DEUTERO NOISE

Characterization of maritime noise in different European basins and its impact on ecological relevant deuterostome invertebrates

JPI Oceans Kick-off meeting – Bruxelles - 14 February 2023

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Department of Biology

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UNIVERSITÀ DEGLI STUDI DI PADOVA

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The consortium and its interdisciplinarity

Plus

Hired young researchers

and

other collaborators

Partner	Team member /*Subcontractor*	Expertise							
		Noise	Modeling	Physics of Complex Systems	Nervous system/ sensory organ biology	Immuno biology	Behavioral biology	Ecology	Developmental Biology and Genetics
1.UNIPD University of Padova	L. Manni				x		x		x
	L. Ballarin					x			
	F. Gasparini				x	x	x		
	I. Guarneri							x	
	S. Candiani				x		x		x
UNIMIB University of Milano-Bicocca	G. Zambon	x	x						
	R. Benocci	x	x						
	A. Bisceglie	x							
	F. Angelini	x							
	R. Pennati				x		x		x
	A. Vailati		x	x			x		
3.SZN Stazione Zoologica Napoli	F. Ristoratore				x	x	x		x
	A. Spagnuolo				x	x	x		x
	Fabio Ferri		x				x		
4.UiB University of Bergen	D. Chourrout								
	M.Chatzigeorgiou				x		x	x	
	TuniCell								
5.Geo EcoMar Institutul National De Cercetare Dezvoltare Pentru Geologie Si Geoecologie Marinali	A.Teaca						x	x	
	M.Muresan						x	x	
	T.Begun						x	x	
	S.Menabit						x	x	
	D.Vasiliu							x	
	D. Vasile							x	
	J. Bujini							x	
6.LS-URL La Salle Ramon Llull University	R.M.Alsina-Pages	x	x						
	M. Freixes	x	x						
	M. Arnela	x	x						
	E. Vidaña-Vila	x	x						
	C. Martinez-Suquía	x	x						
7.UB University of Barcelona	C. Canestro				x		x		x
	R. Albalat								x

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INTERSECTORIALITY of the consortium

DeuteroNoise integrates researchers belonging to different sectors:

- Universities: UNIPD, UNIMIB, UiB, LS-URL, UB, University of Genova (UNIPD's subcontractor), University of Milan (UNIMIB's subcontractor), University of Insubria (SZN 's subcontractor)

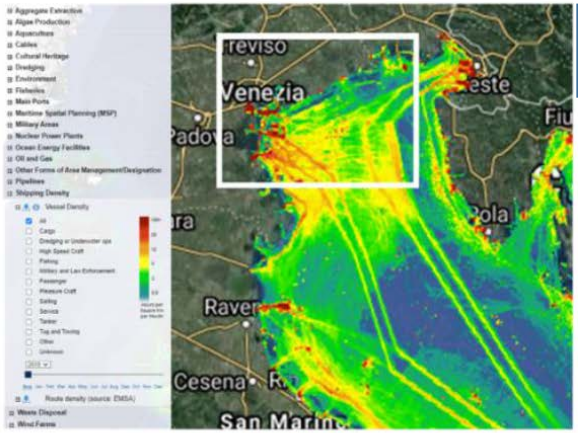
- Research Institutions: SZN, GeoEcoMar, CNR (UNIPD's subcontractor)

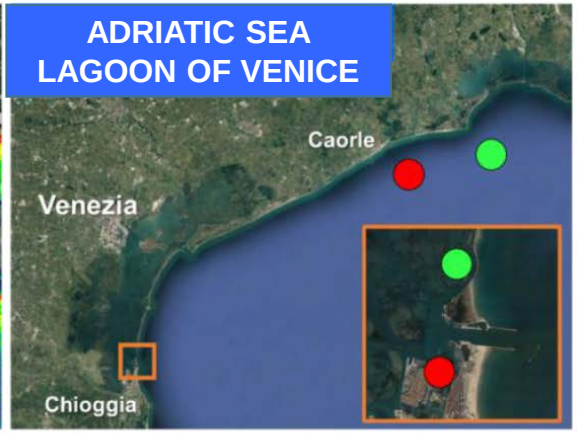
- SME: TuniCell (UiB's subcontractor)

