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## **Editors' Introduction**

The 'Sea Lines of Communication' series aims to bring together post-graduate and early career research from diverse disciplines ranging from engineering, history, oceanography and many more with a common interest in oceans and the maritime world. It challenges researchers to express their research in a way which is accessible to those outside of their discipline and who may be unfamiliar with the subject-specific vernacular and the foundational concepts of their field. In this, the second volume of the series, postgraduate researchers were asked to consider how their research related to the theme of 'construction'.

The concept of 'construction' with relationship to multidisciplinary marine and maritime studies seemed an odd topic to some who thought it too rigid in its parameters: for engineers it clearly referred to things that maybe constructed to cross the ocean or work at sea, to lawyers, it referenced the complex construction of international maritime law and to archaeologists it spoke to the delicate constructions of maritime archaeological sites, and the necessary construction of ways to effectively and responsibly excavate them. Researchers from every discipline saw the relevance of construction to their field, but often struggled to immediately understand its relevance to the work of others. This publication hopes to provide a glimpse at the diversity of understandings we all bring to our concept of 'construction' in the belief that such understanding can only benefit the work of all who work in vastly different areas of research which are all united in their desire to further our understanding of the marine and maritime world.

In compiling these chapters which all look at 'construction' in very different ways, we have had our own challenges in working out how to best construct these articulations of construction. It is potentially difficult to compile a volume of papers with such diverse subjects. As such, we decided to arrange the essays in a simple manner. Based on the interdisciplinary ethos of the University of Southampton Marine and Maritime Postgraduate Group, the papers fall into four broad and overlapping groups: Trade and

Transport, Energy and Resources, Society and Government and Climate and Environment, corresponding with the themes of the 'Sea Lines of Communication' colloquium, held at the University of Southampton on 17 September 2015. Whatever links we drew through any alternative editorial arrangement would only risk reflecting our own understanding of how these papers related. Yet, we suspect that each reader will approach this collection differently, seeing connections that others would not even consider and have thus left the collections arrangement as simple and functional as possible.

Rolf Warming's chapter opens the publication and the first section, 'Trade and Transport'. A translation of his grandfather's account of captaining the *Preussen* which ran aground in Dover in 1910, where it still lies. The chapter helps reveal the delicacy of humanity's constructions which aim to cross the sea, while more subtly provoking thoughts of how memory and stories such as this shape our contemporary understanding of the ocean and what it means to go to sea. Brenna Gibson's paper then takes a very different approach to the life of the mariner by looking at the seafaring communities of Devon and Norfolk in the late-middle ages by trying to draw an understanding of their social position through available economic data, such as tax records. In doing so, Gibson draws the knowledge to be gained through such economic analysis, but also the limits for such an approach provide a complete picture of the complexity of these past communities.

The 'Energy and Resources' section opens with a paper from Tim Hughes who examines the impact that the properties of the marine sediment and the environmental situation have on the dissipation of heat from HV cables. This is followed by a paper by Amelia Astley et al. who explore the potential for multibeam bathymetry time series to help archaeologists understand the changing environmental effects upon shipwreck sites in a study which could revolutionise the way archaeologists explore and protect valuable marine archaeological sites. The final paper in this section is by Doug Forsyth who analyses two epigraphic 'fish lists' from Akraiphia and Delphi, two market towns of central in Greece, as a means to

present the sophisticated trade techniques used with regards to fish processing and transportation in Hellenistic Greece c. 200 BC.

In 'Society and Government' Dirk Siebels assess the current state of West African maritime security and the measures needed to construct a secure maritime environment, providing a fresh look at maritime security measures in a time when maritime threats to the African continent are increasingly paramount. Catherine Scheybeler analyses the potential for modernisation in naval construction through the adoption of foreign practices, particularly looking at three Spanish arsenals in the mid-eighteenth century. Alexander Hay looks at how the press have contributed to a British construction of the ocean as the 'weird sea', feeding from and further contributing to an increasing distance between the British populace and the ocean which has been so crucial to their national history and identity.

The final section, 'Climate and Environment' includes three papers. Esmé Flegg looks at the causes of disruptive maritime disasters on UK coasts since 1950 and likely future challenges. Clementine Chirol et al. review the current state of knowledge with regard to wetland habitats, particularly creek networks while Thomas Spray considers the link between the development of nationalist identity and tourism with regard to Icelandic sagas in the nineteenth century.

Ultimately, we hope that the wide range of papers will encourage the reader to explore topics outside their normal area of interest, maybe discovering a new perspective on the complex and multivalent constructions of the ocean.

Joel Found  
Maria Newbery  
Ayan Salaad

# **I. Trade and Transport**



## I was at the helm when *Preussen* ran aground

*Rolf Warming*

*Originally published in Mariner's Mirror and reproduced by kind permission of the Society for Nautical Research (snr.org.uk).*

*Preussen*, built in Germany in 1902, was the largest sailing ship of her time and, until the launch of the *Royal Clipper* in 2000, was the only five-masted, full-rigged ship ever built. Known as the 'Queen of the Queens of the Seas' to seamen, she was one of the last great sailing ships. She sailed around the world shipping cargo from Europe to South America and back, setting several speed records in the process. She was severely damaged in the English Channel on an outward journey in 1910, when she collided with a steamer. Despite the relentless efforts of the crew to keep her afloat, she was eventually abandoned after having ran aground beneath the cliffs at Dover. Christian Friedrich Warming, a young and ambitious Dane, was employed as Able Seaman aboard and acted as helmsman when she ran aground (Fig. 1).

C.F. Warming (1890-1988) was born into a traditional seafaring family who had earned their living in maritime affairs for generations.<sup>1</sup> Christian Friedrich's grandfather was a fisherman whose work often led him to whaling off the coast of Greenland. His father, Christian Peder, was a skipper and an accomplished shipwright who, along with other members of the family, built several galeases, yawls and sloops, some of which were employed in the family's small shipping business. Christian Friedrich and his two brothers assisted in the building of some of these boats, dragging heavy oak timbers across the icy fjord during the winter by sheer manpower. Christian Friedrich was the youngest of the three sons and, naturally, followed in the footsteps of his father and brothers. They were all committed to a life at sea from a very early age, starting their seafaring careers as young teenagers. Like his brothers, Christian Friedrich first sailed with his father as skipper on smaller boats which were primarily involved in the brick shipping industry. Driven by his ambitions and the spirit of adventure, he soon left the small shipping industry to join the larger ships that sailed from Hamburg. In doing so, he

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<sup>1</sup> C.F. Warming was my great grandfather.

embarked on a long and successful career at sea, sailing as seaman, helmsman and eventually ship's master. There are many family tales stemming from his long life at sea, ranging from dealing with crew mutiny to throwing a Nazi-German Consul overboard in the harbor of Santos in April 1940.<sup>2</sup> Among these many experiences, which offer insight into both the mundane and dramatic aspects of seafaring life in the early 1900s, there is a collection of memoirs that have been particularly cherished in the family, stemming from his time aboard the *Preussen*.

These newly translated memoirs presented here offer a detailed first-hand account of the demise of the *Preussen*, which demonstrate the crew's admiration for the ship and their dedication to save her.<sup>3</sup> A version originally appeared in the short-lived Danish journal *Søens Verden* (Warming 1961). This story provides a voice for the many traditional seafaring families who were caught up in a rapidly changing world and witnessed the disappearance of the last great sailing ships in the beginning of the 1900s. C.F. Warming, like many others, had to find employment aboard the oceangoing steamers if he was to make a living at sea. His account of the *Preussen*, the last great sailing ship on which he was employed, reflects his sentiments on these technological developments. The wreck of the *Preussen* still lies beneath the chalk cliffs of Dover where she was stranded, although there is little left of her now.

Rolf Christian Warming  
Frederiksberg, Denmark.

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<sup>2</sup> Reported in *The Times*, 27 April 1940, with the headline 'Danish "Ducking" for German Consul'

<sup>3</sup> Translated by Rolf Christian Warming & Barry Bradley-Young.





**Figure 1.** Ship's Master C.F. Warming on the bridge of *Egyptian Reefer*, returning to Copenhagen at the end of the Second World War after 6 years overseas. Copenhagen, 12 December 1945. (Author's collection)

I was born and raised in a seafaring family on the Flensburg Fjord. As a youngster, I had already decided that I wanted to go to sea, so that I could enter navigation school and become a chief officer. My older brothers and cousins had first sailed for a year or two in smaller boats, then with a Marstal or Svendborg schooner, and then continued in the great sailing ships from Hamburg. It was this lifestyle I hankered after. I started by making three short summer voyages with my father in

the small shipping industry. In winter these vessels were laid up for some months. Then came a trip on the barquentine *Hansigne* of Marstal from Hamburg to Maracaibo and back where I sailed as an Ordinary Seaman.

Next I sailed aboard the bark *Tellus* as Able Seaman, outward bound from Hamburg with a cargo for three ports in Chile, returning with saltpetre to Falmouth where we were to receive our orders. We unloaded in Dunkirk but after discharging the cargo we went back to Hamburg where I went in search of a more modern ship. The *Tellus* was somewhat old-fashioned in design and for me it was all about getting as good an education as possible. For young would-be mates of the day, an apprenticeship aboard one of the Hamburg sailing ships was highly coveted.

My next ship was the four-masted barque *Pamir* of Hamburg, a fully modern sailing ship, just four years old, which belonged to the firm of Laeisz. She was tied up at Antwerp but due to the bad times in shipping it was made a precondition that the crew members should themselves pay for the outward passage from Hamburg, otherwise new hands would be sought for in Antwerp. The ship was to take cargo from Antwerp to Valparaiso and Iquique, and then return to Hamburg with Chilean saltpetre.

By that time, I had spent the necessary sea time aboard a sailing ship, but still lacked about seven months service as an Able Seaman to get into navigation school. I tried a short trip on the steamer *Baghdad* to the Mediterranean but that did not appeal to me, so I signed off on my return to Hamburg. The barquentine *Carla* of Marstal, which was loading for Rio Grande, needed an Able Seaman. It seemed suitable to me but when I had been aboard for a day I was told that it was going to be away for three years, sailing between Australia and New Zealand. This did not fit in with my plans, so I signed off and got my papers. On the way ashore, I met one of my old shipmates from the *Pamir*. He said that he was aboard the *Preussen* and that they probably still needed Able Seamen. We hurried along to the Agent's office. I asked if by any chance they needed seamen aboard the *Preussen* and was told they were looking for an Able Seaman who had already served aboard any of the Laeisz sailing ships. Since my papers showed that I met the requirements, I was told to meet at the medical examination at nine o'clock the following morning. As agreed, I met up for the examination and was subsequently signed on the same morning, 10 October 1910.



**Figure 2.** The world's only five-masted, full rigged ship. (Courtesy of the German Maritime Museum)

On that same afternoon, I went aboard the *Preussen* which was tied to the mooring piles in the sailing ship dock with sails flapping and just about everything ready to go. It was like a dream come true. The *Preussen* with her five fully rigged masts was a magnificent sight to behold. She wore upper and lower topsails and topgallants. Since she was the only fully rigged ship with five masts in the world, one of the masts had a special name in honor of the owners. From the bow aft, the masts came to be called the fore-mast, main-mast, middle-mast, Laiesz-mast, and the mizzen-mast. Everything was so conveniently placed and as mechanical as possible, all for the express purpose of working the ship. All halyards from the square sails were led down to hand-winches which could haul in and pay out. The

braces for the lower yards were led down to brace winches and any slack could be taken up by crab winches under the pinrails. The sheets and tacks of the lower sails could be pulled taut by deck capstans, fitted at a suitable distance outboard. In the boiler-house behind the foremast there were two donkey boilers to supply steam to the anchor capstan and windlass, and deck winches.

The living quarters for the ship's company, both officers and crew, were situated in the superstructure amidships, which also housed the navigating bridge. At the centre of the superstructure was a very spacious chart room with access to the officers' quarters. In front of the deckhouse was the steering station with the ship's double wheel for manual steering. The binnacle was situated just ahead of the wheel and a little abaft the middle-mast with its belaying points and traditional pin rail around its base. Ahead of the main-mast was its brace winch, and a skylight over the galley; then came a passage with free access from one side of the ship to the other.

The aft half of the superstructure contained the accommodation for the ship's officers. On the starboard side was the captain's private quarters with a large saloon amidships after which there came a continuous fore-and-aft passage. In addition, on the port hand side were the officers' cabins with that of the Chief Officer positioned abaft. In the forward half of the superstructure on the port side were cabins for the boatswains, ship's artificers and the cook. Amidships was the galley and on the starboard side there were two large cabins for the rest of the crew. There were also some cabins in the poop aft, one of which was the ship's hospital.

The whole crew normally consisted of 48 men, divided as follows: captain, 3 mates, 2 boatswains, 1 carpenter, 1 blacksmith, 1 cook, 1 cabin steward, 18 Able Seamen, 12 Ordinary Seamen, and 8 boys. There were also two passengers making the trip - a marine artist and a navigation instructor. The crew was divided into two watches which were sub-divided into 4 men per mast. If there was neither mate nor boatswain to take charge of a mast, an Able Seaman was appointed 'Senior Man'. I was the 'Senior Man' for the middle-mast. My crew consisted of a young Able Seaman, an ordinary seaman and a boy. I was proud to be appointed; it was an acknowledgement of me being a fully-fledged leading hand. The entire time spent at sea under sail was an extension of Navigation School. By that time, nearly all the large sailing ships were training ships carrying cargo of one kind or another.

The crews - mostly young men wanting to gain experience - had to provide proof of at least 12 months sea-time to work as an Able Seaman aboard a sailing ship.

On Sunday 30 October, the *Preussen* was towed from the sailing ship dock, *Segelschiffshafen*, to the mooring piles outside Vorsetzen. The ship, being fully laden with cargo, lay low in the water, bound for Valparaiso and Iquique. In the process of leaving the docks and entering the river, she went aground on the mud flats. The tugs - four in total, I believe - had some difficulty in getting her off, but eventually they succeeded.

The next morning, Monday 31 October 1910, the tug *President de Leeuw* of Rotterdam arrived and joined the *Preussen* on the tide for what would be her last voyage. The tug had been especially contracted to tow the *Preussen* across the North Sea to the English Channel.

In the North Sea, the wind was from the west and the square sails were thus of little use; occasionally, however, the staysails could be set. When the wind backed to starboard, so that the yards could be braced fully round, the sails were hoisted and hauled down again when the wind veered. One night when they had to be set, my right hand man was nowhere to be found. All the yelling and calling for him was in vain. Meanwhile, the other masts had their sails set. I told my Ordinary Seaman and the boy to forget the sails until I found the hand in question. When he turned up, he was punished by having to haul the sails alone. I asked where he had been and got the answer that he had been amongst the others on the after deck; that is how they had always skived in the training ship on which he had previously served. However, the *Preussen* was by no means over-manned and there was no room for slackers.

The tow across the North Sea was undertaken without any greater difficulties. As Dungeness was passed on Saturday 5 November, more sail was gradually got on. The wind was about NNW, so now the square sails could be set. In the afternoon before dusk, the tug was discharged and disappeared eastward up the Channel.

All sails were set, and during the night the deck was cleared and everything stowed away. The voyage had only just begun, and we looked forward to the following day, Sunday, where we could enjoy being under sail aboard the great ship. The *Royal Sovereign* lightship and Beachy Head lights were passed during the evening's run. Towards the changing of the watch, I went with several friends to the starboard side of the aft deck. The weather was hazy as it so often is in the English Channel.



Suddenly, two top-mast lights hove into sight, somewhat across in front of the starboard bow. It advanced rapidly and we briefly discussed whether the steamer would cross ahead or behind us. When the foremost masthead light had disappeared behind the forward sails, I just managed to say, 'It will pass in front' – but, instantaneously, there was an almighty bang. The ship heeled over to starboard and straightened up again.

The fact was that we had collided. Of that there was no doubt, although the steamer went off to port. From the aft deck we could not see how much damage had been done but we knew straight away that it was serious. Immediately, commands rang out for various sailing manoeuvres. The collision occurred just before the change of watch and both watches were on deck ready for the handover. After a short while, the steamer returned and hove to at hailing distance. It turned out to be the British passenger steamer *Brighton* which was heading towards France on its route between Newhaven and Dieppe. Captain Nissen asked for a tug to be sent out to us, but he believed that the ship would survive the collision. The steamer then sailed back to Newhaven.

Aboard the *Preussen*, we were busy taking in sail; lower, topgallants and royals were fastened. The ship was put on a starboard tack that countered the wind and brought the ship almost to a standstill. Thus we lay until daylight, when the full extent of the damage could be assessed.

It did not look well up there in the front. Our jib-boom was severely damaged and lay at an angle of approximately 70° to port. It was still attached, but only just, to a plate on the port bow. All the jib-boom stays were torn from their fixing points on the starboard bow. The stem was twisted and the bow plates sprung down to below the load line. The fore peak was full of water but the watertight bulkhead was holding. The steamer had two funnels. Our jib-boom pierced the first, tearing a large hole in the after part, and the second funnel and mainmast were carried away. All the damage appeared to be on the port side; the davits, lifeboats, and railings - a tangle of twisted metal and splintered wood. Miraculously, nobody was injured.

After dawn on Sunday morning, the *Preussen* was worn round and, with her sails set, a course was laid in to take her eastward. The wind freshened and began to gust, blowing hard from the SW, and then it started to rain too. Captain Nissen's intention was to sail the ship back to Hamburg. In the afternoon we made good speed. The tug *John Bull*, which the steamer had sent out to us, followed at some distance. As we approached Dungeness, the German tug *Albatros*, came

within hailing distance. Captain Nissen was advised to anchor behind Dungeness, so that the signal station on shore could be contacted and instructions sought from the shipping company.

I was helmsman at this time and heard the conversation. It was to the effect that there were calm waters behind the lighthouse and the *Albatros* had anchored there shortly beforehand. Following this conversation, the captain decided to anchor in the shelter of Dungeness. Sail was reduced and adjusted for anchoring. As soon as we reached the anchorage, the port anchor was let go first. It struck bottom and held. Sparks flew off the chain stoppers – so the men told us later – and the chains jumped over the windlass, running out in their entirety and tearing the tump from the keelson with the sound of an explosion. The starboard anchor was then let go – but the same thing happened here. Anchoring under staysails, the ship had driven round so that it now lay with the battered bow to the south. Since both anchors were lost, the German tug threw a hawser aboard and was ordered to tow the *Preussen* to Hamburg.

The pilot cutter from Dover and London, stationed off Dungeness, sent a boat with two pilots aboard. They had a long conversation with Captain Nissen regarding the situation and suggested that the ship was to be taken into Dover where it was possible to moor it to the buoys in the outer harbour. In this situation – with damaged headgear, forepeak flooded and anchors lost – it was only natural that Dover was chosen.

The tug *John Bull* was now hailed to come alongside and was instructed to carry a message to the *Albatros*, countermanding the previous order and confirming that we should now be towed into Dover. Then the tug returned and put their own hawser aboard. Bringing the ship around was difficult but we managed it. Subsequently, a course was laid in for Dover. In order to avoid the risk of the ship being carried onto the piers, the intention was to take her into the harbour by the eastern entrance so that she could be brought head to wind.

But the wind was gusting and the seas were sharp. The tugs could not cope when we were to sway up against the wind. The *Preussen* now lay with her broadside on to the wind, taking the full force of the gale on her port. Despite both tugs working at a maximum, all three vessels were drifting slowly towards the shore. A small tug came out from Dover and got a hawser from the poop, beginning to assist on the lee side of the ship. It did help but unfortunately there was not enough time. To avoid pushing the tug into the surf, the hawser had to be cast off.

About the same time, one of the wire hawsers ahead snapped, after which the other on board was cast off.

The ship was then struck by the first jolt from a severe impact. It seemed as if everything would come down, blocks and yards alike. With the bow facing the shore, the ship remained afloat for a while yet. The lower topsails were hastily braced aback to drive the ship astern. It failed. We soon began to bump heavily on the rocks on the foreshore.

The time at which the ship struck was Sunday night at 16.50. I can remember it because fifteen minutes earlier one of the passengers and I were speculating about when the ship would go aground, and our guess turned out to be exact. He had been put on the helm with me, so we had the opportunity to note the time and talk to each other. Captain Nissen – who, despite the rainy weather, had been walking with his sou'wester in his hands for a while - finally gave orders to lash the helm, so 'it can not come to beat', he said. Proud *Preussen*; her sailing days were over.

All hands were ordered to make for the fo'c'sle as far forward as possible. Here we stood by and waited in case the foremast broke and came down. It was still standing but each time the ship grounded, it swayed like a whip in a peasant's cart. I asked the first Mate Jürs if he did not think it was better for us to stay on the poop; the mizzen-mast was the smallest and had all its stays and shrouds intact. He pointed out that the fore-mast had no fastenings in front and, if it fell, it could bring down the following mast and then the next, and so on and so forth.

At 8 o'clock in the evening, the foremast fractured at the top, snapping where the lower and topmasts joined. As the top-mast fell, there was a tremendous screech of tearing metal and the whole crew let out a spontaneous cheer. It was a great relief to be free of everything that swayed and rattled up there. The masts were made of steel right up to the button on the truck and likewise the yards.

The break occurred at a point where there would be no danger of anything else coming down. The topgallant sail yard had reached the port rail and broke there. The royal-yard had completely disappeared. The upper topsail yard came to stick through the shrouds, transversely above the boiler house, and extended beyond the starboard side. Directly above this, the lower topsail yard extended from beyond the port side and stuck out through the shrouds on the starboard side, still clinging onto the broken mast by the halyard. The fractured mast hung on to a twisted steel plate above. On the deck below lay a chaotic tangle of spars and rigging that had come crashing down.



We were now told to go down below under the fo'c'sle where there was shelter from the wind and rain. I went to the cabin to change my clothes. Although I had been in oilskins all day, I was soaked through to the skin. I changed completely and put on the best clothes I had. On top of this, I put on a dry set of oilskins and then joined the rest of the crew under the fo'c'sle. 'I've put on dry clothes now and it's a lot more comfortable', I said to a friend of mine. One of the boys who was standing nearby said in a pitiful voice, 'I would also like to change but I cannot get there.' I took him on my back through the tangle of rigging and spars that had crashed down and went with him to the cabin. As soon as he had changed, we both made our way back forward to our shipmates under the fo'c'sle.

Meanwhile, some victuals had appeared. We were very hungry because there had been no opportunity to get anything to eat since dinner. With a great lump of bread in one hand and a chunk of ham in the other, we stood or sat and ate with a voracious appetite.

Then to the pumps. We worked with both steam pumps and hand pumps. The hand pumps were of the twin cylinder type with a flywheel that was cranked round a great many times. But it was hopeless. In the evening I accompanied the carpenter to sound the water levels in the holds and bottom tanks. Tubes for sounding the water level in several locations were up to around a foot above the deckhead, so it was clear that the ship's bottom had already been breached.

When we started, the carpenter asked me how much water I thought was in the ship. I guessed and said, 'It must almost be full because she doesn't cut into the rocks anymore.' There appeared to be up to 16 feet of water in the wreck. After that the pumping stopped. The crew gathered again under the fo'c'sle deck, with a few taking refuge in the cabins on the starboard side. At high tide, the sea swamped the port side from the after edge of the fo'c'sle, along the foredeck above the gunnels and the superstructure amidships. It was, however, possible to move around on the deck at will during low tide.

The stranded *Preussen* was kept illuminated throughout the whole night by searchlights from within Dover harbour. A tug with a lifeboat in tow also stood by all night and the following day, but, naturally, kept out of the surf. The next day the wind was still blowing a full gale. More tugs and salvage vessels stood by to render assistance, amongst them the *President de Leeuw* that had towed the *Preussen* to the Channel. On the third day, the storm abated and we left the ship in our own boats. We were towed to Dover where the rest of the crew were staying at the

Seamen's Home. Weather permitting, there was always a boat out to the stranded ship in the mornings.

A production company came out to film the event on one of the first days we were aboard the wreck. However, since we were only a small party of seamen, they put some film people in oilskins and climbed up into the shrouds. It was a pitiful sight for a seaman to behold.

Amongst the tugs and salvage vessels present there was also the Danish salvage tug *Viking*, belonging to Svitzer. On a calm day, they came alongside and put four hoses into the holds in an attempt to pump out the ship. The Danish salvage people told me that if the water level in the vessel went down with the four suction hoses, all available equipment would be deployed. The pumping, however, remained unrewarding. The offloading of salvaged cargo began. It was stowed in barges sent from Hamburg. The crew salvaged the sails and whatever else they could from the ship's interior, which was also taken off by a barge. I received my discharge papers on 19 November 1910. I was in the last party of the *Preussen's* crew to be repatriated to Hamburg via London.

For many years, the wreck of the *Preussen* remained there under the chalk cliffs, right on the spot where she had stranded. Gradually, however, she disappeared more and more beneath the waves. Later, as master of my own ship, whenever I passed Dover at low tide, I kept close into the shore. Even as late as just prior to the last world war, I could see a few frames protruding above the water - the remains of one of the largest and most beautiful sailing ships ever made.



**Figure 3.** (Courtesy of the German Maritime Museum)



# English Seafarer Communities in the Late Middle Ages: an economic and cultural exploration of Devon and Norfolk

Brenna Gibson

In the fourteenth century, English seafarers formed an essential part of the social and economic fabric of the kingdom. Ports were the hubs of the trade networks, which connected England with the rest of the world, importing goods as well as influence and culture from the Continent. Closer to home, seafarers not only fished both inshore and offshore, but were also an integral part of the nation's martial and diplomatic endeavours through the transport of armies, supplies and envoys. The fourteenth century was a turbulent time, with famine, plague, and war being ever-present dangers. However, it was also a time of expanding trade, which offered opportunities to mariners (Ormrod, 1987, pp. 27–40); as the conduits through which trade flowed, shipmasters were in a favourable position to exploit economic expansion (Kowaleski, 2003, pp. 177–231). For instance, if an abbot needed to sell the wool from his vast estates, he relied on a shipmaster to freight his clip. Additionally, the wine that flowed freely at aristocratic tables was transported in the hulls of English ships.

There is an absence of interest in maritime communities amongst medieval historians, which is surprising as research has shown that the seaman was a cosmopolitan individual used to working with diverse peoples, and whose line of work gave a knowledge of the wider world that was denied to most of his land based contemporaries (Kowaleski, 2007, pp. 96–121). This is not to say that mariners have been entirely neglected. In fact, there is an expanding literature on this group and their importance was not lost on their contemporaries. Geoffrey Chaucer, in his *Canterbury Tales*, wrote about characters that had important (although not always powerful) roles in fourteenth-century England, one of which was called the Shipman.:

A Shipman was ther, wonynge fer by weste;  
For aught I woot, he was of Dertemouthe.  
He rood upon a rouncy, as he kouthe,  
In a gowne of faldyng to the knee.  
A daggere hangynge on a laas hadde he  
Aboute his nekke, under his arm adoun.  
The hoote somer hadde maad his hewe al broun,  
And certainly he was a good felawe.

Ful many a draughte of wyn had he ydrawe  
 From Burdeux-ward, whil that the chapman sleep.  
 Of nyce conscience took he no keep.  
 If that he faught, and hadde the hyer hond,  
 By water he sente hem hoom to every lond.  
 But of his craft, to rekene wel his tydes,  
 His stremes, and his daungers hym bisides.  
 His herberwe and his moone, his lodemenage,  
 Ther nas noon swich from Hulle to Cartage.  
 Hardy he was, and wys to undertake;  
 With many a tempest hadde his berd been shake.  
 He knew alle the havenes as they were,  
 From Gootlond to the Cape of Fynystere,  
 And every cryke in Britaigne and in Spayne.  
 His barge ycleped was the Maudelayne. (Chaucer, 2007, l. 348–410)

In his description, key information about the seafarer is included such as the homeport—Dartmouth—and his ship's name—*Maudelayne*. The only thing missing is the Shipman's own name, but then Chaucer does not name any of his characters. While it is not a completely accurate representation of all mariners in the fourteenth century, Chaucer's description does highlight the importance of seafarers during this time, as well as the integral personal qualities he might have needed.

There are thousands of documents from the fourteenth century, like those manuscripts of *The Canterbury Tales*, which have survived into modern times. Documents surviving from the fourteenth century are often incomplete and inconsistent. This is especially true for statistical information; economic historians struggle to speak with certainty on this period. This paper will investigate the economic standing and culture of seafarers from Devon and Norfolk, using a wide range of source material. The most important foundational records for my purposes are those from the Exchequer and the Chancery, as well as various customs accounts. The records that will be the focal point for my project in general are the Lay Subsidies and the Poll Taxes, both taxation documents from the fourteenth century. The Lay Subsidies occurred in the first half of the century and were based on the moveable wealth of the individual (Hadwin, 1983); the Poll Taxes in the later half of the century were, for the most part, sliding scale tax

brackets that an individual was categorized in to. The Poll Taxes also often included the occupation of the individual being taxed (Fenwick, 1998a).

The methodology for the gathering of my data is relatively straightforward. Using the records of the Chancery, Exchequer and other material, a database has been compiled that contains prosopographical data on seafarers' careers. This database has over 8,000 records relevant to the fourteenth century. This information includes the names of seafarers' ships and the ports from which they sailed, in addition to the nature, the geographical range, and the dates of their voyages. Often the size of the crew is also recorded, therefore providing valuable demographic data. From here, a comparison is made between the names of shipmasters for which their ships' homeports are specified in the naval records with the names of taxpayers listed for those same ports. Due to the problems associated with nominal record linkage, we can never be certain of linking royal governmental records. However, if done carefully, new progress can be made on our understanding of this occupational group. Consequently, certain parameters were created in order to ensure a reliable dataset: each match must have an unusual name, have sailed within 20 years of the tax year, and have been found within a ten mile radius of the port city.

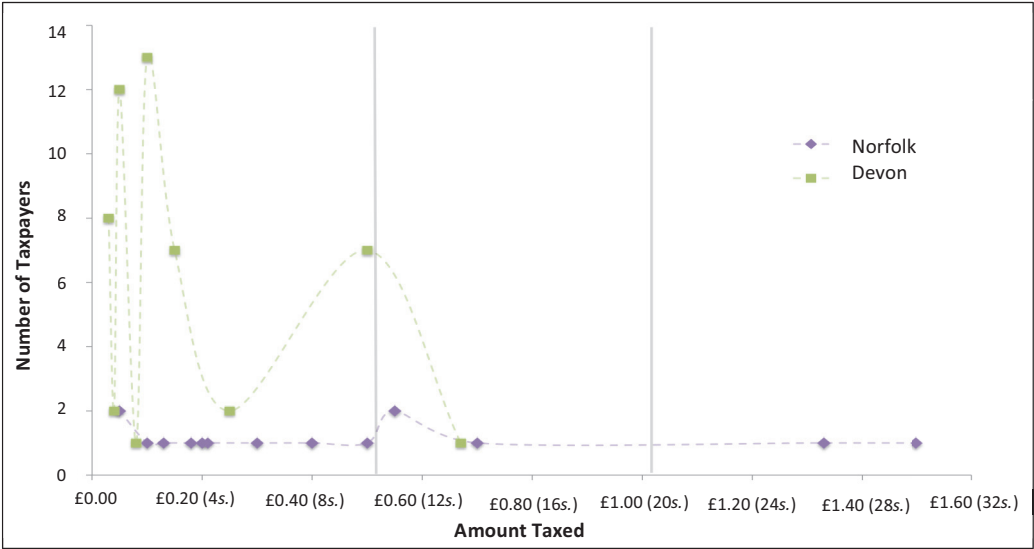
### **Economic Status**

The Devon Lay Subsidy rolls have survived well, and because of this a high number of matches were made between the foundational records and the tax records (Figure 1). Devon displays a wide range of tax amounts, with the lowest amount being 8d. (£0.03) from men such as Michael Abraham (Erskine, 1969, p. 4; The National Archives<sup>a</sup>, The National Archives<sup>b</sup>, pp. 228, 238) and John Broun (Erskine, 1969, p. 2; Exeter Customs Records, 1357), who both sailed from Dartmouth and William Henry who sailed from Teignmouth (Erskine, 1969, p. 59; Exeter Customs Records, 1331). The highest tax amount came from John Baker, who also sailed from Dartmouth, at 14s. (£0.70) (Erskine, 1969, pp. 93, 103; Exeter Customs Records, 1358, 1357, 1333; The National Archives<sup>c</sup>, The National Archives<sup>d</sup>, The National Archives<sup>e</sup>, p. 372).

The highest tax amount in Norfolk, however, was double that found in Devon, with 30s. from William Benet (Hawes, 2000, p. 196; The National Archives<sup>f</sup>, The National Archives<sup>g</sup>). This amount is 30-times higher than the lowest tax amount found in Norfolk, which was 8d. from John Turnour (*Calendar of Inquisitions Miscellaneous, 1307-49*, p. 45; Hawes, 2000, p. 195) and William Rede



(Hawes, 2000, p. 196; Lyte, 1898, p. 492). Benet, Turnour and Rede all sailed from Great Yarmouth.



