Assessing and monitoring the impacts of a hidden legacy of pollution from World War shipwrecks

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Hidden legacy of pollution WW Shipwrecks

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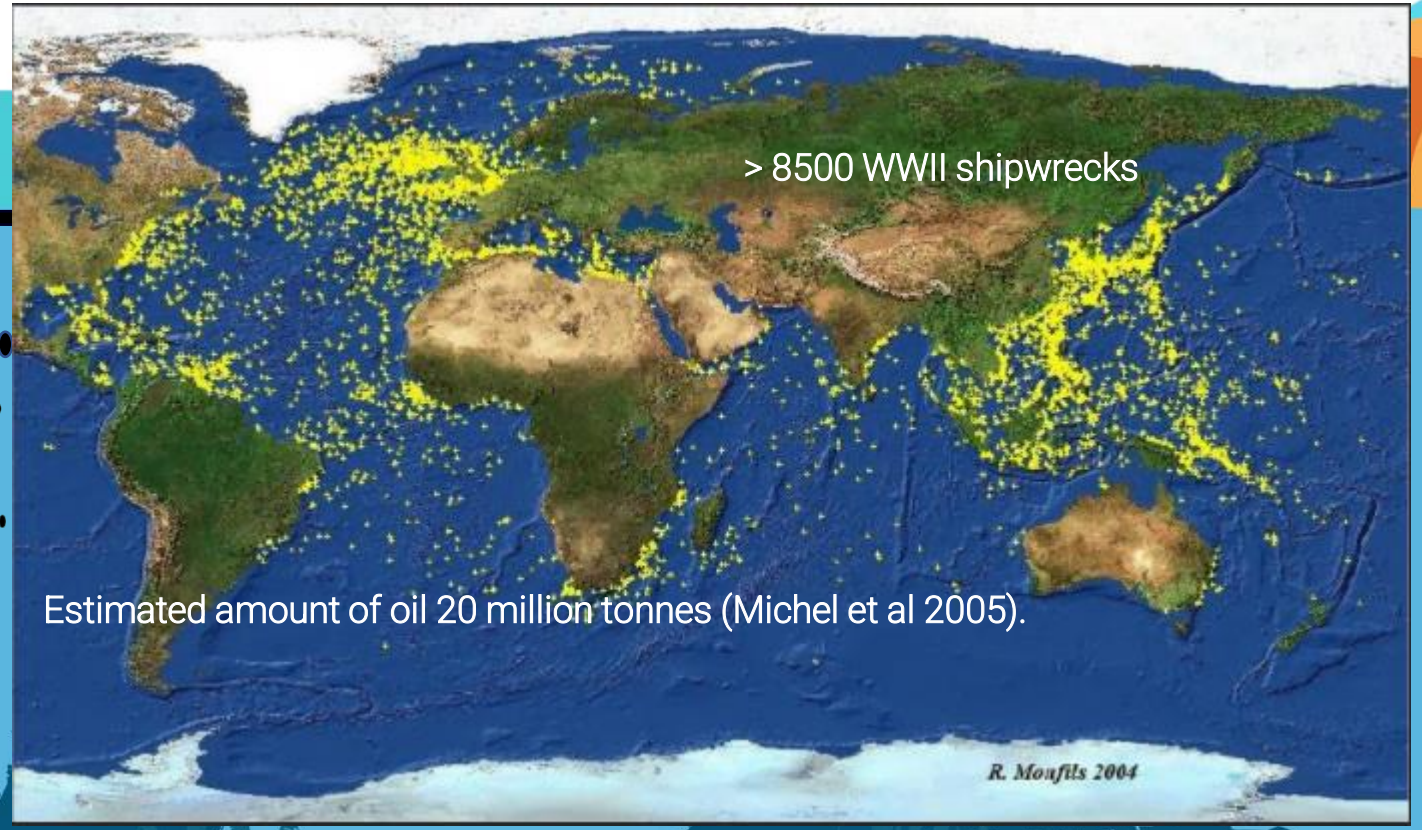


Why should we be concerned

- Oil spills cause a wide range of impacts in the marine environment both short and long term.
- Heavy persistent oils (crude, fuel oil), to lighter, non-persistent oils (e.g. diesels or petrol).
- Larger oil spills have a higher potential to spread to the shoreline impacting on coastal communities and their livelihoods.
- High profile incidents MV *Wakashio* (Mauritius), MV *Solomon Trader* (Solomon Islands), S.S. *Jacob Luckenbach* (USA) demonstrate first hand the devastating effects of oil spills.
- Significant environmental impacts and high clean-up costs.

