




Detrimental impacts of jellyfish on finfish aquaculture: insights from the North East Atlantic

Thomas K. Doyle, Emily J. Baxter, Thomas Bastian,
Graeme C. Hays, Hamish D. Rodger and Neil M. Ruane

Coastal & Marine Research Centre, University College Cork



Some great posters to check out!



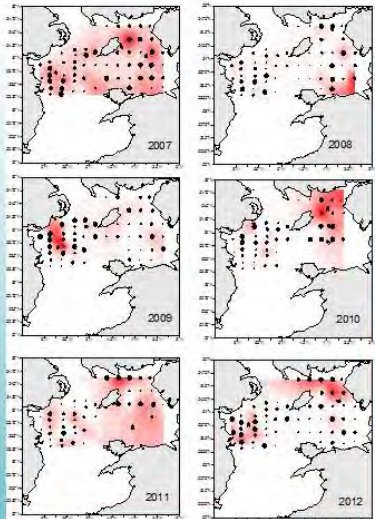

Annual variations in associations between Scyphomedusae and juvenile whiting (*Merlangius merlangus*) in the Irish Sea.

S.E. Beggs¹, T. Bastian², M.K.S. Lilley³ and T. Doyle⁴

¹Fisheries and Aquatic Ecosystems Branch, Agri-Food and Biosciences Institute, Newforge Lane, Belfast BT9 5PX, UK
²Centre de Recherches en Nutrition Humaine, Rhone-Alpes, Centre Hospitalier Lyon Sud, 69310 Pierre Benite, France
³MIO Aix-Marseille Université, Campus de Luminy, 13288 Marseille, France
⁴Coastal and Marine Resources Centre, ERI, University College Cork, Gluckstein Marine Facility, Naval Base, Haulbowline, Coon, Cork, Ireland

INTRODUCTION

Identifying interactions between scyphomedusae and other components of the ecosystem requires information on distribution and abundance. Six years of data (2007-2012) on jellyfish (*Aurelia aurita* and *Cyanea capillata*) and juvenile whiting (*Merlangius merlangus*) collected from the Irish Sea were analysed. While scyphomedusae are known predators of fish eggs and larvae, juvenile fish may benefit via enhanced survival through their presence, actively seeking shelter and food from them.

METHOD

Night surveys were conducted onboard the RV *Corystes* using a Methot Isaacs Kidd (MIK) frame net with a 5mm mesh designed to sample juvenile pelagic 0-group gadoids (Methot, 1986). The net was towed in a double oblique profile through the water column to within 4m of the seabed, with a second double-oblique profile at stations where the depth prevented initial tow durations of ~15 min. An impeller flowmeter recorded the volume filtered during each tow. All jellyfish in the catch were separated from fish, crustaceans and cnephorans and then weighed. Jellyfish catches were dominated by medusae of *A. aurita* and *C. capillata*.

RESULTS and DISCUSSION

Significant spatial overlap between *C. capillata* and juvenile whiting was detected in most years, only 1 year of association was detected with *A. aurita*. This association between whiting and *Cyanea* sp. documented in previous studies, is thought to provide a survival advantage to the juvenile fish. The tentacles providing both shelter from predation and a source of prey. *A. aurita* having less extensive tentacles may not provide such effective shelter or feeding opportunity. Further work is required to understand the association identified by this study.







Fig 1. Annual variations in the spatial abundance of *C. capillata* (red contours) and whiting (black circles) in the Irish Sea.

Year	stations	Cc (ind.m ⁻³) vs whg psi	p-value	Cc (g m ⁻³) vs whg psi	p-value	Aa (ind.m ⁻³) vs whg psi	p-value	Aa (g m ⁻³) vs whg psi	p-value
2007	77	0.12	0.143	0.06	0.353	0.12	0.279	0.23	0.023
2008	78	0.98	0.371	0.35	0.168	0.18	0.062	1.01	0.004
2009	81	0.38	0.371	0.35	0.168	1.01	0.004	0.83	0.002
2010	83	0.39	0.057	0.12	0.393	2.73	0.001	1.66	0.001
2011	45	0.11	0.006	0.01	0.831	0.81	0.002	0.64	0.001
2012	87	0.13	0.2	0.25	0.016	1.51	0.002	1.05	0.001





