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Conclusion
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8.1 Summary
Through the example of the Western Wadden Sea area, this thesis aimed to demonstrate some of the dilemmas that are confronting underwater cultural heritage management. These concern the abundance of underwater cultural heritage (as shown in Chapters 1 and 2), the complexity of gaining insight into underwater resources (Chapter 2), the various threats these resources are subject to (Chapter 3) and, in relation to this, the possibilities there are to mitigate against these threats (Chapters 5, 6 and 7). The latter is specifically focused on the possibilities and impossibilities associated with applying in situ preservation to an underwater site.

Each year many sites of high archaeological significance are found on and in the seabeds of the world. This also regularly occurs in the Western Wadden Sea area. The potential of these new sites is high. Usually when they are found, they are already at risk. Once exposed they are under threat from biological, mechanical, human and even chemical deterioration. The different deterioration processes affect each other. Erosion of the seabed exposes the wreck site. This causes abrasion on the wood, the introduction of oxygen and easier accessibility for humans and animals. Bioturbation causes direct disturbance of the find layers but also more oxygen in the ground, which stimulates bio-activity.

There are several ways to mitigate against these threats. We can, for example, excavate (and thus preserve ex situ), but then we need to have a sufficient budget, sufficient capacity, appropriate facilities and sound scientific input, among other things, as well as robust research questions and high-quality research methodologies to ensure the optimal safeguarding of materials, data and information, as we have seen in Chapter 5 (Section 5.8). We can also aim for in situ preservation over the long run or as a temporary measure. The reasons to do so were laid out in Chapter 4. However, and although often thought to the contrary, choosing this option does not relieve us from any further responsibility or action.

While in situ preservation concerns the overall aim of maintaining sites where they are found, in situ protection concerns a more active role, making sure these sites remain preserved in place. This involves physical protection of archaeological sites, as well as monitoring and maintenance. This was explained in Chapters 5 and 6. Protection is the preferred way of dealing with sites in the Western Wadden Sea area because of the dynamics of the area.

Physical in situ protection may be a solution that keeps the sites protected on the seabed. However, this protection requires a clear purpose and goal. We need to understand why we are protecting the site. For example, if we wish to preserve the intrinsic significance of the site, what needs to be protected and against what kind of threats? What is the significance of any change in circumstances? Through practical experiments over the years, different methods have been developed, but there is a need to continue developing new protection methods in order to find the best solutions for each site; each with its own circumstances. The best way to develop new techniques and ideas is to work in a multidisciplinary way with researchers, engineers, conservators, marine archaeologists and other practitioners working, for example, in the field of maritime engineering and construction. An excellent example of this is the project that has been initiated in the Wadden Sea by the Cultural Heritage Agency of the Netherlands (RCE) and the Programma Rijke Waddenzee (Rich Wadden Sea Programme) to not only physically protect the most valuable wrecks, but also to use them as artificial reefs in order to promote biodiversity.

A multidisciplinary approach can thus be ensured through cooperation between different stakeholders protecting different values. Sites may then be protected for their cultural heritage value as well as for biodiversity reasons and/or for the recreational enjoyment of divers. The protection of underwater cultural heritage is therefore not just something for individuals to strive for, involving only a single stakeholder group. Sometimes it is not even one governmental body alone that is involved, but concerns a number of cooperating stakeholders and alliances between governments at different levels. The protection should be balanced against different issues such as cultural and economic benefit or public engagement. This balancing act is the core of cultural heritage management.

For the cultural heritage manager it is important to make choices between what will and will not be managed at the level he or she is involved in. One important choice to make is whether a site needs in situ protection, can be ‘deselected’ or if an excavation is needed. This decision should be based on reliable data and with an acknowledgement that ‘gone is gone’. One needs to realize that underwater excavations are expensive and must be done according to specific national and international procedures, such as those stipulated in the UNESCO Convention for the Protection of the Underwater Cultural Heritage (Paris, 2001), the ICOMOS Charter for the Protection and Management of the Underwater Cultural Heritage (Sophia 1996) or the Dutch Quality Standards (KNA). Conversely, in situ preservation also requires taking responsibility over a longer period of time, involving intensive and high-quality research and monitoring. The heritage or site manager should also be aware of different values attributed to the site and the importance of balancing the wishes and needs of different stakeholders in order to create a well-supported in situ preservation system in close collaboration with multiple shareholders. He or she then becomes a broker, balancing the different needs and wishes necessary to preserve a site for future generations, the nation, region or location and the wishes of other – often multiple – stakeholders. Structural budgets are needed to create and to sustain such a well-supported in situ preservation system.
For many years, since the signing of the Valletta Treaty in 1992, in situ preservation has been generally thought of as a panacea in cultural heritage management in general. This has resulted in a somewhat one-sided aim and approach to our heritage: the aim to protect over a long period of time for future generations and future research. In other words, for later, later and later. This has frequently led to a situation in which out of sight was out of mind. The development of underwater cultural heritage management was explained in Chapter 1. The lack of ability to bring sites and their inclusive information about the past to the people for enjoyment or research has often alienated people from the resource. This has been rather disadvantageous to the emancipation of in situ protection as part of underwater cultural heritage management. It is true that in situ preservation and management have an accepted place on the political level. Law has also provided tools for protection and law enforcement (although not sufficient). However, unfortunately, generally no structural financial means are available for in situ protection and monitoring to support this policy in the Netherlands and many other countries in the world. This illustrates the difference in perceptions between stakeholders about what we expect in situ preservation to be or what it should be. It is either considered a cheaper option in management or the best way to keep sites available for future research and enjoyment. In relation to the former, no regular financial investments are deemed necessary and responsibility often stops immediately after the decision to leave a site in situ, while for the latter, active involvement – and thus management – is often needed to keep the site and the potential information it contains available for later study.

