Marine Biosecurity – technology to improve surveillance and biofouling verification

Brendan Gould

Biosecurity New Zealand

Abraham Growcott, Eugene Georgiades, Tracey Bates, Dan Kluza, Brett Hickman, Vanessa Smith – Biosecurity New Zealand

Graeme Inglis, Leigh Tait - NIWA

Justin McDonald, Dave Abdo - Department of Primary Industries and Regional Development

Kevin Ellard – Biosecurity Tasmania

Ben King – Boxfish Research

BIOSECURITY INNOVATION EXCHANGE 2019

NIWA Taihoro Nukurangi

Department of Primary Industries and Regional Development, Government of Western Australia

Tasmanian Government

BOXFISH RESEARCH

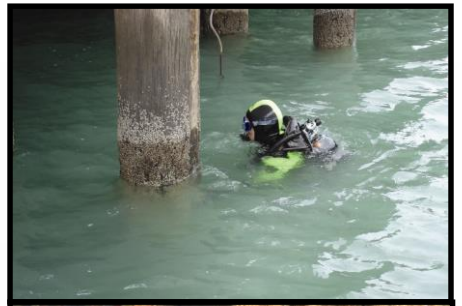
Biosecurity New Zealand, Ministry for Primary Industries, Manatū Ahu Matua