Tracking the lion's mane jellyfish

Horizontal and vertical movements of *Cyanea capillata* (Scyphozoa) in a shallow coastal environment

Thomas Bastian^{1,2}, Damien Haberlin^{1,2}, Mary Catherine Gallagher^{1,2}, Sean Rooney³, Graeme C. Hays⁴ and Thomas K. Doyle¹

¹Coastal and Marine Resources Centre, ERI, University College Cork, Co. Cork, Ireland | ²School of Biological, Earth and Environmental Sciences, University College Cork, Co. Cork, Ireland | ³Irish Sea Research, Swinburn Business Campus, Swinburn, Co. Dublin, Ireland | ⁴Department of Biosciences, Swansea University, Swansea, United Kingdom | Contact: t.bastian@ucc.ie or t.k.doyle@ucc.ie

Background and aims

Jellyfish outbreaks can adversely impact human health and economic activities⁽¹⁾ in the North Atlantic and Pacific Oceans, the highly venomous lion's mane jellyfish (*Cyanea capillata*) is a serious hazard for open-water swimmers and fishermen, and is suspected to impact on fish larvae survival and recruitment⁽²⁾. Understanding the factors that drive the distribution of *C. capillata* is critical in order to develop strategies to manage its impacts on human activities.

Hydrographical parameters often play an important role in redistributing and aggregating scyphomedusae⁽³⁾. However, several studies have suggested that scyphomedusae swimming behaviour can actively affect their distribution⁽⁴⁾.

In the present study we used acoustic tracking techniques and drifter deployment to investigate the horizontal and vertical movements of *C. capillata* in a coastal region near Dublin (Ireland) where the species impacts on bathers every year.

Materials and methods

Tag deployment

- An acoustic transmitter (VEMCO V9, 9 mm x 45 mm, 3.5 g in water) was attached to a medusa with a cable tie and fishing line.
- A float was attached to the tag as a visual aid for tag recovery (floatability was set in-situ to be slightly buoyant only in top meter).
- Right after deployment, a crucialion drifter with a handheld GPS attached to it was deployed to give indications on local subsurface currents.

Tracking

- The tag was set to transmit pressure data every 2s.
- A handheld directional hydrophone linked to a receiver unit (VEMCO VR100) was used to detect and visualize depth data in real-time, and automatically record them.
- The direction from which the strongest signal was received was measured with a compass, and the jellyfish was relocated using triangulation techniques.
- At times, when the jellyfish and drifter had drifted too much apart, the drifter was recovered and redeployed at the next medusa relocation trial.

Results

- Five individual *Cyanea capillata* were successfully tracked in July 2010 (see Table 1 for details).
- Cyanea capillata* horizontal movements broadly followed local currents as indicated by drifter trajectories and change of direction with turning tide (Figure 1).
- Cyanea capillata* vertical movements were diverse and changing, with periods of constant swimming through the water column and periods of time when medusae stayed at a constant depth (Figure 2).
- This active swimming behaviour and small scale hydrographical features could account for some of the differences between the velocity of medusae and velocity of drifters.

Medusa	Best position (lat)	Date	Deployment Time	Recovery Time	Duration (h)	Positive localizations	Distance travelled (km)	Mean vertical speed (m/s)
A	53° 06'	05-Jul	11:10	17:54	6:43	10	4.90	0.78 (N=10)
B	48° 48'	12-Jul	12:28	15:56	3:45	4	5.66	1.61 (N=5)
C	53° 25'	20-Jul	18:40	19:21	2:68	4	1.64	2.53 (N=7)
D	53° 35'	21-Jul	11:06	18:48	7:40	5	5.84	1.63 (N=3)
E	53° 35'	22-Jul	18:47	19:20	4:06	7	2.81	1.97 (N=8)

Figure 1. Horizontal movements of five *Cyanea capillata*. Black dots show the successive positions of tracked medusae with indications on time of tag deployment and recovery. Grey arrows show the actual GPS-tracks of the drifter. A black star marks the location of the Forth Foot, a famous and popular place for open-water swimming in Ireland. Please note change of direction in the medusa and drifter trajectories reflecting the turn of tidal flow; and the presence of small scale eddies in the tracking areas. No drifter was deployed with medusae B and C.