Smothering

Tainting of edible food

Fouling of marine infrastructure

Loss of species result
and function of mari

Interruption to marine activities

Loss of habitat

Step 1: Prioritise

Step 2: Evaluate

Step 3: Manage

Standardised Risk Assessment Approach to prioritise shipwrecks where intervention may be required by assessing the likelihood of a shipwreck to release oil.

Likelihood of Oil Release Assessment

Risk assessment criteria	Weighting of Criteria	Low (Score of 1)	Medium (Score of 2)	High (Score of 3)
Vessel depth	2	>100 m	30-100 m	<30 m
History of leaks	3	No known leaks	Unknown or anecdotal evidence	Documented history of leaks
Integrity of wrecks	2	Broken into more than three pieces	Broken into two or three pieces	Intact, in one piece or unknown
Age of vessel at time of sinking	1	<10 years	10-30 years	>30 years
Length of time vessel has been submerged	3	<50 years	50-90 years	>90 years
Method of Storage	2	Specific bunker tank	In hold	On deck, drums, containers, crates
Type of incident causing sinking	1	Multiple torpedo detonations, multiple mines, severe explosion	Single torpedo, shellfire, single mine, rupture of hull, breaking in half, grounding on rocky shoreline or unknown	Foul weather, grounding on soft bottom, collision
Stability of seabed	2	Known to be stable seabed	Relatively stable or not known	Unstable and/or high degree of movement

Assessment criteria from Goodsir et al. 2019, 'A standardised approach to the environmental risk assessment of potentially polluting wrecks', *Marine Pollution Bulletin*, vol. 142,

- Scores of 1 (lowest) to 3 (highest) are applied for risk to the eight criteria.
- To generate the likelihood of oil release score, scores assigned for each criterion are multiplied by a weighting of 1-3.
- The sum total of is used to produce a risk of oil release score, and can be quantitively ranked with other shipwrecks.
- Confidence assessment is applied to assess indicate the suitability and accuracy of available information.

Low risk of oil release	<24
Medium risk of oil release	24-32
High risk of oil release	>32

Likelihood of Oil Release Assessment

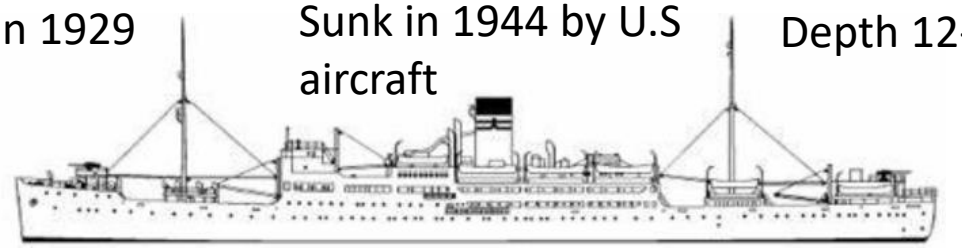
Rio de Janeiro Maru Chuuk Lagoon

Launched in 1929

Sunk in 1944 by U.S aircraft

Depth 12-35m

Oil leaks have been reported in 2008, 2017 and 2019



Submarine tender for the Imperial Japanese Navy

Risk assessment criteria	Specifics of wrecks	Low (Score of 1)	Medium (Score of 2)	High (Score of 3)	Weighting of criteria	Score
Vessel depth (metres)	12 - 35 m			3	2	6
History of leaks	Yes			3	3	9
Integrity of wreck	Intact			3	2	6
Age of vessel at time of sinking	15		**2**		1	2
Length of time vessel has been submerged	76		**2**		2	4
Method of storage	Tanks	**1**			2	2
Type of incident causing sinking	AB		**2**		1	2
Seabed type	Stable	**1**			2	2
Total Score						**33**

Total Score
<22 Low risk of oil release
22-32 Medium risk of oil release
>32 High risk of oil release.

