Into the wild: documenting and predicting the spread of Pacific oysters (*Crassostrea gigas*) in Ireland

Judith Kochmann

GREP in Sustainable Development, Urban Institute Ireland, UCD
Supervisor: Tasman Crowe
Collaborators: Francis O'Beirn (MI), Jon Yearsley (UCD), Stefano Mariani (The University of Salford), Jens Carlsson (UCC)

UCD DUBLIN
IRCSET Irish Research Council for Science, Engineering & Technology
Investing in People and Ideas
SIMBIOSYS
Sectoral Impacts on Biodiversity and Ecosystem Services
IRCHSS

Influences of aquaculture on ecosystems

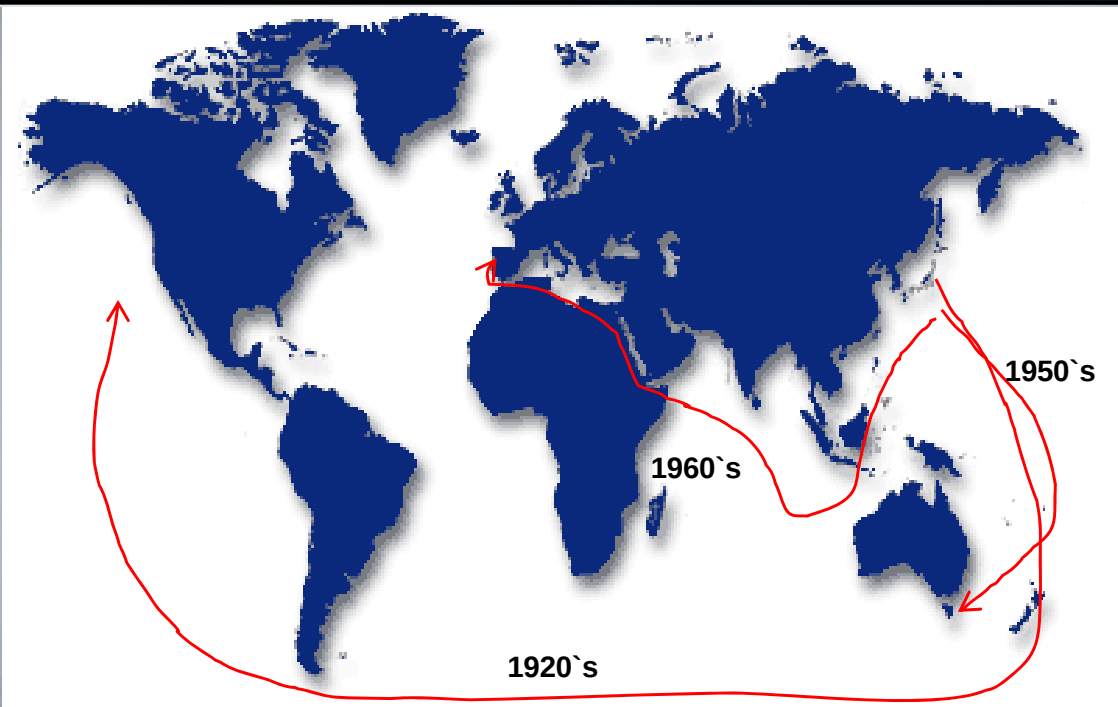
- Interactions with wild-fisheries resources
  - capture of seed mussels
  - fish capture for feed production
- Physical changes to the habitat
  - addition of structures
- Organic and nutrient enrichment
- Invasive species
  - Vectors, escapes, facilitation
- Interactions with seals and birds
  - positive and negative

photo: Valdimar Ingi Gunnarsson

Ireland

- One of the three main aquaculture species in Ireland is the Pacific oyster
- Pacific oysters cultured on intertidal trestles since early 1970`s
- 6-7 k tonnes produced in 2007, valued € 15 million

Pacific oyster



- Shell length of 30-40 cm, up to 1 kg live wet weight

Range of impacts

- Invasive populations in many parts of the world with significant changes on ecosystems:
  - decrease carrying capacity, especially of aquaculture bays
  - native mussels show reduced growth between oysters
  - act as a vector for other non-native species
- Most obvious and significant change is change of habitat structure

Shift from mussel beds to oyster reefs in the Wadden Sea

Pacific oyster in

- Thought not to be able to reproduce in Ireland
- Some individuals observed outside aquaculture
- Extent of feral populations not known

Aims

- **Aim 1** Characterise the distribution and abundance of Pacific oysters in Ireland – observational approach

- **Aim 2** Test the influence of relevant factors on survival and growth of oysters – experimental approach

- **Aim 3** Comparison of genetic structure between feral and aquaculture oyster populations - molecular tools

