, IMTA, Sea cucumber

Various studies have demonstrated the interest of including deposit feeders, as integrated elements of IMTA systems. Experiments tested the potential of the integrated culture of the sea cucumber *Holothurian sanctori* with the abalone *Haliotis tuberculata coccinea* to develop the integrated Land Based IMTA production of these species. Young individuals of *H. sanctori* were placed under abalone (*H. tuberculata coccinea*) baskets, in experimental IMTA units, in which abalone were fed macroalgae, compound feed or a mix of both. Experimental IMTA systems consisted in 50l perforated baskets, to stock the abalone, suspended in 300l capacity tanks in which the sea cucumbers received abalone wastes. Experiments tested different abalone and sea cucumbers sizes and densities and feeding sources for the abalone. Sea cucumber Weight Gain (WG), Specific Growth Rate (SGR) as well as ingestion rate, faecal production rate, body wall proximate biochemical composition and water quality were analysed. Overall, mean SGR and WG values differed significantly ($p < 0.05$) among density, sizes, and feed treatments. No significant difference ($p > 0.05$) was observed between the proximate biochemical composition of sea cucumbers produced in the tested IMTA system and wild-caught specimens, supporting the suitability of such system to produce this sea cucumber species. The studies highlighted the variation of sea cucumber growth potential as a function of the nature of abalone feed employed and differences in ingestion and faecal production according to size and density. Overall, they highlighted the potential to develop IMTA systems including only low trophic species.

Evaluation of low-trophic species inclusion in aquafeeds: effect on abalone *Haliotis tuberculata coccinea* grow-out performance

Gercende Courtois de Viçose, Nuria Marrero, María del Pino Viera

[1]Institute of Sustainable Aquaculture and Marine Ecosystems (IU-ECOAQUA), Aquaculture Research Group (GIA), University of Las Palmas de Gran Canaria (ULPGC), Las Palmas de Gran Canaria, Spain.

Keywords: Abalone, Formulated diet, *Haliotis tuberculate*, IMTA, Macroalgae

Macroalgae are foreseen as a possible alternative protein source to be included in feed to reduce dependency on fishmeal and fish oil. Macroalgae produced in IMTA systems, offering protein-rich supplementary feed, were used to formulate and produce innovative diets for abalone. 6-month-old *Haliotis tuberculata coccinea* juveniles were used in a 12 weeks experiment comparing 11 feeding treatments including; fresh algae (FA) (*Gracilaria cornea* and *Ulva rigida*), commercial feed (CF), a mixture of both (MIX), 100% vegetal feed (VEG), and feed including 1,5% of *Sacharina latissima* (SAC), *Ulva sp.* (U), *Gracilaria sp.* (G) as well as feed including 1,5% of *Ulva sp.* and *Gracilaria sp*. (UG1, UG2) and 3% of *Ulva sp.* and *Gracilaria sp.* (UG3, UG4). Experiments were performed in triplicate, under natural photoperiod, at a temperature of 19±0.5º C. 100% of animals weight and length were sampled to assess their growth and survival. FA feeding resulted in significantly higher final size and DGSL of 32,52±0,37 and 137,98±3,11 respectively while weight gain was significantly higher in the MIX treatment. Feed intake (146,90±10,50 mg ab^{-1} d^{-1}) was significantly higher in the FA treatment due to the nature of the feed, while the ones observed in the experimental diets were not significantly different from the one of the CF treatments. Food conversion ratio (FCR) in all the experimental compound feed treatments were not significantly different from the one of the CF. The results obtained reinforce the possibility to consider inclusion of IMTA produced macroalgae in compound feed as a sustainable protein source.

Optimising abalone settlement and metamorphosis: a red macroalgae candidate as an alternative to existing algal substrates

Gercende Courtois de Viçose, Nuria Marrero, María del Pino Viera

[1]Institute of Sustainable Aquaculture and Marine Ecosystems (IU-ECOAQUA), Aquaculture Research Group (GIA), University of Las Palmas de Gran Canaria (ULPGC), Las Palmas de Gran Canaria, Spain.

Keywords: Abalone, *Haliotis tuberculata*, Metamorphosis, Red macroalgae germlings, Settlement

Abalone have been the focus of many settlement and metamorphosis induction studies as these steps are key for juvenile's production. Consequently, experiments were performed to evaluate metamorphosis, survival, and growth of *Haliotis tuberculata* larvae exposed to settlement surfaces coated with biofilms of CCA, *Ulvella leptochaete, Rhodosorus marinus* and *Sahlingia subintegra.* Experiments were performed in triplicate, under flow through and in 2L Aquariums, in which were introduced four 5x 5 cm plates colonized by algal substrate and a total of 200 larvae/l/ aquarium. During 5 weeks after settlement each aquarium was fed twice a week with 50 ml of a diatom mixture (*Amphora sp.* and *Navicula incerta*) at a density of 106 cells/ml and post larval survival and growth were monitored. Live post larvae were counted on every settlement plate of each replicate (n 12/treatment) under a dissecting microscope at weekly intervals. 72h after larval introduction metamorphosis rates were significantly higher ($p<0,05$) on the red macroalgae germlings presenting an average settlement rate of 58 ±12% followed by settlement rates of 30 ± 6% on CCA, the latter being significantly higher ($P < 0.05$) than the ones observed for *U. leptochaete* and *R. marinus*. Post-larval survival and growth during the five weeks after settlement were not significantly different ($P>0.05$) between the different algae treatment tested. Germlings of the red macroalgae *S. subintegra*, could easily be produced and efficiently colonised settlement plates, consequently, they could offer a consistent and efficient settlement and metamorphosis induction alternative to existing algal substrates currently used at commercial level.

Sensory characterisation and physical properties of abalone, *Haliotis tuberculata coccinea* reared under different conditions

Patricia Burgos, Nuria Marrero, Gercende Courtois de Viçose, María del Pino Viera, Rafael Ginés

[1]Institute of Sustainable Aquaculture and Marine Ecosystems (IU-ECOAQUA), Aquaculture Research Group (GIA), University of Las Palmas de Gran Canaria (ULPGC), Las Palmas de Gran Canaria, Spain.

Keywords: Abalone, Colour, Panel training, Texture, Sensory properties

H. tuberculata coccinea has been identified as a target species for European aquaculture diversification. Sensory and physical properties are important market traits that have drawn increasing attention from seafood researchers. In the present study, we assess the potential quality differences on cultured abalone, at commercial size, under two different production systems: Recirculating System (RAS) and open flow (FLOW), and these, under three feeding regimes: Fresh algae (FA), commercial feed (CF) and a mixture of both (MIX). The proper cooking method, TPA (Texture Profile Analysis) and colour analysis were evaluated. An abalone taster panel was trained to develop a sensory attributes profile for local abalone and performed the sensory evaluation. Steaming for 2 minutes preserved the aromatic, texture, and consistency of abalone´s flesh. Feeding a compound diet had a significant effect on the colour of raw foots, animals fed on CF showing a whitish colour whereas those fed on FA presented a more yellowish one, however, after cooking, all the abalone´s foot showed similar colours regardless of the diet provided. Attributes scores from the sensory evaluation panel showed that seafood odour and flavour of abalone fed FA and MIX diets were higher than those of abalone fed CF. However, abalone fed CF scores lower than abalone fed FA and MIX diets in terms of texture evaluation, hardness, gumminess, and chewiness. Not significant differences were found, for all

parameters tested, between rearing systems. Results suggest that dietary regime can influence abalone quality hence consumers acceptance.

Credible international standards and certification schemes for the abalone industry

Sabine Daume, Jo-anne McCrea, Sascha Brand-Gardner, Kim Bedford

Bio.inspecta Pty Ltd, Centre for Seafood Certification, Victoria 3068 Australia

Bio: Dr Daume is the Managing Director of bio.inspecta Pty Ltd, Centre for Seafood Certification based in Melbourne Australia which covers Marine Stewardship Council (MSC), Aquaculture Stewardship Council (ASC) and Fisheries Improvement programs. Since 2009, Dr Daume has led numerous MSC evaluation audits including several large and controversial assessments, and many assessments in Australia including the only two abalone fisheries in the world to be certified to the MSC standard and ASC farm certifications in Australia, South Africa, and New Zealand.

Keywords: Certification, Ecolabel, Environmental and social impacts, Sustainability

The sustainability of seafood products has become more important to buyers and consumers alike. Increasingly, seafood producers are adopting a positive approach, clearly identifying products that they can demonstrate are produced through legitimate harvest and production with minimal impact on the environment. Seafood certification programs like the Marine Stewardship Council (MSC) and the Aquaculture Stewardship council (ASC) provide one such mechanism. The risk of illegal activity is often more pronounced with high value products like abalone and still presents an ongoing and significant risk to the sustainability and legitimacy of abalone fisheries. Regulators focusing on monitoring, control and surveillance have an important role to play, however, voluntary standards like MSC and ASC can have a more positive and wide-reaching impact, as they are effective in the marketplace, providing direct positive reinforcement to producers.

Drawn from our group's collective experience in the seafood certification industry and with abalone specifically, we will explain the assessment and certification process based on real examples at a level that will allow:
- Fisheries, producers, and supply chain actors to assess operational characteristics and market environments that lend themselves to the successful adoption of such schemes.
- Fisheries, producers, and supply chain actors to prepare their operations, staff, and stakeholders, to most effectively and efficiently navigate the process.
- Regulators and policy makers to understand their role, and how to effectively support the industry in certification aspirations, and
- Industry and government to understand the ways to enhance the benefits and values of certification.

Evaluation of *Candidatus Xenohaliotis californiensis* (CXc) and its associated phage pCXc in black abalone of Baja California

Casandra Delgadillo-Anguiano[1], Fabiola Lafarga-De la Cruz[2], Julio Lorda[3], Carmen E. Vargas-Peralta[2], Alicia Abadía-Cardoso[1]

[1]Universidad Autónoma de Baja California, Facultad de Ciencias Marinas
[2]Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE), Departamento de Acuicultura
[3]Universidad Autónoma de Baja California, Facultad de Ciencias, Mexico

Bio: Currently, Casandra is working as a laboratory technician in the molecular ecology laboratory at the Universidad Autónoma de Baja California (UABC). She received her master's degree in molecular ecology and biotechnology last year.

She intends to continue my academic preparation to eventually obtain a PhD in the area of molecular biology in the near future. She has been doing research work with abalone species from Baja California for both my bachelor's degree and my master's. As for now, her goal is to gain as much experience in the laboratory and the abalone field as possible.

Keywords: Bacteriophage, Black abalone, *Candidatus Xenohaliotis californiensis*, Withering Syndrome

Black abalone (*Haliotis cracherodii),* a specie present in California, USA and Baja California, Mexico has experienced massive declines since the 1980s. One reason for these is the Withering Syndrome (WS), a lethal disease caused by the bacteria *Candidatus Xenohaliotis californiensis* (CXc). In recent years, a slow recovery of black abalone populations has been detected. Additionally, the presence of a phage hyperparasite associated to CXc, called *Xenohaliotis* phage (pCXc), has been identified. This phage infects the CXc bacteria and reduces its pathogenicity. Therefore, we used a non-lethal sampling method to collect feces from 199 black abalones from 14 sites along the coast of Baja California and determined the prevalence of both CXc and pCXc using a polymerase chain reaction amplification. We found the presence of CXc in 44% of the sampled abalones and pCXc in 38%. Also, we found no effect of zone or abalone length on prevalence of both pathogens, except for one site, Isla Todos Santos, where we found a positive correlation between length and prevalence. Also, we did not find an effect of density on the prevalence of CXc or pCXc. Finally, we found a positive correlation of the prevalence between CXc and pCXc, although, it was not significant. This study demonstrates that CXc is still present in black abalones from Baja California, and these populations are still at risk of being affected by the WS, especially due to the stress caused by recent drastic environmental changes.

Indigenous abalone harvesting, 40 thousand years of history, and still going

Bryan Denny

Tasmania seafood industry council, Land and sea aboriginal council, Tasmania, Australia

Bio: Indigenous Tasmanian wild harvest abalone fisher, with 20 years' experience in the Tasmanian abalone industry as well as knowledge of Indigenous Sea country and harvester of Indigenous held abalone quota.

Keywords: Sea country history

The history of Aboriginal involvement in harvesting abalone (muttonfish, carner, netepa), to today's industry and indigenous leaseback of government held quota. My personal journey with organisations and corporations to work with them to deliver better inclusiveness and knowledge sharing of first nations peoples connect to sea country.

Population genomics of wild and hatchery-raised pinto abalone (*Haliotis kamtschatkana*)

James L. Dimond[1], Joshua V. Bouma[2], Henry S. Carson[3], Mackenzie R. Gavery[4], Caitlin O'Brien[2], Crystal Simchick[4], Kathleen Sowul[3], Fabiola Lafarga-De La Cruz[5]

[1]Western Washington University, Shannon Point Marine Center, Washington, United States of America
[2]Puget Sound Restoration Fund
[3]Washington Department of Fish and Wildlife
[4]National Oceanic and Atmospheric Administration
[5]Centro de Investigación Científica y de Educación Superior de Ensenada

Bio: James is a marine biologist who uses genomic approaches to address questions in ecology, evolutionary biology, and conservation. His current interests and directions include (1) the molecular basis of phenotypic variation and acclimatisation, (2) conservation genetics, and (3) the use of environmental DNA to address conservation goals.

Keywords: Conservation, Genetics, Genomics, Pinto abalone, Restoration

Pinto abalone (*Haliotis kamtschatkana*) are the widest ranging North American abalone species, occurring from Mexico to Alaska. Decades of overharvest pushed pinto abalone populations to the brink of collapse throughout this range, and by the early 1990s, fishery closures were implemented in Alaska, British Columbia, Washington, and California. Since then, most populations have shown little recovery, with limited natural recruitment observed only in Alaska and British Columbia. In Washington, a growing recovery effort via conservation aquaculture outplants several thousand hatchery-raised juvenile abalone each year. We used genotyping by sequencing to evaluate the efficacy of this restoration program from a genomic standpoint. Although older hatchery outplants exhibited evidence of genetic drift based on genomic divergence from wild abalone, more recent hatchery operations with higher output and larger family sizes appear poised to overcome the effects of genetic drift. We found no evidence of a genetic bottleneck among remnant wild populations in Washington, indicating that these abalone have sufficient genetic diversity to support the restoration program, but also highlighting the need for large broodstock sizes to overcome potential reductions in effective population size. To enable continued restoration efforts, broodstock from beyond Washington may need to be sourced, yet this would require an understanding of range-wide pinto abalone population genetics. To this end, we sequenced additional abalone from throughout the species' range. Initial analyses suggest little population differentiation of pinto abalone over most of the Pacific Coast of North America, with the exception of Southern California and Baja California.

Taking the lab to the field: Physiology of NZ pāua at the Chatham Islands

Jessica Ericson[1], Andrea Alfaro[2], Leonie Venter[2], Thao Van Nguyen[2,3], Shaneel Sharma[2], Jinchen Guo[2], Joanna Copedo[1,2], Stephen Archer[2], Jeremy Cooper[4], Tom McCowan[4], Nick Cameron[5], Craig Mundy[6], Norman Ragg[1]

[1]Cawthron Institute, Private Bag 2, Nelson 7042, New Zealand
[2]Aquaculture Biotechnology Research Group, Department of Environmental Sciences, School of Science, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand
[3]NTT Hi-Tech Institute, Nguyen Tat Thanh University, Ho Chi Minh City, Vietnam
[4]Pāua Industry Council; 12/7 Waterloo Quay, Pipitea, Wellington 6011, New Zealand
[5]Dive Chathams, Waitangi, Chatham Island, New Zealand
[6]Institute for Marine and Antarctic Studies, University of Tasmania, 20 Castray Esplanade, Battery Point, Hobart, Tasmania 7004, Australia

Bio: Jessica a varied background in marine science ranging from working for an aquaculture company as an applied scientist, to working on intensive research programmes in the Antarctic. Her research focuses on the effects of climate change stressors (e.g., ocean warming and acidification) on marine invertebrates. She combines a range of physiological measurements from the whole animal to the cellular level to understand the complex responses of marine organisms to environmental stress. Her current research investigates the effects of chronic ocean warming and marine heatwaves on shellfish, to assist marine industries in their preparation for a high CO_2 future.

Keywords: Biotechnology, Climate change, Environmental indicators, Fisheries

The Chatham Islands have some of the most prized blackfoot abalone (*Haliotis iris*) beds in New Zealand. This well-managed fishery incorporates catch spreading, size limits and selective fishing methods. Recent declines in biomass and growth, along with increasing frequency of marine heat events, have prompted the need for new tools to examine the biological responses of abalone to its local environment. We investigated the physiological and metabolic states of juvenile and adult abalone from slow-growing ('stunted' or partially fished) and fast-growing (intensively fished) harvest areas around the Chatham Islands, to scientifically support the continued management of a sustainable abalone fishery. Metabolomics analyses indicated that abalone from the fast-growing areas fuelled metabolic functions via carbohydrate sources, providing energy for fatty acid and amino acid synthesis. Microbiomics analyses showed that gut microflora was more diverse in the samples collected from sites where faster abalone growth were reported (compared to the slow-growing sites), with large differences measured in red and green macroalgal species. The total haemocyte counts, haemocyte viability and total antioxidant capacity of the haemolymph did not vary significantly between populations. This research provides unique physiological insights into abalone populations, supporting the use of omics tools to investigate processes related to growth and population productivity. This work provides context for monitoring biological trends and environmental responses, such as marine heatwaves, around the Chatham Islands, contributing to the design of adaptive management strategies to mitigate the impacts of environmental stressors.

Stakeholder engagement: A key element of harvest strategy development

Katherine Farag-Page

Department of Natural Resources and Environment Tasmania, Australia

Bio: Katherine Farag-Page studied Marine Science at the University of Wollongong, Australia and has applied this scientific knowledge to her career in Fisheries Management since graduating in 2010. She currently works for the Tasmanian government on projects to improve sustainable management of the abalone fishery through policy development and stakeholder engagement. She also has previously worked in wild harvest fisheries management and licensing in New South Wales, Australia.

Keywords: Abalone, Consultation, Fisheries management, Governance

Approximately a quarter of the world's wild abalone harvest is from a tiny corner of the globe – Tasmania. Currently, annual extraction in the Tasmanian Abalone Fishery is over 750 tonnes which is a fraction of historical catches, that peaked at over 2,000 tonnes. Approximately 95% of catch is attributed to commercial fishing activities which provides a major contribution to the State's economy. Although non-commercial extraction can be considered negligible the importance of the resource to those fishers is culturally and socially significant. Aboriginal people have a strong connection to Sea Country that is central to their identity and culture; fishing recreationally for abalone is an important activity for many Tasmanians that exemplifies the Tasmanian lifestyle particularly in East Coast communities. Holistic management which considers the aspirations of all sectors is essential but developing a harvest strategy that balances the diverse needs of all stakeholder groups is challenging. A robust harvest strategy requires consideration of historic trends, current practices, goals, and operations across all sectors of the fishery. If a shared vision for the fishery is to be achieved all stakeholders need to be engaged throughout the policy development process from conception to implementation. Harvest strategies that provide the framework for evidence-based management decisions guided by best-practice scientific advice underpinned by good governance and meaningful stakeholder engagement are key to successful fisheries management. This presentation explores lessons from recent experience with developing and implementing the first Abalone Harvest Strategy in Tasmania and evolving rules to manage Aboriginal, recreational, and commercial fishing.

Physiological and behavioural responses of the European abalone *Haliotis tuberculata* to thermal stress

Justine Fouassier[1], Sophie Martin[2,3], Stéphanie Auzoux-Bordenave[3,4], Sylvain Huchette[5], Sabine Roussel[1]

[1]Université de Brest, CNRS, IRD, Ifremer, LEMAR, Plouzané F-29280, France
[2]UMR 7144, Adaptation et Diversité en Milieu Marin, CNRS/SU, Station Biologique de Roscoff, Roscoff Cedex 29680, France
[3]Sorbonne Université, 4 place Jussieu, Paris 75005, France
[4]UMR, Biologie des Organismes et Ecosystèmes Aquatiques, (BOREA), MNHN/CNRS/SU/IRD, Muséum National d'Histoire Naturelle, Station Marine de Concarneau, Concarneau 29900, France
[5]Ecloserie de France Haliotis, Kerazan, Plouguerneau 29880, France

Bio: Currently a first year PhD student, Justine's research focuses on the study of stressful environmental effects on the European abalone, such as warming and acidification of seawater. In this context, she is interested in the biology of the abalone in a broad sense by studying its physiology, behaviour and shell structure and morphology. In parallel, she also seeks to characterise the natural physico-chemical environment of the abalone and the role that algae have on it.

Keywords: European abalone, Behaviour, Physiology, Stress, Temperature

The effect of environmental drivers, such as warming, are still unknown in the European abalone *Haliotis tuberculata*. This species is the subject of commercial fisheries and growing aquaculture in France and could be threatened by the rise in temperature in its naturel environment and in aquaculture facilities. This study focused on the effects of different temperatures on the biology of adult abalone to assess optimal temperature and thermal limit of this species. Adult *H. tuberculata* were exposed to 12°C, 15°C, 18°C, 21°C, 24°C, 27°C in their aquaria (n=3 aquariums per temperature, 30 abalone per aquarium). After 3 weeks of exposure, physiological (including metabolism, growth, oxidative stress, histopathology, reproduction, intern acid-base balance), and behavioural (diurnal rhythm, feeding, righting, and sheltering) responses were assessed. Our results showed that temperature has an influence on the overall energy budget of *H. tuberculata* via effects on inputs (feeding behaviour), costs (growth, reproduction, maintenance of metabolism and activity during diurnal rhythm) and energy reserves (evaluated with righting and sheltering tests). A temperature between 18°C and 21C° allowed maximal growth performance for *H. tuberculata*, although investment in reproduction could result in higher sensitivity to pathogens at these temperature levels. Temperature of 27°C had negative consequences on gill morphology. The next step will consist in modelling the abalone energy budget using the results of this experiment to extrapolate the consequences of ocean warming at the population level.