Australian Government, Department of Agriculture

KO TĀTOU THIS IS US BIOSECURITY 2025

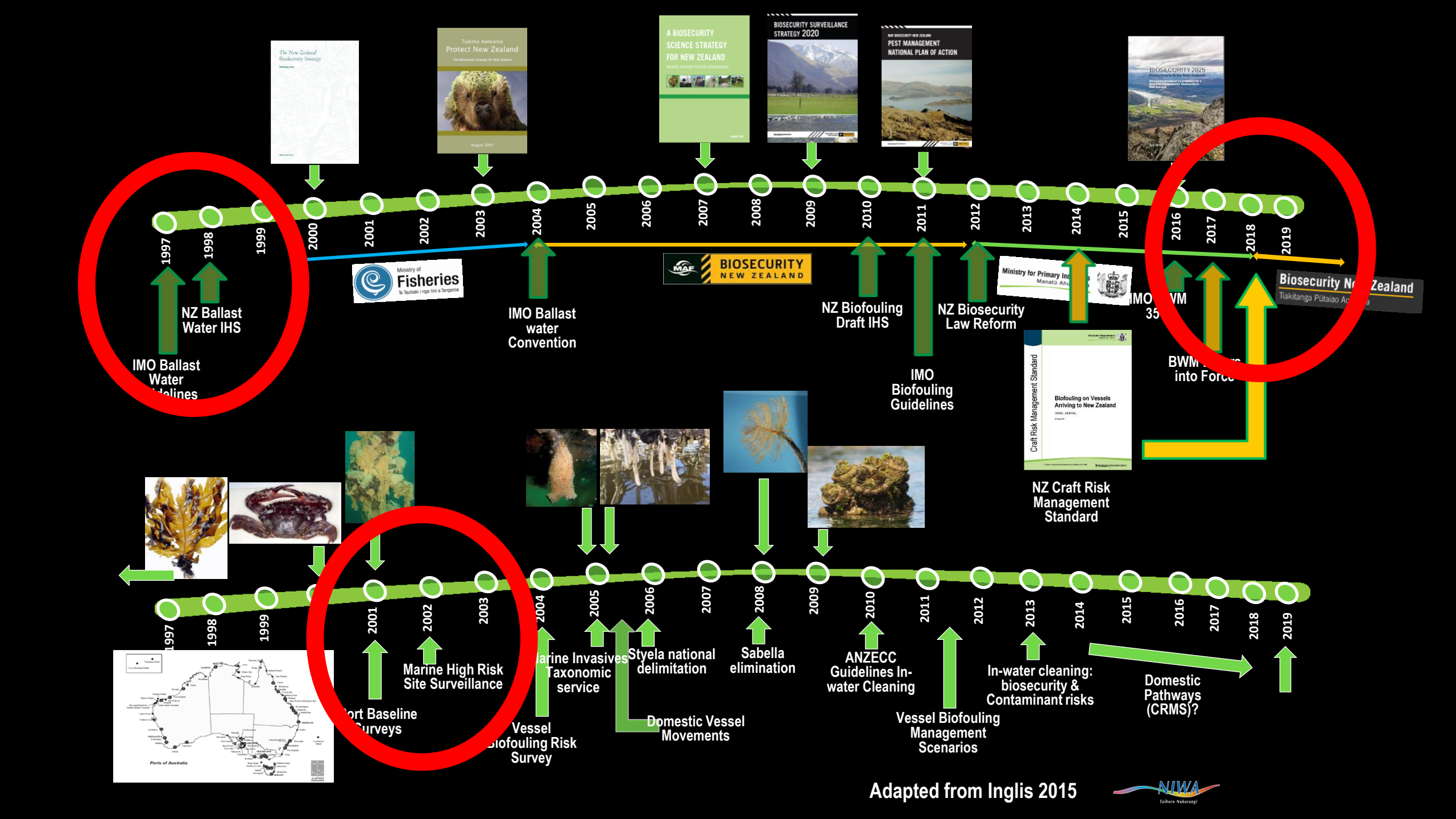
Overview

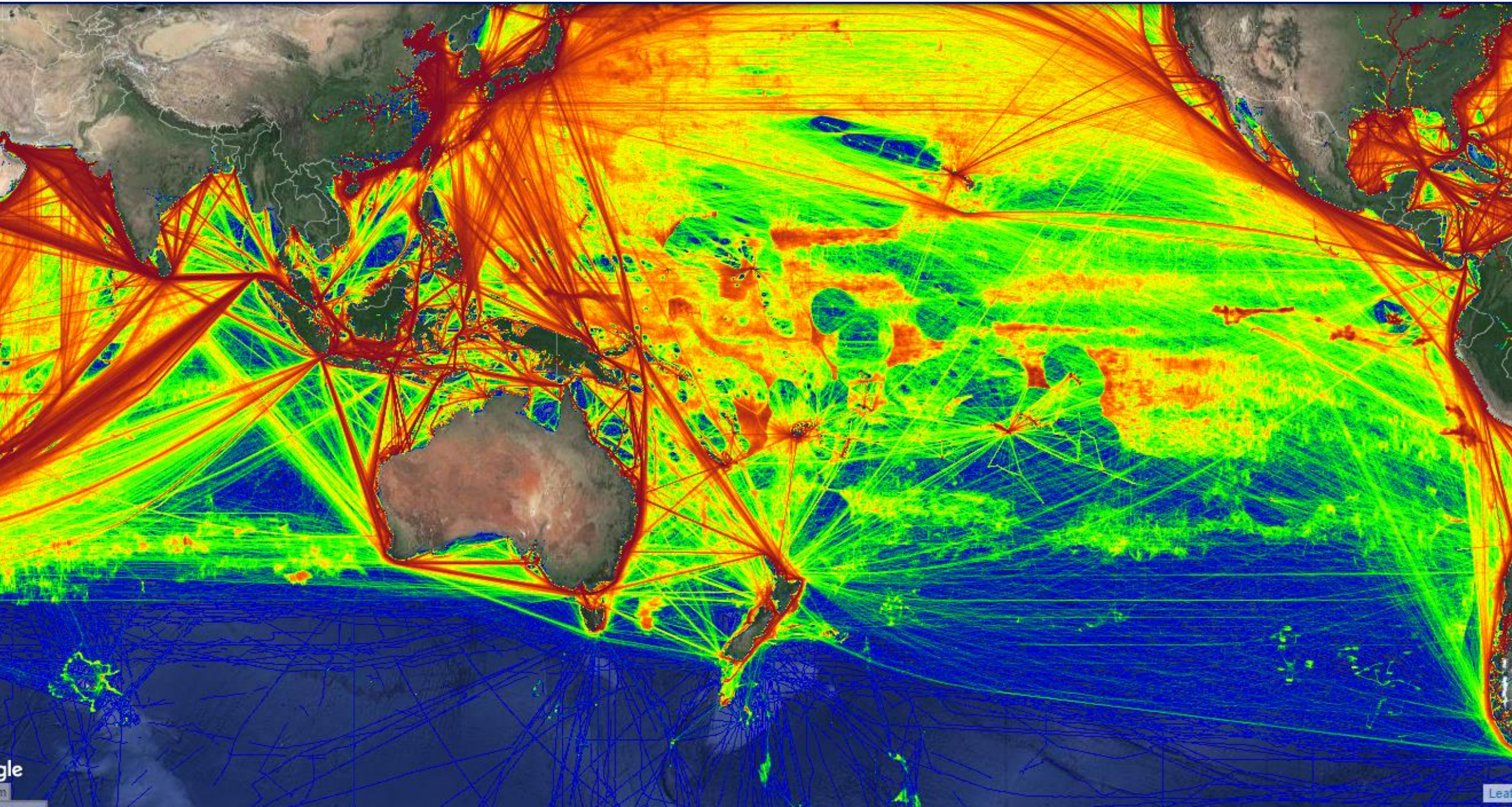
1. Introduction and Brief History of Marine Biosecurity in NZ
2. Craft Risk Management Standard (CRMS)
3. Marine Biosecurity Surveillance

