Understanding the shellfish food requirements of birds

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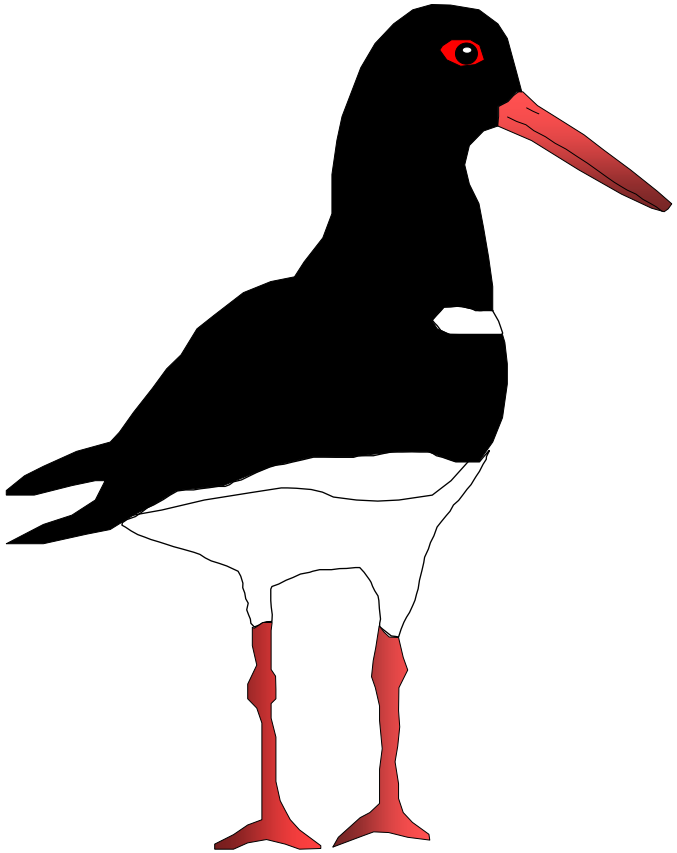
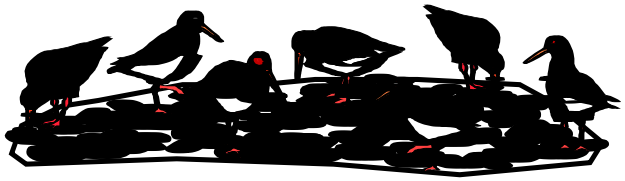
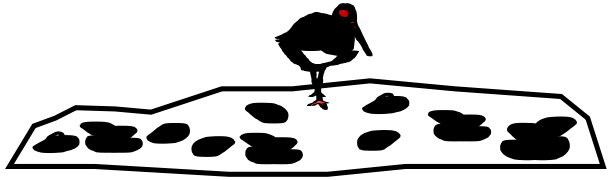
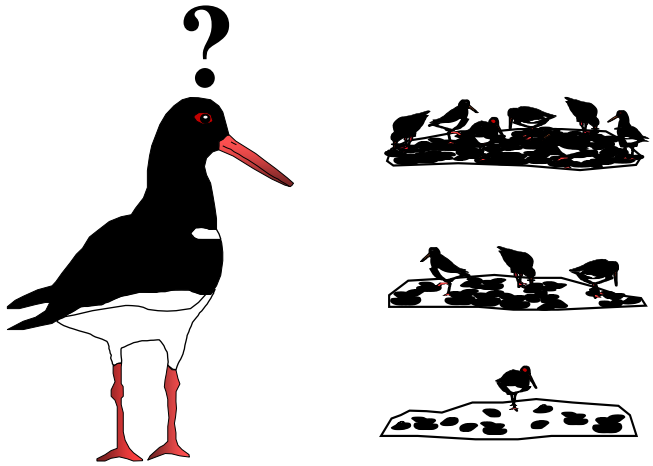




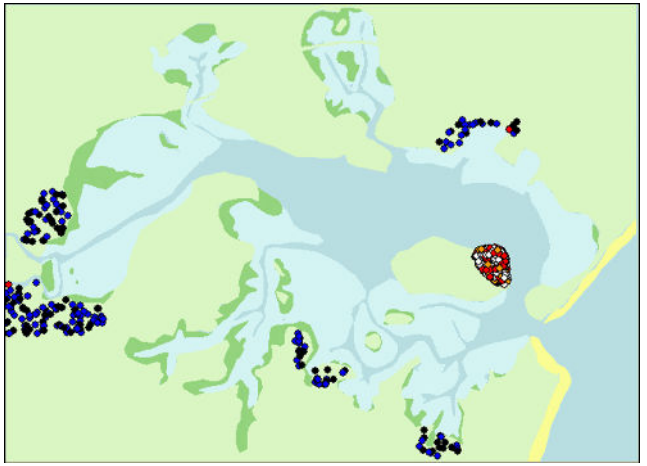


Linking behaviour to populations

Behaviour - understand how individual animals respond to changes in the environment
- Foraging behaviour – food competition, food supply
- Response to disturbance – habituation or desperation?
- Decision rules – trading-off costs and benefits



Population - Build computer models to predict how the population of animals will be affected
- based on behavioural research
- models mimic the behaviour of real animals



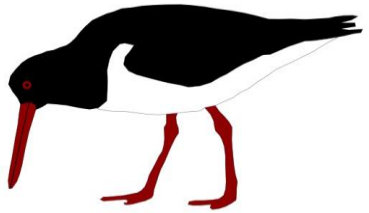
Contents of the talk

- Which bird species consume shellfish and what determines the size of shellfish consumed?
- What determines the amount of shellfish consumed by birds?
- How much shellfish is required in the environment for birds to have high survival?
- How can the requirements of bird be accounted for?

