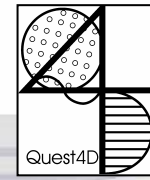


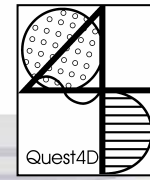
How to integrate historic knowledge in defining GES for gravel bed integrity

J.-S. Houziaux – BMM/UGMM

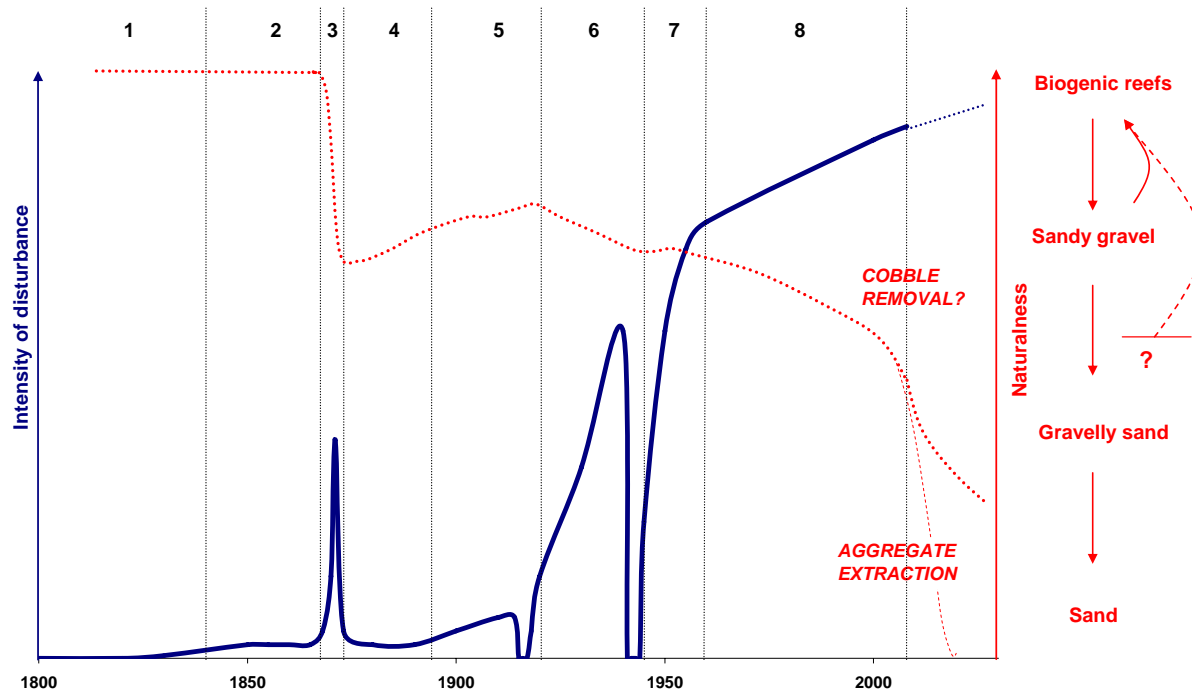


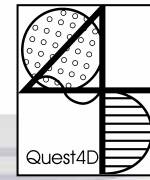
Baseline situation: gravels of the southern bight

- Three main aspects:
 - Hard substratum
 - High levels of associated benthic biodiversity through branching fauna (sponges, hydrozoans, bryozoans, ...)
 - European flat oysters: “deep-sea” beds
 - Provision of biogenic reef structures on top of sandy gravel
 - Provision of propagules: “source” populations => ‘seeding’ coastal beds?
 - Down’s herring: gravels used for spawning
 - Herring is a major prey species in the North Sea ecosystem
 - North Sea historic spawning grounds seem abandoned
- One major pressure through time : dredge and trawl fisheries
 - Gravel beds and biogenic reefs are most sensitive (Kaiser et al, 2006)
- Evaluation of long-term changes
 - Historic data (one survey + literature)
 - Chronology of human-induced disturbance
 - Recent data (one survey!)

