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A European Community Funded Project for On-board Treatment of Ballast Water and Application of Low Sulphur Fuels

Presented, on behalf of MARTOB Consortium, by

Ehsan Mesbahi

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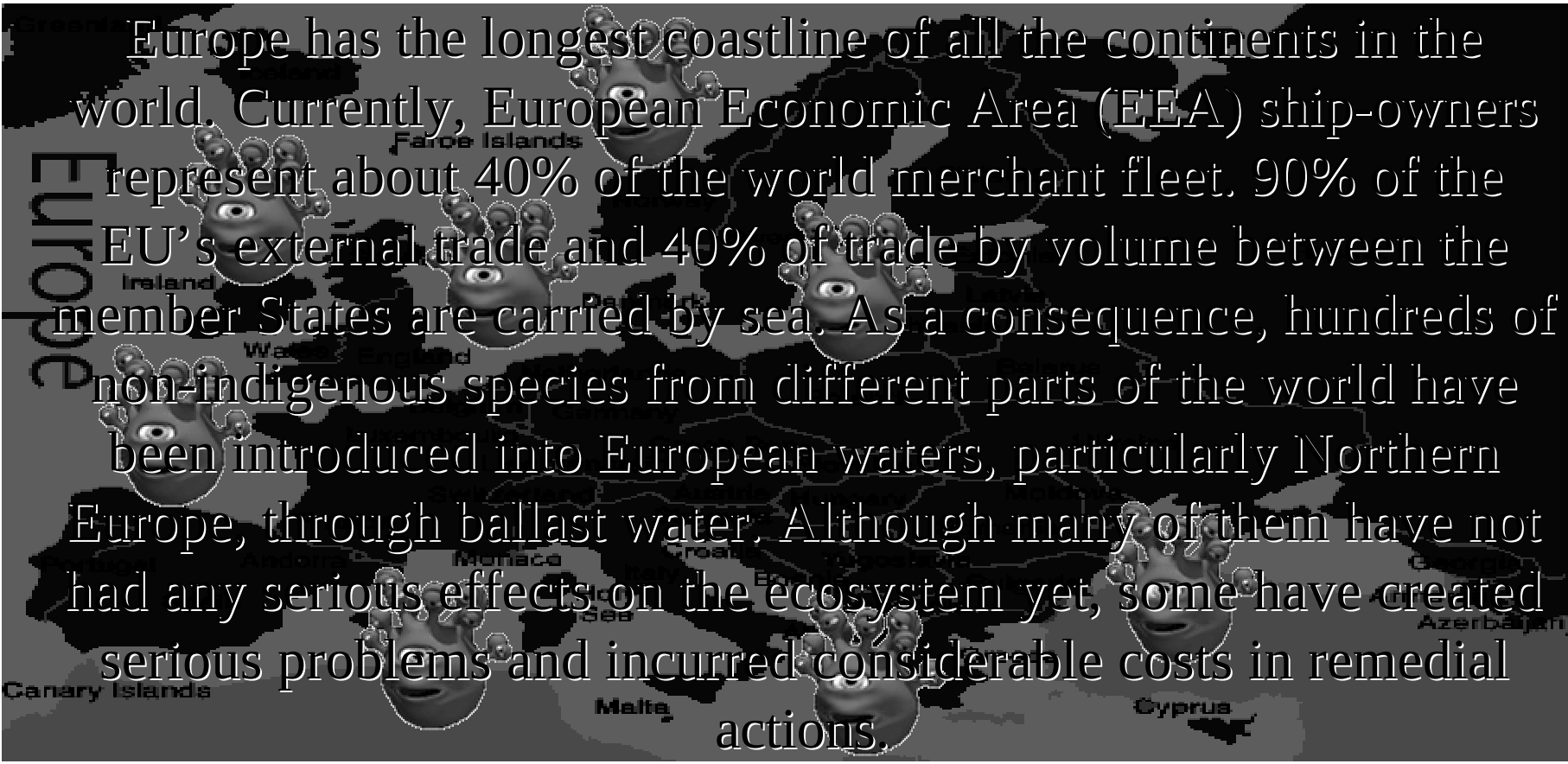
The requirement



Europe has the longest coastline of all the continents in the world. Currently, European Economic Area (EEA) ship-owners represent about 40% of the world merchant fleet. 90% of the EU's external trade and 40% of trade by volume between the member States are carried by sea. As a consequence, hundreds of non-indigenous species from different parts of the world have been introduced into European waters, particularly Northern Europe, through ballast water. Although many of them have not had any serious effects on the ecosystem yet, some have created serious problems and incurred considerable costs in remedial actions.