Luckily, a change in attitude is slowly becoming apparent. However, the current circumstances may not be conducive to the real story about the costs of in situ protection, that there is a need for follow up, or that it is not a solution for eternity, may frighten investors and primary public bodies, especially in times of economic and financial deficit or crisis. However, this only means it is even more important to be fair about needs and to reserve budgets for the longer term. With pressure from different stakeholder groups (sometimes appreciating sites for different reasons), public bodies will confront the problem that needs to be resolved. This may entail becoming actively involved in preservation in situ, or pointing out to others their responsibility, or even taking the decision to excavate and thus preserve knowledge and objects ex situ. Selectively, sites or areas may also be proclaimed National Monuments as part of a series of stepping stones illustrating the national maritime history of the Netherlands. This will increase the need for the national government to take up its responsibility for the management of these sites. The stepping stones may then be a tool for all of us, young and old, and from all parts of society, to tell and explain to others the maritime history of the Netherlands. The stories may then be brought to the public through museums or by bringing people to the physical sites, or by using new technologies, as described in Chapter 7.

8.2 Answering the research questions
In the following, I will systematically summarize the possible answers to the research questions developed at the start of this research and formulated in Chapter 1 of this thesis.

If possible, how can we gain insight into the presence of underwater cultural heritage and of maritime underwater heritage, in particular, in the Western Wadden Sea?
To a certain extent we can. Water itself, unfortunately, prevents most people in society from engaging with underwater cultural heritage when it is preserved in situ. However, technological developments are giving us increasing numbers of technical tools to help us to create better knowledge and insight. As we saw in Chapter 2, we are now able to develop a reliable overview of the known underwater cultural heritage in an area. There are, however, different levels of what we can consider ‘known’ and ‘reliable’. An analysis of the many databases – from governmental organizations such as the RCE, the Ministry of Infrastructure and Water Management (Rijkswaterstaat) and the Hydrographic Service of the Navy, to the databases of several amateur archaeological associations – that was used to gain insight into the locations known on the Dutch seabeds, showed that there are different levels of accuracy in relation to positioning, as well as archaeological and historical information. Sometimes we will only have a position, while at other times there is a full assessment report. Expert judgements to assess the quality of the information forms a good basis for management. The information from the Hydrographic Service and the Ministry of Infrastructure and Water Management may be just as important for management as the information from archaeologists and sports divers. While the first two usually have precise and correct positions in their databases, most objects are referred to as ‘obstacles’ and there may not be much archaeological information available. In relation to the databases of the RCE, but also those of amateur archaeologists, positions may not be always accurate due to the use of inferior techniques and the transformation of these positions into different projection systems. This ultimately leads to the loss of accuracy in relation to each individual site but also – and more seriously – to a devaluation of the whole database, to the extent that the accurate location of each site is not known.

The underwater cultural heritage, however, not only consists of what we know, there is still so much we do not know. Often the sites are hidden under the seabed surface. Techniques are becoming available, such as the 3D sub-bottom profilers that are currently being tested at different sites in Europe, with which we can create accurate images of what lies in the sediment, especially over large areas. However, at the moment the chances of finding something like a shipwreck in the seabed are still minimal as the perception grid of this equipment is relatively small.
Gaining an insight into the unknown resources is thus far from being a straightforward exercise. We can predict or model the unknown resources to some extent. We can divide areas into places where there is a likelihood of finding sites, or where we will certainly not find them and where they are very likely to be present. Whether we can regard all of the ‘positive’ predictions as cultural heritage is another question. This depends on what society thinks is worth preserving and what we want to use it for. This may, for example, be for future research, commemoration or enjoyment. Although touched upon here, it has not been the aim of this thesis to answer this latter question.

Objects may be purposely or accidentally left behind. It is not always easy to identify the reasons. However, each site can provide us with information about the locational characteristics of the area in which it is positioned. Landscapes are formed by interactions of natural and human processes. Understanding these processes is an important key to the biography of a place. With that understanding, we may be able to look further than just those archaeological or other sites that have been discovered already (known resources). We can predict the chances of cultural heritage still existing in specific areas or places (predicted but yet unknown resources). From this basis of validated information we can add non-validated information, such as historical sources, historic maps or sightings by others, which can yield a treasure of information as well, although this is often subjective and should never be confused with objective data from systematic research.

The Western Wadden Sea in the Netherlands is a very dynamic region, heavily influenced by tidal effects, erosion and sedimentation processes. A constant flow of these natural processes has shaped the seabed, while human activities have adapted the area for their own use. This has been going on for centuries. If we want to manage the underwater cultural heritage effectively under these dynamic conditions, we need to set priorities. It is essential to create an overview of the area’s palaeo-geographical and environmental development to be able to make decisions about where to actively protect sites, where sites can remain on the seabed without much interference or where there will most probably not be any valuable sites present. Choices will have to be made due to the potential richness of the resources and the threats present or predicted. These choices will have to be based on both ‘hard’ facts and figures (e.g. the amount of sediment disappearing where sites have been discovered) and ‘soft’ impressions (where sites and future threats are predicted). The combined information will provide the ammunition for well-grounded mitigation strategies that preserve our underwater cultural heritage more effectively.

By understanding the place and its geological and cultural genesis and development – being able to read the landscape from past but also from current perspectives, as has been described in Chapter 2 – we can focus on its current and future use; for example, for enjoyment, as is outlined in Chapter 7.