Assessment criteria from Goodsir et al. 2019, 'A standardised approach to the environmental risk assessment of potentially polluting wrecks', *Marine Pollution Bulletin*, vol. 142,

Evaluate

Desk based assessments

- Remote sensing techniques
- Spill trajectory and fate modelling
- EIAs and Ecosystem assessment

On-site surveys

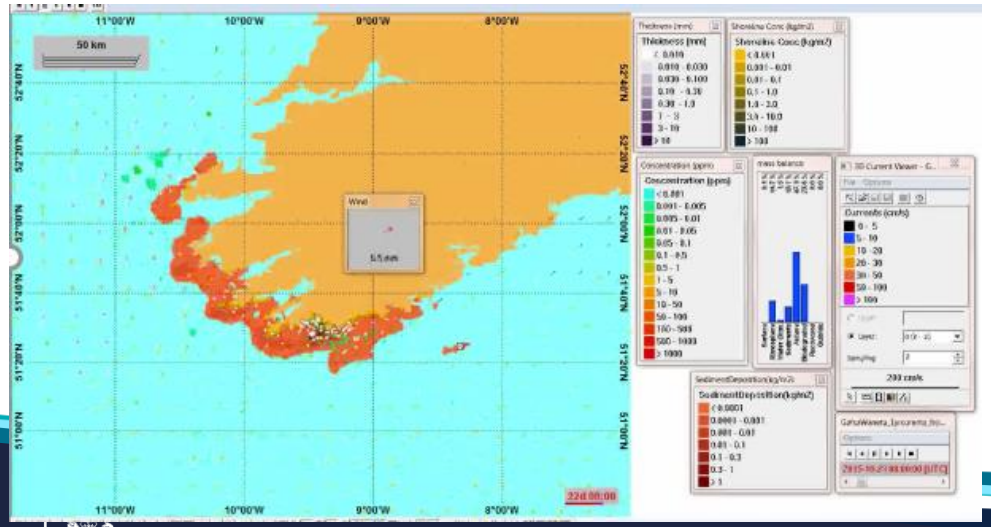
- Baseline condition assessments
- Environmental monitoring surveys

