IUCN Conservation Outlook Assessment 2014 **(archived)**
Finalised on 13 November 2014

Please note: this is an archived Conservation Outlook Assessment for High Coast / Kvarken Archipelago. To access the most up-to-date Conservation Outlook Assessment for this site, please visit https://www.worldheritageoutlook.iucn.org.

High Coast / Kvarken Archipelago

SITE INFORMATION

Country:
Finland, Sweden
Inscribed in: 2000
Criteria:
(viii)

Site description:
The Kvarken Archipelago (Finland) and the High Coast (Sweden) are situated in the Gulf of Bothnia, a northern extension of the Baltic Sea. The 5,600 islands of the Kvarken Archipelago feature unusual ridged washboard moraines, ‘De Geer moraines’, formed by the melting of the continental ice sheet, 10,000 to 24,000 years ago. The Archipelago is continuously rising from the sea in a process of rapid glacio-isostatic uplift, whereby the land, previously weighed down under the weight of a glacier, lifts at rates that are among the highest in the world. As a consequence islands appear and unite, peninsulas expand, and lakes evolve from bays and develop into marshes and peat fens. The High Coast has also been largely shaped by the combined processes of glaciation, glacial retreat and the emergence of new land from the sea. Since the last retreat of the ice from the High Coast 9,600 years ago, the uplift has been in the order of 285 m which is the highest known ''rebound''. The site affords outstanding opportunities for the understanding of the important processes that formed the glaciated and land uplift areas of the Earth''s surface. © UNESCO

SUMMARY

2014 Conservation Outlook

Good

On the whole the conservation outlook for the geological features of the site, which are the basis for its Outstanding Universal Value, is good. However some concerns exist regarding its important biodiversity values. The marine environment within the site is under serious pressure and is facing a multitude of threats, most of them being a consequence of the threats facing the Baltic Sea as a whole. The cumulative and synergetic effects of these threats are unknown, as is the resilience of the ecosystem within and around the site. The marine environment is already showing signs of deterioration (eutrophication, oxygen free bottoms, regime shifts etc). There are several national and international structures in place to try to improve the general state of the Baltic Sea but due to the complexity of the ecosystem in general and the ecosystem functions it is very hard to predict the final result of the measures taken. Management of the site in Finland is well structured both temporally (dealing with both current and future plans and issues) as well as having a clear set of tasks with associated responsible parties. Management on the Swedish side could benefit from the development of a more clear management structure for the World Heritage site, which would also allow the already good transboundary cooperation to be taken to the level for which it has potential. On both sides a steady source of financing is needed in order to take on long-term projects/plans.

Current state and trend of VALUES

Good
Trend: Stable

Geological features and processes of the site are stable and in good condition. There are no serious threats to these values currently and they are unlikely to be affected in the foreseeable future. However, the overall marine environment of the site is facing a number of threats and is likely to experience high pressure

within the foreseeable future.

Overall THREATS

Low Threat

The geological values of the site which are the basis for its inscription on the World Heritage list are well preserved and are currently not threatened. The site's broader marine environment of which its geological features are an integral part, however, is impacted by a number of threats, particularly eutrophication caused by human activities on land, marine litter and contamination with various substances. This is partly due to the fact that marine environment is more dynamic and has a much higher exchange and interaction with the surrounding environment than the terrestrial parts of the site. And the Baltic Sea in general is highly affected by anthropogenic pressures. However, despite these pressures, the geological features of the site are likely to remain well preserved in the foreseeable future.

Overall PROTECTION and MANAGEMENT

Mostly Effective

Overall the management is effective in protecting the site's Outstanding Universal Value, however, a management system specifically for the site needs to be established in Sweden, which will also allow the management in both countries to organize better transboundary cooperation. A funding plan is needed in both countries to enable long term planning and work. Effort should be put into facilitating the work of researchers, as this brings more information about the area but also raises its profile.

FULL ASSESSMENT

Description of values

Values

World Heritage values

▶ **Isostatic uplift**
Criterion:(viii)

The best, fastest, and most scientifically renowned, demonstration anywhere in the world of the ongoing geological phenomenon of isostatic uplift of land, entirely due to the disappearance of the continental Pleistocene ice sheet. (IUCN World Heritage Evaluation Report May 2006, 24COM X.A.1, SoOUV 2013)

▶ **Glacial landforms**
Criterion:(viii)

The area is an illustration of the processes accompanying the growth and recession of a continental ice sheet and their effects on glacial landform evolution. The range of coastal and marine landform features displayed is a result of the long period of uplift (up to 20,000 years) (IUCN World Heritage Evaluation Report, May 2006). The sites possess a distinctive array of glacial depositional landforms representing complementary examples of post-glacial uplifting landscapes (SoOUV2013). The High Coast’s hilly scenery with high islands, steep shores, smooth cliffs, and deep inlets is a complete contrast to the Kvarken area with its thousands of low-lying islands, shallow bays, drumlins and flute lines parallel to the flow; hummocky, transverse, terminal and unusual washboard ridge moraines (De Greer moraines) at right angles to it as well as thick till deposits and massive boulder fields, all add to the variety of glacial landscapes features in the region (30COM 8B.27, IUCN

World Heritage Evaluation Report May 2006)

- **Interactions of ongoing geological processes with the biotic and abiotic environment**
  Criterion:(viii)

The Baltic Sea as a whole, and the site in particular (30COM 8B.27), has undergone dramatic changes since the last Ice Age, including a series of transitions from marine water to freshwater and then to brackish water, consequently causing subsequent changes in plant and animal life. This serial transboundary property serves as an outstanding example of the continuity of this change with dynamic ongoing geological processes forming the land- and seascape, including interesting interactions with biological processes and ecosystem development. (SoOUV 2013).
The High Coast and Kvarken areas differ considerably in the ways land uplift processes act on the biota. They are, in fact, complementary in terms of their biophysical evolution. They represent, respectively, the high and low topographical extremes of post-glacial uplifted landscapes in the Baltic. Here the two sites differ significantly: The High Coast (being much older at around 10.000 years compared to Kvarken’s 2000 years) provides a relatively stable biological environment, while Kvarken, whose low-lying landscape is constantly changing due to rising land, is biologically highly dynamic, with plants and animals continuously colonising newly emergent land surfaces and successional habitats (IUCN World Heritage Evaluation Report May 2006). The terrestrial influence progressively extends seawards into the Bothnian Sea and the continually emerging shores are colonized by pioneer species which are gradually replaced by a succession of plant communities (including e.g. the endemic hairgrass (Deschampsia bottnica) as the land rises. These biotopes are also acted on by waves and ice-drift, seawater salinity, substrate, topography, microclimate, chemical and physical properties and distance to the mainland. The result is that the seashore habitats are very heterogeneous and high in biodiversity and represent several Natura 2000 coastal habitat types. All of these processes have major effects for the plants and animals associated with the biotopes that must constantly adapt to the changing environments. (IUCN World Heritage Evaluation Report May 2006, IUCN World Heritage Evaluation Report Addendum 2000, UNEP-WCMC 2011)