To gain better insight into the known and the unknown (predicted) heritage resources a system of comparable maps from primary and secondary sources, and with a combination of quantitative and qualitative information, was developed. With the Historical Geomorphological Map Set (HGMS; Chapter 2), it is possible to gain an understanding of the biography of the landscape from geological, morphological and historical perspectives. In this way, the Western Wadden Sea might be described as an area where the known resources can be divided into different groups, with different levels of accuracy about their location and the level of information assessed.

From the cultural heritage resource database (ARCHIS 2), for example, 190 wrecks and 416 other observations over 109 locations are known to lie in the limited study area of the Western Wadden Sea. The combined official governmental agency databases, managed through the National Contact Number (NCN) system, contained (on the same date, December 2013), in total, 3,393 observations within the limits of the study area. This differs significantly from the number of sites in ARCHIS 2, but can be explained by the fact that ARCHIS contains cultural-historical weighted sites while the databases from the Hydrographic Service and the Ministry of Infrastructure and Water Management include ‘obstacles’ in general, as mentioned above. The latter databases, for example, also include the Texel Stone Field, with approximately 2,280 natural erratic stones of glacial (Saalian) origin, which makes a huge difference.

If we compare ARCHIS with the total of 6,636 observations from other unverified sources, mainly consisting of amateur archaeology databases that are known for the Western Wadden Sea area, we see another discrepancy in numbers. None of the observations from these sources, however, have been verified, and the overlap with the NCN system has yet to be determined. This number of observations does, however, show the potential of the area.

If we look at the unknown or predicted resources, we see more of this potential. Roughly between Vogelzwin and Vaarwater naar de Cocksdorp, as well as parts of Lutjeswaard and Zuidoostrik and parts of the Balgzand area were all geologically and morphologically relatively stable in the period between 1925 and 2005. The historic maps dating from 1584 to 1852 show – although in less detail – more or less the same information. This means that although most areas within the Western Wadden Sea have been influenced by ever-changing gullies and thus there has been erosion of the Holocene and sometimes even the Pleistocene seabed, some shallow areas have remained relatively stable. These places may have never been ideal for navigational purposes, but early settlements and ships that may have run-aground may still be found there. If so, they will likely be in a comparably good state.

8. Conclusion
Preserving a layered history of the Western Wadden Sea

Cultural heritage in the eastern part of the Burgzand area and on/in Vogelzand, Scheer, Texelstroom and Scheurrrak are most at risk of being uncovered and degraded by erosion and subsequently exposed to other threats. In these areas, we find most wreck sites. Sometimes, if recently uncovered, they are in a remarkably good state of preservation, such as BZN 10 and especially BZN 17. Sometimes, however, they are already heavily degraded due to having been exposed for too long before discovery or because they have been exposed multiple times, with a loss of a great deal of information of archaeological value.

If possible, how can we develop an approach to co-create this knowledge by means of desktop research that can serve as a basis for heritage management?

As demonstrated in Chapter 2, this is currently being done through the combination of maps in the Historical Geomorphological Map Set (HGMS). This process is combining ‘hard’ (quantitative and science-based) as well as ‘soft’ (qualitative and interpretative) information. For example, it includes the known resources, the geological make up in the area, sedimentation versus erosion processes, and mechanical, chemical and anthropogenic threats, but also historical maps. The information they provide on former uses of the area have proved to be an asset in gaining a thorough understanding of the history and development of the area.

Thus, the HGMS will help us to predict where sites are likely to be located. The power of the tool lies in the combination of different sources of information and the metadata that it also contains. Making data sets available, combining them for interpretation, but also keeping them physically separate, is exactly the right thing to do, as we have seen above. There is a lot of data available that may not be compared on a one-to-one basis. Not all the data has the same detail or the same level of accuracy. Simply putting them altogether would mean that the overall dataset would be ‘corrupted’ to some extent, its quality no better than the lowest quality data set included.

Although the HGMS consists of a set of basic information – providing maps that give an overview of the quality and quantity of archaeological heritage in the area – it is also a flexible data set. This means that new information can be added to the model without changing the original data sets. In combination with a geographical information system (GIS), it is very easy to add new data layers and to visually combine and correlate different data sets and information. Metadata added to the different data sets will provide the user with all the information about the source, the owner, and also the accuracy of the data.

Being able to add other data sets provides variability in the analyses. While the basic set of data provides the essential information that is needed for the analyses of the known and the unknown/predicted resources in the area, newly added information may provide a more accurate view, a more dense observation grid or a different and new focus for research. This may, for example, be the case when local databases of finds are added, or newly discovered and digitalized maps, recent analyses of cores, or sand layers dated with OSL, are included (see also Chapter 6).

By combining or comparing the maps with this new data, our knowledge of the archaeology and heritage of the Western Wadden Sea area and the way to deal with it will be improved. However, expert judgement will always be needed in addition to the objective data. Insights into what has happened in the past can only be created through a combination of quantifiable data, current (personal) knowledge about a specific area and/or a specific period and deductive reasoning. This can aid in predicting the likelihood of finding sites buried in the seabed of the Western Wadden Sea. By systematically processing the data and by clearly separating objective and subjective observations, we may also better identify the gaps in our present knowledge. These gaps can then be distilled into fundamental research questions and added to national and international research agendas.

The HGMS may serve several purposes: as a foundation for the drawing up of policy maps by municipalities and provinces, for example, or as an aid to answer academic questions. The HGMS for the Wadden Sea can serve as a sound basis for academic research, since each data set has been validated and summarized taking into consideration the manner in which the data was collected, when it was collected, the original purpose of the data, the reason for the collection and the processing that the data set has undergone. It is also suitable to an academic approach because of the modulated set up, which makes it easy to combine, add one’s own insights and thus to differentiate potentially without limit.