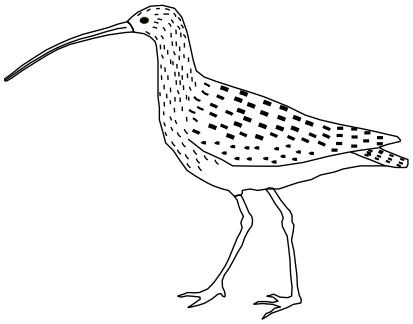
Birds that consume shellfish

(in approximate size order with feeding method)

- Dunlin - swallows shell
- Knot - swallows shell (bivalve specialist)
- Redshank - swallows shell
- Grey Plover - swallows shell
- Bar-tailed Godwit & Black-tailed Godwit - swallow shell
- Oystercatcher - opens shell
- Curlew - swallows shell
- Common Scoter - swallows shell
- Eider - swallows shell



Oystercatcher



Curlew

Size of shellfish consumed by waders

	Mytilus	*Mya*	*Cerastoderma*	*Scrobicularia*	*Macoma*	*Hydrobia*	*Corophium*	*Hediste**	*Arenicola*	*Carcinus*	*Crangon*
Bar-tailed godwit	—	—	—	8–19	8–19	—	—	25-max	25-max	—	—
Black-tailed godwit	—	—	—	8–19	8–19	—	—	25-max	—	—	4-max
Curlew	—	25-max	8–19	20–49	8-max	—	—	50-max	50-max	10–39	—
Curlew sandpiper/ dunlin	—	—	—	3–6	3–6	1–4	3-max	10–59	—	—	—
Grey plover	—	—	—	8–19	8–19	1–4	—	20-max	20-max	—	—
Knot	5–24	8–16	5–14	8–16	8–16	1–4	—	10–59	—	—	—
Oystercatcher	30–59	16–39	15-max	20-max	12-max	—	—	0–99.9	50-max	10–50	—
Redshank	—	7–13	—	7–13	7–13	1–4	4-max	15–79	—	3–7	4-max
Ringed/Kentish plover	—	—	—	—	—	1–4	3-max	10–49	—	—	—

* =and other worms too, such as *Lanice*, Cirratulids *etc*.

- Knot and oystercatcher are the main species that consume shellfish
- Oystercatcher consume shellfish within the usual fishable size range

What determines the amount consumed?

= the physiological requirement

- Daily energy requirements of the birds
  - depends on body mass
- Weather (temperature and wind speed)
  e.g. oystercatcher need to thermoregulate below 10^{o}c
- Other sources of increased energy demands
  e.g. disturbance
- Amount of flesh within prey shell
  - tends to decrease through the winter
- Energy content of the prey
  - can vary between species

Each oystercatcher can consumed around 1 kg of shellfish per day

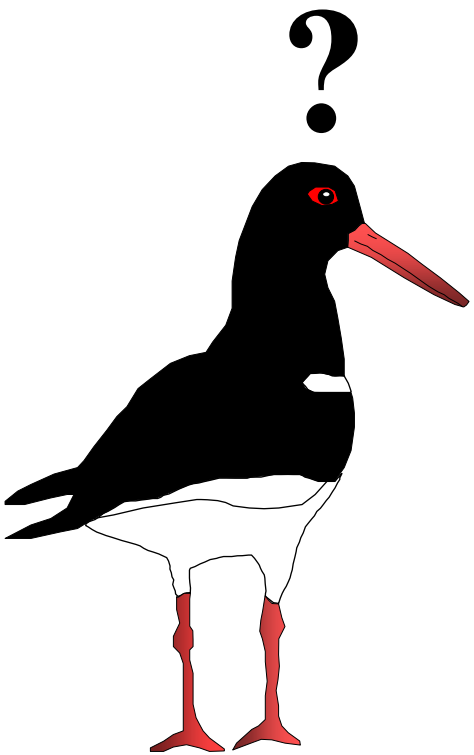
Predicting the amount of food required in the environment to maintain high wader survival

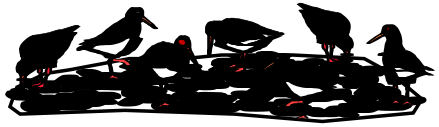
= the ecological requirement

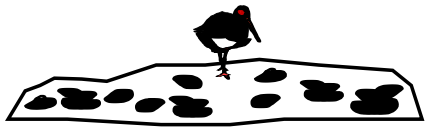
Ecological requirement could be larger than physiological requirement if:

- Birds cannot find all of the food
- Some birds are excluded from some food
- Some food is lost due to other causes

