



Figure 1. The warship Vasa displayed at the Vasa museum in Stockholm, Sweden.



Figure 2. Heavy attack by *Teredo navalis*. The mollusc penetrates and digests the wood material forming up to one centimetre wide tunnels.

Work packages (WP)	Title
WP 1	Coordinating present biological and environmental data
WP 2	Review of methods for protection of historical wreck and settlements in marine environments
WP 3	Strategy and tools for protection of cultural heritage
WP 4	Dissemination to stakeholders, managers and conservators

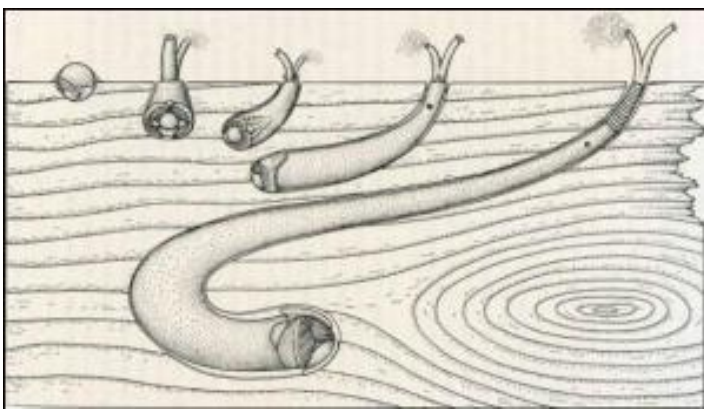


Fig. 3a. Life-cycle of *T. navalis* from Nair and Saraswarthy 1971

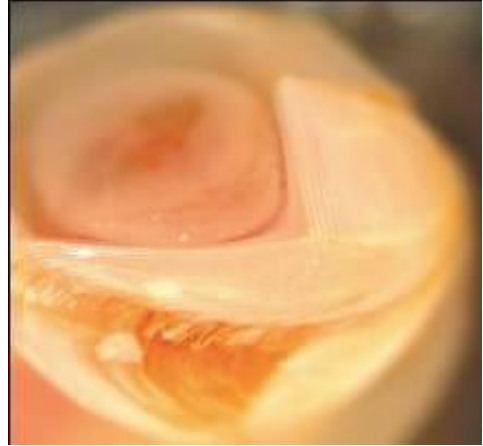


Fig. 3b. Shell and muscular foot (\varnothing 5mm) of an adult *T. Navalis*. Photo C. Appelqvist.



Figure 3c. Front part of an adult shipworm, 60 mm long.

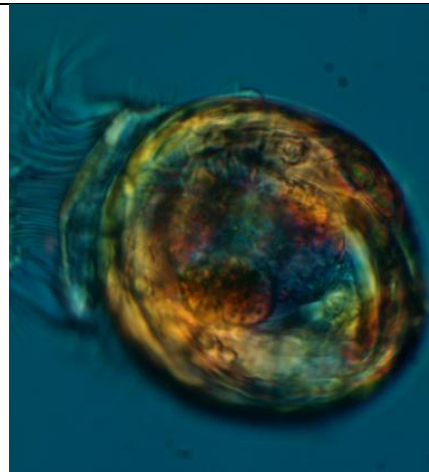


Figure 3d. Larvae of *Teredo navalis*, \varnothing 0,120 mm.

Results: Larvae (Top-layer)

Temperature ($^{\circ}\text{C}$)	< 7 lethal	7 – 12 survival	> 12 optimal for development
Salinity (PSU)	< 5 lethal	5 – 8 survival	> 8 minimum metamorphosis
Oxygen ($\text{mg O}^2/\text{l}$)	< 1 lethal 24 hr	1 – 4 effect on physiology	> 4 healthy condition
Currents (cm/s)	10	10-20	> 20

Results: Adults (bottom-layer)

Temperature (°C)	< - 2 lethal	2 – 11 survival	> 11 reproduction possible
Salinity (PSU)	< 4 lethal	4 – 8 survival	> 8 reproduction possible
Oxygen (mg O ² /l)	< 1 lethal 4 wks	1 - 4 effect on physiology	> 4 healthy condition