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Objectives:

1. **To investigate methodologies and technologies for preventing the introduction of non-indigenous species through ships' ballast water,**
2. **To develop design tools and treatment equipment to be used in the further development of ballast water treatment techniques,**
3. **To assess the effectiveness, safety, and environmental and economic aspects of current and newly developed methods,**
4. **To develop cost-effective (capital and operating), safe, environmentally friendly onboard ballast water treatment methods which have a minimum impact on ship operations,**
5. **To produce guidelines for crew training and criteria for selecting an appropriate ballast water management method.**

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Partners:

UNEW-University of Newcastle upon Tyne, UK
AAU-Aabo Akademi University, Finland
VTT-VTT Industrial Systems, Finland
TNO-Environment, Energy and Process Innovation, Netherlands
TME-Institute for Applied Environmental Economics, Netherlands
SINTEF- Applied Chemistry, Norway
FRS-Fisheries Research Services, UK
IFREMER-French Research Institute for the Exploitation of the Sea, France
ABC-Association of Bulk Carriers, UK
AL-Alfa Laval AB, Sweden
BERSON-Berson Milieutechniek B.V., Netherlands
EPE-Environmental Protection Engineering S.A., Greece

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Partners:

HW-Van den Heuvel Watertechnologie, Netherlands
IT-The International Association of Independent Tanker Owners, UK
SOU-Souter Shipping Ltd., UK
SSPA-SSPA Sweden AB
TQ-Three Quays Marine Services, UK
ICS-International Chamber of Shipping, UK
BV-Bureau Veritas, France
MT-(MARINTEK) Norwegian MarineTechnology Research Institute, Norway
SMP-Shell Marine Products, Norway
WW-Wallenius Wilhelmsen Lines, Norway
MAN-MAN B&W, Denmark
FT-Fueltech AS, Norway
NSA-Norwegian Shipowner Association, Norway

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Acknowledgement

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GROWTH,

and is managed by the Direction-General for Energy and Transport

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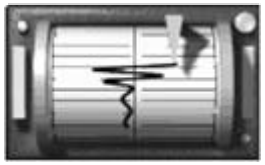
Programme:

a) Data collection and proposed methods

b) Further development and demonstration of selected methods

c) Installation of large/full-scale systems and sea trials

d) Applications, reviews and recommendations



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a) Data collection and proposed methods

1- Legislative update and future indication

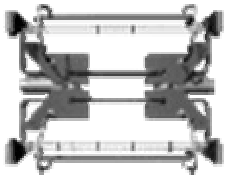
2- Update of aliens in European water

3- Indirect environmental aspects and risk assessment

4- Current methods and limitations

5- Programme of requirements for ballast water treatment

6- Framework of Evaluation



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b) Further development and demonstration of selected methods

1- Design of system

2- Assessment of direct and indirect environmental aspects

3- Verification of the conformity of the system design

4- Definition and strategy of large and full-scale trials

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c) Installation of large/full-scale systems and sea trials

1- Validation of system installation

2- System installations and sea trials

3- Assessment of biological effectiveness and direct and indirect environmental aspects

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d) Applications, reviews and recommendations

1- Large scale trials review

2- Summary of direct and indirect environmental aspects

3- Biological justification of developed methods

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a-1) Legislative update and future indication

UNEW, EPE, IT

Local Regulations

Argentina
Australia
Canada
Chile
Israel
New Zealand
UK
USA

International Legal Instruments With Programs/ Activities pertaining to Invasive Alien Species

Global Conventions/Treaties
European
North American
African
Asia/Pacific

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a-2) Update of aliens in European water

AAU, UNEW, TNO, IFREMER, EPE, SSPA

ALIENS AND THEIR IMPACTS IN EUROPEAN COASTAL WATERS

REGIONAL OVERVIEW

North-eastern Atlantic coast
North Sea
Baltic Sea
British and Irish coasts
Mediterranean Sea
Black Sea and the Sea of Azov
Caspian Sea

ECOLOGICAL IMPACTS

RESOURCES AT RISK

Nuisance Species
Economic Impacts
Water-based Technology
Fisheries
Parasites and Pests on Fish and Shellfish
Interference with Research and Monitoring
Human Health

RISK ASSESSMENT OF AQUATIC SPECIES INVASIONS

DATABASES ON BALLAST WATER AND INTRODUCED AQUATIC SPECIES

European Databases
North American Databases
Australian and New Zealand Databases
Global Databases

BALLAST WATER DISCHARGES AND SHIPPING PATTERN IN EUROPE

European Shipping Pattern
Ballast Water Releases In European Waters

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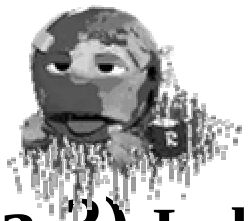