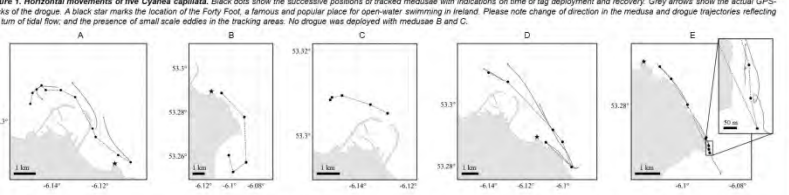
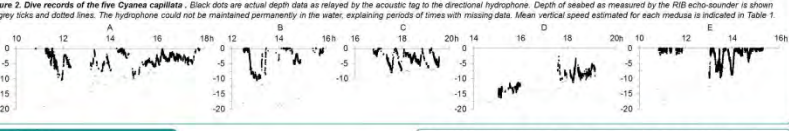


Figure 2. Dive records of the five *Cyanea capillata*. Black dots are actual depth data as relayed by the acoustic tag to the directional hydrophone. Depth of seabed as measured by the RIB echosounder is shown by grey ticks and dotted lines. The hydrophone could not be maintained permanently in the water, explaining periods of times with missing data. Mean vertical speed estimated for each medusa is indicated in Table 1.










Conclusion

- The present study has demonstrated the feasibility of active acoustic tracking of *Cyanea capillata*, and provided original data on the horizontal and vertical movements of this species.
- Future studies will provide details on how swimming behaviour varies over longer tracking periods and in different environments, enhancing our understanding of the ecology of these animals which are not quite as passive as once thought.

Further details on this study can be found in Bastian (2011) The Broad-scale distribution and abundance of Scyphomedusae around Ireland: PhD thesis, University College Cork, Cork, Ireland

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References: (1) Robinson et al. (2009) PLoS 24; (2) Laven et al. (2006) MBRS 308; (3) Laven & Brierley (2008) Mar Biol 150; (4) Granan et al. (2001) Hydrobiologia 441; (5) Hays & Granan (2006) LMO 51