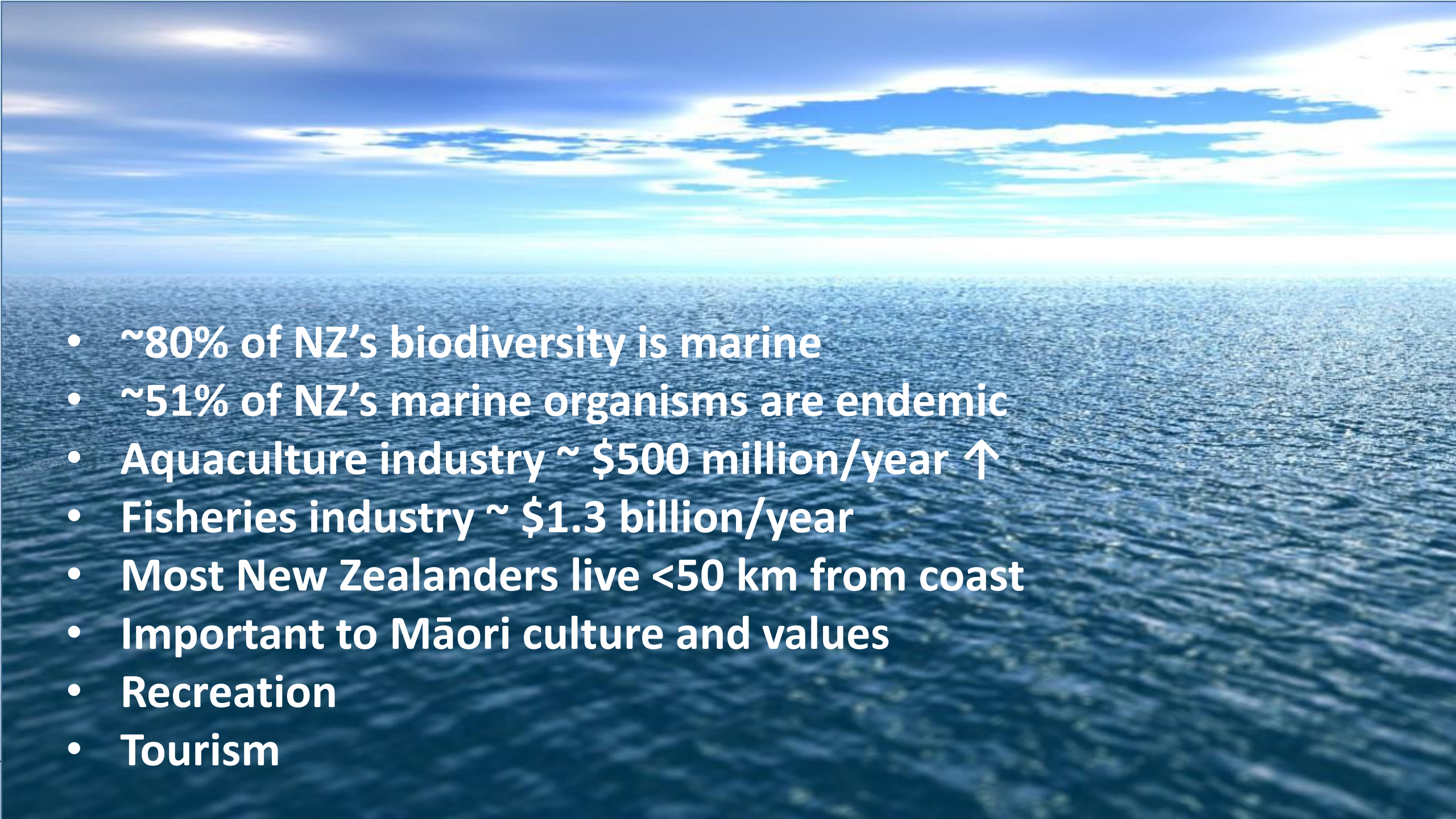


Biosecurity New Zealand
Ministry for Primary Industries
Manatū Ahu Matua

Australian Government
Department of Agriculture

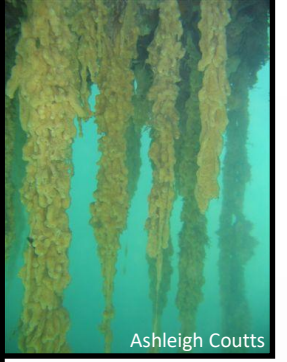

The New Zealand Biodiversity Strategy
Tiakina Aotearoa Protect New Zealand
A BIOSECURITY SCIENCE STRATEGY FOR NEW ZEALAND
BIOSECURITY SURVEILLANCE STRATEGY 2020
PEST MANAGEMENT NATIONAL PLAN OF ACTION
BIOSECURITY 2025
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Ministry of Fisheries
BIOSECURITY NEW ZEALAND
Ministry for Primary Industries
Manatū Ahu
Biosecurity New Zealand
Tiakitanga Pūtaiao Aotearoa
NZ Ballast Water IHS
IMO Ballast Water Guidelines
IMO Ballast water Convention
NZ Biofouling Draft IHS
NZ Biosecurity Law Reform
IMO Biofouling Guidelines
BWM into Force
Craft Risk Management Standard
Biofouling on Vessels Arriving to New Zealand
NZ Craft Risk Management Standard
Ports of Australia
Port Baseline Surveys
Marine High Risk Site Surveillance
Vessel Biofouling Risk Survey
Marine Invasives Taxonomic service
Domestic Vessel Movements
Styela national delimitation
Sabella elimination
ANZECC Guidelines In-water Cleaning
Vessel Biofouling Management Scenarios
In-water cleaning: biosecurity & Contaminant risks
Domestic Pathways (CRMS)?
Adapted from Inglis 2015
NIWA
Taihoro Nukurangi




~80% of NZ’s biodiversity is marine
~51% of NZ’s marine organisms are endemic
Aquaculture industry ~ $500 million/year ↑
Fisheries industry ~ $1.3 billion/year
Most New Zealanders live <50 km from coast
Important to Māori culture and values
Recreation
Tourism

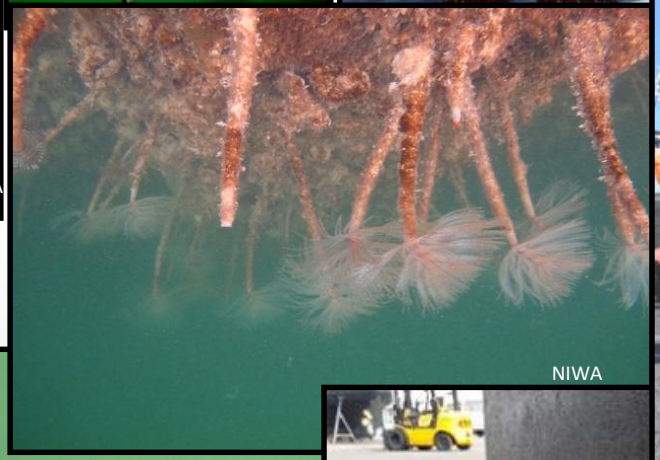

NIWA


NIWA

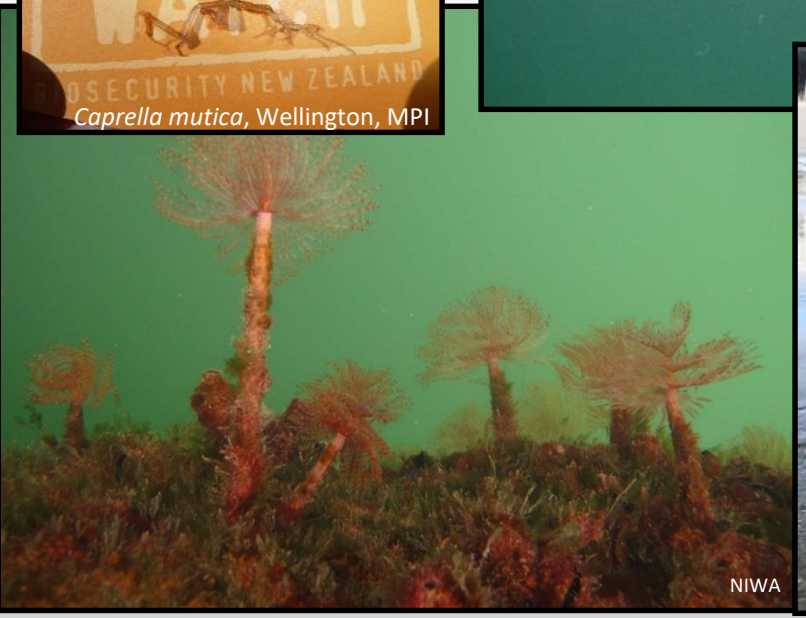

Ashleigh Coutts


Ashleigh Coutts


NIWA


NIWA

Caprella mutica, Wellington, MPI


NIWA

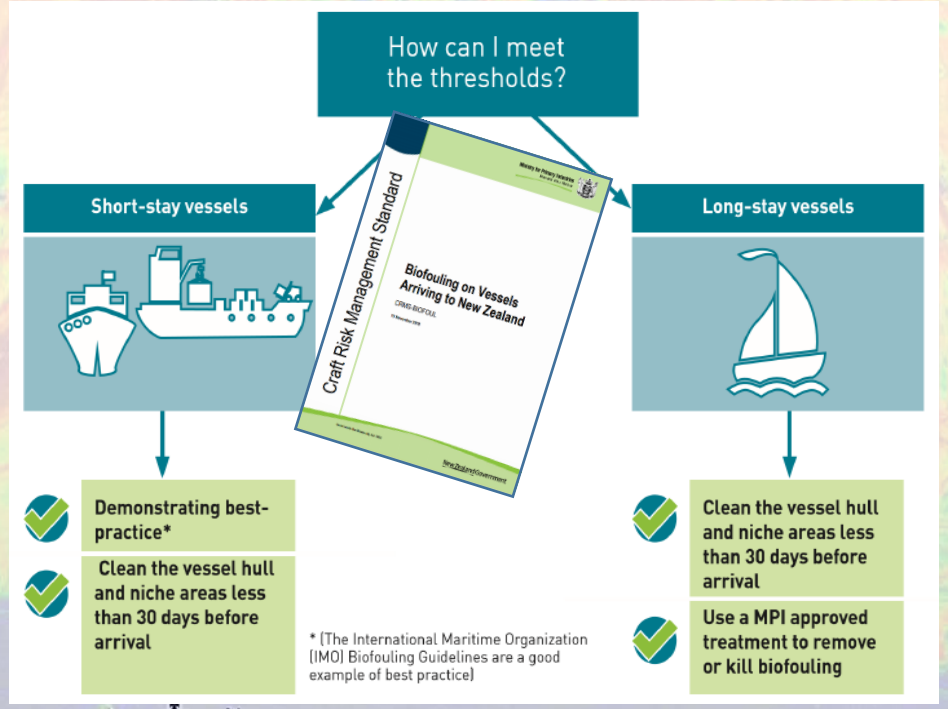

Marlborough Sounds Marinas


Kathy Walls

Craft Risk Management Standard for Biofouling (CRMS)

Intent: To reduce risk of biofouling by requiring operators to take preventative measures to manage biofouling **before** they arrive into NZ.