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a-3) Indirect environmental aspects and risk assessment

SSPA, AAU, TME

RISK AND SAFETY ISSUES

- **Hazards, Risk and Safety Assessment**
- **Assessment of Methods**

INDIRECT ENVIRONMENTAL IMPACTS

- **Assessment of Environmental Impacts**

NON-ENVIRONMENTAL ASPECTS

- **Existing cost data**
- **Identification of data gaps**
- **Potential economic benefits and economic disadvantages**
- **Selection of time horizon and discount rate**

METHODS:

Ballast water exchange

Low Temp. Thermal Treatment

UltraViolet Irradiation (UV)

Filtration

HydroCyclone

Biocides

Shore-Based Treatment Methods

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a-4) Current methods and limitations

FRS, UNEW, IFREMER, BERSON, EPE, TQ

Methods that have been assessed on a pilot or full scale

- *Ballast water exchange*
- *Filtration*
- *Cyclonic separation*

Methods in the first stages of development

- *Biocides*
- *Gas super saturation*
- *Natural air injection*
- *Electro-ionisation*
- *Use of fresh or treated water*
- *Shore based treatment*

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a-5) Programme of requirements for ballast water treatment

UNEW, VTT, TNO, TME, SINTEF, ABC, AL, BERSON, EPE, HW, IT, SOU, SSPA

Selected Treatment Methods

Thermal Treatment

De-Oxygenation

UV/US and Ozone Systems

Oxicide

Hurdle Technologies

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a-5) Programme of requirements for ballast water treatment

UNEW, VTT, TNO, TME, SINTEF, ABC, AL, BERSON, EPE, HW, IT, SOU, SSPA

General requirements

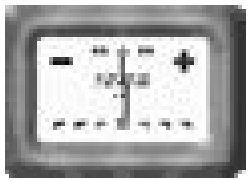
Ship requirements and limitations

- *Ship Types and BW Volumes*
- *Pump Capacity*
- *Ballast Tank Sizes and Design*
- *Equipment Space Requirements*
- *Vessel Transit Patterns*
- *Ship requirements*

Water quality

- *In Ballast Water and selected Ports*
- *In coastal areas*
- *Changes in Water Quality over Time*
- *Water Quality Standards*

Economic and environmental effects



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a-6) Framework of Evaluation (1)

TME, UNEW, SSPA, BV

BOUNDARIES FOR TESTING

Evaluation criteria

SAMPLING AND TEST PROTOCOL

Water quality Standards

Species selection

Composition of a test mixture

Assessing biological effectiveness

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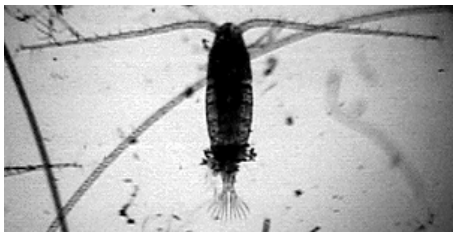
Proposed Standard Sea Water

MARTOB Soup



Calanoid copepod

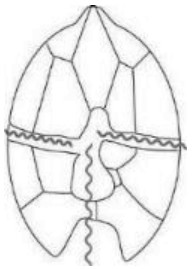
Acartia sp

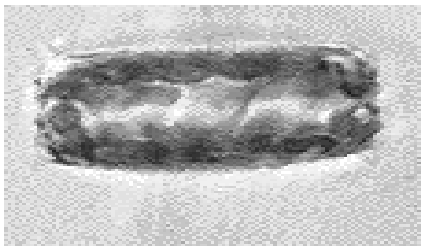
Benthic Larvae

Nereis virens – Nectochaete larvae

Dinoflagellates

Alexandrium sp





Diatoms

Thallasiosira sp

Harpacticoid copepod

Tisbe sp

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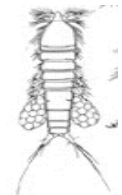
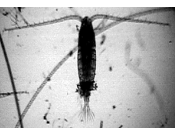
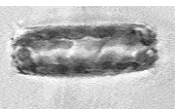
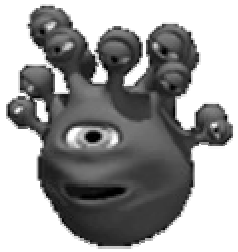
Proposed Standard Sea Water