Desk Based Monitoring

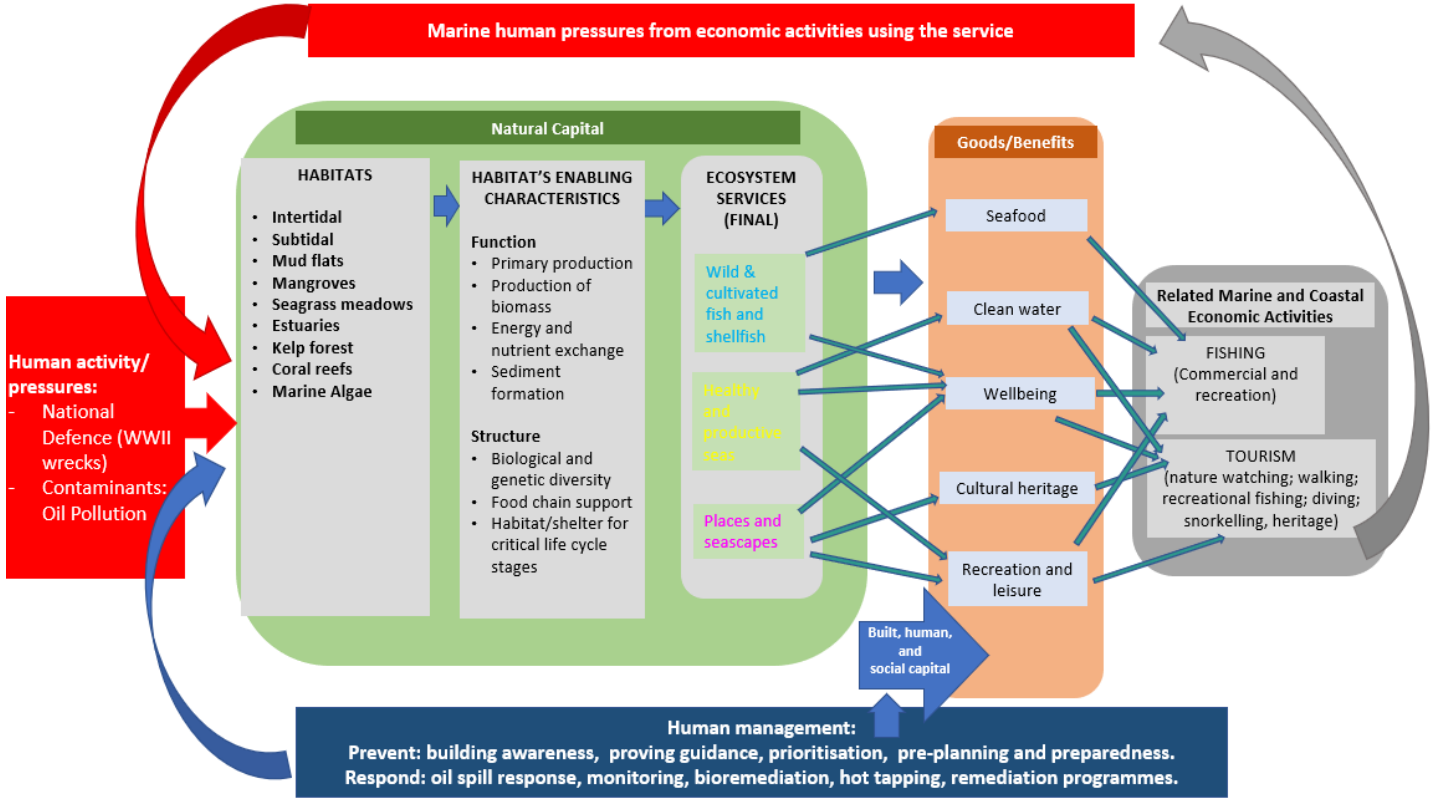
Remote Sensing techniques

- Identify active oil spills from historical wrecks through high resolution imagery.
- Multiyear data sets of both optical and radar images can be investigated.
- Indicate the extent of pollution, and frequency of a spill.
- Help prioritise shipwrecks which are actively leaking
- Determine the probability and magnitude of risk of exposure from an oil spill.
- A standard set of scenarios can be used to compare between shipwrecks, to aid the prioritisation process.
- Stochastic models can be used to provide probability risk maps identifying areas at greatest risk.
- Sensitivity data can be overlain with probability maps to provide an understanding of likelihood of risk to receptors
- Properties of oil (type) and quantity is not always know for shipwrecks.