- Aim 1: Characterise the distribution and abundance of Pacific oysters in Ireland

  - Assess the current range and status of Pacific oysters in Ireland

  - Identify main factors associated with the presence/absence of oysters – observational approach

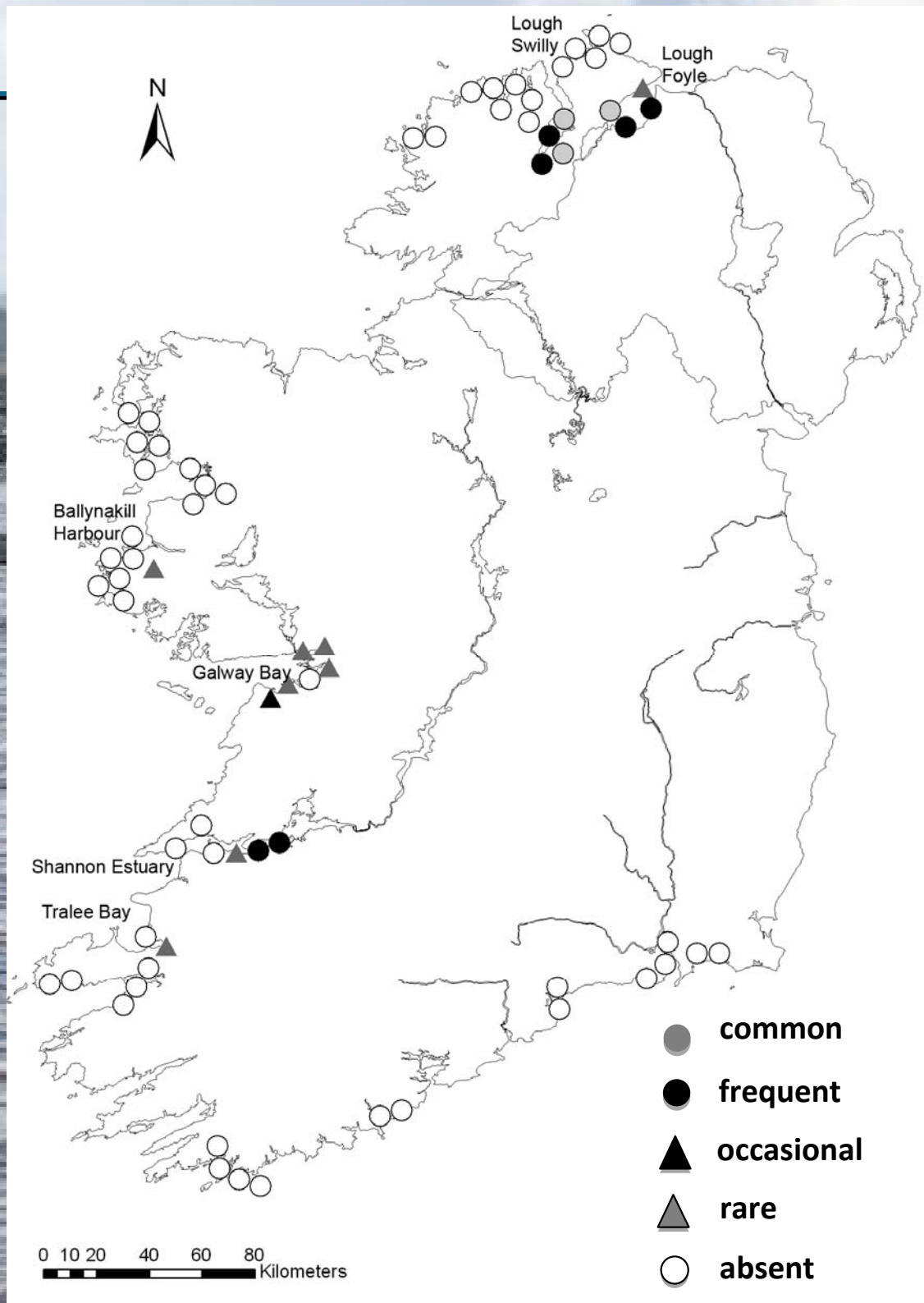
Sampling Design

- 2009 sampling programme undertaken together with Marine Institute, Lough's Agency, Queen's University Belfast, BIM
- Repeatable, cost effective protocol developed
  - Semi-quantitative assessment of abundance and habitat types at all sites (SACFOR, EUNIS framework)
  - Quantitative transects to assess maximal densities and small-scale habitat associations

