

Date prints on stranded macroplastics: Marine litter as a chronological marker in recent coastal deposits

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Plastic is a collective term describing a group of synthetic materials, most of which were invented over the course of the last century. Already in the 1970s, the magnitude of plastic pollution has been recognized as an issue of concern for the global marine environment. It is hence no longer a rare event to encounter plastic fragments and objects in coastal or marine deposits. Plastic holds a chronological indication: a deposit containing plastic must be younger than the invention of the material.

The potential of this approach was tested in an investigation into the spatial distribution of stranded macroplastics in recent overwash deposits in SW Denmark. Larger litter items can be surveyed as discrete objects and allow the retrieval of more precise, though indirect age-information, such as production-date prints. A subgroup of >110 georeferenced surface samples containing date information were surveyed in summer 2015. Objects with ages from the late 1970s until 2014 were encountered. The distribution of the litter was clearly non-random in relation to overwash morphology, and based on the collected samples, it was possible to reconstruct indication on both the timing and the extent of extreme events since the 1990s. These observations were cross-compared with a dense time series of satellite images and orthophotos.

It is proposed that an improved interpretation of indications from the plastic record may be obtained by broader surveys including additional parameters, such as the exact location, elevation, chemical composition, assemblage, origin, product design, decay, fracturing or the colonization by marine sessile organisms, from all encountered macroplastic objects. If calibrated properly, the plastic assemblages may serve as fast, cheap and reliable chronological markers in recent coastal deposits.

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Abstract

Plastic is a collective term describing a group of synthetic organic polymers with diverse properties, chemical compositions and applications. Since the 1950s, the annual global production volume has been increasing each year and will have reached 300 megatons before AD 2020. Plastics have become highly competitive alternatives to conventional solids and fibers in industrial production, primarily due to their low cost and weight, as well as due to the versatility and the durability of the materials. While the latter may be a desirable property of an item in use, durability can become an issue at the end of the product lifecycle. Today, between 40 and 80% of all marine litter are made from plastic, resulting in an estimated amount of five trillion pieces of plastic afloat in the world oceans at present (Eriksen *et al.* 2014, *PLoS ONE*). Consequently, it is no longer a rare event to encounter pieces of plastic in coastal and marine depositional environments.

In late Holocene landscape history, the presence of any form of plastic buried in a natural sedimentary deposit holds a chronological indication (since the invention of plastic was recent). Larger items can be surveyed as discrete objects and may allow the retrieval of indirect age-information e.g. production dates (meaning: "the deposit is younger than the date print on the litter item"). This poster presents results, observations, conceptual considerations and ideas based on field data collected in storm deposits along the Skallingen peninsula, located on the eastern seaboard of the southern North Sea.



Along beaches of the southern North Sea, 200 - 600 items of marine litter are on average found per 100 m of shoreline. Storm events transport material inland and thus also move litter into the protected dune or marsh environments.