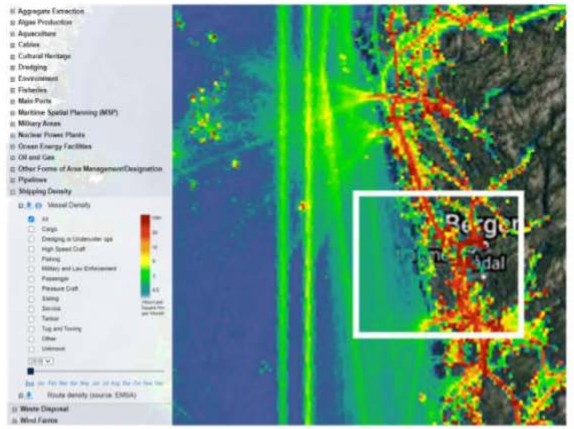
The objective

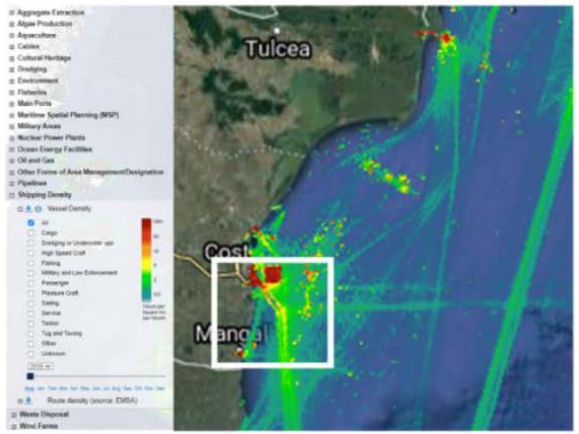
to contribute to reach the GES of European seas and oceans by characterizing noise pollution caused by maritime traffic in selected sites of the North Adriatic Sea, Lagoon of Venice, Barcelona shore, North Sea, and Black Sea, and testing its effects on animal behavior, nervous system and sensory organs, immune system, and resilience in marine invertebrate deuterostomes

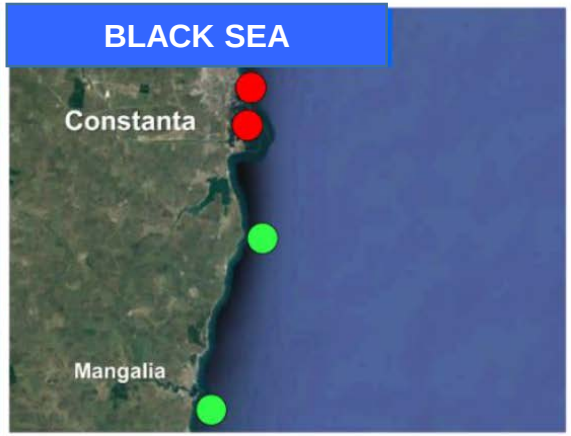
The studied basins and their maritime trafic