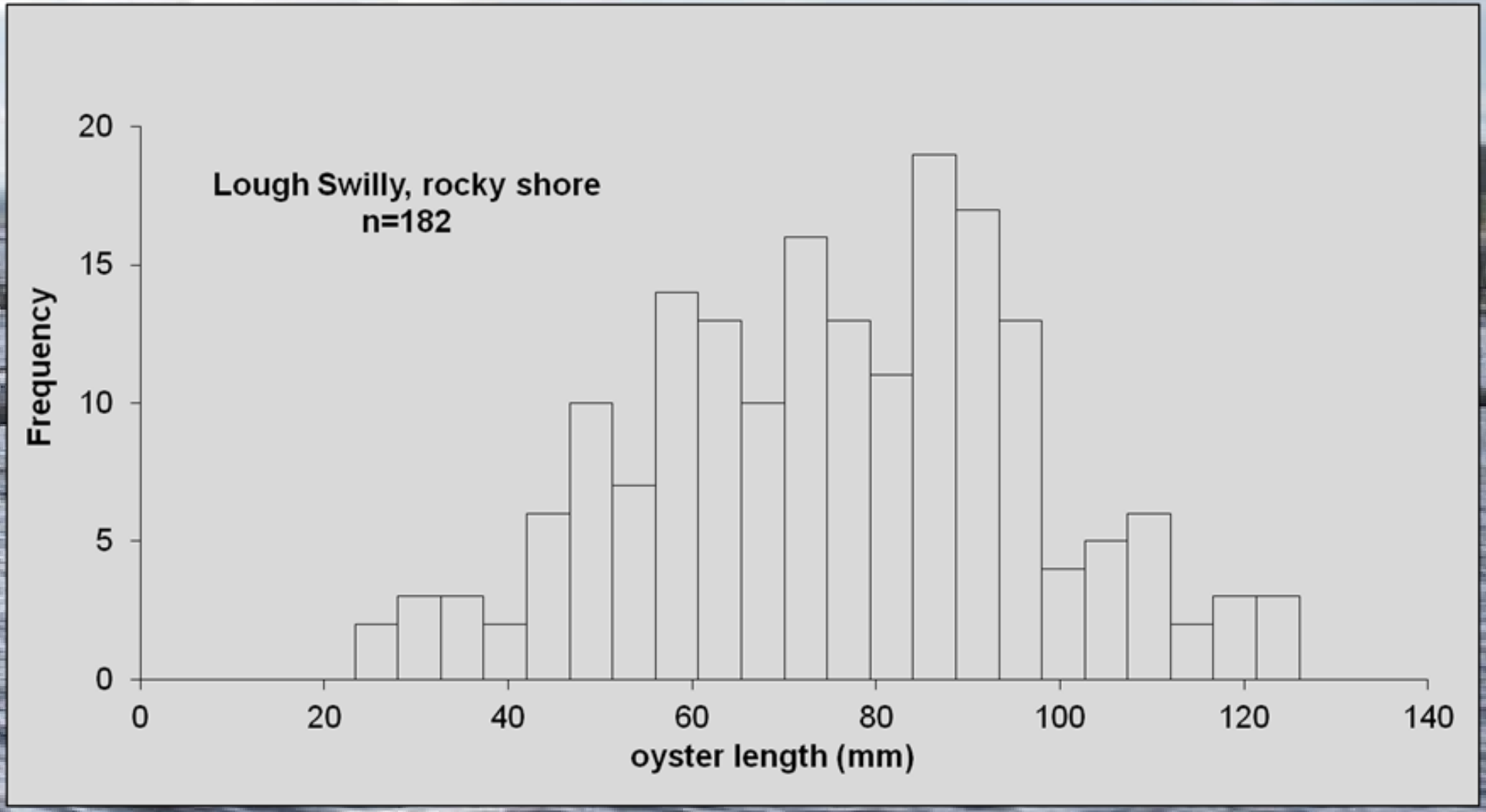
Distribution and abundance

- Oysters were found at 18 out of 69 sites visited

- Transect results:
  - Lough Swilly, rocky shore: 6.3 ind/m^2
  - Lough Foyle, mussel bed: 5.4 ind./m^2
  - Shannon Estuary, rocky shore: 0.7 ind./m^2



Size frequencies



- Sizes ranged from 25 – 135 mm indicating several recruitment events

Environmental factors

- Probability of oyster presence was assessed as a function of variables using logistic regression and stepwise model selection (AIC)
- Factors explaining oyster presence best:

Aquaculture present but > 500 m;
***p* = 0.035**

Residence time;
***p* = 0.001**

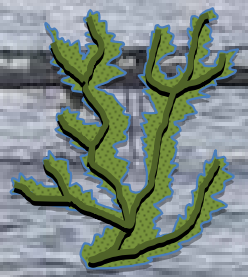
Hard substrate and biogenic reef;
***p* = 0.002**

Shore width > 50 m;
***p* = 0.010**

- Aim 2: Test the influence of relevant factors on survival and growth of oysters – experimental approach