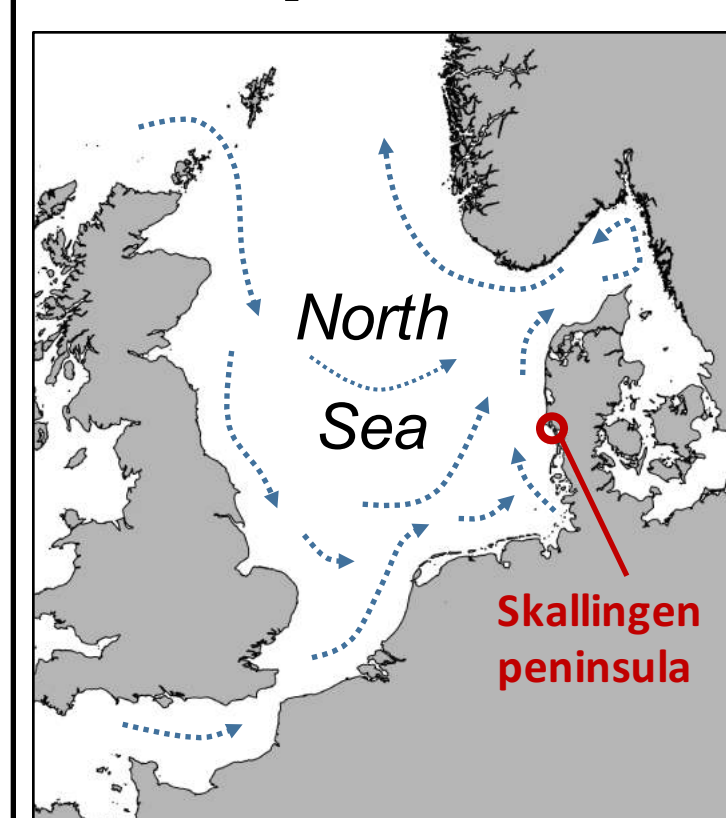


A recent wrackline in the distal part of an area affected by overwash deposition at Skallingen (see below). Large amounts of anthropogenic and natural litter of can be found here as the only sedimentary expression of a past storm event.