Spill trajectory and fate modelling



Desk Based monitoring



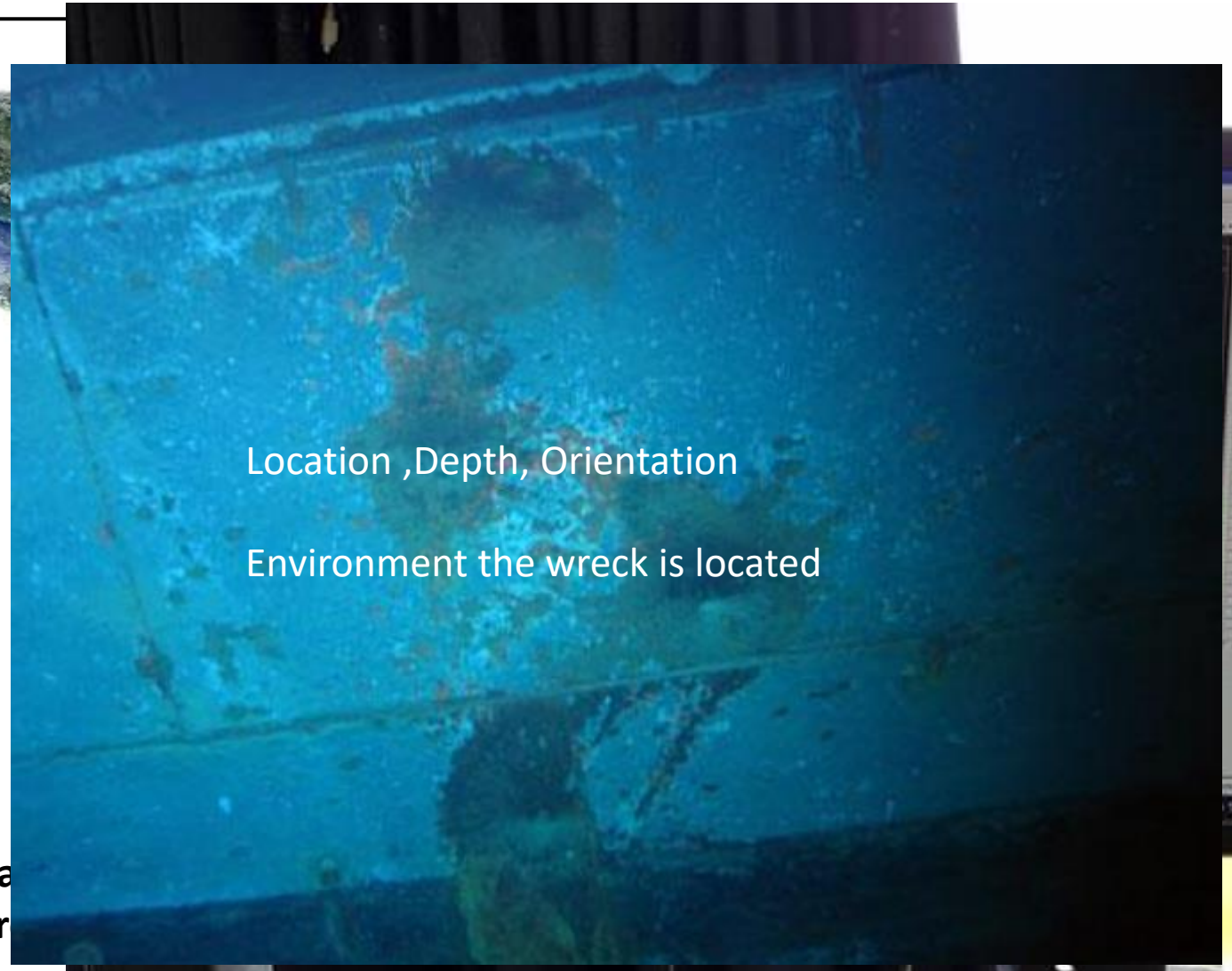
- Ecosystem assessment

- Potential impacts from an oil spill on coastal and marine ecosystem services, including the goods and benefits they provide.
- Seafood provisioning service negatively impacted by and oil spill through the closure of fishing areas.

China oil spill: warning over seafood contamination

Scientists say consumers should be wary of buying any seafood that may have passed through the area until the toxic impact of the spill has been assessed