**Figure 1.** Norfolk vs. Devon Taxation Frequency, 1327-1334

Looking at the range of wealth for each of these counties helps us understand where each stood economically. It can be seen in Figure 1 that, despite the fact that Devon has more mariner-matches than Norfolk, Norfolk was in fact the richer county per person during this period. All mariners from Devon, with the exception of one, fell into the "low" taxation bracket. Norfolk, while having a majority in the "low" bracket also sees several men appearing in the "middle" and "high" taxation brackets.

With the standardization of tax amounts under the Poll Taxes, less variance is to be expected in the tax amounts. Four pence was the lowest amount that could be paid during this time, unless the person was a pauper (in which case, he or she was exempt). From Devon, Richard Matheu, who sailed from Dartmouth, was taxed the lowest amount, at 4*d.* (£0.02) (Fenwick, 1998b, p. 143; Kowaleski, 2001, p. 225) and Thomas Asshendon was taxed at the higher rate of 3*s.* (£0.15) (The National Archives<sup>h</sup>). Asshendon also sailed from Dartmouth.

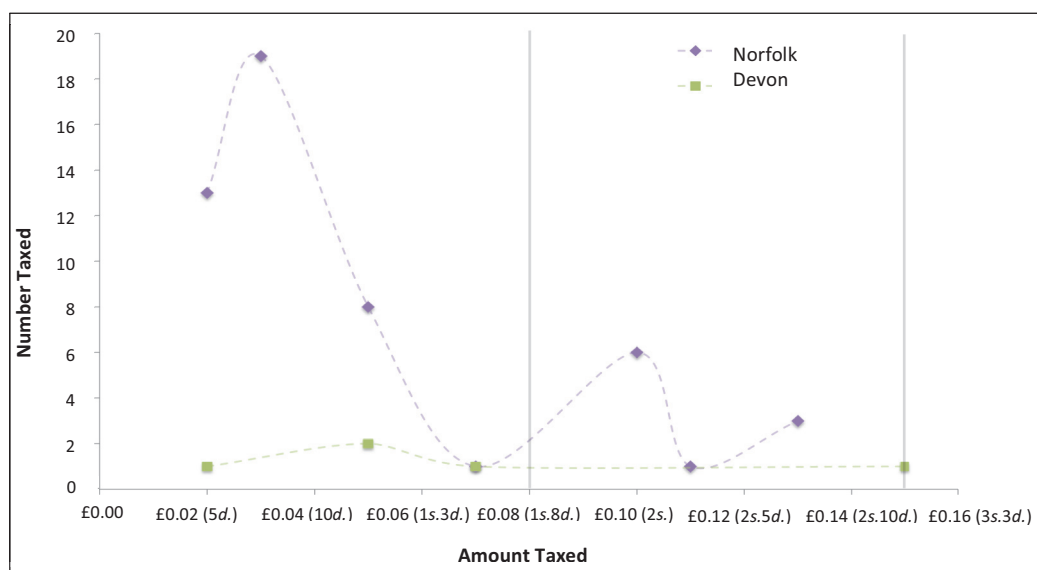
Mariners identified in the Norfolk Poll Taxes were made up of a mixture of matches to foundation records and of identifications made from occupational data. There were 13 mariners taxed at the lowest amount, 4*d.* (£0.02); for example,



Richard Clerk, Jacob Hardy, John Ingrith, and Stephen Shipman. All four of these men lived in Lynn and were listed as a 'married mariner' in the Poll Taxes (Fenwick, 1998c, pp. 182–185). Of these men, John Ingrith is the only one for whom foundational records exist (The National Archives<sup>i</sup>). Ingrith proves to be an interesting case, as the owner of his ship is listed as William Ingrith, for whom there is also a foundational record in the

database. William could possibly be John's father or uncle. This is an example of how foundational and tax records, when used together, can be more than just an economic tool by linking families together. John Rowland, who sailed from Great Yarmouth and was listed as a 'shipman', and Roger Sutere, who was from North Walsham and was listed as a *nauta* or 'sailor', were both taxed the highest amount, *2s 6d*. (£0.13) (Fenwick, 1998c, p. 198).

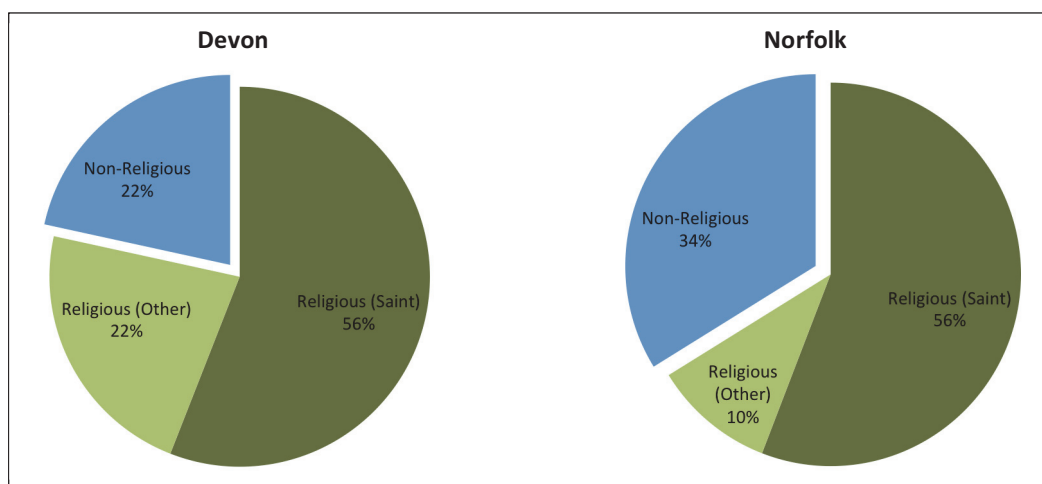
Looking at Figure 2, it could be argued that there are two tax brackets for Devon: low income and high income. The majority of people fall between £0.02 and £0.05 decimal, but as there are only five records this is difficult to declare with certainty. Interestingly, Devon has no taxpayers that fall within the middle tax bracket but does have a solitary person who was taxed within the high bracket. All of the men were from Dartmouth, which shows that the town had a range of taxpayer wealth, but also means that it is difficult to know whether Dartmouth is representative of the other port towns in Devon. Norfolk, however, has no taxpayers in the highest bracket, potentially supporting the belief that eastern fisheries decline in the later half of the century is represented by the tax data. Much can be discovered about shipmasters in the fourteenth century, if a wide range of resources are used to create a more complete snapshot. As such, cultural elements, such as ship naming practices, can add a different layer of information to a prosopographical study.



**Figure 2.** Norfolk vs. Devon Taxation Frequency, 1377-1381

## Ship Naming Practices

Two ways in which ship-naming practices can be explored are by looking at the choices in ship names before and after the Black Death, as well as the change in popularity across the century. Before the Black Death, it can clearly be seen that religious names greatly outnumber non-religious ones in Devon, with non-religious names making up only 22% (see Figure 3). In this paper, a ‘religious’ saint name is defined as one that is related directly to the sea (e.g., *Thomas*) or is a highly recognizable one (e.g., *Peter*). All other religious names (e.g., *Trinity*) are classified under ‘religious-other’. If a name does not have a connection to the sea and it is not a highly recognizable saints’ name, then it has been classified as ‘non-religious’, whether there is a saint with that name or not. This is due to the fact that it is hard to know whether the name was chosen because of the saint, or because of an affiliation that shipmaster has with the name (something that might be discovered after more rigorous research).



**Figure 3.** Percent of Religious vs. Non-Religious Ship Names, 1300-1348

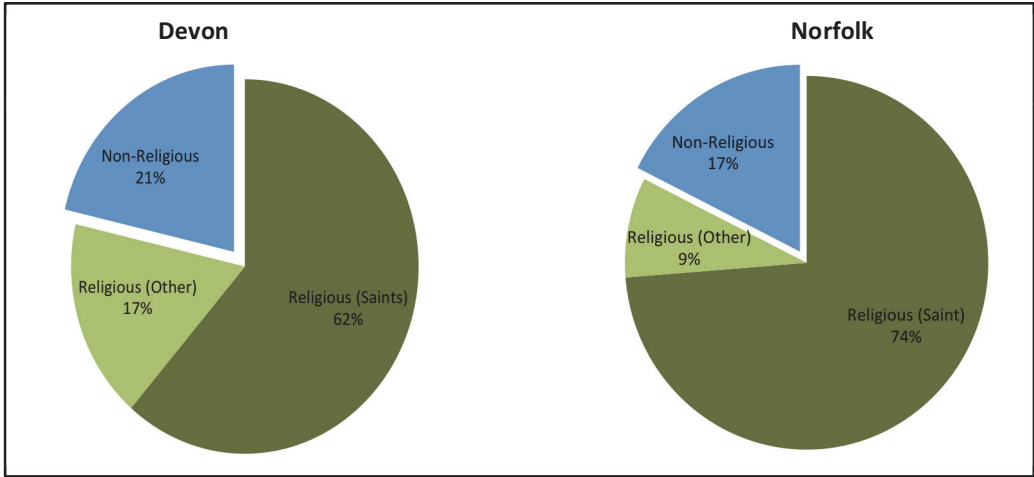
Devon			Norfolk		
Name		% of Total	Name		% of Total
1	Variations of Mary	12.1%	1	Margrete	9.4%
2	James	5.5%	2	Nicholas	8.5%
3	Godyer	5.3%	3	Blithe	5.2%
4	Michel	5.1%	4	Katerine	4.7%
5	John	4.8%	4	Variations of Mary	4.7%
5	Nicholas	4.8%	5	James	4.2%
6	Margrete	4.4%	5	Michel	4.2%
7	Peter	4.2%	5	Rose	4.2%
8	Trinity	3.8%	5	Welfare	4.2%
9	George	3.3%	6	John	3.8%
10	Grace Dieu	3.1%	6	Peter	3.8%
11	Jonette	2.9%	7	Godyer	3.3%
11	Rodecog	2.9%	8	Garland	2.8%
12	Katerine	2.7%	9	Grace Dieu	2.3%
13	Thomas	2.4%	9	Laurence	2.3%
13	Saint Saviour	2.4%	9	Maudeleyne	2.3%
14	Andrew	2.0%	10	Bartholomew	1.9%
15	Seinte Espirit	1.8%	10	Charite	1.9%
16	Dieu	1.5%	11	Clement	1.4%
16	Bartholomew	1.5%	11	Eleyne	1.4%

*Note: As some names are equally popular, there are at times more than one name at a single ranking. Therefore, the 20 most popular names are not necessarily ranked 1-20. The colour of the text indicates the classification seen in Figure 3.*

**Figure 4.** Top Names in Devon and Norfolk, 1300-1348

In fact, the top ten ranked names are all religious ones, with the clear leader being the variations of Mary, at 12.1% of the total Devon ship names before the Black Death (Figure 4). Further, there are only two other non-religious ship names found within the 20 most popular names. Norfolk, on the other hand, had a higher percentage of non-religious ship names during the period between 1300-1348, at 34% (Figure 3). Within the top ten ranked names, four are non-religious (Figure 4).

By 1348, the Black Death had fully reached England. Many scholars today speculate as to the effects the Black Death had on the country’s inhabitants, as I will begin to do here. Interestingly, in Devon, the percent of religious names barely changes from the 22% before the Black Death to 21% after (Figure 5). However, falling within the top 10 ranked names is now a single non-religious name, with three others found in the 20 most popular (Figure 6).



**Figure 5.** Percent of Religious vs. Non-Religious Ship Names, 1349-1399

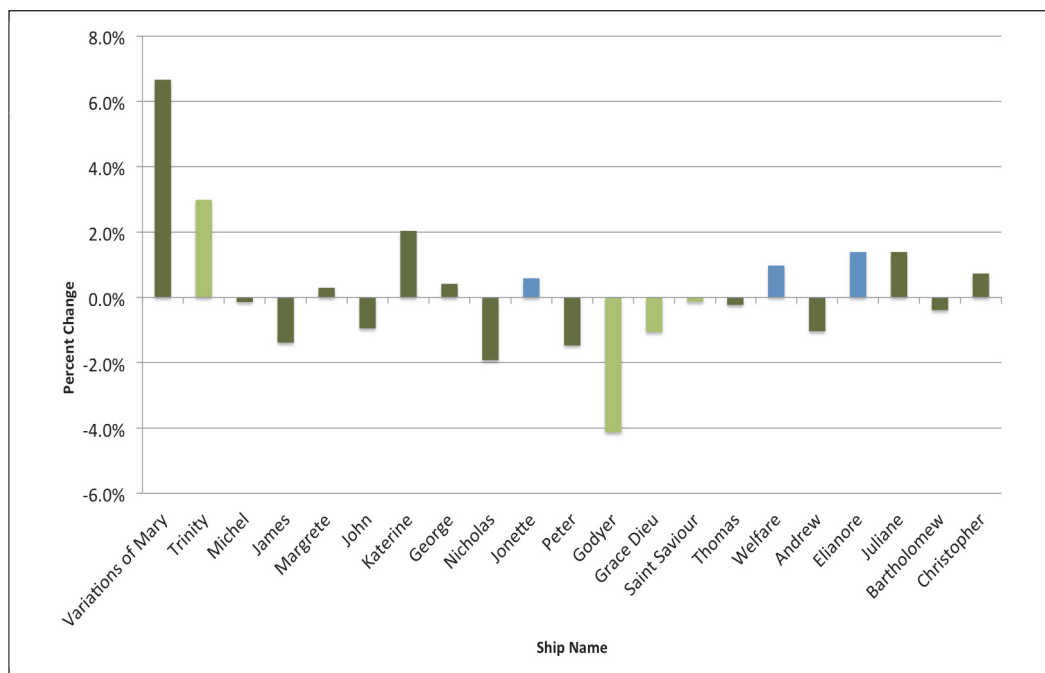
An even more thought-provoking change has occurred in Norfolk by the period of 1349-1399, however. Where there had been 34% non-religious names before the Black Death, there were only 17% after it (see Figure 5). This drop is reflected in both the top 10 ranked names and the 20 most popular names (see Figure 6), as there are no longer any non-religious names in the top ten ranked and only two in the most popular names. Are these shifts responses to the Black Death? Or was it to other economic changes? It is impossible to do anything more than speculate until a similar study has been done on the other coastal counties, correlating the data found with possible causes.

Devon		Norfolk	
Names	% of Total	Name	% of Total
1 Variations of Mary	18.7%	1 Variations of Mary	14.0%
2 Trinity	6.8%	2 James	9.8%
3 Michel	5.0%	3 Peter	7.3%
4 Katerine	4.8%	4 Margrete	7.0%
5 Margrete	4.7%	5 Katerine	5.9%
6 James	4.1%	6 Nicholas	5.3%
7 John	3.8%	7 Christopher	4.7%
8 George	3.7%	7 Michel	4.7%
9 Jonette	3.5%	8 Thomas	3.6%
10 Nicholas	2.8%	9 Trinity	3.1%
11 Peter	2.7%	10 John	2.8%
12 Welfare	2.4%	11 Anne	2.5%
13 Saint Saviour	2.2%	11 George	2.5%
14 Thomas	2.1%	11 Grace Dieu	2.5%
15 Grace Dieu	2.0%	12 Maudeleyne	1.7%
16 Elianore	1.8%	13 Welfare	1.7%
16 Juliane	1.8%	14 Edmund	1.4%
17 Peterok	1.6%	14 Godbefor	1.4%
18 Christopher	1.5%	14 Grace	1.4%
18 Edward	1.5%	14 Laurence	1.4%

**Figure 6.** Top Names in Devon and Norfolk, 1349-1399

Tracking ship name popularity throughout the century is another way to trace changes that might have been caused by the Black Death. In order to track this, the 20 most popular names for the entire century in both Devon and Norfolk were found. Then, the change in the percent of the total ship names from before the Black Death was found and compared to the percent after the Black Death, as can be seen in Figure 7 and 8.

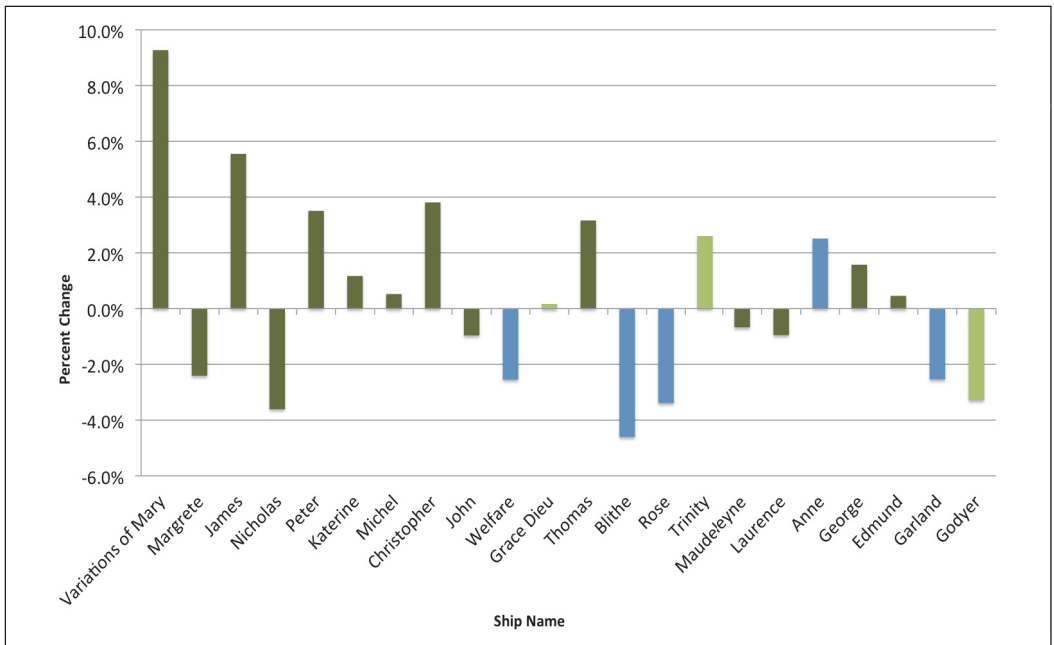
In Devon, the variations of 'Mary' remain the most popular, rising by nearly 7% in popularity after the Black Death. *Godyer* sees the most significant drop in popularity, falling by about 4%. All of the non-religious names that made it onto the list rose in popularity, with *Elianore* and *Welfare* both rising by over 1%.



**Figure 7.** Changes in Ship Name Popularity in Devon 1300-1399

In Norfolk, however, the opposite is seen. All non-religious names bar one fall in popularity across the century. Where the name *Welfare* rose in popularity by 1% in Devon, it falls by 2.5% in Norfolk. The only non-religious name that sees a rise in popularity is *Anne*, a name which is not in any of the foundational records of Norfolk between 1300-1348. These changes compare easily with the changes seen to the rise and fall of religious and non-religious names in Devon and Norfolk, as discussed earlier.

The question of the popularity of *Anne* springing up after the Black Death is an interesting one. There are two possible reasons that *Anne* rose in popularity: on one hand it could in actuality be named after St Anne, making it a religious name; or, on the other hand, it could be that the name Anne has special significance to the shipmasters or shipowners. While St Anne has no connection to the sea, she was the mother of the Virgin Mary. Furthermore, there are connections to St Anne in King's Lynn, one of Norfolk's main port towns, where St Nicholas church has a stained glass window depicting St Anne teaching Mary to read.



**Figure 8.** Changes in Ship Name Popularity in Norfolk 1300-1399

## Conclusion

It is not possible to compare mariners' economic status from the first half of the century to those from the second half, as the taxation methods were different. Therefore, I will be using a basket of goods<sup>4</sup> and wage data in order to determine where shipmasters stood economically, as compared to other members of society. Even without a basket of goods, it can be seen that the taxation of mariners in both halves of the fourteenth century was varied and complex, no matter which method of taxation is observed. There are many factors which appear to be involved; for example, the existence of large ports, tax exemptions, and sheer number of records that have survived can all influence our vision of the taxation of mariners occurring in a county.

Giving a nominal value to culture is not always an easy task; however, here it can be seen that a new dimension of research could be added to the current literature on the Black Death by tracking changes in ship name popularity. With

<sup>4</sup> A basket of goods and services is defined as 'a hypothetical group of different items, with specified quantities of each one meant to represent a "typical" set of consumer purchases, used as a basis for calculating how the price level changes over time' (Textbook Equity Edition, 2014, p. 461)

further and more comprehensive study, an exploration of the ups and downs of ship naming practices can be done, potentially correlating the ebbs and flows with the Black Death, as well as economic changes in port towns. Furthermore, comparisons between ship name choices and economic standing of the shipmaster or ship-owner can be drawn by linking nominal tax data to these men and ship names. I hope to prove throughout the course of my research that this method of linking foundational records to taxation records can provide new and accurate insights into the seafarer in English coastal communities.



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## **II. Energy and Resources**



# Understanding How Heat Generated in Submarine High Voltage Cables is Dissipated in the Surrounding Sediment

*Tim Hughes<sup>1</sup>, Tim Henstock<sup>1</sup>, James Pilgrim<sup>2</sup>, Justin Dix<sup>1</sup>, Tom Gernon<sup>1</sup>, Charlie Thompson<sup>1</sup>*

## Introduction

One of the defining aspects of life in the modern world is convenient access to a reliable and plentiful supply of electricity. This essential utility is delivered from power generating stations to consumers through a vast and intricate network of cables. These networks are designed with a plethora of different considerations in mind; a fine balance must be struck between them when constructing and installing cables. The supply of electricity must be comfortably accommodated by the network at times of very high demand, while minimising the amount of raw materials required to construct the constituent cables, and the amount of energy lost during the delivery of electricity to consumers.

In this context, the electric current is defined as being the movement of charged electrons along a cable (Landau & Liftshitz 1975). Inevitably, there are collisions between these electrons in motion and the constituent atoms of the cable conductor. During these collisions, electrons lose a proportion of their kinetic energy to the conductor atoms, which is manifest as an increase in the temperature of the conductor (Tayal 2009). In fact the power loss,  $P_{loss}$ , from a cable due to this effect (which is known as Ohmic, or sometimes Joule heating), is proportional to the square of the current,  $I$ , that passes through it (Elgerd & van der Puije 2012):

$$P_{loss} = I^2 R = \frac{V^2}{R} \quad (1)$$

Here, the resistance,  $R$ , is dependent on the material that the conductor is made from as well as its cross-sectional area. The transmitted power,  $P$ , is equal to (Elgerd & van der Puije 2012):

$$P = IV \quad (2)$$

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Hence, it turns out to be much more efficient to transmit power over large distances at the lowest currents and highest voltages available. The supply voltage must be stepped down for domestic use (which is a relatively efficient process (Fardo & Patrick 2009)). In recognition of this, the electricity network is composed of large high voltage (HV) cables for bulk transmission of electricity over large distances, medium voltage cables for transmission of moderate amounts of power over smaller distances, and small low voltage cables for distributing power from local substations to consumers.

### **How are Submarine HV Cables Integrated into these Networks?**

The incorporation of submarine HV cable links into the electricity network is becoming increasingly important. This is due in part to the large amount of recent investment into offshore power generation from renewable energy sources (*e.g.* wind, wave *etc.*), which require submarine connections to transmit generated power back to consumers on land. At the time of writing the aggregate power generation capacity of offshore wind projects in the UK alone stood at over 4GW (OWPG 2015). Draft plans indicate that up to 16GW (the UK year-averaged power consumption is currently just less than 40GW (DECC 2014)) of offshore wind generation could be available for the UK market by 2020 (DECC 2013), with a large number of wind farms currently under construction, awaiting construction, or in the planning stages.

Another application of submarine HV cable links is the continued expansion of the “European supergrid”. The purpose of this initiative is to increase the number of connections between the national electricity grids of different European nations (or, over long distances within nations, *e.g.* the UK’s “Moyle interconnector” (Worzyk 2009), which consists of two 250 MW cables (Atkinson *et al.* 2002)), so that energy can be more easily shared between them. Sharing electricity in this way can help to reduce the strain on the domestic power stations of the consumer region during times of peak demand, while simultaneously reducing the extent to which complicated energy storage solutions might be required in the supplying region.

Submarine cable links are becoming increasingly prevalent in modern power grid networks. It is therefore of critical importance to understand as much as possible about the *in situ* operation of HV cables to ensure that they operate efficiently and reliably.

## Cable Ratings

It is vital that the aforementioned Ohmic heating effect is accounted for during the design and construction of all HV cables; the material commonly used (Worzyk 2009, Thue 1999) for the cable insulation (cross-linked polyethylene, or XLPE for short) starts to degrade a lot faster when exposed to temperatures in excess of about 90°C (Anders & Radhakrishna 1988, Pigrim 2011), which reduces the lifetime of the cable. Each HV cable must be given a “thermal current rating”, which denotes the maximum amount of current that it can safely and continuously transmit while maintaining the temperature of the XLPE insulation material below this 90°C threshold. In order to calculate these current ratings, an equation that describes the transfer of heat from where it is generated within the cable (largely in the conductors) to the surrounding environment must be solved. This equation must account for the thermal properties of both the cable components, and the material into which the cable has been buried.

There are two main approaches that can be taken to solve this equation and obtain current ratings for cables buried on land. The first type of approach involves solving the relevant equations *a priori* by making simplifying assumptions about the nature of the problem (one example of this kind of approach is laid out in the IEC 60287 standard (IEC 2006)). These necessary simplifications of the situation may not be reasonable under all circumstances, and may compromise the accuracy of the predictions made. For example, two common assumptions that are commonly employed are that the material into which the cable is buried is completely homogeneous with respect to its thermal properties, and that the temperature at the surface of this material is isothermal. Neither of these conditions are accurate in all circumstances; there will inevitably be some degree of inhomogeneity in the sediment, and the isothermal boundary condition essentially assumes that heat can be transferred with perfect efficiency from the top layer of the soil to the air (which is not the case, especially for shallow burial depths and low windspeeds (Swaffield, Lewin, & Sutton 2008)).

The second approach involves using numerical models to obtain an approximate solution to the equations to within a predetermined tolerance. The advantage of this method is that more complicated scenarios can be examined, without having to make as many simplifications. Advances in computing have made this approach more and more viable by reducing both the length of time

required to compute simulation runs, and the associated costs of doing so (Mack 2011). Consequently, numerical approaches have been used extensively to study heat dissipation from HV cables buried on land (Anders & Radhakrishna 1988, Swaffield, Lewin, & Sutton 2008, de León & Anders 2008).

While the procedures for evaluating the current ratings for cables buried on land is well established, comparatively little work has been done explicitly on how these cables behave when buried in a marine environment. There are a number of differences between the two environments that might potentially affect the nature of the heat transfer away from the cable. Perhaps the most obvious of these is the presence of the large body of seawater that lies directly over the burial sediment (for land-buried cables, there is just air); this provides a much more effective heat sink than is present for land cable scenarios. The dissipation of heat from HV cables buried on land can cause drying out of the surrounding soil (Milne & Mochlinski 1964). Increasing the pore water temperature increases water vapour pressure and reduces the fluid viscosity, resulting in the movement of heated water away from the region around the cable. In the marine environment, the saturated nature of the sediment means that pore water transported away from the cable is replaced more readily from the surroundings with cold water. The composition of the seawater found in the porous burial sediment will also be different from the fresh rainwater that falls on land, hence there will be differences in the physical properties of the pore fluid. Additionally, the degree of saturation experienced by sediments in the marine environment is likely to be much greater than those on land. Finally, sediments in the marine environment are often altered much more quickly than those on land. For example, the migration of marine sediment features (called bedforms) along the ocean floor can result in a change in seabed depth by as much as 5m per year (van Landeghem *et al.* 2012). This kind of rapid transport of material is not experienced by sediments on land.

## Method

One common numerical technique that has previously been used to model cables on land is called the finite element method (Lewis, Nithiarasu, & Seetharamu 2004) (FEM). We have developed two-dimensional computer simulations using this technique to model the dissipation of heat from HV cable cross-sections into the sediment in which they are buried (Hughes *et al.* 2015) (Submarine HV cables are commonly buried at a depth of about 1m below the



seafloor into the surrounding natural sediment (Worzyk 2009)). The constructed model accounts for the dissipation of heat from both conduction and convection. The equation that describes this dissipation from a source,  $Q_{in}$ , is (Lewis, Nithiarasu, & Seetharamu 2004):

$$Q_{in} = -\lambda \nabla^2 T + \rho c_p \mathbf{u} \cdot \nabla T \quad (3)$$

where  $\lambda$  ( $\text{Wm}^{-1}\text{K}^{-1}$ ) is the thermal conductivity,  $T$  ( $^{\circ}\text{C}$ ) is the temperature,  $\rho$  ( $\text{kgm}^{-3}$ ) is the density of the seawater,  $c_p$  ( $\text{Jkg}^{-1}\text{ }^{\circ}\text{C}^{-1}$ ) is the specific heat capacity of the seawater, and  $\mathbf{u}$  ( $\text{ms}^{-1}$ ) is the velocity of the fluid within the sediment. The value for the bulk thermal conductivity that is used in the model is an arithmetic estimate based on a combination of the individual thermal conductivities of the sediment grains and the pore water (Woodside & Messmer 1961). The motion of the pore water contained within the burial sediment ( $\mathbf{u}$ ) is assumed to be well described by Darcy's law (Darcy 1856). Buoyancy forces will also begin to act on the pore fluid as it is heated up; hotter water is less dense than cooler water and has a tendency to rise. This effect is accounted for by substituting in a temperature dependent density term into Darcy's law,  $\rho = \rho_0(1 - \beta(T - T_c))$ , such that the form of  $\mathbf{u}$  in equation (3) that is actually used in our FEM model is:

$$\mathbf{u} = -\frac{1}{n\mu} \kappa (\nabla p + g\rho_0(1 - \beta(T - T_c))\hat{\mathbf{y}}) \quad (4)$$

Here,  $n$  is porosity,  $\mu$  ( $\text{Pa}\cdot\text{s}$ ) is the dynamic viscosity,  $\kappa$  ( $\text{m}^2$ ) is the permeability,  $p$  ( $\text{Pa}$ ) is the pressure,  $g$  ( $\text{ms}^{-2}$ ) is the acceleration due to gravity,  $\beta$  ( $^{\circ}\text{C}^{-1}$ ) is the coefficient of thermal expansion, and  $T_c$  ( $^{\circ}\text{C}$ ) is the ambient temperature.

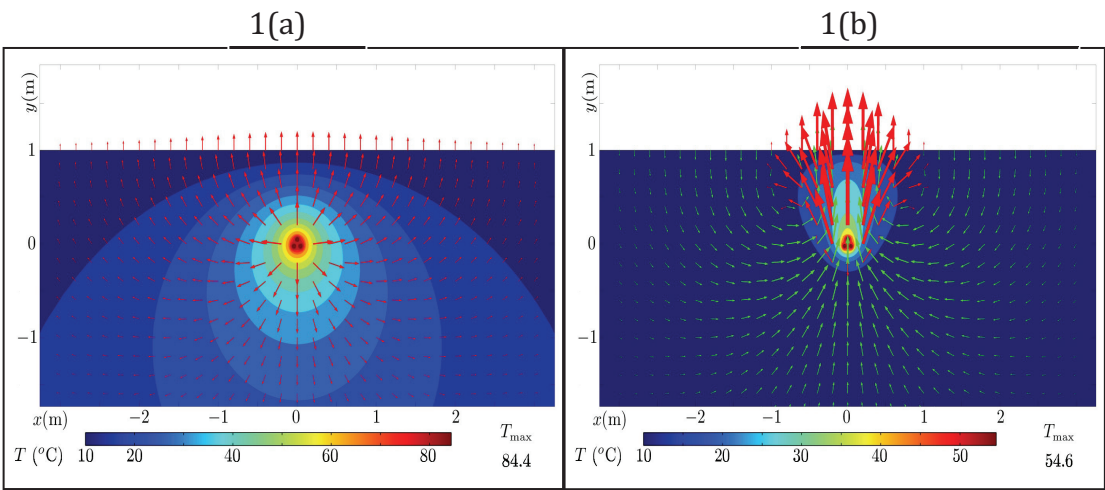
The cable used in the model is based on a generic design of a 132kV alternating current cable. It has three cores arranged with two side by side, and the third resting on top between the other two such that the centres of the cores form an equilateral triangle. Heat is generated as realistically as possible within the cable (in a number of components, mainly the conductors at the centre of each core, but also in the other metallic parts where currents are induced which then experience resistive losses themselves (Thue 1999). The transfer of this generated heat through the cable components is by conduction only.