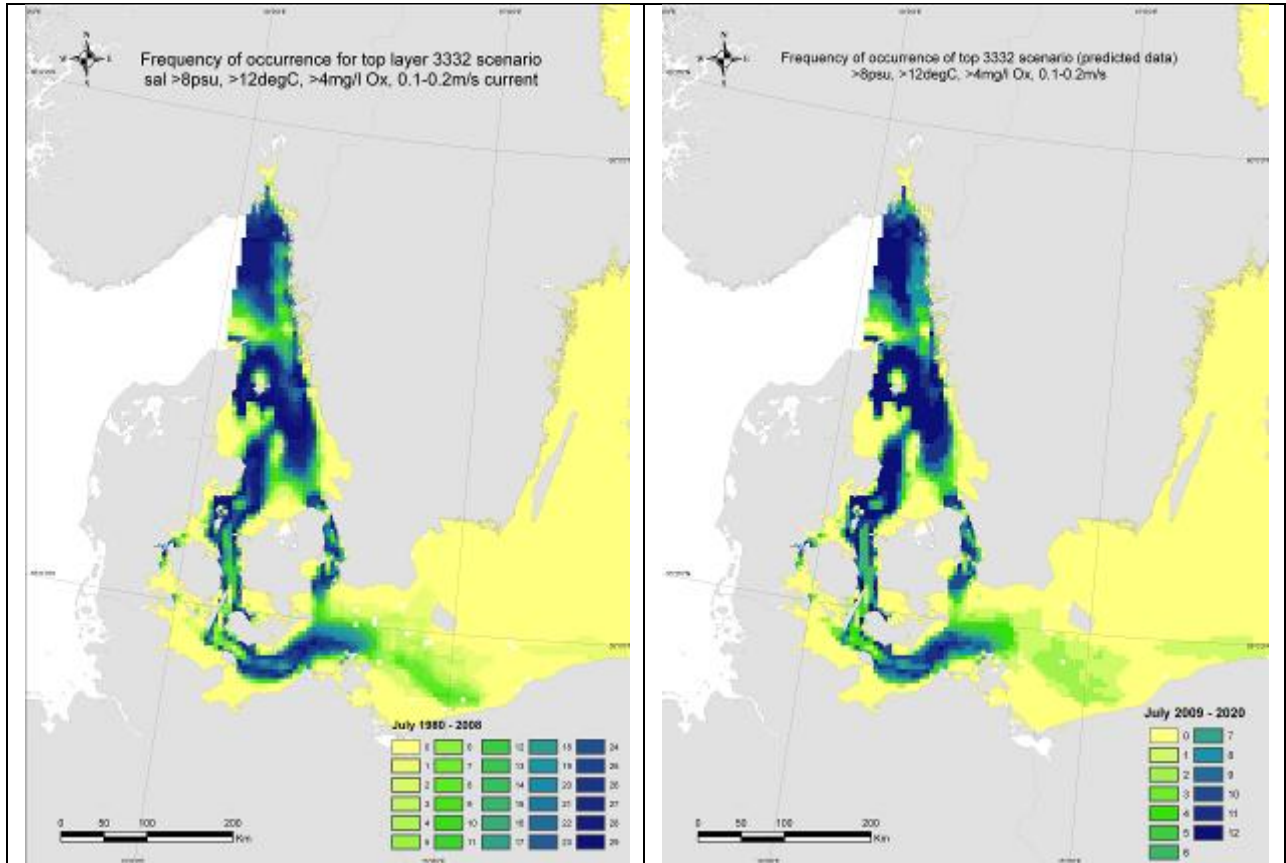


Fig. 4. Top layer/larvae: No significant difference in spread into the Baltic Sea of *Teredo navalis* in the hind cast GIS map of July 1989 – 2009 (left) compared to fig b predicted spread hind cast GIS map of July 2009 – 2020 (right).