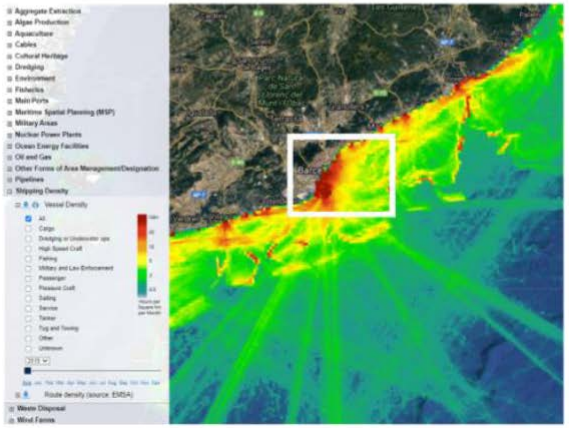












- Noise polluted site
- Unpolluted site

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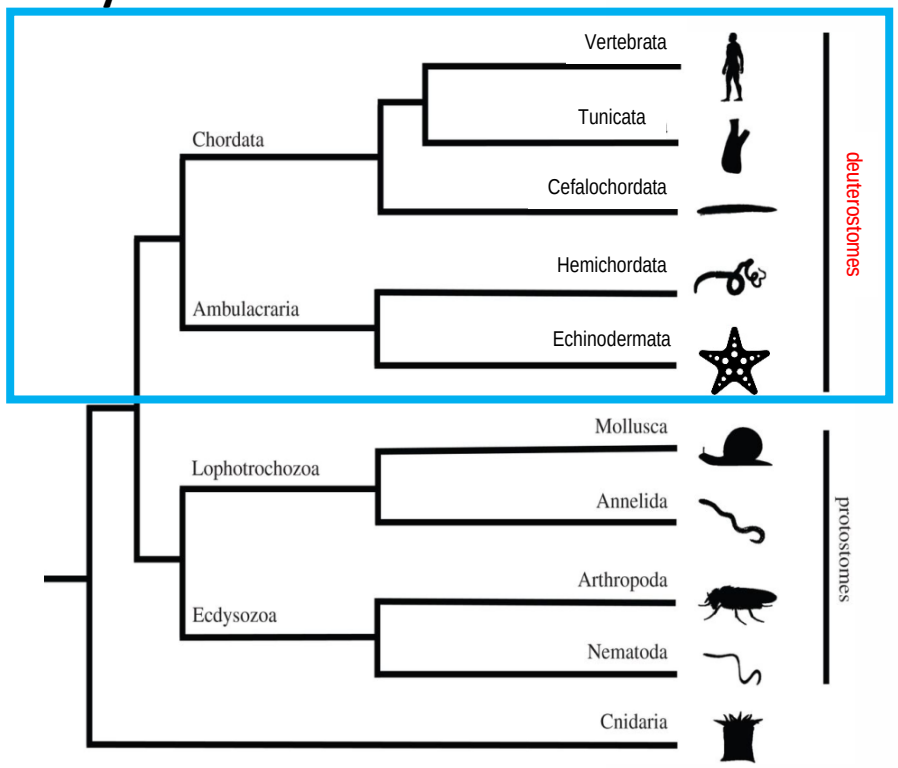
The studied species

Why marine invertebrate deuterostomes?



https://sites.google.com/site/section69group6echinodermata/feeding-habits

- Species abundant in European seas
- Sessile or sedentary filter-feeders as adults
- Planktonic, during at least part of their life style
- Noise effect not known on marine invertebrate deuterostomes
- Larval and embryonic stages easy to study (impaired development and larval mortality provoked by noise)
- Anatomical simplicity, but
- Sensory cells homologous to vertebrate hair cells, at least in some taxa
- Behavioral, morphological and molecular tools available

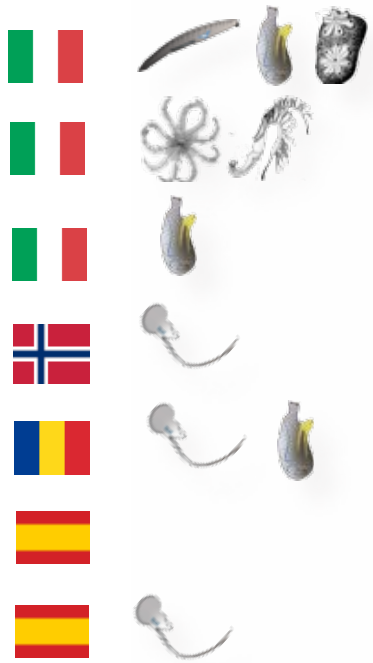
Why Deuterostomes?