Tools for saving a species: Using ecophysiology to improve endangered white abalone production

Alyssa Frederick[1], Lauren W. Ashlock[1], Audrey A. Deutsch[1], Leela Dixit[1], Nora J. Frank[1], Priya Shukla[1], Colleen A. Burge[1,2], Blythe C. Marshman[1,2], Donovan P. German[3], Newton Z. Hood[3], Kristin M. Aquilino[1]

[1]University of California Davis Bodega Marine Lab, CA 94923 United States
[2]California Department of Fish and Wildlife
[3]University of California Irvine

Bio: Dr Frederick (she/they) is the Director of the White Abalone Captive Breeding Program, based at the UC Davis Bodega Marine Lab. Their research focus is using ecophysiology to determine how climate and disease impact invertebrate biology, with a specific focus on developing tools to improve restoration. A former Fulbright New Zealand Fellow and US National Academy of Sciences science policy fellow, Dr Frederick also builds international and local partnerships that engage community stakeholders and decision makers. They are passionate about sustainable aquaculture, science communication and creating just and equitable opportunities across the sciences.

Keywords: Climate, Breeding, Physiology, Reproduction, Restoration

All of the USA's abalone have suffered from overfishing, but none as severely as white abalone (*Haliotis sorenseni*). Ninety-nine percent of the species was commercially harvested in just under a decade. The White Abalone Captive Breeding Program, begun in 2000 and now based at the University of California-Davis' Bodega Marine Laboratory, lies at the heart of the efforts to restore this species. Despite huge improvements in production over the past ten years, the number of one-year-old animals produced annually falls short of what is needed to support repopulation in the wild by about an order of magnitude. The most significant barriers to increasing captive production include unreliable gametogenesis and unpredictable responses to known spawning methods in broodstock. Additionally, increasing post-settlement survival and resilience to climate change are important for accelerating species recovery. Therefore, current research to improve captive reproduction falls into three main categories: enhancing reproductive conditioning and spawning reliability, improving post-settlement survival, and building climate resiliency into production. We are exploring the use of reproductive hormone injections to improve gonad development and spawning success and to develop methods to measure abalone reproductive hormones in situ. Our work also considers how dietary lipids might improve egg production, reproductive hormone expression, and post-settlement survival. Additionally, we are studying which settlement cues and substrates optimize juvenile survival and the impacts of climate-related and disease stressors on all stages of captive production.

Cataclysmic mortality, recovery, and reopening of an iconic New Zealand abalone fishery

Shawn Gerrity & David R. Schiel

University of Canterbury, Christchurch, New Zealand

Bio: Shawn is a PhD student within the Marine Ecology Research Group (Univ. of Canterbury), studying the recovery of abalone populations following mass mortality, and the initial effects from the resumption of harvest after a 5-year closure. He has spent the last 6 years fully immersed in assessing blackfoot abalone populations affected by the 2016 Kaikoura earthquakes, their recovery during a 5-year closure, and the reopening of harvest in 2021. He takes particular interest in juvenile abalone population dynamics, developing stock enhancement methods, and working with commercial, recreational, and customary fishers, and policy makers. He also takes time to develop lesson plans for local school kids and encourage a sense of guardianship over their local marine resources.

Keywords*:* Disturbance, Management, Overfishing, Pāua, Recovery

The 2016 magnitude 7.8 Kaikoura earthquakes caused variable coastal uplift along 130km of highly productive shoreline. The uplift caused immediate mortality of mature biogenic habitats and speciose intertidal communities. The effects on the New Zealand blackfoot abalone (called pāua), a species of high cultural and economic importance, were devastating. Widespread mortality of pāua and losses of critical juvenile recruitment habitat prompted an emergency ban in all commercial and recreational harvest. During the 5-year harvest closure, we used shore-based surveys across 26 sites to quantify changes in pāua abundance and population structure. We documented a remarkable recovery, with large increases in pāua abundance across nearly all sites, accompanied by dynamic shifts in population structure towards much larger individuals. To quantify the effects of the resumption of harvest in 2021, we used a series of shore-based and dive surveys just before and just after the 3-month season. Here we detected up to a 92% decline in legal pāua biomass at the most accessible sites, with almost all sites showing significant negative responses. This work highlights the strong recovery potential that this fishery has in response to natural disaster, but also a high susceptibility to acute harvest over short periods, raising concerns of serial depletion if effective protective measures are not in place.

Pāua - Restoring a cultural icon

Gaya Gnanalingam[1,2], Brendan Flack[1,3], Nigel Scott[4], Daniel Pritchard[1], Chris Hepburn[1,2]

[1]Coastal People Southern Skies Centre of Research Excellence
[2]Department of Marine Science, University of Otago
[3]Kāti Huirapa Rūnaka ki Puketeraki, Karitane
[4]Strategy and Influence, Te Rūnanga o Ngāi Tahu, Christchurch

Bio: Gaya is an early career researcher based at the University of Otago and her research focuses on integrating marine ecology and fisheries policy for long term sustainable use of resources. She pairs scientific methods (field observations, laboratory experiments, computer modelling) with policy analysis and legislative review. She also has an interest in customary fisheries and combining multiple sources of knowledge (ecological, Indigenous, local) to understand our marine environment and manage its use.

Keywords: Customary, Fishery, Mātauranga, Pāua, Restoration

In Aotearoa New Zealand, a number of local pāua (blackfoot abalone, *Haliotis iris*) populations are in decline. Where it was once possible to 'walk on pāua in low water' tangata tiaki/kaitiaki (legislatively empowered customary managers) now say it is impossible to harvest pāua without being able to swim and dive. Pāua are a taonga (treasure, cultural keystone) for a number of iwi and hapū around Aotearoa thus with stock declines and decreased access, there comes associated losses to community wellbeing, cultural identity, and connection to the environment. The East Otago Taiāpure (EOT) one of Aotearoa's oldest customary protected areas was applied for in part because of concerns over diminishing pāua stocks. After more than a decade of committed research and targeted management, the pāua fishery was closed in December 2019 - until such time as it was deemed to have recovered. Building on more than a decade of research on pāua ecology and community led management in the East Otago Taiāpure, Pāua – Restoring a Cultural Icon, aims to assess multiple ways in which we can substantially increase the number and size of pāua on our reefs to increase resilience and the prospect of this taonga persisting into the future. To do so, the projecting is utilising a combination of ecological surveys, mātauranga Māori (Māori knowledge), stock enhancement, modelling, and outreach. Here we will provide an overview of the work to-date, and the work to-come to restore this iconic species.

A tribal-scientific alliance to produce and restore the red abalone (*Haliotis rufescens*) in Northern California's kelp forest ecosystem

Severino Gomes[1], Fred Carr[1], Nina Hapner[1], Daniel Swezey[2]

[1]Kashia Band of Pomo Indians of the Stewarts Point Rancheria, Santa Rosa, California 95403 USA
[2]UC Davis Bodega Marine Laboratory

Bio: The Kashia Band of Pomo Indians of the Stewarts Point Rancheria is a Northern California Native American Indian Tribe with ancestral territory extending along 38 miles of coastline in Sonoma County. In response to the recent kelp forest collapse, the Kashia are collaborating with scientists, engineers, and aquaculture industry experts to develop the first tribally owned and operated abalone farm in the history of the USA. This facility, being developed on Kashia tribal land, will focus on the production of red abalone for commercial sales in order to financially support the coordinated conservation and restoration of wild abalone populations in California.

Keywords: Aquaculture, Climate change, Conservation, Indigenous

The red abalone (*Haliotis rufescens*) is a species of critical cultural and economic importance to residents of California, USA. This is especially true for California's indigenous peoples, who have harvested abalone along California's coastline for over 10,000 years. Beginning in 2014, a climate driven "perfect storm" of environmental stressors contributed to the collapse of kelp forests in Northern California. These kelp forests previously supported abundant red abalone populations, and this impact has resulted in the closure of California's red abalone fishery, the last remaining wild abalone fishery in the state. For Native American communities in California, the conservation and sustainable harvest of abalone holds an importance surpassing many contemporary environmental issues as tribes are intimately linked to this resource. In response to this disaster, the Kashia Band of Pomo Indians of the Stewarts Point Rancheria, a Native American Indian Tribe from Northern California, USA are collaborating with scientists, engineers, and aquaculture industry experts to develop the first tribally owned and operated abalone farm in the history of the USA. Through this effort, the Kashia seek to meaningfully participate in the management of this iconic and culturally important resource, which plays a crucial role in tribal culture, history, and teaching. There are stories about abalone. There are stories about why her shell is red. There are stories that tie Kashia people to her and the ocean. For some, she is money on the table. For some, she is the continuance and resilience of culture and history. For many, she is both.

When are commercial abalone catch rates informative?

Malcolm Haddon and Craig Mundy

Institute of Marine and Antarctic Science, University of Tasmania

Bio: Previously, in amongst it, Malcolm have worked in New Zealand Fisheries, the Universities of Sydney and Tasmania, and in CSIRO, Hobart. His main professional interest is now ecological population dynamics, especially models of relevance to wild fisheries. Malcolm has retired but could be described as a part time consultant who is trying to write more books. He is fortunate in his collaborations, and he is currently involved with constructing an R package for conducting management strategy evaluation on the empirical harvest strategies used with abalone. That also involved constructing an R package for conducting size-based stock assessment modelling.

Keywords: Contrast, CPUE, Hyperstability, Size-based assessments

The catastrophic collapse of North American abalone stocks gave commercial catch rates (cpue) a bad reputation as a basis for abalone fishery management advice. Spatial patchiness with possible serial depletion leading to hyperstability were among the criticisms of cpue. Despite this, all formal Australian abalone harvest strategies, or the informal expert-based workshop processes, use either commercial or survey catch rates and all assessments of stock status rely on commercial catch rates (they are also used in New Zealand). The potential problems of serial depletion, spatial heterogeneity, and hyperstability remain relevant. An exploration of when cpue can be considered informative for abalone fisheries was thus considered of value. Catch rate data from Tasmanian quota zones were used to characterize how often cpue declined as catches increased and increased as catches decreased, as would be expected if cpue reflected relative abundance at the scales used in stock assessments (this was a search for contrast in fishery data). Commercial divers are certain catch rate hyperstability occurs in Tasmania, and this has recently been demonstrated analytically. A custom size-based stock assessment model was used to examine the influence of different levels of hyperstability on stock assessment outcomes. Not surprisingly, the results are often dependent upon location and the relative intensity of fishing. In Tasmania, we conclude that in the more productive assessment blocks, cpue remained informative despite the presence of hyperstability. In less productive blocks the importance of size-composition data increases.

Partners in sustainability: the abalone industry association of South Australia's successful self-management arrangement

Nicole Hancox

Abalone Industry Association of South Australian Inc (AIASA), South Australia

Bio: As the Executive Officer of the Abalone Industry Association of South Australia (AIASA), Nicole is committed to representing the industry, building strong partnerships, and ensuring its long-term sustainability and growth through digital innovation. With my research experience, she brings a multi-faceted approach and innovative mindset to my work seeking to drive meaningful change and make significant strides for AIASA.

Keywords: Industry-collaboration, Self-management

For nearly a decade, the Abalone Industry Association of South Australia (AIASA) has successfully implemented self-management arrangements through a Memorandum of Agreement (MOA) with Industry Licence Holders, recognised by the Government. The MOA covers a suite of various measures to support management, inform resource assessment, data gathering and protect against resource threats. The arrangement has demonstrated success in improving productivity, minimizing resource impact and building resilience in the fishery by effectively addressing the ongoing challenges faced. Industry's self-management arrangement started with small steps, such as alternating access to an area by licence number and has now become more complex to include voluntary quota withholding arrangements, spatial/temporal management, and biosecurity protocols. Implementing and monitoring the arrangement is cost-effective and allows the Industry to respond quickly to changes, making it efficient without the need for Government intervention. Furthermore, Industry has the capability to collect and share data in real-time, whereas Government departments can be hindered by restrictions on data sharing and reporting. AIASA demonstrates the positive impact of the MOA in the collaboration between Industry and the Government. Its self-management arrangement serves as a prime example of Industry's ability to manage resources and overcome challenges effectively. The presentation will highlight the industry's achievements and demonstrate the potential for other Industries to adopt a similar approach.

Colour change kinetics of greenlip abalone, *Haliotis laevigata* Donovan, fed dried macroalgae meals

Mark Purvis[1], Krishna-Lee Currie[1], Amy Bates[2], Matthew S. Bansemer[3], Jian G Qin[1], James O. Harris[1], David A. J. Stone[1,2,3]

[1]Flinders University, College of Science & Engineering, GPO box 2001, Adelaide, South Australia, Australia, 5001.
[2]The University of Adelaide, School of Animal and Veterinary Sciences, Roseworthy Campus, South Australia, Australia 5371.
[3]SARDI Aquatic Sciences, Marine Innovation Southern Australia, PO Box 120, Henley Beach, South Australia, Australia. 5022.

Bio: James works in the areas of aquatic animal health and physiology, in a 30-year career so far! The focus of much of his work is on abalone, with forays into work on other species, such as yellowtail kingfish, silver perch, flat oysters, trout, and salmon. The approaches he uses looking at animal health is extensive, ranging from histopathology to respiratory and nutritional physiology, water quality management, nutritional intervention, invertebrate immunology, using food waste products in diets to improve abalone growth and make use of waste material, chemotherapeutic treatment delivery optimisation and more.

Keywords: Color, Formulated feed, *Gracilaria cliftonii*, Greenlip abalone, Macroalgae

Inclusions of red macroalgae meal to formulated diets for greenlip abalone (*Haliotis laevigata*) can influence colour change in their lip, foot, and shell. In a four month on-farm trial using a formulated diet containing 15% of a commercially available mixed species macroalgae meal (MSM), we examined the effect on greenlip abalone colour. In laboratory trials we tested the dietary treatments used on-farm and a six-month phase feeding trial where the formulated diet containing 15% *Gracilaria cliftonii* meal was fed for three months then replaced with a commercial diet at three months. 15% inclusion of MSM into formulated abalone diet did not change greenlip abalone lip, foot, or shell colour, both on farm and in the laboratory trial. Inclusion of 15% *G. cliftonii* meal to a formulated diet changed lip hue towards yellow/green, resulting in a visually greener lip. Shell colour changed from green/blue to a deep red/brown, but foot colour was not affected. After withdrawal of the diet containing 15 % *G. cliftonii* meal there was a steady decrease in lip hue and lip colour saturation. Addition of 15% MSM to formulated diets is not viable to manipulate colour in greenlip abalone. The addition of 15% *G. cliftonii* meal to formulated diets can be used to manipulate greenlip abalone lip and shell, but not foot colour. A minimum of three months will result in a significant change to lip colour, and abalone should be harvested within one month to maintain any colour changes if feeding the diet ceases.

Comparisons of amount of movement and degree of aggregation by adult *Haliotis discus hannai* between spawning and non-spawning seasons

Jun Hayakawa[1], Naoya Ohtsuchi[1], Takayuki Kanki[2], Yuki Minegishi[1], Tomohiko Kawamura[1]

[1]The University of Tokyo, Otsuchi, Iwate 028-1102, Japan
[2]Kyushu University

Bio: Associate Professor of Atmosphere and Ocean Research Institute, the University of Tokyo. Jun's research focuses on the ecology of abalone species, including interspecific relationships and population dynamics, through field studies and laboratory experiments.

Keywords: Kelp bed, Nocturnality, Spawning aggregation, Spawning behaviour

Aggregation of adult *Haliotis discus hannai* is reported to occur during the spawning season (Aug – Oct) in the field, and differences in the species and the cover degree of macroalgae are considered to influence the degree of the aggregation. However, the mechanism by which the aggregation is maintained during the spawning season is poorly understood. Rearing experiments using the adult abalone were conducted to determine if amount of movement and degree of aggregation differ between spawning and non-spawning seasons. In the experiment, location of each identified individual inside water tanks (315 × 145 × 90 cm) with a running seawater and outdoor light conditions was recorded hourly for 48 hours, five times during the spawning season of 3 months and six times during non-spawning season in 2021. Based on the location data, relative amount of movement (RAM) and score of the number of neighbouring individuals with opposite sex (SNNIOS) were calculated for each individual. In addition, experiments were carried out to clarify if the presence of natural and mimic plastic kelp affect night-time RAM of the abalone. The abalone showed distinct nocturnality with higher night-time RAM and lower SNNIOS than daytime, throughout the experiment. No clear differences in RAM and SNNIOS were found between spawning and non-spawning seasons. The existence of the kelp significantly decreased the night-time RAM, although the mimic kelp did not. From the results, the presence of kelps is considered as a factor maintaining spawning aggregation of the abalone by reducing night-time movement searching for diets.

Status of the endangered Northern abalone, *Haliotis kamtschatkana*, on the Pacific coast of Canada

Erin Herder & Dominique Bureau

Fisheries and Oceans Canada (DFO), Nanaimo, British Columbia V9T 6N7 Canada

Bio: Erin is the Species At Risk Biologist for Molluscs in the Stock Assessment and Research Division (Pacific Biological Station) of the Department of Fisheries and Oceans Canada. She conducts population monitoring of Northern abalone and Olympia oyster across the Pacific coast of Canada, both species are listed under the Species at Risk Act (SARA in Canada). Erin is also a Mollusc Sub-Committee member for the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as an early career scientist. COSEWIC makes recommendations to SARA on the conservation status of species at risk in Canada. Outside of the office, Erin can be found scuba diving and teaching diving in the Pacific Northwest.

Keywords: Index surveys, Recovery strategy, Recovery targets, Species-at-risk

Northern abalone, *Haliotis kamtschatkana*, is present along the Pacific coast of Canada (province of British Columbia, BC) and has been listed as Endangered under the Species at Risk Act in Canada since 2011. Despite a moratorium on all harvest since 1990, the Northern abalone population remained at low levels for decades. In 2007, a recovery strategy was developed that outlined recovery targets for the species. Since 1978, Fisheries and Oceans Canada has conducted index site dive surveys to monitor the population status of Northern abalone in Canada. These index site surveys are currently used to measure recovery status against the recovery targets. Mean total density of Northern abalone began to increase in Northern BC in the late 2000s, primarily driven by an increase in the density of juvenile (shell length > 20 to < 70 mm) abalone. Densities in Southern BC have not shown a similar trend. The increase in juvenile density may have resulted from mass mortality of the predatory star, *Pycnopodia helianthoides*, from sea star wasting syndrome, which began in 2013 and extended throughout the BC coast by 2015. High juvenile mortality appears to be preventing this size class from recruiting to the adult population. Additionally, sea otter predation (re-introduced) and illegal harvest may be preventing cohorts from contributing to the adult population or may be targeting large abalone which increases adult mortality. Lastly, changing environmental or habitat conditions may be causing reductions in growth rates and preventing or slowing recruitment of abalone to the adult population.

Size-dependent maximum thermal limits in Australian farmed hybrid abalone: implications for productivity shifts with ocean warming

Owen J. Holland[1], Callum Smythe[1], Timothy D. Clark[1], Norman L. C. Ragg[2], Julie Mondon[1], Adam D. Miller[1]

[1]School of Life and Environmental Sciences, Deakin University, Victoria, Australia
[2]Cawthron Institute, Nelson, New Zealand

Bio: Owen is a postdoc working within the EcoGenetics Lab at Deakin University, Victoria, Australia. He completed his thesis in 2022, where he investigated the impacts of environmental change on Australian abalone fisheries. He is primarily interested in better understanding how environmental change is impacting fisheries and ecosystems worldwide, with a focus on informing management with effective strategies to navigate these changes. Presently, he is working with Australian crab fisheries, aiming to provide managers with a resource for establishing sustainable management programs that account for patterns of stock connectivity and the sensitivities of individual stocks to environmental disturbance and fishing pressure.

Keywords: CTmax, Ocean warming, Provenance, Size, Thermal stress

Rising ocean temperatures pose significant threats to marine species, including those that support commercial fisheries and aquaculture. Predicting the future responses of these industries depends on understanding which life stages are most vulnerable, the potential for adaptation to changing thermal environments, and the availability of thermally adapted genotypes to help enhance stock resilience through strategic interventions. Here, we shed light on some of these knowledge gaps by quantifying the critical thermal maximum (CTmax) of hybrid abalone (*Haliotis rubra* × *H. laevigata*) from two farms representing contrasting thermal environments from south-eastern Australia. CTmax was not dependent on body size or provenance (farm) when heating rates were rapid (1°C per h), but a significant negative linear relationship between CTmax and body size was observed for both farm stocks when heating rates were slower and more ecologically realistic (1°C per 12 h). Histological analyses revealed a negative relationship between CTmax and the stage of gonadal development when abalone were exposed to chronic thermal stress conditions. These results suggest that marine heatwaves and ongoing ocean warming might favour, and possibly select for, smaller, less fecund animals in natural and farm settings. This could potentially impact future harvestable biomass, recruitment and population dynamics in wild-capture fisheries, and production of larger, high-value animals in farm settings. This study adds to a growing body of literature pointing to complex and often negative effects of climate change on commercial fisheries, and the potential need for interventions aimed at bolstering fisheries resilience against the effects of ocean warming.

Recent advances in abalone IMTA in South Africa – the AquaVitae story

Clifford L. W. Jones[1], Peter J. Britz[1], Gercende Courtois de Viçose[2], Abiodun Falade[1], Brett M. Macey[3], Njabulo Madlala[1], Petronilla Mwangudza[1], Abigail J. Onomu[4], Matthew Slater[5], Niall G. Vine[4], Dirk Weich[6], Yu (Ann) Wu[1]

[1]Department of Ichthyology & Fisheries Science, Rhodes University, Makhanda, South Africa
[2]IU-ECOAQUA, Aquaculture Research Group, Universidad de Las Palmas de Gran Canaria, Spain
[3]Department of Forestry, Fisheries and the Environment, Cape Town, South Africa
[4]Department of Zoology & Entomology, University of Fort Hare, Alice, South Africa
[5]Alfred Wegener Institute, Bremerhaven, Germany
[6]Marifeed Pty Ltd, Hermanus, South Africa

Bio: Cliff Jones is the Head of Department and an Associate Professor in the Department of Ichthyology and Fisheries Science at Rhodes University, South Africa. His research is focussed on developing circular economies in aquaculture, where by-products are circulated back into production with the aim of improved environmental and financial sustainability in this industry.