Other important biodiversity values

► Unique marine environment with unusual combination of species

The biological character of the marine environment is a consequence of several major controlling influences such as: brackish waters of very low salinity; the most sharply contoured submarine topography in the Baltic, extending to depths in excess of 200 m close inshore; little tidal influence, with shifting water levels determined mainly by changing weather conditions of air pressure and wind; and seasonal ice cover (SoOUV 2013). The ecosystem is also highly productive due to phosphate-rich water from the north and nitrate-rich water from the south, and combines freshwater and marine species as the salinity decreases from 5-6 ‰ in the south to 3-4 ‰ in the north of the archipelago. In addition to these factors, the mild climate has resulted in many southern species finding their northern limit of distribution here (UNEP-WCMC 2011). The resultant mosaic of shallow, sheltered embayment and deep, open waters provides a range of habitats for a mix of marine, brackish and freshwater species, low in species diversity but high in population numbers for some macrofauna species. Some species found in the area are relics of earlier periods, and others are at the extremes of their latitudinal and environmental limits (IUCN World Heritage Evaluation Report Addendum 2000). This mean species normally separated by widely different habitat preferences cohabit in the same ecosystem, ranging from top predators to the coexistence of freshwater plants side by side with algae). Two of the keystone underwater habitats in the region is formed by such vegetation, one being meadows of freshwater submerged plants (providing nurseries for fish etc.) and the other that of the algae Fucus radicans, a brown seaweed endemic to the area (Bergström et al. 2005). The trophic system is simplified compared to other marine ecosystems, it is a young and very dynamic system and several of the niches are not yet utilized, and as such it relies more heavily on the role of each species (Johannesson et al. 2012).

► Terrestrial birds

The High Coast shows a rich and varied terrestrial birdlife due to the

altitudinal range and topographic diversity which also provide habitats attractive to some rare birds of southern origin (IUCN World Heritage Evaluation Report Addendum 2000).

► Migratory birds

The Kvarken Archipelago is on an important migratory route and offers excellent breeding habitats for birds. There are important Baltic populations of black guillemot (6,000 pairs, a quarter of the Baltic population) and razorbill (1,000 pairs); also Caspian and Arctic terns, whitetailed eagle (35 pairs), osprey and great scaup. Thousands of roughlegged buzzards and cranes also migrate through. (IUCN World Heritage Evaluation Report May 2006)

► High floristic diversity

The High Coast is marked by high floristic diversity, due to the complex pattern of soils and substrate on an uplifted, high-relief land surface. For example, a full range of forest types is concentrated within a small area, with mature forests on till-capped plateau surfaces above the highest shoreline (285m asl) being particularly noteworthy. The geological, topographical and climatic conditions also combine to make the HC a distinctive vegetation boundary zone, with a rare blend of southern plants with northern Boreal, western oceanic and eastern continental species. There is also intermixing of southern and relict alpine plant species from warmer and colder periods, respectively (IUCN World Heritage Evaluation Report Addendum 2000). Kvarken on the other hand is characterized by succession as as described under V3.

► Wetlands

The Quark Archipelago Wetland (RAMSAR 2014). The site is also included in the Ramsar Convention on Wetlands since it is important for breeding and migrating wetland birds. (Nomination dossier 2006)

RAMSAR area within the site (HELCOM 2014)

► Natura 2000

A large part of the Kvarken Archipelago is included in the Natura 2000 Network. The total Natura 2000 area is 122 968 ha, of which 10 376 ha is land, and 112 592 ha is sea. The Helsinki Commission (HELCOM) has approved the Natura 2000 area of the Kvarken Archipelago for inclusion in the network of Baltic Sea Protected Areas (BSPA). On the Swedish side there are also several areas within the site that belong to the Natura 2000 network. (Naturvardsverket 2014)

Assessment information

Threats

Current Threats

Low Threat

There are almost no serious threats to the site’s geological values, however, its marine environment of which those values are an integral part, is threatened by a number of issues, the most serious of them being eutrophication caused by human activities on land, marine litter and hazardous substances.

► Other

Low Threat

Introduction of NIS (Non-indigenous species) occurs unintentionally by marine and inland shipping (ballast water and ship hulls) and intentionally for improving fisheries and for use in aquaculture. Non-indigenous species may destabilize existing ecological relationships and in the worst cases may have serious consequences on the local food web (Oguz and Gilbert 2007). Although some superior competitors and predators, for example, the American mink (Muscula vison) (UNEP-WCMC 2011) and three species of the polychaete Marenzelleria, have found their way to the site, there has not yet been any wide-scale economic or ecological impact following the invasion of

a non- indigenous species. (HELCOM, 2010). Due to the nature of the area (salinity, temperature, etc) as well as the low diversity, the region has several unexploited or shareable niches, meaning that not all NIS end up competing with or ousting already established species.
However, the American mink can have a very adverse effect on the marine bird population breeding in the area. Measures are being taken to diminish the negative impact.
Risk: Low risk-High risk (Likelihood: Possible Consequence: Minor-major)
Trend: Static
Management capacity: As with any marine area the exchange and interaction with the environment outside the site is very high and cannot be directly regulated by eg. enclosures. There is very little to no possibility for the management of the site to respond to this threat, especially after a species has already arrived, as it is an outside threat that is extremely hard to control. (HELCOM 2010)

► Fishing / Harvesting Aquatic Resources

Low Threat
Outside site

Overfishing has a cascade effect on the rest of the trophic levels and can cause regime shifts when a key species is either removed entirely or ousted from its niche by another species (HELCOM, 2010). Herring, sea trout and salmon are both subject to ICES stock advice (ICES 2013a, ICES 2013b, ICES 2013c). Coastal fisheries have targeted species such as whitefish, pike and pikeperch, which do not fall under regulations stipulating total allowable catches (HELCOM 2010). Within and in the vicinity of the site there is commercial fishing for whitefish, salmon and herring (Kvarken nominations dossier 2006, Planning the Bothnian Sea 2012). With the exception of herring all of these species are trophic level four top predators in the local ecosystem, meaning that they are fewer in number but have a proportionally larger effect on the ecosystem per individual. There are several important herring spawning grounds within the site, some of which overlap with the fishing grounds. Nearly all of the herring catches, 96.5 per cent, are taken by vessels under the Finnish flag. The fishing is almost exclusively done by mid-water and bottom trawls. The most intense period of herring fisheries is July to September each year (Planning the Bothnian Sea 2012)
Risk: High (Likelihood: Possible Consequence: Major)

Trend: Static, increasing (depending on species).
Management capacity: Most fisheries are currently not under quota and as such are not regulated by any international body.