The main focus of this research is to evaluate the impact that the properties of the marine sediment and the environmental situation have on the dissipation of heat from HV cables (and how this may differ from the case of a cable buried on land). The relevant parameters that appear in equations (3) and (4) are: the thermal conductivity ( $\lambda$ ), porosity ( $n$ ), permeability ( $\kappa$ ), and burial depth ( $b$ ). Note

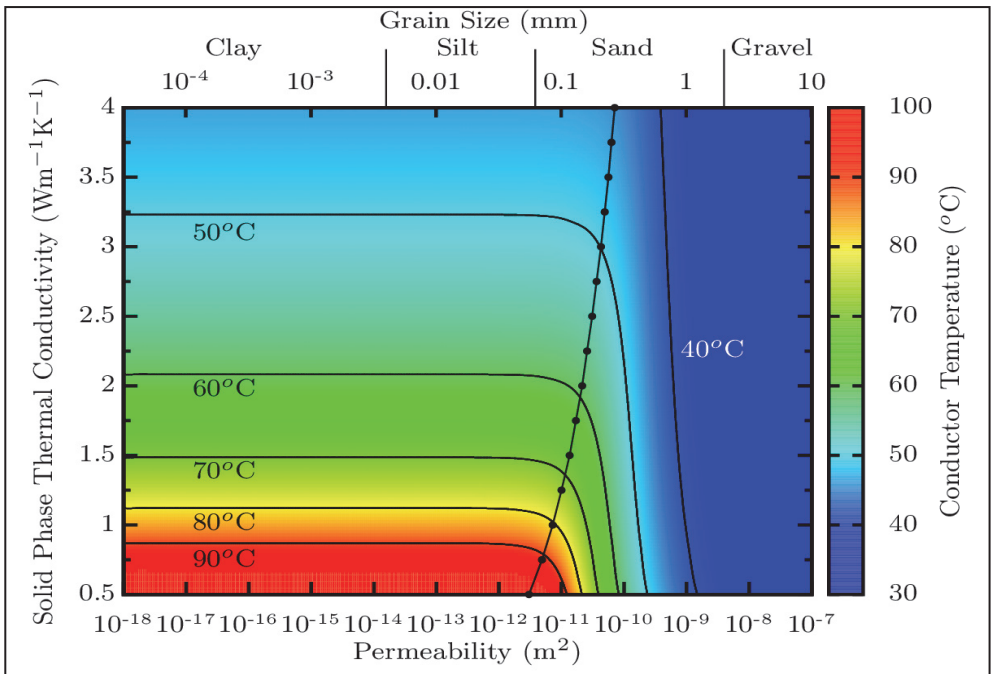
that the burial depth is not present in the equations explicitly, but the temperature gradient terms (  $\nabla T$  ) are dependent on it. We carried out studies to assess which quantities exhibit the greatest amount of variation between different naturally occurring marine sediments, and hence which ones are likely to influence the nature of the heat flow the most. We discovered that the permeability ( $\kappa$ ) varies over many more orders of magnitude ( $\sim 10^{-18}$  -  $\sim 10^{-7} \text{m}^2$  (Hughes *et al.* 2015)) between different marine sediments than any of the other parameters previously mentioned. To put this in context, our literature review found that the range of bulk thermal conductivities was  $0.80 - 3.11 \text{Wm}^{-1}\text{K}^{-1}$ . We therefore selected the permeability as the primary subject of the investigation. Following this, the effects of the other parameters were also investigated.

### Results

We ran a number of simulations for a wide range of values for permeability based on the observed natural variation. The results from two example simulations which are identical except for the value of the permeability of the surrounding sediment are displayed below in Figure 1. The permeabilities in Fig. 1(a) and 1(b) are representative of a typical clay and a medium sand respectively



**Fig. 1.** Example simulation results for a low permeability (a) of  $10^{-14} \text{m}^2$ , and a high permeability (b) of  $10^{-10} \text{m}^2$ . The red arrows denote the net flow of heat from conduction and convection combined. The green arrows denote the flow of seawater within the sediment.



**Fig. 2.** The dependence of the maximum cable temperature on the permeability and thermal conductivity of the surrounding sediment. The dotted black line represents the point at which 20% of all heat is transferred by convection. *N.B.* The permeability is strongly correlated with the sediment grain size. An empirical approximation of the corresponding grain sizes for the model permeabilities is given on the top axis (Bear 1972).

For low permeability sediments, the fluid movement is restricted - hence the lack of green arrows in Fig 1(a). Consequently, the transfer of heat away from the cable is almost completely by conduction. In this case, heat is transferred away from the cable in approximately equal amounts in all directions. However, there is still a slight preference for the heat to be transferred upwards, towards the heat sink provided by the overlying seawater. For high permeability sediments (Fig. 1b), the opposite is true. Buoyancy forces act on heated seawater contained within the porous marine sediment surrounding the cable. This results in the warmed water being advected upwards, taking heat from the cable with it as it is transported out into the overlying seawater. Water is drawn in from the sediment at the sides and below the cable to replace the heated water that has been transported upwards. Convection plays a much larger role in the dissipation of heat in this case. From Figure 1 it can be seen that when there is a substantial

contribution to the total heat transfer from convection, the cable does not get as hot as it otherwise would do without this additional cooling affect (Hughes *et al.* 2015).

For cables buried on land, the thermal conductivity of the surrounding soil is often a significant factor in determining how effectively heat generated within the cable will be dissipated into the surrounding environment (de León & Anders 2008). We have run numerous simulations with different values of sediment permeability and thermal conductivity to investigate how these two parameters affect the heat flow together for submarine cables. The model predicts that the thermal behaviour of the cable is partitioned into two distinct sections; to the left of the dotted line in Figure 2, the thermal conductivity has much more influence on the cable conductor core temperatures than the permeability. To the right, the reverse is true. The change in behaviour seen here is a consequence of the transition from mainly conductive to mainly convective heat transfer. It is important to note that there are naturally occurring marine sediments with permeability on either side of this transition.

### **Implications for Cable Design**

The established methods for calculating the thermal rating for a cable assume that all heat transfer through the sediment is by conduction only. However, our model suggests that under certain environmental conditions, convection can make a significant contribution to the transfer of heat away from HV cables buried under the seafloor. This conclusion is supported by the results of a number of laboratory experiments that have been conducted in parallel with the modelling work discussed herein (Emeana *et al.* 2014), which show that convection can occur in situations representative of HV cables buried in the submarine environment. For cables buried in sediments that do support convection, heat can be dissipated from them a lot more effectively than the current methods of estimating cable ratings suggest. If the extent of this additional cooling can be determined by accurate measurements of all the relevant parameters of the sediment, it might allow for an increase in the overall rating of the cable (Hughes *et al.* 2015). An increase in the current rating would either allow an increase in the amount of power that the cable is able to transmit, or a reduction in the amount of material required to construct the cable conductor. For example, a 132kV cable identical in design to the one used in our FEM model that is buried in a sediment with a permeability of  $10^{-14}\text{m}^2$  as illustrated in Fig. 1(a) has a predicted current rating of 168MW. If instead,

it could be ensured that the cable only passed through sediments with a permeability in excess of the  $10^{-10}\text{m}^2$  value displayed in Fig. 1(b), the same cable could be used to transmit 235MW of power.

## **Conclusions**

Two dimensional computer models have been developed to investigate the dissipation of heat from HV cables buried under the seafloor, and how certain physical characteristics of the soil influence this heat flow. It was discovered that the permeability of the sediment can have a significant impact on the nature of the heat transfer away from these cables, while the exact behaviour of the system is a function of many variables.

Traditional techniques for calculating the thermal ratings for submarine cables can significantly underestimate the effectiveness of environmental cooling. This may mean that more resources are used during the manufacture of some cables than is strictly necessary. Understanding more about how heat is dissipated from HV cables buried in a submarine environment will help to make their construction and operation more economical.

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# UK maritime disasters since 1950 and their implications for ports, coastline and the Exclusive Economic Zone (EEZ)

*Esmé Frances Flegg*

## Introduction

For an island state such as the UK, economic activity and trade associated with its maritime regions of ports, coastline, and the Exclusive Economic Zone (EEZ) is vital. Recent studies have found 95% of trade by volume and 75% by value enters the UK by shipping (Department for Transport, 2012; HR Wallingford, 2012). In 2011, additionally to its key role in transporting traded goods, the port sector was responsible for 0.4% of total UK employment and 0.5% of its GDP (Oxford Economics, 2013). In contrast air transport, a sector focused on the transportation of people rather than commodities, provided 1% of total UK employment and 3.6% of UK GDP in 2009 (Oxford Economics, 2011). The continued success and safety of operations in these maritime regions are predicted to be tested in future decades through sea-level rise, rising average temperatures, possible changes in extreme weather events, competition for business from other ports and shifts in demand of commodity types. An understanding of past and present vulnerability to extreme conditions provides an important context which will inform assessments of these future challenges (McEvoy and Mullett, 2013; Scott *et al.*, 2013; Met Office, 2014). This study aimed to investigate two key aspects of maritime disasters affecting the UK since 1950:

- To assess how the severities of disasters differ.
- To investigate how the vulnerability of ports, coastline and EEZ differs both spatially (such as between different ports) and temporally (for example if comparable events occurred in 1950 and 2010).

In the context of this study the following definitions were used:

- EEZ – An area of water extending up to 200 nautical miles from the baseline. In this zone the sovereign, or coastal, state has rights of using, exploiting and managing the waters and seabed (*United Nations Convention on the Law of the Sea, Article 55, 1982*).
- Natural variability – Climate varies naturally through time, and variability occurs in stable unchanging environments (Madden, 1976).



For example one June may be hotter than mean conditions; or rainfall in one year may be less than the recorded average.

- Climate Change – It is identified as long-term changes in climate (either in mean or extreme conditions) which can be confirmed by scientific analysis, such as statistical tests (IPCC, 2012). Climate change can arise from both natural conditions (such as the solar cycle), and anthropogenic forcing. In the context of this study climate change refers to changes caused by anthropogenic activity (such as from burning of fossil fuels).
- Risk – the probability of a circumstance occurring with a particular severity of impact(s) (Schneider *et al.*, 2007).
- Vulnerability – the extent to which a system or society is likely to be negatively affected by a situation – such as a storm surge (IPCC, 2012).
- Maritime disasters – situations caused by a hazardous event, or sequence of events, that negatively affects 'business as usual' conditions. The outcomes of such situations can affect many variables such as the environment, finance and construction.

In many historical cases maritime disasters have left a legacy of damage and disruption, often requiring physical and financial support from internal and external organisations beyond local or national government. Examples of this include €166.91 million contribution from the European Union Solidarity Fund (EUSF) to Germany following damage caused by storm Kyrill (European Commission, 2015) and payments from the Federal Emergency Management Agency (FEMA) for those affected by events such as hurricanes Katrina, Rita and Wilma (Federal Emergency Management Agency, 2006). Such disasters have been found to have a wide range of severe impacts on the built environment and construction zones of the marine region (Wilby, 2007). Impacts have included the loss of, or damage to, offshore oil platforms; port closures or damage; or result in coastal damage (such as breaching of sea defences and/or flooding of coastal communities).

The legacy of severe maritime disasters, and their impact on society, cling on in public memory, as more recent disasters are often touted as “the worst of its kind since...”. The aptly named ‘Great Storm’ of 1703 captured the imagination of Daniel Defoe and was immortalised in his book *The Storm*, which was one of the first publications to combine journalistic analysis and scientific observation (Defoe,

1704). Approximately 8,000 men lost their lives (Lamb, 2012), with most deaths occurring on vessels sunk by the storm, making it as one of the most severe, and deadly, disasters in UK history. The significance of loss of life from this event is made even more apparent considering the UK's population was only an estimated 5.2 million (Lee and Schofield, 1981). Other damages included extensive flooding, damage to traded goods (e.g. sugar and tobacco), structural damage to a number of ports and harbours (including Bristol, Gloucester, Portsmouth and King's Lynn) and a loss of over 300 vessels, including 12 from the Royal Navy (Anon, 1826; Brayne, 2003).

### **Methodology**

There is no catalogue of maritime events and disasters, their impacts, severity and legacy. However, records of maritime disasters are available, primarily through media reports rather than academic articles, allowing the development of such a database. This study aimed to build a database of maritime disasters affecting the UK since 1950. Events prior to this were excluded as a consequence of inconsistent recording of events. This is particularly apparent during the two world wars, as events including maritime disasters, which highlight vulnerability, tended not to be published in order to prevent contradiction of positive propaganda produced by Allied Forces for British citizens (Marquis, 1978). Data were analysed from the UK's 111 active commercial ports (Department for Transport, 2014), with a focus on its 45 major ports.

The data gathered were used to develop an understanding of how ports, coastline and EEZ are vulnerable to maritime disasters. 91 disaster events were identified since 1950. Disaster severity were scaled from those that caused only disruption, to events which caused extensive damage and loss of life. Disasters can arise from a single factor, such as human error, or can be composite events. Composite disasters refer to events where damage is caused by multiple causes, such as a combined wind storm and storm surge (Wisner *et al.*, 2004). For the purpose of this study each event was classified according to the primary cause of damage or disruption, even if the event types were related. This method was used to improve the understanding of whether particular aspects of composite events tend to be most disastrous.

## **Severities of maritime disasters**

Ports were found to have been affected by the most maritime disasters – 56 out of 91; whilst the EEZ was impacted by 35 and the coastline 27 events respectively. If a disaster affected more than one region, for example both ports and coastline, it was recorded twice. Twenty of the recorded events affected multiple regions, with eight of these affecting ports, coastline and the EEZ. The majority of the events were recorded since the 1990s. This does not reflect a change in the number of disasters but instead points to increased reporting of minor events recorded following the development of internet based news reporting. Serious maritime disasters tend to be recorded in multiple reports (e.g. newspapers, online articles, audio and visual media) whereas less severe events tend to have smaller readerships and are usually recorded in online reports alone (Althaus and Tewksbury, 2002).

Eight primary causes, or mechanisms, were identified for maritime disasters:

- Coastal flooding
- Human error
- Mechanical fault (occurring on board a vessel, aircraft or offshore platform)
- Poor visibility
- Rough seas
- Snow and ice
- Storm surge
- Wind storm

The most common disasters were wind storms and human error which caused over 60% of events. Maritime disasters caused by natural processes, such as storm surges, showed a strong seasonal distribution, with the most events occurring between November and January. This result was expected, as during the winter months UK maritime conditions tend to be worse. Planning mechanisms can be put in place by stakeholders in anticipation of periods of increased risk or vulnerability.

The UK government (both local and national), industry and port operators were shown to suffer a range of negative financial implications following maritime disasters. These impacts included loss of trade, and the necessary measures of

setting up compensation schemes, and implementing environmental clean-up operations (such as recovery after oil spills).

Ports were impacted by four of the five most expensive maritime disasters (Table 1). The majority of the costliest maritime disasters were found to be primarily caused by wind storms. Impacts from wind storms included damage to infrastructure and vessels, and delays to services (such as transport of goods and passengers).

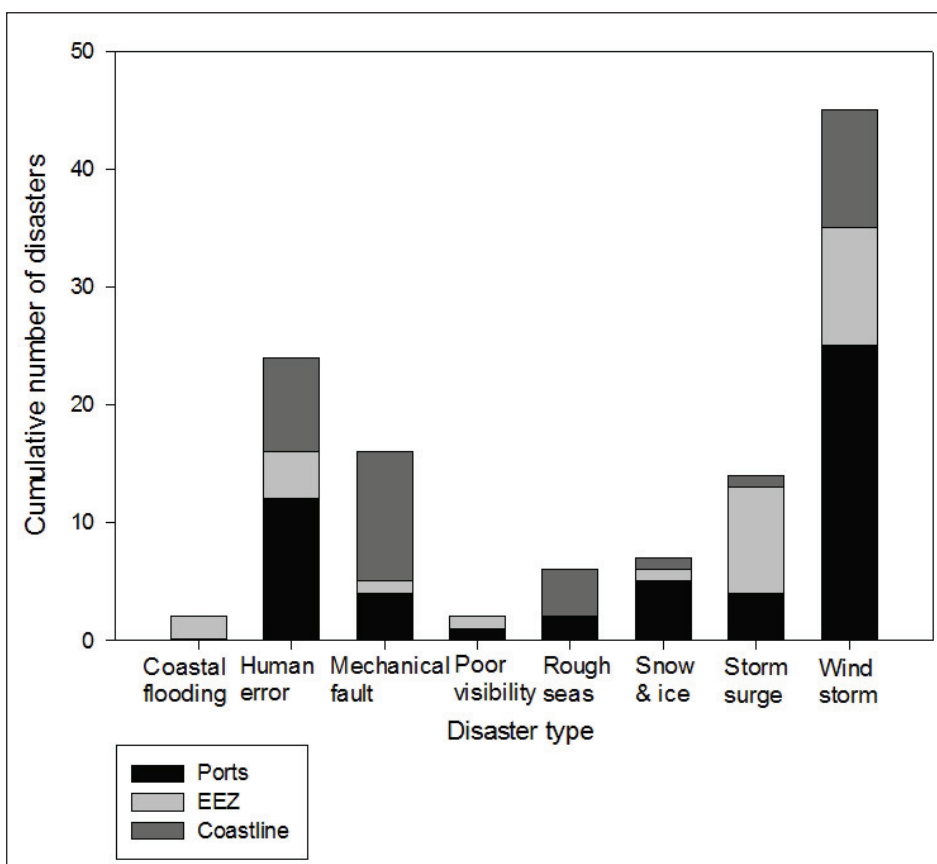
<i>Date</i>	<i>Event classification</i>	<i>Insured losses (2014 values)</i>
<i>January 25<sup>th</sup> 1990</i>	Wind storm	£4 billion
<i>October 15<sup>th</sup> – 16<sup>th</sup> 1987</i>	Wind storm	£3.46 billion
<i>January 31<sup>st</sup> – February 1<sup>st</sup> 1953</i>	Storm surge	£1.2 billion (absolute)
<i>January 2<sup>nd</sup> – 4<sup>th</sup> 1976</i>	Wind storm	£816 million
<i>January 17<sup>th</sup> – 19<sup>th</sup> 2007</i>	Wind storm	£484 million

**Table 1.** Insured losses resulting from the five most expensive maritime disasters since 1950 (nb. losses from 1953 are absolute – total losses – as many businesses and houses were uninsured at that time).

**Spatial and temporal differences in vulnerability**

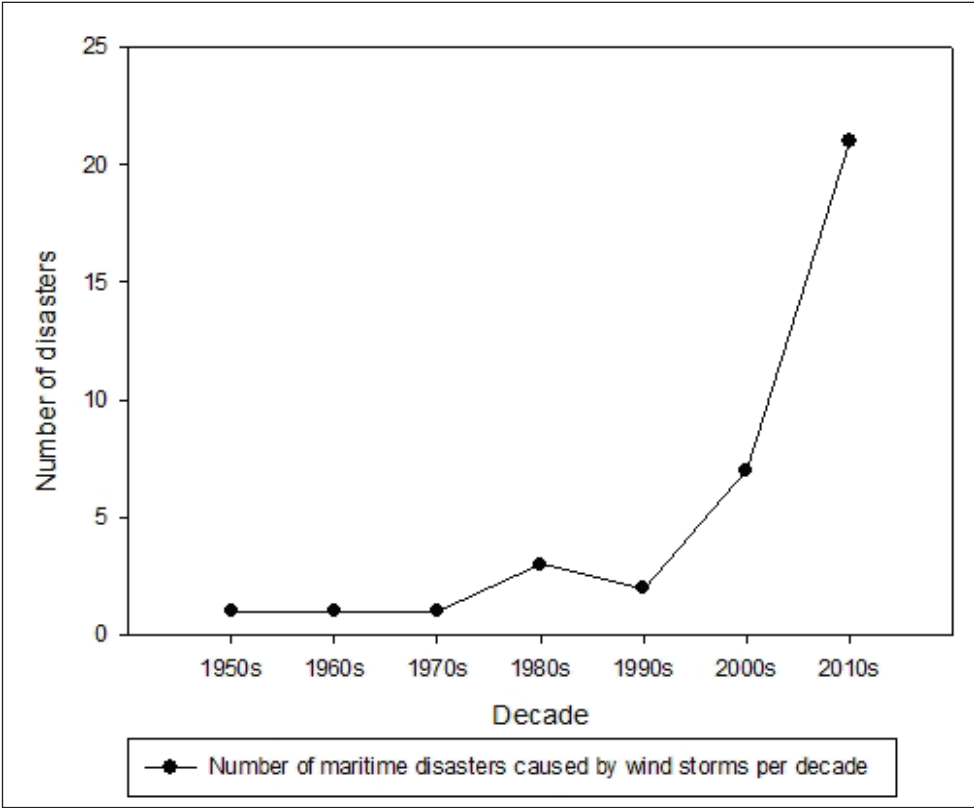
It was found that few maritime disasters affected the entire UK, but instead particular regions were impacted. The extent of the region displaying negative impacts varied greatly, mainly in accordance with the disaster type and severity. The majority of recorded events affected part of the south of England (from Selsey Bill to Lyme Regis), the shipping regions of Fair Isle (around Shetland in Scotland) and Dover, and the ports of Felixstowe and Dover.

The most common maritime disaster recorded varied by the zone of interest; namely wind storms affected ports and the coastline most frequently, whilst the EEZ demonstrated a particular vulnerability to disasters caused by mechanical faults from vessels, oil platforms and related aircraft (such as those transporting platform staff) (see Figure 1).



**Figure 1.** Stacked bar graph of the 8 recorded disaster types and the number of recorded occurrences in ports, EEZ and coastline since 1950.

The number of wind storms has increased significantly since the 1990s (see Figure 2). A concern that has developed alongside this trend is that ports have become more susceptible to wind storms in recent decades. This is a direct consequence of the increased mechanisation in ports, such as the use of high level cranes, and containerisation of trade (Bakermans, 2014). This infrastructure is vulnerable in high winds, reducing much of its functionality and putting the safety of workers at risk. Other causes of this increased frequency of recorded wind storm events arises from pre-emptive closures following implementation of more rigorous health and safety regulations, and improved communications through announcements and blogs covering closures and disruptions.



**Figure 2.** Graph of the number of recorded events caused by wind storms per decade since 1950.

Events located at the start of the study period tended to be associated with lives lost, extensive inland flooding and consequential damage to homes, businesses, infrastructure and agricultural land. The severity of these disasters were met by strong, active, responses by the government and other bodies of authority. Examples of their acceptance of the risk and dangers posed by these events are detailed in Table 2.

Measures such as these have acted to assist in a reduction in the UK’s vulnerability to storm surges and flooding. This is represented by a decline in the recorded severity of such events. For example, during the winter storms of 2013/2014, waters higher than the devastating 1953 storm surge were recorded (BBC, 2013b; BBC, 2013a; BBC, 2013c), but the extent of the disaster was mainly restricted to major disruptions and financial losses. This is in strong contrast to the

extensive damage and loss of life experienced as a consequence of the 1953 storm surge.

<b>Date of disaster(s)</b>	<b>Response to maritime disaster</b>
31 <sup>st</sup> January to 1 <sup>st</sup> February 1953 13 <sup>th</sup> December 1981	Improved sea defences (Burnham on Sea, 2011; Lumbroso and Vinet, 2011)
31 <sup>st</sup> January to 1 <sup>st</sup> February 1953	Development of early warning systems (Lumbroso and Vinet, 2011)
3 <sup>rd</sup> April 2012	The Met Office clarified terminology used to describe severe weather conditions (MAIB, 2013)

**Table 2.** Responses by the Government and other bodies of authorities to disaster events.

The nature and extent of maritime disasters have been shown to alter through time regardless of availability of data. This has arisen from increased preparedness for disaster and shifts in the activity and use of these regions. For example, an increase in events affecting the EEZ was identified from the 1960s following the discovery of oil in the North Sea. The first British offshore oil platform Sea Gem was installed in 1965, and also resulted in the first UK disaster involving an oil rig (Burke, 2013). The majority of disasters recorded in the EEZ until 1990 were related to oil platforms; 50% of events in the 1960s, 100% in the 1970s and 83% in the 1980s.

## Conclusions

This research has filled a vital gap in records of maritime disasters by building a catalogue of events which have affected the UK. The events recorded have had severe damaging and disruptive consequences for many sectors in the UK – such as industry, environment, trade and society.

The UK is vulnerable to maritime disasters from a number of sources that are both natural and anthropogenic. Wind storms and human error were identified

as the most common causes of maritime disasters. Ports were shown to have experienced more disasters than the coastline and EEZ. Decision makers have, and are continuing, to take key steps to tackle the sensitivity of ports, coastline and the EEZ. However, many of these decisions have occurred in the wake of events. This means that decisions are often response-led, rather than in line with predictions of likely risk or vulnerability.

The next stage of this research will be to look at in further detail what the consequences of maritime disasters are for UK ports. This will allow answers to be given for many questions, such as what aspects of ports are most vulnerable to disasters, and what techniques are currently used to recover from damage and disruption. The overall goal of this work will be to aid port decision-makers in their preparations for the challenges they face from extreme events.



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# **Constructing multibeam bathymetry time-series to constrain temporal variability at shipwreck sites**

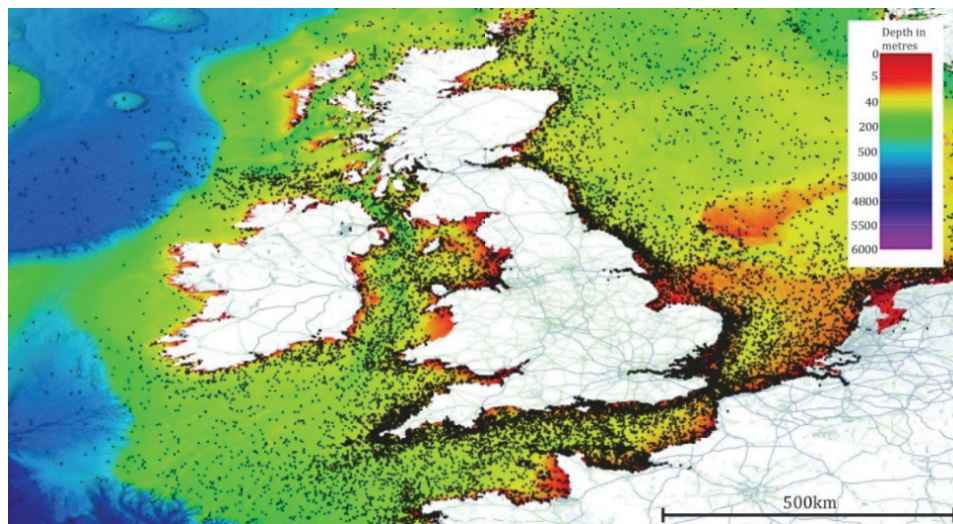
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University of Southampton, UK*

The appreciation of the preservation potential of shipwreck sites has grown beyond initial concerns that the marine environment was destructive and only capable of preservation in extreme circumstances. Now site-formation processes are considered as a mechanism which can be identified, understood and potentially reverse-engineered. Materials (sediment and artefacts) and energy (wave, tidal, storm) at shipwreck sites can freely exchange across boundaries. Therefore, shipwreck sites are described as open systems, or as being in a state of dynamic/quasi- equilibrium with respect to their surroundings. A large component of this equilibrium is due to shipwreck structures acting as bluff obstacles to near bed flow, enhancing local flow velocities and turbulence. This in turn increases the local sediment transport, known as scouring. Because of this quasi-equilibrium a single time-step survey (in this paper, a single multibeam bathymetry survey) can only ever describe the site at one point in time. By repeating the survey over some time period, a time-series of bathymetric surfaces can be constructed and the variability at the site can be constrained. Through an assessment of the hydrodynamic and geological conditions of the site, the role of environmental conditions in forcing shipwreck site formation processes can be better understood. This comprehension is fundamental to the efficacy of heritage management, allowing protective measures to be site-tailored, and fills a large data and knowledge-gap in the long term (multi-annual) evolution of scour around marine anthropogenic structures (e.g. windfarm turbines, pipelines and breakwaters) crucial to harnessing marine energy resources.

## **Introduction**

There are over 3 million shipwrecks worldwide (UNESCO 2014) and more than 60,000 of these wrecks are located within UK territorial waters (Fig. 1; Cant, 2013). These precious archaeological resources have the potential both to enhance the terrestrial archaeological record, and also crucially provide unique information that is not preserved within the terrestrial record. For example, a 9<sup>th</sup> century wreck

off Indonesia provides the earliest evidence for direct trade between India and China (Flecker 2001).



**Figure 1.** Distribution of wreck sites across northwestern Europe overlain on mean depth and land geography. The bathymetric metadata and Digital Terrain Model data products have been derived from the EMODnet Bathymetry portal - <http://www.emodnet-bathymetry.eu>.

In order to interpret the spatial relationships between artefacts and the shipwreck superstructure at these sites and potentially reverse engineer the site formation processes we require an understanding of the taphonomic processes, i.e. the exchanges of energy (wave and tidal action) and material (sediment, artefacts, shipwreck superstructure) across the site boundaries. By quantifying these taphonomic processes, maritime archaeologists are better able to tailor site protection and management techniques to the wreck site settings, ensuring that the deposit is preserved for future investigation and potential excavation.

Multibeam echosounder (MBES) time-series have been utilised at a handful of wreck sites to quantify the temporal variability of the wreck structure and surrounding seabed (Bates et al. 2011; Ernstsens, Noormets, Hebbeln, et al. 2006; Manders 2009; Orange & García-garcía 2012; Quinn & Boland 2010; Stieglitz & Waterson 2013; Trembanis et al. 2013). In this paper a review of the current knowledge of wreck site taphonomy is presented. From, this three major issues are highlighted. These issues are then addressed through the use of a case study, the SS

*Richard Montgomery*, for which we have an exceptional multibeam bathymetry time-series made up of fourteen repeat surveys spanning a period of seventeen years.

### **Issues of bathymetric time-series**

The temporal variability of a wreck structure and surrounding seabed is forced by the local hydrodynamics, sediment dynamics and oceanographic conditions. These processes operate over a huge range of time scales, from seconds to minutes (turbulence, winds, individual waves, individual grains) to decades and even centuries (collective sediment movement and large scale morphology change) (Kraus, Larson & Kriebel 1991).

In order to assess the impact of the whole range of hydrodynamic, sediment dynamic and oceanographic processes on a wreck site, the multibeam bathymetry time-series would have to exceed in time the longest processes influencing the site. For example, the *Stirling Castle* wreck site is presently situated in the gully of a very dynamic large sandbank system. On a decadal time scale this wreck has been observed to completely disappear beneath the sandbank (Bates et al. 2011). Bates and colleague's (2011) study of the site was composed of five multibeam bathymetry surveys over a period of just four years. While they observed large changes in bed-level at the site (changes in excess of 2.5m over the four year time period) they concluded that this time-series was insufficient both spatially and temporally to allow for future prediction of accretion-erosion at the site due to its dynamic setting.

As well as the length of the time-series, the repeat interval is also critical in capturing the effects of processes occurring at different time-scales at the wreck site (wave, tidal, storm, large-scale sediment movement etc.). For example, repeating a survey with an annual interval might be insufficient to capture the effects of a single storm since a whole range of other processes will have operated at the site over the interim period.

Often wreck sites are surveyed annually and at a similar time of year for each survey. At the Burgzand Noord wreck site, a collection of 14 wrecks in the Netherlands, surveys have been conducted annually with a minimum spacing of five months (van der Brenk, Manders & Coenen 2014). Therefore, an assessment of a single storm event or a single tidal cycle is difficult since other processes will also have operated at the site in the intervening period. Fortunately since the Burgzand Noord site covers a large area of seafloor (0.73km<sup>2</sup> in total) surveys are often

conducted over several days. In 2011 two surveys repeated the same patch of bedforms with a five day interval. Since the same bedforms could be identified in both surveys the rate of sand-ridge migration could be quantified (0.7m per day). This provides evidence that there is active sediment transport at the site; this is potentially useful information for the heritage management of these wrecks.

Multibeam bathymetry time-series have also been used to attempt to capture the effects of a single storm or hurricane event on a wreck site (Raineault et al. 2013; Stieglitz & Waterson 2013). In order to do so first the effect of ambient conditions (wave and tidal) on bed-level change at the site must be quantified so that any storm damage can be isolated from the prevailing trends at the site i.e. using just a single survey before and after a storm and no knowledge of the prevailing conditions would rely on there being a minimal impact from prevailing conditions at the site.

Finally, when considering what effect differing environmental conditions have on geomorphic change at a wreck site, consideration must be made as to the horizontal and vertical uncertainty of the data. When multibeam bathymetry surveys are compared, a certain amount of the difference between the measurements will be due to errors within the collection and processing of the data. When these errors are greater than the real geomorphic change then the degree to which changes are real becomes less certain.

Ernstsen et al. (2006) evaluated the horizontal and vertical precision of their multibeam bathymetry system in the field and found them to be  $\pm 0.30\text{m}$  and  $\pm 0.08\text{m}$ , respectively. This knowledge allowed the authors to quantify morphological change on a scale greater than these values elsewhere, including at a pile (Noormets et al. 2006) and over a series of dunes (Ernstsen, Noormets, Winter, et al. 2006).

In other studies, including Bates et al. (2011) and Stieglitz & Waterson (2013), the vertical error of the multibeam bathymetry data was so great that surveys were corrected using fixed offsets ( $>2\text{m}$  in some years), assuming that the most recent survey was the most accurate. This methodology purely relies on the assumption that there has been no mean bed-level change at the wreck site and could potentially remove a real trend in bed-level accretion or erosion.

From the above review of the use of multibeam bathymetry time-series at wreck sites it is shown that there are three principal issues which must be addressed when attempting to assess the impact of site conditions on taphonomic processes. These are: i) length of time-series, ii) repeat interval of surveys and iii)



survey uncertainty. In the following section an exceptional multibeam bathymetry time-series is introduced, which is composed of fourteen surveys over a seventeen year time period. Using this time-series an attempt is made to overcome the three principal issues and demonstrate the value of multibeam bathymetry time-series in constraining taphonomic processes at wreck sites.