Outcome: a "**clean**" hull.



Vessel Submits pre-arrival documents

Assessed as having Low, Medium, or High risk indicators

A percentage of vessels from each category selected for audit of documentation (100% of high risk vessels)

Vessel passes audit – meets requirements

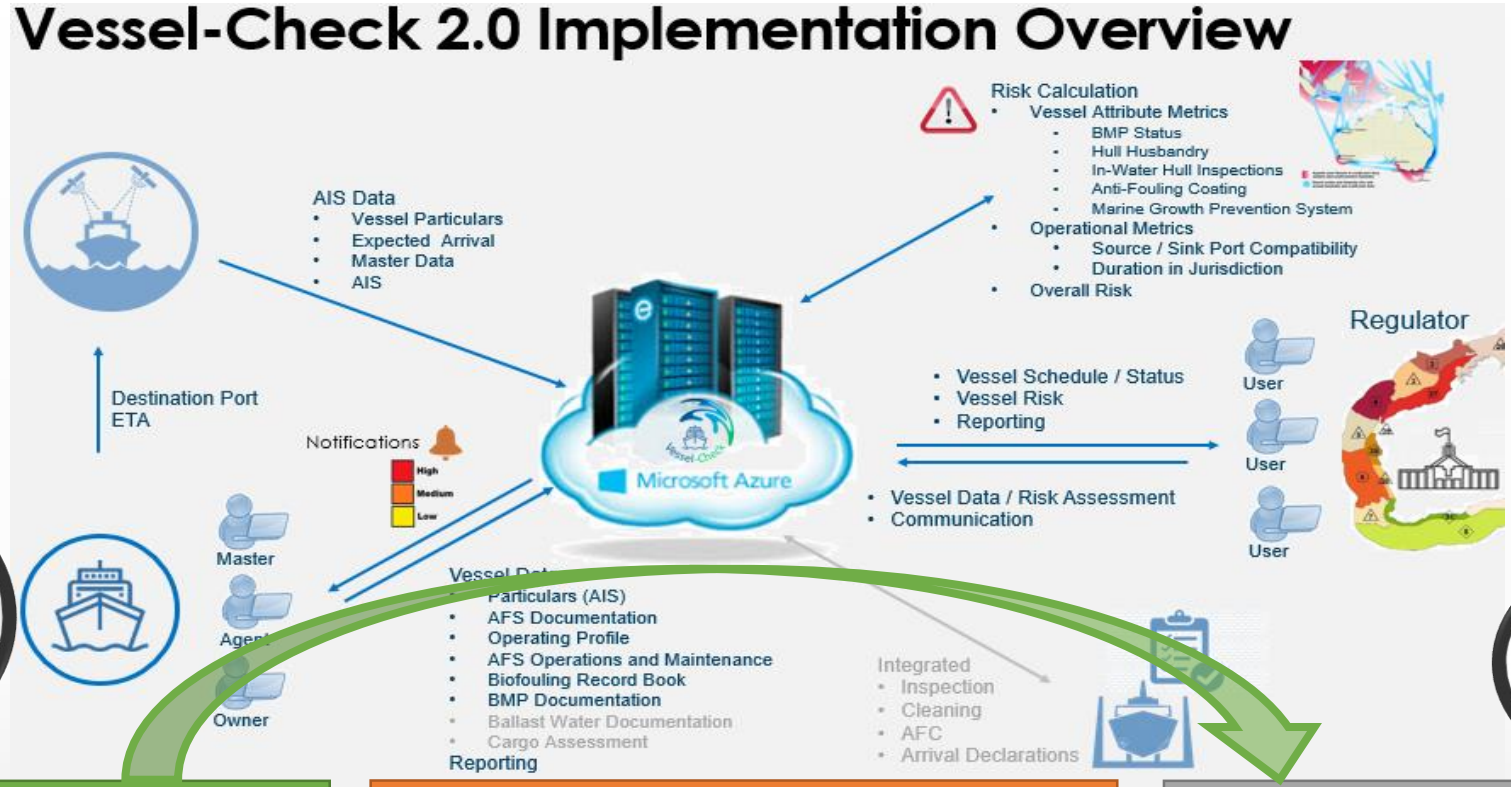
Vessel fails audit – referred to border staff for verification (i.e., hull inspection) and or action

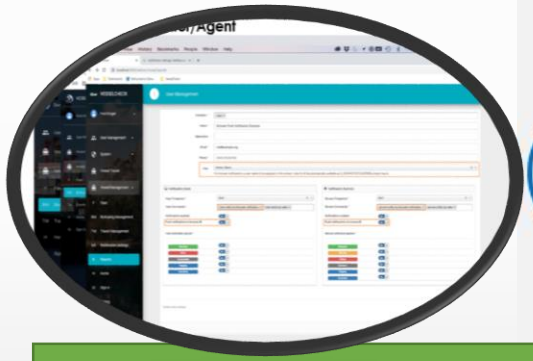
Biosecurity New Zealand
Ministry for Primary Industries
Manatū Ahu Matua

Australian Government
Department of Agriculture

Ko Tātou This Is Us
BIOSECURITY 2025

Vessel-Check 2.0 Implementation Overview





Vessel Owner / Operator

- User friendly online solution to capture biofouling information.
- Avoid duplication between jurisdictions
- Align with IMO guidelines
- Management reporting & notification
- Integrated processes to request and track cleaning & inspections

Biosecurity Risk

- Consistent and transparent approach to calculate risk
- Flexible risk decision tree
- Focus on hull management practices
- Ability to track risk history.
- Real-Time risk reporting