Keywords: Aquaculture, Circular economy, *Haliotis midae*, Seaweed, *Ulva lactuca*

Abalone has been farmed in South Africa using commercial-scale integrated multitrophic aquaculture (IMTA) technology for decades. Farms use land-based, pump-ashore production systems where sea water passes through abalone tanks. The stock is fed either a formulated feed or a combination of a formulated feed and fresh seaweed. For farms that use IMTA, the abalone farm effluent is channel through seaweed production tanks. In some instances, the treated effluent is cycled back to the abalone tanks forming partial recirculation systems, and in others the treated effluent is returned to the ocean. In both cases the seaweed that is grown in the farm effluent is harvested and fed back to the abalone. This presentation is a program overview of various advances made in abalone IMTA, that forms part of the AquaVitae project (Horizon 2020 Research and Innovation Action BG-2018-2; Grand number: SEP-210522256). It will include synoptics of research results into the: 1) environmental cost/saving of IMTA compared to monoculture production; 2) benefits of IMTA produced algae in abalone feeds; 3) potential biosecurity risks associated with including IMTA algae in aqua-feeds, and measures to mitigate potential risks; and 4) the inclusion of sea-cucumber production to address solids removal in the system. This is a strategic coordinated effort, among researchers across the Atlantic, that aims to develop and promote IMTA. The presentation will show how this research has

contributed to the overall aim of the AquaVitae project, which is to develop low trophic species aquaculture value chains across the Atlantic Ocean.

Sustainable overfishing of longspined sea urchins to protect key abalone habitat

John Keane & Katie Creswell

Institute for Marine and Antarctic Studies, Hobart, Australia

Bio: Dr John Keane is a Research Fellow within the Institute for Marine and Antarctic Studies at the University of Tasmania. He has over a decade of fisheries research experience, predominantly focusing on commercial dive fisheries. The climate driven range extension of the Longspined Sea Urchin has led him to oversee the establishment of a new fishery for this species.

Keywords: Climate change, Habitat protection, Harvest subsidies, Stock assessment, Urchin

The climate-driven range-extension and population explosion of the Longspined Sea Urchin, *Centrostephanus rodgersii*, is degrading key abalone habitat across south-eastern Australia. Off the island state of Tasmania, an increase from zero to 20 million urchins within four decades has resulted in 15% of the eastern coast becoming unproductive urchin barren, with predictions barrens could increase to more than 50%. Sustainable overfishing of the urchin has become a key management objective to prevent reef destruction and substantial negative impact on abalone populations. Harvest subsidies have facilitated the urchin fishery to rapidly increase to 500 t pa representing a harvest fraction of 6.5% within the fishable range. Urchin abundances are in decline in three of nine regions where harvest fractions are up to 10%. A size structured stock assessment model has shown densities would be almost doubled in key regions if no commercial urchin fishing had occurred. For each region, we explore projections of harvest intensity and filter this by potential abalone productivity to provide a framework for possible management goals, indicating regions where an ecological density target could be obtained through fishing, or regions where intervention would likely be unnecessary depending on the goal. Carefully management of the urchin fishery is required into the future, as a collapse from overfishing would result in processor shutdown and termination of the key control mechanism. Harvest strategies need to facilitate sustainable overfishing; fishing urchin populations beyond MSY but not to levels where fisheries collapse.

Population genetic structure of natural and hatchery-raised populations of European abalone *Haliotis tuberculata tuberculata*: Lessons for future restocking and stock-enhancement

Ronan Le Gall[1], Pierre Chauvaud[1], Sabine Roussel[1], Eric Pante[2], Amélia Viricel[1], Grégory Charrier[1]

[1]Univ. Brest, Laboratoire des Sciences de l'Environnement Marin (LEMAR, CNRS/IRD/UBO/Ifremer), Institut Universitaire Européen de la Mer, 29280 Plouzané, France
[2]CNRS, Laboratoire des Sciences de l'Environnement Marin (LEMAR, CNRS/IRD/UBO/Ifremer), Institut Universitaire Européen de la Mer, 29280 Plouzané, France

Bio: Ronan is a first-year PhD candidate in marine population genetics and genomics. His PhD subject is about the effects of restocking on the local adaptation of natural populations of two emblematic molluscs in Brittany (*Haliotis tuberculata & Pecten maximus*).

Keywords: Genetic diversity, Genetic structure, *Haliotis tuberculata*, Restocking, Stock-enhancement.

Up to 80% of European abalone (*Haliotis tuberculata tuberculata*) populations have declined sharply along North-western French coasts (Brittany and Normandy) over the last two decades, mainly due to a pathogenic bacterium (*Vibrio harveyi*).

Restocking or stock-enhancement operations based on hatchery-reared juveniles might be efficient to restore collapsed populations and preserve fishing activities. Assessing the genetic composition of wild populations and hatchery-reared individuals is a primary concern in supplementation programs, to preserve the genetic diversity and adaptive potential of wild populations. The genetic diversity of ten wild abalone populations was assessed along the coasts of Brittany and Normandy, as well as 14 hatchery-reared samples, using 157 SNPs. Similar levels of genetic variability were found between wild and hatchery samples. However, those samples were strongly differentiated, thus reflecting strong genetic drift in the hatchery. Thus, despite hatchery practices ensured a high level of genetic diversity in hatchery-raised cohorts, the seeds released in natural populations should be composed of several cohorts and/or generations to buffer the genetic heterogeneity between cultured individuals and wild populations. In addition, a clear genetic structure was observed between wild populations from Normandy and northern Brittany and those from western and southern Brittany. This spatial structuring of wild abalone populations suggested that the farm broodstock should be chosen depending on the locality where the produced seeds would be released. Overall, the guidelines depicted here should strongly reduce the risk of altering the genetic diversity of natural populations, and thus maintain their adaptive potential to environmental variability.

Chemical induced autotriploid and allotriploid abalone and performance grown in sea-based systems in southern China

Yi Wang, Jianpeng Zhang, Weiwei You, Xuan Luo, Caihuan Ke

College of Ocean and Earth Sciences, Xiamen University, Fujian, China

Bio: Xuan Luo is the senior engineer for Xiamen University. He received his Ph.D. on marine biology from Xiamen University and has published more than 50 peer reviewed papers on abalone aquaculture. His work focuses on genetic breeding related methods, such as selection, hybridisation, and triploid.

Keywords: Growth, Heat tolerance, Survival rate, Triploid

Two types of abalone, *Haliotis discus hannai* and *H. discus hannai* ♀ × *H. fulgens* ♂, was conducted by inhibiting polar body II (PB2) with two chemical methods: cytochalasin-B (CB) and 6-dimethylaminopurine (6-DMAP). Combined both high rates of triploidy and reasonable hatching, the optimal treatment combination for triploid induction in autotriploid abalone is using 1.75 mg/L CB for 15 min and 40 mg/L 6-DMAP for 10 min, and optimization of triploidy induction in allotriploid abalone is CB (1.75 mg/L) for 15 min and 6-DMAP (30 mg/L) for 20 min, the normal veliger rate and triploid rate was between 73.11~85.20% and 91.66~100.00%, respectively. Here, we also present a comprehensive comparative study on the triploids and their diploids siblings cultivated on the sea-based suspended systems in southern China for up to 30 months. The survival of both two treatments was mostly found to be similar to that of diploids except for the first high temperature period (Jun-Dec), when significant decreases in the survival were observed ($P < 0.05$). Surprisingly, there was no difference in thermal tolerance between triploids and diploids through the assessment of heat adhesion duration ($P > 0.05$). Growth of triploids was distinguished across the two ploidy levels, where triploids within the CB group did not differ from control diploids throughout the observation period ($P > 0.05$), whereas triploids in the 6-DMAP group showed a superior growth in body weight on 20 mpf ($P < 0.05$). The advantage of meat yield may be attributed to the hypothesis of the diversion of energy from gonadal to somatic growth. Despite the normal sex ratio (1:1) of triploids, their reproductive potential was significantly reduced, showing infertile in the females with highly reduced numbers of oocytes or abnormal oogonia, and sterility in the males with an absence of spermatozoa. Our study confirms a definite triploid advantage of triploid in terms of the meat yield and provides insights for the commercial promotion of triploid strains in the abalone aquaculture industry in southern China.

Preliminary DNA barcoding of abalone, *Haliotis spp.* from Sabah, Malaysia

Nur-Syahirah Mamat[1], Yuzine Esa[1,2], Nur Leena W. S. Wong[1,2], Siti-Azizah Mohd Nor[3], Julia D. Sigwart[4,5], Nazia Abdul Kadar[6]

[1]International Institute of Aquaculture and Aquatic Sciences (I-AQUAS), Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
[2]Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
[3]Institute of Marine Biotechnology, Universiti Malaysia Terengganu, 21030 Kuala Nerus, Terengganu, Malaysia
[4]Department of Marine Zoology, Senckenberg Research Institute and Museum, Frankfurt, Germany
[5]Queen's University Belfast, Marine Laboratory, Portaferry, Northern Ireland
[6]Borneo Marine Research Institute, Universiti Malaysia Sabah, 88400 Kota Kinabalu, Sabah, Malaysia

Bio: Nur-Syahirah is a PhD student that currently studying in the Aquatic Biotechnology Programme at University Putra Malaysia (UPM) at Malaysia. Her current research interest is on biotechnology and aquaculture of abalone. She is also interested in understanding the relationship of abalone between populations and determining whether environmental factors affect the genetic diversity or structure of abalone. She is still in the process of enriching my knowledge in this field.

Keywords: Abalone, DNA barcoding, Gastropod, Malaysia

The abalone is a marine gastropod belonging to single genus *Haliotis* in Haliotidae family. There have been found several species of abalone in Malaysian waters. Yet, the scientific studies are still lacking including information on its taxonomic and systematic status. A prerequisite of any population genetics assessment is the correct taxonomic identification of the species under study. However, morphological identification of gastropods can be challenging due to high similarity within the same genus as the shell patterns are highly variable and influenced by the phenotypic plasticity. Therefore, this present study is a pilot study in Malaysia that utilized DNA barcoding to validate species identification of abalone in Malaysian waters. The aim of this study was to develop a comprehensive barcoding reference database of abalone in Malaysian waters. As a preliminary study, a 514-bp partial sequence of the CO1 gene was sequenced for 22 samples from the Balambangan Island of Sabah, located in North Borneo, Malaysia. Based on GenBank BLAST databases, the CO1 gene successfully identified all 22 samples of abalone samples to species level with 99% sequence similarity as *Haliotis asinina* with absence of discrepancies observed. Phylogenetic analysis using Neighbour-Joining (NJ) and Maximum Likelihood (ML) showed that all 22 samples of *H. asinina* formed a monophyletic clustering group with the GenBank reference sequences. This study highlights the importance of using DNA barcoding approach to prevent misidentification in population studies of abalone species which could lead to erroneous conclusions that aimed for conservation and sustainable management.

Monitoring the Tasmanian East Coast blacklip abalone (*Haliotis rubra*) stock rebuild: Fishery-independent time swim survey program

Jaime McAllister, Craig Mundy, Lachlan Tainsh

University of Tasmania, Institute for Marine and Antarctic Studies, Private Bag 49, Hobart, Tasmania 7001 Australia

Bio: Jaime is Research Fellow with the University of Tasmania's Institute for Marine and Antarctic Studies where he primarily focused on contributing research towards the management of the Tasmanian Abalone Fishery. Jaime has a broad experience in fisheries research and have a strong interest in conducting practical, applied research that lead to balanced outcomes for fisheries resources and their various stakeholders.

Keywords: Blacklip, Fishery-independent, Monitoring, Rebuild, Timed-swim,

Re-building heavily exploited abalone fisheries is highly dependent on implementing effective management strategies and having practical survey techniques to monitor their performance. Parts of the Tasmanian Eastern Zone abalone fishery have experienced significant catch declines and fluctuating catch rates following the peak of exploitation in the 1990s. Catches have fallen to around 10% of those recorded in the 1990's, the depletion largely driven by a combination of historical overfishing, incursion of long-spined sea urchin, and recruitment failure following marine heat waves. Management and industry strategies have largely failed to generate any significant re-build of the abalone population and in 2020 it was decided to close these areas to commercial harvesting. In the absence of commercial catch an effort data used to monitor stock performance, IMAS in collaboration with industry were engaged to implement a fishery independent survey program to establish the geographic extent of depletion and monitor the effect of the closure on the population rebuild. However, monitoring nearly 200 km of coastline within a timeframe of two months meant traditional fine-scale transect-based research surveys were impractical to deliver timely reporting and in making management decisions. Here we present a modified timed swim survey technique that has been used successfully since 2020 to monitor stock performance. We demonstrate the effectiveness of timed swims as an alternative, cost efficient and timely approach to rapidly inform relative changes in abundance and population size structure across a large geographic range, and provide evidence of ongoing recruitment failure following the closure.

The Kaikoura earthquake and the pāua fishery: The road to re-opening and management of a new fishery

Tom McCowan[1] & Phillip Neubauer[2]

[1]Paua Industry Council Ltd, New Zealand
[1]Dragonfly Science, New Zealand

Bio: Tom is the Science Officer for the Pāua Industry Council Ltd. His role is centred around the collection of pāua fisheries data to inform stock assessment as well as industry-based management and enhancement initiatives for New Zealand's commercial pāua fishery.

Keywords: Fishery, Monitoring, Management, Recovery

The coastal uplift from the 2016 Kaikōura Earthquake caused widespread mortality and habitat loss for pāua, resulting in the closure of the pāua fishery along the earthquake-affected coast for five years. We employed modified-timed swim methodologies to monitor abundance and recruitment trends of pāua populations following the earthquake to measure rates of recovery and inform fisheries management decisions. Outcomes helped support the 're-opening criteria' of widespread post-earthquake recruitment and a sustained increase in mature biomass which informed the proposal to re-open the fishery in December 2021. The commercial fishery has re-commenced under management measures detailed in the PAU3 Fisheries Plan and informed by survey data. These measures, including catch spreading, minimum harvest size and fine-scale fisheries data collection, are part of a suite of initiatives intended to promote an adaptive rebuild of this iconic fishery towards its former production.

Using genomics to inform the management of fisheries facing new environmental challenges: Blacklip abalone as a case study

Adam Miller[1], Owen Holland[1], Madeline Toomey[1], Collin Ahrens[2], Ary Hoffmann[3]

[1]School of Life and Environmental Sciences, Deakin University, Warrnambool, Vic 3280 Australia

[2]University of New South Wales
[3]University of Melbourne

Bio: Adam Miller is an Associate Professor in ecological genomics at Deakin University and co-lead of the EcoGenetics Lab. Adam's research program focuses on addressing fundamental questions about species ecology and evolution and resilience to environmental change and working with industry and government agencies to assist the management of threatened, commercially important, and pest species. He has a particularly keen interest in environmental stress and adaptation research, drawing on genetic and quantitative experimental methods to assess species evolutionary trajectories and vulnerabilities to environmental change, providing a basis for adaptive management that enhances biodiversity outcomes in changing environments.

Keywords: Disease resistance, Environmental adaptation, Genomics, *Haliotis rubra*, Trophic ecology

The south-eastern coastline of Australia is recognised as a climate change hotspot; a region prone to marine heatwaves, and where sea surface temperatures are rising at four times the global average. The region also supports multiple fisheries of high commercial value, many of which are already showing signs of climate stress. In particular, climate change poses a significant risk to the region's wild abalone fisheries, many of which have also been heavily impacted by pests and pathogens in recent years. In this talk I will present the findings from recent genomic studies on the Australian blacklip abalone (*Haliotis rubra*) that have provided valuable insights into patterns of connectivity and adaptation across the species range, evolutionary responses to disease outbreaks, and critical trophic interactions supporting the fishery. I will discuss the findings of this research in the context of abalone fisheries management in a rapidly changing world.

Standardising wild abalone fishery catch rates: Partitioning weather effects from biomass changes

Craig Mundy[1], Malcolm Haddon[1], Catherine Dichmont[1], Bill Venables

[1]University of Tasmania, Private Bag 49, Hobart, Tasmania 7001 Australia

Bio: Dr Craig Mundy is an abalone biologist at the Institute for Marine and Antarctic Studies, University of Tasmania. He is primarily responsible for fishery assessment and strategic research to ensure sustainable management of the Tasmanian abalone fishery. His current research interests are focused on the fisheries ecology of exploited abalone populations, and the use of geo-referenced fisheries data and the application of spatial statistical methods for informing fishery assessment in small vessel fisheries.

Keywords: CPUE, GLM, Standardisation, Waves, Wind

Wild abalone fisheries are distributed along high wave energy rocky reef systems across the majority of Australasia. The most productive fisheries occur between 35 and 45 degrees south, and access is defined by significant and rapid changes in wind and swell. In the higher wave energy southern reefs, fishing occurs within short, unpredictable windows of calm weather. There is both inter-annual and seasonal variability in the number and extent of calm weather windows. While there are thresholds of swell and wind beyond which fishing is either not possible or too dangerous, fishing does occur over a gradient of calm to severe wave and wind conditions. Fishers are aware of an impact of high wave energy or strong wind conditions on their catch rates and have expressed concern that if researchers rely on catch rates as an index of abundance, we risk CPUE underestimating relative abundance on days of significant weather, and incorrectly conclude that stock biomass is in decline. Here we explore the potential to account for weather effects (wind speed and direction, wave height/ power and direction) in catch rate standardisation processes.

Quantifying hyperstability in abalone fishery catch rates

Craig Mundy[1], **Malcolm Haddon**[1], **Catherine Dichmont**[1], **Bill Venables**

[1]University of Tasmania, Private Bag 49, Hobart, Tasmania 7001 Australia

Keywords: CPUE, Hyperstability, Spatial

Hyper-stability is an often-cited catch-all term to describe properties of available data that mask real trends in biomass. This is nearly always a concern when a decline in the metric fails to represent the true decline (and examples are always in this context). There are three classic forms of Hyper-Stability in fisheries: 1) moving from recently depleted grounds to new fishing grounds in an emerging fishery, 2) switching between species as they deplete, and 3) re-aggregation of target species after fishing. In long established abalone fisheries, none of these scenarios apply, however a fourth form of hyper-stability is present in the way fishers operate - changes in the swim rate and extent of coast utilised per dive event. Both of these behavioural parameters are inherently spatial in nature and can be captured using geo-referenced fisher-dependent data. We demonstrate a process for quantifying the relative effect of adaptive behaviour by fishers in response to stock biomass changes, and show that rather than completely masking trends, hyper-stable catch rates only underestimate the magnitude of changes in indices of abundance (i.e., the ratio – kilograms harvested per hour fished) but continue to be informative.

Evaluating management options for pāua fisheries in New Zealand: Towards fine scale management

Philipp Neubauer

Dragonfly Data Science, Wellington 6011 New Zealand

Bio: Philipp is a director and fisheries scientist at Dragonfly Data Science in Wellington. His expertise is in using theoretical methods, Bayesian statistical analysis and reproducible research to inform actions that promote sustainable fisheries. Recent work has included stock assessments of New Zealand pāua (abalone) for Fisheries New Zealand and risk assessments of the threatened whale shark and oceanic whitetip shark for the Western and Central Pacific Fisheries Commission. Philipp is a member and reviewer for several Fisheries New Zealand working groups – including the Rock Lobster, Shellfish and Statistics & Assessment Methods working groups.

Keywords: Impact assessment, Management procedures, Population models

Like many of the last remaining wild abalone fisheries in the world, Aotearoa/New Zealand's pāua fisheries have endured a range of challenges in recent years, in the form of over-harvesting, changing productivity and natural disasters (Kaikoura earthquake). While it is often acknowledged that the appropriate scale of management for abalone is at small spatial scales, statutory assessments, and management of Aotearoa's pāua fisheries has largely occurred on scales of quota management areas (QMAs - often 100s of km), with little explicit link to the small spatial scales at which pāua populations function on ecological timescales. Recent challenges in managing fishing rates in space and time have led to the development of spatial modelling tools that enable the investigation management options on smaller scales, while allowing scaling of relevant trends and metrics to scales relevant to statutory management at QMA scales, thereby linking small scale, often industry driven management, with regulatory frameworks. The development of these models has allowed exploring of trade-offs in management in areas where impacts such as harvest rates, earthquake impacts, or productivity shifts have been spatial heterogeneous. I illustrate the opportunities and challenges with developing increasingly fine-scale modelling approaches and show how these models have been used to understand management trade-offs in the re-opening of the Kaikoura pāua fishery

since the 2016 earthquake led to a region-wide fisheries closure. The development of these models should go hand in hand with enhanced spatial data collection that will lead to improvements in our ability to develop and statistically fit pāua population models on relevant spatial scales.

Restoring the iconic white abalone (*Haliotis sorenseni*) to the kelp forests of Southern California, USA

Melissa Neuman[1], David Witting[1], Amanda Bird[2], Heather Burdick[3], Tom Ford[3], Benjamin Grime[3], Jennifer Hofmeister[4], Adam Obaza[2], Rilee Sanders[3], Ian Taniguchi[4]

[1]NOAA National Marine Fisheries Service
[2]Paua Marine Research Group LLC
[3]The Bay Foundation
[4]California Department of Fish and Wildlife, California, USA

Bio: Mellis's work is focused on restoring endangered and threatened marine species in the U.S. One of her primary responsibilities is to rebuild white abalone populations through captive propagation and enhancement activities. Working closely with partners and under my leadership, over 8,000 white abalone have been placed onto wild reef habitats since 2019. Melissa is a scientific diver who enjoys staying connected with the resources she helps protect. This helps her communicate the importance of safeguarding our marine resources to bolster the cultural, economic, and biological resilience of coastal communities.

Keywords: Conservation, Habitat suitability, Restoration

White abalone (*Haliotis sorenseni*) is one of nine species identified in the U.S.'s 2015 Species in the Spotlight initiative to promote recovery of the country's most critically endangered marine species. The cornerstone of this initiative for white abalone is an enhancement program that began rebuilding populations in 2019. Outplant sites were selected based on the presence of white abalone, macroalgal assemblage, physical attributes, risk of disease, and logistical considerations. In situ data collection of physical and biological attributes suggest variability in benthic conditions across outplant sites, seasons, and years. From 2019-2021, 7,038 white abalone (19-126 mm shell length) were out planted. Mortality estimates are similar between sites (42.7 and 47.5 %) and two deployment methods (36.3, 39.4 %) that utilise a semi-enclosed module prior to release onto reefs. A third method involving hand planting abalone directly to the reef experienced higher mortality (46.7%) than module-based methods. Estimating post-outplant survival is challenging because survivors are cryptic and difficult for divers to relocate without putting the abalone at higher risk of mortality. Currently, 55% of our abalone remain at large based on the number of confirmed mortalities. Out planted abalone should become emergent and more visible to divers ~5-7 years post-out planting. Until then, we will continue to refine methods, establish additional outplant sites, re-stock established outplant sites, and monitor on a regular basis to keep track of survival and growth of the abalone and any notable changes in the biological and/or physical characteristics of the sites.