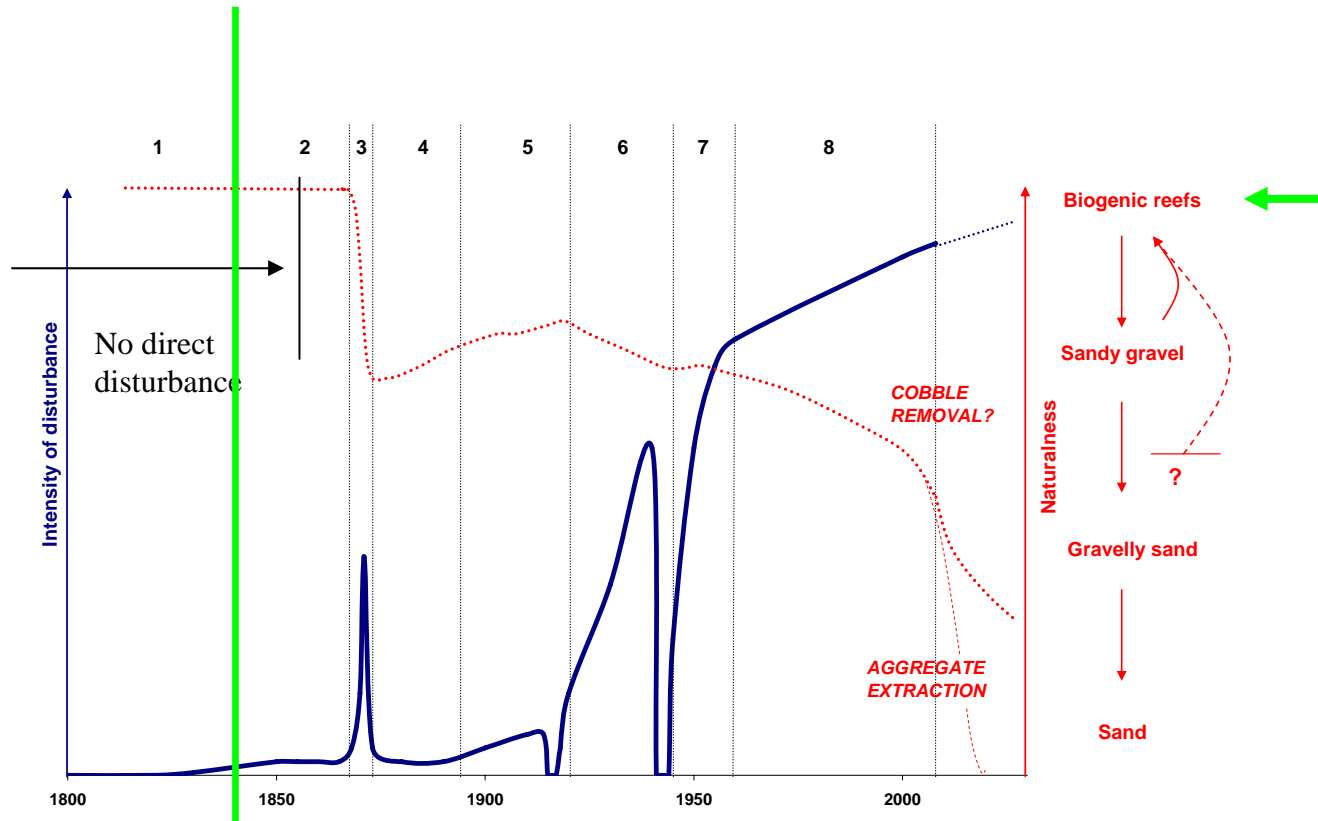


Conceptual model of habitat degradation: Westhinder gravels

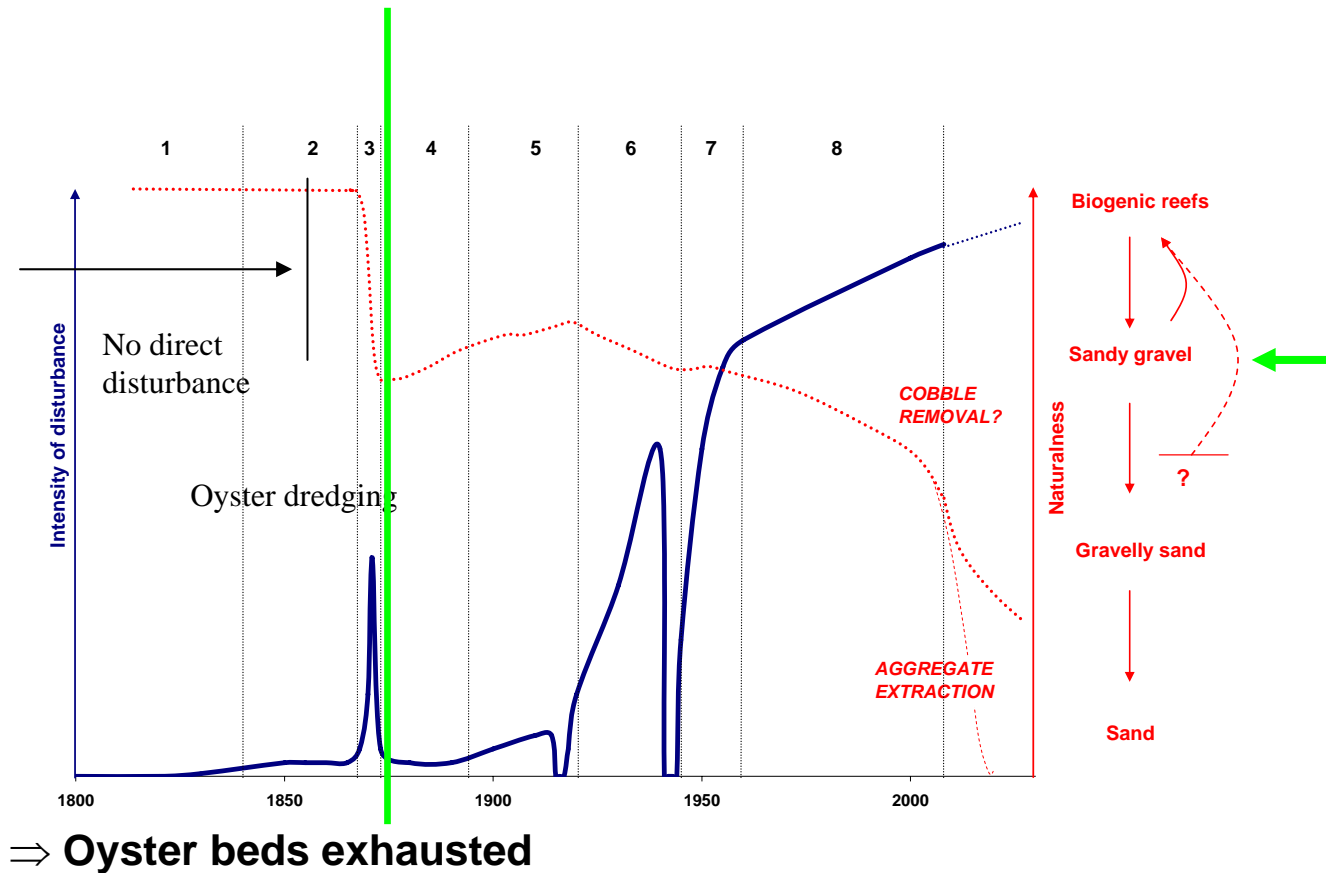