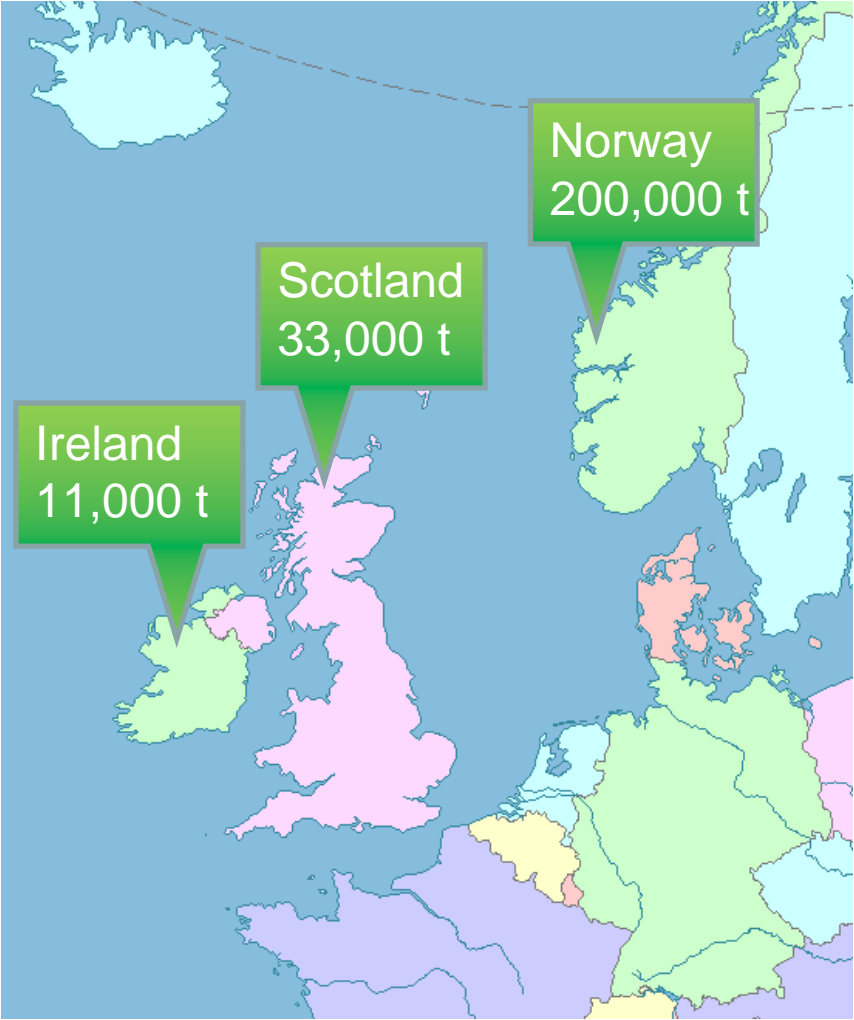








A collaborative effort

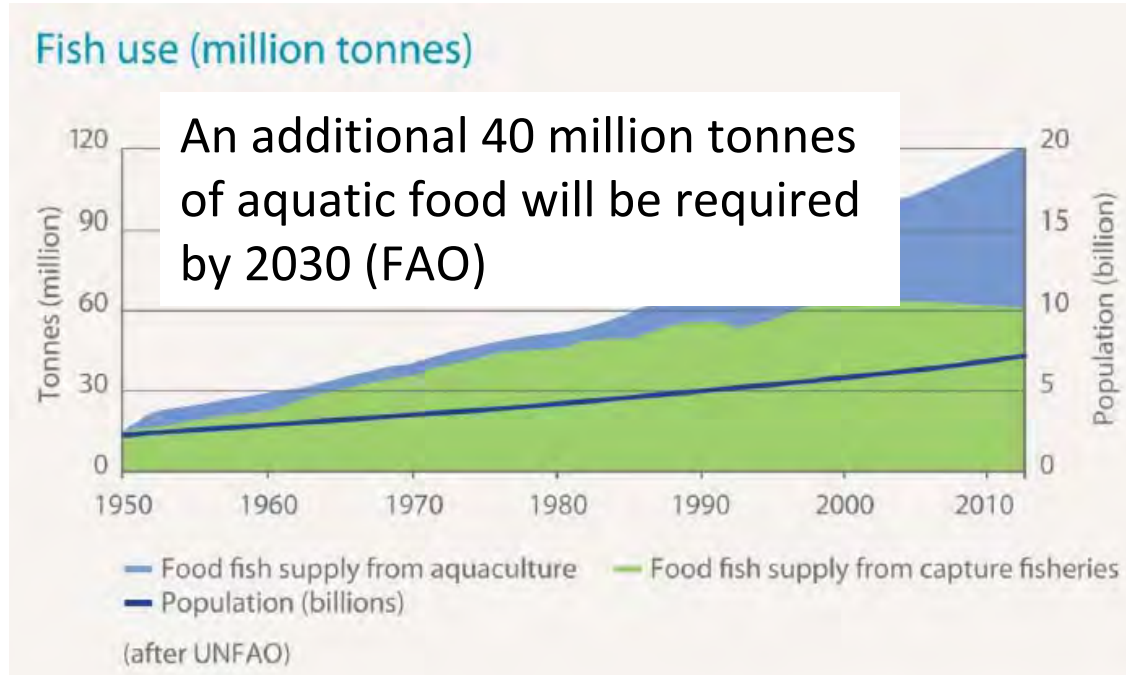


Salmon (*Salmo salar*) aquaculture in North East Europe (NEA)

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The future of salmon aquaculture in NEA