► Hyper-Abundant Species

High Threat
Inside site
Outside site

The side effects of eutrophication such as reduced water clarity and increased sedimentation of organic matter have benefited some algal species (primarily filamentous algae) while perennial species such as bladder- wrack (Fucus) have declined. This has caused changes in the invertebrate community (Korpinen and Jormalainen 2008) (HELCOM 2010). In the site the prevailing Fucus species is also the only endemic species in the region.
Risk: Very high (Likelihood: Almost certain Consequence: Moderat-major)
Trend: increasing
Management capacity: As with any marine area the exchange and interaction with the environment outside the site is very high and cannot be regulated. This is a result of the general eutrophication of the Baltic Sea and originates outside the site. The management does not have the capacity or resources to address this threat.

► Water Pollution

High Threat
Outside site

The site is assessed as being disturbed by hazardous substances by HELCOM. Hazardous substances are having a marked effect on the wildlife, species composition and diversity all over the Baltic). The combined effects of the substances are to a large extent unknown. Hazardous substances exhibit disturbing characteristics including persistence, the ability to accumulate in organisms such as predator species (bioaccumula- tion), and toxic effects. Compounds featuring all three traits are labelled PBT-compounds (Persistent, Bioaccumulating and Toxic). Hazardous substances can be man-made, such as most of the chemical compounds termed ‘Persistent Organic Pollutants’ (‘POPs’) or occur naturally, such as heavy metals. Hazardous substances reach the site through normal water exchange with the southern Baltic

atmospheric deposition, river water (especially nikel and zinc), harbors, marinas and shipping lanes, as well as re-release of accumulated substances by dredging and disposal of dredged material. (IUCN World Heritage Evaluation Report May 2006, HELCOM, 2010) (HELCOM 2014)
Risk: High (Likelihood: Possible Consequence: Moderate to major)
Trend: Decreasing
Management capacity: As with any marine area the exchange and interaction with the environment outside the site is very high and cannot be regulated. This is a result of the general pollution level of the Baltic Sea and originates outside the site.

► Water Pollution

High Threat
Outside site

Eutrophication is triggered by excessive amounts of nutrients washed into the sea. Although nutrient chemicals are themselves harmless, in large quantities they cause eutrophication. The nutrients come from farmlands, homes and gardens, cars, cities and industries. In the sea, the nutrients first foster the production of planktonic algae forming algal blooms, as well as short lived high yield filamentous algae species. This increased production of organic matter often has secondary and drastic negative consequences: the water becomes murkier and less transparent, fast growing, short lived species smother habitat forming perennials, the sedimentation of organic material to the sea floor increases, decomposition of organic matter increases and oxygen is consumed, thus depleting the bottom waters of oxygen.
Benthic communities such as meadows of submerged aquatic vegetation are deprived of light, and benthic invertebrate communities and fish are affected by oxygen depletion, ultimately suffocating.
However, possibly the most important effect of stratification in terms of eutrophication: hindering or preventing ventilation and oxygenation of the bottom waters and sediments by vertical mixing of the water, a situation that often leads to oxygen depletion. Furthermore, hypoxia and anoxia worsen the situation by affecting nutrient transformation processes, such as nitrification and denitrification, as well as the capacity of the sediments to bind phosphorus. In the absence of oxygen, reduced sediments release significant quantities of phosphorus to the overlying water. Climate change

also risks increasing the nutrients carried into the sea via rivers and runoff as the precipitation increases (IUCN World Heritage Evaluation Report May 2006, HELCOM, 2010, Planning the Bothnian Sea 2012)
Risk: Very high (Likelihood: Almost certain Consequence: Major)
Trend: Increasing
Management capacity: This is in essence a threat that originates outside the site and of which the site is only a small part. The management does not have the capacity or resources to address this threat, only a change in local behavior and international agreements can help alleviate the process (there is no way of reversing it). Any dredging should be strictly regulated and on a permission basis, however, this will cause tension with the stakeholders.

► Solid Waste

High Threat
Inside site
Outside site

Macroscopic litter on the shores of the site causes visual intrusion and impacts on the scenic value of the area. The macroscopic marine litter in the site originates from fishing, shipping, leisure boating, tourism, coastal urban areas and rivers. Surveys done in the Baltic, concentrated on medium-sized or large particles, count up to 700–1200 particles, per 100 metres of coastal strip (HELCOM 2007d) and even though the Kvarken/High coast is amongst the less polluted areas the litter accumulates over years (it is for the most part plastic) and the long shoreline means that there is a lot of available beach for the litter to strand on.
Not all marine litter is visible to the human eye. Microscopic particles from various sources, e.g., degradation of plastic waste, disturb food webs by mimicking food particles, attaching to organisms’ feeding appendices and causing famine to passive filter-feeders. Some hazardous substances adsorb onto the litter particles and may cause enhanced accumulation of hazardous substances in the food web. Studies in Swedish waters have shown that the amounts range from several hundred to a hundred thousand microscopic pieces in a cubic meter of seawater (Noren 2007, Noren et al. 2009). For unknown reasons, the largest micro-litter problem was found in the Gulf of Bothnia, bordering the site. (HELCOM 2010)
Risk: High (Likelihood: Likely Consequence: Moderate)
Trend: Increasing

Management capacity: Here the management has potential to reverse the effect of the threat (with regards to macro plastics). Cleaning efforts aiming at most heavily used areas would already help alleviate the visual intrusion.