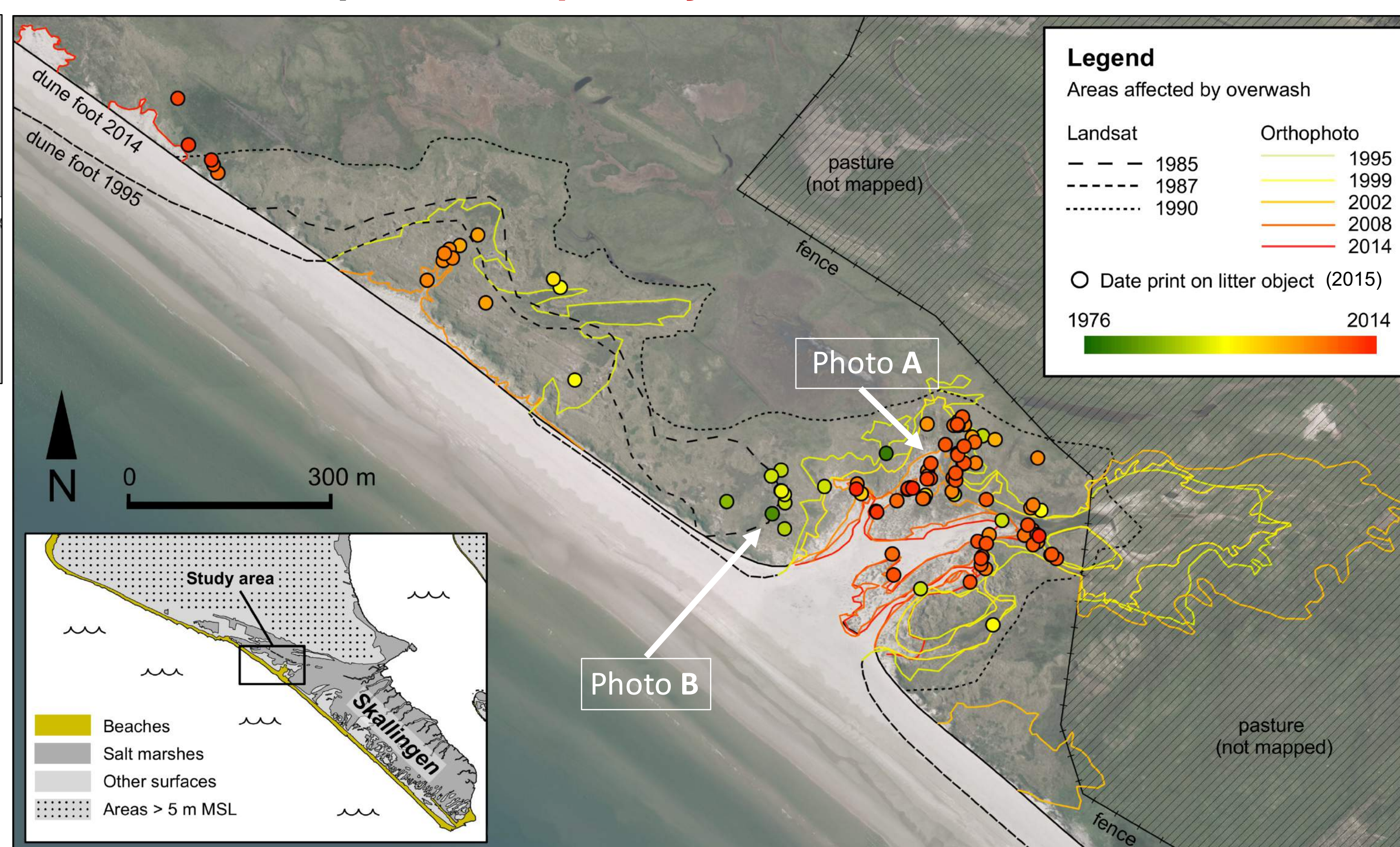


A fossil wrackline composed of large debris, which was deposited during a storm event in the 1990s. The site is today located behind a vegetated foredune ridge. All the encountered date prints predate the storm event.

Date prints on stranded macro plastics: Spatially discrete observations



Main current patterns in the North Sea and the location of the field site in SW Denmark.



The geomorphology of the low-lying barrier spit Skallingen (SW Denmark) is characterized by indication of repeated overwash deposition during the late Holocene. Large amounts of marine debris are preserved at the surface of the storm deposits. More than 110 coordinates of date prints were collected and combined with observations from remotely sensed data. The high degree of overlap suggests that the amount of plastic items with age information is large enough as to allow a reconstruction of the timing and extent of overwash deposition at the Skallingen peninsula over a period of more than three decades.

The age of plastic: Material, design and society

Plastic is a versatile material that has entered virtually all spheres of our lives. Based on its function, plastic comes in a wide range of properties and designs, with brand names, ingredient list, price tags, serial numbers etc. These are specific properties that are subject to change through time, but remain decipherable in discarded objects.

The photo (furthest to the right) shows a detergent container found in a fossil wrackline. Based on vintage advertisements for the product (collector's items) the age of the object could be constrained to the mid-1960s. Such changes hold valuable information for refining chronological interpretations.