Macroalgae

- Modify flow, affecting sediment (-) or food (+)
- Smother and interfere with filter apparatus



Predators

- Consume juvenile stages

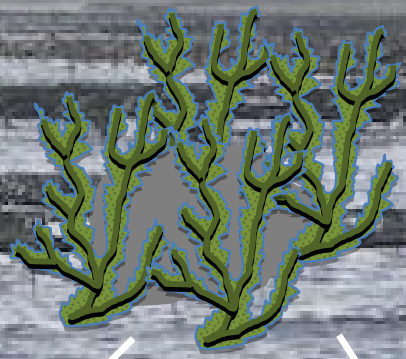
Interaction

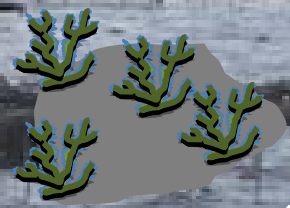
- Macroalgae may increase influence of predation by providing habitat for predators

Aim 2

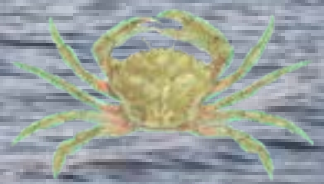
10 individuals per tile

1. Macroalgae





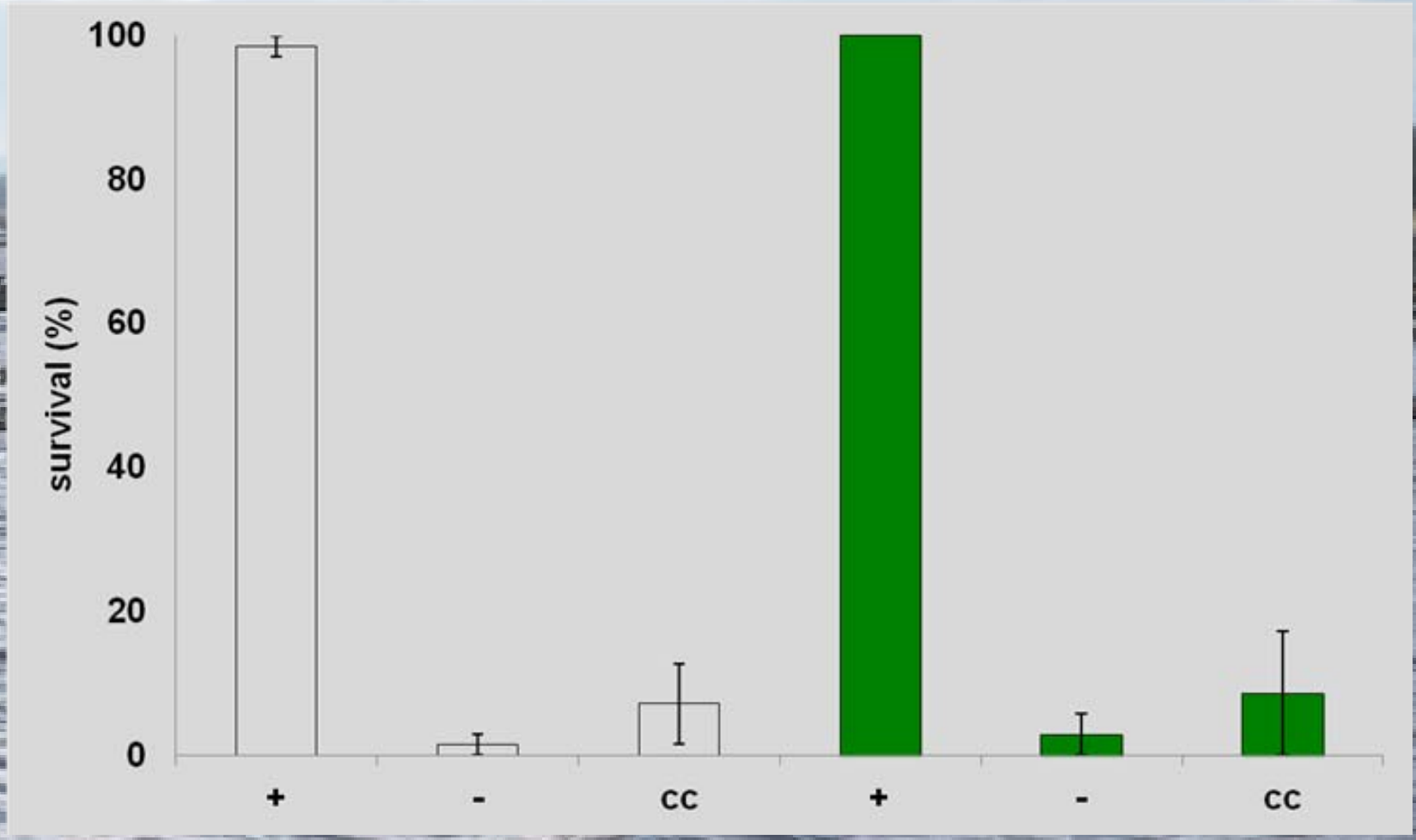
2. Predation



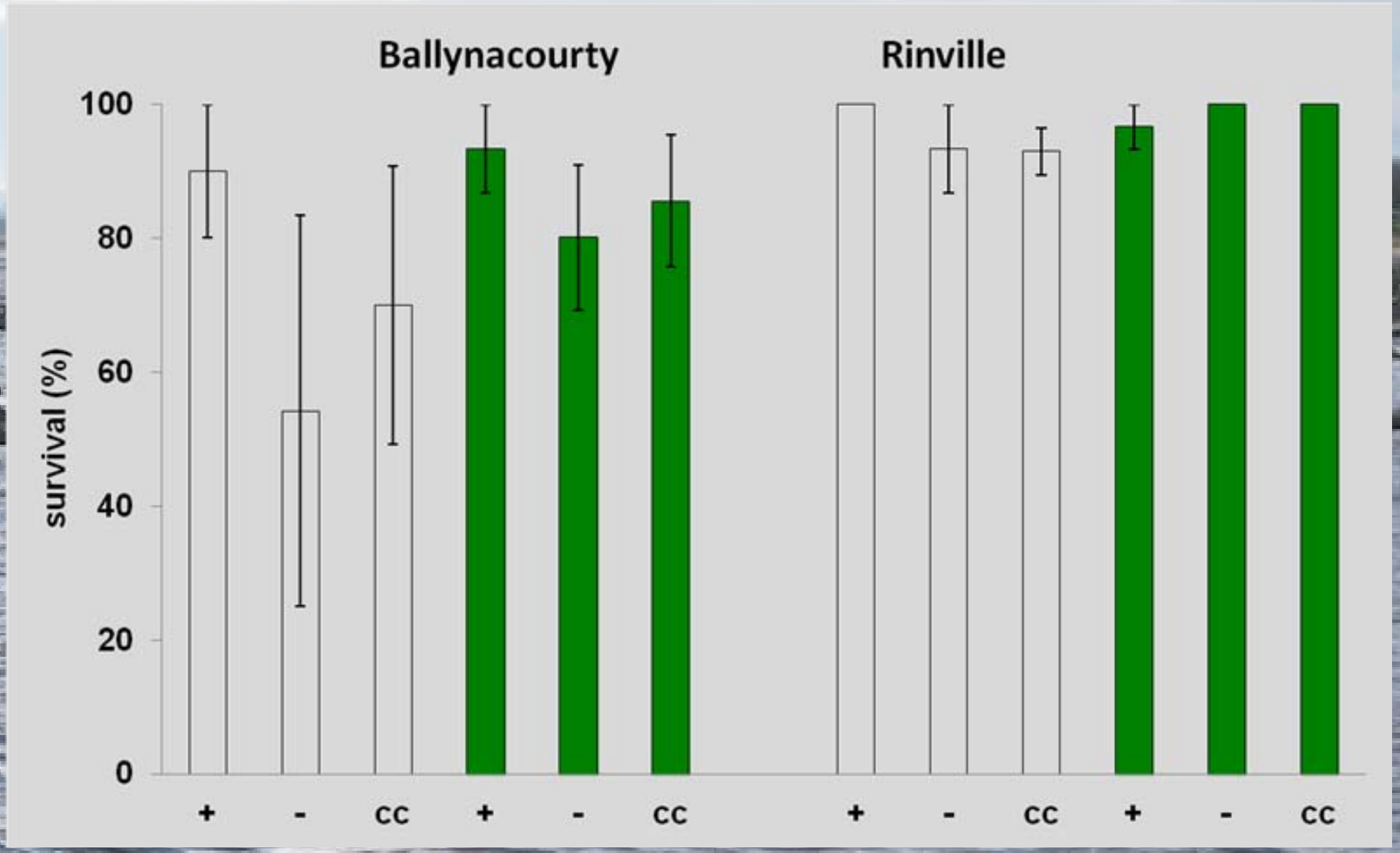
No cage | Cage control | Cage | No cage | Cage control | Cage