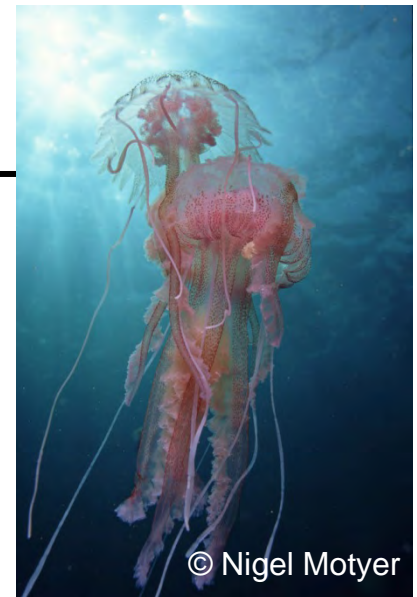


- However, there are a number of key problems:
 - Increasing competition for space
 - Environmental protection
 - Animal health – specifically Pancreas disease (PD), sea lice control and gill disorders & mass mortality events



Jellyfish that cause 'mass mortality events'

- There are four species that have caused major salmon fish kills in the past
 - The mauve stinger (*Pelagia noctiluca*)
 - *Muggiaea atlantica* (siphonophore)
 - *Apolemia uvaria* (siphonophore)
 - *Solmaris corona*



Doyle et al (2009) J Plankt Res

Baxter et al (2011) Aquacult Environ Interact









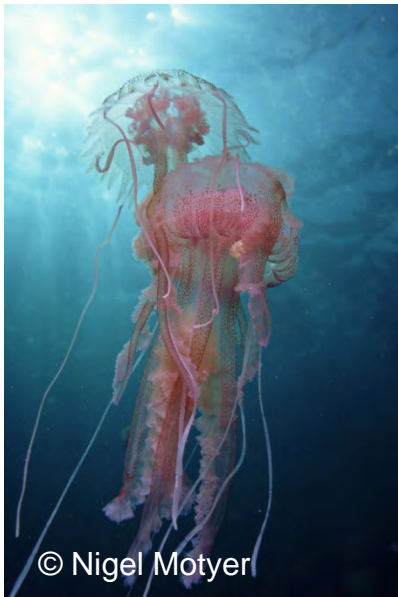
Other mass mortality events...

- >100,000 farmed salmon in Norway caused by the siphonophore *Muggiaea atlantica* (Fosså et al. 2003)
- This species was also a suspected causative agent of over 1,000,000 salmon killed off northwest Ireland in 2003 (Cronin et al. 2004)
- The siphonophore *Apolemia uvaria*, the oceanic hydromedusa *Solmaris corona* and the neritic hydromedusa *Phialella quadrata* have also been previously implicated in fish kill events (Bruno & Ellis 1985, Båmstedt et al. 1998)



Characteristics of jellyfish that cause mass mortality events

- Most are oceanic or shelf species (i.e. they need to be carried into an aquaculture site)
- Some of them can multiple very rapidly (3-4 weeks)
- Can occur in very high densities e.g. 100s – 1000s individuals m^{-3}
- Can occur in enormous aggregations 10s – 100s km^{-2} spatial extent



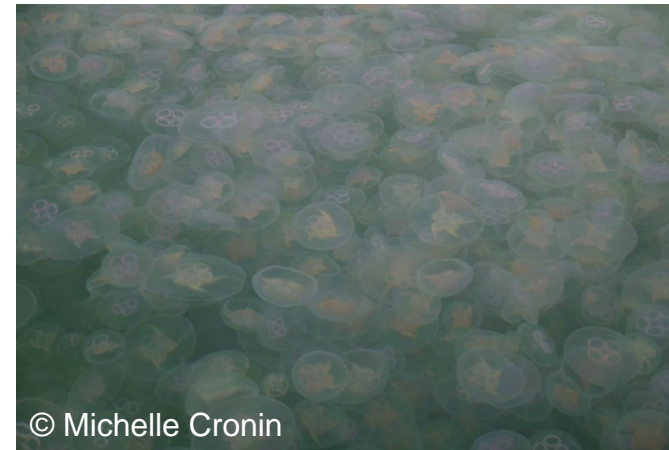
Gill disorders in salmon aquaculture

- Gill disorders may be multi-factorial with 1[□] damage caused by jellyfish and then 2[□] infection by bacteria or parasite
- Between 2003 and 2006 Irish farms suffered an average of 12% mortality due to gill disorders (Rodger & Mitchell 2005)



