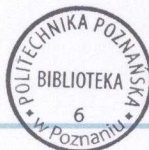


TABLE OF CONTENTS



A 201485

CHAPTER 1: Introduction.....	4
CHAPTER 2: Survey methods	7
2.1 Determining the order and methods of data collection	7
2.2 Important steps in the wreck investigation, having an impact on the workload and the quality of acquired knowledge	9
2.2.1 Magnetometric and geoseismic tests	9
2.2.2 Geological, biological and ecotoxicological tests	9
2.2.3 In situ observations and measurements (photographic, film and sonar documentation)	10
2.3 Other important information to be taken into account when investigating the wreck	11
2.3.1 Estimating the risk of fuel leakage at all stages of the procedure	11
2.3.2 Construction of the vessel and its impact on the fuel distribution	11
2.4 Ammunition, unexploded mines, and other dangerous materials in the wreck	14
CHAPTER 3: Wreck environmental risk assessment methods	16
3.1 Assessing the risk assessment methods of wrecks constituting a potential threat to the environment	16
3.1.1 General frames of risk management	17
3.2 Overview of the Environmental Desk-Based Assessment (E-DBA)	19
3.2.1 Key definitions	20
3.2.2 E-DBA Process diagram	21
3.2.3 Likelihood of oil release	23
3.2.4 Oil release modelling	26
3.2.5 Quantification of risk for sensitive areas and selected environmental receptors	30
3.2.6 Final risk score	30
3.2.7. Calculating confidence score	
3.3 Risk assessment methodology for Polish wrecks	32
CHAPTER 4: Methodology for conducting geophysical surveys	40
4.1 Positioning systems	40
4.1.1 RTK GPS – Trimble SPS 851 satellite positioning system	40
4.1.2 System for providing the heeling lever, heading and acceleration	40
4.1.3 USBL Sonardyne Ranger 2 underwater positioning system	41
4.2 Bathymetric and 3D data	41
4.2.1 Data acquisition methods	43
4.2.2 Data presentation and processing	43
4.3 Sidescan sonar	45
4.3.1 An example of a sidescan sonar used in marine surveys	46
4.4 Sub-bottom profilers (SBP)	48
4.5 Magnetometer Surveys	49
4.6 Marine laser systems	53
4.7 Systems supporting environmental data collection	54

4.7.1	Sensors used for measurements of temperature, salinity, and oxygen content	54
4.7.2	AWAC profiler for measurements of currents and waves	54
4.7.3	Environmental monitoring buoy	55
4.8	Geological analysis	56
4.8.1	Scoop sampling	56
4.8.2	Core samples	58
4.9	Acquiring data using optical methods	59
4.9.1	Photographic and film data	59
4.9.2	Photographic data showing oil spills (also from wrecks)	60
4.10	Methodology of chemical and biological tests	62
4.10.1	Methodology for testing water, bottom sediments and marine organisms	62
4.10.2	Analysis of near-bottom water	63
4.10.3	Chemical analysis of benthos organisms	64
4.11	Biological analysis	64
4.11.1	Material and method of biological analysis	65
	Sampling	65
	Analysis of macrobenthos structure	66
	Assessment of ecological status	66
4.12	Ecotoxicological analysis	66
4.13	Ecotoxicological analysis – methodology	66
4.13.1	Determination of acute toxicity using marine bacteria <i>Vibrio fischeri</i>	66
4.13.2	Chronic toxicity using Ostracodtoxkit F™ test	67
4.13.3	Determination of toxicity using <i>Sorghum sacharatum</i> plants	67
CHAPTER 5: Review of available methods and technologies for removing fuel from shipwrecks and remediating the contaminated sediments		71
5.1	Monitored natural recovery	72
5.2	Separating the contaminated area with a fence	74
5.3	Solidification and stabilisation of contaminated sediment. Use of fly ash	76
5.4	Capping the contaminated area	78
5.5	Bioremediation	82
5.6	Removal of contaminated sediment by dredging	85
5.7	Hot-tapping and pumping fuel residues from the wreck with a ROV	89
5.8	Auxiliary supporting technologies for oil removal	93
5.8.1	Booms	93
5.8.2	Skimmers	94
5.8.3	Other pumps	95
5.8.4	Oil, water and sediment separators	95
5.8.5	Other technologies	95
5.9	Comparison of methods and proposals for remediation of contamination	96
5.9.1	General costs	96
CHAPTER 6: Summary		102