► Other Ecosystem Modifications

High Threat
Inside site
Outside site

Dredging operations (both large and small scale) and the disposal of dredged material reintroduce sediment- bound TBT and other POPs to the marine environment. (IUCN World Heritage Evaluation Report May 2006).
Developmental pressures include dredging of shallow areas and continual dredging of boat channels creates some disturbance (UNEP-WCMC 2011).
Due to land rise dredging is very common in the area, especially on a small scale. Small scale operations, while under regulations e.g. on dumping of the dredged materials, do not need permission from any authority and are not followed up upon. The companies doing the work also need no certification, and illegal dumping of the materials straight into the sea is common.
Because of the nature of the areas that need dredging (shallow, enclosed bays in the process of rising out of the sea) this practice is more common in Kvarken then in the High Coast. The effect of the recirculated nutrients is at best a complete ecosystem shift at worst they are catastrophic, leading to the death of the bay ecosystem.
Management capacity: Currently management has no legal way of regulating the small scale dredging. Regulating the stakeholders rights to dredge will also create serious tension between management and stakeholders.

► Housing/ Urban Areas

Very Low Threat
Inside site

(IUCN World Heritage Evaluation Report May 2006)
These seashore properties have considerable monetary and non-monetary value to a large number of people in both areas. A rough average of the number of secondary dwellings to permanently inhabited homes in the region is 1/1 to 0.5/1 (Planning the Bothnian Sea 2012).
Risk: Low risk
Trend: Static/decreasing

Management capacity: Building of new cottages requires permission from the governing body (depending on country) and the rules are quite strict. Again, the main negative effect of summer cottages is dredging for the harbors of each house.

Potential Threats

Low Threat

There are no potential threats to the geological values of the site; however there are certain risks to its broader marine environment from potential oil spills and spread of invasive species. Construction of wind turbines in the area could also potentially disturb the overall setting of the site.

► Renewable Energy

Low Threat
Inside site
Outside site

Visual intrusion (IUCN World Heritage Evaluation Report Addendum 2000). The development of wind farms is also associated with the direct loss of species and habitats in the zone around the structures as well as the potential for severe disturbance during the construction phase through the emission of noise and stirring up of sediments (HELCOM, 2010). There is one current planned wind park in the vicinity of the site (120-160 turbines with 600-800 MW capacity), in Korsnas. The Environmental Impact assessment is underway (Planning the Bothnian Sea 2012).
Risk: High (Likelihood: Possible Consequence: Moderate)
Trend: Increasing
Management capacity: building of new windfarms is under regulation (The Land Use and Building Act in Finland) and demands permission from the governing body.

► Other

Low Threat

NIS can be a threat to biodiversity in the area. The degree to which non-native species change the Baltic marine environment depends on their invasiveness and cannot be predicted beforehand (HELCOM 2010)

Non-indigenous species may destabilize existing ecological relationships and in the worst cases may have serious consequences on the local food web (Oguz and Gilbert 2007).
Risk: Low to high risk (Likelihood: Possible Consequence: Minor/moderate)
Trend: Increasing/static

► Shipping Lanes

Low Threat

There is some risk of oil spills from maritime traffic (UNEP-WCMC 2011). Safety concerns for the increasingly intensive traffic through the narrow international strait have made Finland propose a TSS to the IMO. (Planning the Bothnian Sea 2012). The last major oil accident in the area was in 1984 (Mäkinen, A. & Leppäkoski, E. 2014).
Risk: High (Likelihood: Unlikely Consequence: Major)
Trend: Static

► Habitat Shifting/ Alteration

High Threat
Inside site
Outside site

Baltic biodiversity is particularly sensitive to changes in salinity and in this way it is easily affected by natural variations in the environmental conditions. (HELCOM, 2010). The site is characterized by species at the extremes of their latitudinal and environmental limits (IUCN World Heritage Evaluation Report Addendum 2000) and these species are especially sensitive to changes in salinity and temperature.
Risk: High (Likelihood: Possible Consequence: Very high)
Trend: Static

► Habitat Shifting/ Alteration

High Threat
Inside site
Outside site

This increased production of organic matter often has secondary and drastic negative consequences: the water becomes murkier and less transparent, the sedimentation of organic material to the sea floor increases,

decomposition of organic matter increases and oxygen is consumed, thus depleting the bottom waters of oxygen. Benthic communities such as meadows of submerged aquatic vegetation are deprived of light, and benthic invertebrate communities and fish are affected by oxygen depletion, ultimately suffocating (HELCOM, 2010)
Risk: Very high (Likelihood: Almost certain Consequence: moderate)
Trend: increasing
Management capacity: There is very little to no possibility for the management of the World Heritage site to respond to this threat as it is an outside threat that is extremely hard to control.

► Tourism/ visitors/ recreation

Very Low Threat

In the future an increase in the number of visitors could endanger the biological and cultural values of the World Heritage Site. (Metsahallitus 2010)

Risk: Low risk (Likelihood: Possible Consequence: Minor)
Trend: static to increasing
Management capacity: here the management has a lot of potential to mitigate the effects of increased visitors pressure by monitoring the possible changes to the area caused by tourism.

Protection and management

Assessing Protection and Management

► Relationships with local people

Mostly Effective

The relationship with local communities and residents, local/municipal authorities and the tourism industry work well and have improved significantly since the time of inscription, and the local communities directly contribute to some decisions related to management. The relationship with landowners is still lacking and their awareness and understanding of the existence and justification for inscription of the site on the World Heritage list is poor. This is the same for local industry. There is only limited cooperation

with industry regarding the management of the World Heritage property, and the relationship with local scientist is also very limited. (Periodic Report 2013)

► Legal framework and enforcement

Mostly Effective

There is no particular legislation that directly protects the Outstanding Universal Values of the High Coast/Kvarken Archipelago, but the general environmental national legislation gives a satisfactory indirect protection of the entire property; however, there are some deficiencies in its implementation. About 37% of the property is either nature reserve or national park, and the site also belongs to Natura 2000 network of protected areas. All these different kinds of protected areas have regulations restricting land use, which provide a good level of protection to geological formations, as well as to flora and fauna. The remaining parts, about 63% of the property, do not have the same level of protection, but the national legislation gives possibilities for safeguarding the integrity of the property. Furthermore, the High Coast is a landscape of national interest, which gives the recreational and nature conservation values of the property additional legal protection and serves as guidance for development. In the Kvarken Archipelago, a regional land use plan protects its Outstanding Universal Value, as well as recognizes its geological values in the zone between the two core areas on the Finnish side. Overall there is acceptable capacity/resources to enforce legislation and / or regulation in the World Heritage property but some deficiencies remain
(SoOUV 2013, Periodic reporting 2013).