Replicated at 2 sites

Results - survival

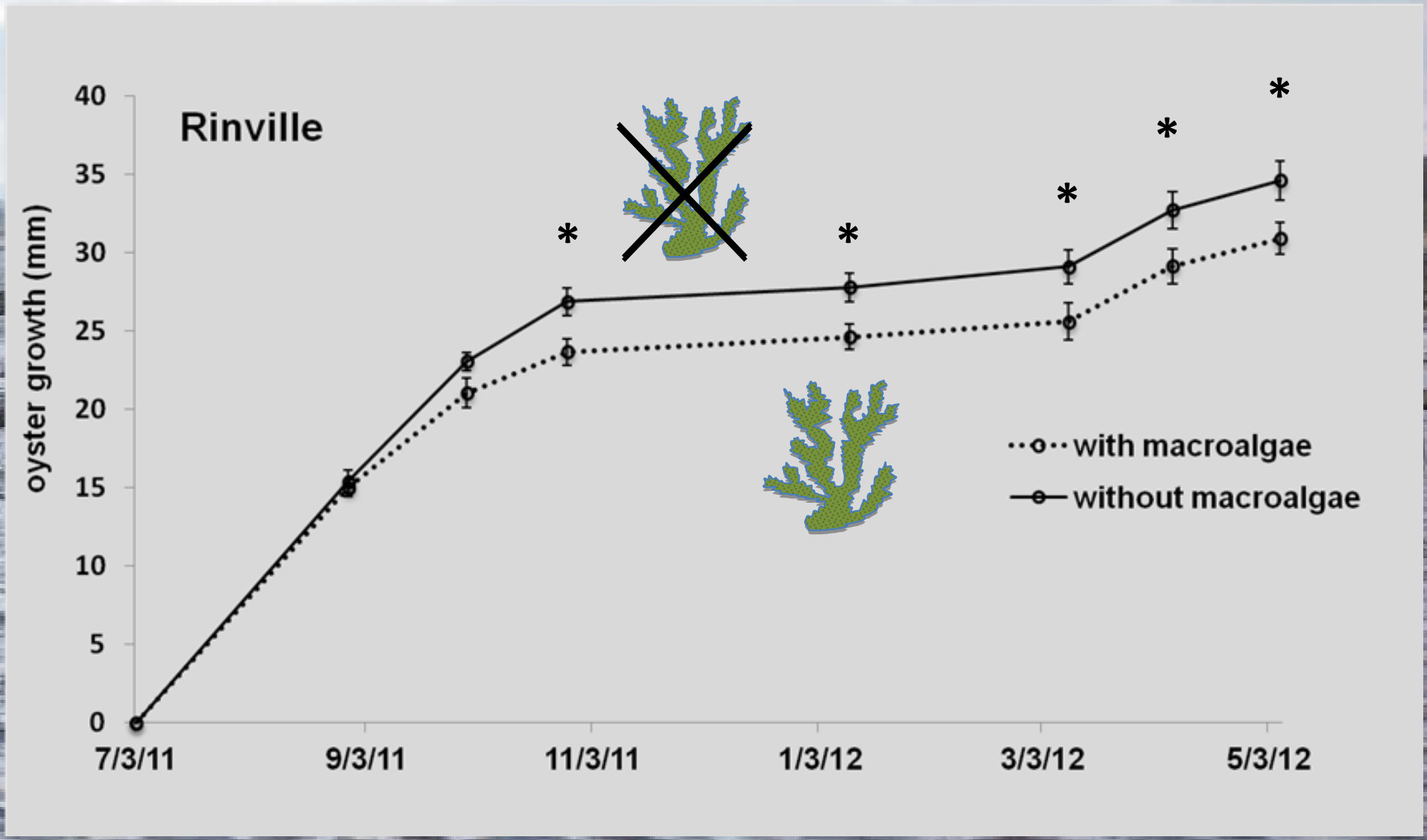


- Strong effect of predation in pilot study July 2010, mean oysters size 16 mm



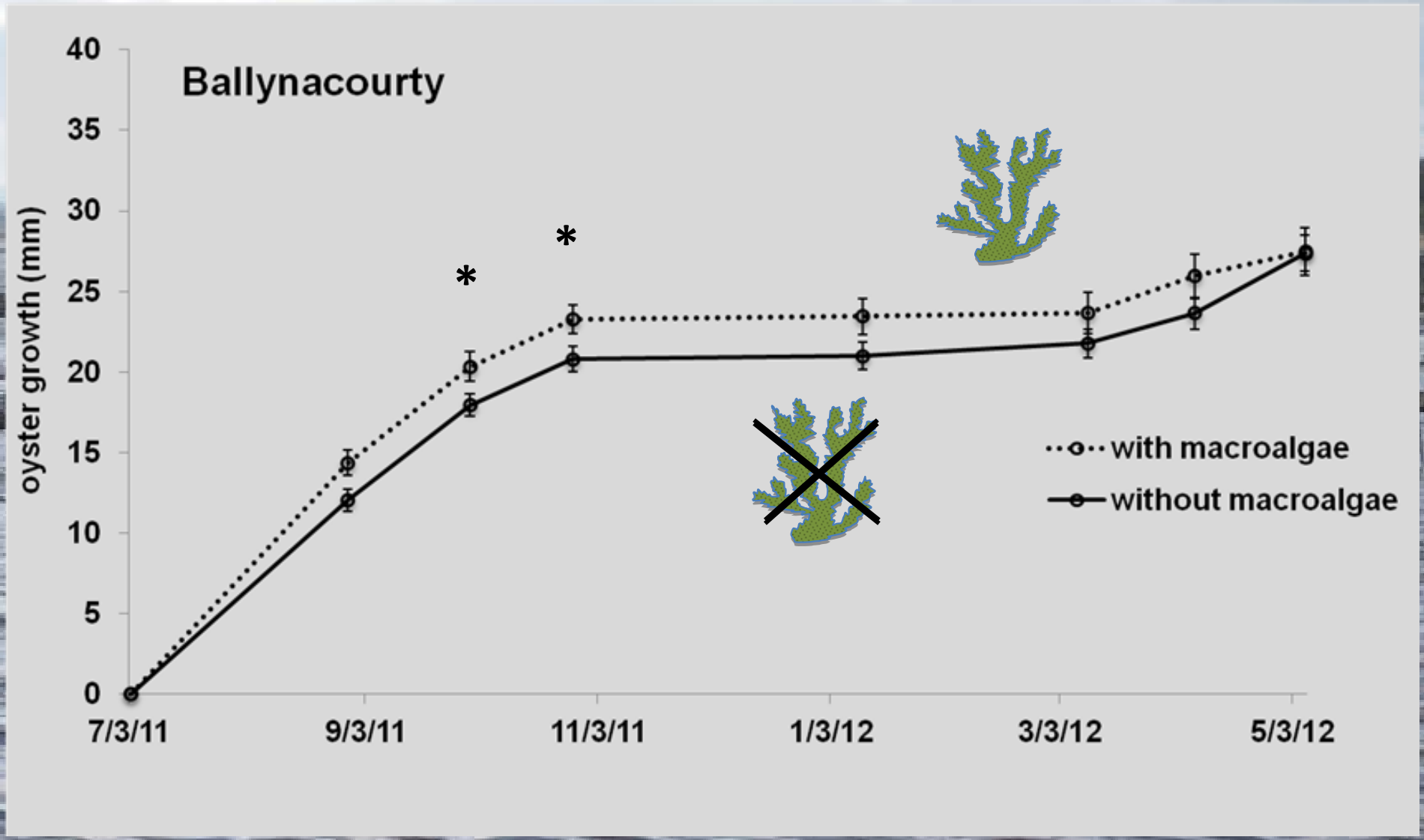
- effect of predation absent in September 2011, mean oysters size 36 mm