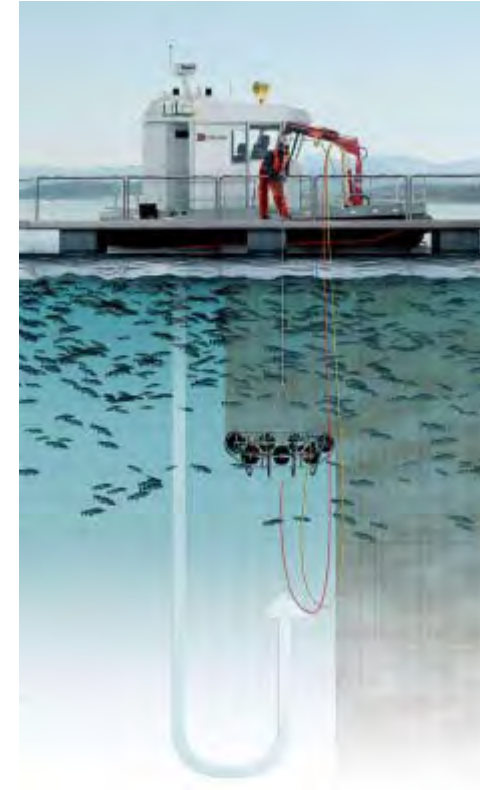
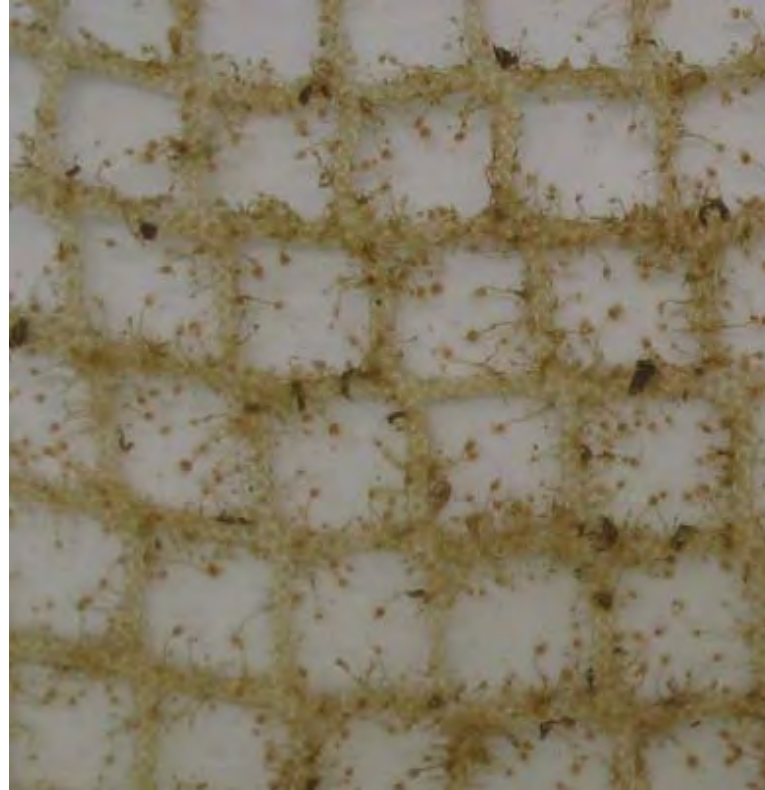
What species cause gill disorders?

- All jellies that cause mass mortality events (e.g. *Pelagia*, *Muggiaea*, *Solmaris*)
- Many small jellyfish species (e.g. *Phialella quadrata*) may cause background mortalities but also many large scyphomedusae e.g.
 - The common jellyfish (*Aurelia aurita*)
 - The Lion's Mane (*Cyanea capillata*)