## Methods and Materials

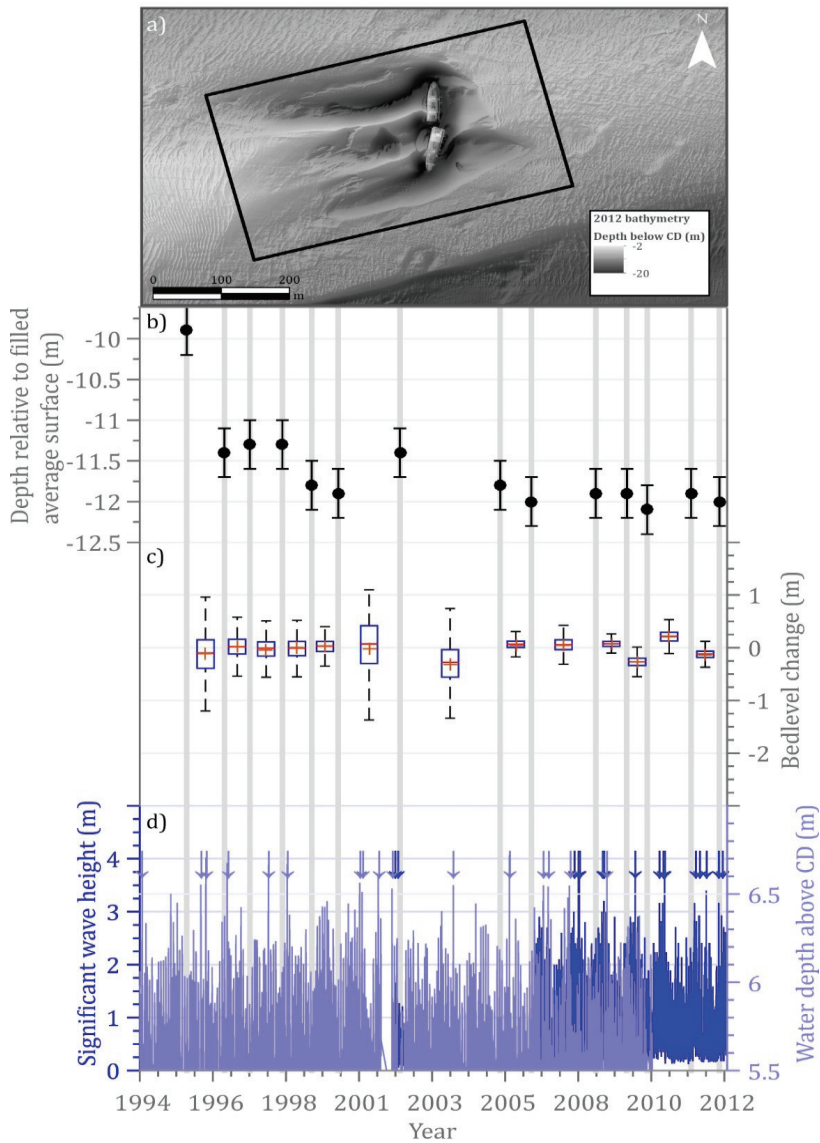
The SS *Richard Montgomery* is a WWII Liberty Ship that was constructed in Florida in 1943. Whilst moored in the Thames she inadvertently became stranded on a sandbank. Both the ship and half of its 7,000 Tonne cargo of munitions sank and have remained *in situ* ever since.

In 1995 a program was initiated to survey the wreck using multibeam bathymetry at a near-annual interval. In this paper fourteen of these surveys conducted over a seventeen year time period are utilised to demonstrate the value of multibeam bathymetry time-series in quantifying taphonomic processes at a wreck site (Fig. 2).

## Results and Discussion

The presence of the 128.5m long vessel on the seafloor has altered the local tidal and wave flow, this in turn has resulted in the scouring of material surrounding the wreck to create a 12m deep crater (Fig. 2a). A triple lobed scour pit indicates that water is able to flow between the two hull sections.

The maximum scour depth in 1996 was 1.7m deeper than in 1995 (Fig. 2b). This large drop is an outlier in comparison to the 1996 to 2012 trend, where all values are within the vertical uncertainty of the surveys ( $\pm 0.3\text{m}$ ) i.e. there was no statistically significant increase in scour depth. Therefore, it is likely that the 1995 survey did not accurately capture the maximum scour depth and so is considered anomalous. The mean bed-level change over the site (Fig. 2c) also remained within the uncertainty of the survey and so did not show an erosional or accretion trend. From 2000 to 2002 and 2002 to 2005 the range of bed-level change values is far greater than in the other years. Either this is due to the increased storm surge activity observed from 2000 to 2002 (more than five different 1 in 1 year storm surge events were recorded) or, perhaps more likely, the 2002 data was less accurate, hence why we observe a larger range of values both from 2000 to 2002 and from 2002 to 2005.



**Figure 2.** Multibeam bathymetry time-series of the SS Richard Montgomery. a) A bathymetric surface of the 2012 survey and analysis boundary box, b) Maximum scour depth for each survey with uncertainty error bars of  $\pm 0.3$  m, c) Box-and-whisker plot of bed-level change between each surface (whiskers indicate 99.3% coverage) and d) Time-series of significant wave height from nearby wave buoys (dark blue), storm events are marked with downward arrows and tide gauge series with 1 in 1 year storms (light blue). Vertical grey bars indicate the time of each survey.



Each issue identified within the previous section is now addressed with respect to the SS *Richard Montgomery* dataset. Firstly the issue of the length of the time-series is considered. Unlike the site of the *Stirling Castle* the *Richard Montgomery* is situated on a sandbank that has remained stable in its position for almost a century (determined through comparison of over 10 historical hydrographic charts from 1924 to 2008). Therefore, the longest processes occurring at this site are likely to be storms with long return periods. Wave buoy data are only readily available for the last decade (Fig. 2d, dark blue). Therefore, using the methods of Wadey, Haigh & Brown (2014), tide gauge data are also utilised as a proxy for storm activity at the wreck site (Fig. 2d, light blue). During the seventeen-year survey period the largest storm to pass over the site was less than a 1 in 5 year storm. This limits the conclusions that can be drawn from this time-series, since the effects of a 1 in 10 year, 1 in 100 year etc. storm are unobservable. However, over the winter of 2013/2014 a 1 in 843 year storm passed over Dover and the surrounding southeast UK coastline (University of Southampton 2014). Therefore, in the following 2014 survey (not yet accessible) we would expect to observe the effects of a multi-century process at the site. Even without the 2013 and 2014 survey data, we can still observe the impacts of the majority of processes occurring at the wreck site (tidal, wave, less than a 1 in 5 year storm).

The second issue, the repeat interval of the time-series, is now considered. Similarly to the Burgzand Noord wreck site, surveys at the *Richard Montgomery* have been performed annually with a minimum spacing between surveys of six months. Remarkably, the mean bed-level between surveys was negligible (Fig. 2c) (i.e. it was smaller than the uncertainty of the data, estimated to be  $\pm 0.3\text{m}$ ). Therefore, some conclusions can be made as to the processes occurring at this site as in order for there to be no mean change in bed-level either i) net transport of sediment is zero through a balance of sediment input and output or ii) there is no transport of sediment into or out from the system (though there could still be some internal transport restricted to the bounds of the wreck site system). There is limited evidence supporting the transport of sediment in to or out from the system (e.g. a dearth of bedforms). Therefore, the latter of the two scenarios is the more likely. To confirm this hypothesis it would be advantageous to conduct surveys with a smaller repeat interval (days to months) to determine that there is not transport occurring into/out from the system over all time-scales.

Finally, the uncertainty of the data is considered. As multibeam bathymetry technology has advanced, positioning errors have decreased. However, somewhat surprisingly, there is still no standardised methodology for quantifying the error in multibeam bathymetry surveys. Commonly, multibeam bathymetry data are provided without any information on the accuracy of the measurements (i.e. a simple x,y,z file). The fourteen surveys of the *SS Richard Montgomery* were provided in this format. In order to estimate the vertical precision of these surveys, the vertical change was quantified between each survey in an area of relatively flat and featureless seabed (as this area is less likely to have been exposed to sedimentary processes which could alter the bed-level). Over all periods of time this value was less than  $\pm 0.3\text{m}$ . Therefore, any change greater than this range is likely to be 'real'. Using such a threshold prevents the interpretation of trends which the system cannot detect. Mean bed-level change in the area surrounding the wreck of the *Richard Montgomery* was never greater than  $\pm 0.1\text{m}$  (Fig. 2b). However, bed-level change values occurred over a range of  $\pm 2.5\text{m/yr}$ . So whilst there was no statistically significant mean change between surveys, the large range in values suggests that there was localised (restricted to within the wreck site system) erosion and accretion occurring at an annual time-scale.

## Conclusions

Through the use of a bathymetric times-series of a wreck in conjunction with meteorological, geological and oceanographic data an assessment has been made of the taphonomic processing occurring at a wreck site, the *SS Richard Montgomery*. Such an understanding is paramount to the management of this hazardous site and could be used to identify if/when intervention is required to sustain the site's safety. At wreck sites of greater archaeological significance this methodology can be applied to demonstrate the efficacy of heritage management techniques and can equally be used to demonstrate whether or not *in situ* preservation could be an effective management strategy. Alternatively, it could be used to determine if the site is an open system, and if so, whether the site could degrade over time, requiring some alternative approach to be employed.

To advance this field forward in the future the authors will be drawing together six shipwreck multibeam bathymetry time-series allowing for a better assessment of the impacts of different environmental settings on wreck site taphonomy over a range of spatial and temporal scales.

## Acknowledgements

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# Epigraphic Fish Lists and Seafood Processing in Hellenistic Greece

*Doug Forsyth*

One of the real challenges in the study of Ancient Greek and Roman history is developing a greater understanding of everyday life. Doing so most often requires ‘teasing out’ information from diverse sources such as plays, epigraphy and iconography. Consider this passage from Aristophanes’ play *The Wasps* performed in Athens in 422 BC in which the character Anticleon comments on the word “Monarchism”:

“And now it’s (monarchism) suddenly as common as salted fish: you can’t even walk through the market without having it flung at you. If you buy a perch instead of sprats, the man at the sprats stall mutters ‘bloody monarchist’.”

(Ar. *Wasps*, 491-5; translated by D. Barrett).

From this passage we can deduce that salt fish was common and sprats were inexpensive, but that perch was relatively expensive and perhaps even elitist.

Archaeology can be especially useful in adding to our understanding of daily life and economic practices. Two unique epigraphic ‘fish lists’ from Akraiphia and Delphi allow us to develop a picture of a sophisticated trade in fresh seafood with regards to fish processing and transportation in Hellenistic Greece c. 200 BC.<sup>6</sup> These are simple lists of fish names and prices posted in two market towns of central Greece. No other lists of this kind have come down to us.<sup>7</sup> From an analysis of these price lists we can derive the techniques utilized by Hellenistic fishmongers to enhance the value of their fresh seafood products. These fish lists raise a multitude of possible investigations; the present inquiry is focused solely on the

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<sup>6</sup> Lytle 2013, 301 used the phrase “artisanal industry” to describe Hellenistic seafood processing but the author of this paper prefers ‘trade’ to avoid implications of mechanization.

<sup>7</sup> The fish market has not been located in ancient Athens despite the frequent references to fish in Attic Comedy. See Lytle 2010, 269-70, n56; Davidson 1968.

implications for seafood processing strategies.<sup>8</sup> This paper will first examine the recent scholarly history of the inscriptions, then their purpose, contents, and finally, the fish processing strategies that can be inferred from them.

### The Epigraphic Evidence

Akraiphia is in Boeotia on the eastern shore of ancient Lake Copais (See Map). It lies about 20 kilometers inland from the fishing port of Anthedon on the east coast of Boeotia. The sanctuary of Apollo Ptoios lies approximately one kilometer east of Akraiphia on the steep slope of Mt. Ptoön (Lytle 2010, 280, n103). Two stone blocks c. 200 - 175 BC from Akraiphia have been found inscribed with a list of saltwater and freshwater fish names followed by prices (*SEG* XXXII 450).

The inscriptions have a relatively convoluted archaeological history. The first block (B) was found in the superstructure of a well by M.P. Guillon in 1934. In 1965 a second inscribed block (A) was found, also in a secondary context in the modern village, by Christian Llinas (Lytle 2010, 254). Claude Vatin published both inscriptions together with a translation in 1971 (Vatin 1971, *SEG* XXXII 450). Three years later Paul Roesch published a new translation of both blocks including eight lines that Vatin omitted from block A as well as the names of the magistrates responsible for the decree (Roesch 1974, *SEG* XXXVII 377). In 2004 Ephraim Lytle examined Block B but was unable to locate Block A (Fig. 1). In examining Block B and studying photos of Block A, Lytle concluded that the two blocks were clearly related. When stacked one on top of the other the columns of text line up and the lettering style looks like a single stonemason created it in a single session. A hammer-dressed raised margin on Block B looks as if the stone cutter had prepared a flat surface for the inscription on two blocks already part of a retaining wall, several of which are extant at the site (Lytle 2010, 261-2, 264, 267-8).

Delphi is in Phocis, a neighboring province to the west of Boeotia, inland and high on the slope of Mt. Parnassus (See Map). It is the site of the famous sanctuary of Apollo Delphinus to which ancient delegations frequently travelled to consult the oracular *Pythia* (Priestess to Apollo). A similar inscription of fish names and prices has been found at Delphi (*SEG* VIII 326). This inscription is in a very poor state of preservation and only a few of the fish names are discernible (Fig. 2). Vatin published it in 1966 (Vatin 1966 274-80). The Delphi inscription is

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<sup>8</sup> Lytle 2010, wrote an excellent article on these inscriptions in which he explored several areas of inquiry.

roughly contemporary with the Akraiphia inscription, c. 200 BC (Lytle 2010, 268). The stone face on which the inscription is carved has a rough surface; the bottom and right side are dressed square while the top and left side are broken off. Similar to those from Akraiphia, this block looks as if it could have been part of a retaining wall.

### **Purpose of the Lists**

These fish price lists seem to have existed for two possible reasons: taxation or market regulation (Lytle 2010, 272-7). The arguments put forth by both Feyel and Lytle that fish taxes were normally collected at the port of landing, rather than at the point of final sale where these inscriptions were located, are persuasive (Feyel 1936, 33; Lytle 2010 273-5). Inscriptions from Delos regarding *ichthyon dekate* (tithe on fish) in 250 BC and *hypotropia* (beneath the keel) in 279, 278, and 274 BC support the interpretation that fish tax was collected at the point of extraction rather than at the fish market (Lytle 2013, 296-7, 303-4). An inscription from Hellenistic Crete recording that the proceeds of a tax on shellfish and fish accrued to the citizens of Praisos, described the tax calculation being applied to the value of the products at the point of extraction (Viviers 1999, 225-6).

Akraiphia and Delphi are both host cities notable for their nearby sanctuaries (Lytle 2010, 280-1). Travellers to these sanctuaries would have been ideal targets for ruthless fishmongers. Most likely the fish lists and prices were decreed and published by the *agoranomoi* (market administrators) as maximum prices to protect consumers from price gouging (Lytle 2010, 287-90, 297, n178; Lytle 2013, 299). It is curious that the lists seem to have been published on stones imbedded in retaining walls rather than on a stele erected within the marketplace where it would have been more visible to consumers.

Ancient Mediterranean regulatory practices seem to have allowed market prices for certain commodities to rise and fall based on supply and demand within an overall regulated structure (Reger 2007, 467-70). The Athenian orator Lysias wrote in c. 385 BC a case for the prosecution against grain importers (Lysias 22). The case is legally complicated but does illustrate that the grain trade operated within a broadly regulated market. The state exercised strict control over the grain retailers, fixing their maximum margin at one *obol* per *medimnos* over the wholesale price and also regulated the quantity of grain that they could purchase (Michelle 1957, 272). The Roman emperor Hadrian (c. AD 125) tried to regulate via rescript middlemen profiteering in the fish markets of Eleusis and Athens (IG



2<sup>2</sup>, 1103, 11.9-12; Lytle 2010, 289-90; Marzano 2013, 291-2, 294). This regulation was potentially related to the sanctuary at Eleusis and possibly a result of price gouging from the fishmongers there.<sup>9</sup> The later Roman emperor Diocletian in his price edict of AD 301 fixed maximum prices for a wide array of goods and services allegedly to protect soldiers from price gouging (*Edict Diocl.* 5.1.4; Trans. Kent 1920; Marzano 2013, 290). Consumer protection in the guise of broad market regulation by the local *agoranomoi* seems the best explanation for these two fish lists. Without knowing the ‘normal’ prices for fish it is impossible to determine just how much protection was being legislated.

### Fish Processing Strategies

Lytle’s translation of the blocks from Akraiphia starts with the proclamation:

“During the archonship of Aristocles, the agonarchs Aminias son of Dionysios, and Hiarokleis son of Enchormas inscribed the things decreed concerning the produce of the sea. Let those selling seafood sell with certified weights: cuckoo wrasse for [.]XX chalks; bonito for [.]XX...”  
(Lytle 2010, 258).<sup>10</sup>

Thereafter is a list of fish names in the genitive case followed by a number, which Lytle interpreted as price per mina of weight (Smyth 1956, §1372: “The genitive is used with verbs signifying to buy, sell, cost, value, exchange.”). The list includes sixty-five to seventy saltwater species arranged alphabetically and six lines of freshwater species organized randomly. Lytle concluded that the saltwater fish list came from the sea port of Anthedon where it had been produced for the purpose of taxation on fish catches landed at Anthedon, to which the local

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<sup>9</sup> The fact that these two inscriptions were found adjacent to sanctuaries and that Hadrian’s rescript likely involved the sanctuary at Eleusis are curious and warrant further study on the relationship between fish and sanctuaries.

<sup>10</sup> Lytle 2010, 284 discussed prices. In the Akraiphian inscription there are four Boeotian units of value: I = 1 obol; H = hemi-obol; Π = four chalks; X = 1 chalk. Twelve chalks = 1 obol. Weights are either one mina or one-half mina; *OCD* 4<sup>th</sup> ed., 1572. In the Attic system one mina = 1/60<sup>th</sup> the weight of a 26 kilogram talent, 430 grams, slightly less than one pound. The inscription from Delphi employed a notational system too fractured to render.



authorities in Akraiphia appended the names of local freshwater fish coming from Lake Copais (Lytle 2010, 268, 275, 280).

In addition to the name and prices of the fish there are several other words on the inscription of significance.

On Block A, line A.i.7 is the phrase σταθμῦ[ς] κο[θ]αροῖς, ‘certified’ weights. Several species in the list (lines A.i.14, 18; A.ii.6, 21) have the word καθάρω/καθαράς following it.

On Block B, lines 4-6 Lytle translated as “Bluefin tuna for the belly meat, two obols, two chalks [per mina], for the rest one obol [.]X chalks [per mina].” (Lytle 2010 258-60, n12, n14, n16)

There are two examples from Block B of fish being size graded with different prices per grade. Lines 17-19: “Grey mullet larger than half-mina, one obol [per mina], smaller than half-mina, 11 chalks [per mina].” Lines 21-23: “Barakos of a mina in weight (price), of a half-mina’s weight 11 chalks, and for a mina of those smaller (than a half-mina) – (price) – chalks.” The significance of these phrases will be discussed below (Lytle 2010, 284).

The extant inscription from Delphi is considerably shorter; only nine fish names are preserved on this block. Eight of the fish names are saltwater species and one, πέρχ[ων] – perch, encapsulates a wide range of both fresh and saltwater species. The fish names are all in the genitive followed by a phrase indicating the size grade of the fish. There are three instances for fish ‘up to two’ (mina presumably), ὅσοι δύο (lines 1, 9, 10); one of ‘up to three’, ὅσοι τριάκοντα (line 5); and one of ‘up to four’, ὅσιο τέσσαρες (line 14).<sup>11</sup> There is then a category for fish larger than these size grades indicated by the phrase ὅσοι πλείονες (greater than). Each of these categories is followed by an acrophonic numeral indicating the price for that size grade of fish.

### Indications of Fish Processing

From these two sets of fish lists we can derive considerable insight into the sophistication of the seafood trade in Hellenistic Greece. It is notable that the lists only have fresh fish on them. Preserved fish, either by drying, smoking or salting,

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<sup>11</sup> Diacritic and breathing marks as per *IG VIII*, 326; Vatin 1966, 274.

are not mentioned. Both Theophrastus and Aristophanes indicate that the salt fish markets were distinct from the fresh fish markets.<sup>12</sup>

The practice of size grading to establish different values is clearly evident from both inscriptions, especially the inscription from Delphi. In all cases, the larger sizes were more expensive than the smaller sizes. There are several reasons why this occurs. The most self-evident is the recovery rate for larger fish compared to smaller. To obtain edible meat, a fish is cleaned, skinned and boned. The percentage of meat recovered from a large fish is greater than a smaller fish. One, four-kilo fish nets the equivalent amount of meat as do five, one-kilo fish.<sup>13</sup> In addition, labor is reduced as only one fish needs to be prepared rather than five. Secondly, larger fish have more 'eye appeal' when served in a social or ritualistic setting thereby reflecting increased favor on the host. Foxhall attributes this aspect of consumption as a major factor in the motivation behind trade (Foxhall 1998, 298-9, 307. See also Marzano 2013, 273 regarding social benefits). A passage from Athenaios described the positive reflection that a host would have received from providing a sumptuous display of fish for his guests:

"Slaves entered the room, bringing us such a quantity of saltwater and freshwater fish on silver platters that we were astonished both at our host's wealth and at how much had been spent; he had purchased every delicacy but the Nereids." (Athenaios 6.224b; translated by D. Olson)

On these lists the larger sizes of fish are more expensive than the smaller sizes, apparently fishmongers recognized these aspects of the added value of larger, display worthy sizes and charged accordingly.

From these lists, we see clear indications of fish processing. Note Akraiphia block B, lines 4-6 "Bluefin tuna for the belly meat, two obols, two chalks [per mina], for the rest one obol." (Lytle 2010, 259) The fat white meat of the belly has been cut away from the red meat to be sold separately, and note, at over twice the price (Lytle 2010, n12). Processing is also indicated in the discussion concerning the letters ἐξεντ[επ--] in Akraiphia Block B, lines 35-8. Lytle argues that this could be

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<sup>12</sup> See Erickson 2010, n156; Theophrastus *Char.* 6.9; Aristophanes *Eq.* 1245-47, Paphlagon: "...did you actually sell your sausages in the Agora, or at the city gates?" Sausage Seller: "At the city gates, where they sell the salt fish." (translation by A. Sommerstein)

<sup>13</sup> The author is a forty-year veteran of the fish processing industry; 'recovery rate', *i.e.* the percentage of meat recovered, is a primary concern in fish processing economics.

the term for ‘gutted’ and that some fish were processed at the port for the removal of fish eggs and the carcass then sold separately (Lytle 2010 265-6, n38, n39, n41). Lytle speculated that this species of fish arrived at the market in Akraiphia at times whole and at times gutted, consequently there were two prices listed. Two alternatives suggested here are either, that prior to transport to Akraiphia for sale, fish may have been gutted to remove the parts of the fish that spoil first, or that large fish too big for individual sale, such as a large tuna, had been cut into smaller portions for sale.

The phrases in line A.i.7 σταθμῦ[ς] κο[θ]αροῖς, ‘certified weights,’ and the words καθάρω/καθαράς in the list (lines A.i.14, 18; A.ii.6, 21), merit discussion. Vatin and Lytle both concluded that in each instance what is being certified is the true identity of the species, not the weight offered for sale (Lytle 2010, 259-60, n14). These particular species, *vatis* (skate) and *rini* (angel shark) were noted for frequently being unscrupulously substituted for other more valuable species and then sold to the unsuspecting consumer (Lytle 2010, n16; Thompson 1947, 221). The market authorities were ‘certifying’ that no such practice would be allowed in Akraiphia.

Lastly, the distance from the port needs to be considered. Neither Akraiphia nor Delphi were seaports. The path to Akraiphia from Anthedon was approximately twenty kilometers long. Delphi lies seventeen kilometers inland and 580 meters above the nearest port of Itea (Talbert 2000, 55). Both would have taken six to eight hours to reach with a cart carrying fresh fish. Fish would have arrived at the market in varying conditions of freshness and consequently been subject to fluctuations in demand based on quality. The cost of transport would have had to be included in the fish prices (Lytle 2010, 290). It is unlikely that fishmongers would have brought their goods to these inland markets unless they could fetch a premium over alternative markets.

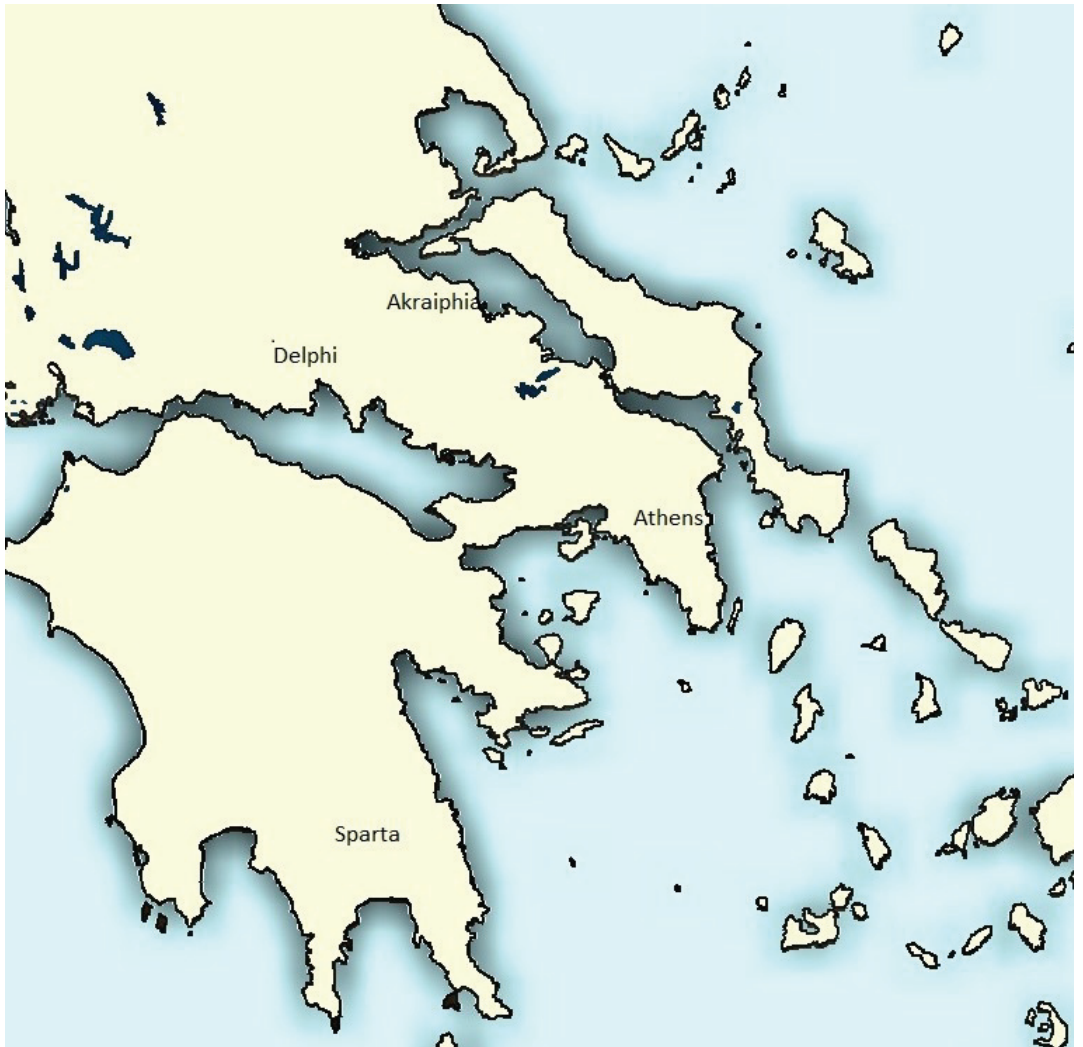
## Conclusion

What we can learn from these two inscriptions is that the seafood processing and distribution systems of Hellenistic Greece were reasonably sophisticated. Fish were size graded as a standard practice and the larger sizes sold for a higher price. On occasion fish was cut into portions so as to maximize their overall value. At Akraiphia and Delphi, catches were transported inland to areas adjacent to sanctuaries where presumably pilgrims would have been prepared to pay a premium price compared to what they would have paid at the

seaport, likely greater than the cost of the catch plus transportation. The existence of these publicly displayed maximum price lists speaks to the success of these value adding strategies; market administration was evidently needed for consumer protection.

It is noteworthy to the author of this paper how similar the fresh fish trade of Hellenistic Greece is to the fresh fish trade of today. Size grading and portioning are the two tools used both then and now to add value. The changes have come in the areas of preservation (ice and chilled seawater), transportation (refrigerated trucks, airplanes), and the mechanization of the fish cutting, but the two basic processing strategies of size grading and portioning to add value have remained the same for 2,300 years.

## Map



Map by Minestrone, Demis Mapper 6, Open Source, Public Domain

ca. 225–175 B.C.

# BLOCK A

	τὸ ἀγόναρχον τὸ ἐπ' Ἀριστοκλείους ἄρχοντος,	
	Ἀμινίας Διονουσία, Δικῆος Διονουσία,	
	Ἱεροκλεῖς Ἐγχόρμα, ἐσταλοκόπεισαν τὰ δεδο[γμένα]	
	οὐπὲρ τὸ θαλαττήον	Κουνόπρεϊστιος Η
5	τὼς δὲ τὸ θαλαττήον	Κουνὸς καρχαρία Π
	πωλίοντας πωλῖμεν	Κανθάρω παντὸς[ς] Η
	σταθμῶ[ς] κο[θ]αροῖς	Κοκκούκων ΗΠΧ
	Ἀλφειστῶ [-.]ΧΧ	Κορακίων [price]
	Ἀμιά[ς] .]ΧΧ	Καλλιονούμω [price]
10	Ἀγκάνω [price]	Λάβρακος [μέδδονος?] [price]
	Ἀρκάνω [-.]ΧΧ	τῶ μόνος τῶ μναήω [price]
	Ἀλλοπιάνω [price]	Μούρω καττὸ ἐπά[νω]
	ΑΓ[-]-----] [price]	Μ[ε]λαγν[ρ]ων [price]
	Αλακ[. . .]ω κοθαρό [-]	Π[. . .]αρη[-]-----] [price]
15	Αν[. . .]κω[-]-----] [price]	[-]-----] [price]
	Α[-]-----] [price]	[-]-----] [price]
	Βογγλῶτι[τω] [price]	[-]-----] [price]
	Βατίδος κοθαράς	[-]-----] [price]
	Ἀβοράτω ΠΤΧΧ	[-]-----] [price]
20	Βορατ[-]-----] [price]	Ῥνοβάτω [- ? - price]
	Βατράχω μέδδονος [-.]Π	Ῥίνας κοθαράς ΗΠ
	[-]-----]ΧΧ	Ῥαφίδων ΗΠΤΧ
	[-]-----]	Σκερήνας ΗΧΧ
	[-]-----]	Σκορπίω μέδδονος [price]
25	[-]-----]	τῶ μνα[τήω] [price]
	[-]-----]	τῶ μόνος [price]
	[-]-----]	[Φά]γρω τῶ μέ[δδονος] [price]
	[-]-----]	Φά[γ]ρων μνατήων [price]
	[-]-----]	τῶ ἄλλω [- ? - price]
30	[.]ΑΠΝ [-]-----]	Χ[-]-----]
	[. . .]Α[-]-----]	[-]-----]
	[. . .]ΤΤΑΟ[-]-----]	[-]-----]
	[.]Α[-]-----]	Χαρακ[ί]ω [price]
	[Β]εμβράδω[v] [price]	Χ[-]-----]
35	[.]αλα[-]-----]	[-]-----]
	Γόνγρω τῶ [-]-----]	τῶ ἄλλω π[αντὸς] [price]
	τῶ ὀμφάλω [price]	[-]-----]ΩΝ[-]-----]
	τῶ ἄλλω [- ? - price]	μνάς Π[-]-----]
	Γελαβρίω ΗΠΤΧ	[-]-----]Ε[-]-----]
40	Γαλιῶ μέδδονος [-.]Χ	[-]-----]ΗΜΑ[-]-----]
	μνατήων ΗΧΧΧ	[-]-----]
	[-]-----]	[-]-----]

# BLOCK B

	Ἐρουθρῶ μίγνος [price]
	Ἐπειτῶ[v] ἐπά[νω]
	Θραιτ[ί]δων ΠΧ
	Θουννοκε[ί]ω τῶ
5	οὐπο[γ]αστρίω ΠΧΧ
	τῶ ἄλλω Π[-.]Χ
	Θουννίδων ΙΧΧ
	Ἰχλας ΗΠΧ
	Κοττούφω [-.]ΠΤΧ
10	Ἰθουλίδων ΗΠΤΧ
	Ἰππούρω [-]-----]
	Ἰώπος ΗΠΤΧ
	Κόριος νεν [price]
	Κιθάρω μέδδονος
15	μνατήω ΗΠΤΧ
	τῶ ἄλλω παντὸς [price]
	Κεστρείος τῶ μέδ[δ]ονος
	εἰμ[ι]μνατήω Ι τῶ
	μόνος ΗΠΤΧ
20	ΛΙΜΝΗΩΝ
	Βαράκω τῶ μνατήω [price]
	τῶ ἱμμνατήω ΗΠΤΧ
	τῶν μόνων τῶς μν[άς] [price]
	Λαβρίχω τῶ μνατήω [-]ΧΧ
25	τῶν μόνων τῶς μνάς
	ΠΤΧ vac
	Πουκρίδων τῶς μν- ας Η vac
	Βαλλεκ[-]-----] [price]
30	Χακακος πογρ[α]μ[ω] Π
	Ἐγγέλιουος μέδδ[ονος]
	τῶν μνῶν ΠΤΧ
	ΤΑΣΤΕΘΝΑ[-.]ΑΣ[-]-----]
	Πλατινί[-]-----]
35	τῶν ἐξεντ[ερ-]
	μνῶν Η τῶ[v]-----]
	νων ΠΤΧ vac
	τῶν δὲ δαπ[-]-----]
	ΝΕΙΣΣΕΜΑΝ[-]-----]
40	ΩΛΙΝΩ[-.]ΑΝ[-]-----]
	[-]-----]Π[-]-----]

**Fig 1.** Akraiphia Fish List SEG XXXII 450. Block A, two columns; Block B, one column.

Source. Lytle 2010, 256-7.