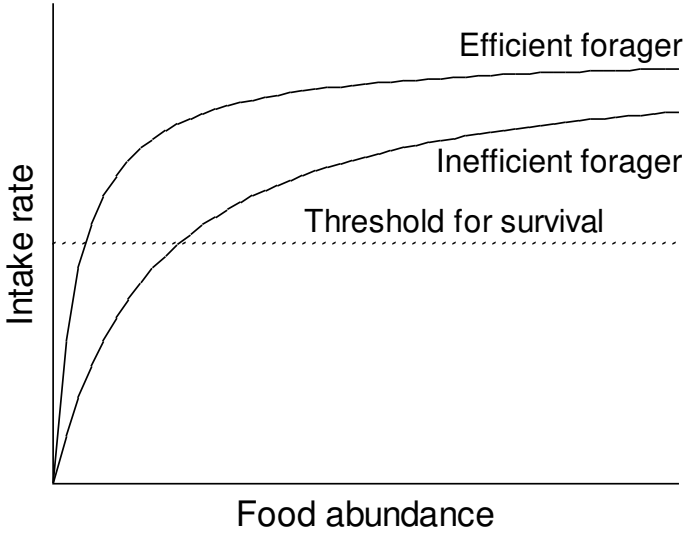
Foraging decisions



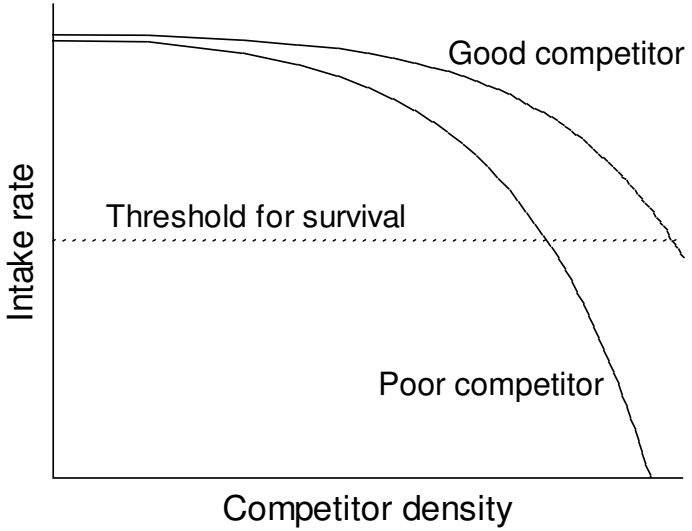




Food abundance

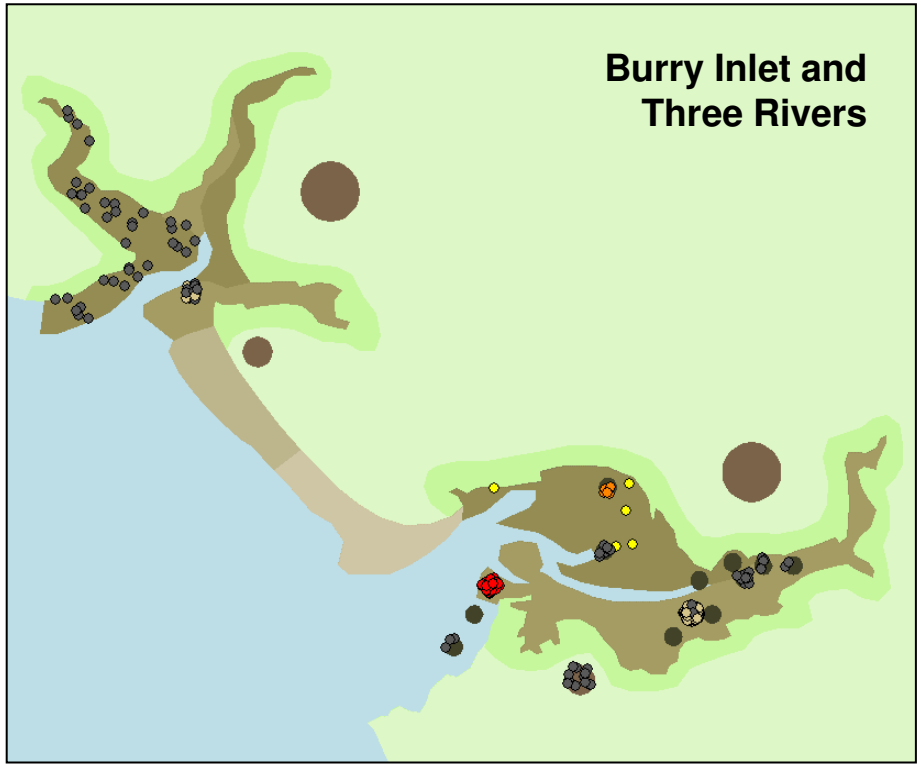


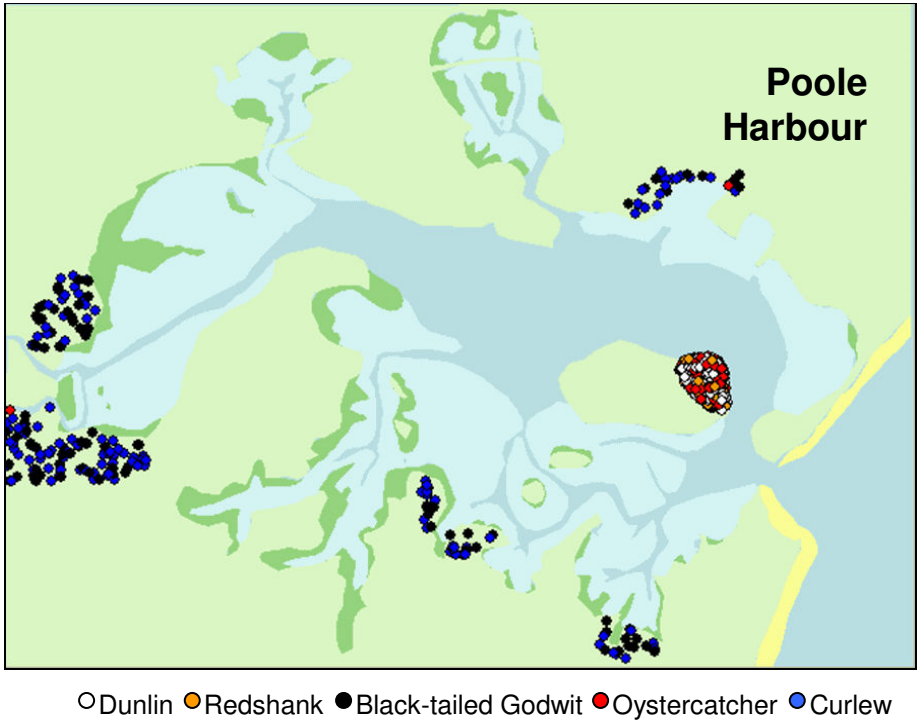
Competitor density



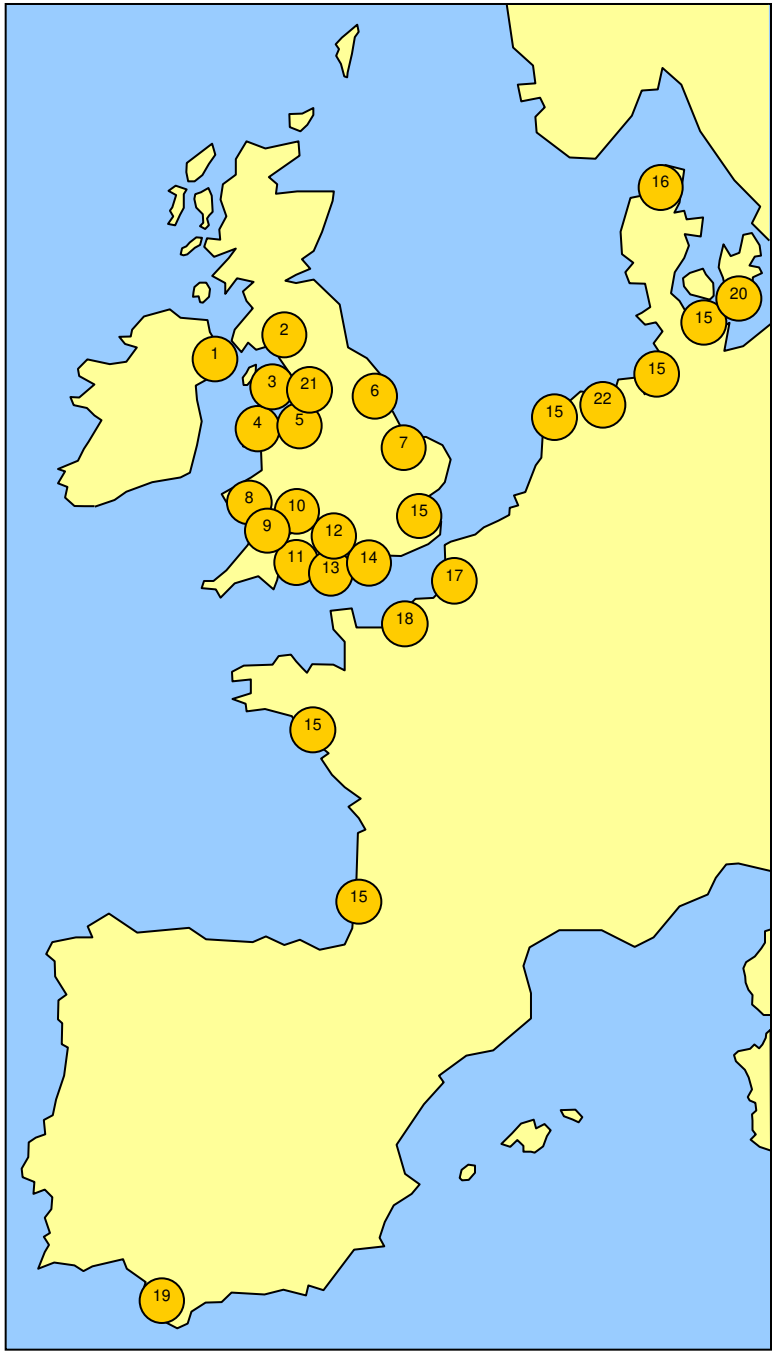
Also - food availability and quality

Creating a virtual environment





Sites, issues and species for which models have been developed



(1) Strangford Lough - Oystercatchers and cockle fishing
(2) Solway Firth - Shorebirds and shellfishing
(3) Liverpool bay - Scoter ducks and wind farms
(4) Menai Straits - Oystercatchers and mussel fishing
(5) Dee estuary - Oystercatchers and shellfishing
(6) Humber estuary - Shorebirds climate change and habitat loss
(7) Wash and North-Norfolk - Oystercatchers, Eiders and Brent geese
(8) Burry Inlet - Oystercatchers and shellfishing
(9) Cardiff Bay - Shorebirds and habitat loss