► Integration into regional and national planning systems

Mostly Effective

The multiple ownership of the High Coast area and the original lack of a single management agency or policy presented problems for unified management of the area. The need was recognised in the nomination, a management plan was drawn up and a management committee established (UNEP-WCMC 2011). Both countries have now agreed on making a shared management plan for the area in the future.

► Management system

Mostly Effective

The site is managed by national and regional authorities (Finland: Natural Heritage Services of Metsähallitus, Sweden: County of Västernorrland) which have established a Cooperation Committee for the property. This transnational consultative body meets twice a year to ensure the site is jointly managed, to coordinate projects and to report to the UNESCO. (PROWAD 2013).
Sweden
Management is a complex issue in this area. There are management plans for all of the Nature Reserves and the National Park, but protected areas constitute only 9% of the area. The remaining land is largely under private ownership, but further regulations may still apply. The site falls within the jurisdiction of two municipalities: Örnsköldsvik and Kramfors and these two relevant municipalities do have development plan. The site also falls within the Västernorrland County which develops policies such as for logging. For some time a management plan for the area has been worked on, prescribing policies for its long-term development. It focuses on the management of its special assets: the geological and biological phenomena related to land uplift, the marine environment and the natural beauty of the landscape
The National Natural Resources Law recognises the High Coast as an area of national interest. A “Management Committee and Reference Group for the High Coast” exisits UNEP-WCMC 2010).

Finland
A pStrategic Management Plan for the Kvarken Archipelago was published in 2010 (Metsähallitus 2010). It deals with the vision for the WH site, covering topics such as marketing, education, tourism, stakeholder participation, threats and protection, research cultural values, economy and funding, monitoring and principles of sustainable nature tourism Overall it is a very good example of a management plan with both immediate effects and a long-term vision.
The main responsibility for nature conservation and environmental protection rests with the Metsähallitus (Forest and Park Service) and the West Finland Regional Environmental Centre which controls most land-use regimes, regulates and permits small-scale farming, fishing and forestry. The

municipalities are responsible for planning and land use within their jurisdictions. Detailed management plans for the area include recent local shore master plans for the Archipelago by the municipalities of Malax, Vaasa and Korsnäs.
(IUCN evaluation of The Kvarken Archipelago 2006, Metsähallitus 2010)

The overall coordination between the range of administrative bodies/levels involved in the management of the property is effective but it could be improved. A more transparent and straightforward division of responsibilities has been called for, to ensure execution within the networks that have developed based on the national level authorities. The idea of what management concerns are the most important and should be prioritized differ somewhat between the two countries.
(Periodic reporting 2013, Svels 2010)

► Management effectiveness

Mostly Effective

An annual work / action plan exists and many activities are being implemented. On the whole though, the management system/plan is only partially effective to maintain the property's Outstanding Universal Value mostly due to that it is only partially being implemented. The establishment of a management system for the Swedish part of the site would greatly ease the management effort.
The recent project “World Heritage in Cooperation 63° N – High Coast/Kvarken” (2007 – 2014) supports the stakeholders in strengthening the cooperation between the countries, increasing public awareness.
(PROWAD 2013, Periodical reporting 2013)

► Implementation of Committee decisions and recommendations

Data Deficient

No relevant Committee recommendations to implement

► Boundaries

Mostly Effective

The boundaries of the World Heritage property are known by both the management authority and local

residents/communities/landowners and they are considered adequate to maintain the property's Outstanding Universal Value. There is no buffer zone, but it is considered unnecessary (Periodic reporting 2013).

▶ Sustainable finance

Mostly Effective

The available budget is acceptable but could be further improved to fully meet the management needs. There is no clear financial plan set down for the management and governance of the entire site. There is a need for secured funding in a long term perspective. The Finnish side currently receives larger governmental finance support but there is no permanent decision on the size of the support. Anchoring the WNHS regionally could spread the financial burden more and make the site less reliant on government support. To a very large part the work has been financed by project based financing which is, although very good and involving lots of stakeholders, not a long term solution.
(Periodic reporting 2013, Svels 2010)

▶ Staff training and development

Mostly Effective

90% of the staff work full time and 80% have permanent positions. However, though human resources are adequate, these are somewhat below optimum to manage the World Heritage Property, with human resources lacking especially in the field of research. Research and monitoring is also the field in which there is low training capacity for staff. This is also the case for risk preparedness. As for the developing of local expertise a capacity development plan or programme is in place and fully implemented; all technical skills are being transferred to those managing the property locally, who are assuming leadership in management (Periodic reporting 2013).

▶ Sustainable use

Mostly Effective

Mostly effective.

▶ Education and interpretation programs

Mostly Effective

In general the World Heritage status has influenced education, information and awareness building activities, but it could be improved. The work to get WH included on school curricula has been brought forward.
The recent project “World Heritage in Cooperation 63° N – High Coast/Kvarken” (2007 – 2014) supports the stakeholders in strengthening the cooperation between the countries, increasing public awareness, and providing material for multipliers in education (teachers, guides, entrepreneurs, politicians) (PROWAD 2013).
There are two visitor centres, one in the High Coast and one in Kvarken with exhibitions, information, movies, guided tours about the WH site and its OUV. Overall the Outstanding Universal Value of the property is adequately presented and interpreted but improvements could be made. (Periodic Report, 2013)

► Tourism and interpretation

Mostly Effective

The High Coast was already a tourism destination at the time of inscription. In Kavrken the work on developing the WH tourism is in progress.
There are a number of cooperation with local entrepreneurs on marketing of products and services, on education and tourism. A Sustainable Tourism Strategy for Kvarken was developed in 2011 (download http://julkaisut.metsa.fi/julkaisut/show/905) The strategy’s objective is to develop the Kvarken Archipelago as a sustainable tourism destination so that the site’s natural and cultural values are retained and the host community’s social fabric does not suffer. The development of tourism within the Kvarken World Heritage Site is focused on improving the quality of the tourist services, the visibility of the world heritage values and respect for locality. The communication and customer service concerning the site, as well as the work carried out with the enterprises, is being intensified. (Meriruoho 2011)
Several activities are carried out on communication, awareness and education (with EU funding). With regard to the tourism sector, knowledge about World Heritage exists, however in many cases, WH is only used as label in marketing and not for conservation of the site. In Sweden, the High Coast is already a known tourism destinations since the 1970s (about 300,000 overnight stays in two municipalities). (PROWAD 2013).