The HGMS consists of three groups of maps. The first consists of maps that were created using objective measurement data. The second consists of combinations of maps from the first group. The third group provides insight into use by humans, reconstructed for the various periods.

The HGMS for the Wadden Sea can also be of great use to policymakers and other parties in the field of cultural heritage management. The main idea behind the method developed is to improve the decision-making process pertaining to the management of underwater cultural heritage. In doing so, it complements the methods used in desktop studies. The modular structure of the HGMS will thus provide opportunities for archaeological organizations to differentiate in their methods of approaching the same questions. This is not only important for a free market, but also for other stakeholders, because in this way, data from different, non-academic sources and from different groups with different aims can be added to answer questions in society and not only those concerned with scientific values.
Shipwrecks are often found by accident. How can the chances of finding them be better predicted?

Prediction is possible to a certain extent. Indeed, shipwrecks are often found by accident, for example during construction work, dredging, fishing or by sports divers. On the basis of the information we can obtain by combining the maps available in the HGMS, we can, however, also predict the likelihood of finding shipwrecks in a certain area. This was discussed in detail in Chapter 2. Although this is not an exact science, it is possible to point out areas in which there is little likelihood of finding shipwrecks (e.g. the areas dredged or eroded down to the Pleistocene) and those in which the likelihood is great (e.g. being located on an important trading route and with little erosion over a long period of time).

Being able to predict the chances of finding shipwrecks is enormously important because this would also mean that the management of unknown resources are taken into consideration in advance, rather than having to deal with unexpected finds when work is already underway. Nevertheless, shipwrecks generally need to be surfacing the seabed before they become evident, as it is still difficult to look into the seabed. Techniques and methods such as 3D sub-bottom profiling are improving drastically and are very promising, but thus far they are not accurate enough for large-scale searches in the sediment.

We need, however, to start acknowledging that it is possible to differentiate areas where the chances of finding wrecks are more or less likely. This was not the case with earlier predictive mappings of the Wadden Sea. The first predictive mapping excluded all areas of water in the Netherlands, as if there was nothing there (see the earlier versions of the IKAW, the Indicative Map of Archaeological Values). In later versions, water covered areas were taken into account to predict the presence of prehistoric settlements on the seabed, but there was no concern about the possible presence and, therefore, also richness of the underwater maritime past. The HGMS, in contrast, will be a tool that can be used for the predictive modelling of shipwrecks as well.

Nevertheless, potential and known underwater heritage is still not being taken into account when municipalities draw up their heritage policy. In the past, neglect of underwater cultural heritage, even by government agencies that should know, has resulted in other agencies, archaeological companies and contracting companies taking this part of the cultural heritage less seriously: ‘out of sight is out of mind’. This was illustrated in Chapter 2.

Moreover, desk-based research and pre-disturbance surveys have often not taken place before seabed disturbance occurred. The combination of disinterest, a lack of incentive to understand and search for sites, a lack of will from governmental organizations, of the false assumption that ships may have sunk anywhere and thus can be found anywhere (i.e. are randomly distributed over an area), the specific nature of the – often hostile – environment (sedimentation-erosion, bad visibility, etc.) and possibly simple ignorance, of not knowing where to start, has led to the fact that when underwater sites are discovered it is usually by accident. This in turn can pose immediate dilemmas, for example, when a site is discovered during a construction project that is already under way.

As shown with the HGMS, we can predict the chances of finding shipwrecks in an area. Our ‘observation grid’ may for now not be as detailed as for sites on land, but the overview it gives us must be accepted and acknowledged. We now have the capacity to make an informed judgement about the likelihood of finding something or not. We can divide a region, in our case the Wadden Sea, into areas with low, medium and high probability of the presence of shipwrecks or other sites. This is important for the overall management of resources. The historical use and the natural condition of an area may increase or diminish the chance of finding a wreck. An area between two important trading cities, for example, will increase the chances. By reconstructing the former maritime cultural landscape, with its harbours, known transportation routes, connected river systems, transition points and its dynamics though time, including the risk areas for transportation, it is possible to differentiate and make significant predictions. Therefore, although often found by accident, shipwrecks do not have to be accidental finds.

How is it possible to preserve ‘unknown resources’ in situ?

We can take precautionary measures to protect an area with a high probability of finding archaeological sites, whether they are shipwrecks, prehistoric or other sites. This can, for example, be done through law and specific policies. This option was explained in Chapters 4 and 5. We may, however, want to make these sites ‘visible’ and thus turn them into sites we know more about. Although this seems to be the best solution in relation to the development of management strategies, it is not as straightforward as it sounds.

Big steps have been made in the development of equipment to detect sites on the seabed. Side scan sonar and multibeam sonar are incomparable to the previous generations of equipment in terms of resolution and accuracy. However, the technology required to detect sites in the seabed is still not sufficiently advanced. While the equipment can usually indicate general disturbances or indications, it remains generally difficult to confirm these or obtain more detailed information. What we might discover in the seabed, therefore, remains an educated guess based on the combining of all the information we can gather (such as that provided by the HGMS, Chapter 2).