Regulator

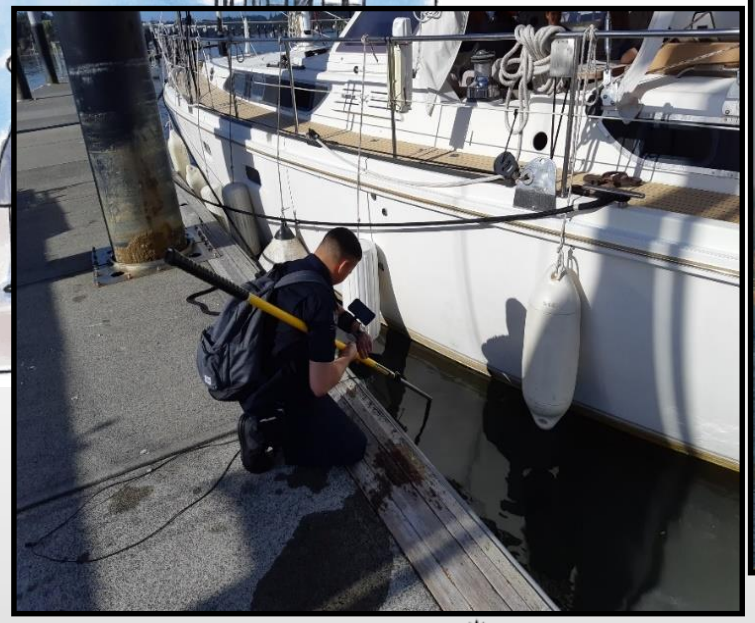
- Integrated with AIS for automated nominations.
- Ability to focus and optimize resources.
- Ability to asses and modify risk assessment / communicate with vessel
- Real-time risk assessment / Reporting
- Account for various marine biosecurity risks (Biofouling, ballast water and concealment in/on cargo).

GOVERNMENT OF WESTERN AUSTRALIA

Department of Primary Industries and Regional Development

DHI

Remote Operated Vehicles (ROV) and Marine Biosecurity



Biosecurity New Zealand
Ministry for Primary Industries
Manatū Ahu Matua

Australian Government
Department of Agriculture

KO TĀTOU THIS IS US
BIOSECURITY 2025

Remote Operated Vehicles (ROV) and Marine Biosecurity

Modifying remotely operated underwater vehicles for biosecurity surveillance

8 months ago

Image: A Remotely Operated Underwater Vehicle on patrol

Article written by Biosecurity Animal Division

Have you ever wondered what creatures are living beneath the surface of Australia's marine environments? We have, and we are constantly on the lookout for invasive marine pest species that could harm Australia's unique environment, and our way of life.

That's why we are providing $200,000 to the Tasmanian Department of Primary Industries, Parks, Water and Environment to modify and trial Remotely Operated Underwater Vehicles (ROVs) for use in marine biosecurity surveillance.

Our challenge in marine biosecurity surveillance is to quickly detect...

Continue reading

Tasmanian Government

Capability Assessment	Adaptation	Training
Assess ROV's currently on the market against project criteria	Investigate where improvements can be made to enhance capability	Design a training program for users of ROV's in marine pest surveillance

Biosecurity New Zealand
Ministry for Primary Industries
Manatū Ahu Matua

Vector design	**Manoeuvrability**	**Service costs**
Safety	**Adaptability**	**Topside units**
Service agents	**Depth holding**	**Robustness**
Size/weight	**Attitude holding**	**Vision quality**

Australian Government
Department of Agriculture

Primary target species





Secondary target species





Crab/seastar traps



Divers


Crab Condos



Benthic Sled


Images: NIWA

Shore / surface Searches

MHRSS Diving Hazards

- Boat strike / wash
- Repetitive dive profiles
- Overhead hazard
- Entanglement
- Poor visibility
- Foul water
- Hypo/Hyperthermia

Image: Peter Marriott, NIWA

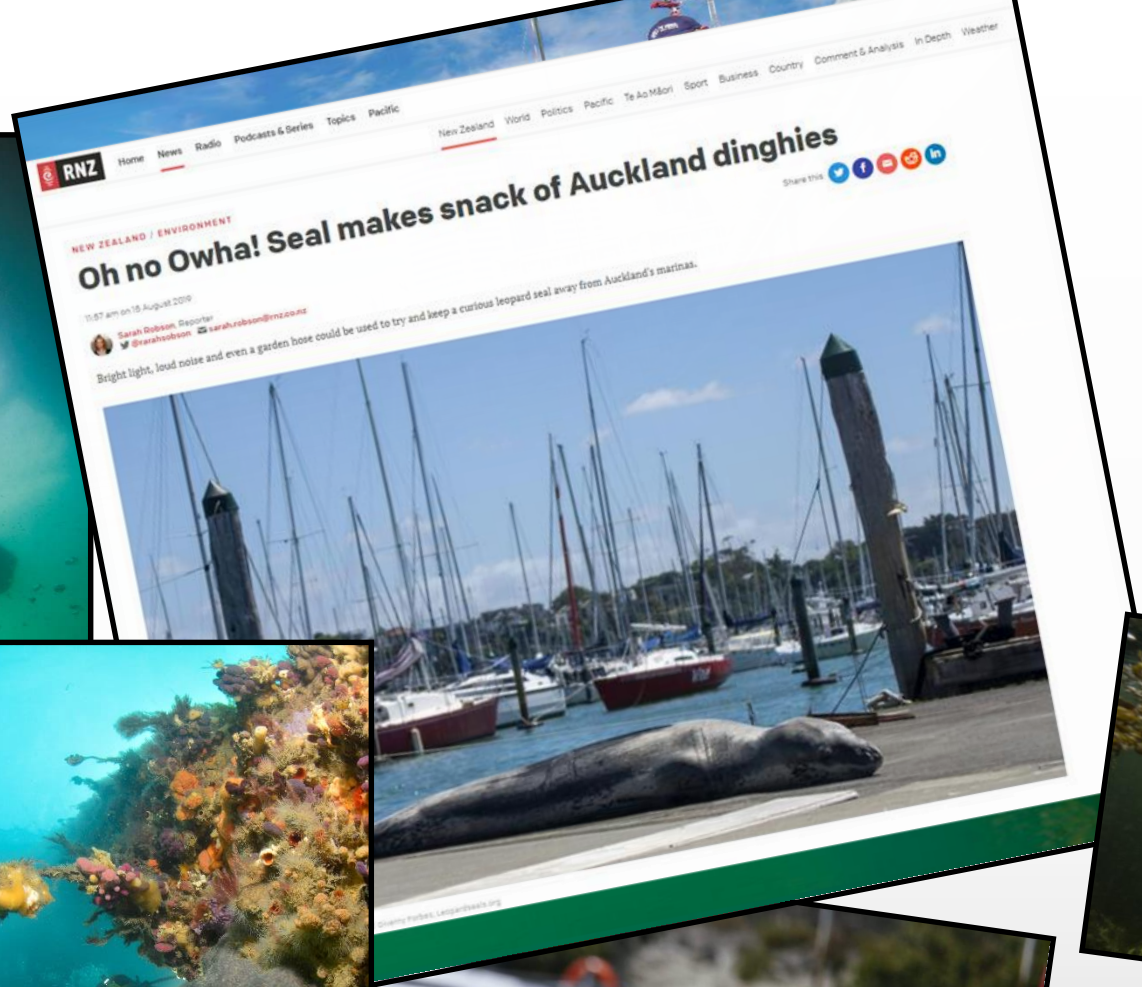
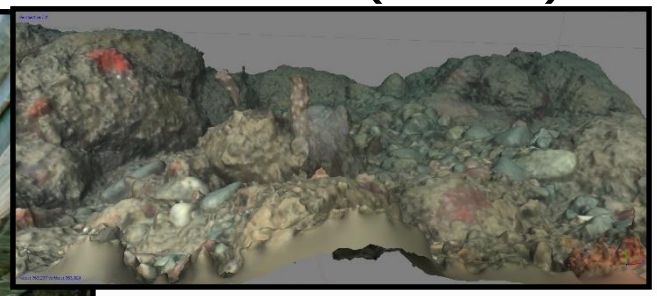
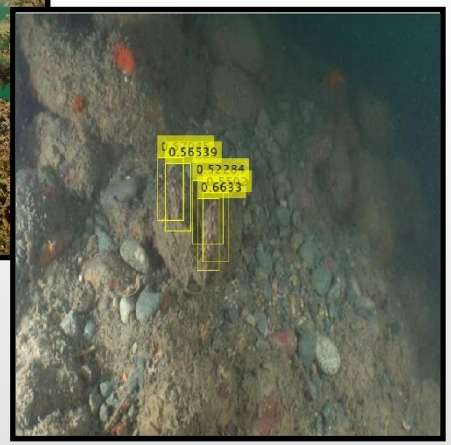