Baseline survey and condition assessment

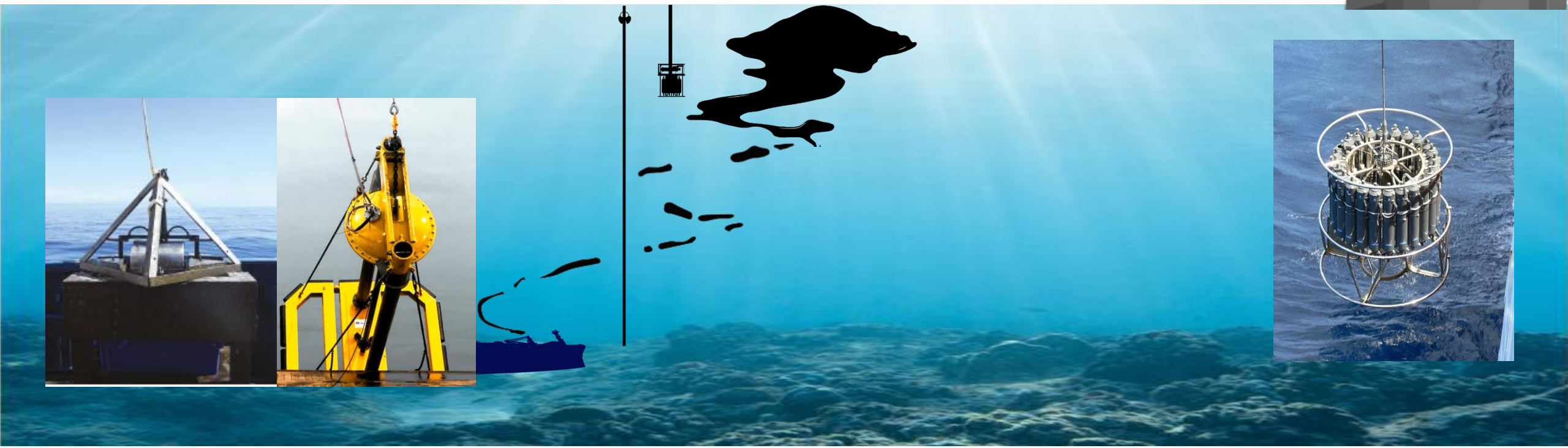


aru in Chuuk

3D modelling ha
with the vessel r

Environmental monitoring survey

- Habitat characterisation and ecology of site (PSA, infauna analysis and microbial community structure).
- Contaminant levels in sediments, water and biota.
- Assessment of contaminant and ecological parameters against regional monitoring data and control sites.
- Production of baseline data and maps against which future impact/status/recovery can be assessed.



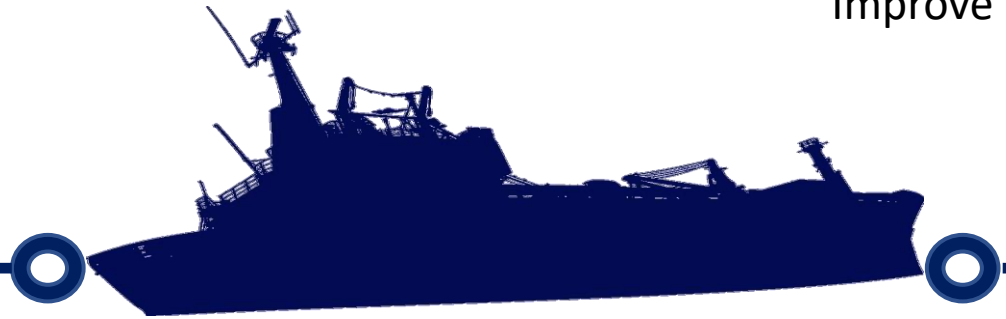
Manage

Tailored management plan

- Legal & political
- Social & cultural

Spill preparedness and mitigation plans

- Provisioning and stockpiling of oil spill response equipment in areas of higher risk
- Awareness and capability training to Improve the response for future oil spills



- Do nothing
- Monitor and evaluate
- Hot tapping and removal of oil
- Partial or complete removal of wreck

- Engaging with local stakeholders and communities to establish best methods for response

Summary

- Large proportion of world war shipwrecks some of which may still have pollution potential.
- Due to the vast number of shipwrecks an approach is needed which can prioritisation, evaluation and management to ensure effective allocation of resources.
- There are a range of monitoring techniques that can be used to evaluate higher priority wrecks, but we recognise that these methods have both advantages and limitations.
- Shipwrecks are unique are require their own tailored management plan, legal, social, cultural and political considerations need to be made, and where possible efforts should be focus to intergrade resource and efforts.
- An approach to prioritise, evaluate and manage PPW like the one presented here is required to minimise the threat of oil pollution from PPW, to ensure the protection of the marine ecosystems, and the benefits, good and services they provide.

Further reading.....

A standardised approach to the environmental risk assessment of potentially polluting wrecks. Freya Goodsir, Jemma A. Lonsdale, Peter J. Mitchell, Roxana Suehring, Adrian Farcas, Paul Whomersley, Jan L. Brant, Charlotte Clarke, Mark F. Kirby, Matthew Skelhorn, Polly G. Hill. A standardised approach to the environmental risk assessment of potentially polluting wrecks, Marine Pollution Bulletin, Volume 142, 2019, Pages 290-302.

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