Date prints

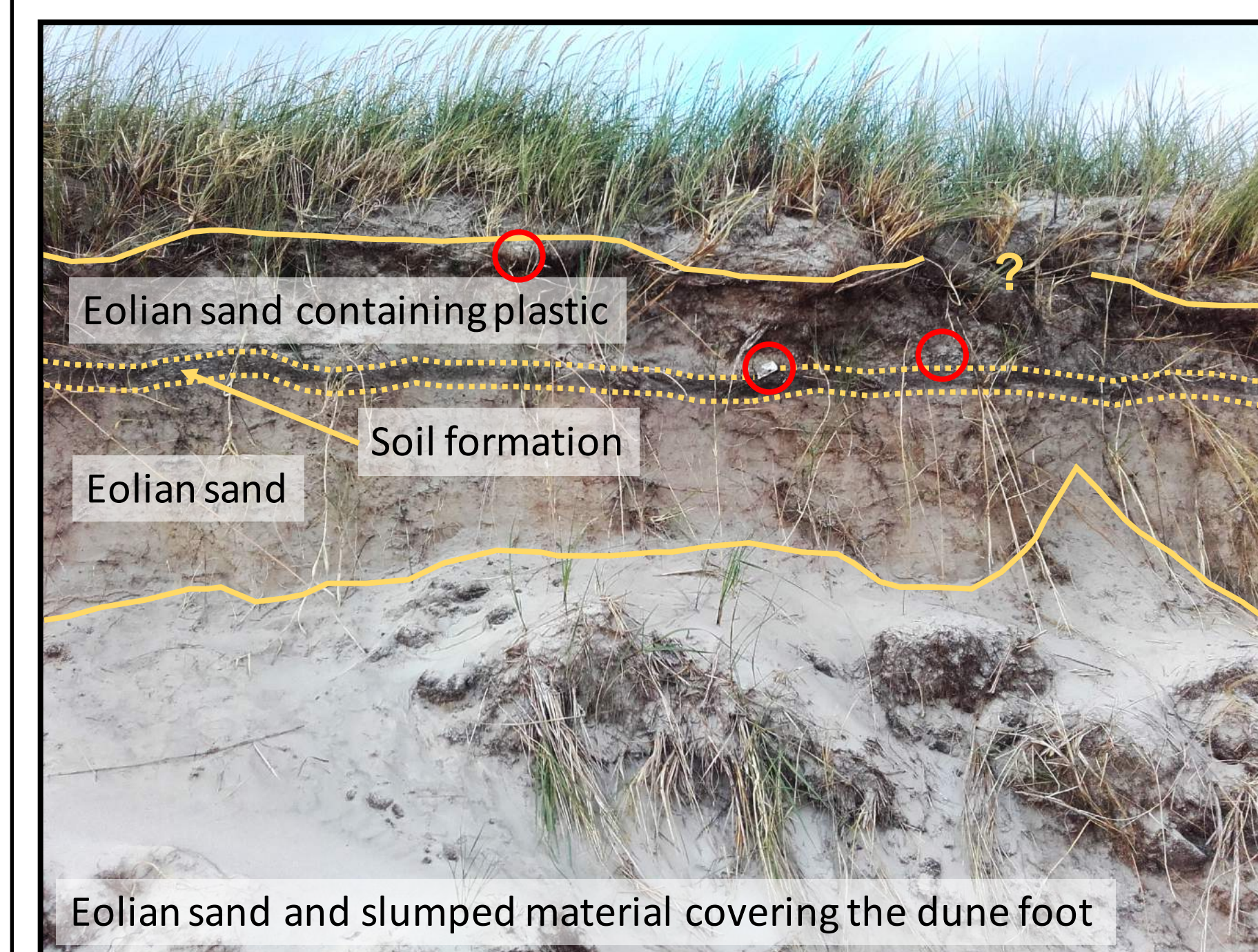
Production or best-before dates can often be found on larger plastic fragments and objects. When retrieved from a marine or coastal deposit, these date prints may serve as a minimum indication for the age of formation of the respective sedimentary layer.

The logic is strikingly simple: Rubber gloves did not exist before they were invented and a plastic bucket is not deposited before it is produced. When properly surveyed and carefully interpreted we can put the plastic record to use as a chronological marker and additional parameter in recent sedimentary environments.