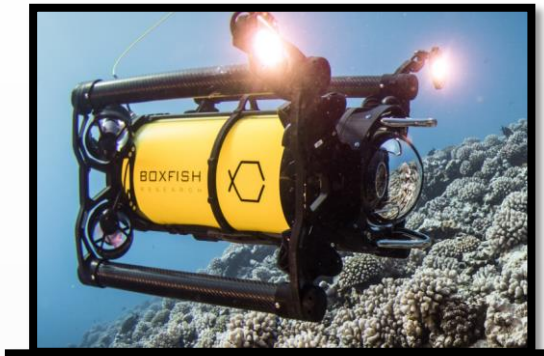
Image: NIWA

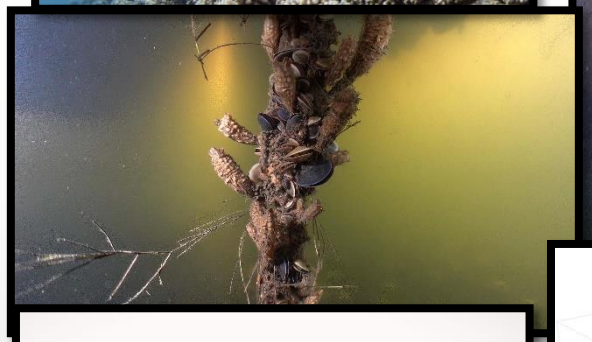
Image: NIWA

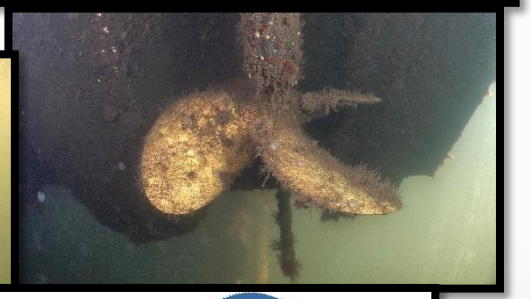
Remote Operated Vehicles (ROV) and Marine Biosecurity

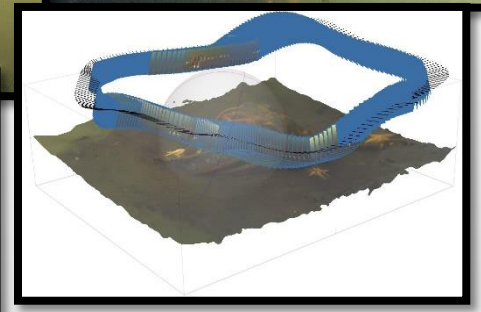












https://sketchfab.com/3d-models/train-wheel-a8c6cfc4ff434c5aa497a6cfc18ad44b

NIWA
Taihoro Nukurangi

Biosecurity New Zealand
Ministry for Primary Industries
Manatū Ahu Matua

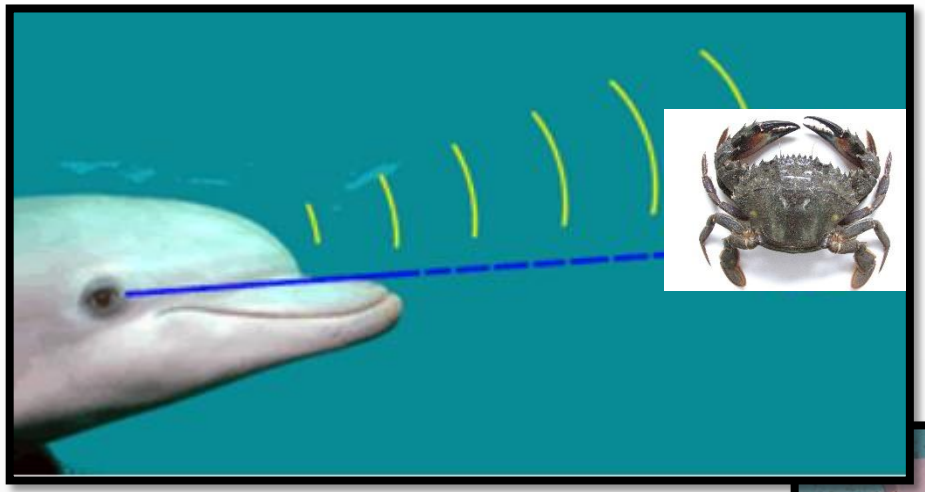
Australian Government
Department of Agriculture