Results - growth



- Significant larger growth (*) without macroalgae in Rinville

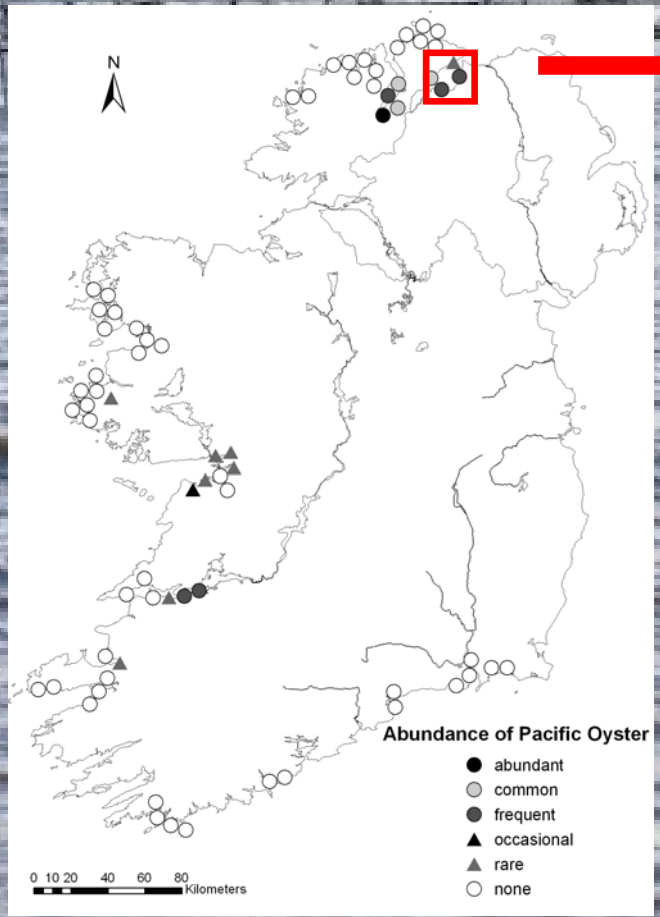
Results - growth



- Opposite pattern, but not significant
- Condition index May 2012 (DTW*1000/DSW)