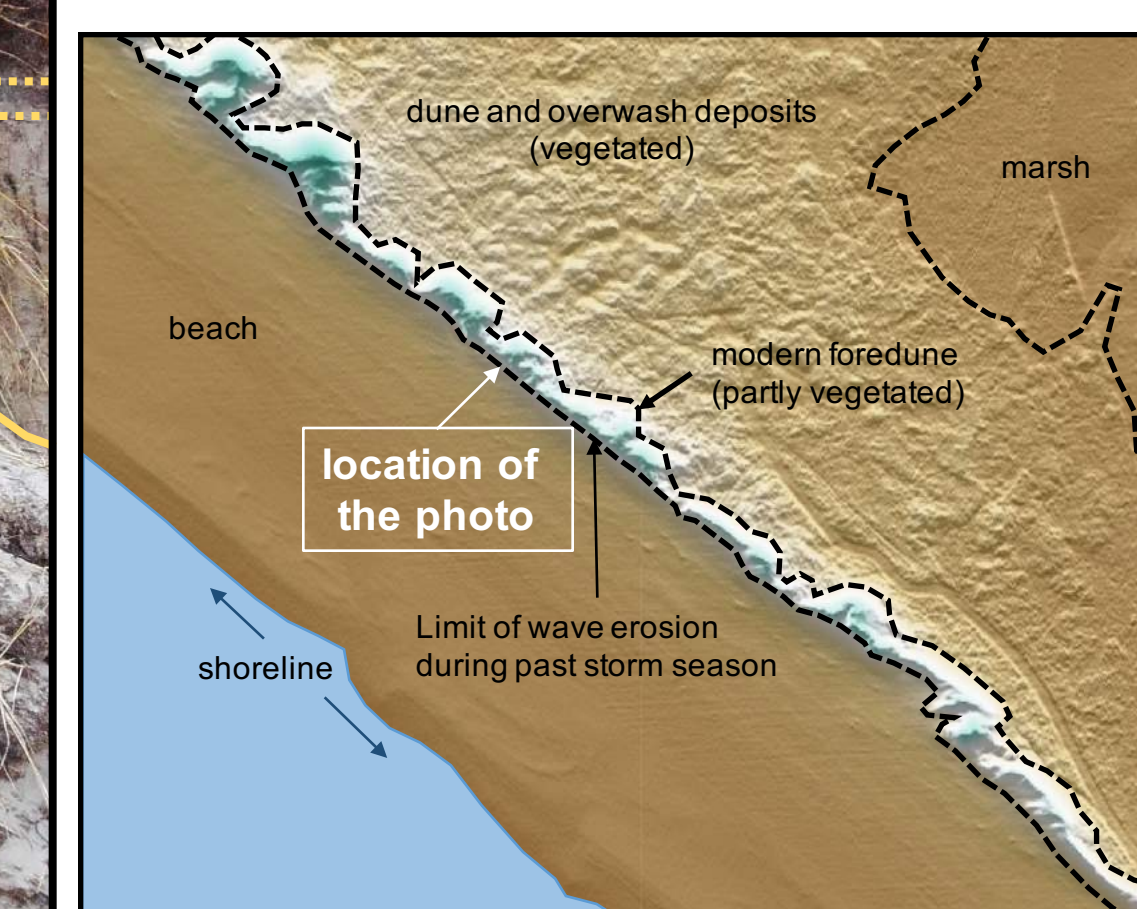


A trace fossil? Plastics in vertically accreted deposits

Plastic was invented only a century ago. If we encounter considerable amounts of plastic in a sedimentary deposit it must be younger than that! In this example from the Skallingen peninsula (see overview map to the left), plastic items appear repeatedly along an exposed dune cliff section (see photo below). The cliff is composed of two layers of eolian deposits separated by a horizon of incipient soil formation. While several plastic fragments were recovered from the upper layer (light objects such as plastic sheets, styrofoam and wrapping), not a single piece of plastic was encountered in the lower layer. Data from an elevation model shows that a sheet of vegetated eolian deposits (i.e. an older layer of unknown Holocene age) is covered by a foredune ridge (i.e. a recent deposit associated with sedimentary input from the beach).



If such observations prove spatially consistent, the plastic record holds a clear chronological indication that is conceptually simple and easy to survey.