Multiple omics approach to evaluate the effect of encapsulated feeds on blacklip abalone (*Haliotis rubra*) during the holding period before live exporting

Thao V. Nguyen[1,2], Andrea C. Alfaro[2], Jaime McAllister[3], Jinchen Guo[2], Omar Mendoza Porras[4], James Broadbent[4], Utpal Bose[4], Sara Masoomi Dezfooli[2], David Beale[5], Craig Mundy[3]

[1]NTT Hi-Tech Institute, Nguyen Tat Thanh University, Ho Chi Minh City, Vietnam
[2]Aquaculture Biotechnology Research Group, School of Science, Auckland University of Technology, Auckland, New Zealand
[3]IMAS Fisheries and Aquaculture Centre, College of Science and Engineering, University of Tasmania, Taroona, Tasmania, Australia

[4]Agriculture and Food, Commonwealth Scientific and Industrial Research Organisation (CSIRO), St Lucia, QLD, Australia
[5]Land and Water, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Ecoscience Precinct, Dutton Park, QLD, Australia

Bio: Dr Van Thao Nguyen is a researcher at Nguyen Tat Thanh University, Vietnam and a visiting scientist at CSIRO, Australia. His research mainly focuses on the applications of metabolomics and omics in aquaculture and the environment. In collaboration with Auckland University of Technology (AUT) and the University of Tasmania (UTAS), Thao is currently working on the abalone metabolomics project that apply metabolomics to understand the metabolic responses of blacklip abalone to transport and heat stress. The project also aims to improve the health and survival of abalone with encapsulated feed developed by AUT.

Keywords: Abalone, Encapsulated feed, Live transport, Omics, Stress

Australia is the world's largest producer of wild-caught abalone, and the majority of its production is exported in live form to Asian markets. Prior to packing for export, abalone are often kept in holding tanks for up to six weeks without feeding, which could have negative effects on the animal health and survival. Hence, the present study aimed to apply a multiple-omics approach to test the applicability of feeding abalone with an encapsulated feed to improve health and survival of abalone during the holding period prior to transport. For this purpose, blacklip abalone (*Haliotis rubra*) were exposed to three different feeding conditions, encapsulated feed, commercial feed, and no feeding treatment. Abalone tissues (haemolymph, muscle and gills) were sampled before and after the 6-week experiment for metabolomics and proteomics analyses using LC-MS approaches, while the gut samples were collected for analysis of microbiome via the 16S rRNA gene amplicon sequencing. The targeted analysis of central carbon metabolism metabolites showed significant differences between feeding treatments in all three tissues. The metabolite profile of encapsulated feed fed abalone showed a higher level of many amino acids compared to animals fed with the commercial feed and starved abalone. Like metabolomics, proteomics analysis of abalone muscle tissues revealed 59 proteins that were significantly different among the abalone groups. The differences in metabolites and proteins among abalone groups suggest the effects of feeding on energy metabolism and amino acid and protein synthesis. At the microbiome level, we observed a significant variation in gut microbiome diversity among treatments at both the prokaryotic genus and class levels, indicating the effects of probiotics in encapsulated feeds on the community of microorganisms. Overall, the study highlights the potential use of encapsulated feed to enhance abalone health during the holding period which could increase the animal survival rate post live transport.

New Zealand pāua fishery research programme

Marine Pomarède

Fisheries New Zealand, Wellington, New Zealand

Bio: Marine manages the shellfish science for Fisheries New Zealand. She is mainly focus on the status of the stocks of shellfish fisheries managed by FNZ.

Keywords: Advice, Fisheries Management, Research programme

Pāua Fishery Research Programme is to design, implement, manage, and coordinate research relevant to the pāua fishery. The intent of the research results is to provide reliable and timely information to support decisions on how best to implement management tools to achieve the management objective of sustainable utilisation. The success of achieving fishery management objectives is largely dependent on the choice of management tools and how effectively these tools are implemented. Choosing the best tools and effectively implementing these is in turn dependent on the quality of data that can be collected and the consequent depth of knowledge regarding the pāua fishery, including an understanding of:

• the biological and behavioural characteristics of pāua,
• the spatial and temporal variation of these characteristics within and between pāua populations,
• how pāua respond to fishing pressure and the fishing activity, and
• the behaviour of customary, recreational, and commercial pāua fishers.

The purpose of this Medium-Term Research Plan is to provide the reader with an in depth understanding of the research programme by:
• explaining why research is undertaken in the pāua fishery.
• describing the fishery management objectives.
• describing the tools that are used to manage the pāua fishery.
• describing how decisions, on how best to implement the management tools are informed by research; and,
• describing current, past, and future research.

Shellogy – Reading the shells to inform and motivate reef-scale management

Jeremy Prince

Biospherics Pty Ltd & Murdoch University, Western Australia

Bio: Since defining the Tragedy of Scale with his 1990 doctorate on the Tasmanian abalone fishery, Jeremy Prince has become one of the world's leading experts on data-poor fisheries assessment. He also free-dived commercially for pāua in southern NZ for 15 years, and one way or another has experience with almost all the world's abalone and sea-urchin fisheries. Now he wants us to foster the reef-scale regeneration of wild abalone stocks by teaching visual assessment methods to divers and facilitating their collection of geo-referenced size.

Keywords: Length-based assessment, Shell morphology

Shellogy is the robust, if rudimentary, qualitative assessment of abalone populations by the shape and appearance of the shells seen on reefs, and in catches. Sustained populations complete a high proportion natural longevity, and fulfil a greater proportion of the reproductive potential, they are dominated by slowly growing, fully mature adults with thick bowl-like shells, with substantial epiphytic fouling, or erosion, on the outside, and breeding scars inside. Declining populations are comprised primarily of fast-growing, emerging sub-adult size classes that get to fulfil little of their spawning potential before being harvested. They are recognised by their thin flat oval-shaped shells, clean on the outside, mirror shiny inside. Since the early 2000s I have been teaching abalone divers, in various regions, to use shellogy to assess reef status for themselves. In every case, informed divers have been energized to engage with implementing more-precautionary finer-scaled management. Three of those regions are now amongst the only four regions in the world (that I know of) where wild abalone biomass has been increasing over the last decade. The qualitative shellogy assessments can now be quantified with length-based assessment and GPS referenced catch size composition data. This at last makes possible, reef-by-reef assessment, and harvest control rules specified to internationally recognised reference points. With divers informed by their own practice of shellogy, conflict between government and industry can be minimised, fostering the foresighted, imaginative, and regenerative reef-scale management that will be needed to rebuild the world's great, empty, wild abalone resources.

The constant volume heart: an old hypothesis finally confirmed in a very old mollusc

Norman L.C. Ragg[1] & Harry H. Taylor[2]

[1]Cawthron Institute, Nelson 7042, New Zealand
[2]University of Canterbury, Christchurch, New Zealand

Bio: Norman trained as an abalone biologist, studying circulatory physiology, stress, and energetics. Norman has also worked as an abalone farmer, developing novel grow-out systems and diets. He is now senior scientist, shellfish team leader and shellfish platform manager at the Cawthron Institute in Nelson, New Zealand.

Keywords: Ancestral physiology, Constant volume, Gill perfusion, Heart, *Haliotis iris*

In the early 1950s J. A. R. Ramsay extended the elegant hypothesis that the molluscan heart retained a constant volume throughout the cardiac cycle. Based on morphological observations, it was suggested that while the ventricular muscle contracted to eject haemolymph into the aorta, pressure was simultaneously lowered in the pericardial fluid, expanding the thin-walled auricle(s) and actively sucking haemolymph into the heart chambers. In vivo assessment in the large abalone *Haliotis iris* allowed the hypothesis to be confirmed and provided insights into haemolymph circulation in primitive molluscs. By carefully removing sections of shell and inserting cannulae into key haemolymph vessels, pressure transducers were able to provide live data records. A mean circulatory filling pressure of 1.9 cmH_2O was maintained. Ventricular contraction (systole) raised aortic pressure to peak at 4.6 cmH_2O and simultaneously created negative pressure, lowering pre-cardiac haemolymph pressure to 1.2 cmH_2O. Pulse-Doppler probes, used to quantify haemolymph flow velocity, established the negative pressure pulse was necessary to perfuse the gills, where haemolymph only flowed when the pressure gradient was at its greatest (i.e., during ventricular systole). These pressure-flow relationships demonstrate an effective but energetically costly cardiac function in this abalone, hinting at possible drivers of the rapid subsequent evolution of the gastropod circulatory and respiratory systems.

Managing range-extending urchins to protect Tasmanian abalone stocks

Sharna Rainer[1], Ian Dutton[1], Matt Bradshaw[1], John Keane[2]

[1]Department of Natural Resources and Environment Tasmania, Australia
[2]Institute of Marine and Antarctic Studies

Bio: Sharna Rainer studied Biological Science at the University of Tasmania, Australia, and is currently employed as a Senior Fisheries Manager for the Tasmanian Government (NRE Tas). Sharna manages the Tasmanian commercial wild-catch urchin, periwinkle, shellfish, and seaweed fisheries. Several of these fisheries have experienced rapid growth, and Sharna is focussed on improving policies and practices to ensure the growing industry is supported for sustainable fishing into the future.

Keywords: Centrostephanus, Fisheries management, Pest, Subsidy

Tasmanian abalone stocks have experienced a long-term decline from the 1980's peak, which is attributable to a range of factors. A key driver is a reduction in habitat and food, largely owing to the southward range-extension of the Longspined sea Urchin, *Centrostephanus rodgersii*, from New South Wales through Victoria and into Tasmania. It is estimated that there are around 20 million individual Longspined Sea Urchin in Tasmanian waters. Management of urchins and abalone are synonymous with one another. In 2018, the abalone industry voluntarily partnered with the Tasmanian Government (via the Department of Natural Resources and Environment Tasmania; NRE Tas) to establish the Abalone Industry Reinvestment Fund (AIRF). The fund has two key purposes: 1) improve abalone stocks and 2) protect abalone habitat. The latter has been primarily

met by promoting rapid growth of the commercial urchin industry via a catch subsidy, and through support of related research. Almost 500 T of urchin have been removed per year since the AIRF's inception, with approximately 30 divers involved in the harvest efforts. Processors are developing the IP, products, and markets necessary to sustain the commercial harvest and achieve real profitability. However, there remain numerous management challenges associated with the fishery and its close ties to abalone. For example, can we achieve a "sustainably overfished" fishery that protects abalone and habitat, whilst also supporting a profitable urchin industry into the future? This presentation will explore some of the key achievements of the AIRF program, and future challenges and key opportunities.

Genomic selection of greenlip abalone for improved growth rate, limiting inbreeding and maintaining genetic diversity

Marie Lillehammer[1], Tom Hyde[2], Craig Marshall[2], Cameron Davidson[2], Nick Robinson[1,3]

[1]Norwegian Instoitute for Food, Fisheries and Aquaculture Research (Nofima)
[2]Yumbah Aquaculture
[3]The University of Melbourne, Victoria 3113 Australia

Bio: Nick is a Senior Scientist with the Norwegian Institute for Food, Fisheries and Aquaculture Research (Nofima) and an Enterprise Fellow in Aquaculture with The University of Melbourne. His research concerns the application of genomics to the genetic improvement of fish and shellfish in aquaculture. He have around 30 years' experience with the genetic improvement of livestock and aquaculture species, working closely with many companies, holding more than 50 research grants and authoring of over 80 journal publications and book chapters with my many collaborators around the world.

Keywords: Genomic selection, Genetic improvement, Greenlip abalone, Genetic diversity, Inbreeding

Genomic selection uses information from DNA variants distributed throughout the genome to predict genomic breeding values (gEBVs). As well as improving selection accuracy, genomic selection enables tighter control for limiting inbreeding and maintaining genetic diversity. Here we give a practical demonstration of the use of genomic selection for improving growth rate in greenlip abalone. Candidates for selection (n=2,455) were derived from the Yumbah Port Lincoln breeding population. The candidates were offspring of August 2019 spawnings pooled as larva and grown in 16 common environments on-farm. The largest animals were visually pre-selected, weighed, sexed, tagged, and transferred to a common tank in April 2022 when tentacle samples were taken for genotyping. Animals were genotyped using 29,556 single nucleotide polymorphisms (GenomNZ). gEBV were predicted using a model accounting for tank and initial sex. Sex was verified just before spawning in September 2022. Mate prioritisation was based on gEBV rankings (genetic improvement), ensuring low genomic pair-relationships (limiting inbreeding) and even contribution of genomic lineages to the next generation (maintaining diversity). In total, 59 full-sibling families and some half-sibling families were created. The heritability of weight (pre-selected abalone) was 0.12. Accuracy of selection was estimated from 10-fold cross-validation to be 0.67. This round of genomic selection is expected to tightly limit inbreeding and loss of genetic variation and result in 3% genetic gain, based on the realized selection differential, in addition to the 3% genetic gain predicted from phenotypic pre-selection (total gain of ~7g at ~32 months).

Red abalone egg production estimates as indicators for fisheries and restoration in a warming ocean: Climate ready management

Laura Rogers-Bennett[1] & Julia Coates[2]

[1]Coastal Marine Science Institute, University of California Davis, USA
[2]California Department of Fish and Wildlife

Bio: Dr Laura Rogers-Bennett is a Research Associate at the Bodega Marine Lab, Coastal Marine Science Institute in the University of California, Davis and a Senior Environmental Scientist with the California Department of Fish and Wildlife. She leads a team investigating marine ecosystem health, fishery management and marine conservation biology in a changing ocean climate. To accomplish this, they use an interdisciplinary approach combining scuba, field, laboratory, and quantitative modelling to examine questions related to marine heatwaves, ecosystem tipping points, conservation biology, fisheries sustainability, and climate change. Dr Rogers-Bennett has authored over 65 scientific publications and 12 book chapters.

Keywords: Adaptive Management, Haliotis, Fecundity, Fisheries, Reference Points

Ocean warming and marine heatwaves are negatively impacting kelp forests around the world and the productivity of fisheries that depend on kelps. Abalone fisheries are known to have a high dependence on kelp forests decreasing growth, survival, and reproduction in poor kelp years. Therefore, measures of abalone productivity in normal and good kelp years maybe far too optimistic in warm or poor kelp years. Fisheries management and restoration will need to be adaptive, responsive to conditions that drive abalone productivity. Egg production can be used to guide fishery management decisions such as Total Allowable Catch and set abalone restoration targets. We use a combination of density (proxy for abundance), size frequency and egg output to set management and restoration thresholds. Egg production estimates examined during baseline years are used to set target reference points when abalone fisheries were productive. Years with large declines in the egg production can be used to set limit reference points. Egg production estimates are sensitive to not only mass mortalities, which can occur with climate change, but also changes in the number of large individuals due to overfishing or the establishment of MPAs. With climate impacts to kelp forest ecosystem around the world increasing, we recommend using indicators that can respond to changes in density as well as the size frequency when crafting climate ready fisheries management and restoration plans.

Ongoing mass mortalities of red abalone, *Haliotis rufescens*, in Northern California threaten population viability and species recovery

Cynthia A. Catton, Robert R. Klamt, Laura Rogers-Bennett

Coastal Marine Science Institute, University of California Davis, USA

Keywords: Climate change, Critically endangered, Mass mortality, Population viability, Red abalone

Mass mortalities of red abalone, *Haliotis rufescens*, have been documented following the sudden and ongoing collapse of the bull kelp, *Nereocystis luetkeana*, forest in northern California in 2014. The red abalone began to die of starvation in 2016, and these populations that once supported a robust recreational fishery are still declining due to ongoing food limitation. The recreational fishery was closed in 2018 due to extremely low population densities and has not recovered. Results from long-term monitoring (2000-2022) in the fishery region suggest that the population declined >80% from baseline (2003-2007: ~70M abalone) by 2018 (~10M abalone). The estimated rate of decline from 2017 to 2018 in Sonoma and Mendocino counties, during the early period of mortalities, was 0.26 yr-1. In 2022, population densities at historically fished sites continued to decline up to 97% from 2018 estimates. The rapid population decline and ongoing high mortalities in northern California prompted a population viability analysis to estimate the time to reach a quasi-extinction threshold. Because the northern California region was the last remaining stronghold for the red abalone population in much of the species' range, the severe impacts and risk of local extinction in northern California populations threaten the species recovery more broadly. In 2021, the red abalone were listed as Critically Endangered on the IUCN Red List under criteria A2acde. The results of these analyses further support the Critically Endangered listing.

Rise in purple sea urchin recruitment and kelp forest collapse precipitates red abalone recruitment failure

Laura Rogers-Bennett[1], Shelby Kawanaulia[2], Daniel Okamoto[3]

[1]Coastal Marine Science Institute, University of California Davis, USA
[2]California Department of Fish and Wildlife
[3]Florida State University

Keywords: Climate Change, Haliotis, Reproduction, Strongylocentrotus, Urchin Barrens

Recruitment rates of young of the year sea urchin grazers in kelp forests are critical to inform climate ready kelp restoration. Kelp forests provide a suite of ecosystem services including valuable fisheries, supporting biodiversity and carbon sequestration. The recruitment success of socio-economically important resources, such as abalone, are directly impacted by the population dynamics and recruitment success of sea urchins. Here we examine a 20-year time series of abalone and urchin recruitment monitoring in Mendocino County, across a period of dramatic change following a major marine heat wave. Divers surveyed artificial reef recruitment modules (N=12) within once robust bull kelp, *Nereocystis leutkeana*, forests supporting formerly productive red abalone, *Haliotis rufescens*, fishing grounds. These annual surveys were conducted before, during and after the marine heatwave (2014-2016), the loss of a major predatory sea star (2012-2016) and the collapse of the bull kelp forest in 2014. From 2014 to 2022, we track the rise of purple sea urchin, *Strongylocentrotus purpuratus*, recruitment at the expense of red abalone recruitment. Nine years following the collapse of the kelp forest, red abalone recruitment rates remain low and comparable to rates of southern California. These data support the continued monitoring of sea urchin recruitment to track the health of formerly productive kelp forests in the heart of the once highly productive and sustainable northern California recreational abalone fishery.

Ocean acidification: What consequences for larvae, juveniles, and adult abalone *H. tuberculata*?

Sabine Roussel[1], Sophie Martin[2], Sylvain Huchette[3], Rob Day[4], Philippe Dubois [5], Aïcha Badou[6], Stephanie Bordenave[7]

[1]Université de Brest, CNRS, IRD, Ifremer, LEMAR, F-29280 Plouzané, France
[2]Laboratoire Adaptation et Diversité en Milieu Marin, AD2M UMR 7144 (CNRS/SU), Station Biologique de Roscoff, 29680 Roscoff, France
[3]France Haliotis, 29880 Plouguerneau, France
[4]School of Biosciences, University of Melbourne, Parkville, Victoria 3010, Australia
[5]Laboratoire de Biologie Marine, Université Libre de Bruxelles, CP160/15, 1050, Brussels, Belgium
[6]ISYEB, UMR 7205 DGD REVE - Muséum national d'Histoire naturelle, Station de Biologie Marine, 29900 Concarneau, France
[7]BOREA, UMR 7208 (MNHN/SU/CNRS/IRD/UCBN), Muséum national d'Histoire naturelle, Station de Biologie Marine, 29 900 Concarneau, France

Bio: From goats to abalone: Sabine Roussel has a MSc in ethology and a PhD in Agronomy and Animal Science. After 10 years studying animal welfare and behaviour of terrestrial animal, she is now specialised in marine science. She has developed several research programs on abalone in France. She has coordinated research projects based on an interdisciplinary approach working with researchers specialised in ecology, quantitative and population genetics, physiologist, pathologists, economists as well as with socio-professional stakeholders such as abalone farmers and fishermen. Her main research interests include animal welfare of aquaculture species, domestication and stock-enhancement, and the effects of acidification and warming on molluscs.

Keywords: Acidification, Calcification, Growth, *H. tuberculate*, Survival

Ocean acidification (OA) is a major stressor that leads to substantial changes in seawater chemistry. According to IPCC (2021), surface ocean pH might decrease up to 0.3-0.4 unit by 2100, with potential significant consequences for calcifying organisms. The objective of our work was to investigate the effect of OA on different stages of the European abalone with an interdisciplinary approach. We performed several experiments from larval to adult stages exposing them to different pHT conditions (low pHT 7.6-7.7 vs ambient pHT 8.0-8.1). Experiments were done from several days up to 5-month duration. Several parameters were assessed such as behaviour (circadian rhythm, hiding tests, predator tests), physiology (phagocytosis efficiency, respiration, calcification, haemolymph pH), shell microstructure and resistance, reproduction (gonad development and fertilization), growth and larval development. No effects of decreased pH were observed on sub-adult and adult abalone metabolism, immunity, and behaviour, suggesting that adult abalone maintain their vital functions. However, a reduction in gonad investment, shell growth, calcification and shell resistance were observed. Important abnormalities and reduced growth were observed at larval stage for pHT 7.7. Higher mortality was reported for juveniles of 2.5 months for pHT 7.7 compared to ambient pH. These results highlight that OA might strongly impact abalone fisheries and aquaculture in the next century. Larvae and juveniles are the most sensitive stage with likely impacts on the success of recruitment in natural population. In addition, reduced growth observed from larval up to adult stage might compromise economic performances in the aquaculture industry.