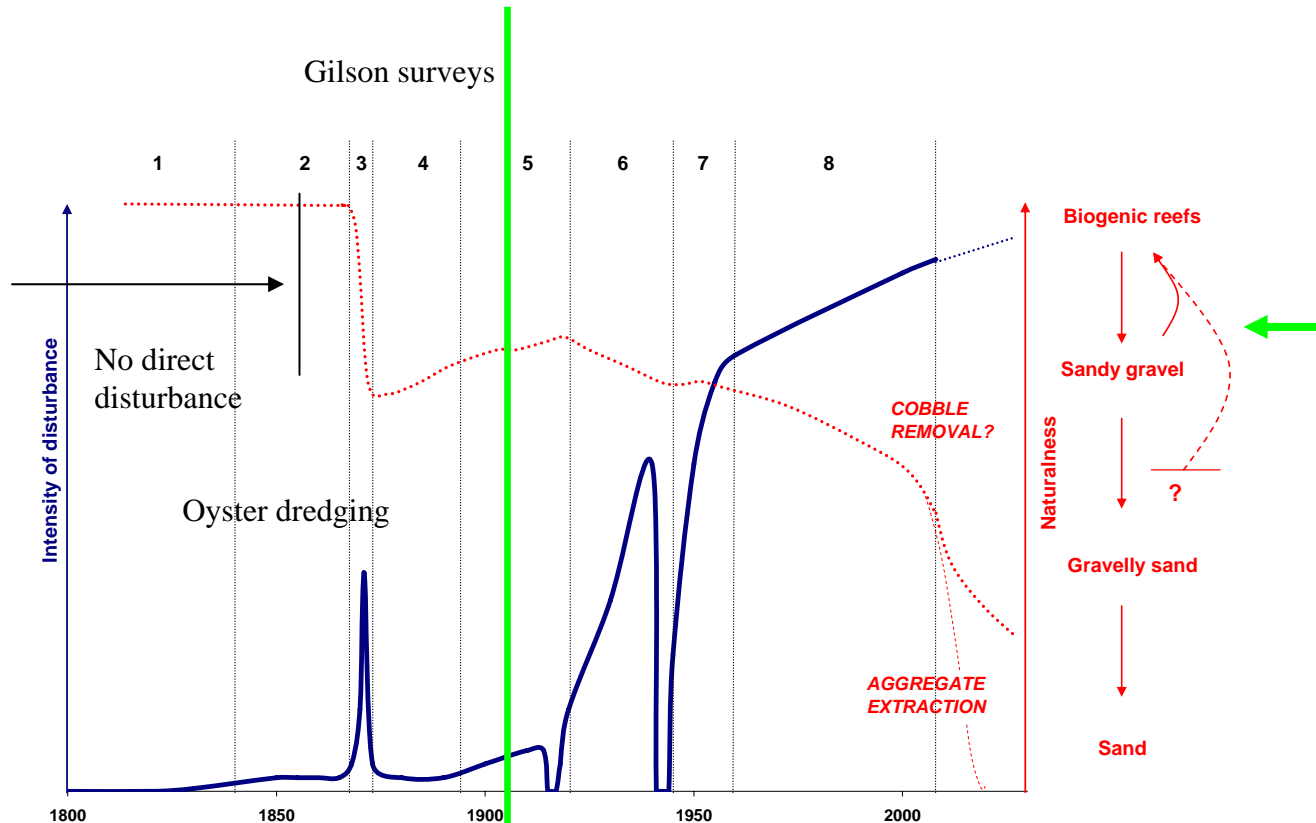
Conceptual model of habitat degradation: Westhinder gravels