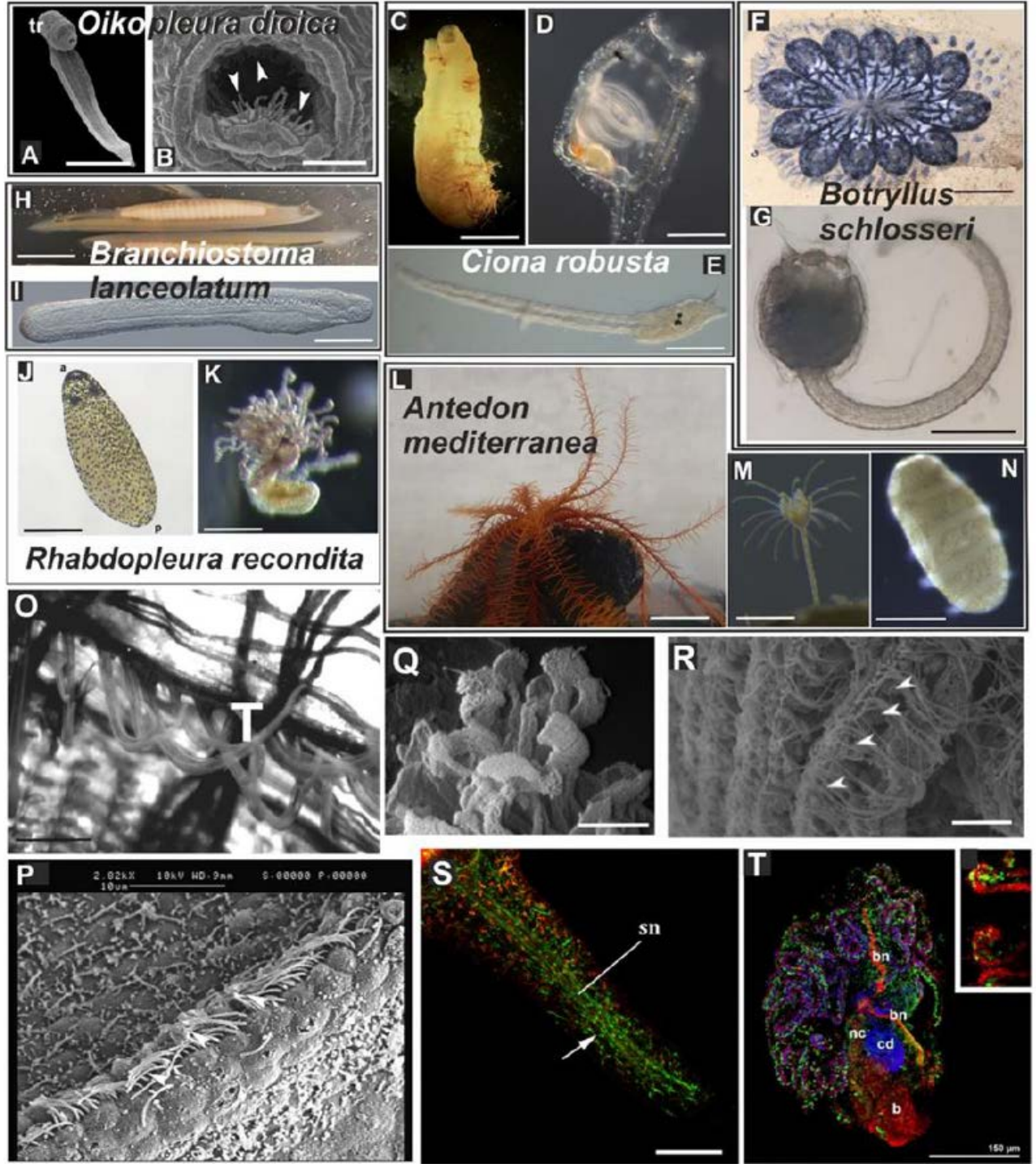
TUNICATES
- Larvaceans
  - Oikopleura dioica
- Solitary ascidians
  - Ciona robusta
  - Ciona intestinalis
  - Ascidiella aspersa
  - Styela plicata
  - Styela clava
  - Molgula manhattensis
- Colonial ascidians
  - Botryllus schlosseri