(10) Severn estuary - Shorebirds and tidal barrage development
(11) Exe Estuary - Shorebirds, shellfishing and disturbance
(12) River Frome - Mute swan grazing in chalk streams
(13) Poole Harbour - Shorebirds, shellfishing and disturbance
(14) Southampton Water - Shorebirds, habitat loss and disturbance
(15) Brent goose sites - Multi-site model of Brent geese
(16) Denmark - Pink-footed goose migration
(17) Baie de Somme - Hunting, shellfishing and shorebirds
(18) Baie de Seine - Shorebirds, port development and habitat creation
(19) Bahia de Cadiz - Fish farms, shellfishing, disturbance and shorebird
(20) Fehmarn Belt - Sea ducks and bridges
(21) Morecambe Bay - Oystercatchers, Knot and Shellfishing
(22) Lauwersmeer - Bewick's Swan and habitat choice

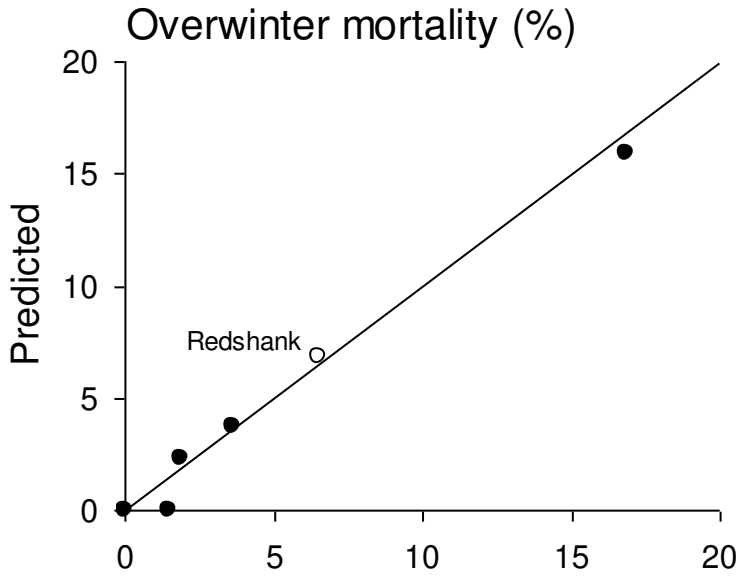
(21) Tasmania - Pied Oystercatchers and habitat loss