Conceptual model of habitat degradation: Westhinder gravels



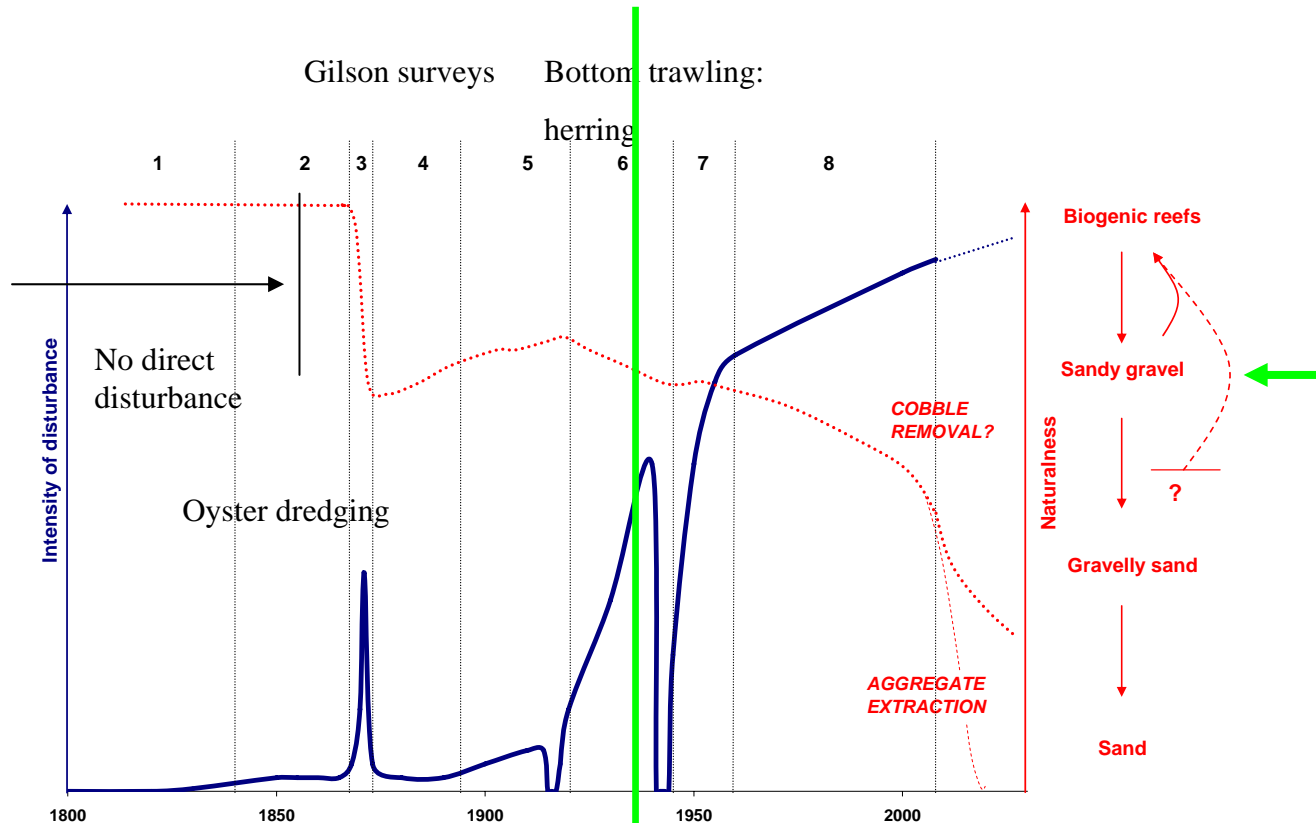
Conceptual model of habitat degradation: Westhinder gravels



⇒ Oyster beds exhausted

⇒ Recovery : $\geq 50-100$ y !