→ no significant effect of macroalgae

- Aim 3: Comparison of genetic structure between feral and aquaculture oyster populations
  - Establish whether oysters outside aquaculture are forming self-sustaining populations or are the result of repeated spawning from aquaculture



VS

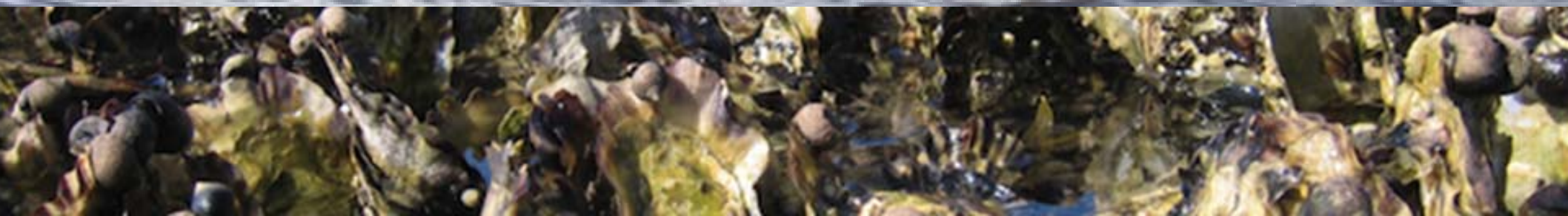
1 Bay
2 Populations
3 Size classes
14 Microsatellites

Results

- Evidence for the uncoupling of aquaculture and feral populations

- Self-recruitment of feral populations likely

Genetic evidence for the uncoupling of local aquaculture activities and a population of an invasive species – a case study of Pacific oysters (*Crassostrea gigas*) by J Kochmann, J Carlsson, T P Crowe, S Mariani (accepted by Journal of Heredity)



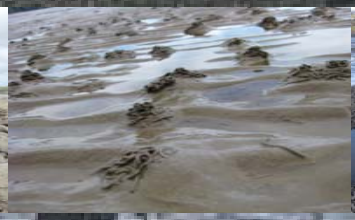
Summary

- Pacific oysters are established in Ireland and most likely self-recruiting
- No dense reefs in the intertidal
- Several cohorts present and new recruits found in 2011
- Occurrences known from shallow subtidal native oyster beds (report by Marine Institute and BIM 2011)
  - 5.64 million feral Pacific oysters estimated for Lough Swilly in intertidal/subtidal habitats

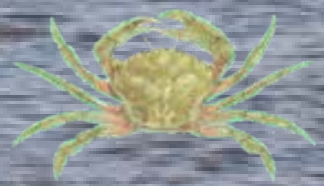
Summary

- Oyster presence strongly associated with hard substrata and biogenic reef, long residence times of embayments and large intertidal areas






- Macroalgae and predators can influence growth and survival, but effects vary

Summary

- Although feral oysters can be demographically uncoupled from closest aquaculture, further sampling of bays without aquaculture is needed to characterise the association of aquaculture more fully

- Sampling protocol provides a baseline and repeatable method for future sampling by state agencies

- Combination of coordinated sampling, experiments and molecular tools can help to identify factors associated with spread of oysters and inform strategies for adaptation and control

Thank you for your attention!

Acknowledgements

HELP and ADVICE

- Tasman Crowe
- Francis O'Beirn
- Jon Yearsley
- Stefano Mariani and Jens Carlsson
- Ciarán McGonigle, Loughs Agency
- Grainne O'Brien & regional officers, BIM
- Heike Büttger, BioConsult, Germany
- Claire Guy & Dai Roberts, Queen's University Belfast

FIELD/LAB WORK

- Jen Coughlan, Rónán Mag Aoidh, Tomasz Dabrowski, Mike Burrows, Sarah Burke, Paul Brooks, Catherine Butler, Myriam Callier, Mave Cavanagh, Mozart Fazito, Vangelis & Panagiotis Giannakakis, Dannielle Green, Hao Li, Colm Ó Murchú, Silvia Saloni, Peter White, Chloe Kinsella, Caroline Kerrigan, Catherine Collins, Eda Ustaoglu, Susanne Schmidt, Jurate Jaraite, Rebecca Doyle, Bas Boots, Erin, Morteza Matkan, Maria Sala-Bonzano, Carlotta Sacchi

FUNDING AGENCIES

- IRCSET & IRCHSS (via UCD Graduate Research Education Programme in Sustainable Development)
- SEED funding, UCD