Starvation and transport before seeding: Implications for stock enhancement programs in the European abalone *Haliotis tuberculata*

Pierre Chauvaud[1], Julie Muller[1], Rob Day[2], Grégory Charrier[1], Sabine Roussel[1]

[1]Université de Brest, CNRS, IRD, Ifremer, LEMAR, F-29280 Plouzané, France
[2]School of Biosciences, University of Melbourne, Parkville, Victoria 3010, Australia

Keywords: Animal welfare, Behaviour, Stock-enhancement, Stress, Transport

Several populations of the European abalone (*Haliotis tuberculata*) have collapsed over the last decades. Stock-enhancement programs are a promising way to restore these populations. The seeding of abalone requires handling as well as transport for periods during which abalone are stressed and have no food. This might affect the subsequent survival of juveniles after seeding. Juveniles of *H. tuberculata* (23 months old) from wild broodstock were exposed to four pre-seeding treatments combining two degrees of nutrition (fed or starved for 10 days) and two degrees of stress due to transport and handling (mild or severe). Their behaviour and survival were then analysed using assays at three different times and scales: (1) short-term responses to simulated contact with a predator, and time taken to hide and to right themselves, (2) activity pattern for 10 days post-seeding using video recording (3) survival after 10 days in mesocosms with or without predators. The severe stress induced longer times to hide and modified several behaviours following contact with the predator. Starvation increased the time that juveniles spent feeding outside the hiding place during the first night. In the mesocosms, crabs significantly decreased the survival in all four treatments. Thus, although severe stress and starvation induced changes in short-term behavioural responses and in feeding activity pattern respectively, these effects did not have significant impacts on the survival rates in the presence of predators, which has been reported to be the main factor explaining mortality post-seeding.

Re-assessment of a blackfoot abalone population in Peraki Bay, New Zealand, after 45 years, and its response to environmental change

Finn J. Ryder[1,2], Keith J. Sainsbury[3], Christopher D. Hepburn[1,2], Daniel W. Pritchard[1], Gaya Gnanalingam[1,2]

[1]Coastal People Southern Skies Centre of Research Excellence, University of Otago, Dunedin 9016, New Zealand
[2]Department of Marine Science, University of Otago, Dunedin 9016, New Zealand
[3]Institute of Marine and Antarctic Studies, University of Tasmania, Hobart, TAS 7001, Australia

Bio: Finn is a PhD student at the University of Otago. His work focuses on the spatial and temporal variation of pāua population dynamics.

Keywords: Declining populations, Environmental stressors, Fisheries management, Population dynamics

Blackfoot abalone (*Haliotis iris*), commonly known as pāua, are a highly prized cultural, recreational, and commercial resource in New Zealand. In recent years, due to multiple stressors, pāua stocks have undergone considerable declines. Despite this, there has not been a fine scale study of a single pāua population over a long timescale. From 1973 to 1976, Keith Sainsbury comprehensively studied a pāua population in Peraki Bay, Banks Peninsula. Using this historical data and similar methods, this study investigates how the population dynamics and size structure of pāua have changed over an extended period. As pāua in Peraki Bay have experienced little fishing pressure, this provided a unique opportunity to assess change. By re-surveying Peraki Bay 45 years after it was first surveyed, a large change in population size and structure was observed. Since 1976, there has been an 84 % decrease in estimated population size. Growth rates showed no change, but mean adult shell length decreased by 16.3 mm. No spawning events were observed during this study; however, recruitment occurred episodically. In addition to a large population decrease, our findings indicate that spawning may not be annual in Peraki Bay. Pāua may be susceptible to multiple stressors that are causing habitat loss and low and inconsistent recruitment. Being the first multidecadal study on a pāua population, and with very little fishing in Peraki Bay, this study helps clarify the rate and causes of population change driven by environmental stressors.

Comparing survival of hatchery-reared pinto abalone (*Haliotis kamtschatkana*) released in mixed-age cohorts in Washington State

Katie Sowul[1], Henry Carson[1], Josh Bouma[2], Bethany Stevick[1], Taylor Frierson[1], Emily Loose[1], Caitlin O'Brien[2]

[1]Washington Department of Fish and Wildlife, Washington 98103 United States of America
[2] Puget Sound Restoration Fund

Bio: Katie Sowul is the Abalone Biologist and Diving Safety Officer for Washington Department of Fish and Wildlife (WDFW). As a member of the 6-person WDFW Subtidal Shellfish Dive Team, she works year-round to manage all shellfish species in the Puget Sound, with Pinto abalone being her main focus.

Keywords: Outplant, Pinto, Restoration, Recovery, Washington

In Washington State, USA, relative abundance of endangered Pinto abalone (*Haliotis kamtschatkana*) has declined by 97% since 1992. Restoration efforts have centred on hatchery supplementation to wild populations. From 2009 to 2017, captive-bred juvenile pinto abalone were raised for 20 months before being released into the wild. In 2017, a pilot study was conducted to determine whether abalone could be released at a younger age. Two age treatments (9-months, 14-months) were released

and monitored. In two years of diver surveys, the 9-month-old treatment had the same or better survival compared to their 14-month old counterparts (4% and 2%, respectively). Survival to 32 months was similar between the 9-month and previously released 20-month age cohorts, suggesting release at a younger age was a viable option. Subsequently, four large-scale juvenile outplants were conducted between 2019-2022 in which 19,000 1-year old abalone were released alongside 9,000 2-year-old abalone to 23 sites. In two of three post-outplant surveys conducted 10 months after release, 1-year old age cohorts had high survival rates (0.8%, 4.5%, 3.7%). Two-year old abalone had reasonable survival rates in all three releases (2.1%, 2.5%, 4.5%). Surveys of 2022 outplants will be conducted in February 2023. The considerable resource savings of releasing the majority of each cohort a year early, the ability to include families from two spawning years together for increased genetic diversity, and minimizing hatchery selection influences and habituation support the practice of mixed-cohort releases of juvenile abalone.

Critical reproduction density and resilience in abalone: A South Australian case study

Ben Stobart and Stephen Mayfield

South Australian Research and Development Institute; The University of Adelaide, Port Lincoln, SA 5606 Australia

Bio: Dr Ben Stobart leads the Molluscan Fisheries Sub-Program at the South Australian Research and Development Institute that delivers stock assessments for a range of commercially fished molluscan species, particularly abalone. Ben has also worked extensively on marine protected areas in the Mediterranean and coral reefs in Australia and elsewhere.

Keywords: Abalone viscera, Biosecurity, *Haliotis rubra, Perkinsus olensi,* Zoosporangia

Abalone are dioecious organisms that reproduce by spawning directly into the water column. The success of reproduction is dependent on gametes encountering each other and effective fertilization. The size of aggregations necessary for the continuity of stocks is unknown, but best estimates put critical densities at 0.15-0.3 m^{-2} for greenlip abalone (*Haliotis laevigata*) and 0.34 m^{-2} for black abalone (*H cracherodii*). In South Australia, the density of greenlip stocks currently ranges from a maximum average of 0.16 m^{-2} to a minimum average density of 0.04 m^{-2}. Values for blacklip abalone (*H. rubra*) are higher with average minimum densities 0.2 m^{-2} and 0.45 m^{-2} in the Western and Southern Zone fisheries, respectively. Proximity of nearest neighbour is also known to be important, with 1-2m suggested as the minimum for successful reproduction. Thus, providing they are aggregated, it is conceivable that successful reproduction may occur at low densities. We examine data from the Western and Central Zones of the South Australian greenlip fishery to determine if greenlip aggregations are still common and whether the number of aggregations have changed over time. Findings suggest that aggregations do still occur, but they contain small numbers of individuals, and the number of aggregations has decreased over time, particularly in the Western Zone. Given the limited number of aggregations and low density of reproductive greenlip abalone, the fertilization success in these South Australian stocks is likely to already be compromised, particularly in some fished areas. We discuss ways in which the success of reproduction may be improved.

The impact and implication of *Perkinsus olseni* on Australian abalone fisheries

Ben Stobart, Katherine Heldt, Kathryn Wiltshire, Stephen Mayfield, Marty Deveney

South Australian Research and Development Institute; The University of Adelaide, Port Lincoln, SA 5606 Australia

Keywords: Abalone viscera, Biosecurity, *Haliotis rubra, Perkinsus olensi,* Zoosporangia

Perkinsus spp. are pathogenic alveolate protozoan parasites of marine molluscs, including abalone. *Perkinsus olseni* Lester & Davis, 1981 causes mortality, morbidity and decreases the quality of meat of infected abalone by inducing development of

unsightly pustules, reducing value, or rendering them unsaleable. In Australia, *P. olseni* caused widespread mortality of blacklip abalone (*Haliotis rubra*) in New South Wales and blacklip and greenlip (*H. laevigata*) abalone in South Australia. The impact of *P. olseni* on abalone fisheries has not been quantified, and the factors driving prevalence and disease expression are poorly understood. As part of a project co-funded by the Fisheries Research and Development Corporation (FRDC), we investigated (1) the economic impact of the disease (2) the fate of viscera discarded at sea and (3) the effect of scavenging on *P. olseni* spores by exposing abalone to *P. olseni* recovered from scavengers or purified from infected abalone. The latter two are important because current practice of shucking abalone at sea and discarding viscera and shells overboard may lead to proliferation and spread of the disease, representing a risk to the health of abalone stocks. We conclude that since 1980, *P. olseni* infections have caused millions of dollars of lost revenue in Australia and substantially displaced blacklip catch in South Australia and NSW. Viscera discarded at sea is mostly rapidly consumed by scavenging fish, particularly the wrasse *Notolabrus fucicola* (Richardson, 1840). Scavenging had a positive effect on *P. olseni* sporulation and increased the likelihood of exposed abalone becoming infected. Fisheries management strategies to reflect the biosecurity risk are under review.

From sustainability to safety: A new age recreational abalone fishery

Lachlan Strain, Jamin Brown, Anthony Hart

Western Australian Fisheries and Marine Research Laboratories, Department of Primary Industry and Regional Development Western Australia, Australia

Bio: Dr Strain is a Senior Research Scientist at the Department of Primary Industries and Regional Development, Western Australia and principally responsible for the scientific research supporting the abalone resource. His expertise spans ecology, fisheries assessment, and aquaculture of sessile marine invertebrates with current research initiatives focused on stock enhancement, restocking and sea ranching of abalone and sea cucumbers. This research unites his interests of scientific diving, fisheries, and aquaculture, while exploring alternative production systems (enhancement) to address the impacts of increasing environmental variability on fisheries.

Keywords: Fishery, Recreational, Safety, Sustainability, Survey

The Perth Metropolitan Roe's abalone (*Haliotis roei*) recreational fishery is unique with the highly prized abalone located on the doorstep of a major metropolitan city. The ease of access, lucrative nature and high density of the nearshore sessile invertebrate makes it susceptible to overfishing and has resulted in this fishery being one of the most restrictive recreational fisheries in the world. The sustainability of this fishery was challenged further by the 2011 extreme marine heatwave and subsequent years of above average sea surface temperatures, resulting in the decline of spawning biomass, growth stunting and recruitment impairment. Consequently, management was tightened, and the fishery is now open for only 4 hours per year! Unfortunately, the restrictive season has resulted in six fatalities since 2012 and given the season length, the fishery has a mortality rate of 1 death per 7.6 fishing hours, making it the most dangerous coastal recreational activity in Western Australia. The political nature of public safety while recreationally fishing prompted the Government to initiate a Safety Review, which facilitated a restructure of the fishing season. The relationship between fisher safety, weather conditions and catch were used to alter season timing and facilitate the opening or closing of a fishing session based on predicted weather conditions. To manage on a session (1 hour) basis an in-season catch prediction model was developed that provides real time recreational fishing estimates. This presentation chronicles these challenges, the management responses over time and how the recreational fishing survey has adapted to facilitate the changes.

Will the endangered white abalone (*Haliotis sorenseni*) survive the climate crisis?

Daniel Swezey[1], Evan Tjeerdema[2], Malina Loeher[3], Blythe Marshman[4], Eric Sanford[5], Jim Moore[4], Chelsea Souza[4], Kristin Aquilino[1], Alyssa Frederick[1]

[1]Bodega Marine Laboratory, University of California, Davis, USA
[2]Center for Marine Biomedicine and Biotechnology, Scripps Institution of Oceanography, University of California, San Diego, USA
[3]Virginia Institute of Marine Science, USA
[4]Bodega Marine Laboratory, University of California, Davis and California Department of Fish and Wildlife Shellfish Health Laboratory, USA
[5]Bodega Marine Laboratory, University of California, Davis and Department of Evolution and Ecology, University of California, Davis, USA

Bio: Dan Swezey is a scientist based at the University of California's Bodega Marine Laboratory in Northern California, USA. He uses field and lab experiments to test hypotheses and solve problems in marine aquaculture, focusing on shellfish and seaweed production systems. He also studies what global changes in temperature, ocean chemistry and disease will mean for wild and cultured marine plants, animals, and ecosystems. Over the last 8 years, he has focused on the production and conservation of California abalone as a focal system for these questions and is excited to build connections and collaborations with international abalone growers and scientists.

Keywords: Abalone restoration, Climate change, Disease, Endangered species, Ocean acidification

Restoration efforts for endangered species are faced with the challenges of climate change. One example is the white abalone (*Haliotis sorenseni*), a critically endangered species endemic to Southern California, USA, and Baja California, Mexico, where fewer than 1000 adult animals are believed to remain in the wild. Captive breeding and out planting of this species will be bolstered by scientific information on the impacts of changes in ocean temperature and pCO_2, which may interact with disease to impact feeding rates, growth, and survival. In this study, we exposed three-year-old captively raised *H. sorenseni* to factorial combinations of temperatures (12, 15, and 18°C) crossed with ocean acidification pCO_2levels of 600 and 1100 µatm (low and high CO_2 respectively), and the presence or absence of CaXc infection (*Candidatus Xenohaliotis californiensis*), a ubiquitous intracellular parasite of abalone for 300 days. We observed a three-way interaction, where warm temperature (≥15°C) crossed with CaXc infection decreased mortality time and overall observed mortality increased by 77%. Conversely, uninfected animal survival did not vary, except under high CO_2 at 18°C. Larger animals exhibited greater survival, and high CO_2 exposure reduced animal growth. We also observed complex interactions among genetic family, size, survival, and environmental treatments, suggesting that adaptive genotypes exist within the white abalone metapopulation that should be prioritized for future breeding and out planting in the face of climate change. We recommend further investigations into the effects of these stressors, adaptation strategies for captive breeding, and careful assessment of locations for the out planting of captive-raised individuals.

Specialised abalone metabolites: Transport of *Haliotis iris* as case study

Leonie Venter[1], Andrea C. Alfaro[1], Jeremie Zander Lindeque[2], Peet J. Jansen van Rensburg[2]

[1]Aquaculture Biotechnology Research Group, Department of Environmental Science, School of Science, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand
[2]Human Metabolomics, North-West University, Potchefstroom Campus, Private Bag X 6001, Potchefstroom 2520, South Africa

Bio: Leonie is working as a post-doctoral research fellow within the Aquaculture Biotechnology Research Group at Auckland University of Technology, striving to serve and advance the New Zealand's growing Aquaculture industry. She supports

changing and diverse ideas applying cutting edge metabolomics research to aquaculture industries, with the main aim of understanding how environmental stressors affect native NZ species (like pāua) and how this knowledge can effectively be transferred to farming practices. She provides significant investment to upcoming researchers, preparing students for the workforce. She contributes to research in New Zealand and internationally by collaborating with established scientists on externally and internally funded projects, bring new ideas and enthusiasm to large research teams.

Keywords: Abalone, Metabolism, Metabolomics, Transport, Recovery.

Metabolites or small molecules within a cell, tissue, organ, biological fluid, or the entire organism constitutes the metabolome, and are likely to contribute to the functional state of cells and serve as a direct signature of biochemical activity. But metabolites might just be much more. While our knowledge of the central carbon metabolism is a web of interconnected intermediates significant knowledge gaps remain in our understanding of these in abalone. By applying a liquid chromatography-tandem mass spectrometry metabolomics method, this study investigated the metabolite responses of *Haliotis iris*, following transport (12 hours) and recovery stress (48 hours). Significant changes in energy metabolism were inferred following transport highlighting a shift towards anaerobic energy production. Abalone have well-defined anaerobic metabolic pathways capable of energy production during hypoxic conditions as highlighted by the current study where metabolites commonly associated with anaerobic metabolism (pyruvate, lactate, succinate, and various amino acids) were increased in the transport stressed group. Metabolites can also be reversed when stress conditions return to normal, causing a decrease in metabolite signals as recovery takes place. In the current study, metabolites linked to the recovery group was lower than the transport group but have not achieved homeostasis (control level) following reimmersion of 48-hours. This study supports research on reimmersion practices in the supply chain of live animal exports, but does much more, as it highlights metabolic pathways and mechanisms that are understudied and underutilised in abalone.

Assessment of various seaweed-based diets and formulated feed on growth, body composition and colour of abalone (*Haliotis tuberculata coccinea*)

María del Pino Viera, Denti Giuseppe, Courtois de Viçose Gercende, Robaina Lidia

Institute of Sustainable Aquaculture and Marine Ecosystems (IU-ECOAQUA), Aquaculture Research Group (GIA), University of Las Palmas de Gran Canaria (ULPGC), Las Palmas de Gran Canaria, Spain

Bio: María del Pino Viera has a PhD in Marine Sciences, with more than 25 years' experience in aquaculture both in private sector and research activities. Specialised in the production of fish, molluscs, especially abalone, seaweed, as well as in sustainable aquaculture techniques and integrated multitrophic aquaculture.

Keywords: Abalone, Fishmeal, *Haliotis tuberculate coccinea*, Nutrition, Seaweed meals

Considering the nutritional variability of wild macroalgae, and the need to limit the use of fishmeal in formulated feed for ecological and sustainable aquaculture, a 16-week trial was conducted to evaluate the suitability of different seaweed meals, included alone or in combination with fishmeal in formulated feeds. All diets included *Ulva sp*. (U) and Gracilar cornea (H) to which were added *Palmaria palmata* (UHPa); *Porphyra sp.* (UHPo) or *Gelidium sp*. (UHGe). These three first diets were 99% vegetable-based, whereas in the fourth one (UHPaFm) 50% of soybean meal was replaced by fishmeal. Fresh algae (FA), reared in an IMTA, and commercial diet (CF) were used as controls. FA overall demonstrated a significantly higher dietary value for *H. tuberculata* coccinea than the compound feeds, although not significantly different from the one of UHPaFm. Feeding abalone with fishmeal-free formulated diets resulted in high survival, sustained growth, and good protein utilization. Nevertheless, the inclusion of *P. palmata* was found to improve growth, while the use of *Porphyra sp.* and *Gelidium sp.* reduced growth, increased FCR and diminished PER. The addition of fishmeal significantly improved growth, validating the benefits of combining both vegetal and animal protein sources. The use of CF diet led to sub-optimal growth, probably linked to a

significantly lowest feed intake. Shell and foot colour were altered by the different feeds, indicating that feeding regimes can also be used as tools to mark the specimens or provide colour enhancer to respond to the abalone market demand.

From the hatchery to the sea: Optimising transportation methods for South African abalone (*Haliotis midae*) larvae

Sharone Bajaba & Niall Vine

Department of Zoology & Entomology, University of Fort Hare, Alice, 5700, South Africa

Bio: Niall is South African academic at the University of Fort Hare who works on a variety of aquaculture species and systems, all in close collaboration with the local aquaculture industry. His research includes topics such as abalone ranching using larvae, IMTA of abalone and sea cucumbers, urchin probiotic development, the use of copepods as live feed and marine finfish diet development.

Keywords: Larval seeding, Ranching, Stock enhancement, Transport

Ocean ranching has been identified as a viable method for enhancing the natural stock of overexploited South African abalone (*Haliotis midae*). Currently, this process involves transporting live juvenile *H. midae* to the seeding site where they are released onto the reef; however, this is both costly and logistically problematic. Transportation of abalone larvae is another cost-effective option, as they are cheaper to produce and can be transported at high densities. A suitable larval transport method is required to minimise larval mortalities and stresses that might compromise settlement. A series of simulated experiments were conducted to optimise the transportation of abalone (*H. midae*) larvae. Firstly, two potential transportation methods [Wet (W) and Dry (D)] were tested at a cooler (14˚C) and commonly used *H. midae* rearing temperature (18˚C) with six replicates each. These were compared to controls (six replicates) that were not subjected to transport but kept in tanks at 18˚C. After transport, the larvae were placed in aquaria with settlement substrates and allowed to settle. The 14W treatment had significantly lower settlement ($p=0.03$) than the other three treatments (14D, 18W, 18D) and the control. The 18˚C dry method was selected as the preferred method to transport larvae as it is logistically simpler to employ.

Response of *Haliotis discus hannai* to thermal, hypoxic stress, and *Vibrio parahaemolyticus* infection based on multi-omics analysis

Yilei Wang, Yulon Sun, Ziping Zhang

Fujian Agriculture and Forestry University, Fuzhou, Fujian 350002, China

Bio: Yilei is interested in Aquatic Physiology.

Keywords: *Haliotis discus hannai*, Hypoxia, Metabolomics, Thermal stress, Transcriptome, *Vibrio parahaemolyticus*

As a species naturally distributed in the North Sea area, *Haliotis discus hannai* encountered the problem of high-temperature stress in summer in the process of transplanting it to the south sea area of China, resulting in huge losses in the abalone aquaculture industry. By combining metabolomics and transcriptomics, 62 co-enrichment pathways were identified, including 244 DEGs and 62 differential metabolic markers. These DEGs and differential metabolites were significantly co-enriched in amino acid metabolism-related pathways, including cysteine and methionine metabolism, lysine degradation, tryptophan metabolism and glutathione metabolism; carbohydrate metabolism-related pathways included glycolysis/ gluconeogenesis pathway, pentose phosphate pathway and pyruvate metabolism; lipid metabolism-related pathways included arachidonic acid

metabolism, glycerophospholipid metabolism and sphingolipid metabolism. The metabolic reactions based on glutathione dominated by glutathione transferase (GST) might exist in *H. discus hannai*, and the differential metabolites, including glutathione and glutathione disulphide, were enriched. The co-enrichment of key genes and differential metabolites suggests that glutathione metabolism might be involved in the repair process after oxidative stress induced by environmental stress. Based on the above results, we proposed that environmental stress induces an oxidative stress response in haemocytes, causes peroxidation damage, and then activates the antioxidant defence system in abalone.

What ever happened to Alaskan abalone? Current insights and historical comparisons of pinto abalone populations in Southeast Alaska

Taylor White[1], Ginny Eckert[2], Pete Raimondi[2]

[1]The University of California Santa Cruz, Ecology and Evolutionary Biology Dept., AK 99835 United States
[2]The University of Alaska, Fairbanks, College of Fisheries and Ocean Sciences

Bio: Taylor is a Ph.D. Candidate at the University of California Santa Cruz, living and working on Tlingit Aani (presently known as Sitka, Alaska). Taylor's research focuses on pinto abalone population dynamics throughout Southeast Alaska.