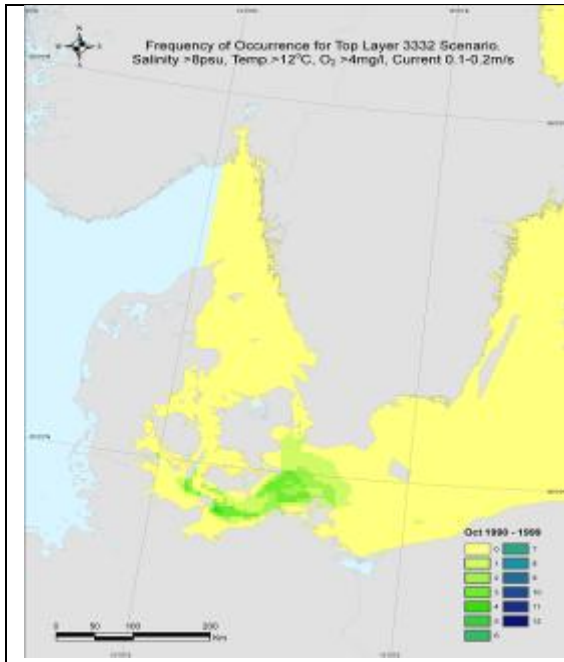


Fig. 5a. Frequency of occurrence in October 1990-1999 is less frequent than the spread found for the future period in fig. 5b.

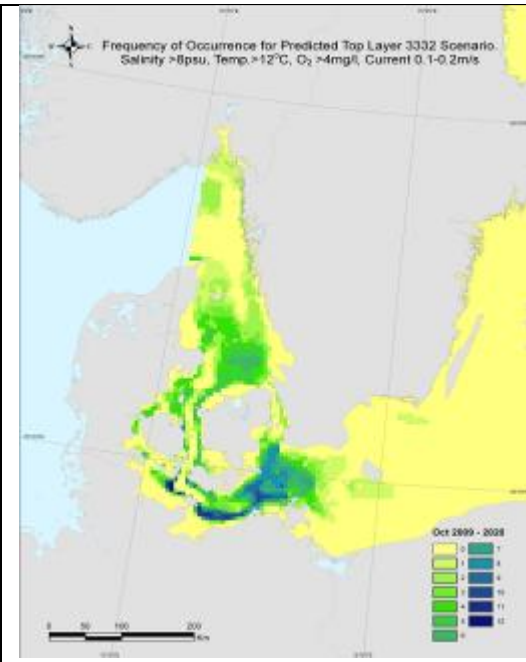


Fig. 5b. Frequency of occurrence in October 2009-2020 based on future climate data show a more frequent and wider spread in the warmer waters.

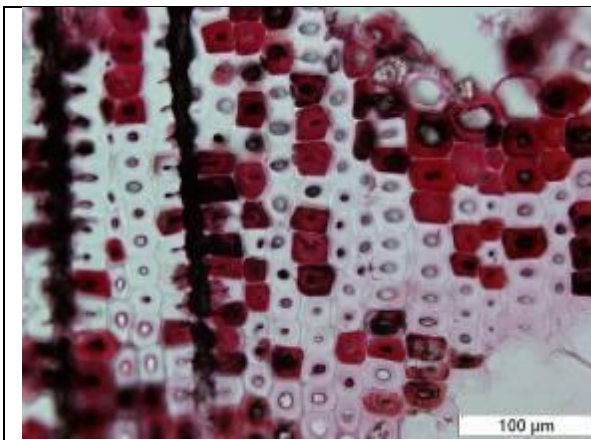


Figure 6a. Erosion bacteria degraded wood. Sound cells (white) adjacent to degraded cells (red).