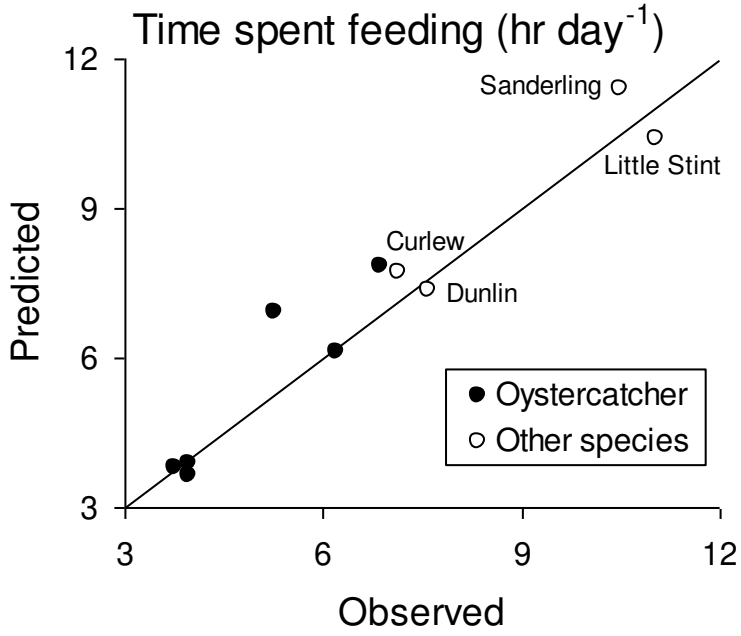
Sites, species, issues and tests

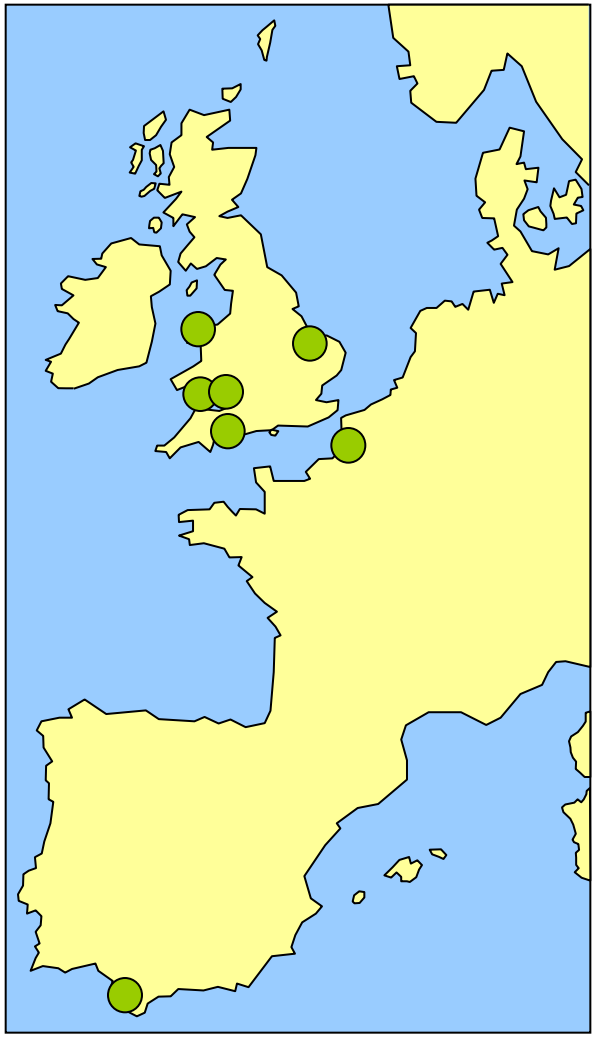
			Tests				
Site	**Species**	**Issues**	**Feed**	**Diet**	**Dist**	**Cond**	**Mort**
Burry Inlet, UK	oystercatcher, knot	Shellfishing, site quality	✓	✓	✓	-	✓
Bahia de Cadiz, Spain	nine shorebird species	Salinas, fish farms, shellfishing, disturbance	✓×	✓×	✓	-	-
Caerlaverock, UK	barnacle goose	Habitat change	-	-	✓	✓	-
Cardiff Bay, UK	redshank	Habitat loss	-	-	-	-	✓
Dee estuary, UK	knot, oystercatcher	Shellfishing	-	-	-	-	-
Exe estuary, UK	oystercatcher	Shellfishing	✓	✓	✓	✓	✓
Exe estuary, UK	six shorebird species	Disturbance, site quality, sea level rise	-	-	✓	-	-
Humber estuary, UK	nine shorebird species	Sea-level rise, port development, habitat loss	-	✓	✓	-	-
Liverpool bay, UK	common scoter	Wind farms, habitat loss, disturbance	-	-	✓	-	-
Menai Straits, UK	oystercatcher	Shellfishery management	✓	-	✓×	-	-
Poole Harbour, UK	five shorebird species	Sea-level rise, site quality	-	-	✓×	-	-
Poole Harbour, UK	oystercatcher	Shellfishing, invasive species	-	✓	✓	-	-
Baie de Seine, France	dunlin, oystercatcher, curlew	Port development, habitat creation	-	✓	✓	-	-
Solway Firth, UK	knot, oystercatcher	Shellfishing	-	-	-	-	-
Baie de Somme, France	dunlin, oystercatcher, curlew	Hunting, shellfishing, sedimentation, site quality	✓	-	✓×	-	-
Southampton Water, UK	eight shorebird species	Port development, habitat loss, site quality	-	✓	✓	-	-
Strangford Lough, UK	oystercatcher	Shellfishing	-	-	-	-	-
Wash, UK	oystercatcher	Shellfishing	-	-	-	-	✓
Wash, UK	eight shorebird species	Site quality	-	✓	-	-	-
Wash, UK	eider	Shellfishing	✓	✓	✓	-	-
Western Europe	brent goose	Agriculture, habitat loss, hunting, disturbance	✓	✓×	✓×	✓	✓