Conceptual model of habitat degradation: Westhinder gravels

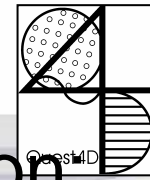


⇒ Oyster beds exhausted

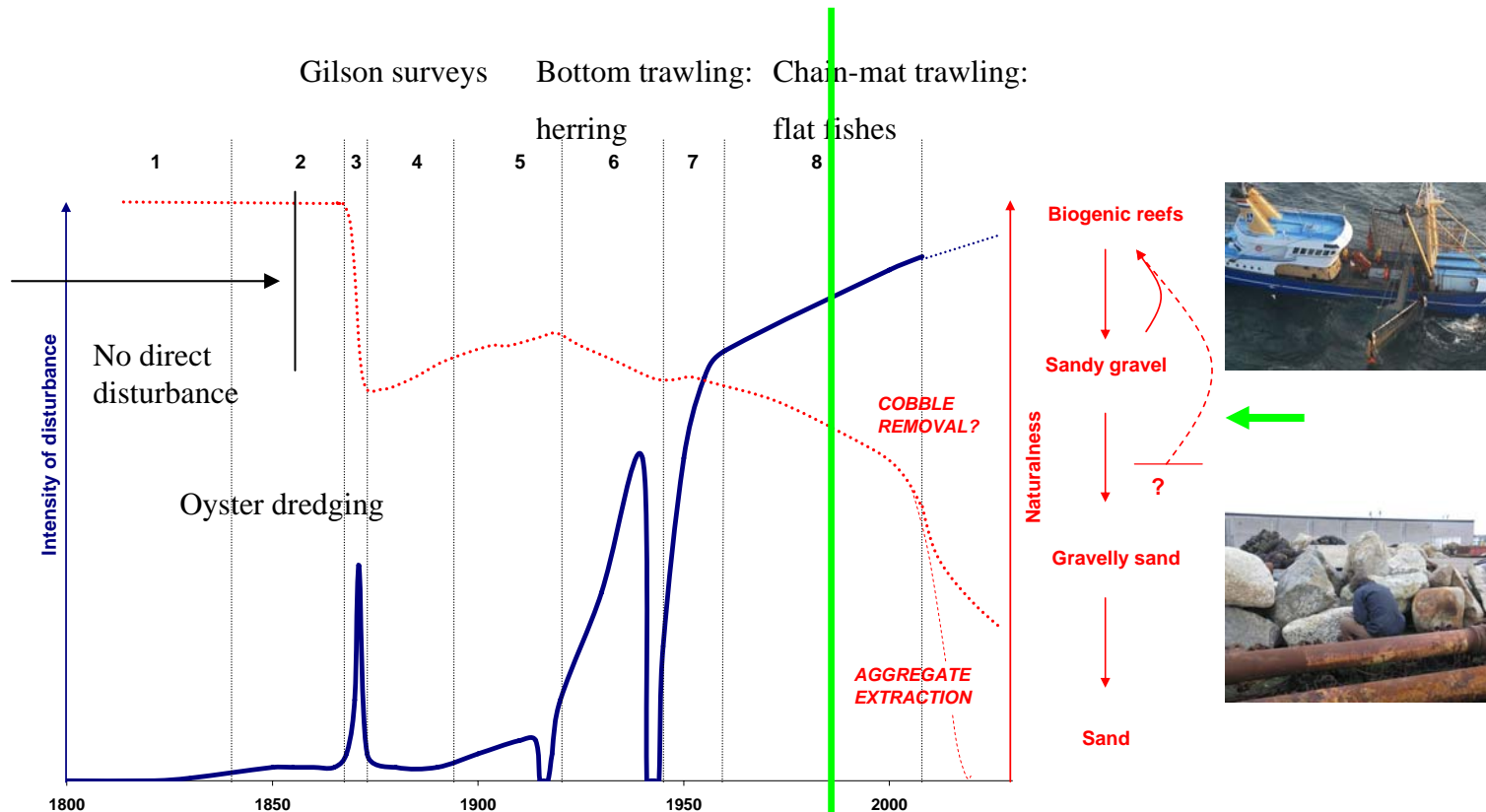
⇒ Recovery : $\geq 50-100$ y !

⇒ bottom trawl fisheries

(otter trawls)



Conceptual model of habitat degradation: Westhinder gravels



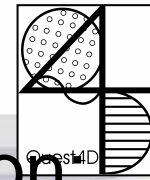
⇒ Oyster beds exhausted

⇒ Recovery : $\geq 50-100$ y !