► Monitoring

Mostly Effective

There are considerable monitoring efforts and key indicators have been defined. However the ongoing monitoring it is not directed towards management needs and/or improving understanding of the site's OUV and the status of indicators could be improved (Periodic Reporting 2013).In Kvarken the site monitoring programs are carried out for uplift, flad and gloe formation, primary forest formation, bird species and visitors; also for sea water quality, invertebrates, macro-vegetation and fish (UNEP-WCMC 2011)

► Research

Mostly Effective

There is a small number of research activities. Knowledge about the values of the World Heritage property is sufficient for most key areas but there are gaps. Networking with university's and the geological institutes (SGU in High Coast, GTK in Kvarken) is under progress and the aim is to strengthen the cooperation. There is a need for more research on different geological phenomena and their interaction with the ecological processes, as well as more precise knowledge of when the land uplift will end. There is also great need for research on the effects of rising sea levels and their effects on the OUV.

Overall assessment of protection and management

Mostly Effective

Overall the management is effective in protecting the site's Outstanding Universal Value, however, a management system specifically for the site needs to be established in Sweden, which will also allow the management in both countries to organize better transboundary cooperation. A funding plan is needed in both countries to enable long term planning and work. Effort should be put into facilitating the work of researchers, as this brings more information about the area but also raises its profile.

► Assessment of the effectiveness of protection and management in

addressing threats outside the site

Mostly Effective

Most threats affecting the site are threats from the outside and very diffuse and difficult to control. As with any marine area the exchange and interaction with the environment outside the site is very high due to water exchange and cannot be directly regulated. There is very little to no possibility for the management of the site to respond to these threats other than through working to inform the public and change public notions on the results of actions taken by them, as well as work with legislators on both a national and an international level to affect change to the general threats to entire Baltic Sea region.

State and trend of values

Assessing the current state and trend of values

World Heritage values

► Isostatic uplift

Good
Trend:Stable

The uplift will continue until the depression of the geoid is reversed or the next oncoming glaciation begins to load and submerge the Earth’s crust in the Kvarken area (Kvarken nomination dossier 2006). Overall, geological features and formations are stable. The unique values of the World Heritage Site could only be affected if the site is very extensively exploited or affected by major natural catastrophes. Global warming is not a threat to land uplift, but rising sea levels may cause floods in the low-lying land uplift landscape of the Kvarken Archipelago. Other natural catastrophes, such as violent earthquakes or volcanic eruptions, do not occur in Sweden and Finland. (Metsahallitus 2010)

► Glacial landforms

Good
Trend:Stable

Overall, geological features and formations are stable. The unique values of the World Heritage Site could only be affected if the site is very extensively exploited or affected by major natural catastrophes. Global warming is not a threat to land uplift, but rising sea levels may cause floods in the low-lying land uplift landscape of the Kvarken Archipelago. Other natural catastrophes, such as violent earthquakes or volcanic eruptions, do not occur in Sweden and Finland. (Metsahallitus 2010)

► Interactions of ongoing geological processes with the biotic and abiotic environment

Low Concern
Trend:Stable

Interactions of geological features of the site with the biotic and abiotic environment are somewhat affected by a number of threats affecting the site’s marine environment, including marine litter, community shifts, pollution and eutrophication (HELCOM 2010)

Other important biodiversity values

► Unique marine environment with unusual combination of species

The biological character of the marine environment is a consequence of several major controlling influences such as: brackish waters of very low salinity; the most sharply contoured submarine topography in the Baltic, extending to depths in excess of 200 m close inshore; little tidal influence, with shifting water levels determined mainly by changing weather conditions of air pressure and wind; and seasonal ice cover (SoOUV 2013). The ecosystem is also highly productive due to phosphate-rich water from the north and nitrate-rich water from the south, and combines freshwater and marine species as the salinity decreases from 5-6 ‰ in the south to 3-4 ‰ in the north of the archipelago. In addition to these factors, the mild climate has resulted in many southern species finding their northern limit of distribution here (UNEP-WCMC 2011). The resultant mosaic of shallow, sheltered embayment and deep, open waters provides a range of habitats for a mix of marine, brackish and freshwater species, low in species diversity but high in population numbers for some macrofauna species. Some species found in the area are relics of earlier periods, and others are at the extremes of their

latitudinal and environmental limits (IUCN World Heritage Evaluation Report Addendum 2000). This mean species normally separated by widely different habitat preferences cohabit in the same ecosystem, ranging from top predators to the coexistence of freshwater plants side by side with algae). Two of the keystone underwater habitats in the region is formed by such vegetation, one being meadows of freshwater submerged plants (providing nurseries for fish etc.) and the other that of the algae Fucus radicans, a brown seaweed endemic to the area (Bergström et al. 2005). The trophic system is simplified compared to other marine ecosystems, it is a young and very dynamic system and several of the niches are not yet utilized, and as such it relies more heavily on the role of each species (Johannesson et al. 2012).

► Terrestrial birds

The High Coast shows a rich and varied terrestrial birdlife due to the altitudinal range and topographic diversity which also provide habitats attractive to some rare birds of southern origin (IUCN World Heritage Evaluation Report Addendum 2000).

► Migratory birds

The Kvarken Archipelago is on an important migratory route and offers excellent breeding habitats for birds. There are important Baltic populations of black guillemot (6,000 pairs, a quarter of the Baltic population) and razorbill (1,000 pairs); also Caspian and Arctic terns, whitetailed eagle (35 pairs), osprey and great scaup. Thousands of roughlegged buzzards and cranes also migrate through. (IUCN World Heritage Evaluation Report May 2006)

► High floristic diversity

The High Coast is marked by high floristic diversity, due to the complex pattern of soils and substrate on an uplifted, high-relief land surface. For example, a full range of forest types is concentrated within a small area, with mature forests on till-capped plateau surfaces above the highest shoreline (285m asl) being particularly noteworthy. The geological, topographical and climatic conditions also combine to make the HC a distinctive vegetation

boundary zone, with a rare blend of southern plants with northern Boreal, western oceanic and eastern continental species. There is also intermixing of southern and relict alpine plant species from warmer and colder periods, respectively (IUCN World Heritage Evaluation Report Addendum 2000). Kvarken on the other hand is characterized by succession as as described under V3.