From Stillman & Goss-Custard (2010) Biological reviews

Testing predictions

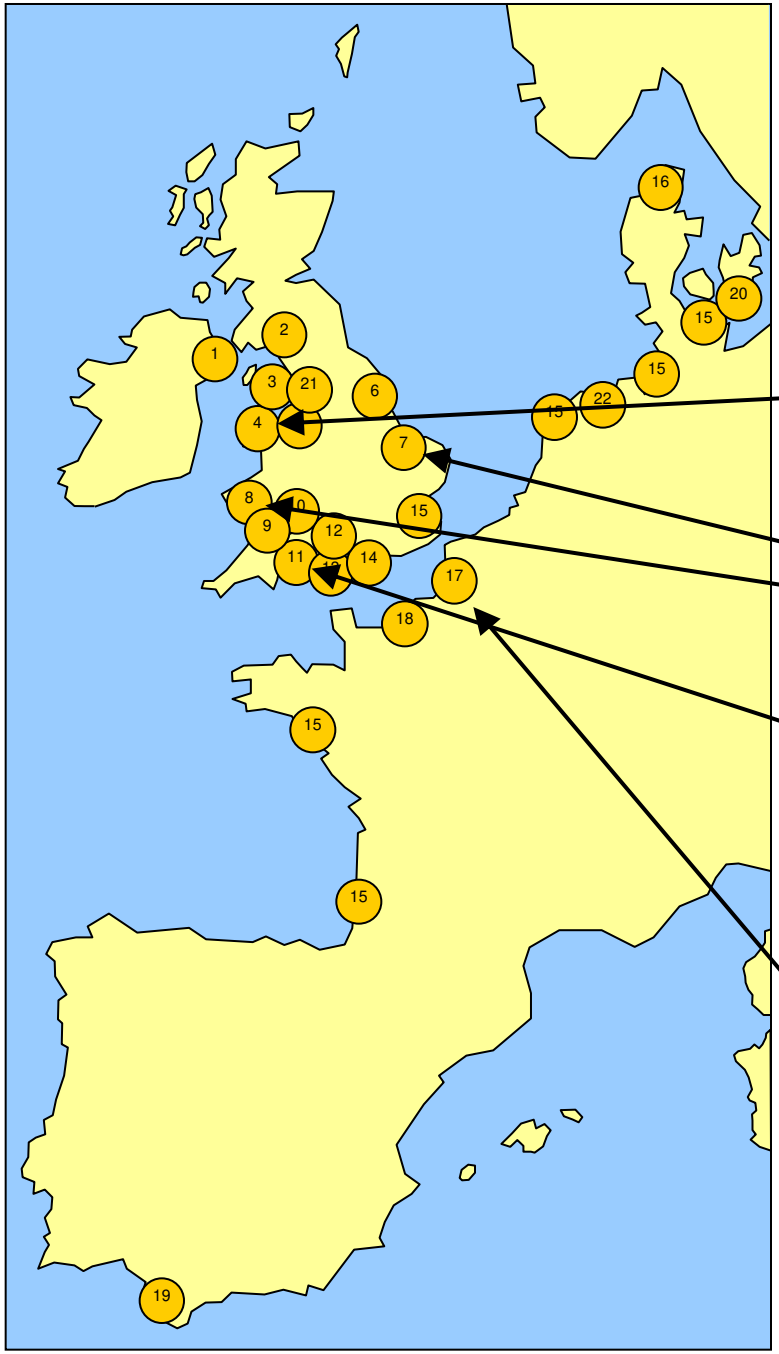






Sites on which model predictions have been tested

Shellfishing



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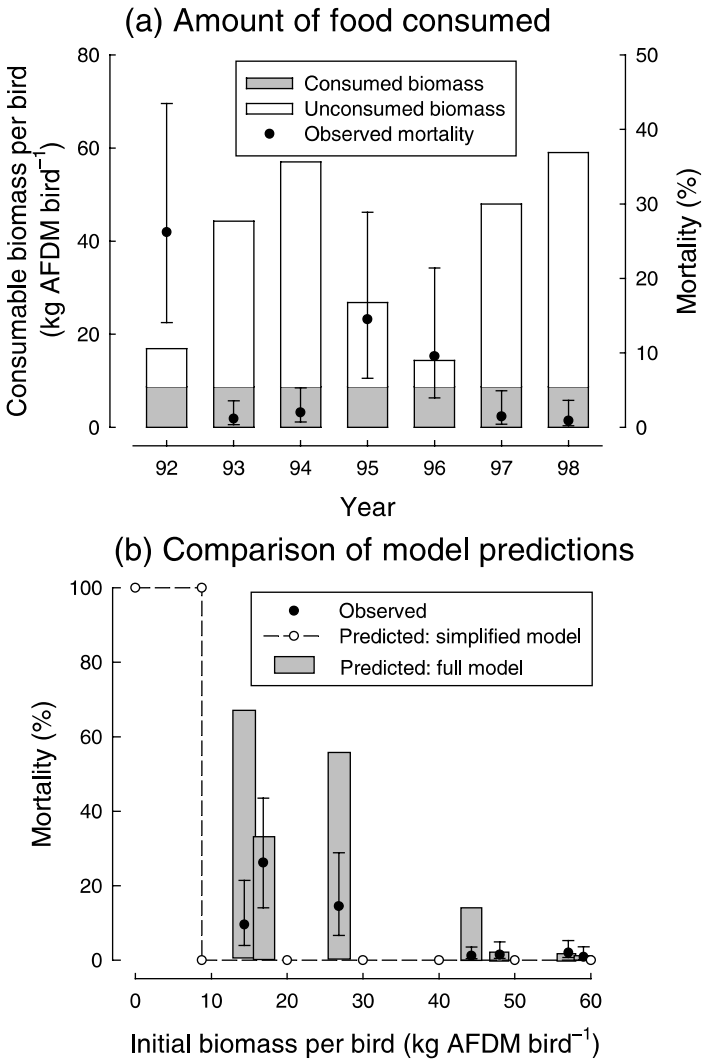
Oystercatcher in The Wash

- Birds observed to die before all food is consumed
- Predicted (full model) and observed mortality higher in years when less than 30 kg ash-free dry mass (AFDM) per bird
- Mortality underestimated if birds assumed to be able to find all food (simplified model)