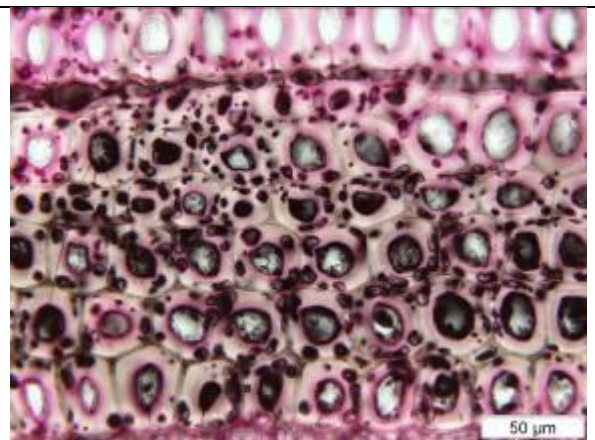


Figure 6b. Degradation by soft rot fungi. Holes in the cell walls produced by penetrating fungal hyphen

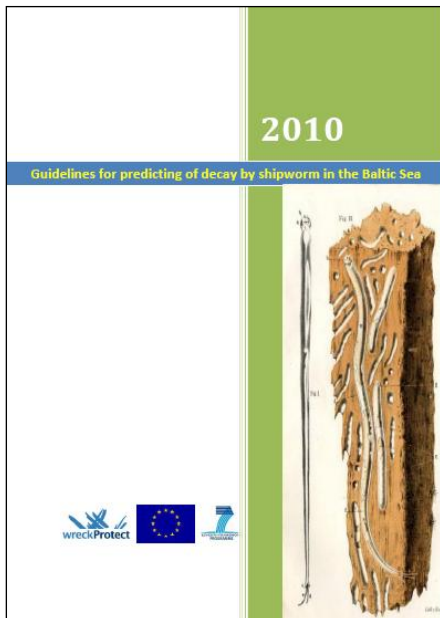


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Fig. 7a. Debris-netting tracks sediment and a protective layer is built up above the timbers



Fig. 7b. Sand bags are an efficient method for securing the sediment layer above the wreck site and establishing unfavourable conditions for biological attack.





Action	Supports
Focus on "in situ" preservation of shipwrecks	Preservation of unique vulnerable cultural heritage large size moveable/immovable objects. Supported by UNESCO convention of underwater cultural heritage and ICOMOS charter
Rising awareness of the problem (Degradation and need for protection of shipwrecks)	Inform and support managers, stakeholders and end-users in Europe
Provides and disseminate tools and methods for protection	Managers, stakeholders and end-users in Europe
GIS model for prediction of decay by shipworm	Tracking underwater deterioration processes with a new approach. An inspiration for other future projects Input to IPCC report on climatic change and the Baltic Forum
Save unique shipwreck for future generation	To the benefit of all future citizens of Europe
In situ as an economical choice	Highlights possibilities for efficient use of resources in cultural heritage

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Action	Supports
Marine biological information on shipworm (environment and biology)	Understanding of processes that degrade Cultural heritage and highlights areas for future research
Information of microbial degradation of shipwrecks	Understanding of processes that degrade Cultural heritage and highlights areas for future research
Guidelines	Readily understandable for a cross disciplinary forum of European and international stakeholders and managers of cultural heritage
Cross disciplinary project	Created a platform for a unique synthesis of knowledge within different disciplines, and provide individual partners with new knowledge and a new network.
Gender aspects are recognised and actions taken	Encouraged by EC and is important in society as well as in research environment

Information sheet on the project sent out to 150 stakeholders in Europe (Front page)



WreckProtect

Strategies for the protection of shipwrecks in the Baltic Sea against forthcoming attack by wood degrading marine borers.

A synthesis and information project based on the effects of climatic changes.

FP7-ENV-2008-1

Coordination and support action



European Commission



SEVENTH FRAMEWORK PROGRAMME



Contractors involved:

The cross-scientific project team involves geophysicists, marine biologists, marine archaeologists, wood scientists, and conservators. The consortia consists of six partners from three countries; the Netherlands, Denmark, and Sweden.

Coordinator: Charlotte Gjelstrup Björdal, SP

List of Participants:

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Web site:

www.wreckprotect.eu

on the project

Here you can find video link and more information



Logo:

Photo of participants:



Background from left: Ziad Al-Hamdani (GEUS), David Gregory (NM), Martijn Manders (RCE). In front from left: Christin Appelqvist (UGOT), Astrid Brandt-Grau (EC), Jörgen Dencker (VM), Charlotte Björdal (SP).