By officially acknowledging that this process of predicting sites is in certain areas is of value and including it in the assessment of an area prior to any development, or recognizing it as a valuable asset in local management policies, unknown resources can be
preserved in situ. For example, areas with high predictive values may be avoided in development activities, additional regular measurements may be carried out to monitor changes in the area (see Chapter 6) and activities to mitigate against possible changes can be supported and promoted. At the same time, we should acknowledge that this protection strategy concerns the protection and preservation of potential (the educated guess); the downside of this is that we may use our efforts for an area that looked promising, but eventually may not contain what we thought it would be. Many areas in which there is a high probability of finding shipwrecks and undisturbed prehistoric layers are those that are not much affected by erosion processes (Chapters 2 and 3). Therefore, the effort to protect may only require the application and recognition of law, ensuring that no human activity such as trawling, dredging or drilling leads to seabed disturbance.

**What is threatening the shipwrecks in the Western Wadden Sea?**
The Western Wadden Sea is home to many deterioration processes. In Chapter 3, we divided them into four categories: mechanical, biological, chemical and anthropogenic.

**Mechanical deterioration**
The Western Wadden Sea is a dynamic area. The Holocene layer regularly changes in thickness, alternately covering and exposing shipwrecks. On a larger scale, it is apparent that currents and wave actions have an influence on the morphology of the seabed. Gullies, tidal channels and sandbanks change place and course, opening up new areas, in which cultural heritage comes under threat. These areas are the Burgzand, Vogelzand, Scheer, Texelstroom and Scheurrak.

As we have seen, there are also more stable areas: roughly the area between Vogelzwin and Vaarwater naar de Cocksdorp, parts of Lutjeswaard and Zuidoostzijde and parts of Balgzand. Historical research has demonstrated that these areas have generally been stable for a long time. Research on sedimentation and erosion patterns in the Wadden Sea has shown that sedimentation rather than erosion is generally occurring in the area. However, mainly due to the building of the Afsluitdijk in 1932, there is not yet stability in the Western Wadden Sea area, and it may take another century before this occurs.

In this study, the dynamics of sedimentation and erosion, the effects of currents and waves on site level, were investigated on some of the wrecks in the Burgzand area. It was found that each year the morphology around the monitored shipwrecks changed. The obstruction of currents by the wreck itself causes local eddy currents that can cause scour and erosion pits in and around the site. The general tendency in the region is that the Texelstroom is moving southwards over the Burgzand area, which in some places will cause strong erosion patterns. However, due to its continuous move from north to south, erosion in the northern part of the area is already slowing down and there are also signs of sedimentation. The erosion and sedimentation patterns are thus temporary and mitigation is possible. However, during periods of strong erosion it is (extremely) difficult to protect the sites.

**Biological deterioration**
Biological deterioration on wooden shipwrecks is a continuous process. In aerobic environments, species such as the shipworm, which can cause rapid deterioration, are active, while in less aerobic and even anaerobic or anoxic environments deterioration is ongoing and bacteria can be active. The speed of deterioration, however, changes. In the Western Wadden Sea, deterioration caused by *Teredo navalis* is extremely violent and rapid, while fungi work at a much slower pace and erosion bacteria at an even slower pace. Biological attack can be accelerated by mechanical attack such as erosion of the seabed. Water flux and the amount of organic matter in the soil also have an influence on the speed of deterioration of wood.

**Chemical deterioration**
The chemical deterioration process most often found in the Wadden Sea is that of corrosion. This process is especially active with iron in high oxygen and saline areas. All objects surfacing the seabed are subject to this process. In low oxygen conditions, for example within the sediment, this process of corrosion is much less rapid, but may exist, especially under the influence of biological attack by bacteria. This form of corrosion may cause major problems when wood is salvaged and it will need to be conserved. The results of this process have been noted in large conservation projects such as that of the Vasa and the *Mary Rose* but were also observed in wood on the BZN 3 wreck. Climate change will probably cause the sea waters to become more acid. This will create all sorts of reactions in the sediment and on the seabed, of which we have no full overview as yet.

**Anthropogenic threat**
The human or anthropogenic threats are divers. Some of the threats are direct and obvious, such as in the case of looting, trawling and dredging. Their impact can easily be understood and measured. However, human activities and interventions may also affect underwater cultural heritage with a delay of many years, decades or even centuries, or in a slow continuous process that can only be measured over such long periods. For example, the Wadden Sea is one of the most diked seas in the world. This, including the building of the Afsluitdijk, has led to a change in sedimentation-erosion patterns and thus mechanical deterioration of underwater cultural heritage over a long period of time. Salvaging, treasure hunting, farming, fishing and dredging have also all had a direct effect by disturbing the seabed, as well as an effect over the long run, by causing change in scour or erosion patterns around, for example, shipwrecks. Even archaeologists may cause unintended damage through improper handling or through a lack of, or bad, treatment of a site after investigation.
Unfortunately, due to the delay in effects, it is often difficult to hold the original disturber financially or otherwise accountable for the degradation of underwater cultural heritage. One final threat to underwater cultural heritage that should be mentioned is the lack of interest in this resource, which can lead to its neglect.

**Management of threats**

There are thus many processes that threaten underwater cultural heritage. A stable area is the most likely place for an archaeological site to survive. Changes in the environment are generally not good for underwater cultural heritage. Cultural heritage managers thus study change and attempt to avoid or mitigate against it. All these processes of change are interlinked and may intensify individual effects.

Erosion, in particular, is a big threat in the Wadden Sea. This process is a catalyst for biological and human activities on site. The moving sediment, however, may be used to the benefit of protection as well. By catching suspended sand particles with nets it is possible to rebury a site. Some threats may thus be easy to identify and mitigate against because they have a direct and obvious effect. However, some may result in damage to underwater cultural heritage over decades or even hundreds of years. These effects are often not taken into consideration when protecting a site in situ, and it may also be very difficult to do so; for example, climate change must be addressed at a different level.