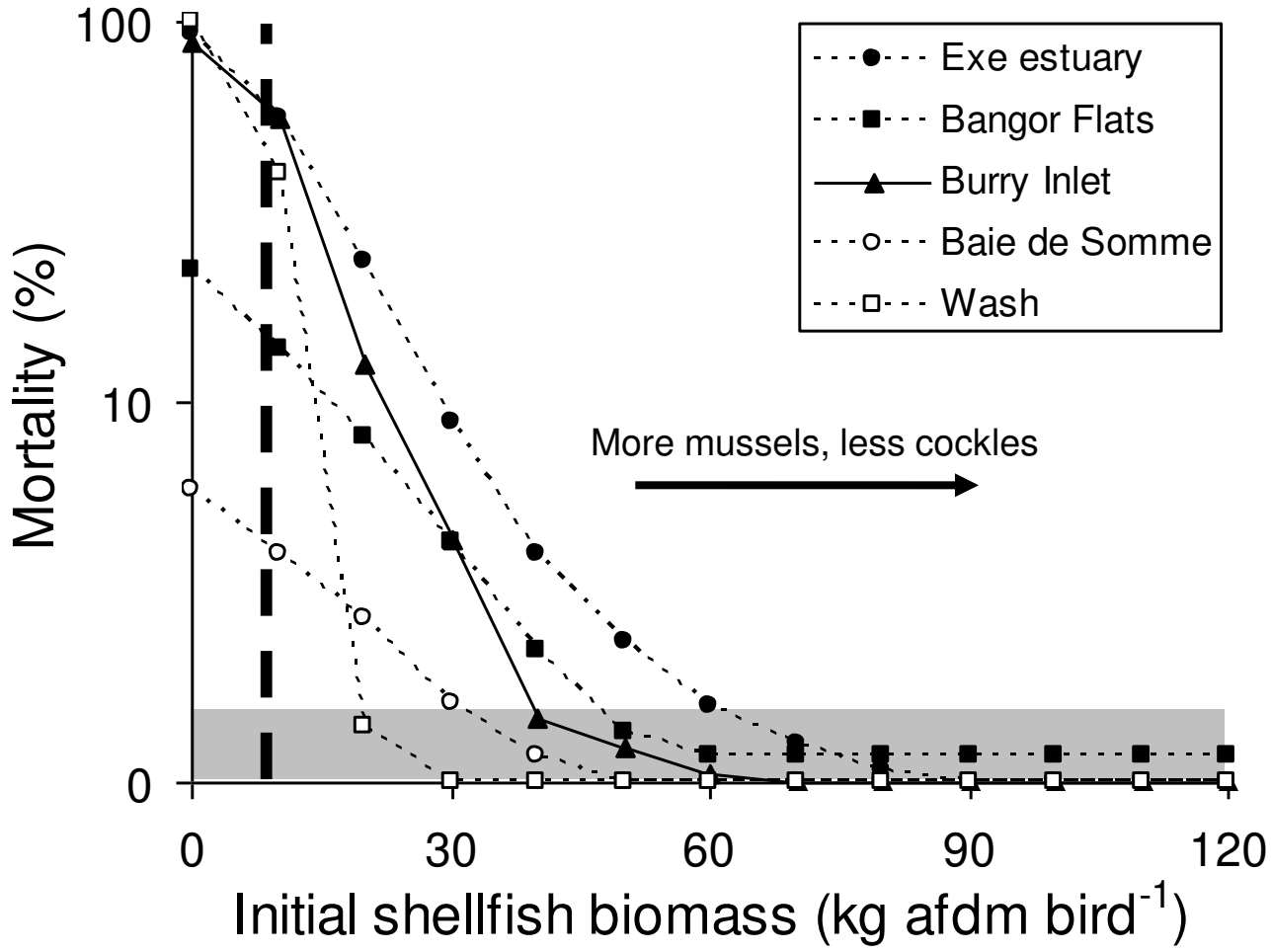
Recommendations in the Menai Strait

- Small seed mussels should be laid in mid-shore areas
  - small losses to oystercatchers, crabs and starfish
- After one year should be re-laid further downshore and spread over a larger intertidal area
  - increased mussel growth and reduced availability to oystercatchers
- Prior to harvest, should be re-laid as far downshore as possible and packed as tightly as possible
  - minimize accessibility to oystercatchers, too large for all but the largest crabs, and comparatively short period for starfish predation

How much food needs to be reserved for oystercatchers?

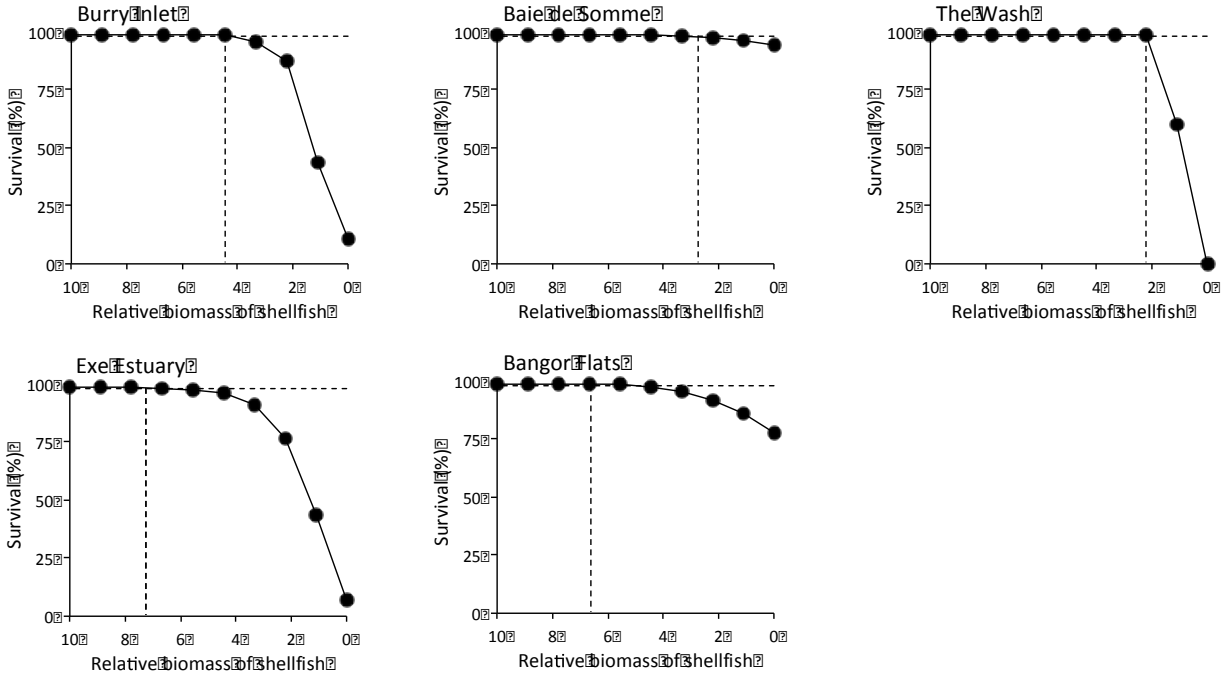
Up to 8 times the amount actually consumed