HEMICHORDATES
- Rhabdopleura recondita

CRINOIDS
- Antedon mediterranea

CEPHALOCHORDATES





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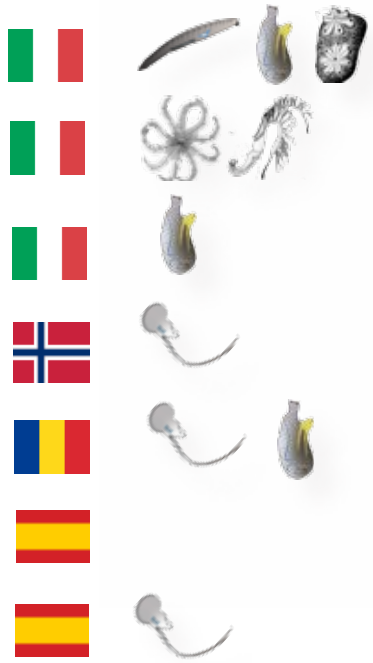
Species studied in the different basins

TUNICATES
- Larvaceans
  - Oikopleura dioica
- Solitary ascidians
  - Ciona robusta
  - Ciona intestinalis
  - Ascidiella aspersa
  - Styela plicata
  - Styela clava
  - Molgula manhattensis
- Colonial ascidians
  - Botryllus schlosseri

HEMICHORDATES
- Rhabdopleura recondita

CRINOIDS
- Antedon mediterranea

CEPHALOCHORDATES



Species		North Adriatic	Lagoon of Venice	North Sea	Black Sea	Barcelona shore
Crinoids	*Antedon mediterranea*	x				
Hemichordates	*Rhabdopleura recondita*	x				
Ascidians	*Ciona robusta*		x			
	Ciona intestinalis			x	x	
	Ascidiella aspersa		x		x	
	Styela plicata		x			
	Styela clava		x			
	Botryllus schlosseri		x		x	
	Molgula manhattensis				x	
Larvaceans	*Oikopleura dioica*			x	x	x
Cephalochordates	*Branchiostoma lanceolatum*	x				

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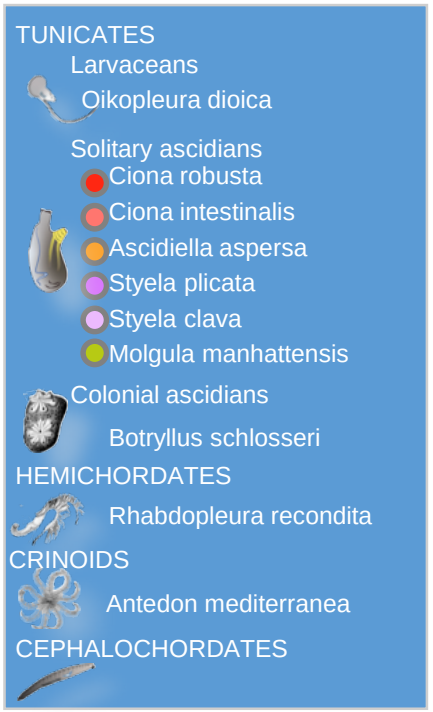
The same species is studied by different partners, allowing comparative



Partner	Crinoids (Echinoderms)	Hemichordates	Ascidians (Tunicates)	Larvaceans (Tunicates)	Cephalochordates
1.UNIPD			Solitary ascidians (*Ciona robusta*, *Ascidiella aspersa*, *Styela plicata*, *S. clava*); colonial ascidians (*Botryllus schlosseri*)		*Branchiostoma lanceolatum*
2.UNIMIB	*Antedon mediterranea*	*Rhabdopleura recondita*			
3.SZN			Solitary ascidians (*Ciona robusta*, *Ascidiella aspersa*, *Styela plicata*, *S. clava*); *Antedon mediterranea; Rhabdopleura recondita*		
4.UiB			*Ciona intestinalis*	*Oikopleura dioica*	
5.GeoEcoMar			Solitary ascidians (*Ciona intestinalis, Ascidiella aspersa, Molgula manhattensis),* colonial ascidians (*Botryllus schlosseri*)	*Oikopleura dioica*	
6.UB				*Oikopleura dioica*	