However, on a smaller scale, it is relatively easy to model the potential long-term effects of a newly built bridge, a wind farm, a dike or sand extraction on current patterns and gullies on the seabed, which may result in the erosion of newly exposed sites. The effects of human behaviour should be investigated by monitoring sites over a sufficient period of time. This was discussed in Chapter 6, where it was argued that such monitoring should be agreed upon project by project, while implementing lessons from past monitoring programmes. Works that have already been executed that clearly show effects on the seabed should also be monitored over a long period of time. This monitoring activity should not be done in order to find someone to blame, but to learn for the future. Politically and legally, it is impossible to still hold the builders of the Afsluitdijk (1932) responsible for the damage done to historic shipwrecks in the Wadden Sea, even if this is – at least partly – true.

Stakeholder perceptions of change and management should also be taken into consideration. One enormous disadvantage for underwater cultural heritage is the fact that it is not, or is barely, visible, especially in the Wadden Sea. In Chapter 7, I made an effort to deal with this issue. It is not always easy to see the advantages of having such a rich resource of the past within one’s territorial boundaries. The implementation of the Valletta Treaty led to a growth in archaeological activities. However, we should ask what has come of it?

The system leans heavily (if not completely) on the ‘disturber pays’ principle. However, as discussed above, it is not always clear who disturbed or destroyed an underwater archaeological site. The damage done may occur over decades or centuries and no one can be held responsible, at least not financially. Those responsible for overall management do not always have the financial resources to pay for activities to preserve in situ or ex situ. However, if we understand deterioration processes and the long-term effects, we may be able to make better decisions when executing large-scale projects (similar to the building of the Afsluitdijk) in the future, or to take measures to mitigate against long-term deterioration processes. Moreover, if this knowledge is taken into account and the principle implemented during the disturbance activities, the initial disturber could be required to allocate funds towards future mitigation measures, rather than attempting to solve the problem afterwards with only limited government money. The costs of mitigation strategies and even long-term monitoring could also – and would have to – be taken into account by the disturber when deciding on the execution of a project.

Deterioration processes are abundant in the Western Wadden Sea (Chapter 3). It is a hostile place for submerged cultural heritage on the one hand, but when protected well (by either nature or society), it is also an area with excellent preservation conditions. The variety of threats and the use value of the wrecks also create various options for finding solutions. There are mitigation strategies for all of the threats. Some are quite obvious, others need to be more creative. They range from in situ protection methods to keeping the soil environment waterlogged and oxygen-free and sometimes even low in organic material. In Chapter 5, these methods were described.

However, it is important stakeholders start sharing responsibility for the shipwrecks. Agreements between different users (stakeholders) can be made on the use, research and enjoyment of the different wreck sites. Which site will be open to the public? Which one will we wrap in protective material to keep it in store for future research? Which site might be a perfect ‘hard substrate’ in the Wadden Sea? In Chapter 7, some solutions were laid out. Not all sites are heavily under threat. Some remain in relatively stable areas, in which we may find well-preserved and very old shipwrecks. The discovery of the Westerveld 2 wreck near Vlieland from around 1500 clearly shows the potential, but also the need to take action after discovery occurs.¹

¹ Although having been protected for many centuries in a relatively safe and stable environment, a sudden change of currents in the area uncovered the Westerveld 2 site and subsequently destroyed the 500-year-old wreck. Efforts to save the wreck in situ by RCE and RWS had little effect. The lack of clarity about who was responsible and who would pay for emergency excavation – the national government or the municipality of Vlieland – resulted in the loss of the wreck without further action being taken.
In relation to the overall management of our resources, it is also important to realize that quite a few of the threats to shipwrecks in the Wadden Sea that have been identified will have negative effects for stakeholders other than archaeologists. Shipwrecks contain information about our past, but may also be important for biodiversity. Shipwrecks are also great places to dive. At the same time, shipwrecks may be destroyed by fishing nets and fishing nets destroyed or lost on shipwrecks. This mutual sense of threat is important to acknowledge, especially when looking for solutions for long-term management, as it will broaden the acceptance of ways to mitigate against the threats.

**Is in situ preservation a panacea for underwater cultural heritage management in general? What are the alternatives?**

In the last two decades, the predominant focus in underwater archaeology has been on in situ preservation and the development of appropriate policies and legislation to politically galvanize these trends (see Chapter 4). However, in situ preservation is not as straightforward as it seems, posing many significant questions for those considering this option. For example, what are the major degradation factors affecting a shipwreck site and what techniques can be suitably employed to halt or at least decrease the rate of deterioration (Chapter 3)? It should be clear that in situ preservation often requires active involvement, using different, often tailor-made, conservation and protection methods (Chapters 5 and 6).

In situ preservation is not a panacea for underwater cultural heritage management. Leaving sites on the seabed, with further, often costly, activities to be undertaken, is one option out of several. Excavation is always another option. Sometimes it is not feasible to leave a wreck on the seabed due to the heavy and rapid deterioration processes or construction work that has to be done. Even if we leave wrecks on the seabed, deterioration is continuous. The choice to leave a wreck in situ depends on what we want to do with it. Is it for enjoyment, commemoration, the spirit of the place, science? A shipwreck may have many values. A combination of these values may even be preserved, since there is no ‘magic pill’ in heritage management. Underwater cultural heritage management comprises many different steps and decisions to be made, involving many different and sometimes incommensurable values. From this perspective, in situ preservation is not always the right solution.