	Maximum field densities (in div.s m^{-3})	Standard mix composition (in div.s m^{-3})	Standard mix composition of a 50 l test solution
 **Benthic Larvae** *Nereis virens – Nectochaete larvae*	740	200	10
 **Harpacticoid copepod** *Tisbe sp*	807	500	25
 **Calanoid copepod** *Acartia sp*	159,659	2500	125
 **Diatoms** *Thallasiosira sp*	3×10^{9}	3.5×10^{8}	175×10^{5}
 **Dinoflagellates** *Alexandrium sp*	80×10^{6}	10×10^{6}	50×10^{4}



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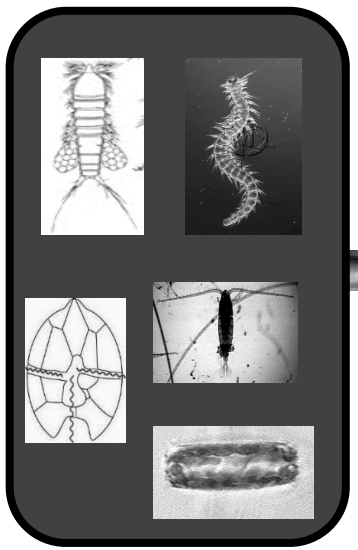
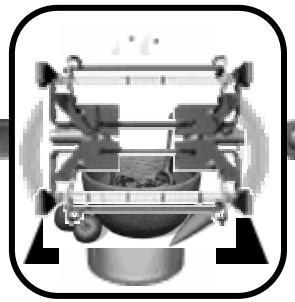
Laboratory-Scale Tests on selected BW Treatment Techniques

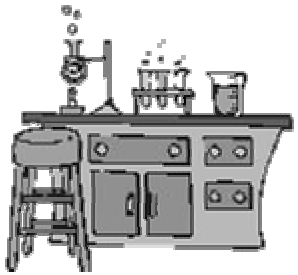


Standard Sea Water
(MARTOB Soup)



Biological Effectiveness
(Standard Test Protocol)

Corrosivity of
Treated BW



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Protocol for Laboratory Testing (1)

1. Artificial seawater for the test should be made up following the manufacturer's instructions. The seawater should be kept in the dark at 10-15C until required, salinity 33-35, pH ~8.3

2. If a turbid sample is required add 1g solid per litre of water. To a 50l sample add 50gm kaolin for inorganic matter or 50gm flour if organic suspended mater is required. This will produce a turbid suspension, representative of a relatively highly turbid estuary.

3. Biological test organisms should be kept in separate containers until the mixture is required and assembled just before use.

4. Once prepared the mixture must be kept cool (10-15C) and in the dark.

5. 10 × 1l samples (5 for zooplankton and 5 for phytoplankton) should be collected before the test commences and fixed as control samples.

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Protocol for Laboratory Testing (2)

6. Zooplankton – Each of the 5 x 1l samples should be treated separately as follows:

- ***Prepare a stock solution of stain by dissolving 1.0g Neutral red powder in 1l distilled water.***
- ***Add 30 ml of stock stain solution to each litre sample***
- ***Leave for 60 min***
- ***Prepare stock solution of buffered fixative by adding 25g borax to 1l 10% formalin***
- ***Prepare stock solution of stain by adding 40ml 1N Sodium Acetate to 1l 10% buffered formalin***
- ***Add 40ml stock fixing solution to each litre sample***
- ***Store samples overnight at 2-3C***

Phytoplankton - to 5 of the 1l samples add (currently under development)

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Protocol for Laboratory Testing (3)

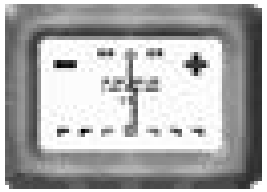
7. The remaining mixture should then be introduced into the treatment process.

8. 10 x 1l samples should be collected immediately on completion of the tests for the assessment of biological effectiveness and preserved in the same way as the control samples i.e. 5 for zooplankton and 5 for phytoplankton (see 4)

9. When the zooplankton samples have been settled replicate sub-samples will be examined microscopically in haematocrit chambers and the survivorship of each species recorded.

10. Phytoplankton samples will be counted (currently under development)

11. Biological effectiveness of each trial will be characterized by the percentage kill of each test organism type.



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a-6) Framework of Evaluation(2)

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ENVIRONMENTAL IMPACTS

Direct Environmental Impact

Indirect Environmental Impact

HEALTH AND SAFETY ASPECTS

Operational Aspects

Storage and Handling of Chemicals and Residuals

ECONOMIC VIABILITY

Cost Effectiveness

ON-BOARD SHIP APPLICABILITY

Criteria for assessment

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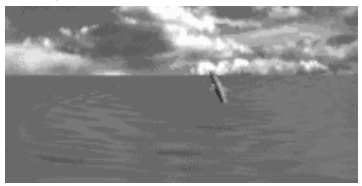
The ballast water regulation has been on the table for some years and could take more time to resolve. As such, more and more countries have adopted local ballast water regulations to prevent the introduction of alien invasive species to their waters. It is with optimism that a foolproof water ballast management programme that is agreed by all, could be reached within the near future.