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The work packages

WP1. Coordination, Integration and Synthesis
WP leader: unipd
Partner: *UNIMIB, SZN, UiB, GeoEcoMar, LS-URL, UB*

Objectives:
O1.1 - Collect, review, and submit all different deliverables to funding agencies
O1.2 - Monitor project progresses and suggest remedies in case of deviations
O1.3 - Organize meetings, conference, workshops, and a summer school
O1.4 - Provide the support for data management
O1.5 - Coordinate outreach and dissemination activities

- Kick-off meeting: 2 February 2023
- Bimonthly Steering Committee meeting
- Web-based cloud drive to share relevant documents
- Web-site by the end of February
- Logo chosen thanks to a contest for Digital Arts Students of La Sale University (Barcelona)

The work packages

WP2. Identification of soundscapes in five different basins by means of measurements and simulations and their reproduction in laboratory
WP leader: unimib
Partner: *unipd, UiB, GeoEcoMar, LS-URL*

Objectives:
O2.1 - Identify soundscapes and sensitive habitats in selected sites of the five basins affected by maritime traffic
O2.2 - Representation of levels by means of noise maps
O2.3 - Develop and improve measurement standards and methods for laboratory reproduction

- Measurement campaigns to characterize noise level in polluted vs not polluted sites
- Visits to set-up laboratory conditions (tanks with hydrophones, accelerometers and loudspeakers) for noise simulations on animals
- Animal rearing

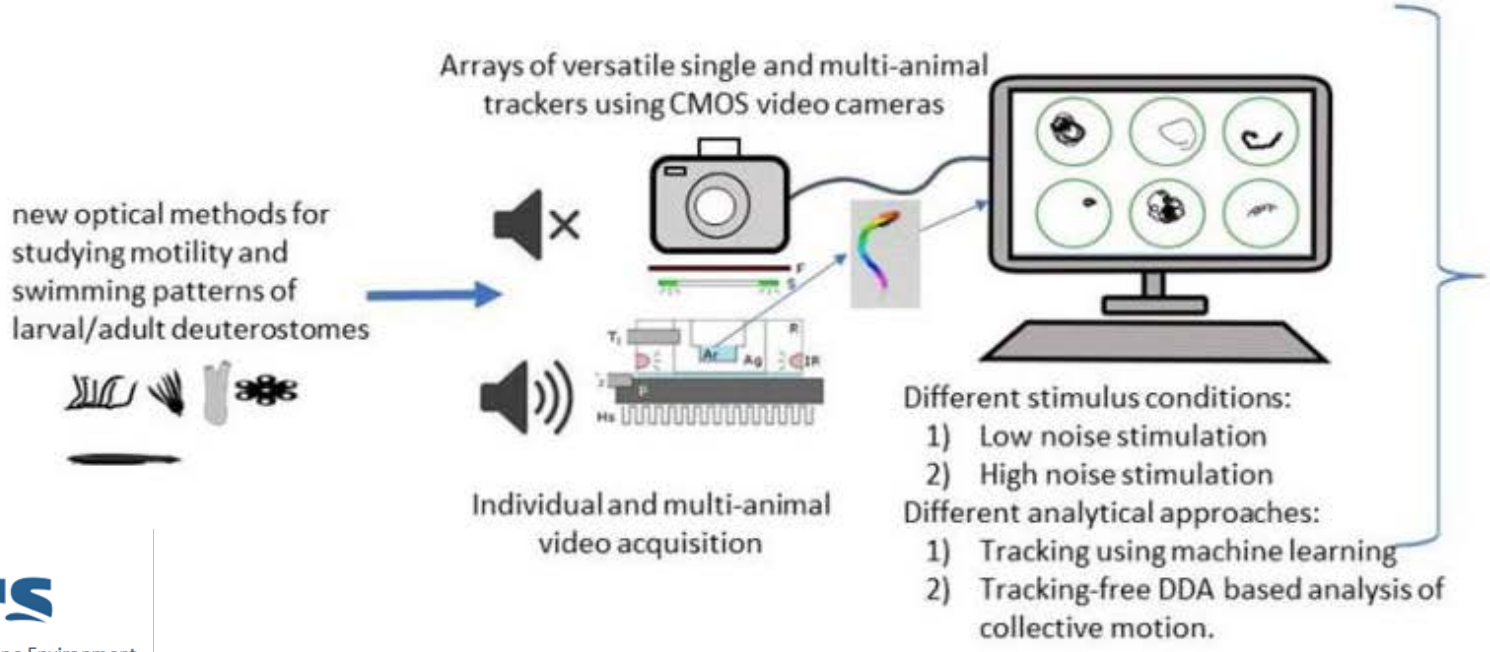
European Marine Region	Mediterranean Sea									Black Sea			North-East Atlantic Ocean		
Subregion	Adriatic Sea						Western Mediterranean Sea			Black Sea			Greater North Sea		
Basin	North Adriatic Sea			Lagoon of Venice			Barcelona Shore			Black Sea			North Sea		
Activity	O	L	M	O	L	M	O	L	M	O	L	M	O	L	M
1.UNIPD	x	x		x	x										
2.UNIMIB	x	x	x	x	x	x							x	x	x
4.UiB													x	x	
5.GeoEcoMar										x	x				
6.LS-URL			x			x	x	x	x	x	x	x			x