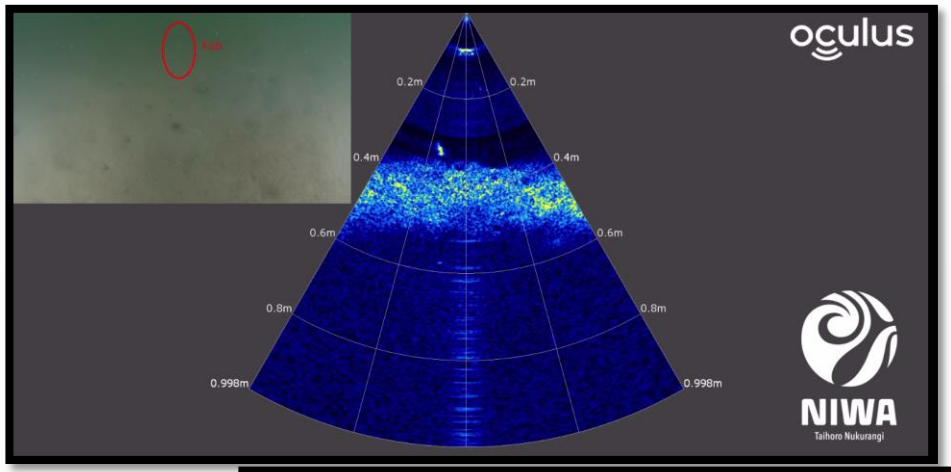
BOXFISH RESEARCH

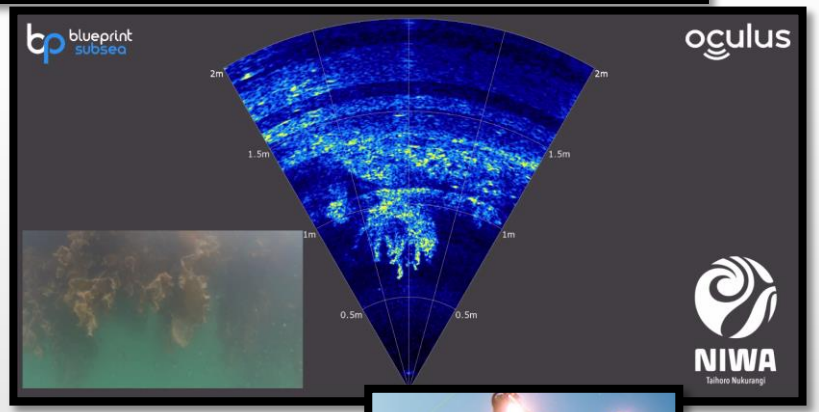
Ko Tātou This Is Us
BIOSECURITY 2025

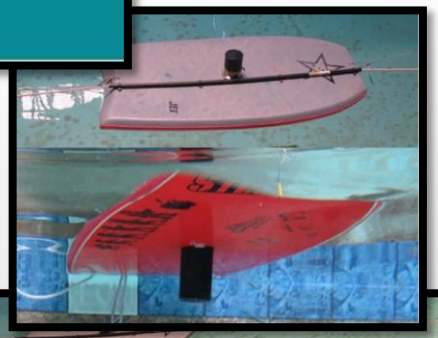
SONAR and Marine Biosecurity

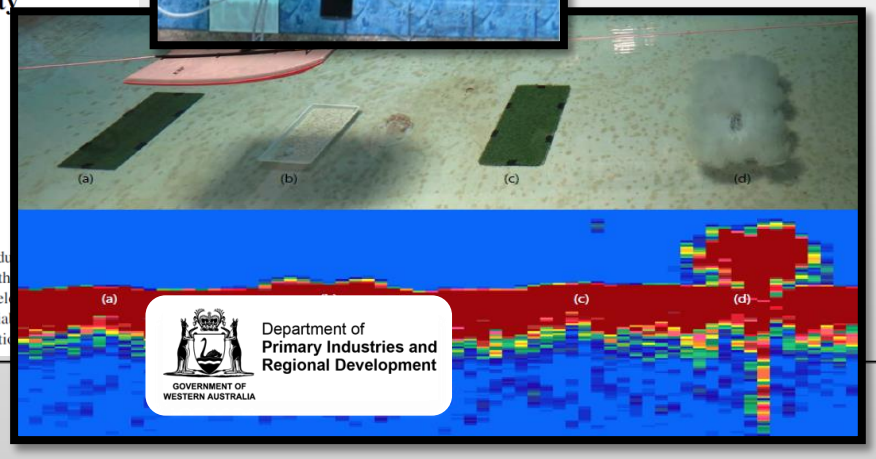
NIWA
Taihoro Nukurangi











Biol Invasions
https://doi.org/10.1007/s10530-018-1792-2

CrossMark

INVASION NOTE

Sounding out pests: the potential of hydroacoustics as a surveillance and compliance tool in aquatic biosecurity

D. A. Abdo · R. L. Duggan · J. I. McDonald

Received: 21 February 2018 / Accepted: 21 June 2018

Abstract Shipping is the main method for goods transportation, accounting for approximately 60% of all global trade. Biofouling of these shipping vessels is a critical pathway for the introduction of non-indigenous species (NIS) across the world's oceans. In order

with the discriminating capability redu
detection of only larger mimics as th
movement increased. With further devel
use of hydroacoustics could become a via
rity surveillance option for the mitigati

Ko Tātou This Is Us
BIOSECURITY 2025

Advances in Molecular Diagnostic Techniques

Slides provided by Graeme Inglis, NIWA

NIWA
Taihoro Nukurangi

Biosecurity 2025 SD2

"Capitalising on innovation and technology, by proactively seeking out and adopting new tools, transforms the way we do things."

eDNA methodologies

Assay design & development

- Fluorescence in situ hybridization (FISH)
- Sandwich hybridization assay (SHA)
- Real-time polymerase chain reaction (qPCR)
- Droplet Digital PCR (ddPCR)
- High-Throughput Sequencing (HTS)

Sample type & method

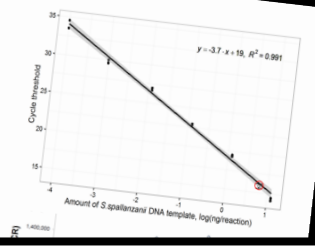
- Water
- Sediment
- Biofouling
- DNA vs RNA

Survey design

- When to sample?
- Where to sample?
- How many samples?

Species-specific assay development (qPCR)

- Marker design
- Test cross reactivity on related native species
- Test sensitivity on serial dilutions of DNA
- Test on environmental samples
- Comparison with ddPCR & HTC



Operationalising eDNA methods

- Visual survey vs. qPCR assay on water samples
- Extracell
- Seasona DNA in sample
- Relatio

Biosecurity 2025 SD4.

"New Zealand takes the lead in international forums, such as the development of international agreements and scientific collaborations."

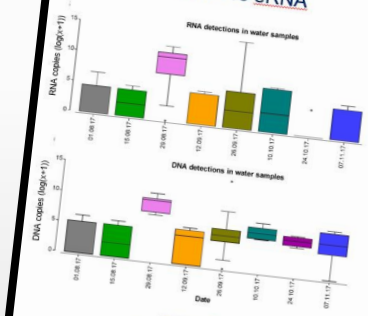
MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Accelerated development of sensitive, cost-efficient tools and capability for marine surveillance.