1 [... (fish name) up to] two [... - greater]  
 2 [than... - ... ] (price) [... (fish name) up to]  
 3 [... ...greater] than (price) [... (fish name) up to]  
 4 [... ...greater] than (price) [.....]  
 5 [..... (fish name)] up to three[... up to]  
 6 [greater than (price)] price – perch[.....]  
 7 [... s]ole price – [... (fish name) up to...]  
 8 [... greater than] (price) [.....]  
 9 [..... - ... (fish name)] up to two (price) - (greater)]  
 10 [ (than)... - ... (fish name)] up to two (price) - (greater)]  
 11 [ (than)... - ...] (fish name) of every kind\* ... - ...]  
 12 [... - (dog) fish\*\* (numerals: weight or price?)[...]  
 13 .... (fish name). – common rock fish (numerals: weight or price?- - - -]  
 14 [red] fish bream up to four[...]  
 15 [greater] than (price) tuna[. greater than]  
 16 [t]wo (price) greater than (price)...  
 17 ... (price) angel shark (price) grey mullet ... -  
 18 ... [?] (price) - ... (price). - ...  
 19 [com]mon type of (price) – cuttle[fish. ...]

\*may refer to a very common fish of which there are many similar varieties so they are combined together.

\*\*speculative lacunae from Vatin, the *voç* is preserved but that is a fairly common Greek ending, the addition of the *κν* makes the word into dog fish, a type of small shark.

**Fig. 2.** Translation of Delphi Inscription (by author of this paper) from Vatin in *SEG VIII 326*. Fish names referenced from Thompson 1947.

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## **III. Society and Government**



# **Constructing a secure environment - improving maritime security in West Africa**

*Dirk Siebells*

Piracy and armed robbery at sea have long been a problem in West Africa. Documented cases were first brought to international attention in the early 1980s. In November 1981, the general assembly of the International Maritime Organisation (IMO) urged governments and maritime organisations to cooperate with the International Maritime Bureau (IMB) and 'to maintain and develop co-ordinated action in all relevant areas' (IMO 1981). Discussions at the time were mostly brought about by attacks against merchant vessels in various West African countries.

IMO resolutions notwithstanding, piracy in Africa has been ignored for the most part. Rising numbers of attacks by Somali pirates finally led to increased media coverage and political attention for maritime security. Problems in West Africa were also finally recognised, underlined by UN Security Council Resolutions 2018 (October 2011) and 2039 (February 2012). The region has even been described as a new piracy hotspot (see for example Cummings 2013, Munich Re 2013, Maritime Executive 2014).

Such an analysis may be misleading but efforts to improve maritime security have certainly become more urgent. Coordination between governments, security agencies and the maritime industry is improving yet the years ahead will not be plain sailing. In this article, I will provide a brief threat analysis and outline the potential value of the maritime environment for countries around the Gulf of Guinea<sup>14</sup>. In the analysis of threats in the region, I will discuss different types of data sets that include information about incidents of piracy and armed robbery at sea such as frequency, location or modus operandi. The second part of the article is an outline of ongoing efforts to improve maritime security, based on the Yaoundé Code of Conduct signed in 2013.

## **Crunching the numbers – no 'right' or 'wrong' piracy statistics**

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<sup>14</sup> In the context of this paper, I will talk about the wider Gulf of Guinea region, ranging from Senegal in the north to Angola in the south.

Reports issued by the International Maritime Bureau (IMB) are widely considered to be among the most important documents containing data about piracy and armed robbery at sea. Efforts are hampered, however, by a lack of incident reports submitted to the IMB. In its report for 2014, the IMB points out that '[t]here is considerable under reporting of incidents in the Gulf of Guinea' (IMB 2015, p. 29). IMB Director Pottengal Mukundan, for example, estimates that up to 70 percent of piracy-related incidents in the region are never reported (Oceans Beyond Piracy 2015).

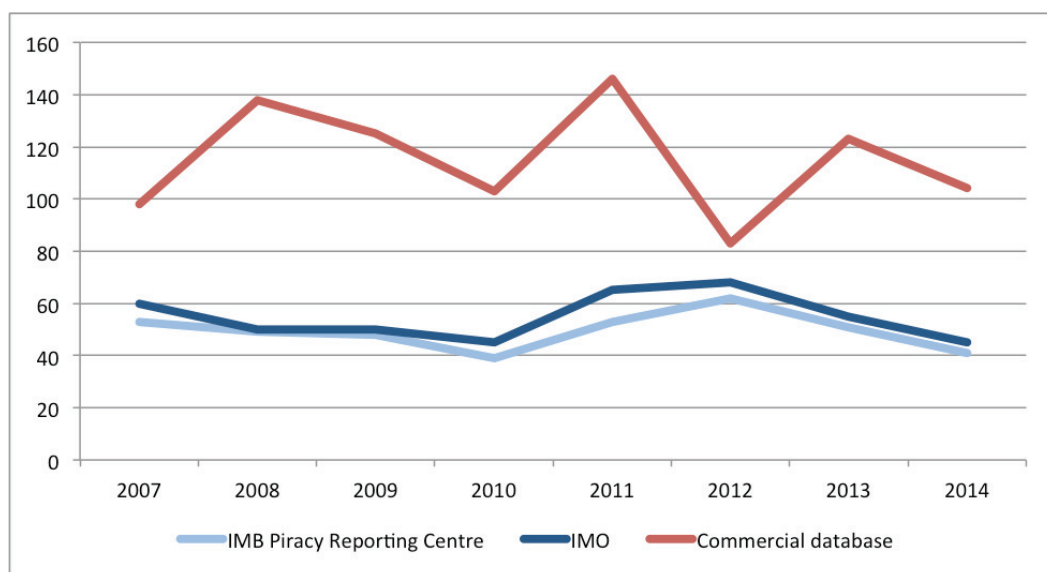
This lack of reporting can be attributed to a number of reasons. Ship operators are concerned about their reputation and fear the commercial fallout if attacks against their vessels become public. Moreover, ship operators and shipmasters do not trust law enforcement agencies in West Africa, perceived to be corrupt and to lack resources to investigate and prosecute crimes committed at sea. Anonymous reports are not a perfect solution either as ships can often be identified with a little research. In short, ship operators generally have little to gain and much to lose from reporting attacks.

Although the IMB is often quoted, other databases also contain data on piracy and armed robbery. The IMO manages the GISIS database, based on similar sources as the IMB. Commercial providers, on the other hand, tap other sources as well, e.g. reports in local media outlets or confidential information from their own clients. That leads to a very different picture of maritime security in the Gulf of Guinea as Figure 1 shows.

It is not surprising that the sheer number of incidents reported by the commercial provider is much higher than in the IMB or IMO figures as the commercial database is not limited to official reports. More importantly, however, trends which can be identified for the short and medium term are very different. A detailed analysis of the different databases is beyond the scope of this article, but in general the IMB offers a practical tool, useful for an analysis of vulnerable ship types and areas. Moreover, the IMB tries to draw attention to symptoms as well as the impact of piracy on ships and crews, "vital to ensuring that adequate resources are allocated by authorities to tackle piracy" (IMB 2015, p. 30). IMB statistics are not, however, designed to be used for academic analysis yet many academic papers are based on exactly those figures (for example Nincic 2009, Onuoha 2010, Forster 2014).

Similarly, the IMO has repeatedly pointed out that its GISIS database is not suited for operational purposes such as route planning or voyage threat

assessments. Several factors lead to delays in reporting by the IMO e.g. limited resources at the IMO secretariat and the fact that incident reports are bundled by some flag states<sup>15</sup>.



**Figure 1.** Maritime security incidents in West and Central Africa (Senegal to Angola)

Commercial providers use a different methodology. Neither IMB nor IMO would usually list attacks against oil and gas infrastructure or passenger boats and fishing vessels on rivers as pirate activity. Examples from the Niger Delta, however, show that criminals may steal boats, engines and equipment and use it for attacks against other vessels later. In June 2015, attackers even seized a cache of weapons and two gun boats in an attack on an armoury run by the Nigerian Marine Police in Calabar (Darlington 2015).

Figure 1 only includes data from one company, others may show differences in details. Sources or the interpretation of incidents may vary, client requirements are another important factor as assessments for offshore supply

<sup>15</sup> Any ship has to be registered in a certain country (the 'flag state') which will then have jurisdiction over the vessel when it is on the high seas, turning it into an 'island of sovereignty'. The flag state is often different from the ship owner's nationality. In fact, the three largest flag states are Panama, Liberia and the Marshall Islands.

operators are very different from analyses for operators of crude oil tankers. Such details, coupled with analytical depth, are important in everyday operations yet they may be equally helpful for strategic planning and policy decisions as 'the interpretation of maritime security in the Gulf of Guinea can differ significantly' (Steffen 2015).

Simple comparisons of numbers are much easier than a qualitative analysis of security incidents. Numbers alone, however, are not enough when data is limited due to under-reporting. Intelligence analysis is, more complicated yet necessary to gain a thorough understanding of the security situation, the basis for any strategy aimed at sustainable security in the maritime environment, whether in the Gulf of Guinea or elsewhere.

### **Oil, fish, trade – economic impacts of maritime security**

West Africa offers a stark contrast to the situation in East Africa. Discussions about maritime security in the Indian Ocean have almost solely been reduced to the fight against piracy and continue to be led by actors from outside the region. Meanwhile, governments in West and Central Africa have realised that sustainable security in the Gulf of Guinea has to address a number of issues, ranging from piracy to illegal fishing, smuggling, human trafficking and even environmental issues as well as other non-traditional security threats.<sup>16</sup>

As mentioned above, insecurity at sea has been a problem throughout the Gulf of Guinea for many years but the effects have been recognised as a substantial problem only recently. African governments are finally beginning to realise the economic value of the maritime environment. In January 2014, the African Union even adopted the 2050 Africa Integrated Maritime (AIM) Strategy. Whether or not such a long-term strategy with inevitably lofty goals is useful is beyond the scope of this article yet it underlines that maritime matters have made it to the agenda of summits at the heads of state level.

Throughout the Gulf of Guinea, the maritime environment is an important part of national economies and, in many cases, government revenues. In theory, maritime security should therefore be important for almost all coastal nations. On the national level, however, such a catchall phrase is open to interpretation and

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<sup>16</sup> During the Ebola crisis, the Ghanaian navy was closely monitoring movements of small fishing vessels as many Ghanaians tend to fish along the Liberian coastline. Infected fishermen returning to Ghana could have led to a health crisis.



priorities may differ considerably as three crucial elements of the 'blue economy' show:

- Offshore oil and gas: Production is increasingly moving offshore, creating potential targets such as offshore installations and supply vessels (Siebels 2014). Security provision can generally be limited to point defence of platforms and similar installations, often in cooperation with large oil companies. Oil companies, for example, may charter patrol vessels which are then manned by naval personnel, a model successfully employed in Ghana and Nigeria.
- Fishing: Various studies have shown the detrimental effects of illegal fishing on coastal communities in West Africa (see for example Nunoo et al. 2014 for impacts in Ghana or Belhabib et al. 2014 for impacts in Senegal). Enforcing fishing regulations, however, requires comprehensive surveillance and enforcement capabilities as well as cooperation of different government agencies and even non-governmental organisations.
- Maritime trade: Ports are important for national economies because customs duties collected there are a major revenue source for many governments. In Benin, for example, the port of Cotonou is involved in 90 percent of all imports and exports (Vidjinguinou 2014) and in most West African countries, government income is based on customs revenues rather than taxes to a much larger extent than in OECD countries<sup>17</sup>. Security in limited areas such as ports and anchorages rather than in the whole Exclusive Economic Zone is therefore important.

These are just three examples for the importance of the maritime environment, other factors such as tourism, drugs or weapons smuggling or illegal migration may come into play. Western governments, for example, are often concerned about drug trafficking, leading to cooperation with national governments in West Africa to destroy smuggling networks. Several large-scale drug seizures have been made in recent years (Hinshaw 2013, Bhattacharjee 2015), but such operations put strains on the already limited resources of navies and law enforcement agencies in the region.

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<sup>17</sup> For an overview over the proportion of customs duties in tax revenue and similar data see World Customs Organization (2014).

Criticism has also been voiced about training programmes and similar forms of assistance. Courses run by Western navies are usually regarded as helpful by their counterparts in West Africa but there are little or no efforts to integrate them into a regular schedule. In a personal conversation with the author, a senior naval officer from West Africa described the current situation: 'The international community offers a lot of assistance but we are often overwhelmed and the efforts are not sustainable. It makes strategic planning on the national level complicated, sometimes impossible.'

### **The Yaoundé process – drop by drop, a river is formed**

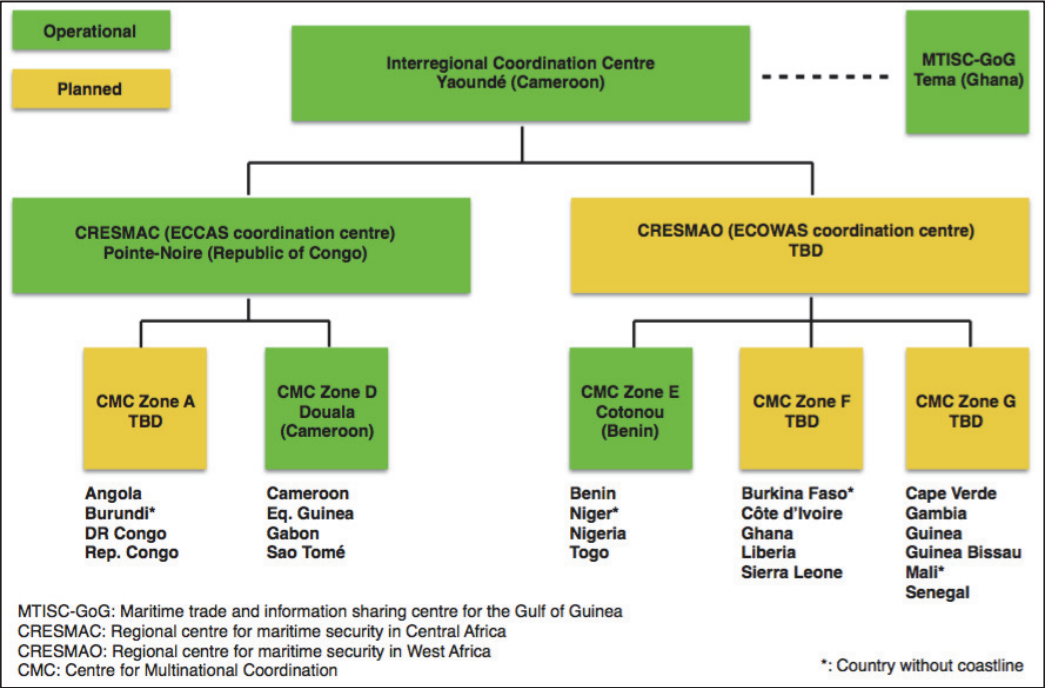
In June 2013, 22 member-states of two regional economic communities (ECOWAS and ECCAS) adopted the 'Code of Conduct concerning the repression of piracy, armed robbery against ships, and illicit maritime activity in West and Central Africa' at a summit in Yaoundé. Negotiations, assisted by the IMO, took years but the result is a document concerned with all kinds of maritime security threats rather than just piracy. Although non-binding, the code fulfils the demands of the UNSC resolutions mentioned above which called on national governments to develop a regional strategy and an organisational framework to counter piracy and armed robbery at sea. It even addresses other security issues, underlining a growing understanding for sustainable solutions.

Regarding the implementation, signatories were facing tremendous challenges from the outset. First and foremost, there was almost no infrastructure in place when the code was signed. On the national level, not all states had designated focal points capable of receiving and responding to alerts or requests for assistance at all times. Some regional cooperation centres had been in place but not along the whole coastline, existing centres were suffering from a lack of resources. Most importantly, all signatories had limited naval capabilities. Security in sub-Saharan Africa has traditionally been land-centric, a lack of naval spending meant that very few ships were available and their operational availability was often limited by a lack of fuel, spare parts and crew training.

Such structural challenges cannot easily be overcome. Nevertheless, progress in West Africa has been impressive, even though governments, navies and other maritime agencies do not always get credit for improvements. First and foremost, security cooperation in the past has often been limited to ad hoc operations on land; institutional capacity to coordinate maritime efforts was

therefore virtually non-existent. Moreover, there are no traditional links between ECOWAS and ECCAS in security or any other political arena. Institutions to coordinate strategic planning will have to be created from scratch, observing a broad variety of national priorities as outlined above.

Since 2013, these challenges have been addressed to an extent. The Yaoundé process may be hampered by institutional and national rivalries as well as by a finite amount of resources. The picture, however, is starting to become clearer as Figure 2 shows.



**Figure 2.** Information infrastucture based on the Yaoundé Code of Conduct

The Interregional Coordination Centre in Yaoundé has been set up but is currently staffed almost solely by Cameroonian personnel. It is supposed to provide a link between ECOWAS and ECCAS for strategic coordination. Its exact responsibilities have yet to be defined but in any case, it is a ground breaking effort. There is no precedent for institutionalised security coordination between both organisations (ECCAS official 2015, pers. comm., 21 May).

One level below, there are coordination centres for both ECCAS and ECOWAS with the former already operational. These centres will supervise five maritime security zones, stretching along the West African coastline from Senegal to Angola. Even landlocked countries are involved in the strategic framework. Niger, for example, has provided a patrol aircraft to the CMC for Zone E, operational since March 2015 (Nkala 2015).

The overview in Figure 2 shows that various centres still have to be developed. The implementation of such an ambitious framework is far from straightforward. If we take into consideration the limitations as well as the fragmented history of regional cooperation, however, progress within the last two years has been impressive.

On the national level, efforts are not always in sync. Different maritime agencies, e.g. navy, marine police, national maritime authority and fisheries protection, have to be coordinated. As in other political areas, external pressure often creates a sense of urgency. Benin, for example, experienced a spike of pirate attacks off Cotonou which led to a substantial drop in maritime traffic (Beattie 2012, Gouchola 2013). The government very quickly agreed to conduct joint naval patrols with Nigeria before embarking on a comprehensive national maritime strategy. Benin, like other francophone countries, follows the French model of state action at sea – *action de l'état en mer* – where a maritime prefect is in charge of all maritime agencies, both military and civilian. Efficient as this strategy may be when fully applied, it would be complicated to implement this model even with unlimited resources, and yet most maritime authorities in Benin have to cope with severe human resources deficits (Bléde, Ouédraogo and Diallo 2015).

Further challenges can be identified on the national level. In recent years, many countries around the Gulf of Guinea have invested in naval assets such as offshore patrol vessels or coastal surveillance systems. While it is encouraging to see naval spending picking up, navies often remain the 'poor brothers' of armies and governments still face their key security challenges on land. At the same time, corruption is not only 'inhibiting the transformation of the economic growth into development dividends for all citizens' (Uwimana 2014), it also hampers coordination between agencies. In Ghana, naval personnel generally regard members of the marine police as suspect and are reluctant to work on joint operations, citing poor training and corrupt behaviour as main impediments for efficient cooperation (Ghana Navy officer 2015, pers. comm., 28 May).

An interesting aspect of the fight against insecurity at sea is the role of the shipping industry in West Africa. Maritime trade in the region is forecast to grow significantly over the coming years, fuelled by economic growth and infrastructure investments. Shipping industry professionals in the region expect 2015 and 2016 to be challenging, but from 2017 onwards the outlook is very positive as infrastructure investments are expected to pay dividends (Country director shipping agency 2015, pers. comm., 29 May). Drewry Maritime Research sees a potential for more than ten million TEU<sup>18</sup> new capacity at container terminals between Côte d'Ivoire and Cameroon (Drewry 2015). Trade in bulk cargoes is also likely to grow substantially. Oil products in particular will soon be transported within the region rather than being imported from outside as various refineries are being upgraded or constructed, headlined by a \$9 billion complex in Nigeria with a processing capacity of 500,000 barrels per day (Cohen 2014).

Faced with immediate security problems while trying to harness the potential for growth led the shipping industry to take the initiative and kick-start a reporting centre. The Maritime Trade Information Sharing Centre - Gulf of Guinea (MTISC-GoG), hosted by Ghana, receives support from various countries within and outside the region as well as from the IMO and Interpol (Cotterell 2014). The concept for MTISC-GoG was developed parallel to the Yaoundé process and the centre has not been integrated into the overall structure. As a single point of contact for merchant ships, however, it serves a different purpose than the other multinational centres. It should therefore be utilised as an operational centre that could provide valuable information from the shipping industry which might get lost otherwise as ship masters are often unwilling or unable to communicate directly with authorities in the region.

## **Conclusion**

Despite a lack of available assets and resources, governments in West Africa have made important steps towards more security in the Gulf of Guinea. Cooperation with international partners may help to address some shortcomings yet African politicians should be wary as Europeans and Americans usually offer

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<sup>18</sup> Twenty-foot equivalent unit (TEU) is based on the volume of a standard-length container (20 foot) and describes the cargo capacity of container ships and terminals. As a comparison, the largest container ports in Europe are Rotterdam (11.6 million TEU) and Hamburg (9.2 million TEU) (see UNCTAD 2014).

help based on their own agendas. Strategic goals may not necessarily overlap. For example, drug smuggling, piracy and armed robbery at sea in the Gulf of Guinea is a much higher priority for Western governments than for many countries in the region. Illegal fishing activities of distant-water fleets from Europe and Asia may cause security issues on land, creating additional problems in an already fragile region. Fishermen in danger of losing their livelihoods could revert to smuggling and other illegal activities to supplement their income and even attack foreign fishing vessels while higher prices for fish could threaten food security.

Public-private partnerships may provide opportunities for regional governments trying to harness the potential of their Exclusive Economic Zones. Such partnerships may be controversial but are already used for very specific purposes e.g. for oil and gas installations offshore Ghana and Nigeria as well as for secure anchorages off Lomé, Cotonou and Lagos. Commercial providers can also be of assistance when it comes to intelligence analysis and the strategic assessment of threats. Risk consultancies have a very good understanding of factors that are important for their clients, ranging from small and medium-sized shipping companies to large oil and gas companies.

Multinational cooperation in West Africa has recently seen considerable improvements. Cameroon, Equatorial Guinea, Gabon and Sao Tomé are actively coordinating their operations. Ghana's Chief of Naval Staff has signed coordination agreements with Togo, Benin and Côte d'Ivoire. Official documents on the ministerial level have not yet been signed, but negotiations are ongoing. Nigeria, where many criminal groups operating in the Gulf of Guinea are based, remains a stumbling block but the country has gained some experiences with regional cooperation during the ongoing fight against Boko Haram. It remains to be seen whether the new Buhari administration is willing to cooperate more closely with neighbouring countries on maritime matters as well.

Expectations should not be too high and short-term solutions are unrealistic. Even in Europe, despite decades of economic integration, security politics are still characterised by national goals and values. Multinational cooperation is often hampered by institutional rivalries or even incompatible equipment.

In West Africa, where both maritime matters and security cooperation are very low on the list of political priorities, it remains to be seen whether initial progress can be sustained. Ongoing developments, however, are encouraging and it seems as if insecurity at sea in the Gulf of Guinea is finally being addressed. It has

taken a long time, but an African proverb already suggests: 'The best time to plant a tree is twenty years ago. The second-best time is now.'

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# British Ships for the King of Spain: An experiment in technology transfer

*Dr. Catherine Scheybeler*

## Introduction

The practice of looking at foreign methods and replicating them at home can be a practical option in considering the methods available for technological modernisation. It is, however, a technique, known as technology transfer, which is fraught with difficulties as S. Herbert Frankel states

‘the problem might appear to be merely one of introducing new methods of production and the instruments, tools or machines appropriate thereto. But what is really involved is a vast change in social beliefs and practices’ (Cipolla, 1965: pp. 129–30)<sup>19</sup>.

This was undoubtedly the case with the development of naval construction in mid-eighteenth century Spain when Ferdinand VI (1746–59) gave royal permission for the recruitment of some 90 British shipbuilding artisans into Spanish service.

## Armed Neutrality

At the beginning of the 1750s Spain was recovering from the War of Jenkins’ Ear (1739–48, known in Spanish as the Guerra del Asiento), a conflict with Britain in which none of the causes that had led to it had been resolved<sup>20</sup>. At the same time, war between France and Britain seemed imminent and Spain was likely to get caught in the crossfire. Ferdinand VI, however, was adamant that he wanted his reign to be peaceful and his chief minister, Zenón de Somodevilla, Marqués de la Ensenada (1702–81), sought to make this possible by developing a policy of ‘armed neutrality’ (Rodríguez Villa, 1878: pp. 43–65)<sup>21</sup>.

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<sup>19</sup> See Fernández González, Ferreiro, Nowacki (eds), 2006; Ferreiro, 2007; Merino Navarro, 1981; and Pritchard, 1987, for various arguments over the value of technology transfer.

<sup>20</sup> See Lynch, 1989, for a history of eighteenth-century Spain, as well as Merino Navarro, 1981, and Fernández Duro, 1895–1903, for the history of the Spanish navy. See Black, 1991; Pares, 1936; and Walker, 1979, for Spain’s foreign policy; Harding, 2010, for the War of Jenkins’ Ear (1739–48) and Dull, 2005, for the Seven Years’ War (1756–63).

<sup>21</sup> Ensenada outlined his policies in a series of ‘Representations’ to Ferdinand VI which were published in full in Rodríguez Villa, 1878. See Gómez Urdáñez, 1996 and Delgado

Spain, he argued, lacked the military and naval capability to challenge either Britain or France by itself, but it could expand its forces so that a potential alliance with either one of them would present a real threat to the other. Both would then respect Spanish interests. Ensenada, who had risen through the administrative ranks of the navy, reasoned that it was the navy in particular which was in need of reform and expansion (Rodríguez Villa, 1878: pp. 109–11, 113–42).

Aware of the tense European situation and the need for urgent action, Ensenada, therefore, pushed through an unprecedented era of naval construction in the 1750s. In the thirteen years of Ferdinand's reign, 48 ships of the line were built. By contrast, 62 had been built in the 46 years of Philip V's reign, 57 were to be built in the 29 years of Charles III's reign and 16 in the 12 years of Charles IV's reign (Harbron, 1988: pp. 164–73).

### **Jorge Juan y Santacilia's Voyage to London**

These ships were built to new designs, the result of an espionage mission to England by a Spanish naval officer, Jorge Juan y Santacilia (1713–73). This officer spent over a year from 1749 to 1750 studying the Royal Navy – especially its shipbuilding – and recruiting shipwrights and artisans for Spain<sup>22</sup>.

Juan, on his return home, became a leading figure in the reform of the navy and, with the assistance of those he recruited, developed and implemented a new establishment of naval construction and design which was given the name *la inglesa*, a term that translates into 'English-style'. This was officially established at the Council of Constructors held in Madrid in 1752 chaired by Juan and attended by his recruits Richard Rooth (the master shipwright at Ferrol arsenal), Matthew Mullins (that at La Carraca in Cadiz), Edward Bryant (in Cartagena) and Almon Hill (Master Draughtsman and shipbuilding instructor at the Academia de Guardias Marinas in Cadiz Department). The plans they drew up (which today can be consulted at the Naval Museum in Madrid) became the designs for Spanish warships built during the 1750s and were only officially replaced in 1765, by 'French-style' shipbuilding under the direction of a French master shipwright, François Gautier.

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Barredo, Gómez Urdáñez (eds) 2002, for an analysis of Ferdinand VI's ministers, their policies and reforms.

<sup>22</sup>See Lafuente and Peset, 1981; Soler Pascual, 2002; and Valverde, 2012, for Juan's biography and time in London, as well as Scheybeler, 2014, pp. 42–109, for an analysis of Juan's mission and *la inglesa* shipbuilding.

## A la Inglesa Construction

A la inglesa design was loosely based on the British 1745 Establishment though from the beginning there existed differences between the two systems. Overall a la inglesa ships were larger, so that the Spanish 68-gun ship of the line was closer to the size of a British 90-gun ship and they had a reduced depth in proportion to their length and breadth<sup>23</sup>.

The construction of the hulls, however, represented a marked break with the previous system of construction. At the risk of over simplifying, where the traditional Spanish system used the largest timber parts possible with the fewest possible joints and bolted these together with iron, the British employed a greater number of smaller parts, scarphing these together into an interlocking frame and securing them with treenails. The latter was introduced to Spain with a la inglesa construction<sup>24</sup>.

When this happened, however, there was one very substantial oversight – timber seasoning was not altered to accommodate the new system of construction. At the Royal Dockyards in Britain compass timber, plank and treenails were seasoned and stored, roughly hewn, in a covered, dry environment (Roberts, 1992: p. 102)<sup>25</sup>. Ships were also built over a longer period of time and allowed to season in frame (Lambert, 1991: pp. 120–21). By contrast, in Spain, timber was cut to size in the forests where it had been felled, transported to the sea by river and seasoned in ponds or on beaches buried in sand or mud where it would regularly be covered by sea water (AGS Marina 315, Autrán, ‘Notas sobre el estado de los arboles ...’, 20 May 1747). This practice was not altered throughout the period of a la inglesa construction even though the British master shipwrights at each of the

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<sup>23</sup>See Kew Adm 95/12 for detailed proportions of 1745 Establishment ships to compare to Kew Adm 49/90 proportions of a la inglesa ships Aquilón, Soberano and San Antonio. These ships were among those taken by the British at Havana in 1762 and their proportions taken in Britain in the British style, thus it is possible to obtain an accurate comparison with 1745 Establishment ships. Details of the 1745 Establishment and Spanish ships taken into British service can also be found in Gardiner, 1992; Lavery, 1998; Lyon, 1993; and Winfield, 2007.

<sup>24</sup> See Rivera, 2012, for a la inglesa ships; Fernández González, Apestegui Cardenal, Migueléz García (eds) 1992, for the previous form of construction and Manera Regueyra (ed) 1981, for the evolution of Spanish naval construction in the eighteenth century.

<sup>25</sup> See Albion, 1926, p. 13 and Lambert, 1991, pp. 110, 118–23 for the preparation and preservation of timber for shipbuilding.

arsenals did ask for it. In May 1750, for example, Rooth wrote that it was not suitable to store the planking in water because:

“it ate its substance and would later cause it to split. The method of seasoning it was to store it in a warehouse where it could not be reached by either rain water nor the sun”

(AGS Marina 318, Alvarez to Ensenada, 12 May 1750).

Ensenada did confer with the Naval Intendants asking them what they thought but they replied that the traditional Spanish methods of timber seasoning were the best. Ensenada, therefore, dismissed Rooth's suggestion (Scheybeler, 2014: pp. 78–80).

A common defect subsequently reported by naval officers who captained these ships was that the treenails and caulking fell out and that the ships needed more iron to hold them together, some specifying that they meant in the freeboard, the portion of the hull that is above the water (AGS Marina 330, 1758 ship reports) – a likely outcome of the timbers contracting as they dried which would be more noticeable above the waterline.

At the same time as these ships were entering Spanish service, a political event which was to have a significant effect on the development of a *la inglesa* construction occurred in Madrid. On 21 July 1754, Ensenada was ousted from power in a political coup and, thereafter, the shipbuilding project and those employed in it received very little support from the central government. Without it, conditions at the three arsenals of Ferrol, Cadiz and Cartagena began to exert a greater force on a *la inglesa* shipbuilding.

## **Ferrol**

Ferrol, due to its location on the north-west coast of Spain, was intended by Ensenada to take over from Cadiz as Spain's principal naval base. The designs for it, therefore, made it larger, with four dry docks to Cartagena's two (none as yet being projected in Cadiz), and it was where Richard Rooth, the most senior of the shipwrights recruited by Juan, was employed (AGS MPD 3/23, 17/17). In 1753, however, it was still just a small regional town, poorly connected with the interior of Spain, relying heavily on food imports and with a skilled workforce brought in from more traditional shipbuilding areas, namely the Basque Provinces. Cramped conditions, frequent shortages of food and elevated prices resulted in a disgruntled

workforce prone to recurrent outbreaks of disobedience and violence even before a group of much better paid foreigners were placed in authority<sup>26</sup>.