O: on-site measurement; L: laboratory simulation; M: Noise modelling

The work packages

WP3. Understanding the effects of noise on animal behavior
WP leader: UiB
Partner: *UNIMIB, SZN, GeoEcoMar, LS-URL, UB*

Objectives:
O3.1 - Set-up of tools for characterizing animal locomotor activity
O3.2 - Investigate the effects of noise exposure to larval motility
O3.3 - Investigate the effects of noise exposure to adult motility and mechano-sensor functionality



Outputs

- Development of tools for recording and analyzing the behavioral output of individuals as well as large numbers of MID animals
- Comprehensive analysis of the effects of anthropogenic noise on adult and larval behaviors across multiple MIDs.

The work packages

WP4. Noise effects on in-lab treated animals
WP leader: UB
Partner: UNIPD, *UNIMIB, SZN, GeoEcoMar*
Objectives:
O4.1 - Investigate the effect of noise pollution on development, survival and morphology of nervous, sensory and immune systems
Noise effect in 1) adult treated animals (cellular level on sensory cells and immune system) and 2) larvae/embryo (development, mortality, hatching rate, larval growth and viability, settlement)
O4.2 - Identify the diagnostic molecular signature of noise effects on nervous, sensory and immune systems ("noisesome")
Noise effects at transcriptomic level: differentially expressed genes in treated vs non-treated animals relate to nervous system and sensory organs, immune and inflammatory factors
O4.3 - Verify by a comparative approach among species the presence of a common molecular signature
Searching for noise effects at transcriptomic level in other species
O4.4 - Verify noise pollution effects over generations to assess animal resilience
Treatment on adults and study of effects in offspring

The work packages

WP5. Validation of the diagnostic prediction tool “noisesome” in on-field animals
WP leader: SZN
Partner: UNIPD, *UNIMIB, UiB, GeoEcoMar, UB*

Objectives:
O5.1 - Perform a lab-field comparison of the “noisesome” in focus species (*Ciona* sp., *B. schlosseri*, amphioxus, *O. dioica*, Crinoids)
Noise effect at transcriptomic level (noisesome) in animals collected in basins with respect to those treated in lab
5.2 - Perform a field-field comparison of the “noisesome” in animals of the same species sampled in different basins (*Ciona* spp., *B. schlosseri*, and *O. dioica*)
O5.3 - Validate the “noisesome” as diagnostic prediction tool in other deuterostome species sampled in different basins

The work packages

WP6. Modeling and statistical analyses of noise
WP leader: LS-URL
Partner: *UNIMIB, UiB*
Objectives:
O6.1 – Improve detection and modeling tools: generation of artificial intelligence algorithms to model and predict the anthropogenic noise existent in the five basins
- Vessel noise characterization depending on the basins
- Modelling of type of vessel noise and underwater propagation