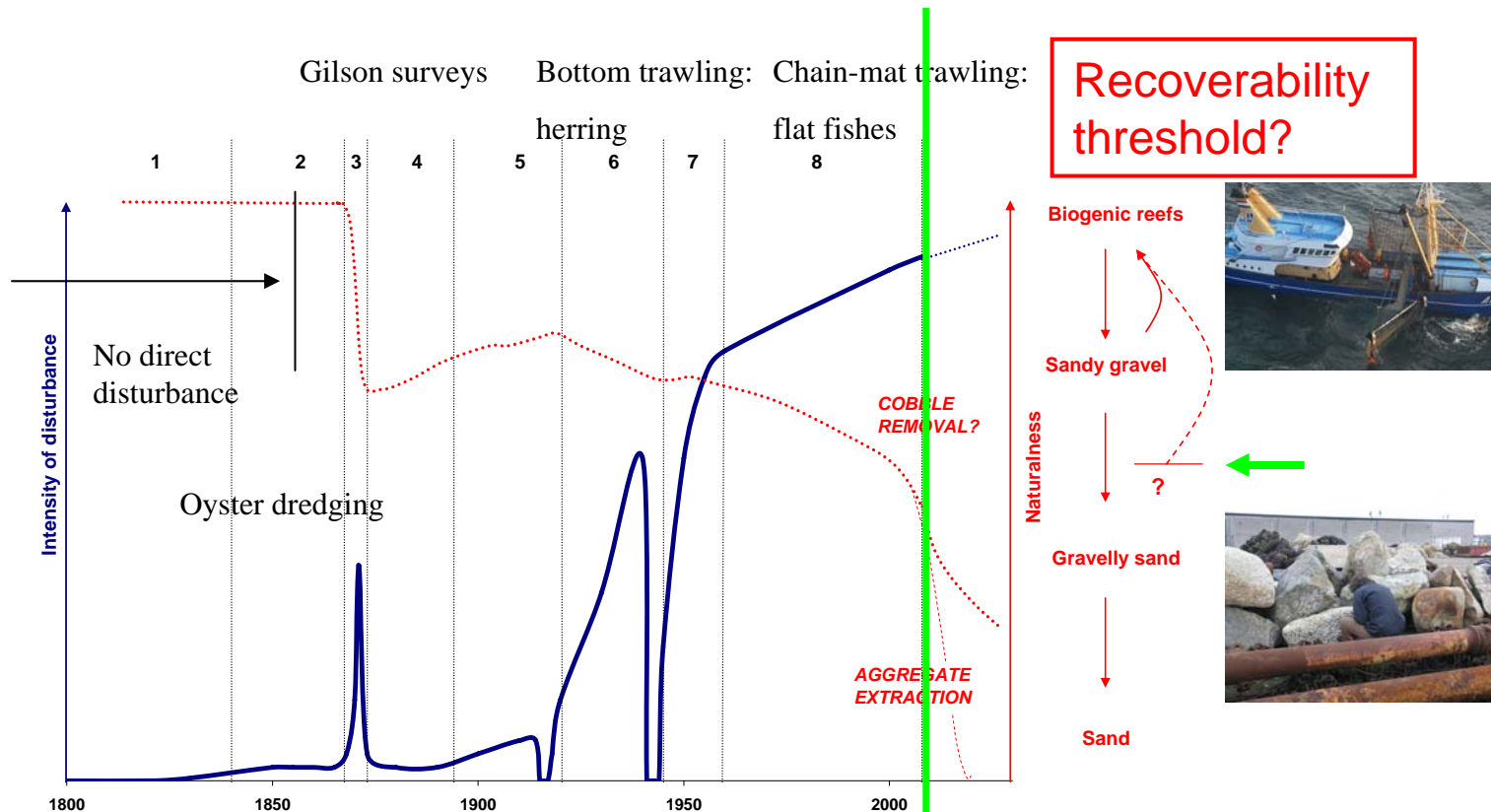
⇒ bottom trawl fisheries

(heavy chain-mat beam trawls)

(+ Eutrophication)



Conceptual model of habitat degradation: Westhinder gravels



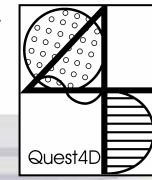
⇒ Oyster beds exhausted

⇒ Recovery : $\geq 50-100$ y !