Keywords: Harvest, Pinto abalone, Sea otter

Pinto abalone (*Haliotis kamtschatkana*) in Southeast Alaska experienced continued population decline following peak years of their commercial harvest, 1978 – 1981. Precipitous declines are shared across the pinto abalone range, Salisbury Sound, Alaska, to Baja California, Mexico, and have been attributed to disease, loss of habitat, and overfishing. Growing populations of re-introduced sea otters have also been blamed for declines in Southeast Alaska. However, in select areas, recent surveys show abalone population growth in the presence of predators, including sea otters. These surveys also find reduced abalone abundance in areas with historically high commercial landings yet little to no current subsistence harvest. Until 2015, questions on abalone densities and population viability largely remained unanswered. Since then, a growing number of dive surveys and inter-agency collaborations have focused on gathering key management parameters for the harvested species, including spatially-explicit estimations of critical density and nearest neighbour distances that allow for successful reproduction, recorded recruitment, and population growth. This talk focuses on most recent findings and historical comparisons from surveys conducted near Sitka, Prince of Wales, and Ketchikan, Alaska. We contrast abalone demographics, reproductive potentials, and behaviours across the mosaic of sea otter and human interactions in Southeast Alaska. In addition, data collected sporadically from 1975 - 1997 on abalone population size and structure will be compared to current metrics in these areas. These findings provide the most spatially accurate depiction of pinto abalone populations across their northernmost range.

Movement patterns of a Southern California abalone species, *Haliotis kamtschatkana*, with implications to management and recovery of abalone in the eastern Pacific

David A. Witting[1], Melissa J. Neuman[2], Amanda Bird[3], Adam Obaza[3]

[1]National Marine Fisheries Service, Office of Habitat Conservation, Restoration Center
[2]National Marine Fisheries Service, West Coast Region
[3]Paua Marine Research Group LLC, California, USA

Bio: David is a Senior Fish Biologist at the NOAA Fisheries Restoration Center in Long Beach, California. He has been implementing projects to restore are recover Coastal Marine Resources in the eastern Pacific for nearly 20 years. His primary focus is restoration and recovery of temperate rocky reef and kelp forest habitats, including the recovery of the seven species

of abalone that occur in Southern California. In addition to implementing restoration projects, he has also conducted Natural Resource Damage Assessment studies and restoration planning for several oil spills in the United States.

Keywords: Movement, Population, Species, Viability

The Southern California coast of the United States supports seven abalone species, all of which are depleted, and two of which are listed as Endangered under the United States Endangered Species Act. Densities of several species are so low; it is uncertain whether the proximity of adults will allow for successful reproduction. This presents a challenge for managers to determine if existing populations are viable and for identifying realistic recovery goals for restoration efforts. Understanding movement patterns of mature abalone is critical for evaluating reproductive potential and population viability. The aim of this study was to track movements of pinto abalone (*Haliotis kamtschatkana*), a species that shares genetic and ecological similarity to endangered white abalone (*H. sorenseni*), using acoustic telemetry over two-time frames in 2015-2016 and 2017-2018. While most of the tagged abalone did not move, 20% moved on the order of ~10-60 m over the course of six months. Oceanographic conditions (i.e., warm ocean temperatures and subsequent kelp die off) associated with a strong El Niño event during the 2015-2016 tracking effort resulted in significant mortality among our first group of acoustically tagged abalone. While we were unable to identify a predictable pattern of movement among tagged abalone, the distances moved were large enough to increase potential mate encounter rates compared to a no movement scenario, suggesting that recovery criteria for this species, and possibly the endangered white abalone, may not require that nearest neighbour distances be within the accepted egg/sperm dispersal distance.

Genotype by environment interaction for growth and survival related traits in Pacific abalone

Fucun Wu & Guofan Zhang

CAS and Shandong Province Key Laboratory of Experimental Marine Biology, Center for Ocean Mega-Science, Institute of Oceanology, Chinese Academy of Sciences, Shandong, China.

Bio: Dr Fucun Wu is an associate professor at the Key Laboratory Experimental Marine Biology, Institute of Oceanology, Chinese Academy of Sciences. His primary research interests are the biology and genetics of marine molluscs, mainly in abalone and oyster species, and marine aquaculture. He is interested in quantitative genetic and statistical genomics that advances our understanding of molluscan genetic architecture, as well as studies that may lead to the development of superior stocks for molluscan aquaculture.

Keywords: Genetic correlation, Genotype by environment interaction, Growth, *Haliotis discus hannai*, One-year survival

Abalone farming is one of the leading aquaculture industries in China, with the annual production of more than 200,000 metric tons since 2020. Of this total, 76.17% were from the warm waters of Fujian (southern China), making it one of China's main abalone culture zones. A family-based selective breeding program in Pacific abalone *Haliotis discus hannai* was established in northern China and the genetic evaluation were introduced to be conducted in southern China in recent years. Since there're very extensive environment conditions in both sea-based and land-based culture systems and between northern and southern regions of China, the objective of this study was to investigate genotype by environment interaction (GEI) effects to optimize Pacific abalone breeding programs at varying environments. In a preliminary study by using the methods of AMMI model and GGE biplot, five Pacific abalone aquaculture stocks were evaluated at six regional sites including northern and southern regions, China. The results revealed that the abalone individual growth and yield traits were significantly influenced by genotype, environment, and genotype by environment interaction (GEI). Based on the preliminary results, superior aquaculture stocks were selected as broodstock aiming to initiate Pacific abalone selection program in southern China. To further determine the characteristics of GEI pattern in Pacific abalone, 21672 individuals from 76 full-sib families were reared in four localities in southern China, dividing into two sea-based and two land-based culture facilities. To estimate the additive genetic components and genetic correlations for the traits of one-year survival status (0/1) and shell lengths between varying environments, genetic

analysis by multivariate model was conducted with restricted maximum likelihood methods. Genetic correlations between the four environmental conditions were of low to moderate level for one-year survival and growth traits, respectively. It indicates a moderate to strong GEI effect for two traits evaluated. Our results imply that selecting Pacific abalone of greater genetic merit evaluated at land-based culture environment may reduce the accuracy of selection when transferred to the animals reared at sea-based environment. The study discussed the optimization of Pacific abalone breeding schemes in northern and southern China, respectively. More accurate estimates of GEI with the genomic approach that may therefore be achievable than was possible in the past were also discussed in the study.

One company's experiences and learnings on the way to commercialising abalone ranching in South Africa

Rowan Yearsley[1], P.F. Venter[2], J.D van der Westhuizen[3]

[1]CEO, Aqunion (Pty) Ltd, Whale Close, New Harbour, Hermanus, Western Cape 7200, South Africa
[2]Operations Manager, Diamond Coast Abalone (Pty) Ltd, South Africa
[3]Assistant Manager, Diamond Coast Abalone (Pty) Ltd, South Africa

Bio: Rowan has worked in various positions for Aqunion Group, a diversified aquaculture company focussed on South African abalone, since 2008. He initially served as the Research & Development Manager and now occupies executive leadership positions at the Group companies: Aqunion (land-based abalone production), Marifeed (abalone feed manufacturing) and Diamond Coast Abalone (abalone ranching). He is currently the chairman of the Abalone Farmers Association of South Africa.

Keywords: Commercialisation, *Haliotis midae*, Ranching

Since 2013, Diamond Coast Abalone, has held the right to ranch abalone along a 38km stretch of South African coastline. Having initially started with small-scale seeding experiments, and then progressed to commercial scale seeding, and first harvests, the company has experienced a number of challenges and rewards over the past nine years. This presentation shares some of those experiences as well as observations on abalone behaviour, survival, growth, and the characteristics of ranched and farmed abalone products. It also discusses the pros and cons of some different approaches to ranching business models, some financial quirks associated with ranching as a business model and investment therein, and opportunities and risks. This presentation will particularly be of interest to abalone farmers or wild quota holders that are considering ranching and to researchers involved in development of ranching techniques or management of abalone fisheries.

The cross-tolerance and metabolic coordination in abalone under long-term thermal acclimation and hypoxia stress

Yawei Shen, Yang Gan, Feng Yu, Xuan Luo, Weiwei You, Caihuan Ke

College of Ocean and Earth Sciences, Xiamen University, Fujian, China

Bio: Weiwei You is the professor for Xiamen University. He received his Ph.D. on marine biology from Xiamen University in 2009 and has published more than 80 peer reviewed papers on aquaculture field. His work focuses on genetic breeding, sustainable aquaculture, and climate change impact on the marine invertebrate organisms.

Keywords: High temperature, Hypoxia, Metabolic, Transcriptome

The global ocean is getting warm and losing oxygen due to anthropogenic activities. Short-term and long-term fluctuations of water temperature and dissolved oxygen may become a further challenge for aquatic organism in aquaculture areas where are under the combined impacts of global climate change and human activities. Here, a controlled laboratory study was conducted by exposing four abalone populations/species, to long-term thermostatic acclimation at two temperatures (20°C and 28°C) and acute hypoxia (~0.5 mg O_2/L). Long-term thermal acclimation would increase the sensitivity of abalone to hypoxia, indicated by the behaviour activities that more abalones left the shelter, lost adhesion, and died under acute hypoxia exposure after long-term thermal acclimation. Long-term thermal acclimation induced metabolic depression in abalone and shaped the hypoxia responses of abalone by reducing phosphorylated metabolites involved in carbohydrate and amino acid metabolism. The cross-tolerance between temperature acclimation and hypoxia tolerance varies among different abalone populations/species, reflecting their various resistance to environmental stressors. Overall, this study provides novel insights into the interactive effects of high-temperature and hypoxia on metabolic coordination in abalone as well as the response and adaptation mechanism of abalone to environmental multi-stressors.

Development of a 40K multipe-SNP array for Pacific abalone and its application in genomic selection for feed efficiency

Wenchao Yu, Junyu Liu, Wenzhu Peng, Xuan Luo, Weiwei You, Caihuan Ke

College of Ocean and Earth Sciences, Xiamen University, Fujian, China

Keywords: SNP array, Feed efficiency, GWAS, Genomic selection

Single nucleotide polymorphism (SNP) arrays are a powerful genotyping tool used in genetic research and genomic selection. In this study, we developed and evaluated a 40 K multiple-SNP (mSNP) liquid array, named as “Baoxin- Ⅰ”, which was based on Genotyping by target sequencing (GBTS) system and capture-in-solution technology. A set of more than 1.67 million SNPs based on the whole genome resequencing data from 1059 individuals were identified and 40 K target genomic regions which included 87,959 SNPs that were evenly distributed across the genome were selected here. Genetic improvement of feed efficiency (FE) related traits in abalone could result in significant cost and energy savings. The genome-wide association study (GWAS) for the FE traits was performed for the first time on abalone. A total of 25 significant SNPs were detected to be associated with feed efficiency ratio (FER) and 30 significant SNPs were detected to be associated with residual feed intake (RFI). This study will not only improve our understanding of the genetics of abalone FE, but it will also provide valuable SNPs for molecular marker selection and breeding in Pacific abalone.

New technologies, new products, and new trends in Chinese abalone processing industry

Irene Zhai

Xiamen Qicheng Marine Technology Co., Ltd, Xiamen, China

Bio: Graduated from Xiamen University, and now studying in the MBA program in CKGSB. AS the CEO of Xiamen Qicheng Marine Technology Co., Ltd, the author now focusses on abalone products' promotion in China, and the instant abalone products have achieved tens of millions of annual sales.

Keywords: China, Market, Product, Processing

Over the past five years, the aquaculture output of abalone in China has continued to grow and exceeded 210,000 tons in 2021. Under the dual impact of oversupply and the COVID-19, the abalone processing industry has developed rapidly in China,

creating new technologies, new products, and new market trends. At present, the consumption pattern of Chinese abalone is undergoing huge changes. Live abalone is still the dominant but not the only sales product. Frozen abalone, dried abalone and 3R (Ready-to-cook, Ready-to-heat and Ready-to-eat) products are constantly being promoted, and many new technologies and products have also emerged. This report will describe the technological innovation, development opportunities and market challenges in the development of abalone processing in China in the past five years, and will also provide important reference for the sustainable development of aquaculture industry.

Immune regulatory of *Haliotis discus hannai* haemocytes in response to *Vibrio parahaemolyticus* reinfection

Ziping Zhang[1], Yulong Sun[2], Yilei Wang[2]

[1]Fujian Agriculture and Forestry University, Xiamen, Fujian 361021, China
[2]Jimei University

Bio: My research is focusing on aquatic stress physiology and breeding for stress tolerance. Abalone is one of my important research models. I am now carrying out several abalone-related projects such as: Differential stress responses of abalone on a global scale: comparing thermal and hypoxic responses of *Haliotis discus hannai* and *H. midae* using integrated multi-omics techniques. Heredity and molecular mechanism of stress-resistance traits of abalone.

Keywords: Haemocytes, *Haliotis discus hannai*, Immune memory, Reinfection, *Vibrio parahaemolyticus*

Traditionally, invertebrates were thought to lack immune memory owing to a lack of acquired immune-related factors such as immunoglobulin. However, our preliminary research suggested the presence of immune priming in abalone. Given the critical role played by haemocytes in abalone resistance to foreign pathogen infestation, it is reasonable to hypothesize that they may be involved in the immune memory process of abalone resistance to repeated infection by pathogenic bacteria. Through transcriptome sequencing, this study screened several immunoregulatory DEGs sets in the haemocytes that have functional differences in response to the re-infection of *V. parahaemolyticus*, and at the same time, explored the important role played by lncRNAs in this process. For the first time, the transcriptome sequencing technology of 10×Genomics scRNAseq was used to construct a transcriptional landscape of abalone haemocytes, and the functional differences between different types of haemocytes were analysed and explored. Finally, the interrelationship between key signalling pathways was verified using RNA interference technology.

Characterisation of the molecular mechanisms of sexual maturation in the greenlip abalone, *Haliotis laevigata*

Ya Zhang[1,2], Carmel McDougall[3], Ido Bar[1], Natasha Botwright[2]

[1]Griffith University, Environmental Futures Research Institute, Nathan, Queensland, Australia
[2]CSIRO Agriculture and Food, Livestock and Aquaculture, St Lucia, Queensland, Australia
[3]Griffith University, Australian Rivers Institute, Nathan, Queensland, Australia

Bio: Ya Zhang is a Ph.D. student at Griffith University. Her work mainly focuses on the prevention of maturation to improve the resilience and growth of the Australian greenlip abalone. She is experimenting with methodologies to prevent maturation and further differentiate the molecular pathways related to maturation and growth. This will enable the development of intervention methods that impact gonadal maturation without producing negative growth outcomes. Her work will be under the

supervision of Dr Carmel McDougall and Dr Ido Bar from Griffith University and Natasha Botwright from CSIRO Agriculture and Food.

Keywords*:* *G*reenlip abalone, Sexual maturation, Transcriptome

Abalone are economically important cultured species in many countries because of their highly palatable muscular foot. However, overfishing and depletion of wild abalone populations has led to a decrease in the global abalone population. Currently in abalone aquaculture the maturation of males and females is not synchronized, and artificial spawning induction methods are reported to be inefficient. This is unfavourable for rapid gains through selective breeding. Exploring reproductive mechanisms may lead to innovative intervention techniques to enhance abalone production. It has been established that sexual maturity of abalone is a complex process closely linked to the neuroendocrine system, however understanding the molecular signalling components and pathways required for gonad maturation remains unclear. In this study, transcriptomics was used to explore differential gene expression during maturation of the greenlip abalone, *Haliotis laevigata*. RNA was extracted from the gonad and ganglia of abalone at different maturation stages from visual gonad index 0 to 4 and used to prepare a library for Next Generation Sequencing. Differential gene expression analysis was conducted between samples from different VGI stages to identify genes likely to be associated with gonad maturation in abalone. Analyses revealed several genes that are involved in sexual maturation. This provides a solid foundation from which further studies aimed at the functional characterisation of these genes can be conducted to further stimulate advances in understanding the cultivation of abalone in closed aquaculture systems.

POSTER PRESENTATION ABSTRACTS

Abstracts are ordered alphabetically by last name of presenter and include those provided to the committee for publishing at the time of printing.

Investigating the immune control of herpesvirus infection in marine molluscs

Jacinta R. Agius, Angus C Watson, Danielle Ackerly, Travis Beddoe, Karla J. Helbig

La Trobe University, Melbourne, Australia.

Bio: Jacinta Agius is a PhD candidate at La Trobe University (Melbourne, Australia) working towards the development of anti-viral therapeutics against Haliotid herpesvirus (HaHV-1) in Australian abalone. Through collaborations with industry partners, a major focus of Jacinta's work is investigating the feasibility of immune priming as a transgenerational protection method while working towards a greater understanding of the anti-viral innate immune response of these molluscs. Jacinta is highly interested in the anti-viral innate immune pathways of molluscs as well as maintaining Australia's biosecurity against agricultural and aquacultural pathogens.

Keywords: Anti-viral Strategies, Haliotid herpesvirus, Immune Priming, Innate Immunology

Our understanding of the specificities of innate immune protection against viral pathogens in non-model invertebrate species is limited, and comparative immunological approaches may offer opportunities to protect aquaculturally significant species such as abalone, against viral threats like Haliotid herpesvirus (HaHV-1). This study sought to examine immune priming strategies against this pathogen, and to describe mechanisms of innate immune antiviral protection in the abalone. Immune priming with non-specific synthetic nucleic acid offered significant protection against HaHV-1 challenge in Australian hybrid abalone a minimum of 5 days prior to viral challenge. To understand the key players involved in the abalone immune response, gene mining strategies and domain analysis of the Australian greenlip abalone draft genome was performed and compared to

the better studied mollusc, the oyster. Notable divergence in members of the TLR, cytosolic RNA/DNA and RNA interference signalling pathways was observed between the two molluscs, with the oyster closely reflecting that of the mammalian immune response. Interestingly, STING, a member of the dsDNA sensing pathway was absent in both the greenlip abalone and in a transcriptome assembly of the Australian blacklip abalone, however, is present in the oyster genome, and two additional abalone species (*Haliotis rufescens, Haliotis discus hannai*). We hypothesise that this may alter susceptibility to HaHV-1 challenge in vivo, however further work needs to be performed to determine this. This work provides a better understanding of the key features of the abalone antiviral innate immune system, providing key information towards the development of anti-viral strategies in these animals.

Investigation of Bluff's farmed abalone's gut microbiome under various formulated feed pellets

Jinchen Guo[1], Natalia Bullon[1,2], Andrea C. Alfaro[1]

[1]Aquaculture Biotechnology Research Group, Department of Environmental Science, School of Science, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand
[2]Drug Delivery Research Group, Science, School of Science, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand

Keywords*: Gut Microbiome, Haliotis iris, Formulated feed, 16S rRNA*

The black-footed pāua (*Haliotis iris*) is commercially farmed in New Zealand (NZ). Cultivated abalone in NZ mostly rely on artificial feed pellets, but their gut microbial composition and diversity under different diet options have been rarely documented. The goal of this project was to investigate farmed pāua gut prokaryotic microbiome composition and diversity under six formulated diets (Diet 1-4, Marifeed, and M50), which varied in nutritional profile, through a feeding trial at an abalone farm in Bluff, South Island. Three hundred juvenile subjects (2.84 ± 0.4 cm) were randomly assigned to the feeding experiment from August 2020 to April 2021. Gut content samples aseptically dissected and collected at the baseline (n=20) and Month 6 (n=9 per diet treatment) were processed through a 16S rRNA amplicon library preparation workflow and sequenced on an Illumina MiSeq platform. Shannon's index of the baseline group was significantly higher than that of the remaining diet groups at both the 97% OTU and prokaryotic phylum levels except that no significance was detected between the baseline and Marifeed groups at the 97% OTU level. Proteobacteria, Bacteroidota, and Fusobacteriota were the most abundant prokaryotic phyla across all diet treatments and accounted for approximately 60%, 20%, and 10% of the total prokaryotic composition, respectively. Furthermore, microbial beta diversity was significantly different across the diet treatments at both taxonomic levels, and the observed significance was mainly associated with the baseline and Marifeed treatments. Additionally, microbial diversity within the baseline group showed sub-clusters, which might be affected by other factors.

Preliminary results of Tasmanian abalone gut microbiome analysis from a feeding experiment

Jinchen Guo[1], Thao Van Nguyen[1,2], Andrea C. Alfaro[1]

[1]Aquaculture Biotechnology Research Group, Department of Environmental Science, School of Science, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand
[2]NTT Hi Tech Institute, Nguyen Tat Thanh University, Ho Chi Minh City, Vietnam

Keywords*: Abalone, Gut Microbiome, Illumina sequencing, 16S rRNA*

The Tasmanian abalone fishery is a large producing sector and supplies over 25% of the annual wild-caught abalone industry globally. Abalone's gut microbiome could be altered during the handling process from harvesting to long-distance transport, so the purpose of this experiment was to identify the effects of encapsulated feed on abalone's gut microbiome. Thirty-six wild

abalone subjects were randomly assigned into four treatment groups (n=9 in each group): right after harvesting, no feed control, an encapsulated feed designed at Auckland University of Technology (AUT), and a local commercial feed. All gut content samples were aseptically processed for 16S rRNA amplicon sequencing on an Illumina MiSeq platform. A total number of 1,799 amplicon sequence variants (ASVs) were discovered and clustered into 879 operational taxonomic units (OTUs) at a similarity threshold of 97%. Furthermore, microbial taxonomic assignment indicated 24 prokaryotic phyla, 45 classes, and 217 identifiable genera. Firmicutes, Fusobacteriota, and Proteobacteria were the most abundant prokaryotic phyla in all treatments, and their relative abundance was approximately 45%, 35%, and 15%, respectively. Shannon's diversity indices of the AUT's feed group and the "no feed control" group were significantly different from that of the rest groups at the 97% OTU and prokaryotic genus levels, respectively. Moreover, diversity comparison among the groups showed significance at all taxonomic levels. The present study provided important evidence on how formulated feed pellets affected Tasmanian abalone gut microflora during the holding period of being transported.