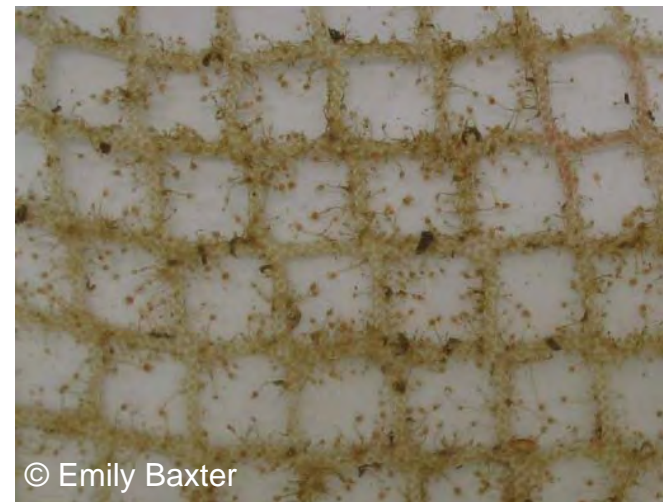
An unexpected cause of gill disorders – biofouling hydroids

- A problematic fouling organism on aquaculture installations is the colonial hydroid *Ectopleura larynx* (syn. *Tubularia larynx*)
- Two types of net cleaning are used: 1) In-situ net washing using high pressure jet washers and 2) changing of fouled nets



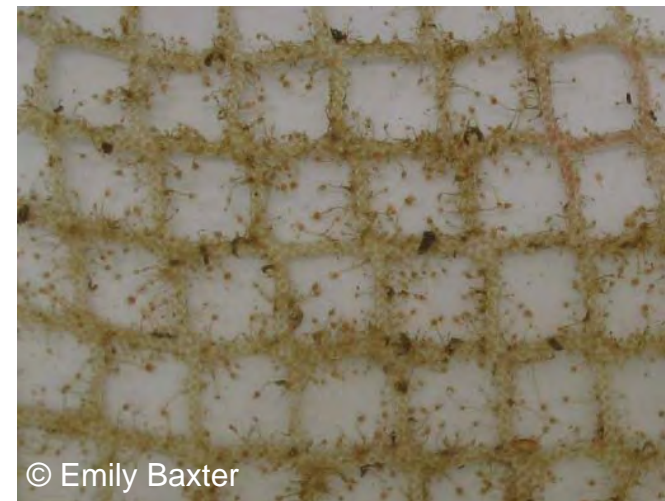
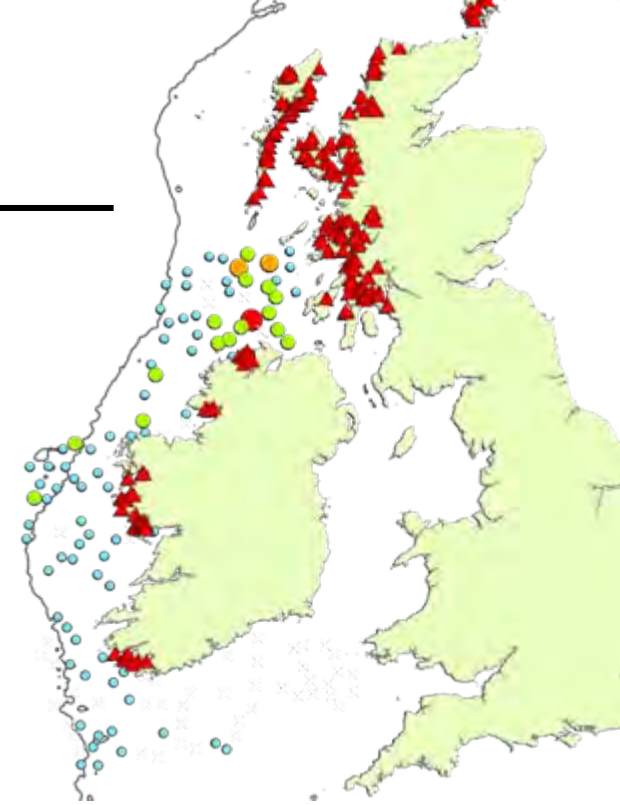
Characteristics of jellyfish that cause gill disorders

- No unifying characteristics but some generalisations can be made:
 - Occur in lower densities
 - Many are local species (home grown)
 - Hydrographic factors or behaviour may lead to local aggregations



So what are the real threats?

- Mass mortality event at a single farm:
 - *The Mauve stinger (Pelagia)*
 - *Muggiaea*
- Gill disorders at a national level:
 - At a single farm losses of 5-10% may seem acceptable, but when widespread such losses add up



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So where to next?