The work packages

WP7. Development of new options and strategies for underwater noise mitigation
WP leader: GeoEcoMar
Partner: UNIPD**,** *UNIMIB, SZN, UiB, LS.URL, UB*

Objectives:
O7.1. Generate technical recommendations based on the project results for noise mitigation
Findings of the project translated in concrete technical and monitoring recommendations for the policy makers
O7.2. Engage public consultation and stakeholders in the process of decision making on noise mitigation measures needed to reach GES (D11) of marine basins
Public consultation with national stakeholders (shipping industry, maritime spatial planners, NGOs, technology developers, interested public) in each pilot study

Dissemination, Outreach, networking, training opportunities

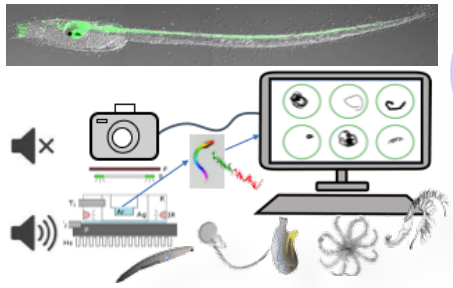
4.1 Outreach (Non-scientific target audiences)
4.2 Scientific community
4.3 Training opportunities (summer school at Ischia, Italy)
4.4 Decision makers

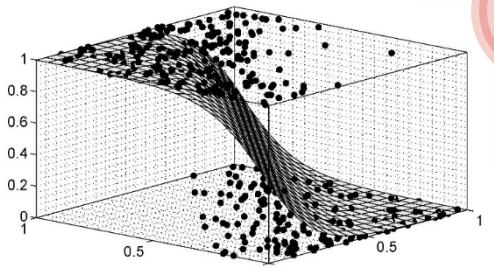
The expected impact

DeuteroNoise will contribute to reach the GES of European seas and oceans at basin scale, since it

- Works on 5 different basins
- Uses a large and innovative panel of species, studied at different developmental stages and ranging from zooplankton to primary consumers
- Conducts observational and experimental research on living organisms combined with numerical modelling
- Defines a diagnostic molecular signature caused by noise
- Connects different expertise converging on noise pollution
- Facilitates knowledge exchange, involving 5 basins, 7 partners, 4 countries
- Stimulates cross-basin comparative research, since some species are diffused in more than one basin
- Promote a pan-European cross-disciplinarity
- Develops and implements a strategy for Dissemination and Communication

Integration





Soundscapes
measurement
Simulations
WP2

Noise impact on
Animal Mechanosensation
and Swimming Behaviours
WP3

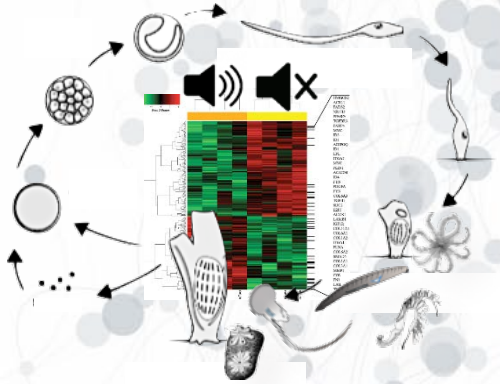
Noise impact on
Embryo development-Adult
Gene expression
WP4

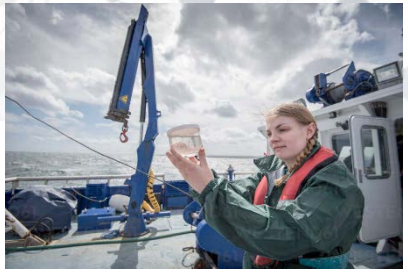
WP1
Coordination &
Mangement

WP6
Modelling
Statistical Analyses

WP5
Field Validation
Noise Biomarkers

WP7
Noise Mitigation
MSFD





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Thank you for your attention!

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