Into this delicate situation was brought Richard Rooth who considered this opportunity to work in Spain as potentially very lucrative. Not only did he earn a large salary as master shipwright but he also set himself up as a merchant, getting favourable contracts transporting naval stores and importing Newcastle coal. It seems that from the outset he flaunted his newly acquired wealth and status. The British consul at Corunna, Joseph Jordan, disliked him intensely, complaining Rooth behaved as 'lord paramount' of a 'clan of English & Irish renegados' and that his 'grand living, keeping an open table &c.' was offending those at the arsenal (Kew SP94/227). Soon Jordan was reporting a rift between Rooth and Antonio de Perea, Naval Intendant at Ferrol, noting that 'the Intendant is no friend to the English in general and a great opposer of Rooth in particular' and later that Perea was 'Rooth's irreconcilable enemy' (Kew SP94/228). By 1754, it seemed the two could no longer work together and either Rooth or Perea would have to be removed from their post (Kew SP94/228). On 7 July 1754, Rooth appeared to have won out and Perea was replaced by Juan Francisco de Medina but after Ensenada was ousted from government on 21 July the new naval minister, Julián Manuel de Arriaga y Ribera (1700–76), reinstated Perea (Kew SP94/228)<sup>27</sup>.

Without support from either the central government or the local naval administration, Rooth struggled to run the arsenal's shipbuilding with any authority. He experienced numerous clashes but an incident while organising the launch of the *Soberano* on 21 July 1755 serves to illustrate his predicament. On this occasion, Perea forwarded Arriaga in Madrid a petition from Antonio de Urbietta, foreman of the *Soberano*, claiming Rooth had ill-used him. According to Urbietta, when Urbietta had used a first-rate timber for the launch of the ship at Rooth's request, the latter had flown into a rage, hitting Urbietta with a cane, calling him a 'filthy cur' ('perro canalla') and telling him never to set foot in the arsenal again. Perea forwarded this complaint without first consulting Rooth complaining to Arriaga that it was difficult to keep the workforce under control when Rooth had such a violent temper (AGS Marina 235, Perea to Arriaga, 22 July 1755).

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<sup>26</sup> See Scheybeler, 2014, pp. 112–36, for an analysis of conditions in Ferrol and difficulties in recruiting skilled labour.

<sup>27</sup> See Baudot Monroy, 2012, for an analysis of Arriaga as naval minister.

At this point, Rooth, in his turn, also complained to Arriaga because Perea had not brought the matter to his attention even though he had visited Perea's house every evening since the altercation. In Rooth's account, Urbieta had used one of the best timbers available when he, Rooth, had assigned a different, less valuable one. When instructed to replace it, Urbieta had just stared at him 'smirking and by way of disrespecting me turning to those present making gestures and ridiculing him' for which reason Rooth had hit him and told him to get on with work. He later discovered that Urbieta, at Perea's suggestion, had left the arsenal, was refusing to return to work and had written a formal complaint against Rooth (AGS Marina 235, Rooth to Arriaga, 29 July 1755)<sup>28</sup>. Arriaga settled the matter by informing Rooth that Perea could be trusted to defend Rooth in such disputes with the workforce and Perea that until Rooth was no longer necessary he should appease both parties (AGS Marina 235, Arriaga to Perea, 6 August 1755).

Rooth remained master shipwright at Ferrol until his death in 1761 without his relations with either Perea or the workforce improving. In 1757, Perea and Francisco de Orozco, Commander General at Ferrol, succeeded in persuading Arriaga to let them build the last ship being built at the arsenal to a la inglesa proportions but fitted in the traditional manner – against the opinions of Jorge Juan and the British shipwrights. The resulting ship, the 58-gun *Campeón*, was found heavy and unwieldy. Arriaga asked Rooth to explain why the *Campeón*'s sailing qualities differed so much from those of the *Tridente*'s but Rooth refused responsibility claiming William Turner, the assistant shipwright at Ferrol who was on better terms with Perea, had drawn her plan and this had been approved by the court. To the best of his knowledge that was how she had been built (Scheybeler, 2014: pp. 98–100).

## **La Carraca**

Cadiz was a long-established naval base and the headquarters of the Director General of the Navy who throughout the 1750s was Juan José Navarro, Marqués de la Victoria (1687–1772). The shipyard was located within Cadiz Bay on the peninsula of La Carraca<sup>29</sup>. As a result of Cadiz's importance and history, it was where most of those who had led the previous method of ship construction were based. Of these, the most significant was Ciprián Austrán Oliver (1718–73), a

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<sup>28</sup> 'sonreíendose y a modo de despreciarme volviendo con mofa y gestos la cara a la gente'.

<sup>29</sup> See Quintero González, 2000, and Quintero González, 2004, for La Carraca.



shipwright who had expected to head the shipbuilding project when preparations began in 1748 but who, in the end, was only to occupy the post of master attendant at La Carraca<sup>30</sup>. He represented the old establishment of naval construction and from the outset was opposed to a la inglesa<sup>31</sup>.

After July 1754, Autrán regained much of the authority he had lost when the a la inglesa project had the full support of the court. With his opinion once again considered valuable and with the support of Juan Gerbaut, Arriaga's replacement as Naval Intendant at Cadiz, Autrán used every opportunity to criticise a la inglesa with the hope of reinstating the previous establishment of naval shipbuilding.

Again, given Cadiz's significance, it was at Cadiz where most of the councils to discuss a la inglesa were called. One of the most noteworthy of these took place on 9 October 1754 and was attended by the Marqués de la Victoria, Juan, Mullins, Gerbaut, Autrán and eight naval officers who were then in Cadiz and had experience of captaining a la inglesa ships. At the meeting, the Marqués de la Victoria asked all those present to submit a written statement outlining their proposed modifications to this form of shipbuilding. Autrán submitted a lengthy critique that categorically rejected a la inglesa construction and advocated a return to the previous system. The Marqués de la Victoria forwarded all the statements to Arriaga but noted that Autrán's had the backing of Gerbaut and most of the naval officers. In Madrid, Arriaga had copies made of Autrán's statement with the addition of an extra paragraph compiled from the statements of the other officers and forwarded these to each of the British master shipwrights giving them eight days to respond. Rooth, Mullins and Bryant each submitted reports rejecting Autrán's proposed modifications point by point. Of these, Rooth's was forwarded to the Marqués de la Victoria who was instructed to call another council. This time with just himself, Juan and Gerbaut and they were to make definitive judgements. They were unable to come to an agreement but after Arriaga again insisted that

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<sup>30</sup> In Spanish dockyards, the master shipwright was in charge of construction and the master attendant, who was the more junior, was in charge of ship repairs and maintenance. In AGS Marina 315, Autrán's correspondence in relation to the preparation of timber for the forthcoming construction makes it quite evident that he expected to be the master shipwright as was only natural considering that, at that time, he was the most senior shipwright in Spanish service.

<sup>31</sup> This is demonstrated by his correspondence with Ensenada on the subject of Jorge Juan's discoveries in London, see Autrán to Ensenada, 8 June 1749 (AGS Marina 316) for an example.

they do so they agreed to make six changes and Almon Hill, the British shipwright at the Academia de Guardias Marinas was called upon to draught the new plans. The changes were small and generally those that Rooth in his report thought appropriate. The only substantial alteration and the one that went against the thinking of Jorge Juan and all the British shipwrights was that iron nails, not treenails, should be used in the freeboard. Even though Juan and all the British master shipwrights pointed to the use of green timbers as being the source of many of the problems, this subject was not addressed (Scheybeler, 2014: pp. 83–98).

This council set the pattern for most of those that were subsequently called. In the end, the debate always seemed to revert to a discussion of whether the previous system of construction was better than a *la inglesa* rather than adapting and improving a *la inglesa*. In these discussions, it was evident that Mullins' opinions, even though he was considered a good shipwright, held less sway at court than Autrán's.

## Cartagena

Edward Bryant had an easier time in Cartagena than either Rooth in Ferrol or Mullins in La Carraca. He handled his situation prudently and, in turn, he was left unhindered in his work and the Intendant's reports generally speak highly of him. In 1760, for example, Barrero said of him that 'this person's skill is of the best known and recognised by all' (AGS Marina 236, Barrero to Arriaga, 13 February 1760)<sup>32</sup>. His ships were, on the whole, the most well-received in Spanish service. The *Tridente*, for example, was considered so good that her plans were officially made the standard design for 58-gun ships in the Spanish navy in 1756 (AGS Marina 326, Arriaga to Juan, 30 December 1756). Hence, as previously mentioned, when Arriaga was asking Rooth to explain the sailing qualities of the *Campeón*, he asked why they were not equal to the *Tridente*'s.

Bryant, however, did not play a significant part in the debate over a *la inglesa* shipbuilding because Cartagena arsenal was not much involved in it. Cartagena had only become a naval base in 1733 when Philip V had made it the Mediterranean Naval Department's capital and transferred his galleys from Barcelona to Cartagena<sup>33</sup>. It had functioned primarily as a galley base until 1748

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<sup>32</sup> 'la inteligencia de este sugeto es de las mejores que se conocen, y notoria a todos'.

<sup>33</sup> See Pérez-Crespo, 1992, for a history of this arsenal.

when this service was cancelled and only then was the arsenal built to cater to ships of the line. It also became the home of a xebec squadron that took over from the galleys as the main force employed against North African privateers.

## **Conclusions**

S. Herbert Frankel's assessment that the introduction of new systems, such as a *la inglesa* construction, required a vast change in 'social beliefs and practices' to be successful was substantially accurate. The need to vary timber-seasoning techniques to suit a *la inglesa* shipbuilding, for example, was necessary but it contravened intrinsic beliefs held in Spain about timber seasoning and was, therefore, impossible at the time.

There were, however, several other factors that hampered the project and these were mainly political and social. Too many ships were built too quickly without adequate testing and research because Ensenada considered Spain dangerously vulnerable without warships to defend its interests. Furthermore, the project was so closely associated with one political faction that when this faction lost its power the incoming politicians were unwilling to support it. The experiment, in fact, highlights how vital consistent, long-term political support was for a revolutionary rather than evolutionary construction scheme. At Ferrol, the behaviour of Rooth and those he brought with him from Britain alienated the local naval administration and workforce making progress nigh on impossible. Whereas in Cadiz those with a vested interest in returning to the previous system of construction – from 1754 unchecked by the central government – also hampered the necessary reform of a *la inglesa* construction. Conversely, Bryant in Cartagena was not brought into the discussion.

Since this paper has focused largely on the immediate difficulties involved in introducing a foreign method of construction, it may appear that this venture yielded few results. The outcome of Jorge Juan's espionage mission to London and the adoption of a *la inglesa* shipbuilding, however, was not all negative especially in the long-term. The challenge to traditional Spanish shipbuilding methods brought about greater thinking on the subject and, moreover, elements of a *la inglesa* construction were kept or later re-instated. The most substantial advantage was in infrastructure. Dry docks, masting engines, stoving ovens, state-run sail and rope factories were built largely based on their British equivalents. In all, this form of technology transfer can be very productive but it cannot be, in

Frankel's words, 'merely one of introducing new methods of production and the instruments, tools or machines appropriate thereto'.

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# **“Here be monsters (and journalists)” – the UK press and the construction of the Weird Sea**

*Dr Alexander Hay*

## **Introduction**

The United Kingdom has a remarkably close relationship with the sea. The length of its coastline comes to a total of almost 20,000 miles. There is no point in the UK that is further than 70 miles away from the coastline. Culturally and historically, the sea has played a major role in defining the UK as a nation.

In many ways, however, the UK faces a crisis in how it perceives the sea, particularly in how it is now depicted in mainstream media. To say that the British are exclusively at odds with the sea is, of course, inaccurate to say the least. Many nations have endured any number of real maritime disasters, shark attacks and fictional sea monsters in their recent history, while rising sea levels threaten whole cities and even nations.

Yet it is the terms of this ‘othering’—a constructed antipathy—that makes it unique to our own shores. As we shall see, this is a relatively recent development, and the result of historical, political and cultural forces peculiar to this country. Here, the apocryphal phrase ‘Here be Monsters’ has become both an assumption and a running theme in media coverage of the sea.

## **It came from the depths**

The British fixation on sea monsters is a common and dependable source of news material. This flows into and melds with ongoing reports of lake and loch monsters, the most famous example being that of the Loch Ness Monster. The aim of this paper is not to argue for or against the existence of these creatures, though the vast amount of evidence suggests they are not there, or at least, are not in the form we would like them to be. Instead, the issue here is how these stories are outlined and expressed to their readers and how this can be seen to suggest a general pattern in how the sea and its contents, real or otherwise, are portrayed.

One recent news story, published in 2014 in the Scottish tabloid, *The Daily Record*, demonstrates a typical water monster narrative:



“I’ve fished the loch man and boy and I haven’t ever seen anything like that. As I say I don’t really believe in anything like that until I see it but what I saw was obviously what the Loch Ness Monster is - I’m not saying it was a fire breathing dragon and I never saw teeth or anything like that, but I must have thought there was something there if I stopped to take pictures. (Archibald, 2014)

In this case the mundanity of the witness is emphasised as a way of establishing their credibility through an implied guilelessness. In this case, ‘Tree planter Richard Collis’ is a ready-made everyman, his implied straightforwardness made pointedly clear by his wife, who points out the shortcomings in his technical and computer skills later in the same article.

Similarly, the other kind of monster authority in these narratives comes in the form of the ‘expert’ – a scientist or other similar authority. While it is not always necessary for the expert to have seen the creature, unlike the everyman, their opinions are given weight by who they are as much as by what they say. As this example, published in *The Daily Mail*, shows, the appeal to authority in such coverage is as important, if not more so, than the claims themselves:

“The huge number of “sea monster” sightings now on record can’t all be explained away as mistakes, sightings of known animals or hoaxes,’ said palaeontologist Dr Darren Naish of the University of Portsmouth... “At least some of the better ones – some of them made by trained naturalists and such – probably are descriptions of encounters with real, unknown animals” (Derbyshire, 2011).

This is not to say that Richard Collis really only saw a log, or that Dr Darren Naish is wrong, but it is important to note that the news stories construct the case for them in a particular, predictable fashion. Often, the two narrative styles are bought together, as a news story regarding Cornwall’s local sea monster, Morgawr, “a hideous hump-backed creature”, demonstrated:

“A television crew from the Discovery Channel series, Animal X, have recently been in Cornwall filming interviews with people who claim they have seen Morgawr...Producer Tony White said: “One of the people we spoke with was an elderly lady who saw the monster in the

Helford River. And the most recent sighting was by some people out fishing on the Carrick Roads who said Morgawr reared up out of the water in front of their boat..." (Western Morning News, November 2000, p.9).

Again, we see a predictable construction of credibility. The experts – in this case, a television crew with a named producer – are portrayed as having come to find the truth (As opposed to just making a television programme). The witnesses, meanwhile, are once again given credibility by their ordinariness, whether it is by being an old woman or recreational fishermen. The implication here is that such everyday folk are incapable of seeing anything not already filtered out by their salt-of-the-earth sensibilities.

The undercurrents of this narrative model are alarming. The implication is that there is an inherent authority granted by one's social rank, whether one is a scientist, a researcher or a television documentary maker. At the same time, the everyday, less informed witnesses are implied to be too wholesomely unsophisticated as to mistake an otter, a log or an errant seal for a sea or lake monster. Needless to say, there have been cases that demonstrate the flaws of this uncritical, not to say socially stratified model. The Surgeon's photo, taken in 1934 by Robert Kenneth Wilson, a gynaecologist, is a case in point, having latterly been exposed as a fake.

Another feature of the narrative is how the local lake or sea monster is personified and given a name, and even a personality, as the Tyneside sea monster Shony demonstrates (Bradbury, August 2000, p.8), or how the latter day preference for aquatic monsters such as Loch Morar's Morag (BBC, February 2013) and a whole raft of other Scottish loch-beasts are freely juxtaposed with existing longstanding maritime mythologies of creatures such as mermaids and kelpies (McQueen, March 2008, p.8). The narrative is also pliable and able to resist challenges to its core message, as demonstrated in this *Evening Herald* report of a sea creature seen off the nearby Devon coast:

A loch NESS monster-type creature has been snapped at sea off Paignton - just days after the sighting of a sperm whale in Tor Bay... The mysterious Plesiosaur-like creature was spotted just 30 yards off shore by locals who reported a sighting of what they first thought was a turtle... But pictures taken by one of the baffled witnesses reveal its

neck may be far too long for any known sea turtle... Boffins at the Marine Conservation Society say the creature may be some kind of turtle, but at present it remains unidentified (Finch, July 2010).

Note that while the story features possible explanations for what witnesses had seen, it puts great effort into dismissing them. The creature itself is envisaged as a 'Loch Ness monster-type', akin to a plesiosaur, thus grounding the sighting in existing myth, and more significantly, palaeontology. Scientists are referred to via the old journalistic cliché of 'boffins;' nameless but intrinsically learned, their authority invoked mainly to say that the creature is 'unidentified' while the story glosses over the more likely scenario they provide. As this story demonstrates, sometimes the presence of 'scientists' is enough to lend credibility to a story. Quotes need simply be attributed to a suitably authoritative-sounding institution and the possibility of a monster not dismissed out of hand, as another story, from the Daily Mirror in 2010 shows:

Marine Conservation Society biodiversity programme manager Peter Richardson said: "It could be another Loch Ness Monster. At the moment, it's an unidentified mystery creature" (Smith, July 2010, p.18).

The rest of this story plays to type. Again, the creature is described as having archetypal features, "like a pre-historic plesiosaur", and the story's eyewitness is, once again, a respectable tradesperson, in this case, an electrician on the verge of retirement. What is telling, however, is how the idea of a lake monster and a sea monster is interchangeable. Both lurk in the depths and so are seen as both exotic and alarming. Time and again, the same essential themes are revisited; the sea is rendered alien, freakish, bizarre and dangerous, though in the first news story covering the Devon monster, it is described as at least preferring to hunt fish.

### **Monsters Everywhere**

Is this strictly harmful, however? A defender of the press might argue that the content of such stories is simply there as entertainment, or that the reader is responsible for their own credulity. This is a problematic argument, however. These stories not only all share the same narratives and tropes but also disseminate them amongst their audiences without caveats. This is a peculiarly

British phenomenon, and so stands in contrast to how media in other nations respond to similar stories. For example, news coverage of cryptozoological events in America, has been strident in its scepticism (Regal, p. 178), up to and including open clashes with believers, while coverage of lake monsters such as Lake Champlain's Champ is coloured with a professional objectivity and distance that the UK press simply does not aspire to (CBS News, December 2011). Recent coverage of an alleged lake monster sighting in Norway, care of the state broadcaster NRK, is notable for its neutrality – leaving the reader to decide whether the eye-witnesses are telling the truth or not. (NRK, August 2012). Australian news coverage of strange sea creatures, alive or extinct, may employ similarly lurid language (Skatssoon, May 2005), but the irony is obvious, and safely expressed with suitably sceptical quotation marks (The Australian, May 2013); the approach ultimately more factual rather than sensationalist (Wells, April 2015).

These stories therefore, more than those delivered in countries with a more sceptical and dismissive media interest in sea monsters, colour and influence how the sea itself is interpreted. Yet a more direct criticism would be that they degrade and undermine journalism as a whole, encouraging the narrative of the weird sea to be applied to news coverage outside of the cryptozoology bracket. A common example of this is how paleontological news stories are reported, specifically those that relate to extinct sea creatures. These all follow a similar pattern; the monstrousness of the creature is emphasised, allusions are made to the Loch Ness Monster where possible and the maritime nature of the creature is also emphasised, casting them as a true monster from the deep. This extends even to less tabloid oriented news outlets, as one BBC news story demonstrates:

The fossilised skull of a colossal "sea monster" has been unearthed along the UK's Jurassic Coast... The ferocious predator, which is called a pliosaur, terrorised the oceans 150 million years ago... The skull is 2.4m long, and experts say it could belong to one of the largest pliosaurs ever found: measuring up to 16m in length (Morelle, October 2009).

Note the emphasis on the monstrousness of the creature, its savagery, and its implied menace. Perhaps fittingly, the news story even features a picture of the pliosaur about to devour a plesiosaur, and a size comparison with a killer whale, emphasising its size and power but also seemingly saying to the reader – 'look!

This sea monster is even nastier than Nessie! It's an even scarier aquatic predator than an Orca!" The first image also emphasises the size of the creature's mouth, open wide and all-consuming. While we can surmise a great deal about the creature's feeding habits and lifestyle from its remains, the news story still seems driven to emphasise this, in so doing once again visiting the depths of the Weird Sea.

The broadsheet *The Guardian* is similarly bewitched by the sea monster narrative. In addition to stories about pliosaurs, (Siddique, October 2009) replete with yet another picture of the beast devouring yet another unfortunate plesiosaur,<sup>34</sup> it emphasises the predatory nature of a new Scottish species of Ichthyosaur in another story, which was once "...among the top marine predators, sharing the seas with long-necked plesiosaurs..." (Sample, January 2015) Another pliosaur-themed news story uses yet another diagram to emphasise the creature's size by demonstrating how much bigger it is than, in this case, various species of Dinosaurs (Sample, March 2009).

The Daily Mail naturally follows this model too, with its description of a primitive shark, "believed to measure as long as 20 feet (6 metres) that prowled the seas 100 million years ago..." (Griffiths, June 2015). The *Western Daily Press* has a species of plesiosaur – again, "a sea monster" – with "flippers shaped like the wings of a Spitfire fighter plane", juxtaposing one British mythologised history with another (Western Daily Press, January 2002, p.16). Even fossilised soft bodied aquatic invertebrates are not spared this 'monstering'; *The Telegraph* reports about "flesh-eating 'penis worms'" from the Cambrian period (around 541 to 485 million years ago) that "could turn their mouths inside out and drag themselves along by their teeth" and which are compared to the vast Sandworms in Frank Herbert's science fiction novel, *Dune*. The journalist only then belatedly notes that the creature was "the length of a finger", its fearsome teeth only a millimetre long (Knapton, May 2015).

This creeps into coverage of modern nautical anomalies. Stories of mysterious bodies or 'blobs' of organic matter (Mirror, January 1998, p. 11) washed up on beaches are a common occurrence in the news media, their being described as innately mysterious and 'baffling' (Western Daily Press, July 2014, pg. 4), their inevitable identification as whale corpses being reported as if this were a startling revelation rather than an obvious conclusion (Daily Record, January 1998,

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<sup>34</sup> This is a surprisingly common theme in media illustrations, making one wonder what exactly plesiosaurs have done to magazine, newspaper and web site picture editors to deserve such consistently harsh treatment...

p.19). Even when the creatures are identified, they are still described in monstrous terms – two ‘huge’ oarfish found beached are described by the *Daily Mail* as being ‘sea serpents’, their deaths perhaps a portent for “a looming major natural disaster” (Olson, October 2013) while a bewildered moray eel is described as “a baby sea monster” (Western Morning News (Plymouth) May 30, 2005).

This rhetoric of the Weird Sea is carried on with stories involving real shark attacks, the realisation of the fantasy the other stories so keenly aspire to. Despite the seriousness of the subject, the same lurid language and imagery are used:

AN Irishman looked on in horror as a huge "dinosaur-sized" shark savaged a bather just yards away... Denis London stood stunned on the shoreline while the sea beast mangled and tore apart a 37-year-old swimmer... Local resident Gregg Coppen, who also witnessed the incident near Cape Town in South Africa, said the monster fish was "longer than a minibus"... He posted on Twitter: "Holy s\*\*\*. We just saw a gigantic shark eat what looked like a person in front of our house. "That shark was huge. Like dinosaur huge" (Conlon, p. 16).

Shark stories, even where there are no deaths involved, follow much the same formula. They include the same implied menace (Marris, June 2014, p. 17), the emphasis on size (McCloskey, March 2014, pp. 6-7), the creature’s mouth and its teeth (Daily Star, May 2015, pg. 20), and once again references to everymen and scientists and their assumed authority (Landreth, July 2015). Even stories concerning the majestically huge but utterly harmless basking (Derry Journal, August 2012) and whale sharks (Metro, August 2012, p. 9) can’t help but mention their size and fearsome appearance, referring to them as possible monsters or threats, before admitting that they pose no threat to anyone but plankton.

This language and outlook sometimes reaches absurd lengths. *The Sun* describes the world’s largest cargo ship as a “sea monster”, its size and capacity described in lurid terms fitting for a real creature from the depths (Spanton, January 2015, pp. 28-29). Meanwhile, *The Daily Record*’s 2012 report on a 14 year old girl hospitalised by a ‘monster wave’ demonstrates its ultimate perversity (Devine, June 2012). In this story, the sea itself is transformed into a villain that “knocked” its victim “repeatedly against the wall” “forced back” would-be rescuers and “dragged” both the girl and her friend “further out to sea”. Here the sea

reaches its final destination in this worldview, and becomes a monster in and of itself, beyond the hidden horrors that lurk in its depths. The UK media reflects and continues to perpetuate an alienation from the sea that is both highly stylised and utterly irrational.

### **Britannia (No Longer) Rules The Waves**

What lies behind this alienation, however? Certainly, UK media values play a role, but this is not simply down to our journalism being innately disingenuous. In part, easy narratives result from a news culture driven by deadlines, in turn the result of an industrialised society where timeliness (as opposed to accuracy) is the key commodity (Schleisinger, pp. 84-85). While this is the case in many nations' news cultures, in each case the exact approach reflects that nation's preoccupations. In the UK's case, this comes in the form of sensationalism and the Weird Sea. Regardless, such requirements naturally lead to stock responses, clichés and received wisdom being fallen back upon. Speed is the lifeblood of journalism but it does not foster critical thought outside its confines, and journalists are not entirely in control over what they report or how as a result (Schleisinger, p. 87), even discounting editorial priorities and each publication's house style. Deadlines require copy and so journalists fall back on certainties and stock formulas, which again reflect national preoccupations and even pathologies. Existing news cultures with their pre-supposed assumptions—their narratives—of what makes news and what the audience want to know (Schleisinger, pp. 116-117) inevitably lead to lurid stories of sea monsters, but have little time for the utter mundanity of fossilised barnacles or washed up starfish and bits of seaweed.

Such a prism is applied to the people as well as the creatures in these stories. They must both become remarkable, as John Langer put it, in order for them to be considered interesting and newsworthy, and join the ranks of the 'interesting', be they celebrities or experts, or—indeed—Loch Ness Monsters. They must be "...positioned by the story as 'ordinary' while at the same time be shown to be breaching expectations by doing extraordinary things", or at least claiming to have seen them (Langer, pp. 48-49). Complicating factors further is how celebrity and institutional elites are being blurred into a single bloc of what journalists assume are innately interesting and authoritative people, all constructed in the same fashion (Langer, p.53). In this structure, the views of celebrities such as pop stars (Hattenstone, November 2013) and 'experts' in strange phenomena are given



equal prominence, the assumption being that their notoriety alone – their newsworthiness – confers on them an innate authority (Dickinson, October 2014).

Needless to say, this is problematic; journalism views the public as a whole, with pre-determined tastes and expectations, the lurid and the escapist as much a lure to middle class readers as those from the working class (Conboy, p. 136). Complicating things further is the long-term effect of postmodernism, where presumptions of what is and isn't credible, serious or salacious or both, have broken down (Conboy, p. 139). This explains why *The Guardian* can win the Pulitzer Prize for journalism but still feature terrifying tales of extinct sea monsters. If it is newsworthy and fits into audience expectations, it is justified in and of itself (Conboy, p. 167).

Certainly, this blurring of the lines between entertainment and information affects all sectors of the press. where commercial pressures and ingrained beliefs about what the audience wants (justified or otherwise) have shifted the UK media as a whole towards 'tabloidisation' (McLachlan & Golding, pp. 76-77). This is historically observable, with the 'quality press' increasingly setting aside more serious content during the last quarter of the 20<sup>th</sup> century (McLachlan & Golding, pp. 78-79) and becoming more visual (McLachlan & Golding, p. 80) and 'accessible' to a presumed popular audience (McLachlan & Golding, p. 85). This has not translated into the much-hoped for rises in circulation—sales of almost all newspapers continue to decline year by year—but it does explain why these stories are so common; there is an existential need for the press to pander to the preoccupations and quirks of their audience, even though this process is innately circular. If the news media gives the public the Weird Sea, the public has learned to expect it as the main narrative for depictions of the sea.

Does the press therefore actively distort how the sea is perceived? As the many examples in this paper demonstrate, certainly, but it would be too simple to say that they do this without the public's connivance. There is also the role journalism plays in the UK cultural landscape. Journalism serves a range of functions, even the most gleefully populist tabloid may sometimes undertake serious journalism, and broadsheets, as we have seen, like a big scary monster as much as the next red top. Yet in providing these stories and fitting into this existing narrative of the Weird Sea, the UK media fulfils another role: that which Jostein Gripsrud described as "ritual communication". Here journalism is the means whereby a society communicates to itself about itself, ensuring its sense of being is both remembered and disseminated (Gripsrud, p. 42). It is how Britain creates and



maintains its collective identity and its relationship with the rest of the world. This, of course, serves a purpose in providing a sense of stability and continuity in a shifting and uncertain world (Hetherington, p. 44). Yet, it also means that the perpetuation of prejudices, obsessions and received wisdom are maintained too (Helm, July 2015). With this in mind, the recurring themes and motifs of the Weird Sea fit into a broader picture. News audiences are not brainwashed or easily lead, but they do rely on underlying assumptions, and the press is the means by which such assumptions are laid.

This leads us to the central question – why does British culture now have such a distorted view of the sea? This is in stark contrast to its history. From the 16<sup>th</sup> Century onwards, the notion of English and latterly British power and national pride was rooted in the sense of it being a maritime power (Peck, p. 32). Arguably the defeat of the Spanish Armada in 1588 was the first defining moment of this trend, its portentousness echoed in the nascent early modern nationalism and popular culture of the time (Cavanagh, p. 72). This reached its apex in the 19<sup>th</sup> Century, following Nelson's victory at Trafalgar which, give or take several minor defeats, prevailed until the early 20<sup>th</sup> Century. This was echoed in novels and popular culture of the time. In the case of Jane Austen and many other writers, British seamen, be they officers or Jolly Jack Tars, were often portrayed as exemplars either of stoicism and courage, or character and masculinity (Peck, p. 28). This had a deep resonance in British culture at the time, and which still has echoes in our day-to-day language (Mack, p. 35) and ideas of society. (Mack, p. 193).

This dominance and confidence, of course, was not to last. The Royal Navy, key to this sense of national confidence, and essential in maintaining the British Empire, reached its high watermark in the 1880s. From that period on, increasing competition from other nation's navies, such as those of Germany and the United States of America, began to challenge this supremacy (Gough, p. 76). By 1914, at the outbreak of the Great War, the Royal Navy found itself no longer unassailable, its officers unprepared for the realities of fighting other well-organised, equipped navies (Gough, p. 253). While Britain could still maintain the illusion of naval power until the outbreak of the Second World War, it had nonetheless been eclipsed by other nations in the meantime (Gough, p. 265). From the 1950s onwards, the navy began a slow and relenting decline in military spending that carries on to this day (Bell, pp. 312-313). The national myth of naval supremacy had come to an end.

At the same time, there has been a growing estrangement between the British and the sea. (Foulke, p. 190) If you fly off on your holidays, have never travelled more than a few hours on a ferry or have never known the era of vast shipyards or the lives of the men who worked in them, then the idea that the sea is an alien place full of strange things to be feared or avoided does not seem so absurd. The press will certainly cater to your preconceptions. After all, they are made up of members of the British public too. Television documentaries and media are full of 'abyssal horrors' such as the Goblin Shark (Guardian, May 2014) and the Giant Squid (Ingham, October 2011, p. 22). According to research conducted by the Sealife Centre chain of aquariums in 2015, 10% of children believe mermaids are real, 17% thought sea dragons can breathe fire, 10% believed fish fingers were a kind of fish and 16% thought that sharks primarily ate humans (Ratcliffe-James, March 2015). Leaving aside the small sample size of 1,000 children and the commercial bias of the research, this still suggests a troubling state of affairs. We are surrounded by the sea and yet we are estranged from it.

Even the British seaside has suffered from 'othering'. This process began in the 1930s when modernist writers—even those on the left—expressed disquiet at the massive popularity of seaside resorts, with their teaming numbers of working class holiday makers, seeing them as a vast, dangerous mob in the midst of barbarous low brow entertainment (Feigel, pp. 16-17). The narrative that has descended from this view, as the fortunes of seaside resorts have declined, dwells on the ongoing decay, (BBC News, August 2013) despair (Barrow, August 2013) and dysfunction (Derounian, October 2013) of these neglected resorts, their inhabitants and visitors dehumanised and either ignored or gawped at (Doctorow, June 2014). The Weird Sea has now become not merely misleading, but harmful, where even those who live by it have become tainted, alienated and 'othered'. It is a very British descent into despair, cynicism and irrationality; the point where we turn against the environment itself.