► Wetlands

The Quark Archipelago Wetland (RAMSAR 2014). The site is also included in the Ramsar Convention on Wetlands since it is important for breeding and migrating wetland birds. (Nomination dossier 2006)

RAMSAR area within the site (HELCOM 2014)

► Natura 2000

A large part of the Kvarken Archipelago is included in the Natura 2000 Network. The total Natura 2000 area is 122 968 ha, of which 10 376 ha is land, and 112 592 ha is sea. The Helsinki Commission (HELCOM) has approved the Natura 2000 area of the Kvarken Archipelago for inclusion in the network of Baltic Sea Protected Areas (BSPA). On the Swedish side there are also several areas within the site that belong to the Natura 2000 network. (Naturvardsverket 2014)

Summary of the Values

► Assessment of the current state and trend of World Heritage values

Good

Trend: Stable

Geological features and processes of the site are stable and in good condition. There are no serious threats to these values currently and they are unlikely to be affected in the foreseeable future. However, the overall marine environment of the site is facing a number of threats and is likely to experience high pressure within the foreseeable future.

▶ Assessment of the current state and trend of other important biodiversity values

Low Concern

Trend: Data Deficient

The marine environment of the site and associated species aer affected by a number of current threats, including non-indigenous species, overfishing, hazardous substances, eutrophication, marine litter, dredging, as well as potential ones, including changes in salinity and community shifts (IUCN World Heritage Evaluation Report May 2006, HELCOM, 2010; UNEP-WCMC 2011; Planning the Bothnian Sea 2012).

Additional information

Key conservation issues

▶ Dredging

Local

Dredging operations (both large and small scale) and the disposal of dredged material reintroduce sediment- bound TBT and other POPs to the marine environment. (IUCN World Heritage Evaluation Report May 2006). Developmental pressures include dredging of shallow areas and continual dredging of boat channels creates some disturbance (UNEP-WCMC 2011). Due to land rise dredging is very common in the area, especially on a small scale. Small-scale operations, while under regulations e.g. on dumping of the dredged materials, do not need permission from any authority. Because of the nature of the areas that need dredging (shallow, enclosed bays in the process of rising out of the sea) this practice is more common in Kvarken then in the High Coast.

▶ Eutrophication

Regional

Eutrophication is triggered by excessive amounts of nutrients washed into the sea. Although nutrient chemicals are themselves harmless, in large quantities they cause eutrophication. The nutrients come from farmlands, homes and

gardens, cars, cities and industries. In the sea, the nutrients first foster the production of planktonic algae forming algal blooms, as well as short lived high yield filamentous algae species. This increased production of organic matter often has secondary and drastic negative consequences: the water becomes murkier and less transparent, fast growing, short lived species smother habitat forming perennials, the sedimentation of organic material to the sea floor increases, decomposition of organic matter increases and oxygen is consumed, thus depleting the bottom waters of oxygen.
Benthic communities such as meadows of submerged aquatic vegetation are deprived of light, and benthic invertebrate communities and fish are affected by oxygen depletion, ultimately suffocating.
This is possibly the most important effect of stratification in terms of eutrophication: hindering or preventing ventilation and oxygenation of the bottom waters and sediments by vertical mixing of the water, a situation that often leads to oxygen depletion. Furthermore, hypoxia and anoxia worsen the situation by affecting nutrient transformation processes, such as nitrification and denitrification, as well as the capacity of the sediments to bind phosphorus. In the absence of oxygen, reduced sediments release significant quantities of phosphorus to the overlying water. (IUCN World Heritage Evaluation Report May 2006, HELCOM, 2010)

▶ Hazardous substances

Local

The site is assessed as being disturbed by hazardous substances by HELCOM. Hazardous substances are having a marked effect on the wildlife, species composition and diversity all over the Baltic, and are having an effect on the behavior if the human population as well (intake recommendations etc). The combined effects of the substances are to a large extent unknown. Hazardous substances exhibit disturbing characteristics including persistence, the ability to accumulate in organisms such as predator species (bioaccumula- tion), and toxic effects. Compounds featuring all three traits are labelled PBT-compounds (Persistent, Bioaccumulating and Toxic). Hazardous substances can be man-made, such as most of the chemical compounds termed ‘Persistent Organic Pollutants’ (‘POPs’) or occur naturally, such as heavy metals. Hazardous substances reach the site through normal water exchange with the southern Baltic atmospheric deposition, river water (especially nikel and zinc), harbors, marinas and shipping lanes, as well as re-release of accumulated substances by dredging and disposal of dredged material. (IUCN World Heritage Evaluation

Report May 2006, HELCOM, 2010)

Benefits

Understanding Benefits

▶ Sacred natural sites or landscapes

For the people living in and around the area the iconic values of the area cannot be overstated, and it far outreaches the time and usage of the area per capita. These seashore properties have considerable monetary and sentimental value to a large number of people in both areas. A rough average of the number of secondary dwellings to permanently inhabited homes in the region is 1/1 to 0.5/1. The area represents a kind of freedom and independence that is hereditary and culturally very important to the local population.

▶ Importance for research

The best and most scientifically renowned, demonstration anywhere in the world of the ongoing geological phenomenon of isostatic uplift of land, entirely due to the disappearance of the continental Pleistocene ice sheet. The site affords outstanding opportunities for the understanding of the important processes that formed the glaciated and land uplift areas of the Earth's surface. It is the type locality for isostatic uplift and the High Coast has been the centre for research on the subject for many years; the highest shoreline in the Baltic was mapped as early as 1888.

▶ Is the protected area valued for its nature conservation?

The area is valued for its natural values and to a large extent unspoiled beauty and these values are a result of the conservation effort, the way the Nordic people traditionally interact with nature and the areas remoteness.

▶ Outdoor recreation and tourism

There is a large number of holiday homeowners in or around the site. These seashore properties have considerable monetary and sentimental value to a

large number of people. Leisure boating is an important maritime form of tourism. In Finland and Sweden leisure boating is a very popular and relatively inexpensive activity accessible to all social classes. People have a strong connection to the sea, shown in the fact there is a leisure boat for every seven people.

▶ **Coastal protection**

The archipelago creates a wide range of microclimates and protects the coastline and the archipelago communities from the effects of extreme weather and offers shelter and protection.

▶ **Livestock grazing areas**

There is a small resident human population in the property (around 4,500 in the High Coast and 2,500 in the Kvarken Archipelago). These people are engaged in small-scale traditional farming, forestry and fishing. The tradition of bringing animals out to graze on the islands in spring and then retrieving them in fall has had a major impact on the habitats of the site and provide niches for a number of species that would otherwise not be occur in the area. Was this tradition of grazing to end there would be a significant loss in both cultural landscapes and biodiversity.