Conclusion

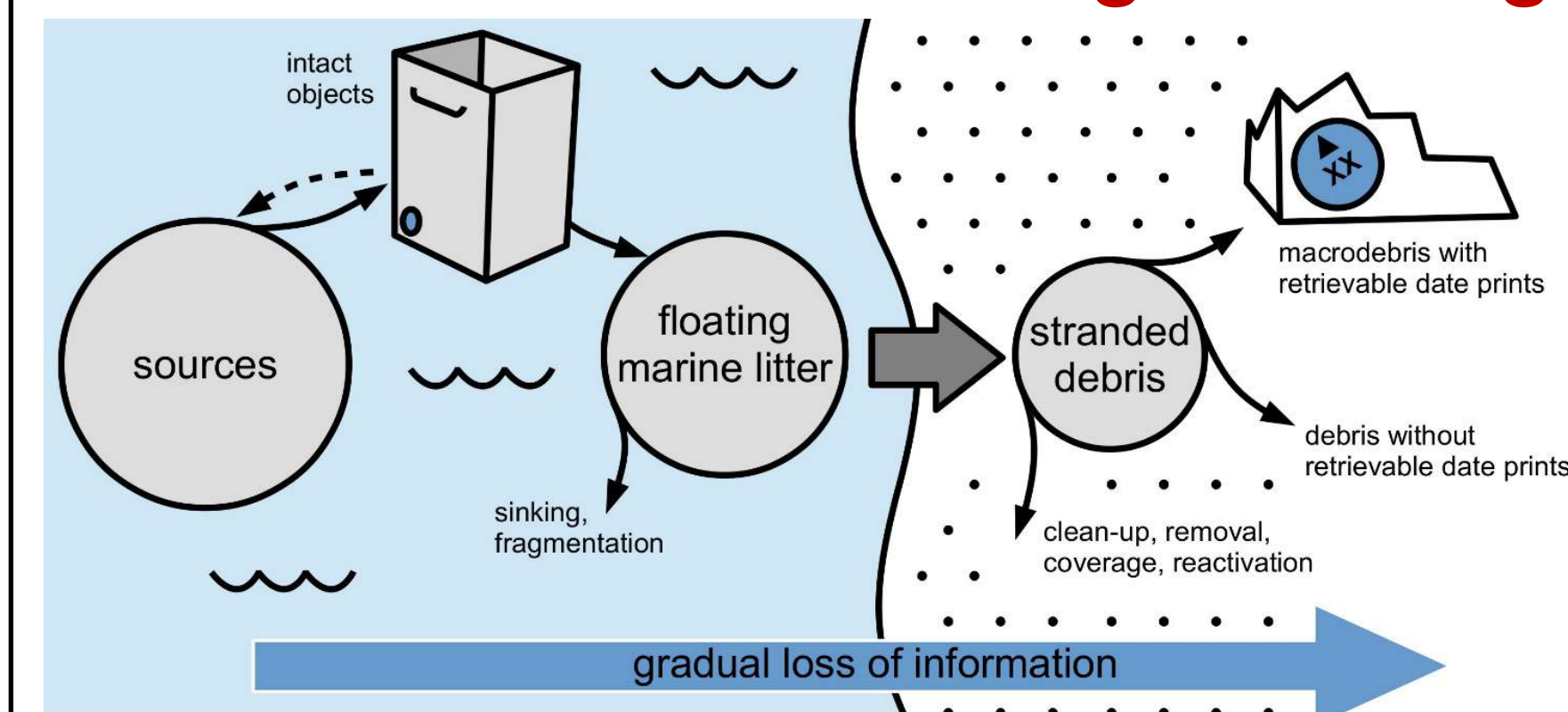
This poster presents data and considerations suggesting that it may prove highly beneficial to analyze and interpret the plastic record contained in recent natural sedimentary deposits. The sheer presence of plastic as a material associated with human industrial development holds chronological value. Additional key parameters are the location, type, size, composition and the readily-readable printed information contained on an object. Plastic assemblages may thus serve as fast, cheap and reliable chronological markers in recent coastal deposits and were shown to hold up against cross-comparison with an independent source of chronological information (Sander 2016, see full reference below).

Check out the article!

Sander, L (2016) Date-prints on stranded macroplastics: Inferring the timing and extent of overwash deposition on the Skallingen peninsula, Denmark. *Marine Pollution Bulletin* 109 (1), 373-77. Doi: dx.doi.org/10.1016/j.marpolbul.2016.05.051



From function to fossil: Age and origin of marine litter



The material, design or labeling of a recently discarded object allows inferring its former user, function or age. Objects lost at sea become soiled, worn, weathered or fragmented with time, entailing a consecutive reduction in the amount of retrievable information.

Consequently, few objects found in coastal and marine deposits allow a straight-forward retrieval of any information besides the fact that the items are made from plastic. Knowledge and experience are needed to interpret the plastic record: The fragment in the picture (right) was identified as part of a fishing basket produced in 1991. The design is widely unchanged today (above).



Based on the location of the sample and a cross comparison with aerial images it is likely that the object was deposited during a storm in the early 1990s. This means that took this basket merely a few years from the factory to deposition in a natural environment.