The management of underwater cultural heritage not only requires the expertise of archaeologists, Chemists, geologists, hydrographers and, of course, cultural heritage managers, planners and nature conservationists (or developers) are also important. In situ management requires many stakeholders to work together. Cultural heritage managers should be able to balance the needs and wishes of these different stakeholders. They are, moreover, not alone. Often parallel issues require management in one and the same area, at a different pace and starting and ending at different times. This may also result in management plans on different issues running in parallel – on heritage, safety, ecology, water management or tourism, for example – a recipe for future friction or even major clashes.

What is important in management is that we create a long-term view of what we would like to achieve. Underwater cultural heritage management concerns management and care over a long period of time. It is important to know what we want to get out of all this management and protection of the underwater cultural heritage: what we intend to learn from it, or how we want to enjoy the sites. To best do this, somebody has to take the lead and responsibility for a site. Very often this is shared. The owner of the land/water resource has a say, the administrator, the municipality and the sometimes also the national government. In the Wadden Sea, this may mean that in one and the same area, activities may be carried out and control may be claimed by the Ministry of Education, Culture and Science, the Ministry of Infrastructure and Water Management, the Ministry of Economic Affairs, the Province of North Holland and the Municipality of Texel. Thus, it can become quite difficult to determine who is doing what, or responsible for what, and to subsequently agree where the money should come from to pay for all the different activities. It is thus important to resolve all these issues and create a responsible management plan for an area, including underwater cultural heritage, a plan that includes a budget for long-term management (Chapters 5 and 6).

In relation to sites that have not yet been discovered, management is even more difficult. We can attempt to manage them as part of our overall resources. This may, however, mean even stronger means of persuasion are needed if we are to convince people to pay for something they cannot see. A maritime landscape approach would be a possibility in this case, combining the protection of natural and cultural values in a restricted area and creating favourable situations for this.

In situ management requires more than merely leaving wrecks in the place they were found. In situ protection, monitoring and maintenance are also part of this, as explained in Chapters 5 and 6. A budget is required to execute such work. If we want to give high priority to in situ preservation, we should have the funds to do so. As we saw in this thesis, adding a protective layer to a wreck in the Wadden Sea costs around €70,000 (e.g. the BZN 10), each monitoring action adds at least another €3,000 (for multibeam) and approximately €6,000 per day for diving (BZN 10). However, the excavation of sites easily costs millions of euros. This remains an option. Developing a national research agenda that includes important questions on these issues that we think should be answered makes it perfectly acceptable to invest in excavation as well. Archaeological sites are certainly locations to learn about our past.
Is in situ preservation the solution for cultural heritage management in the Western Wadden Sea? What are the alternatives?

In situ preservation with the use of in situ protection methods has proven to be effective in the Western Wadden Sea. The methods that have been developed – and that are described in Chapter 5 – and the structural monitoring of these protected sites – described in Chapter 6 – have proven this. For 30 years physical methods have been applied, ranging from sandbags and polypropylene nets to artificial seagrass. The oldest protected wreck, the BZN 3, is still well protected after all these decades, while the physical protection placed on other wrecks in the Burgzand is still functioning. We can clearly see their effect if we compare the results with the BZN 11 wreck, a site that has not been protected and that has now almost completely disappeared.

It is good to see that protection has made a difference, even under demanding circumstances. The constant tidal changes create a situation of cyclic erosion and sedimentation, which is also periodically fierce or moderate. This may mean that a site comes under threat for a while, but subsequently is naturally well protected under a thick layer of sediment. We need to be prepared for these changes and can do so by examining previous processes of erosion and sedimentation (hindcast), predicting the future processes (forecast) and the effect they may have on known and unknown archaeological sites in the seabed. We also need to be able to predict how long a threat to a site may last. This is very specific to each location because it also includes the reasons why we choose preservation (Chapter 4). The technical data on the basis of which we make such decision can be extracted from the information gathered and compared in a system such as the HGMS (Chapter 2).

In order to be effective, in situ preservation should be part of an overall management plan for the Western Wadden Sea. Such a plan should at least be implemented by the different Wadden Sea municipalities and the two provinces of North Holland and Friesland, and possibly included in the management of the Wadden Sea as a World Heritage Monument. The time is ripe to include the outstanding cultural values of the Wadden Sea into its management strategy, and eventually add the maritime cultural heritage, recognizing its outstanding value and making the Wadden Sea a combined natural and cultural World Heritage site. Whatever happens, a permanent budget to preserve cultural sites in situ should be provided and soon. There will be a permanent responsibility that needs to be taken up. Synergy between natural heritage protection, cultural heritage protection, economic activities and tourism, for example, as part of the overall management of the area, should be part of the solution.

Ideally, a local interdisciplinary team of heritage managers and underwater archaeologists for the (Western) Wadden Sea area should be established. Sharing the responsibility in this way would not be that much of a financial burden and will have a lot of positive outcomes. It will create more local involvement because it will become a combined regional responsibility. This will most probably also result in quicker response times when sites are discovered, and activities will be executed in closer proximity to local stakeholders and therefore be more visible to them. There may then be more flexibility in relation to potential activities in municipal cultural heritage management, science (even in collaboration with the Wadden Academy) and activities within the framework of the Valletta Treaty. The relationship between society and the waters of the Wadden Sea, as a means of transport and a resource of high-quality food still forms the essence of the Wadden Sea today. In other words, it is largely created and cultivated by society and its needs, and is therefore to be highly regarded in all its cultural value.

Regarding the techniques for physical protection of sites in situ as laid out in Chapter 5, over the last 20 years, many experiments have been undertaken in as many different environments across the world. Some of these locations have been little monitored since. Moreover, in instances of reburial there was no pre-reburial surveying or post-reburial monitoring, which makes an evaluation of the different techniques extremely difficult, if not impossible. Some general rules, however, can be deduced from the many projects executed, including those in the Western Wadden Sea.