Perkinsus olseni and other parasites in New Zealand pāua, or black-footed abalone (*Haliotis iris*)

Farhana Muznebin[1,2], Stephen C. Webb[3], Andrea C. Alfaro[1]

[1]Aquaculture Biotechnology Research Group, Department of Environmental Science, School of Science, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand
[2]Department of Zoology, Faculty of Life and Earth Science, Jagannath University, Dhaka, Bangladesh
[3]Cawthron Institute, Nelson, New Zealand

Keywords: Ceroid material; Haemocytosis; Histology; In situ–hybridization; *Perkinsus olseni*

The endemic New Zealand Pāua or black-footed abalone (*Haliotis iris*) represents a growing aquaculture industry, which is potentially threatened by pathogens and parasites. To identify and characterise health risks, a targeted sampling event was conducted of healthy- and unhealthy-looking abalone (shell deformities, tissue damage and brown creamy substance/fluid in tissues) at a land-based farm. For the first time in *H. iris*, detailed histological observations, followed by confirmatory in situ hybridization (ISH) resulted in the identification of *Perkinsus olseni* (5% prevalence). Other parasites and pathogens were identified by histology: Scyphidia-like ciliates (56%), Sphenophrya-like ciliates (55%), unidentified disintegrated ciliates (26%), intracellular microcolonies of bacteria (IMCs) (9%), apicomplexan-like cells (1%) and bacteria (2%) across different organs. There was a significant association between the presence of *P. olseni* and IMCs. Immunological tissue responses (haemocytosis and ceroid material) and gill pathology were evaluated semi-quantitatively and were significantly associated with *P. olseni*. Gross abalone appearance was also significantly associated with *P. olseni* and unidentified disintegrated ciliates. These findings indicate the types of pathogens and parasites found in cultured New Zealand black-footed abalone (H. iris) for future health assessment studies of this important shellfish.

Mana o te Pāua

Dean Barber[1], Beverly Te Huia[1,2,3], Maia Te Huia[2]

[1]Waimarama/Waipuka Kaitiaki, Hawkes Bay 4130 Aotearoa
[2]Katoa Ltd Research
[3]Kainga Tahi, Kainga Rua

Bio: Dean Barber is a chosen Kaitiaki for his hapu, Ngati Whakaiti and Ngati Kurukuru. He is following in the footsteps of his tipuna, who maintained and protected the fragile balance of marine ecology and biodiversity for over 500 years. Dean continues this legacy using traditional matauranga Māori (Māori Knowledge) which has been passed down through the generations, along with new technologies to ensure Paua and Moana Taonga (marine environment) will be here for his mokopuna and

theirs. Dean attended the 2013 Abalone Symposium in Hobart to present on the reseeding project that his hapu and Iwi had embarked on.

Keywords: Kaitiaki, Matauranga Māori, Transdisciplinary, Traditional

Background: In 2005, kaitiaki decided to reseed chosen costal marine sites within hapu boundaries. Matauranga Māori (traditional Māori knowledge) was applied to what was considered a contemporary issue due to increasing recreational fishing activities along the east coast of Aotearoa. This presentation is chapter 2 of the journey. This presentation will outline the mixed methodology, matauranga Māori and western science and technology which has been trialled and used to monitor the resilience of pāua for the past three years. It will also outline the learnings and challenges that such research and monitoring present. e.g., the generational learnings and the importance of teaching the youth, and challenges with cross cultural understandings/translation barriers and values/entitlement, and the challenges of certain laws and fiscal barriers which Māori experience.

A pilot study testing sustainable aquafeed formulations for farmed New Zealand abalone

Natalia Bullon[1,2], Ali Seyfoddin[2], Andrea C. Alfaro[1]

[1]Aquaculture Biotechnology Research Group, Department of Environmental Science, School of Science, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand
[2]Drug Delivery Research Group, Science, School of Science, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand

Keywords: Abalone, Aquafeed, Encapsulated feed, Grape marc, Insect meal.

Globally, the aquaculture industry has been criticised for the excessive use of fishmeal (FM) in formulated feeds due to the over-utilisation of wild fish sources to feed farmed aquaculture species. Land-based abalone aquaculture mainly use commercial formulated feeds (CF) to sustain animal growth, utilising fishmeal as the primary protein component. Alternative ingredients, such as insect meal (IM) and grape marc (GM) are potential candidates for FM replacement due to their comparable nutritional profiles and sustainable production methods. Thus, the aim of this study was to characterise the physical and chemical properties of formulated diets containing IM and GM in a novel delivery approach using a polymer matrix (alginate) to support the feeding of farmed New Zealand abalone. There were significant differences between experimental diets and the CF in terms of feed sinking time, particle weight and microscopy, and the inclusion of IM and GM did compromise the stability of the alginate beads compared to the extruded pellets from the CF. The experimental diets showed greater water stability than the CF, potentially aiding tank cleaning activities and reducing solid losses. The inclusion of IM and GM did not compromise the bioavailability of feed nutrients to animals as weight gain was not greatly affected between groups, however, shell length and FCR was significantly different amongst diets. In conclusion, alginate beads are a more stable delivery method for feeding practises of *Haliotis iris*. Insect meal and grape marc are effective replacements of protein in abalone feed formulations, supporting growth and favourable physicochemical characteristics.

Histopathological investigation of four populations of abalone (*Haliotis iris*) exhibiting divergent growth performance

Joanna Copedo[1,2], Stephen C. Webb[2], Norman L. C. Ragg[2], Leonie Venter[1], Andrea C. Alfaro[1]

[1]Aquaculture Biotechnology Research Group, Department of Environmental Science, School of Science, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand
[2]Cawthron Institute, Nelson 7042, New Zealand

Keywords: Abalone, Climate change, Concretions, Histopathology, Nutrition

Abalone are marine gastropods that can display a high level of phenotypic variation, including growth rate. The black-foot abalone, *Haliotis iris*, also known as pāua, is a valuable species unique to New Zealand. Pāua inhabit subtidal coastal habitats from bare rocky shores to kelp forests and are potentially exposed to ongoing fluctuations in environmental conditions. In this study, histopathological tools were used to identify how alterations in a range of tissues (including gills, gonad, digestive tubules, gut, and kidney) correlate with differential growth rates seen in populations of pāua from the Chatham Islands. Individuals from slow-growing populations were observed to have more degraded macroalgal fragments in the midgut when compared to the fast-growing populations, increased amounts of ceroid material, as well as increased prevalence of haplosporidian-like parasites and mineral concretions in the right kidney. The histological alterations complement anecdotal field observations of reduced seaweed availability and increased sand incursion at slow-growing sites, while providing a deeper insight into the health of pāua populations in the Chatham Islands of New Zealand.

How to estimate zoosanitary status of abalone?

Marie-Agnès Travers[1], Céline Garcia[2], Salomé Bélec[1], Olivier Basuyaux[3], Justine Fouassier[4], Corentin De Charnace[4], Sabine Roussel[4]

[1]IHPE, Univ Montpellier, CNRS, IFREMER, Univ Perpignan Via Domitia, Montpellier, France
[2]ASIM IFREMER, Avenue de Mus de Loup, La Tremblade, France
[3]SMEL
[4]LEMAR, Univ Bretagne Occidentale, Plouzané, France

Bio: Corentin is a chemist by training, but has recently opened to biology, in particular through the OURMEL project, which aims to re-establish the abalone *Haliotis Tuberculata* in Brittany (France). Corentin is currently a research engineer at the Laboratoire des sciences de l'Environnement Marin at the Institut Universitaire Européen de la Mer (LEMAR - IUEM) in Brest (France) working on the OURMEL project.

Keywords: European abalone; *Haliotis tuberculata*, Pathogens, Molecular tools, Stock-enhancement, *Vibrio harveyi*

Haliotis tuberculata is present from West of France Normandy to North Africa. In France, wild populations are declining since the late 1990s, following mass mortality events caused by the bacteria *Vibrio harveyi*. Even nowadays, stocks struggle to recover. Restoration programs could offer opportunities to help developing the fishing activity around this emblematic species in France, even if such program have to tackle risk of introducing or transferring new pathogens to native stocks. With the French project OURMEL, we develop innovative processes for implanting young abalones produced in hatchery in order to support existing stocks, but also methods (1) to check the zoosanitary status of future implanted juveniles and to ensure the absence of known pathogens, and (2) to estimate the basal prevalence of known pathogen in wild populations inhabiting targeted restoration sites. In this project, we successfully developed and adapted molecular methods to screen batches of

abalone for the presence of 16 pathogens able to affect either abalone populations or other mollusc species present in French coastal areas. A total number of 150 abalone was tested, based on the OIE 'Aquatic Animal Health Standards' to demonstrate freedom from disease with 95% confidence (i.e., at a prevalence lower than 2 %). Briefly, none of the pathogens was detected by real-time PCR in hatchery-produced abalone in North Finistère (Brittany, France). In wild stocks from the same area, only traces of *Perkinsus olseni* DNA were noticed, in an area where the pathogen has already been observed in clams.

Predation is the key component to explain high mortality during stock enhancement program

Justine Fouassier[1], Pierre Chauvaud[1], Corentin de Charnacé[1], Rob Day[2], Sabine Roussel[1]

[1]Université de Brest, CNRS, IRD, Ifremer, LEMAR, F-29280 Plouzané, France
[2]School of Biosciences, University of Melbourne, Parkville, Victoria 3010, Australia

Keywords: Behaviour, European abalone, Mortality, Predation, Stock-enhancement

Abalone natural populations have declined sharply in Europe due to a pathogen, *Vibrio harveyi*, causing up to 80% mortality. One of the main difficulties for the successful implantation of juveniles from nurseries is the very high mortality, often reaching more than 90% in the first month after implantation, a large part of which can be attributed to predation. To re-establish these populations, a stock-enhancement program has recently been set up in France, Ourmel. The objective of this project was therefore to gain a better understanding of the key components explaining this initial mortality. The first experiment consisted of studying the behaviour of abalone and one of its main predators, *Necora puber*. Behaviours were filmed for a week in 12-L aquariums. The results showed that 50% of the mortality was the result of the crab's prey-seeking behaviour, and the other half the result of poorly adapted juvenile behaviour, with movements outside the shelter during daytime. The second experiment, carried out in 260-L mesocosms showed that the predation of juveniles was dependent on the juvenile size as well as the predator size. The last experiment, carried out in large 5-m^3 mesocosms, showed that the presence of a shelter for implantation adapted to the abalone behaviour improved the survival of juveniles in the short term, but that this difference disappeared after one month. The next step will consist in studying if shelters designed to protect abalone from predation and used to implant juveniles in natural environment will allow to reduce this initial mortality.

Combining a novel outplant module with metareplication to further abalone restoration capacity in California

Adam K. Obaza[1], Amanda Bird[1], Heather Burdick[2], Benjamin Grime[2], Melissa Neuman[3], David Witting[3]

[1]Pāua Marine Research Group, California 92120 United States
[2]The Bay Foundation
[3]NOAA National Marine Fisheries Service

Keywords: Conservation, Predator behaviour, Restoration methods

Species reintroductions are made inherently difficult by large resource investments required for rearing and placement and are further complicated by the paucity of robust monitoring regimes necessary to document lessons learned. Nonetheless, continued population declines in many species necessitate such actions. The white abalone (*Haliotis sorenseni*) in California has experienced steep population declines from overfishing, and outplanting is considered necessary for its recovery. In order to improve success of future *H. sorenseni* out-planting, a novel outplant module known as the Short-term Abalone Fixed Enclosure (SAFE) was developed to allow captive-bred animals a period of adjustment before dispersing and tested on a

model species (*H. rufescens*). Outplants were conducted at two sites and monitored regularly for shells and live animals in a process known as metareplication, considered essential for robust outplant reporting. Time lapse cameras were also placed on SAFEs to document predator visitation. Both sites were dominated by understory kelps, red urchin, and coralline algae. Live animals and shells increased on site throughout the first six months and levelled off thereafter, with the majority of animals unaccounted for. Predator visitation was generally low, and no significant differences were found across outplant periods delineated by animal addition, acclimation and module opening ($p > 0.05$). Results from this study indicate outplant mortality may peak early and predator activity is generally low and unrelated to abalone introduction. This vital step in preparing for release of *H. sorenseni* illustrates this outplant method may be an effective tool in restoring the species.

Spatial variation in metabolomic profiling of black-foot abalone in the Chatham islands of New Zealand

Thao V. Nguyen[1,2], Andrea C. Alfaro[1], Leonie Venter[1], Jessica A. Ericson[3], Norman L.C Ragg[3], Tom McCowand[4], Craig Mundy[5]

[1]Aquaculture Biotechnology Research Group, Department of Environmental Science, School of Science, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand
[2]NTT Hi Tech Institute, Nguyen Tat Thanh University, Ho Chi Minh City, Vietnam
[3]Cawthron Institute, Nelson, New Zealand
[4]Paua Industry Council Ltd., New Zealand
[5]IMAS Fisheries and Aquaculture Centre, College of Science and Engineering, University of Tasmania, Taroona, Tasmania, Australia.

Keywords: Abalone, Abalone fishery, Growth variations, *Haliotis iris*, Metabolomics, Stunting

Broad phenotypic variation in shell morphology is a common phenomenon across wild abalone populations worldwide. Many shellfish species, such as abalone, show slower growth rates, smaller maximum size of individuals, and reduced biomass in some habitats compared to others. Such habitats are often inferred to be sub-optimal, and for a fishery, the shellfish within these sites are referred to as “stunted populations”. It has been suggested that these geographically based variations are a function of environment, rather than genotypic in nature. For haliotid stocks, such as the New Zealand black-footed abalone (*Haliotis iris*), there is concern that environmental stressors may increase the proportion of stocks that are slow-growing, with potential flow-on effects for the fishery. Despite the relevance to fisheries, not much information is known about this growth phenomenon at the molecular level. Hence, this study was carried out to reveal insights into metabolic differences between non-stunted (fast-growing) and stunted (slow-growing) juvenile and adult abalone from two separated populations in the Chatham Islands, New Zealand, using a high throughput gas chromatography-mass spectrometry (GC-MS)-based metabolomics approach. The metabolite profiles revealed differences in many metabolites between juveniles and adults, which indicate higher levels of many amino acids, fatty acids, and other energy-related metabolites in juveniles. Differences between stunted and non-stunted abalone populations mostly occurred in haemolymph of adults, which mainly included higher levels of amino acids, fatty acids and other organic acids in fast-growing abalone compared to slow-growing individuals. These differences may be due to distinct food and environmental conditions between these two sites. The findings from this study provide important insights into the origins of spatial variation in growth which will assist management strategies to ensure the sustainability of abalone populations and the fishery they sustain.

Two shells and seven arms: assessing interactions between three key invertebrate species in East Otago, Southern New Zealand

Joshua Percy and Gaya Gnanalingam

Marine Science, University of Otago, Coastal People Southern Skies: Centre of Research Excellence, Dunedin, Otago 9010 New Zealand

Bio: Joshua is a 23-year-old marine science student studying my masters at the University of Otago. He loves the ocean and have grown up around the ocean all my life. His research interests are the ecology of invertebrates among coastal ecosystems. This research project aims to assist customary protection areas for pāua restoration.

Keywords: Customary protection, Ecology, Interactions, Pāua, Restoration

Species interactions specifically, predator-prey and competitive interactions, are important drivers of species diversity and community structure within marine ecosystems. These interactions are particularly important to understand for fisheries management as they can increase the success of targeted restoration and stock enhancement efforts. Pāua (*Haliotis iris*) are a taonga (treasure) and cultural keystone for many Māori communities and support significant and recreational fisheries within Aotearoa New Zealand. In some areas however, pāua are in decline and tangata tiaki/kaitiaki (legislatively empowered customary managers) are seeking to actively restore local stocks. Although there has been some research on various aspect of pāua ecology, there is a noticeable gap in our knowledge with respect to the relationship of pāua with the seven-armed seastar (*Astrostole scabra*), a known predator, and the Cook's turban (*Cookia sulcata*), a possible competitor, in southern Aotearoa New Zealand. Understanding more about the interactions among these species is key for the holistic management of pāua fisheries and identifying potential imbalances in the coastal ecosystem they occupy. Using a combination of dive surveys in customary protection areas along the East Otago coast to map species distributions, and laboratory experiments assessing prey preferences, grazing rates, and non-consumptive effects, this research will look at the relationship among these three species. This research aims to increase our understanding of pāua ecology in southern Aotearoa New Zealand and provide information of use to restoration efforts of culturally significant pāua populations around East Otago.

Stock-enhancement of the European abalone: transdisciplinary approach of the OURMEL project to evaluate the practical feasibility of the program

Olivier Basuyaux[1], Gregory Charrier[2], Pierre Chauvaud[2], Corentin De Charnace[2], Jacques Doudet[3], Julien Dubreuil[3], Justine Fouassier[2], Céline Garcia[4], Jacques Grall[2], Vincent Lefebvre[1], Sabine Roussel[2], Agnes Travers[5]

1Synergie Mer et Littoral (SMEL), Zac de Blainville, 50560 Blainville-sur-Mer, France
2Université de Brest, CNRS, IRD, Ifremer, LEMAR, F-29280 Plouzané, France
3Comité Régional des Pêches Maritimes et des Élevages Marins de Bretagne (CRPMEM), 1 sq René Cassin 35700 Rennes, France
4Ifremer, ASIM, 17390 La Tremblade, France
5Ifremer, IHPE, 66860 Perpignan, France

Keywords: Behaviour, Genetic, *Haliotis tuberculata*, Pathology, Stock-enhancement

Wild abalone stocks have declined significantly in France at the end of the 1990s following massive mortalities due to the pathogenic bacteria *Vibrio harveyi*. Stock enhancement, which consists in increasing or maintaining fisheries of wild

populations, and re-introduction that aims at implanting juveniles in order to re-establish disappeared stocks, could be opportunities to develop sustainable fisheries with the European species *H. tuberculata*. A project was therefore launched with the aim of developing innovative processes for the implantation of young abalone produced in hatcheries. Four phases were identified. The first task consisted in understanding the biology, pre-transfer and post-transfer acclimation of this species to its environment in order to achieve successful implantation and reduce post-transfer mortality. The second task aimed at minimizing the impact of hatchery abalone on existing wild populations by checking the pathogen status of implanted abalone and by evaluating the genetic diversity of these implanted juveniles in comparison to wild populations in order to not alter genetic diversity of natural populations. The third task consisted in describing the biotic and abiotic parameters of the environment favourable to *H. tuberculata*, and to carry out implantation trials on a semi-commercial scale. The fourth task will consist in communicating about the project to professionals, scientists, and the general public. The stakeholders, both scientists and representatives of the socio-professional community, have put in place a responsible approach in OURMEL project based on the recommendations to be applied in marine stock enhancement programs (Blankenship and Leber, 1995).

Metabolite profiling of abalone (*Haliotis iris*) energy metabolism: A Chatham Islands case study

Leonie Venter[1], Andrea C. Alfaro[1], Thao Van Nguyen[1,2], Jeremie Zander Lindeque[3]

[1]Aquaculture Biotechnology Research Group, Department of Environmental Science, School of Science, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand
[2]NTT Hi Tech Institute, Nguyen Tat Thanh University, Ho Chi Minh City, Vietnam
[3]Human Metabolomics, North-West University, Potchefstroom Campus, Private Bag X 6001, Potchefstroom 2520, South Africa

Keywords: Abalone, Anabolism, Chatham Islands, Metabolomics, Populations

The Chatham Islands has some of the most prized black-footed abalone (*Haliotis iris*) beds in New Zealand. This well-managed fishery includes restrictions on catch and size limits, selective fishing methods, and shellfish management. However, recent declines in biomass and growth parameters have prompted omics research to characterise the biological responses of abalone, potentially contributing towards animal management strategies. The aim of this study was to characterise the metabolite profiles of slow and fast growing, juvenile and adult abalone, relating to metabolites supporting energy metabolism. A gas chromatography–mass spectrometry metabolite profiling, applying methyl chloroformate alkylation, was performed on juvenile and adult abalone samples collected from Point Durham and Wharekauri sites, Chatham Islands, New Zealand. The results obtained from haemolymph and muscle samples indicated that abalone from the fast-growing area, Wharekauri, fuelled metabolic functions via carbohydrate sources, providing energy for fatty acid and amino acid synthesis. Conversely, higher amino acid levels were largely utilised to promote growth in this population. The metabolism of juvenile abalone favoured anabolism, where metabolites were diverted from glycolysis and the tricarboxylic acid cycle, and used to produce nucleotides, amino acids, and fatty acids. This research provides unique physiological insights towards abalone populations supporting the use of metabolomics as a tool to investigate metabolic processes related to growth. This work sets the stage for future work aimed at developing biomarkers for growth and health monitoring to support a growing and more sustainably abalone fishery.

Does the on-growing diet influences consumer acceptance of cultured abalone?

Celia de Sádaba, María del Pino Viera, Gercende Courtois de Viçose, Nuria Marrero, Rafael Ginés

Institute of Sustainable Aquaculture and Marine Ecosystems (IU-ECOAQUA), Aquaculture Research Group (GIA), University of Las Palmas de Gran Canaria (ULPGC), Spain

Keywords: Abalone, Algae, Consumers, Neophobia, Pellet, Tasting session

A consumer study has been carried out to evaluate the possibilities to offer European abalone, *Haliotis tuberculata coccinea*, as a new product on the seafood market. This mollusc production is hardly present in Europe, therefore such delicacy remain largely unknown by European customers despite being highly appreciated in the rest of the world and more specifically in Asia. A series of testing sessions were carried out to obtain a measurable evaluation of this seafood product, proposed through different cooking preparations, by potential consumers. Abalone to be evaluated were fed with different diets, including fresh macroalgae and commercial compound feed, with the purpose of analysing the repercussion of diet on the perception of the product and on the sensory analysis. Results were consistent with data obtained in other sensorial studies, taking into account the influence of information on consumers perceptions, and resulted in high ratings for the product. The traditional exploitation of this resource almost led to its local extinction a couple of decades ago, so reaching its sustainable production represents an achievement and a good opportunity at many levels, including the diversification of Spanish aquaculture and promoting the creation of new jobs. The level of neophobia was also analysed by evaluating its influence on the introduction of new products to the market, in order to establish the starting point of the participants during the study and to be able to extrapolate certain conclusions from the answers obtained.

Does the on-growing diet influences consumer acceptance of cultured abalone?