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- We know we have a growing problem...
hurricane analogy (batten down the hatches)



Development of an early warning system

- It would help if we knew when a jellyfish bloom is going to occur
- However, this is only part of the solution e.g. what do farmers do if they know a large bloom of *Pelagia* is heading their way?



How can the aquaculture industry 'batten down the hatches'?

- Bubble curtains...



- Design and field trials (several weeks) of such a system are required to assess the effectiveness of this technology and to investigate the operating parameters such as operating depth, pressure and air flow rates
- If it works, we need to develop low cost method for running the bubble curtains (renewable energy)

How can the aquaculture industry 'batten down the hatches'?

- Forcing salmon lower in the water...



- We need to understand the vertical distribution of jellyfish



How can the aquaculture industry 'batten down the hatches'?

- Moving aquaculture cages offshore



- Are there less aggregations further offshore?

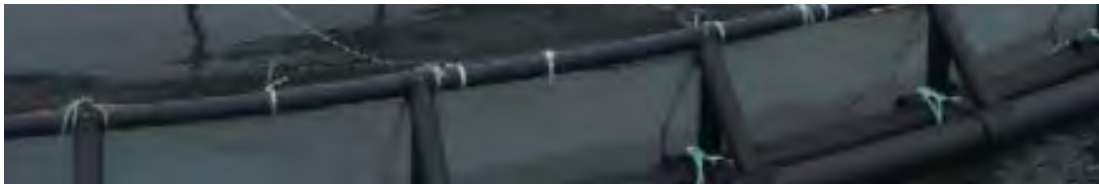


How can the aquaculture industry 'batten down the hatches'?

- New cage designs with rotating meshes and scrubbers

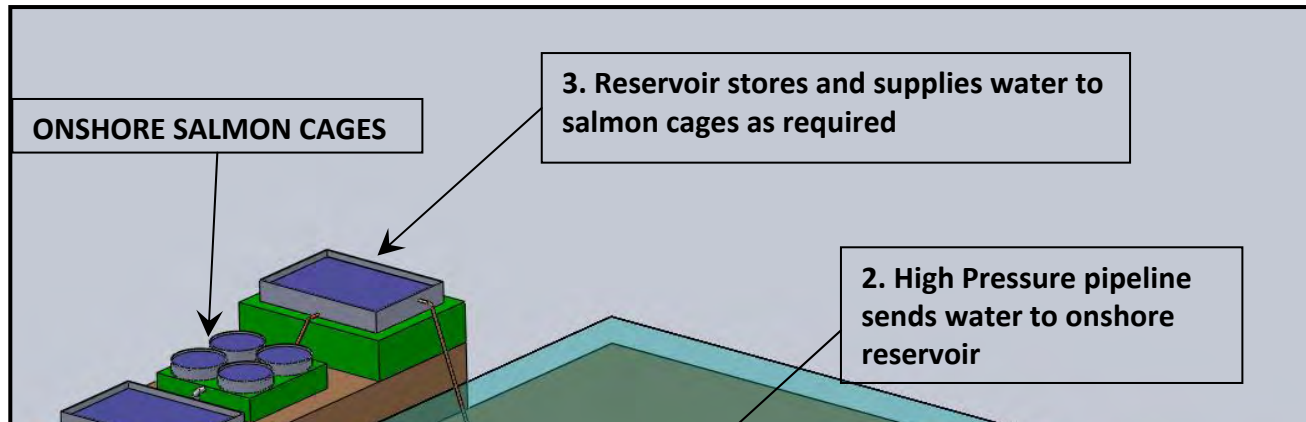


- Requires new cage design that is cost effective, and removes waste (jelly debris) generated from scrubbers



How can the aquaculture industry 'batten down the hatches'?

- Moving aquaculture onshore (closed containment systems)



- The high cost currently makes closed containment salmon aquaculture not commercially viable
- Concepts where renewable energy devices are used to meet the water flow and energy requirements of salmon farms should be developed and assessed technically, economically and in terms of their practicality.

which can be used onsite or sold to the grid. Energy can also be recovered from the high pressure water which can be used for aeration/ waste water treatment etc.

converters pump water to shore

The future?

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