First of all, mitigation must focus on the factors that cause the most degradation (Chapters 3, 4, 5 and 6). If possible, different threats should be overcome or ameliorated using one method. In addition to the mitigation of the most significant physical-mechanical, biological, chemical and human threats, it is also very important to think of why the site needs to be preserved. What value prevails? As we have seen, a site will be preserved in one way if it needs to be protected for future research, or in another way if it is to be enjoyed by sports divers. The protection of underwater archaeological sites will always be, in part, individually customized to accommodate the unique qualities of each site.

Shared responsibility is the key for in situ management. It will be the task of the heritage manager to balance the different values assigned to a wreck, and the various wishes and needs of the different stakeholders. These heritage managers may very well be government employees at the national, provincial or municipal level. However, cultural heritage concerns what a society as a whole wants to preserve and not only what heritage managers employed by government think is important. The source community must have a say in what happens. Moreover, those who might want to disturb a site for one reason or another must also be part of the conversation if they are to make an informed decision on whether to disturb or to avoid. Archaeologists and cultural heritage officers should consider roles such as offering guidance, explaining and describing the site, or as brokers, connecting different ideas about the significance and the uses of cultural heritage in the public domain.
Preserving a layered history of the Western Wadden Sea

Convincing others will become increasingly important. In situ management entails a difficult balance of the different needs and wishes of different stakeholders. This is important because without the support of several stakeholder groups there will not be a basis for in situ management. Awareness-raising is thus very important. Sites need to be explained and become physically and virtually accessible. This means that we not only require in situ management, but that there needs to be room for ex situ preservation as well. This might entail the removal of artefacts through excavation or, for example, 3D visualizations. Underwater sites should be opened to the public through underwater museums and dive trails; reconstructions of what is left on the seabed should also be made, examples of which were given in Chapter 7. Only by opening up this often very invisible but highly significant cultural heritage will support grow: we need to bring the sites to the people and the people to the sites.

Reaching large groups of new people in order to increase awareness remains a challenge, but one that must be faced. This is not due to the nature of the subject – as in fact most people find underwater cultural heritage and underwater archaeology interesting and exciting – the problem is largely one of resources and awareness, utilizing the right channels of information. With the ratification of the UNESCO Convention on the Protection of the Underwater Cultural Heritage by the Netherlands soon to take place and an increased interest in the ratification of the Faro Convention as well, this issue needs to be made a priority to ensure that awareness of the richness of our underwater cultural resource continues to grow and to ensure its management is a shared responsibility.

Here also, the Western Wadden Sea could play a leading role. We already have a good idea of the richness of the material cultural past that is present on and in the seabed. This is due to the efforts of the national government over years in this area, as is reflected in this thesis. The underwater sites largely represent a story of the area we know and which also has its material witnesses onshore. The entire Wadden Sea area in fact represents the influence human beings have had and still have on nature. This active engagement and influence of culture and nature – however logical and very much visible in the area – has not yet led to the inclusion of outstanding cultural heritage values in the UNESCO world heritage nomination of the Wadden Sea, as we have seen above. Fortunately, the views are changing and it would not be surprising if in a few years this is set right. The area can serve as an example of the perfect balance between the two.

The appreciation of the different values of underwater cultural heritage may play an important role in this as well. Shipwrecks may form hotspots of biodiversity on the seabed. More fish may mean a thriving sustainable fishing industry, not only in the Wadden Sea itself but also in the adjacent North Sea. The Wadden Sea has been a central place for trade, a food resource and a way of life for many centuries. This past is visible in traditions and stories, but also through the only objective resource – the material witnesses of the past – archaeological sites in and on the seabed. They are undeniably part of the area; their presence should be acknowledged and managed in situ and ex situ.

8.3 Final word
To conclude this thesis, I would like to return to my initial research question:

How can we manage the underwater cultural resource?
The underwater cultural resource can be managed only by looking at it from a high level, inclusively rather than on a case by case basis, proactively rather than reactively. What we know about it – the sites that have been detected – is probably only a fraction of what is present in the area. The value of each site can be measured on different levels and by different stakeholders, and quite rightly so. Cultural heritage concerns what we as a society want to preserve for the future. Sites need, therefore, to be connected to that society, and all the individual sites connected to each other through the society protecting them.

Managing underwater cultural heritage can be and often is structured, ranging from desktop research and surveys to in situ protection and excavation. All of these different steps are important in the process of management and need to be balanced. If there are no inventories or surveys, there will be no overview; if there are no assessments, there will be no clear knowledge and no well-founded decisions about what to keep and what not; if there is no in situ protection, there will be a loss of many sites before any decision is made about what to do with them; if there is no excavation, there will be no or only little building of knowledge. This knowledge is, in turn, the basis of decisions to preserve, deselect or excavate.

An important question to ask ourselves is: Who is responsible for making decisions within this process? This is not an easy question to answer, however, the more inclusive the process, the more sustainable these decisions will be, even if the decision-making process itself may become more difficult. We are all in it for something. The view of an archaeologist may differ from that of a politician. However, as long as the discussion about what needs to occur is fair and open, the decision will have results that last.

The question: ‘What’s in it for me or us?’ should be asked. Solutions can be sought. A shipwreck can be preserved in situ while promoting biodiversity and creating an enthusiastic diving community around the wreck site. New technologies are making new forms of interaction between archaeologists and non-archaeologists possible, and also between divers and non-divers, between sites and museum visitors. This is the way forward because, in the end, awareness-raising, respect and understanding are the key to ensuring the future of our underwater cultural heritage and its management, also in the Western Wadden Sea.