⇒ bottom trawl fisheries

(heavy chain-mat beam trawls)

⇒ Recoverability of seafloor integrity?



Characteristic and numerically dominant species

'PRISTINE' (< 1860):

Flat oyster beds -biogenic reef structures + sandy gravel +

Invertebrates:

- **Ostrea edulis**
=> **PATCH REEFS**
- **Alcyonium digitatum** (octocorallia) **LARGE**
- **Pomatoceros triqueter** (worm)
- **Sabellaria spinulosa** (worm)
Cirone cellata (a sponge)
- Hydrozoans (Tubularia, Sertularia, Abietinaria, Hydrallmania, etc)
- Ascidians (e.g. *C. intestinalis*)
- **Paguridae** (hermit crabs)
- (... + Large array of associated less common species)

Fishes

- Large rays!
 - **R. clavata thornback**
 - **D. pastinaca eagle**
- **Herring (spawning)**
- Flat fishes in sandy gravel patches?
- Gobies
- Young cod?

Moderately disturbed (1900s):

Scattered oyster aggregates + sandy gravel

Invertebrates

- **Ostrea edulis** (aggregates)
- **Pomatoceros triqueter**
- **Sabellaria spinulosa**
- **A. digitatum**
- **Pisidia longicornis** (small crab)
- **Flustra foliacea** (a branching bryozoan)
- **Mytilus edulis** (common mussel)
- **Galathea intermedia** (a decapod crustacean)
- **Paguridae** (hermit crabs)
- **Lepidonotus squamatus** (a typical worm)
- Hydrallmania (a hydrozoan)
- Bryozoan eating sea-slugs

Fishes:

- Lesser spotted dogfish (egg case attachment to branching colonies)
- **Herring (spawning)**
- Flat fishes – dab, sole
- Gobies
- Young cod?

Heavily disturbed (2000s):

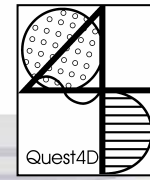
Disturbed sandy gravel
(+ eutrophication effect?)

Invertebrates

- **Asterias rubens**
- **Ophiura albida**
- **Pomatoceros triqueter** (*)
- **Tubularia indivisa** (* C)
- **Tubularia larynx** (* C)
- **Psammechinus miliaris**
- **Electra pilosa** (* C)
- **Paguridae**
- **Swimming crabs (Liocarcinus)**
- *Necora puber*
- **Pisidia longicornis**
- (Actiniaria) *Metridium senile* (*)
- *Ciona intestinalis* (*)
- *Alcyonidium digitatum* (* C)
- SMALL
- **Ophiothrix fragilis**
- Hydrozoan-eating sea-slugs

Fishes:

- Flat fishes – Dab, Sole
- *E. vipera*
- Gobies
- Sea horses observed!



“Good Ecosystem State” for open-sea gravels: lessons from the past

- Occurrence of **biogenic reef structures** formed by **branching epifauna and/or flat oysters**
- Large proportion of **seafloor occupied by hard substratum**, i.e. limited sand content
(metrics: percentage cover - how to evaluate what is ‘good’...?)
- **High level of diversity and evenness in the associated species**, not numerically dominated by opportunistic species, occurrence of older / larger animals, no impact by invasive species
(metrics: species composition; diversity indices, biomass and species size spectra; natural history / sensitivity traits proportions = functional composition)
- Optimum habitat for **herring** to spawn? (=> effect on recruitment – link with herring stock management)
(metrics: herring larvae densities, targeted autumn monitoring?)
- Optional? Occurrence of **beds of the European flat oyster**
(metrics: oyster densities, reef height, reproductive activity + associated biodiversity monitoring)
 - => Provision of larger “reef” structure above the seafloor (elevation level?)
 - => Metapopulation of oysters; source / sink dynamics on the larger scale?
- **Natural fragmentation: Connectivity** with other similar habitats (larvae spreading)

=> Integration of targets and measures at regional level !