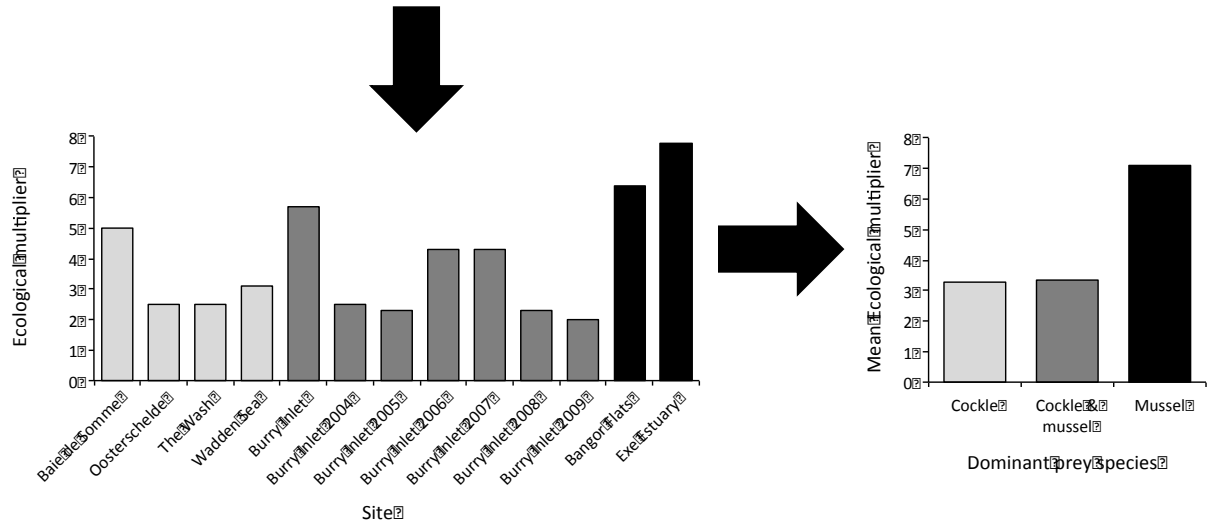
= ecological requirement up to 8 times physiological requirement



NB: Observed data show the same trend for Exe estuary and Wash. No suitable data for other sites.

How can the requirements of bird be accounted for?





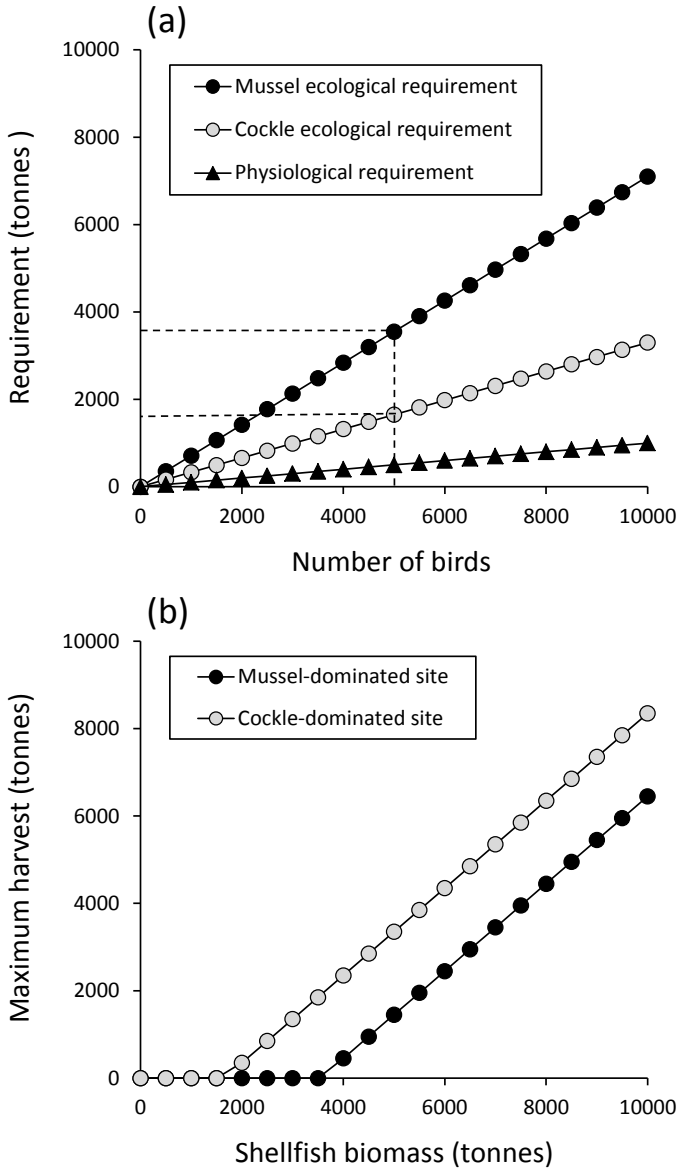
Shellfish food requirement of oystercatchers

Ecological requirement =

3.3 x Physiological requirement if site cockle dominated or a mixture of cockles and mussels

7.1* x Physiological requirement if site dominated by mussels

* as mussels more aggregated and so more birds can be excluded from the food supply



Next steps

- Look for similar “rules of thumb” in other species
- Develop website through which calculations can be made
- Website purpose is to allow any stakeholder to calculate food requirements of the birds to inform shellfishery management