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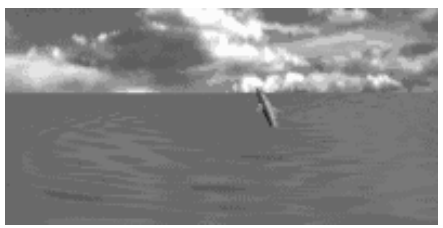
With the completion of MARTOB programme, it is envisaged that the results of this programme would be able to provide an insight on global ballast water legislative measures and recommendations on probable future ballast water treatment solutions through research and shipboard trials.



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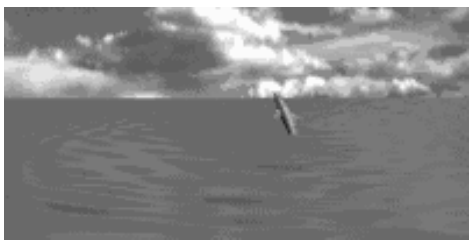
In addition recommendations resulting from this programme of research on ballast water management would provide another source of information to various international organisations like IMO, ICES, IOC and other maritime organisations, marine environment agencies and regulatory bodies.



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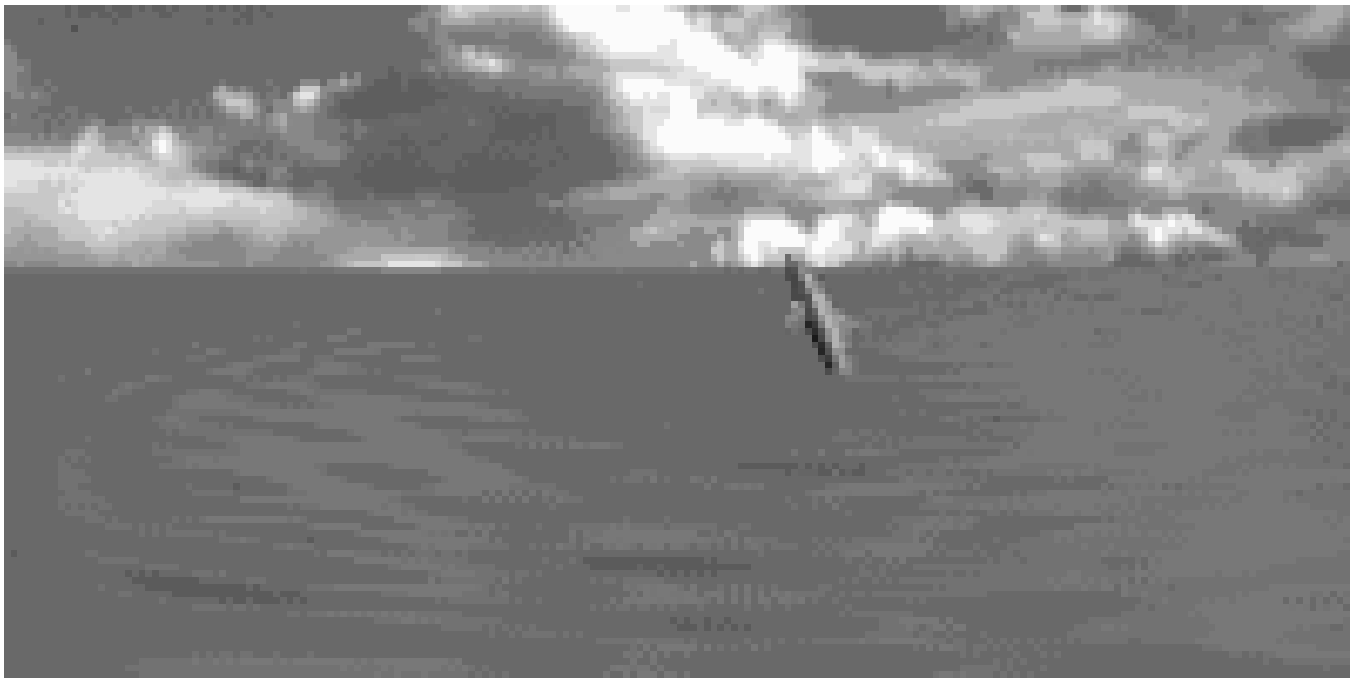

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