- Shared protocols for High-Throughput Sequencing (HTS) in marine biosecurity
- Exchange of data and reference collections
- Collaborative research to test the HTS protocols
  - Sample processing
  - Bioinformatics
  - Reference databases

NIWA · CAWTHRON The power of science® · The University of Waikato · Department of Primary Industries and Regional Development · Australian Government Department of Agriculture and Water Resources · Smithsonian Environmental Research Center · Fisheries and Oceans Canada · Pêches et Océans Canada · illumina · QIAGEN · Genome

Utility of eDNA vs eRNA



- eDNA does not necessarily indicate presence of living organisms
- eRNA deteriorates faster & may be better proxy
- Study showed a relationship between the magnitude of DNA signal and the likelihood of RNA detection
- Prediction threshold of ~400 COI DNA copies provided an indicator for the detection of *S. spallanzanii* eRNA

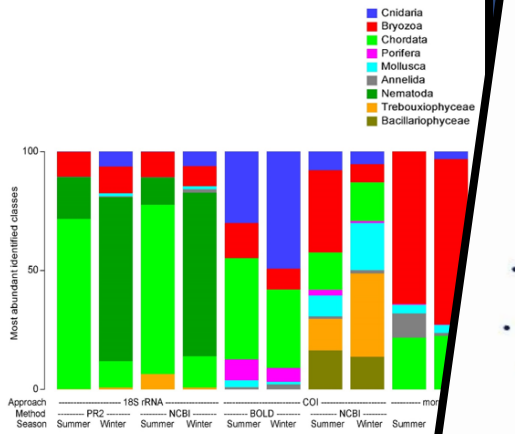
Mediterranean fanworm

von Ammon et al. (2019). *Frontiers in Marine Science*, 6(621). doi:10.3389/fmars.2019.00621

CAWTHRON The power of science® · NIWA Taihoro Nukurangi

Metabarcoding

- Challenges
  - Choices in the bioinformatic pipelines
  - Incomplete reference databases
  - Marker sensitivity & specificity
- Need for
  - Standardized methods & reference collections
  - Measures of sensitivity & specificity
  - Decision guidelines that appropriately weight parsimony and precaution
- Efficacy
  - Comparison with targeted approached showed detection probabilities of the targeted methods (qPCR & ddPCR) were nearly double that from metabarcoding



Von Ammon et al. (2018). *Scientific Reports* 8: 16290, DOI: 10.1038/s41598-018-34541-1.

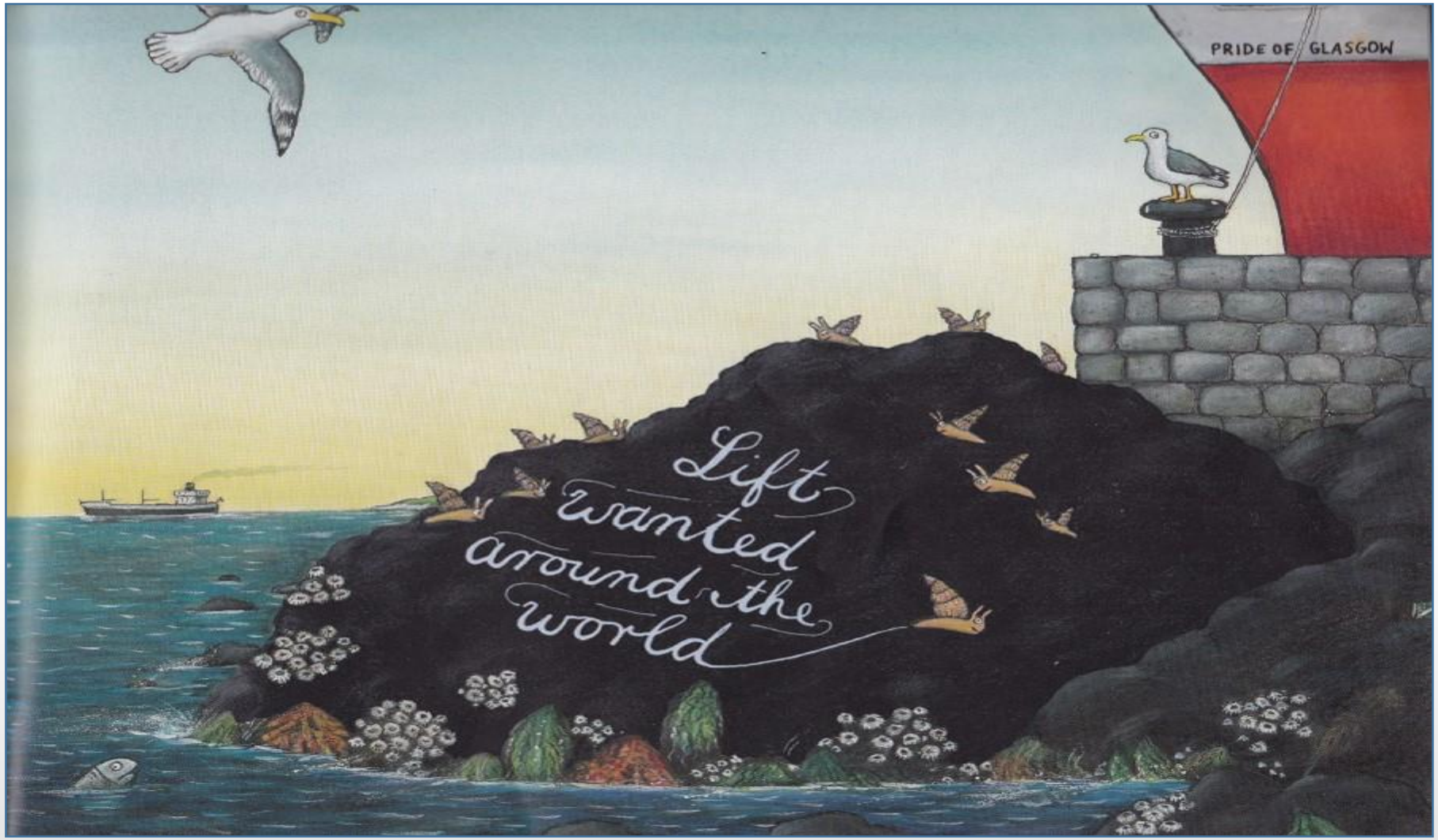
Wood et al. (2019). *Molecular Ecology Resources*. DOI:10.1111/1 0998.13055

CAWTHRON The power of science® · NIWA Taihoro Nukurangi

Biosecurity New Zealand
Ministry for Primary Industries
Manatū Ahu Matua

Australian Government
Department of Agriculture

KO TĀTOU THIS IS US
BIOSECURITY 2025



Biosecurity New Zealand
Ministry for Primary Industries
Manatū Ahu Matua

Australian Government
Department of Agriculture

KO TĀTOU THIS IS US
BIOSECURITY 2025