▶ **Collection of wild plants and mushrooms**

In both Finland and Sweden there is a law (called “Every Man’s Right”) enabling anyone to collect berries, mushrooms and fruit, as well as fishing with a fishing pole, on all land. This is a very integral part of the national identity and is highly cherished by a large part of the population. Some berries (hawthorn eg.) can only be harvested out in the islands.

Summary of benefits

Currently most of the benefits are relating to the people living in or around the area and in many ways they signify an important aspect of the cultural identity of those that come in contact with the site or the surrounding area. For the people living in and around the area the iconic values of the area cannot be overstated. The reason why the area is so well preserved is that the locals value it and have historically take care of it, whereas most threats are

originating from outside the area.

Projects

Compilation of active conservation projects

№	Organization/ individuals	Project duration	Brief description of Active Projects
1	NA		NA

Compilation of potential site needs

№	Site need title	Brief description of potential site needs	Support needed for following years
1	NA	NA	

REFERENCES

№	References
1	BACC Author Team (2008): Assessment of climate change for the Baltic Sea basin. Series: Regional Climate Studies. Springer-Verlag, Berlin Heidel- berg. 473 pp.
2	Backer H. & Frias M. (2012): Planning the Bothnian Sea- key findings of the Plan Bothnia project. Finepress Turku ISBN 978-952-67207-4-8
3	Bergström, A., Tatarenkov, A., Johannesson, K., Jonsson, R.B. & Kautsky, L. (2005). Genetic and morphological identification of Fucus radicans sp. nov. (Fucales, Phaeophyceae) in the brackish Baltic Sea. Journal of Phycology 41: 1025-1038.
4	Casini, M., J. Lövgren, J. Hjelm, M. Cardinale, J.-C. Moinero & G. Kornilovs (2008): Multi-level trophic cascades in a heavily exploited open marine ecosystem. Proceedings of the Royal Society B 275:1793-1801.
5	Eriksson, B.K. & G. Johansson (2005): Effects of sedimentation on macroalgae: species-specific responses are related to reproductive traits. Oecologia 143:438-448.
6	Eriksson, B.K., L. Ljungberg, A. Sandström, G. Johans- son, J. Mattila, A. Rubach, S. Råberg & M. Snickars (2009): Declines in predatory fish promote bloom-forming macroalgae. Ecological Applications 19:1975-1988.
7	HELCOM (2007d): Assessment of the marine litter problem in the Baltic region and priorities for response. HELCOM, 21 pp.
8	HELCOM 2014: http://maps.helcom.fi/website/mapservice/index.html
9	HELCOM, 2010: Ecosystem Health of the Baltic Sea 2003–2007: HELCOM Initial Holistic Assessment. Balt. Sea Environ. Proc. No. 122
10	Heck, K.L. Jr. & J.F. Valentine (2007): The primacy of top-down effects in shallow benthic ecosys- tems. Estuaries and Coasts 30:371-381.
11	ICES 2013a.1: http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2…
12	ICES 2013a.2: http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2…
13	ICES 2013b: http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2…

№	References
14	ICES 2013c: http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2…
15	Johannesson et al. BMC Ecology 2012, 12:2
16	Korpinen, S. & V. Jormalainen (2008): Grazing and nutrients reduce recruitment success of Fucus vesiculosus L. (Fucales: Phaeophyceae). Estua- rine, Coastal and Shelf Science 78:437-444.
17	Korpinen, S. (2008): Nutrient enrichment and water depth modify consumer control in rocky shore macroalgal communities. Doctoral thesis, Uni- versity of Turku, Finland. Annales Universitatis Turkuensis SER AII: 222, 37 pp. Available at: https://oa.doria.fi/handle/10024/37818.
18	Matthäus, W. & G. Nausch (2003): Hydrographic-hydro- chemical variability in the Baltic Sea during the 1990s in relation to changes during the 20th century. ICES Marine Science Symposia 219:132-143.
19	Metsahallitus 2010: Stategic management plan for the Kvarken Archipelago World Heritage Site. (contact Susanna Lindeman for an English version)
20	Ministry of the Environment (MoE) (2005). Proposal of New Boundaries. (Appendix 16 to Nomination).
21	Morton, B. (1996): The subsidiary impacts of dredging (and trawling) on a subtidal benthic Molluscan community in the Southern Waters of Hong Kong. Marine Pollution Bulletin 32:701-710
22	Mäkinen, A. & Leppäkoski, E. (2014): OLJEOLYCKOR HAR VI INTE RÅD MED Tidskriften Skärgård Årgång 27 Nr 4 / 2004
23	Möllman, C., B. Müller-Karulis, R. Diekmann, J. Flink- man & A. Gårdmark (2007): Ecosystem regime state in the Baltic Proper, Gulf of Riga, Gulf of Finland, and the Bothnian Sea. HELCOM indica- tor fact sheet 2007.
24	Naturvardsverket, 2014: http://w3.vic-metria.nu/n2k/jsp/main.jsp
25	Norén, F. (2007): Mikroskopiska plastpartiklar i väster- havet. K. S. K. I. Miljöorganisation: 1-10. [In Swedish]
26	Norén, F., S. Ekendahl & U. Johansson (2009): Mikroskopiska antropogena partiklar i svenska hav. Report to Swedish Environment Protection Agency. [In Swedish]

№	References
27	Oguz, D. & D. Gilbert (2007): Abrupt transitions of the top-down controlled Black Sea pelagic ecosystem during 1960–2000: Evidence for regime-shifts under strong fishery exploitation and nutrient enrichment modulated by climate- induced variations. Deep Sea Research Part I: Oceanographic Research Papers 54:220-242.
28	Reusch TBH, Ehlers A, Hämmerli A, Worm B: Ecosystem recovery after climatic extremes enhanced by genotypic diversity. Proc Natl Acad Sci USA 2005, 102:2826-2831.
29	Riemann, B. & E. Hoffmann (1991): Ecological con- sequences of dredging and bottom trawling in the Limfjord, Denmark. Marine Ecology Progress Series 69:171-178.
30	Vos, M., B.W. Kooi, D.L. DeAngelis & W.M. Mooij (2004): Inducible defences and the paradox of enrichment. Oikos 105:471-480.
31	Österblom, H., S. Hansson, U. Larsson, O. Hjerne, F. Wulff, R. Elmgren & C. Folke (2007): Human- induced trophic cascades and ecological regime shifts in the Baltic Sea. Ecosystems 10:877-889.