María del Pino Viera, Nuria Marrero, Gercende Courtois de Viçose

Institute of Sustainable Aquaculture and Marine Ecosystems (IU-ECOAQUA), Aquaculture Research Group (GIA), University of Las Palmas de Gran Canaria (ULPGC), Spain

Keywords: Macroalgae, Nutrient pulse, Chemical composition, *Ulva rigida*, Yield

Since wild algae are not commercially available in the Canary Islands, the development of the abalone industry should be reliant on the use of cultured macroalgae, nutrient supply being an important operating parameter in the management of seaweed cultivation systems. An experimental design was used to investigate the effect of two concentrations levels of nutrient pulses on growth, nutrient uptake, chemical and fatty acids composition of the green macroalgae Ulva rigida. Nutrients were added in the form of (NH4)2SO4 (HIGH: 824 and LOW: 412 µM of N) and KH2PO4 (HIGH: 82 and LOW: 41 µM of P) with bi-weekly frequency pulse. Seaweed was reared in duplicates with fortnightly harvests, the control (SW) not receiving any pulse. Fresh sea water was pumped from an adjacent coastal inlet to a settlement tank for the removal of suspended particles and then pumped to six, white elliptical 2.500 l fibreglass tanks located outdoor. Algal initial stocking density was 1.5g/l. During each pulse, macroalgae had nutrient availability in the static system during 5 h. After the pulse-feeding, seawater flow-through (14 l min^{-1}) was restored and maintained until the following pulse. Concentration of the nutrient pulses affected chemical composition of *U. rigida*, increasing protein content from 11% (SW) up to 25%CP (HIGH). However, no differences were found on biological indexes growth rate (5.9 $\%d^{-1}$) and yield (31.5 $gPSm2\ d^{-1}$) in both pulse treatments being significantly lower than those obtained with fresh seawater (7.9%d-1, 45.6 $gPSm2\ d^{-1}$).

Haliotis tuberculata coccinea grow-out under two different feeding regimes: Evaluating potential strategies for abalone culture in the Canary Islands

María del Pino Viera, Nuria Marrero, Gercende Courtois de Viçose

Institute of Sustainable Aquaculture and Marine Ecosystems (IU-ECOAQUA), Aquaculture Research Group (GIA), University of Las Palmas de Gran Canaria (ULPGC), Spain

Keywords: Abalone, Compound feed, Grow-out, *Haliotis tuberculata coccinea*, Macroalgae

H. tuberculata coccinea has been identified as a target species for European aquaculture diversification. Feed options for growing out abalone are mostly based on the use of wild seaweed or artificial feeds. Since wild algae are not commercially available in the Canary Islands, the development of the abalone industry, should be reliant on the use of cultured macroalgae and/or formulated feeds. A 38 weeks feeding trial was conducted to assess the effect of two different feeding regimes: Commercial (CF) and a mixture of the latter and fresh algae (MIX) on the growth performance, feed utilisation and survival of abalone *Haliotis tuberculata coccinea* starting at an average size and weight of 20 ± 2.8 mm and 1.2 ± 0.5 g up to cocktail/market size of 50 mm. Fresh algae treatment consisted in a mixture (50:50) of *Gracilaria cornea* and *Ulva rigida*, reared in a land-based integrated multi-trophic aquaculture system. Trial was performed in commercial abalone baskets (Blue Ivy, South Africa), where animals were initially stocked at 50 individuals/m2. Survival rates were very high (90-95%) regardless the diet fed. Sustained high linear growth (DGR: 95-116 µm d^{-1}; SGR: 0.9-1.1%) was recorded for both feeding regimens. However, a 36% increase in weight gain was obtained when adding the fresh algae to the CF resulting in three months gain to reach market size. However, this scenario would require a large production of seaweeds. Therefore, cost benefit analysis would be required to determine the optimum feeding regimen when setting up abalone on-growing operations.

A flexible, sustainable data management system for abalone restoration

Charles A. Boch[1], Amanda Bird[2], Adam Obaza[2], Jenny Hofmeister[3], Gulce Ozturk[3], Ian Taniguchi[3], Laura Rogers-Bennett[3], Heather Burdick[4], Ben Grimes[4], Rilee Sanders[4], Kristin M. Aquilino[5], Alyssa R. Frederick[5], David Witting[1], John R. Hyde[1], Melissa Neuman[1]

[1]National Oceanographic and Atmospheric Administration, California 92037 USA
[2]Paua Marine Research Group
[3]California Department of Fish and Wildlife
[4]The Bay Foundation
[5]University of California Davis

Keywords: Abalone, Data management, Interdisciplinary, Restoration, Technology

Restoring endangered marine species to self-sustaining population levels is a critical test of modern human society. Rising to meet this challenge requires 'All-Hands-On-Deck' approaches and scalable applications of knowledge, skills, and tools integrated from multiple fields. For example, the white abalone (*Haliotis sorenseni*) restoration program involves the coordinated efforts of multiple organizations. These efforts include collection of wild broodstock, captive propagation, disease, and health assessments, and out planting captive-bred abalone to habitats with the best chances for survival and reproductive success. Given the operational complexity and the scope of the challenge in restoring an endangered species, efforts have often been driven by practical needs, on an ad hoc basis, and not necessarily or exclusively by data insights. Despite these challenges, sharing high quality data can help highlight relative successes to date, as well as reveal the challenges and opportunities ahead. Here, we present an open-source data management approach and a web application prototype as an example of how shared information can be leveraged to save an endangered species. For example, our database system helps Users find integrated information from multiple data repositories to get estimates on the number of animals propagated, out planted, and possibly surviving. Our system also helps us track each abalone by lineage, age, size, outplant location, and outplant method. Instruction modules for advanced open-source coding were also developed and archived in the database for training data stewards. Overall, our database management system helps us develop a holistic approach to meeting the challenges of restoring an endangered marine species.

PARTNERS

Marifeed

Marifeed is a global leader in providing nutritional solutions to the abalone farming industry. Marifeed values and benefits from its long-term positive relationships with its shareholders, 100% of whom are abalone farmers, research institutions and its customers. All play a role in ensuring that Marifeed is able to drive innovation and improvements in abalone nutrition, providing scientifically designed products that have been extensively tested by farmers. We understand the investment that our customers have made in the development of their businesses and our aim is to help them unlock their full potential. For this purpose, our state-of-the-art production facility manufactures an extensive range of abalone feeds, with products available for all stages of the farming process, including broodstock. We advise our clients on the best products and feeding strategies for all conditions. However, we also realize that many of our customers have unique farming systems, which require a customized feed solution. Our production facility is designed to cost-effectively produce batches of such customized feeds and our preference is to remain involved in assisting our customers trial these on their farms, to ensure the desired effect is achieved.

Quality assurance and best practices are extremely important to us. We do not least-cost formulations, by varying ingredients, without customer approval. In 2021, we took the step of adding to our existing accreditations by becoming the first Compound Feed Manufacturer in Africa to be accredited according to Global G.A.P.'s Compound Feed Manufacturing Standard.

Since we began production of abalone feeds in 1994, we have built customer relationships in five countries. In contributing to the sponsorship of IAS 2023, Marifeed seeks to support the industry that supports it.

We also manufacture other specialized feeds for aquaculture, with a focus lately on nutritional solutions for the developing sea urchin farming industry.

https://www.marifeed.com/

Tasmanian Seafoods Pty Ltd was established in 1969 and is a fully vertically integrated harvester, processor and exporter, the largest processor of abalone in Australia. Our processing of abalone is conducted in three factories, located at Smithton and Margate in Tasmania, and Dandenong in Victoria. For over five decades we have been carefully hand-harvesting wild abalone, sea cucumber along with other seafoods from the pristine Australian waters; providing only the freshest seafood to kitchens and restaurants all over the world in many different forms from canned and retort pouches to live, dried and frozen products.

The location of our establishments is well-positioned to assist in providing the freshest abalone for export as it is sourced from oceans surrounding the whole of Tasmania and the south coast of Victoria. The result is a well-organised network, which maintains supplies of abalone to be processed for export on a regular basis. We also produce a large range of Australian sea cucumber products and have interests in other Australian Seafoods across Australia. Our attention to detail and commitment to quality has earned Approved Arrangement (AA) certification for all of our products.

We have many years of harvesting, processing, and marketing expertise with Australia's high value seafood species. Our markets are all throughout Asia as well as the UK, Europe and North America along with a domestic supply line also.

https://www.tasmanianseafoods.com.au/

MOANA™

NEW ZEALAND

Moana New Zealand, fish, and harvest solely from the coastal waters of New Zealand, one of the world's most pristine and sustainably managed fisheries. We bring you New Zealand's most sought-after species of blue abalone, wild abalone, fin fish, lobster, oyster, and ready-to-eat meals. We have a deep sense of responsibility and respect for our kaimoana (seafood), honouring the taonga (treasure) we have been entrusted with. Taking a long-term view in everything we do; we work in harmony with nature to ensure the sustainability of our fisheries for future generations.

https://moana.co.nz/

TRUE SOUTH SEAFOOD

True South Seafood is the leading supplier of premium Tasmanian and New Zealand wild caught live abalone and Pāua, as well as the largest exporter of sea urchin roe from Tasmania. True South Seafood is the amalgamation of two well-known wild caught seafood companies, Ralph's Tasmanian Seafood in Tasmania, and PauaCo in New Zealand. From its Tasmanian location, True South Seafood also supplies wild scallops and is the only supplier of wild Tasmanian belon oysters. From its New Zealand location, True South Seafood also produces canned abalone under the highly regarded PH403 packhouse number and also live geoduck.

https://truesouthseafood.com/

THE NEW ZEALAND ABALONE COMPANY

The New Zealand Abalone Company farms Pāua (abalone) is located at the gateway to Bluff. Bluff is one of Aotearoa / New Zealand's oldest towns and is situated at one the most Southern points of the country. The Pāua are bred from adult stock sourced from Rakiura (Stewart Island) and are hand reared in tanks utilising the cold clean water from the Southern Ocean. The Pāua are fed on a 100% New Zealand made feed that is made on site. The GMO-free feed ingredients are largely sourced from the surrounding region. This high level of care is reflected in the exceptional tender texture and taste profile which has been endorsed by some of New Zealand's top chefs. This high-quality product will be supplied to domestic and international markets from the end of 2023. The New Zealand Abalone Company are proud to be a sponsor for the symposium and welcome you all to our beautiful country.

https://www.tnzac.com/

SPONSORED BY

Tasmanian Government

The Department of Natural Resources and Environment Tasmania is responsible for the sustainable management of the State's natural and cultural heritage for the benefit of the Tasmanian community. The Marine Resources Division aims to sustainably manage all fishing activities in Tasmanian state waters, with consideration to the environment and the needs of all sectors including commercial, recreational, cultural fishing, and the general community. The Department aims to ensure sustainable fishing for generations to come.

https://fishing.tas.gov.au/

PĀUA INDUSTRY COUNCIL

The Pāua Industry Council (PIC) is the peak national umbrella organisation representing the interests of pāua quota owners, annual catch entitlement owners and other participants in New Zealand's commercial pāua fisheries. The organisation is a Limited Liability Company, managed by a board of directors which includes the chairs or representatives of all regional Pāua Management Area Councils (PāuaMACs). We provide advocacy, consultation, oversight, and support to the five PāuaMACs in their efforts to manage their fisheries in ways that ensure their long-term health and sustainability. PIC seeks to protect and enhance the rights of quota owners and industry participants implicit in the Fisheries Act and the Quota Management System while recognising the individual and collective obligations inherent in commercial fishing rights – including obligations relating to ecological sustainability, the rights of tangata whenua, and the interests of other fisheries stakeholders and local communities. PIC liaises with government, media, fisheries stakeholders, and environmental groups, with the aim of establish positive relationships and being recognised as a respected participant in shared fisheries. We promote industry unity and responsibility, and innovative, sustainable management of pāua fisheries.

https://www.paua.org.nz/

MariHealth solutions

We are a marine biotech company developing diagnostic solutions for effectively & proactively managing farmed aquatic animal health. Our service offers aquaculture farmers, veterinarians, and feed companies a greater understanding of the health of their produce, and the impact feeds and farming practices have on farmed animals.

https://www.marihealthsolutions.com/

Abalone Council Australia Ltd

Abalone Council Australia Ltd (ACA) is the peak industry body representing the wild-harvest abalone Industry from the five producing states of Tasmania, Victoria, South Australia, Western Australia, and New South Wales. Collectively these state-managed fisheries provide approximately 50% of the total global supply of wild caught abalone. One of the primary functions of ACA is to oversee and manage national Research and Development investment in abalone related research. ACA has partnered with the Fisheries Research and Development Corporation (FRDC) to ensure that investment in abalone related R&D supports and underpins the developmental needs of the Australian Wild Harvest Abalone industry.

In addition to its main function as an industry R&D Advisory body, ACA also advocates on national issues impacting the following state-based abalone organisations:

- Tasmanian Abalone Council - www.tasabalone.com.au
- Abalone Council Victoria - www.abalonecouncilvictoria.com.au
- Abalone Industry Association of Western Australia - www.abalonewa.com.au
- Abalone Association of New South Wales - www.aansw.com.au
- Abalone Industry Association of South Australia

ACA also works closely with the Abalone Association of Australasia (AAA) which is the peak body representing Australian and New Zealand abalone processors.

https://www.abalonecouncil.com.au/

FRDC
FISHERIES RESEARCH AND DEVELOPMENT CORPORATION

Fisheries Research and Development Corporation (FRDC) takes a leading role in planning and investment in fisheries research and development (R&D) to support the ongoing sustainability of Australia's aquatic sectors and aquatic ecosystems. FRDC is a co-funded partnership between the Australian Government and fisheries and aquaculture. In addition to planning, investing in and managing R&D for fishing and aquaculture and the wider community, FRDC also prioritises the adoption of the knowledge and innovations resulting from its investments. FRDC's investments are directed to R&D that has a benefit for Indigenous, commercial, and recreational fishing and aquaculture, while also delivering a public good benefit to the Australian community.

https://www.frdc.com.au/

NEWFISH®

Kia ora, we're NewFish®, a growing biotechnology venture from New Zealand on a mission to re-imagine seafood utilising microalgae technology. Our mission is to enable everybody to eat towards abundance –by better protecting our precious marine resources and utilising technology to create more abundant foods and nutrition that grow our next generation. It's important to us this doesn't cost the earth, or our oceans.

https://newfish.co.nz/

Fisheries New Zealand

Tini a Tangaroa

Fisheries New Zealand - Tini a Tangaroa works to ensure the sustainability of New Zealand's wild fish stocks, aquaculture, and the wider marine environment, now and for future generations. In operating the country's fisheries management system, Fisheries New Zealand advises the Government about where, when, and how much fishing can be undertaken by commercial, customary, and recreational fishers. It also provides advice about managing the environmental impacts of fishing and plays an active role in international fisheries issues. Through the Aquaculture Strategy, Fisheries New Zealand leads the work plan for accelerating sustainable aquaculture. The aim is to grow the aquaculture industry to $3 billion in yearly revenue – five times its current value. Fisheries New Zealand's work is underpinned by fisheries and aquaculture science and verified information about commercial fish-catch using electronic reporting, on-board cameras, and observers. The rights and interests of tāngata whenua are recognised, considered, and provided for, across all areas of work in the fisheries and aquaculture sectors.

https://www.mpi.govt.nz/

ROYAL SOCIETY TE APĀRANGI

EXPLORE | DISCOVER | SHARE

Royal Society Te Apārangi is an independent not-for-profit organisation that supports all New Zealanders to explore, discover and share knowledge. The New Zealand Journal of Marine and Freshwater Research (NZJMFR) is one of the eight quality, peer-reviewed research journals published by Royal Society Te Apārangi in partnership with Taylor & Francis. NZJMFR welcomes submissions on all aspects of aquatic science in habitats ranging from lakes, streams and wetlands to rocky shores, fjords, and the open ocean, with particular emphasis on Australasia, South America, Antarctica, and the Pacific and Southern oceans. A special issue derived from the selected presentations at the IAS 2023 will be published in NZJMFR.

https://www.tandfonline.com/toc/tnzm20/current

SciElex

HARSH ENVIRONMENT ELECTRONICS

Scielex specialises in manufacturing harsh environment electronic equipment, including electronic shellfish and finfish measuring boards, data loggers & submersible video cameras. They also offer custom designs, one-offs, and highly specific assemblies.

https://scielex.com.au/

32 years ago, Oceanshell was a commodity broker selling Pāua Shell to the Asian Markets. Shell Laminate sheets and jewellery factories were the main buyers. Ocean Shell has worked hard to develop unparalleled expertise in drawing higher value out of Pāua Shell for New Zealand. It has in turn benefited the Pāua Fishing Industry as well as Designers and Makers. Today, Ocean Shell ltd has a huge "value added" product range, sold to more than 50 niche industries worldwide. Our "Luméa" brand provides semi processed shell products for multipurpose industries, and our "Ocean Shell Studios" manufacture Giftware products for tourism retailers. Some of the most enthusiastic Pāua users include Jewellers, Arts and Craft Artisans, Furniture Makers, Interior Designers including Superyacht Experts, New Zealand Tourism Giftware Manufacturers, USA Pool Cue Makers and Fishing Lure Specialists. Establishing successful relationships with overseas re-sellers has been one of the key achievements in our effort to bring the beauty of Pāua Shell to the world. Oceanshell Ltd are proud of providing employment in our local economy. We hope to see great emphasis on conservation of Pāua Fisheries at the Symposium.

https://www.oceanshellstudios.nz ~ /https://shop.lumea.co/

Not just about the chocolate... For me, it's never been just about the chocolate. It's about the people, the place, and doing something we love. We handcraft with aroha and Southern grit to create that taste of New Zealandness our customers love. We're proud to develop Grandad's recipe into a company that promotes our heritage to the world through chocolate. Taste what it means to be Kiwi, one bite at a time.

https://seriouslygoodchocolate.com/

Fresh By Design (FBD) was founded in 2004 to provide the Australian and New Zealand aquaculture industry with high quality equipment and expertise, together with an extensive product range and strong after sale service and support. Fresh By Design has several locations across Australia including Head office located in Moss Vale NSW, a Projects office based in Hobart, Tasmania, and a New Zealand office based in Auckland. All offices include warehouses and service workshops. With a team of experienced aquaculture professionals based throughout Australia and New Zealand, Fresh by Design offers the most comprehensive and diverse source of consultancy in the region to guarantee the best outcome for your business or project. All of our staff have extensive operational experience in commercial RAS operation and maintenance along with similar experience in the design processes.

https://freshbydesign.com.au/

SourceCertain

We bring a unique forensic-based understanding of global supply chains and expertise in chemical profiling to address challenges of credibility, trust, and provenance verification for modern supply chains. Our provenance science service verifies the provenance of various products via scientific analysis of physical product samples to mitigate risk, validate digital data, protect client brands, and support transparency within supply chains. By scientifically verifying the claimed provenance of food and non-food items it supports promises that relate to the source of origin.

https://www.sourcecertain.com/

wettie

Wettie is New Zealand's largest spearfishing equipment specialist as well as stocking the widest variety of wetsuits & snorkelling equipment. We are a NZ family owned & operated business.

https://www.wettie.co.nz/

AUT | AQUACULTURE BIOTECHNOLOGY RESEARCH GROUP

SCHOOL OF SCIENCE AUT

The Aquaculture Biotechnology Research Group combines multidisciplinary approaches to carry out applied research that assists and advances New Zealand's growing aquaculture industry. Postgraduate students experience a dynamic environment where they participate in collaborative research that emphasises the development and application of innovative tools and approaches to solve complex 'real world' problems. The team brings together experience and expertise from different fields, such as ecology, biochemistry, immunology, microbiology, molecular biology, microscopy, drug delivery, bioprospecting, commercialisation, and biotechnology. We have a long track record securing external research grants, an extensive publication record, and numerous project success stories.

https://www.aut.ac.nz/study/study-options/science/research/aquaculture-biotechnology-group

MANĀKI

Manāki Premium Marine Technology Limited is New Zealand's first and only 100% sustainably produced whitebait.

https://whitebait.co.nz/

HOW THE PĀUA GOT ITS SHELL

The myths and legends of New Zealand's earliest inhabitants, the Māori tell us that once, in the days of old, Pāua had no shell. In Māori mythology, Tangaroa is one of the great gods, the god of the sea. He is a son of Ranginui (Sky) and Papatūānuku (Earth). Tangaroa, god of the sea, saw the difficulties that this created for Pāua and decided to create something special for him. He said:

"I will take from my domain the coolest blues of the ocean. And ask of my brother Tane the freshest greens of the forest. From the dawn you shall have a tinge of violet. From the sunset a blush of pink. And overall, there will be a shimmer of mother of pearl".

With this, Tangaroa fashioned for Pāua a wonderful coat that sparkled and dazzled with its beauty. But it was fragile and soon broken by those sea creatures who were envious of Pāua's new appearance. Tangaroa saw this, so he strengthened the shell with many layers of the coolest blues of the ocean, the freshest greens of the forest, the violet of the dawn and the pink of the sunset. Finally, he added a camouflage coat to enable Pāua to blend in with the drab greys and browns of the rocks. Tangaroa then charged Pāua with the life-long task of adding layer upon delicate layer, each a different hue and blend.

So it was that Pāua got his shell. He hugs the secret of his inner beauty to himself and only at the end of his life, when his empty shell washes ashore, is his artistry revealed.

THE LEGEND OF TANGAROA

In Māori and Polynesian mythology, Tangaroa is the god of the ocean. Tangaroa made laws to protect the ocean and its sea creatures "Tiaki mai i ahau, maku ano koe e tiaki"… If you look after me, then I will look after you…"

Māori view water as an entity connecting all living things as an energy source necessary for life to occur. In its many differing forms, water is a lifeline as if it were the veins of a body transporting oxygen around a body. Like any other living thing, it has many moods. It can be calm and life-giving or dangerous and destructive.

Māori and their Polynesian forebears have been island peoples for many generations, so it is not surprising that water, particularly the sea, figures prominently in their world view. In some traditions the oceans' depths are considered to be the origin and source of all life. The islands are believed to be fish, pulled up from beneath the sea, and humans are thought to have evolved from aquatic beginnings.

Perhaps the most well-known expression of this idea can be found in the whakairo (wood carvings) which adorn meeting houses throughout the country. The bulbous heads of the carved ancestors, their three fingers and serpentine bodies indicate the belief that humankind had marine origins.