## Conclusions

This paper is not an argument for or against cryptozoology. Should a sea serpent one day emerge from the depths, live on national television, then that is a discussion for the life scientists. Nor is it a jeremiad for the halcyon days of British naval domination; Britannia should not 'rule the waves' again, no more than anyone else should. Rather, we should learn to reconnect with the sea because it was, is, and shall remain an essential fixture of our geography, our history and our

day-to-day lives, with or without the press as gatekeepers. At the very least, we should engage with it on its own terms rather than as an outlet for our fears and irrationalities. Perhaps we can then learn to accept the sea for all its wonder, horror and its ordinariness. Yet first we must discard the Weird Sea and the process of othering: perhaps then we will remember that Britain remains a series of islands surrounded and defined by the sea.

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## **IV. Climate and Environment**



# UK maritime disasters since 1950 and their implications for ports, coastline and the Exclusive Economic Zone (EEZ)

*Esmé Frances Flegg*

## Introduction

For an island state such as the UK, economic activity and trade associated with its maritime regions of ports, coastline, and the Exclusive Economic Zone (EEZ) is vital. Recent studies have found 95% of trade by volume and 75% by value enters the UK by shipping (Department for Transport, 2012; HR Wallingford, 2012). In 2011, additionally to its key role in transporting traded goods, the port sector was responsible for 0.4% of total UK employment and 0.5% of its GDP (Oxford Economics, 2013). In contrast air transport, a sector focused on the transportation of people rather than commodities, provided 1% of total UK employment and 3.6% of UK GDP in 2009 (Oxford Economics, 2011). The continued success and safety of operations in these maritime regions are predicted to be tested in future decades through sea-level rise, rising average temperatures, possible changes in extreme weather events, competition for business from other ports and shifts in demand of commodity types. An understanding of past and present vulnerability to extreme conditions provides an important context which will inform assessments of these future challenges (McEvoy and Mullett, 2013; Scott *et al.*, 2013; Met Office, 2014). This study aimed to investigate two key aspects of maritime disasters affecting the UK since 1950:

- To assess how the severities of disasters differ.
- To investigate how the vulnerability of ports, coastline and EEZ differs both spatially (such as between different ports) and temporally (for example if comparable events occurred in 1950 and 2010).

In the context of this study the following definitions were used:

- EEZ – An area of water extending up to 200 nautical miles from the baseline. In this zone the sovereign, or coastal, state has rights of using, exploiting and managing the waters and seabed (*United Nations Convention on the Law of the Sea, Article 55, 1982*).
- Natural variability – Climate varies naturally through time, and variability occurs in stable unchanging environments (Madden, 1976).

For example one June may be hotter than mean conditions; or rainfall in one year may be less than the recorded average.

- Climate Change – It is identified as long-term changes in climate (either in mean or extreme conditions) which can be confirmed by scientific analysis, such as statistical tests (IPCC, 2012). Climate change can arise from both natural conditions (such as the solar cycle), and anthropogenic forcing. In the context of this study climate change refers to changes caused by anthropogenic activity (such as from burning of fossil fuels).
- Risk – the probability of a circumstance occurring with a particular severity of impact(s) (Schneider *et al.*, 2007).
- Vulnerability – the extent to which a system or society is likely to be negatively affected by a situation – such as a storm surge (IPCC, 2012).
- Maritime disasters – situations caused by a hazardous event, or sequence of events, that negatively affects ‘business as usual’ conditions. The outcomes of such situations can affect many variables such as the environment, finance and construction.

In many historical cases maritime disasters have left a legacy of damage and disruption, often requiring physical and financial support from internal and external organisations beyond local or national government. Examples of this include €166.91 million contribution from the European Union Solidarity Fund (EUSF) to Germany following damage caused by storm Kyrill (European Commission, 2015) and payments from the Federal Emergency Management Agency (FEMA) for those affected by events such as hurricanes Katrina, Rita and Wilma (Federal Emergency Management Agency, 2006). Such disasters have been found to have a wide range of severe impacts on the built environment and construction zones of the marine region (Wilby, 2007). Impacts have included the loss of, or damage to, offshore oil platforms; port closures or damage; or result in coastal damage (such as breaching of sea defences and/or flooding of coastal communities).

The legacy of severe maritime disasters, and their impact on society, cling on in public memory, as more recent disasters are often touted as “the worst of its kind since...”. The aptly named ‘Great Storm’ of 1703 captured the imagination of Daniel Defoe and was immortalised in his book *The Storm*, which was one of the first publications to combine journalistic analysis and scientific observation (Defoe,

1704). Approximately 8,000 men lost their lives (Lamb, 2012), with most deaths occurring on vessels sunk by the storm, making it as one of the most severe, and deadly, disasters in UK history. The significance of loss of life from this event is made even more apparent considering the UK's population was only an estimated 5.2 million (Lee and Schofield, 1981). Other damages included extensive flooding, damage to traded goods (e.g. sugar and tobacco), structural damage to a number of ports and harbours (including Bristol, Gloucester, Portsmouth and King's Lynn) and a loss of over 300 vessels, including 12 from the Royal Navy (Anon, 1826; Brayne, 2003).

### **Methodology**

There is no catalogue of maritime events and disasters, their impacts, severity and legacy. However, records of maritime disasters are available, primarily through media reports rather than academic articles, allowing the development of such a database. This study aimed to build a database of maritime disasters affecting the UK since 1950. Events prior to this were excluded as a consequence of inconsistent recording of events. This is particularly apparent during the two world wars, as events including maritime disasters, which highlight vulnerability, tended not to be published in order to prevent contradiction of positive propaganda produced by Allied Forces for British citizens (Marquis, 1978). Data were analysed from the UK's 111 active commercial ports (Department for Transport, 2014), with a focus on its 45 major ports.

The data gathered were used to develop an understanding of how ports, coastline and EEZ are vulnerable to maritime disasters. 91 disaster events were identified since 1950. Disaster severity were scaled from those that caused only disruption, to events which caused extensive damage and loss of life. Disasters can arise from a single factor, such as human error, or can be composite events. Composite disasters refer to events where damage is caused by multiple causes, such as a combined wind storm and storm surge (Wisner *et al.*, 2004). For the purpose of this study each event was classified according to the primary cause of damage or disruption, even if the event types were related. This method was used to improve the understanding of whether particular aspects of composite events tend to be most disastrous.

## **Severities of maritime disasters**

Ports were found to have been affected by the most maritime disasters – 56 out of 91; whilst the EEZ was impacted by 35 and the coastline 27 events respectively. If a disaster affected more than one region, for example both ports and coastline, it was recorded twice. Twenty of the recorded events affected multiple regions, with eight of these affecting ports, coastline and the EEZ. The majority of the events were recorded since the 1990s. This does not reflect a change in the number of disasters but instead points to increased reporting of minor events recorded following the development of internet based news reporting. Serious maritime disasters tend to be recorded in multiple reports (e.g. newspapers, online articles, audio and visual media) whereas less severe events tend to have smaller readerships and are usually recorded in online reports alone (Althaus and Tewksbury, 2002).

Eight primary causes, or mechanisms, were identified for maritime disasters:

- Coastal flooding
- Human error
- Mechanical fault (occurring on board a vessel, aircraft or offshore platform)
- Poor visibility
- Rough seas
- Snow and ice
- Storm surge
- Wind storm

The most common disasters were wind storms and human error which caused over 60% of events. Maritime disasters caused by natural processes, such as storm surges, showed a strong seasonal distribution, with the most events occurring between November and January. This result was expected, as during the winter months UK maritime conditions tend to be worse. Planning mechanisms can be put in place by stakeholders in anticipation of periods of increased risk or vulnerability.

The UK government (both local and national), industry and port operators were shown to suffer a range of negative financial implications following maritime disasters. These impacts included loss of trade, and the necessary measures of



setting up compensation schemes, and implementing environmental clean-up operations (such as recovery after oil spills).

Ports were impacted by four of the five most expensive maritime disasters (Table 1). The majority of the costliest maritime disasters were found to be primarily caused by wind storms. Impacts from wind storms included damage to infrastructure and vessels, and delays to services (such as transport of goods and passengers).

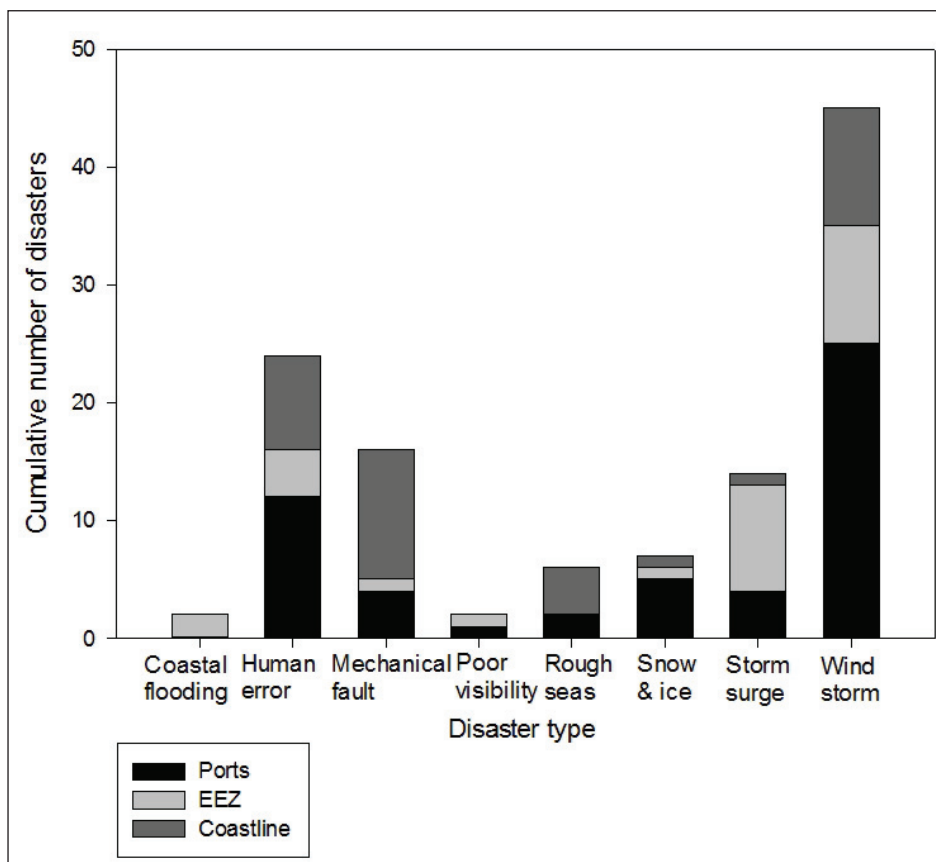
<i>Date</i>	<i>Event classification</i>	<i>Insured losses (2014 values)</i>
<i>January 25<sup>th</sup> 1990</i>	Wind storm	£4 billion
<i>October 15<sup>th</sup> – 16<sup>th</sup> 1987</i>	Wind storm	£3.46 billion
<i>January 31<sup>st</sup> – February 1<sup>st</sup> 1953</i>	Storm surge	£1.2 billion (absolute)
<i>January 2<sup>nd</sup> – 4<sup>th</sup> 1976</i>	Wind storm	£816 million
<i>January 17<sup>th</sup> – 19<sup>th</sup> 2007</i>	Wind storm	£484 million

**Table 1:** Insured losses resulting from the five most expensive maritime disasters since 1950 (nb. losses from 1953 are absolute – total losses – as many businesses and houses were uninsured at that time).

### **Spatial and temporal differences in vulnerability**

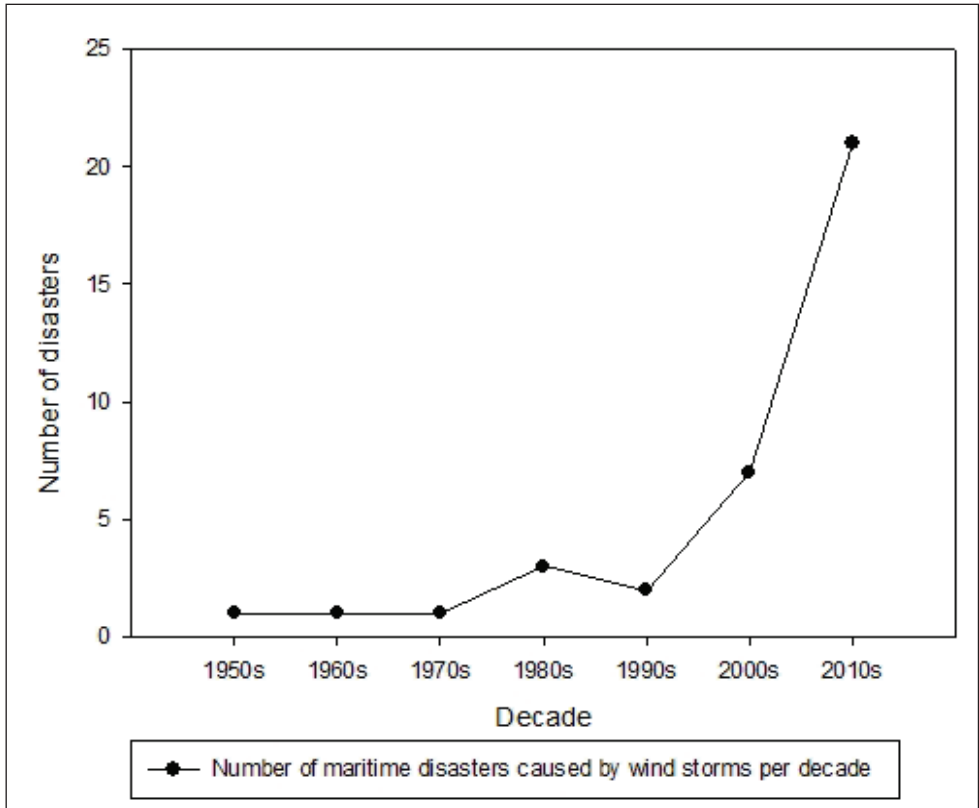
It was found that few maritime disasters affected the entire UK, but instead particular regions were impacted. The extent of the region displaying negative impacts varied greatly, mainly in accordance with the disaster type and severity. The majority of recorded events affected part of the south of England (from Selsey Bill to Lyme Regis), the shipping regions of Fair Isle (around Shetland in Scotland) and Dover, and the ports of Felixstowe and Dover.

The most common maritime disaster recorded varied by the zone of interest; namely wind storms affected ports and the coastline most frequently, whilst the EEZ demonstrated a particular vulnerability to disasters caused by mechanical faults from vessels, oil platforms and related aircraft (such as those transporting platform staff) (see Figure 1).



**Figure 1:** Stacked bar graph of the 8 recorded disaster types and the number of recorded occurrences in ports, EEZ and coastline since 1950.

The number of wind storms has increased significantly since the 1990s (see Figure 2). A concern that has developed alongside this trend is that ports have become more susceptible to wind storms in recent decades. This is a direct consequence of the increased mechanisation in ports, such as the use of high level cranes, and containerisation of trade (Bakermans, 2014). This infrastructure is vulnerable in high winds, reducing much of its functionality and putting the safety of workers at risk. Other causes of this increased frequency of recorded wind storm events arises from pre-emptive closures following implementation of more rigorous health and safety regulations, and improved communications through announcements and blogs covering closures and disruptions.



**Figure 2:** Graph of the number of recorded events caused by wind storms per decade since 1950.

Events located at the start of the study period tended to be associated with lives lost, extensive inland flooding and consequential damage to homes, businesses, infrastructure and agricultural land. The severity of these disasters were met by strong, active, responses by the government and other bodies of authority. Examples of their acceptance of the risk and dangers posed by these events are detailed in Table 2.

Measures such as these have acted to assist in a reduction in the UK's vulnerability to storm surges and flooding. This is represented by a decline in the recorded severity of such events. For example, during the winter storms of 2013/2014, waters higher than the devastating 1953 storm surge were recorded (BBC, 2013b; BBC, 2013a; BBC, 2013c), but the extent of the disaster was mainly restricted to major disruptions and financial losses. This is in strong contrast to the

extensive damage and loss of life experienced as a consequence of the 1953 storm surge.

Date of disaster(s)	Response to maritime disaster
31 <sup>st</sup> January to 1 <sup>st</sup> February 1953 13 <sup>th</sup> December 1981	Improved sea defences (Burnham on Sea, 2011; Lumbroso and Vinet, 2011)
31 <sup>st</sup> January to 1 <sup>st</sup> February 1953	Development of early warning systems (Lumbroso and Vinet, 2011)
3 <sup>rd</sup> April 2012	The Met Office clarified terminology used to describe severe weather conditions (MAIB, 2013)

**Table 2:** Responses by the Government and other bodies of authorities to disaster events.

The nature and extent of maritime disasters have been shown to alter through time regardless of availability of data. This has arisen from increased preparedness for disaster and shifts in the activity and use of these regions. For example, an increase in events affecting the EEZ was identified from the 1960s following the discovery of oil in the North Sea. The first British offshore oil platform Sea Gem was installed in 1965, and also resulted in the first UK disaster involving an oil rig (Burke, 2013). The majority of disasters recorded in the EEZ until 1990 were related to oil platforms; 50% of events in the 1960s, 100% in the 1970s and 83% in the 1980s.

**Conclusions**

This research has filled a vital gap in records of maritime disasters by building a catalogue of events which have affected the UK. The events recorded have had severe damaging and disruptive consequences for many sectors in the UK – such as industry, environment, trade and society.

The UK is vulnerable to maritime disasters from a number of sources that are both natural and anthropogenic. Wind storms and human error were identified

as the most common causes of maritime disasters. Ports were shown to have experienced more disasters than the coastline and EEZ. Decision makers have, and are continuing, to take key steps to tackle the sensitivity of ports, coastline and the EEZ. However, many of these decisions have occurred in the wake of events. This means that decisions are often response-led, rather than in line with predictions of likely risk or vulnerability.

The next stage of this research will be to look at in further detail what the consequences of maritime disasters are for UK ports. This will allow answers to be given for many questions, such as what aspects of ports are most vulnerable to disasters, and what techniques are currently used to recover from damage and disruption. The overall goal of this work will be to aid port decision-makers in their preparations for the challenges they face from extreme events.

## Acknowledgements

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# Creek networks: natural evolution and design choices for intertidal habitat recreation

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## Abstract

With the current rise in sea level jeopardising coastal biodiversity and the efficiency of traditional flood defence solutions, more sustainable coastal management options are being considered. The use of artificially restored intertidal habitats (mudflats and saltmarshes) as buffer zones for tidal and wave energy has been tested at numerous sites in the UK and around the world. Since the 1970s, the design of these habitats has significantly evolved along with our understanding of the natural processes involved. This paper reviews the state of the art in intertidal habitat recreation, focusing mainly on creek networks, for which no global systematic design method exists. The main parameters that control their initiation and development are investigated through the observation of natural creek networks and through the reproduction of this development in laboratory and numerical models. In areas like San Francisco Bay, such parameters have already been used in geometric relationships to provide guidelines for creek network implementation, but these empirical relationships are likely to be very site dependent. A series of steps is proposed to extend this implementation technique to other sites, thus making the design strategy more systematic and globally applicable. The sustainability of existing habitat recreation schemes remains a debated point, making the need for quantitatively defined objectives and better implementation guidelines all the more pressing.

## 1. Introduction

The coastal zone is one of the most populated environments in the world, with over 10% of the population living less than 10 m above mean sea level (Gedan et al. 2011). In the context of rising sea levels, these populations are becoming increasingly vulnerable to flooding and coastal erosion as existing flood defences are becoming less efficient at protecting the low-lying coastal areas. The cost of maintaining the flood defences is likely to increase because of the enhanced impact

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of the waves and the higher defences needed to contain the higher sea levels (Turner, Adger & Doktor 1995). Furthermore, natural coastal habitats such as vegetated saltmarshes and unvegetated mudflats are being lost globally due to sea level rise and urbanisation, with dramatic consequences for biodiversity (Atkinson et al. 2004; Doody 2004; Tempest, Harvey & Spencer 2014). In the UK, more than 100 ha of intertidal habitats are being lost per year (Atkinson et al. 2004).

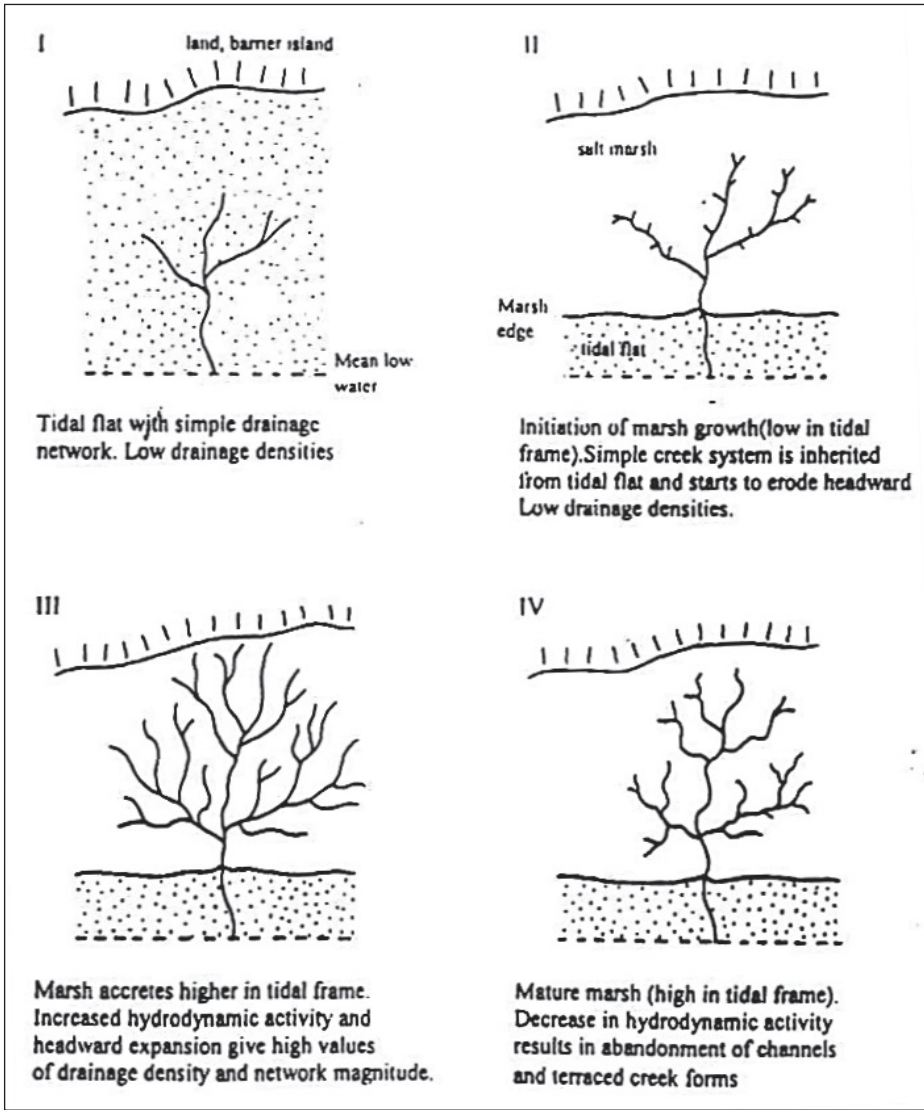
The value of these habitats as natural coastal defences is being increasingly recognised: they play a significant role in reducing tide and wave action, and in preventing coastal erosion (Van der Wal and Pye 2008; Gedan et al. 2011; Möller et al. 2014). The loss of wetland habitats such as saltmarshes also has a potential impact for carbon emissions since they act as a natural carbon sink (Ahn and Jones 2013; Tempest, Harvey & Spencer 2014).

In order to face these issues, intertidal habitat recreation has been attempted in a number of countries. The schemes, generally occurring in previously reclaimed agricultural lands, involve varying degrees of engineering and landscaping. The simplest strategy is to breach the old defence and open the site to tidal influence without any additional engineering. More elaborate schemes involve the excavation of a creek network: according to the ABPmer Online Marine Registry Database, out of 40 flood defence realignment projects implemented in the UK, 8 involved some form of creek excavation or reactivation of relic features (ABPmer Online Marine Registry 2014).

This trend is likely to continue as creeks are increasingly recognised to be a key feature in natural systems due to their influence on drainage and nutrient circulation (D'Alpaos et al. 2006; Tesser, Alpaos & Lanzoni 2007; Zhou et al. 2014). Their branching nature is also thought to contribute to the dissipation of tidal energy, and thus to the efficiency of the coastal wetland as a flood defence (Steel 1996).

The aim of this paper is to review the current state of the art in creek network design for habitat recreation in order to provide a more systematic implementation method. The first objective is to review our understanding of the initiation and development of creek networks in natural intertidal habitats. The second objective explores how reproducing this development in laboratory experiments and numerical models can provide insight into the processes involved. Finally, different implementation techniques will be assessed based on case studies. A concern is whether or not these newly implemented intertidal

habitats will provide the same biological functions and ecosystem services as a natural, mature environment.



**Fig. 1.** Evolution model for a tidal creek network (Steel and Pye 1997).

**Understanding creek systems in natural marshes**

In shallow coastal environments, a creek system drives the exchange of sediment and water. It is thought that the tidal regime plays an important role in

the development of a creek network. According to Steel and Pye’s (1997) creek evolution model, this evolution occurs in several main stages (Fig. 1). In the initial phase where vegetation starts to colonise, the morphology of the creek network is largely controlled by the runnels that were eroded by the tide in the mudflat and the drainage density is poorly developed (Fig. 1. II). The intermediate phase sees the marsh accrete vertically; the elevation gradient enhances the water energy in the channels, causing the appearance of lower order creeks (more intersections) as the drainage density increases (Fig. 1. III). In the final phase, however, the elevation is such that only large tidal events affect the upper marsh (Fig. 1. IV). The drainage density decreases and the lower order creeks are abandoned (Steel and Pye 1997).

This creek evolution model is very simplified: creek morphologies (the shape of a creek network and its ramifications) can vary considerably, even within the same estuary (Hugues 2012). Indeed, the morphology and stability of the creeks depend on the local conditions of the site: antecedent geology, sediment type, presence or absence of vegetation, tidal and wave forces all play an important role. Finally, the presence of relic features such as trenches for agricultural drainage can influence the development of a creek network by constraining it to a particular morphology. Table 1 attempts to summarise how different factors influence the creek volume, creek order and growth rate of a creek network based on the published literature. Notice that the proportion of vegetated marsh has been added since it is a primary condition for creek network development, as seen in Steel and Pye’s (1997) model.

Depending on the local conditions, the initiation and development of a creek network can take place within a few tidal cycles or over several years (Hugues 2012). Since being able to observe the initiation and early development of a creek network is rare, the monitoring of creek network development in controlled conditions has been explored by various models.

**Table 1. (overleaf)** Summary of factors influencing creek network development and stability (Light green represents a positive impact, dark red a negative impact, and white a variable or unknown impact on creek network development).

	Creek volume	Creek order	Creek network growth rate	Proportion vegetated marsh / unvegetated mudflat
<b>Vegetation density</b>	Can either stabilise the creek banks or favour erosion by focusing the flow (D'Alpaos et al. 2007; Schwarz et al. 2014).	Denser vegetation increases drainage density of creeks according to physical and numerical models (Temmerman et al. 2007).	Can either stabilise the creek banks or favour erosion by focusing the flow (D'Alpaos et al. 2007; Schwarz et al. 2014).	Positive feedback as vegetation acts as sediment trap, encouraging further plant growth (Gedan et al. 2011).
<b>Presence of relic features</b>	Initial irregularities will largely impact the creek shape due to strong feedback processes (Zhou et al. 2014).	Causes superimposed features as the creek network develops (Crooks et al. 2002; Hugues 2012).	Jump-starts the development of creeks by focusing the flow (Knighton 1992; Wallace et al. 2005).	More bed irregularities, encouraging plant diversity and development (Zedler et al. 1999).
<b>Sediment compaction (ex: agricultural lands)</b>	Sediment compaction can limit creek incision (Williams et al. 2004).	Sediment compaction can limit creek incision (Williams et al. 2004).	Sediment compaction can limit creek incision (Williams et al. 2004).	Compaction prevents root development (Spencer & Harvey 2012).
<b>High sedimentation rate</b>	Too high sedimentation rate can block the channel (Zedler & West 2008).	Favours complex, high density creek networks (Crooks et al. 2002).	Creek growth is a combination of erosion and sedimentation processes (Steel 1996).	Accumulation of sediment encourages plant growth (Crooks et al. 2002).
<b>Openness to sea conditions (the marsh is not sheltered)</b>	Higher tidal and wave energy favours creek incision (Marani et al. 2003).	Higher tidal and wave energy favours creek incision (Marani et al. 2003).	Higher tidal and wave energy favours creek incision (Marani et al. 2003).	Discourages sedimentation and favours unvegetated mudflats (Mazik et al. 2010).
<b>High tidal range</b>	Higher tidal energy favours creek incision (Marani et al. 2003).	Higher tidal energy favours creek incision (Marani et al. 2003).	Higher tidal energy favours creek incision (Marani et al. 2003).	Higher tidal range means more inundated areas where the vegetation cannot develop (Steel 1996).

## **Reproduction in laboratory experiments and numerical models**

Physical or numerical models make it possible to monitor a simplified system at a superior resolution and frequency than could be achieved with field observations (Vlaswinkel & Cantelli 2012). Models give control over the external conditions impacting the study site, such as the tidal regime or the initial channel geometry (Tambroni et al. 2005). However they still need to be validated with field data, especially in the case of complex systems like creek networks (Stammerman 2013; Zhou et al. 2014).

Laboratory modelling of tidal creek networks in tanks has only been undertaken recently (Tesser, Alpaos & Lanzoni 2007). Compared to numerical modelling, it has the advantage of reproducing several physical processes that cannot be simulated through equations, such as the erosion of the banks, and are thus less simplified (Kleinhans et al. 2012; Zhou et al. 2014).

The main limitation of laboratory models is the scaling effect. Since the modelled creek network develops in a much smaller basin than its real-world counterpart, and in a much shorter timescale, the forces involved will not be identical (Heller 2011). A geometric similarity can be kept by preserving the same width:depth ratio as in a natural system. Dimensionless numbers such as Reynolds, Froude and Weber are used to try and obtain dynamic similarity, although a choice must generally be made between different relevant forces when obtaining similarity for all of them is incompatible (Heller 2011).

The scaling effect is hardest to avoid in the case of sediment transport modelling: even if similar width:depth ratios are preserved, the grains used will be too large compared to the size of the creek network. The hydraulic energy of the system is then too low to allow sediment motion to occur. Such inaccuracies can be partially compensated by other distortions, in this case choosing a sediment of lesser density (Tambroni et al. 2005). A common substitute consists of lightweight cohesionless plastic grains, which reproduce the bedload sediment transport (sliding of sediment without resuspension), but neglect sediment suspension (Tambroni et al. 2005; Tesser, Alpaos & Lanzoni 2007; Stefanon et al. 2010; Iwasaki, Shimizu & Kimura 2012). Additionally, the recreation of sediment suspension is attempted with fine sand, and cohesive sediment is mimicked by fine (0.04 mm diameter) silica flour (Kleinhans et al. 2012).

Bearing in mind the limitations associated with scaling, experiments have succeeded in reproducing a morphology similar to that of natural systems. However, the channels obtained are overly wide and shallow (Stefanon et al. 2010;

Iwasaki, Shimizu & Kimura 2012). This exclusively erosive behaviour is partly due to the absence of sediment input from the sea or from the hinterland, and also probably related to the absence of vegetation and cohesive sediment.

Similarly to laboratory experiments, numerical models allow the researchers to target specific influencing factors in order to see their impact on the whole system. Some numerical models use a simplified coastal morphology (Marciano et al. 2005; Iwasaki, Shimizu & Kimura 2012); others base themselves on tidal channel networks extracted from digital terrain maps. The end result of the mode can then be compared with the equilibrium state observed on site (D'Alpaos et al. 2007). Such models have demonstrated the importance of the initial morphology of the site: the synthetic creeks obtained tend to closely resemble the ones observed in real life, even when the other input parameters (tide and sediment characteristics) are changed. Indeed the topography controls the inundation time and flow routes, hence where channel incision will occur (D'Alpaos et al. 2007).

Though some of the experiments reproduce the laboratory conditions with cohesionless grains and unvegetated beds (Iwasaki, Shimizu & Kimura 2012), the effect of vegetation can be investigated with numerical models. This requires knowledge of the interaction processes between the plants and the flow around them (Temmerman et al. 2005). Interestingly, results from such models challenge the generally accepted view that vegetation only has a stabilising effect on the creek network, pointing to an erosive effect under certain circumstances. It is generally accepted that vegetation stabilises the substrate, directly through the binding properties of the roots and indirectly through the flow reduction caused by the stems and leaves (Marani et al. 2006; Gedan et al. 2011). However, if the elevation is enough that the vegetation is not entirely submerged at high water, dense vegetation patches can obstruct the flow and redirect it to channels that will thus be incised more efficiently (Temmerman et al. 2007; Schwarz et al. 2014). Here again, the role of the initial topography is predominant.

Numerical models and laboratory experiments can test and if necessary challenge our preconceptions regarding the main controlling parameters for creek network development. However both have their limitations and need to be validated with field data whenever possible.

### **Design choices in habitat recreation projects and limits**

Findings from numerical and laboratory models stress the importance of initial topography for creek network development. Habitat recreation schemes generally occur in agricultural lands: it is suspected that the compacted ground could slow down or even prevent the spontaneous initiation of a creek network, especially if the elevation of the site is high compared to the tidal range (Williams et al. 2004). As a result, engineering work on the realignment site can be necessary to initialise a creek network and ensure that the appropriate habitats are created.

The implementation technique depends on the particular objectives of each habitat restoration scheme. These objectives are generally multiple and typically include saltmarsh or mudflat recreation, improved flood defences and reduction of flood defence costs (Esteves 2013). The initial elevation is a determining factor for whether the site will evolve into a vegetated saltmarsh or an unvegetated mudflat (Blott & Pye 2004), as the distribution of species in natural coastal wetlands depends on the elevation and on the proximity to tidal creeks (Zedler et al. 1999).

Ignoring these physical factors has led to the failure of several habitat restoration projects in San Francisco Bay, where unmanaged sites proved too high and insufficiently exposed to tidal inundation for vegetation to survive (Williams et al. 2001). Excavation or infill has been tested in several projects to obtain similar topographies and creek networks to those found in mature coastal wetlands; however while this engineering work has jump-started drainage in some sites (Wallace, Callaway & Zedler 2005), in others there was no significant acceleration of vegetation development compared to unmanaged restoration projects (Williams et al. 2001). Further comparison of highly engineered restoration projects with cases of passive ecosystem recovery is necessary to improve decision making (Almeida et al. 2014).

It is widely considered that a restoration project should have a starting morphology that encourages physical processes such as sedimentation and tidal incision of the creeks (D'Alpaos et al. 2007). Yet in the natural environment, the creek network morphology can vary greatly within the same estuary depending on the vegetation, sediment properties and tidal regime (Hugues 2012). That is why the use of laboratory or numerical models are needed to observe the evolution of the creek network for the conditions characteristic of a given restoration site. Design guidelines exist for saltmarsh creation projects, but they either limit their mention of creek networks to a few paragraphs (Nottage & Robertson 2005) or focus on a specific area such as San Francisco Bay (Williams et al. 2004).



A new model is needed to give more systematic guidelines regarding creek network design. Two main types of constraints arise from this review: on the one hand, limitations sets by the available site itself (tidal range, size of the site, characteristics of the sediment); on the other hand, the pre-defined objectives of the restoration project (proportion of saltmarsh and mudflat, type of vegetation, which gives an idea of the desired elevation of the site). The latter necessitates a good primary definition of the objectives of the restoration projects by the stakeholders (Esteves 2013).

The desired output from such a model is a morphological template, like a map of how the creek network should look. This would come in the form of a set of dimensionless parameters, such as the width:depth ratio and creek density that should be excavated to optimise the drainage of the site (Zeff 1999). Some creek network geometry relationships can be found in the literature (Williams et al. 2004), but their applicability beyond San Francisco Bay needs to be investigated.

Unfortunately, even this type of model would not ensure the creation of a sustainable restoration habitat. Indeed considering the morphology and hydrodynamics is not sufficient to predict the evolution of a habitat recreation site: biogeochemical processes also play a major role. In an intertidal habitat recreated over agricultural land, the sediments have been altered and compacted thus preventing drainage, nutrient transport and root growth (Spencer 2012; Tempest 2014). This is a problem for long-term biodiversity (Garbutt, Reading & Wolters 2006), but also for the carbon storage capacity of wetlands, which depends a lot on the biomass production (Ahn & Jones 2013). Interestingly, the machinery work that is used to obtain the correct elevation enhances the compaction of the soil: thus inappropriate landscaping can have negative effects on vegetation colonisation (Nottage & Robertson 2005). For this reason some restoration sites have been ploughed to reduce the compaction of surface sediments following earthworks (Nottage & Robertson 2005).

In the same way as models need to be validated with field data, many current questions regarding recreated habitat design will only be answered through long term monitoring of existing schemes. The Steart coastal management project (Fig. 2), the largest coastal management scheme undertaken in Europe to date with about 440 hectares of agricultural lands converted into intertidal and freshwater habitats since September 2014 (Townsend 2014), is a valuable site for monitoring the effect of soil compaction and creek network excavation on habitat development. Indeed, extensive landscaping has been undertaken prior to



breaching, with the implementation of a large herring-bone shaped creek network (Fig. 2). Field data are being regularly collected since the implementation of the scheme, including the sediment resistance to erosion and the morphological evolution of the creek network. However only long-term monitoring will provide information as to whether the creek network encourages the development of a sustainable habitat despite the altered soil.



**Figure 2.** Steart managed realignment scheme, September 2014 (Sacha Dent, WWT).

Ideally, a way around costly engineering would be to select sites of adequate initial morphology to develop into coastal wetlands with minimum intervention: the development of creek network can be jump-started by reactivating relic creek systems for instance (Hampshire 2011). A list of potential sites for wetland restoration in Europe has been proposed by previous studies (Schleupner et al. 2013), but the probability of finding a perfectly suitable site for a given project is low. Indeed, the number of potential restoration sites is limited not only by geomorphological aspects, but also because of economic and social factors such as proximity of the site to urban areas and opposition from the stakeholders (Pontee 2014).

## Conclusion

This paper has summarised the current state of knowledge for creek network development, and how that information is being used for coastal wetland restoration projects. The determinant role of tidal creek networks for drainage, nutrient transport and vegetation colonisation has been widely recognised. Modelling creek network development in physical and numerical models suggests that the initial morphology of the site plays a major role in the ultimate development of drainage density. Furthermore, many restoration sites are initially agricultural lands: the compacted soil and inappropriate elevation put into question their capacity to evolve into fully functioning intertidal ecosystems without engineering work. As a result, focus should be put on optimising the design of artificial creek networks in order to jump-start the drainage density of a restored coastal wetland when deemed necessary. At present, restoration guidelines are either vague regarding creek network implementation, or specific to certain areas. More systematic guidelines based on the following steps are needed:

- Quantitatively define the objectives of the wetland restoration schemes to get a better idea of the desired habitats, and thus of the necessary elevation distributions.
- Use the parameters inferred from these objectives (elevation gradients, distribution of habitats) as well as the specific conditions of a site (site area, tidal range, sediment characteristics) to apply empirical geometry relationships to the particular scheme. The end products of these relationships are geometrical parameters such as width:depth ratio and creek density to guide the implementation of a creek network. Such relationships exist for San Francisco Bay, but need to be tested in numerical and laboratory models to verify their wider applicability.

This strategy aims to provide the 'best possible' creek network morphology for a given coastal wetland restoration project. In reality, the choice will be complicated by several considerations: what sites are made available to habitat restoration? Are the environmental gains worth the cost of creek network implementation in these sites? Is there a relic creek network present on site, and should it be reactivated? Answering most of these questions will require long-term monitoring of existing habitat restoration schemes made with different implementation choices.

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# Of Schooners and Sagamen: Anglo-Icelandic Tourism in the Nineteenth Century

*Thomas Spray*

This paper will demonstrate how the construction of nationalist identity changed the focus of British maritime travel to Iceland from the geo-environmental to the literary, exploring the figure of the travelling English ‘Sagaman’ across the nineteenth century. Firstly, through a comparison of accounts of travel to Iceland in the two halves of the nineteenth century, it will consider how Anglo-Scandinavian seafaring was bolstered by interest emerging from interaction with the Icelandic sagas. Secondly, it will look at the concurrent construction and expansion of the sea lines of communication between Britain and Iceland during this period.

In 1856 Lord Dufferin set out in the schooner yacht *Foam* to Iceland in an attempt to sample the peculiarities of the alluring ‘True North.’<sup>37</sup> His self-chosen expedition title: ‘Navigator, Artist, and Sagaman’ (Dufferin 1903, xxiv). In the mid-1800s such non-trade-related travel to Iceland was not unheard of. Many seafarers were drawn by scientific interests: as shown by a contemporary traveller Charles Forbes, in his 1860 account of *Volcanoes, Geysers, and Glaciers*. Yet Dufferin’s approach was indicative of an increasing interest in Iceland as an English nationalist’s ideal. The top theories of the day suggested that the Scandinavians had given the British Empire many of its finest inherited qualities, paving the path for imperial greatness (Dufferin 1903, 219). As a preserved sample of a common, early northern European culture, Iceland was ancestral ground. Its literature and histories provided important studies in racial construction. As Forbes put it, all that was good about Britain could be ‘traced to the spark left burning upon our shores by those northern barbarians’ (Forbes 1860, 81).

The Icelandic sagas, medieval accounts of the histories and legends of early northern Europe, were simply unavailable to the public in the early nineteenth

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<sup>37</sup> Frederick William Hamilton Temple Blackwood, 1st Marquis of Dufferin and Ava (1826-1902), came from Irish nobility and served as a British diplomat and ambassador for numerous countries including Canada, France, India, and Russia. His account of his voyage to Iceland and Norway was one of the most popular Victorian travel books, and at his death was approaching its eleventh edition. For more information see Hansson 2009.

century, published only in the original Old Norse and in rare and costly Latin translations (often via other Scandinavian languages). Nationalist engagement with Iceland, in the form of travel accounts stressing Anglo-Icelandic similarities, was undoubtedly linked with the rise of translated saga literature. Publications such as Walter Scott's *Eyrbyggja saga* extracts and George Dasent's *Njáls saga* translation encouraged a wave of seafaring artists, novelists, and poets to pick up their pens and set sail for Iceland. William Morris, Anthony Trollope, and W. G. Collingwood were just a handful of well-known names amidst a veritable crowd of literary pilgrims. Back in Britain, general interest in northern antiquity, encouraged through the works of writers such as Percy, Blackwell, Thorpe, and Laing, both supported and inspired research into the leading theories of northern Romantic Nationalist philology. Dufferin's account drew eagerly from these, particularly Scott's *Eyrbyggja saga* extracts (although he did not always credit Scott) and Laing's *Heimskringla*, picking and choosing elements as he pleased (Dufferin 1903, 96-98; 31). Such combinations of nationalist-framed translations and ethnographic histories encouraged yet more travellers, including the explorer Richard Burton, intent on mapping the racial characteristics of the north.

### **Ice and Fire: Accounts of Travel to Iceland 1800-1860**

In order to contextualise this development, one should consider the focus of Anglo-Icelandic sea-faring in the early nineteenth century. Sabine Baring-Gould, who published his *Iceland: Its Scenes and Sagas* in 1863, listed eighteen other travel accounts available to the English reader – provided they took the occasional dip into German (Baring-Gould 2007, lxxvii). While many of these authors were interested in the literature of Iceland, the focus for the majority of travel between Britain and Iceland was trading opportunities, racial profiling, or scientific discovery. On the literary front, the poetry and mythology of the *Eddas* had long been subject for discussion, but the Icelandic 'family sagas', or *Íslendingasögur*, did not seriously make their mark on the public's imagination until the publication of George Webbe Dasent's *The Story of Burnt Njal* in 1861, even with such eminent early admirers as Sir Walter Scott.

Instead, profiles of Iceland took a scientific angle. The scientist Joseph Banks visited the country in 1772 and although he never published his notes he lent them to the travellers of the early 1800s, notably William Jackson Hooker. Banks neither visited saga sites nor engaged with the sagas themselves, despite collecting a large number of manuscripts including a copy of *Njála* (Add. 4867)



which he later donated to the British Library (Halldór Hermannsson 1966, 15-17; see also von Troil 1780, ix; 30). None of the party spoke Icelandic. On returning to Britain, Banks remained an expert on Icelandic matters but his engagement was largely dictated by Britain's open hostilities with Denmark in the early 1800's. The government was interested in the possibility of seizing Iceland by force, and Banks was essentially asked to construct a plan of attack. '500 men,' he suggested, could comfortably take the entire country with little if any loss of life; Banks argued Iceland was logically a part of the British Empire anyway, this being in his mind all that was accessible only by sea (Halldór Hermannsson 1966, 29; 31). Constructed with the help of Banks' notes, William Jackson Hooker's account of his 1809 trip follows similar lines of interest. Hooker explains that he had been inspired by the earlier voyage and longed to see the volcanoes and the hot springs (Hooker 1813, i). Brief flirtations with antiquity and even the book's pictures are adopted second-hand from Banks or Ólafsson & Pálsson, and Hooker does not dwell on the sagas (Hooker 1813, lxxxiii-lxxxiv; Ólafsson & Pálsson 1805, 154).

Sir George Steuart Mackenzie obviously sailed and rode past several saga sites in his 1810 travels. Mackenzie's principle goal was mineralogical research alongside exploring the 'many extraordinary natural phenomena' of Iceland, chiefly the eponymous Geysir (Mackenzie 1812, ix-x). For non-geographers Mackenzie's account had something of a first: an extensive dissertation on Icelandic literature written by co-traveller Henry Holland. Yet it transpired this was not as useful as one might have hoped. Holland's dissertation relied heavily on Latin sources rather than Old Norse originals, and his discussion on sagas rested almost entirely on the works of Mallet, Herbert and Scott (Mackenzie 1812, 15; 32). In situ, the pair spectacularly failed to discuss the *Íslendingasögur* relating to the areas through which they travelled, managing all of Snæfellsnes without a hint of its *Eyrbyggja saga* and the heart of Fljótshlíð without naming *Njáls saga* once (Mackenzie 1812, 185; 253).

They were not alone. George Clayton Atkinson, friend and biographer of Thomas Bewick, showed more interest in birds than books in his 1833 trip (Atkinson 1989, xi). For Atkinson it was the passing fulmars, puffins, guillemots, and auks which occupied pride of place in his illustrations (Atkinson 1989, 93; 96). The infamous gorges and crystal-clear waters of Þingvellir, backdrop to many a historic event, were chiefly of interest for the fact that some contained harlequin ducks (Atkinson 1989, 130). Similarly, John Barrow's 1834 tour was dotted with borrowed literary knowledge but contained little original material. His aims in

travelling to Iceland were twofold: he wished to compare the Icelanders' national composition of character with that of the Norwegians and to view first-hand the 'subterranean fire' for which the island was by then renowned (Barrow 1835, ix). As with Banks, Barrow's lack of Icelandic meant he overlooked the significance of several historical sites.

As late as 1860, tourists such as Charles S. Forbes managed to stare saga sites in the face and walk on unawares. His first sight of Iceland revealed a fog-shrouded land: 'this mysterious isle of sagas and sayings,' but soon it transpired that Forbes was more interested in the geology and geography of the country (Forbes 1860, 30). He was undoubtedly intrigued by the saga genre but as with his predecessors he relied heavily on the earlier accounts mentioned above. His brief discussion drew almost exclusively from Konrad Maurer's *Isländische Volkssagen der Gegenwart*. Forbes had more time for *Eyrbyggja saga*, telling with relish the tale of 'The Berserker-way' (taken directly from Scott's translation) and commenting that 'every peasant in the country narrates the story' (Forbes 1860, 217). Indeed, unlike those before, he is aware of the general areas occupied by the sagas. Looking southwards from the top of Hekla, he mentions that the general area is home to 'the famous *Njáls Saga*' (Forbes 1860, 278). But his authority on the matter is frequently undermined by his mentioning sites of saga narrative with no apparent realisation of their significance (Forbes 1860, 169-171).

Travellers from elsewhere in Europe demonstrated a similar focus. Neither the Swedish Uno von Troil's 1780 collection of letters, nor the Viennese Ida Pfeiffer's self-proclaimed all-encompassing 1845 account included much to whet the appetite of saga-readers (Von Troil 1780; Pfeiffer 1852). The subjects of Von Troil's letters provide an idea of foreign interests in Iceland: eight of the twenty-five concern the physical geography of the country, and the remaining letters deal largely with the constitution of Icelandic society, with only a passing reference to the sagas (Von Troil, 1880). In the first half of the nineteenth century, Anglo-Icelandic seafaring retained a scientific focus, with attractions such as the volcano Hekla and the hot springs of Geysir taking centre stage. Saga-tourism would have to wait.

### **The Rise of Saga Tourism: Travel Accounts 1861-1900**

A notable exception of the early 1800s, Ebenezer Henderson travelled to Iceland in 1814 and 1815 as part of a mission to hand out bibles to the inhabitants in the extremities of the country (Henderson 1818, vol. 1, 2). Henderson included a

map which clearly marked several important saga sites, and while he did not dwell on them for long, he receives credit for being one of the few (almost the only) in the first half of the century to acknowledge the important locations of *Njáls saga* such as ‘Hlydarenda’ – a good indicator of interest in Icelandic literature as they lie on the south coast, on the main sea line and easily visible from the water (Henderson 1818, vol. 1, 335; see Wawn 2000). Henderson offered his own emendations to Walter Scott’s *Eyrbyggja saga* extracts, and while he often strayed further from the Old Norse than Scott did, he clearly had the interest of his readers in mind (Henderson 1818, vol. 2, 59-63; Percy 1947, 525-527). Henderson’s literary engagement paraphrased Holland’s ‘Preliminary Dissertation’ and his history of Iceland skipped over the commonwealth period with alarming brevity, yet he saw importance in the early Scandinavian histories as an influential factor in the development of national character: Icelandic was the mother tongue of the northern peoples; its sagas displayed classic northern values such as political liberty and personal autonomy (Henderson 1818, vol. 1, xxxv-xxxvi).

In Henderson’s time the classic ground in Iceland for the ‘Sagaman’ was the Snæfellsnes peninsula, made famous through Walter Scott’s brief but measured *Eyrbyggja saga* extracts, first published in 1814 and republished in I. A. Blackwell’s 1847 edition of Bishop Thomas Percy’s *Northern Antiquities*. For travellers after 1860, inspiration more than likely came from George Webbe Dasent’s 1861 translation of *Njáls saga* – an *Íslendingasaga* of immense scope, detailing cross-generational blood-feud on Iceland’s south coast. Dasent’s translation was almost two decades in the making, and had an influence on writers even before its publication. Sabine Baring-Gould and Frederick Metcalfe both referred to it in their travel books of Iceland, despite it having yet to be published. *The Story of Burnt Njal* drew attention to Iceland as a location for high literature and enjoyed a long uncontested position of authority, being the only English translation of one of the most popular *Íslendingasögur* for over ninety years. Its influence is apparent. The focus of Anglo-Icelandic seafaring after Dasent is remarkably different, with saga sites replacing geological interests as the main reason to visit the country.

The reverend Frederick Metcalfe visited Iceland in the summer of 1860 and his book came out the same year as Dasent’s translation. While Dasent used Metcalfe’s descriptions in order to give a scenic grounding to his saga, clearly Metcalfe had had access to Dasent’s text too (Metcalfe 1861, 5). Metcalfe presents the British society of the mid-nineteenth century as deeply versed in the sagas; his friends recommend that he travels there, ‘to see with your own eyes the spots we

have been reading of in the Sagas' (Metcalf 1861, 3). Metcalf's reasons for his travel, as he explains to the Rector of the High School in Reykjavík, are those of the genuine literary tourist:

"I want to see with my own eyes some of the places where the scenes of your Sagas and legends are laid. I belong to a nation arrived at a very high state of civilisation, artificial in the extreme [...]. And somehow this very modernism begets a desire for reverting now and then to old things, old people, old ballads, old customs – something fresh, and rare, and vigorous. I want to look for a bit at the rock from whence we were digged."  
(Metcalf 1861, 56-57)

Metcalf's visits to these sites of northern antiquity displayed equal parts scientific intent and poetic scope, as he endeavoured to gauge the realities of the sagas for readers back home and to use his imagination to populate the landscape. Similarly, in Sabine Baring-Gould's 1863 travel account, in which he set the scene for the following years with his focus on the 'Scenes and Sagas' of Iceland, we find mentions of the excellence of Dasent's *Burnt Njal*, only recently in print. Baring-Gould quotes from Dasent ('our highest English authority on the subject') at great length and fully recommends his saga translation (Baring-Gould 2007, xli-xlii). For the like-minded among his readers Baring-Gould supplied in an appendix a list of existing published Icelandic sagas – although not, much to his displeasure, published in English (Baring-Gould 2007, 440-446). While in Iceland, Baring-Gould rarely stops thinking about sagas, noting sites from the sea and including pictures for his readers (Baring-Gould 2007, 5-7). His own life-long interaction with *Grettis saga* found public popularity in *Iceland: Its Scenes and Sagas*, wherein he provided episodic adventures adapted from his favourite of the *Íslendingasögur*.

For Dasent's own travels of Iceland one has to consult *Travels by 'Umbra'* of 1865. 'Umbra' (aka Charles Cavendish Clifford) toured the country in 1861, the same year *Burnt Njal* was published (Clifford 1865, 1). One of Clifford's travelling companions was a 'Mr. Darwin' (Dasent), and subsequently his translation features prominently. 'Umbra' is anything but a reliable narrator (see Clifford 1865, 156). One believable aspect of his narrative is the claim that Dasent's name 'was a passport' affording them the highest treatment, as all the clergymen whom they met knew his saga translation well (Clifford 1865, 53). In 1871 and 1873 the poet

and medievalist William Morris took ships to Iceland, and was treated with similar reverence. On the back of his first voyage he composed two poems on Iceland: 'Iceland First Seen' and 'Gunnar's Howe above the House at Lithend,' the latter drawing on first-hand experience of the *Njáls saga* location. He and his fellow translator Eiríkur Magnússon visited the site, and spent two nights there (Morris 1911, 47-49). Sampling the locations and lifestyle of the early settlers was a vital factor for Morris (Morris 1911, 51-6). Morris' second trip in 1873 produced more concise notes, and lacked the grandeur of the earlier writings, yet once again Morris sought out saga sites as key stops on his itinerary (Morris 1911, 198).

Richard Francis Burton travelled to Iceland in 1872. Burton is often portrayed as an anti-saga writer (see Wawn 2000), but while it is true that he accuses other travel writers of having 'Iceland on the brain' – allowing romantic notions of the perilous or heroic North to cloud their judgement – he nevertheless provides a comprehensive description of the land (Burton 1875, vol. 1, x). Burton claimed to have read forty-nine separate accounts of Iceland, which if nothing else demonstrates the level of attention Iceland had gained from the British since the start of the century. Among these accounts, he found Baring-Gould's book indispensable, largely for its ornithological data and notes on volcanism (Burton 1875, vol. 1, 44; 77; 172). Moreover Burton had read Dasent's translation and mentioned the saga sites as: 'classic ground' (Burton 1875, vol. 2, 155). Quite against his reputation, Burton found particular episodes of the sagas to be outstanding in depth and pathos.

Steamers to Iceland were not solely reserved for the adventurous. Robert Angus Smith, knew and respected Dasent's translation when he set out for Iceland, but finds exploration by land a daunting prospect; 'We are almost afraid to come near,' he remarks of the south coast (Smith 1873, 33;121). On the timid side, and overly wary of the perils of northern travel even for the time, Smith largely limited his expeditions to Reykjavík. He even opted out of the customary trip to Geysir, still very much a feature of Anglo-Icelandic tourism. Other converts to saga literature found themselves or the saga sites wanting. Under the chapter title 'EXPLANATION' Samuel Edward Waller explains that *Burnt Njal* was the main reason behind his painting holiday of 1872: 'I had gone through Dr. Dasent's admirable version of the book with the very deepest interest, and was wild to visit the scene of such a tremendous tragedy' he tells his readers (Waller 1874, 1). *Njáls saga*, Waller explains, is the greatest of all the sagas, and Njáll himself is clearly a personal hero of the painter's – 'a man of peace among a population of vikings'

(Waller 1874, 3). Waller provides a short summary of the saga, stressing the beauty of the landscape. This last point is constantly on his mind during the trip. 'The air was exquisite and our ride delicious' he tells readers, 'We passed through the sweetest scenery I had yet to come across in Iceland' (Waller 1874, 75). This devotion to the saga reached lofty heights, and it is not surprising that Waller's actual experience turned out to be underwhelming. On reaching Gunnarr Hámundarsson's farmstead, 'the most sacred spot in all the country,' he finds it to be 'very still, very quiet, and utterly desolate and forgotten' (Waller 1874, 112-113; see also 115). Waller's disappointment was consolidated when an effort to sketch the wonderful view seen by Gunnarr as he walked down to the seafront (a defining moment in the narrative of *Njáls saga*) turned to disaster. He was trapped in a sheep-pen by an angry bullock and unheroically escaped by striking it on the back with a piece of wood while it was not looking (Waller 1874, 116-119).

Drawing on her travels in 1875, 1878, and 1879, Elizabeth Jane Oswald placed the bar higher still for sagamen and sagawomen in her publication *By Fell & Fjord* of 1882. By this time, Oswald explained, British tourists were generally drawn to Iceland by, 'the fishing, the geology, or the old literature' (Oswald 1882, 1). Oswald was clearly in the latter camp, being the first to produce a saga map and stressing the unique nature of her book in that it looked at Iceland *through* the sagas (Oswald 1882, 40-41; preface). She frequently mentioned her debt to sagas in the original Old Norse as well as translations such as Dasent's (Oswald 1882, 34). By her second visit, only the original would do (Oswald 1882, 138). Oswald was not overly impressed by the sites themselves. Waller's pilgrimage site is merely a 'poor farm' from whence the view was obscured by 'driving vapours and rain' (Oswald 1882, 155). Oswald's account demonstrates an increase in literary awareness further exhibited in William Mitchell Banks' 1880 voyage. Banks pointed his readers in the direction of *Burnt Njal*; to get a true impression of the nation, one had to read its tales (Banks 1881, 34-35). For all his teasing (see in particular chapter 4: Banks 1881, 38-49), Banks proved throughout his book to be a genuine saga fan.

Towards the end of the century saga-tourism showed no signs of abating. Between 1894 and 1914 Mary Disney Leith visited Iceland several times (Gunnar Guðmundsson 1993, 27-40). She acknowledged saga sites and indeed planned her trips to take in important locations: in 1896 making a trip with the expressed purpose of visiting the *Njála* country (Disney Leith 1897, 16-17; 62; 143; 145). In the 1895 *Original Verses and Translations* she wrote several poems in response to

these travels, and seven in response to Dasent's *Burnt Njal*. Another northern scholar, W. G. Collingwood, toured Iceland in 1897, and was also among those inspired by Dasent's translation. Collingwood was enthusiastic in writing to his young daughter on the significance of the saga sites, something of which she was apparently well aware. He played out the actions of the characters and interacted with their landscape: 'the house and the howe I have painted,' he tells of a particular scene; 'I have crossed the river, and seen the view he saw and drawn it too' he remarks of another (Collingwood & Stefánsson 2013, 110). This idea of an interactive 'pilgrimage' was not new: Disney Leith used the term on her many trips to Iceland, particularly on trips to the churches and farmsteads of *Njáls saga* (Disney Leith 1897, 138).

### **To Iceland by Boat**

Poems on re-discovered sagas were not the only indication of a dramatic shift in Anglo-Icelandic tourism. Aside from the content of travel literature, one might also consider the frequency of scheduled ships from Britain to Iceland in the two halves of the nineteenth century. Whereas early travellers were forced by necessity to arrange expensive private transport or bargain with those in the fishing industry, in later decades trips to Iceland could be taken almost on an impulsive inclination. Joseph Banks' ship took forty-eight days to sail from Britain to Iceland, with extensive planning required, setting sail on the 12<sup>th</sup> July 1772 and arriving on the 28<sup>th</sup> August (Halldór Hermannsson 1966, 6). In 1809, by contrast, William Hooker managed the trip in under three weeks, departing from Graves End in the *Margaret and Anne* on Friday 2<sup>nd</sup> June with first sight of Iceland on the 14<sup>th</sup> and arrival in Reykjavík on the 21<sup>st</sup> (Hooker 1813, 1;5;9). Oswald, like many before her, took a steamer from Leith; by her 1879 trip the voyage from Britain to Iceland had been shortened to a mere five days (Oswald 1882, 4; Mackenzie and Forbes also employed steamers out of Leith). In the latter half of the nineteenth century last-minute trips were not uncommon (see for example Forbes 1860, 5).

Perusing the extant nineteenth-century travel accounts, one can slowly construct a picture of the sea lines between Britain and Iceland. Atkinson's 1833 trip employed the *Ardincaple* from Newhaven, via Edinburgh (Atkinson 1989, xxv). In 1834 Barrow used the yacht *Flower of the Yarrow* (Barrow 1835). In acquiring transport, nineteenth-century travellers often had to contend with political and military tensions between Britain and her neighbours. In the first decade of the century, hostility between Britain and Denmark made travel particularly difficult.



Two days into Hooker's return voyage, Danish prisoners of war set fire to their ship and the crew were phenomenally lucky to be rescued by the *Orion* (Hooker 1813, 360-364). The writer Anthony Trollope's 1878 voyage was similarly affected when their steamer – the *Mastiff* – was recalled due to the possibility of war with Russia, the ship being needed for transporting troops (Stone 1998, 147). Private vessels provided a way around this inconvenience, and in the latter half of the century most notions of Iceland as a distant, dangerous wasteland had been dispelled. Instead, trips north were treated more as relaxed vacations: as shown by Dufferin's travels in his schooner yacht *Foam* and William Mitchell Banks' 1880 party of fifteen aboard the *Argo*. Robert Angus Smith accepted an invitation of a 'holiday' to Iceland on a friend's yacht *Nyanza* and together they took their five children (Smith 1873, 1).

Richard Burton provides us with by far the most comprehensive list of available sea lines, with a chapter on 'Communication and Commerce' (Burton 1875, 219-224) describing the current state of contact between Britain and Iceland. November 29<sup>th</sup> to February 15<sup>th</sup>, Burton explains, was a dead period with little or no activity from even postal ships. During the summer however there were plenty of opportunities for the common traveller. The first regular transport was provided by the 'old *Arcturus*', built on the Clyde and carrying Scottish engineers and a Danish crew. According to Burton, the *Arcturus* weighed 280 tons, boasted eighty horse-power, and ran between four to six trips per year: '£2, 2s for 8 days' board, wine and whiskey' (Burton 1875, 223; see also Stone 2005, 224). Metcalfe took this ship from Grangemouth on the 16<sup>th</sup> July 1860, after reading an advert in *the Times* (Metcalfe 1861, 1). A little under a year later, on the 10<sup>th</sup> June, Joseph Shackleton (an older relative of Ernest) did the same (Stone 2005, 223). Business certainly seemed to be strong in Shackleton's time, with twenty-five passengers including many tourists, or as Shackleton puts it: 'pleasure seekers, or as it might please them better, we will say travellers for the promotion of science' (Stone 2005, 224). Yet pleasure seemed to be a good way off. The ship's heavy build did not lend itself to the northern seas, and clearly much of Shackleton's voyage was blighted by sea-sickness (Stone 2005, 226).

Following after the *Arcturus* came the *Diana* – a mail steamship converted from a man-of-war and run by the Danish government. *Diana* increased the number of trips to five to seven per year (Burton 1875, 223). The painter Samuel Edward Waller sampled its delights in 1872, and was violently seasick along with the rest of the passengers (Waller 1874, 30). Difficult weather was common and



the way was frequently perilous. On Mackenzie's voyage the sea was so rough that a member of the crew fell from the main-yard and died (Mackenzie 1812, 76). After narrowly escaping being burnt alive, Hooker's already unpleasant journey home was made worse when one of the accompanying boats was smashed in two during a violent storm (Hooker 1813, 368). Toward the end of the century, Oswald remarks that a proposed winter service was hastily cancelled when the *S. S. Phönix* was lost in abnormally foul weather (Oswald 1882, 135).

Aside from the storm-tossed *Diana*, by 1872 Burton had yet further choices. The *Jón Sigurðsson* was a 460 ton, iron-hulled Norwegian steamer operating out of the Shetlands, and was described as 'broad, tubby, and high out of the water' (Burton 1875, vol. 2, 90). Also available was the *Queen* of the Aberdeen, Leith, and Clyde Shipping Company, and the *Yarrow*, a Glaswegian vessel owned by a Mr. Slimon (Burton 1875, 268-269). Of Mr. Slimon's continuing business Oswald writes that 'communication with Iceland is now more frequent than in the year 1875' after Slimon established another steamer, the *Camoens*, from Granton to Iceland; Oswald mentions that a Danish mail steamer was also in operation 'from March to November about once a month between Copenhagen and Iceland, calling at Leith' (Oswald 1882, 135). At the close of the century such mail ships were still the most reliable method of transport for literary wanderers. On her first trip, Disney Leith took the Danish mail steamer *Laura* from Granton via the Faroes to Reykjavík. The steamer was lively, with other British passengers going to fish in Þingvellir (1897, 5). Many features of the modern tourist experience in Iceland were present, including the boost in the summer population; 'So many visitors of all sorts seem to come that it rather demoralises the Icelanders' comments Disney Leith (1897, 21).

Increasingly reliable schedules, a host of fresh saga translations, interest in the Romantic north, the decline of Danish naval power and subsequent rise of Icelandic nationalism – clearly there were many factors affecting the development of sea lines of communication between Britain and Iceland in the nineteenth century. What is clear from the above accounts is that British travel in the latter half of the nineteenth century was dictated by literary interaction with the north. The modern British traveller in Iceland is most likely to be geographically inclined – drawn by retreating glaciers and renowned geysers. It is intriguing to imagine a period in which the sagamen (and women) held sway.

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